Journal of African Earth Sciences 124 (2016) 383–408

Contents lists available at ScienceDirect

Journal of African Earth Sciences

journal homepage: www.elsevier.com/locate/jafrearsci

Meiofauna, microflora and geochemical properties of the late quaternary (Holocene) core sediments in the Gulf of Izmir (Eastern Aegean Sea, Turkey)

Zeki Ü. Yümün [a, *], Engin Meriç [b], Niyazi Avşar [c], Atike Nazik [c], İpek F. Barut [d], Baki Yokeş [e], Enis K. Sagular [f], Ayşegül Yildiz [g], Mustafa Eryilmaz [h], Erol Kam [i], Asiye Başsari [j], Bora Sonuvar [k], Feyza Dinçer [l], Kubilay Baykal [k], Seyhan Kaya [a]

[a] Namık Kemal University, Çorlu Engineering Faculty, Environmental Engineering Department, 59860, Çorlu, Tekirdağ, Turkey
[b] Moda Hüseyin Bey Sokak No: 15/4, 34710, Kadıköy, İstanbul, Turkey
[c] Çukurova University, Faculty of Engineering-Architecture, Geological Engineering Department, 01330, Balcalı, Adana, Turkey
[d] İstanbul University, Institute of Marine Sciences and Management, 34134, Vefa, Fatih, İstanbul, Turkey
[e] Haliç University, Faculty of Science, Department of Molecular Biology, 34406. Kağıthane, İstanbul, Turkey
[f] Süleyman Demirel University, Faculty of Engineering-Architecture, Department of Geological Engineering, 32260, Çünür, Isparta, Turkey
[g] Aksaray University, Faculty of Engineering, Geological Engineering Department, 68100, Aksaray, Turkey
[h] Mersin University, Faculty of Engineering, Geological Engineering Department, 33343, Çiftlikköy, Mersin, Turkey
[i] Yildiz Technical University, Faculty of Arts and Sciences, Physics Department, Davutpaşa Campus, 34220, Esenler, İstanbul, Turkey
[j] Çekmece Nuclear Research and Training Center (ÇNAEM), P. K. 1, Atatürk Airport, 34149, İstanbul, Turkey
[k] Tramola International Naval Research Services Const. Eng. ve Tic. Ltd. Ltd. Sti., 856 Road No: 7/404 Asil Han, 35250 İzmir, Turkey
[l] Nevşehir University, Faculty of Engineering-Architecture, Geological Engineering Department, 50300, Nevşehir, Turkey

ARTICLE INFO

Article history:
Received 3 April 2016
Received in revised form
12 August 2016
Accepted 15 September 2016
Available online 28 September 2016

Keywords:
Meiofauna
Microflora
Geochemical analysis
Quaternary sediments
Gulf of Izmir
Turkey

ABSTRACT

The Gulf of Izmir has seen the construction of marinas at four locations; Karşıyaka, Bayraklı, İnciraltı and Urla (Çeşmealtı). Six drilling holes have been structured for each location. Morphological abnormities observed in foraminifer tests, obtained from these core drillings, and coloring encountered in both foraminifer tests and ostracod carapeces, provide evidence of natural and unnatural environmental pollution. The objectives of this study are to identify micro and macro fauna, foraminifers in particular, contained within sediments in the above-mentioned locations; to investigate the background of pollution in the Gulf Region; and to determine pollution's impact upon benthic foraminifer and ostracods.

Çeşmealtı foraminifera tests did not lead to color and morphological changes. But foraminifera tests samples collected from Karşıyaka, Bayraklı and İnciraltı led them to turn black (Plate 4–6). However, concentrations of heavy metals (Ni, Cr and Mn) obtained from the sediments of Karşıyaka, Bayraklı and İnciraltı locations are higher than those obtained from the Çeşmealtı samples and high concentrations of these elements may be the cause of the color change in the samples during the foraminifera tests. In Karşıyaka and Bayraklı ostracod samples, *Bosquetina carinella*, *Pterygocythereis jonesi*, *Semicytherura* species; in the Çeşmealtı/Urla zone, *Cyprideis torosa*; in İnciraltı, *Pseudopsammocythere reniformis;* and in four zones, *Loxoconcha* and *Xestoleberis* species were observed in the range of relative frequency. The same analyses were done on nannoplankton but they did not lead to color and morphological changes.

1. Introduction

Turkey's Gulf of Izmir similar to the shape of a boot facing towards the east is on the northern end of the Karaburun Peninsula and south of the Aslan Cape line. In the center of the gulf are Uzun and Hekim Isles and in the north, from Urla Harbor, one can view the Çiçek Island groups. The Uzun Isle gulf, extending from the north to the south, is divided into two parts. To the east it connects to part of Izmir Harbor via the Gülbahçe Bay, Menteş Gate (Fig. 1).

There have been many studies examining the relationship between the fauna of the current sediments of Izmir Bay and its heavy

* Corresponding author.
E-mail address: zyumun@nku.edu.tr (Z.Ü. Yümün).

http://dx.doi.org/10.1016/j.jafrearsci.2016.09.015

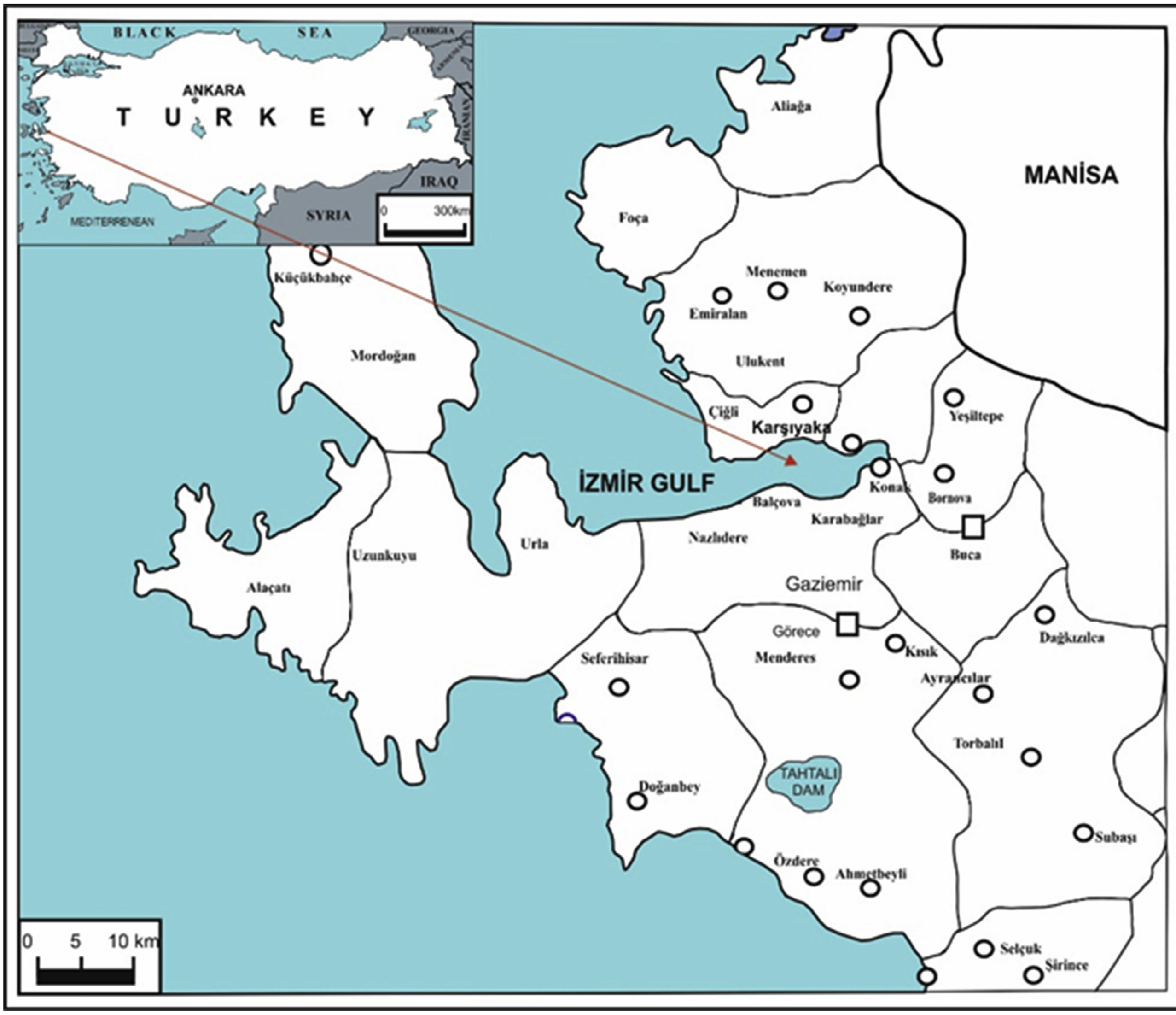


Fig. 1. Location map of investigation area (İzmir Gulf).

metal contents (Akgün, 1995; Bergin et al., 2006; Erdoğan, 2009; Meriç et al., 2009). Akgün (1995) identified palynoflora insamples collected from the bottom sediments of Izmit Bay during drilling. Depending on palynological data, he stressed that palaeovegetation in and around Izmit Bay did not change between 1.000.000 years and 6.000 years and that conifer and oak forests (*Pinus, Quercus* and *Abies*) spread throughout the region. Akgün (1995) further pointed out that the young sediments of Izmit Bay developed under the damp-cool climatic conditions of the pluvial period and that the effect of these climatic conditions remained unchanged for a long time as a result of marine influence. Erdoğan (2009) conducted a study on heavy metal pollution in sediments along Izmir Bay. The study investigated the sediments in areas of Izmir Bay where marine pollution is observed, and statistically evaluated (the detected) concentrations of heavy metals. The analyses of heavy metals (Cr, Cd, Co, Ni, Pb, Mn, Zn, and Cu) in the sediments were performed using an ICP-MS device. However, the study did not investigate the relationship between the concentrations of heavy metals and flora or fauna. Meriç et al. (2009) carried out a study on the effect of thermal mineral water sources in the Eastern Aegean Sea Coastal regions on benthic foraminifera communities. They investigated reasons for the differences in benthic foraminifera shells detected in different locations of the Aegean Sea between 1986 and 2009. In addition, they investigated the causes of benthic foraminifera shell forms they observed in the Aegean Sea that are normally found in the Red Sea and the Indian and Pacific Oceans. The authors demonstrated that variations in shell structure are associated with hydrothermal sources of Bergin et al. (2006) investigated the effect of heavy metal pollution on 16 spot (instantaneous) samples of ostracod and foraminifera communities. The study noted that the numerical abundance of foraminifera is not directly associated with heavy metal contents in the sediments. In addition, the study points out that the number of foraminifera is at its maximum in areas where mostly treated waters are discharged into the sea. The current study, on the other hand, investigated drillhole samples for variations in heavy metal concentrations over time and their effects on ostracods, nannoplanktons, foraminifera and mollusks.

In the Gulf of Izmir, due to the construction of marinas in four separate locations; Karşıyaka, Bayraklı, İnciraltı and Urla (Çeşmealtı), six core drillings have been done for each location (Fig. 2, Table 1). In these locations sea water depths ranged from 1.00 to 13.00 m. The drilling intersected young sediments at depths between 1.00 and 22.00 m. This paper used core specimens from one single drilling in these zones with the objectives of

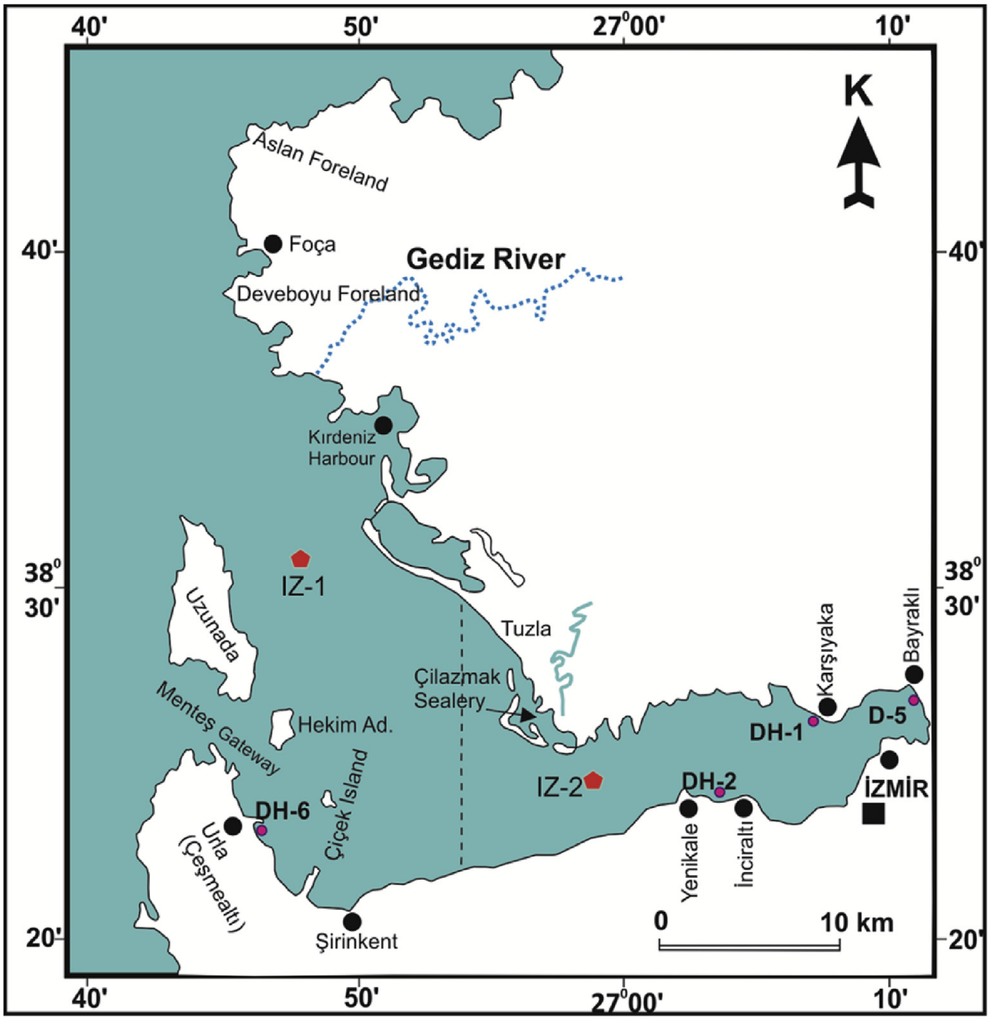


Fig. 2. Location map of Drillhole (DH) sites at İzmir Gulf.

Table 1
The coordinates of the drill sites in the studied area, the sea and the total drilling depths.

Locations	Drill hole no	Latitude	Longitude	Seawater depth (m)	Depth of drill (m)
Karşıyaka	DH-5 (DH-5)	4256077	510436	9	21
Bayraklı	DH-4 (DH-4)	4256697	514184	3	21
İnciraltı	DH-1 (DH-1)	4253810	502830	10	16
Urla	DH-2 (DH-2)	4249980	478300	3	4

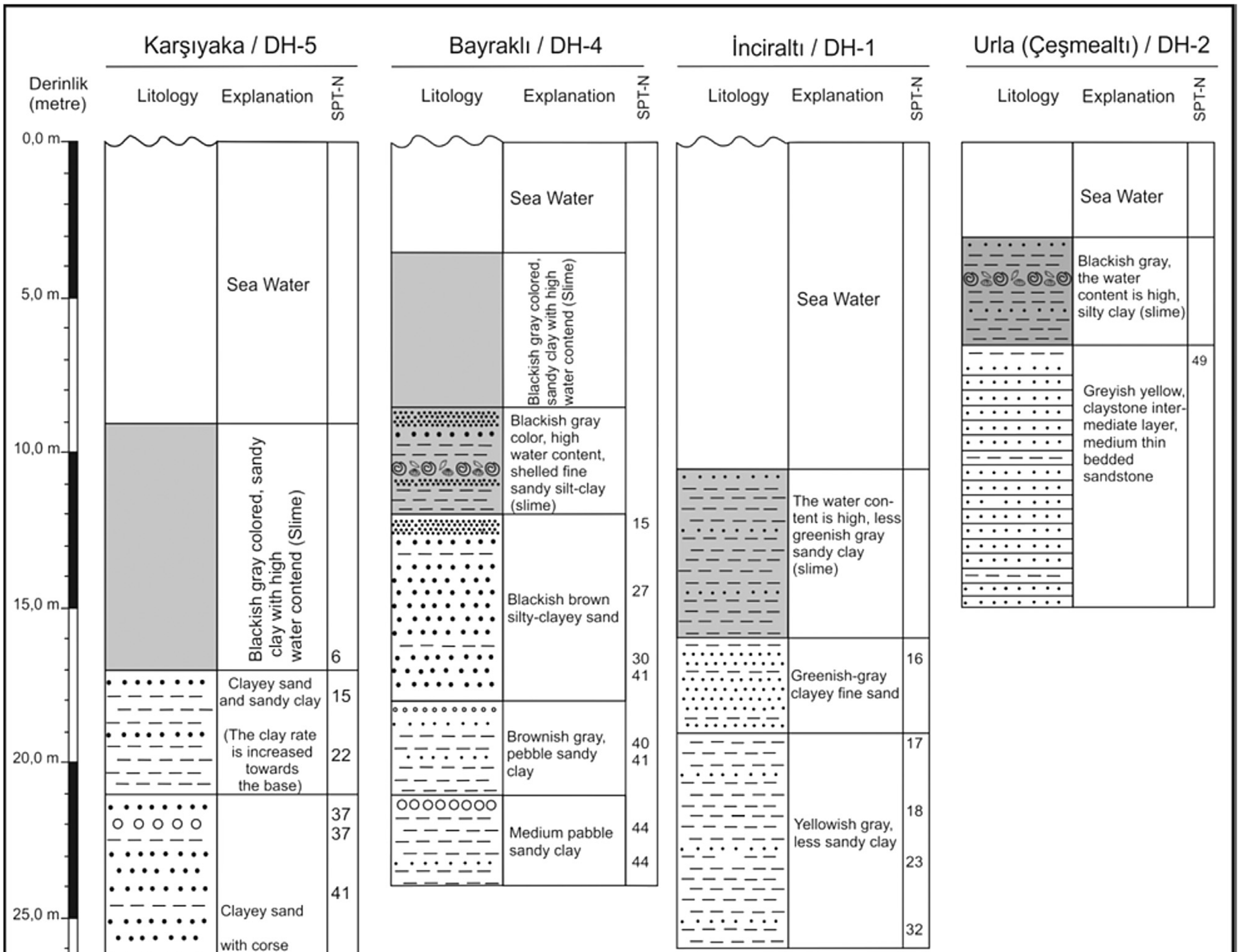
determining the micro fauna contained therein it explores the effects of environmental pollution on the specimens and identifiesheavy metals and trace elements within the young sediments.

1.1. Current sedimentation

The deep sediments of the Gulf of Izmir are affected by the topographic properties of the land, meteorological activities, waves, currents, undersea morphological composite and the shape of the coasts. The Gulf is affected by the materials transferred via the streams running from nearby basins. The transferred materials which originate on the land were deposited in the sea according to their grain sizes. On the coast line materials subject to the action of waves encounter a second abrasion and grain size gradually shrinks until grains are eventually deposited on the bottom of the Gulf. Accordingly, Gulf of Izmir sediment grain sizes become smaller as one goes from the coast to deeper sea levels (Eryılmaz and Aydın, 1998, 2001; Yücesoy-Eryılmaz and Eryılmaz, 2000; Eryılmaz et al., 2002).

1.2. Methods and materialsMaterials and methods

In this paper 326 units of sediment specimens extracted from the seabed since July 2000 employing orange-peel and snapper type grape tools, have been analyzed. In order to determine soil type and grain sizes, extracted surface specimens were sieved and wet analyzed (Folk, 1974). Pebble, silt and clay percentages of each specimen were computed and classified as in Folk's triangle diagram. The data obtained were used to construct percentage pebble-plus-sand, percentage silt and percentage clay maps. These maps



Soil Evaluation - SPT			
Fine Grain (Cohesive)		Coarse Grained (Cohesionless)	
N	Definition	N	Definition
0-2	Very Soft	0-4	Very Loose
3-4	Soft	5-10	Loose
5-8	Very Solid	11-30	Medium
9-13	Solid	31-50	Tight
14-30	Very Solid	>50	Very Tight
>30			

Fig. 3. Comparison of soils taken from marine drilling.

were analyzed alongside a bathymetry map of the worksite and a sediment distribution map (with respect to grain sizes) was produced for the region (Fig. 3).

The young sediment drillhole specimens gathered for this study were taken from four drill sites Karşıyaka (DH-5), Bayraklı (DH-4), İnciraltı (DH-1) and Çeşmealtı (Urla) (DH-2) (Fig. 2). The quantity of specimens analyzed with respect to pile thickness varied at different drill sites. A total of 278 specimens were analyzed: 88 samples from DH-5, 90 from DH-4, 60 from DH-1 and 40 from DH-2. Due to the presence of different units intersected in the different drill sites, a total of 17 novel specimens were included: 4 from DH-4, 7 from DH-4 and 6 from DH-2. Thus the total number of samples analyzed was 295.

To prepare the samples for analysis 10% H_2O_2 was added to wet sediment specimens weighed at 10 g each and these were allowed to stand for 24 h. Next they were washed in 0.063 mm sieve using pressured water. They were then dried inside a 50 °C oven and sifted through 2.00, 1.00, 0.500, 0.250, 0.125 mm sized sieves. These specimens were studied under a binocular microscope. Foraminifer, ostracod and miscellaneous organisms were found in the studied samples. Slides were prepared for nannoplankton, diatom and palynology analysis according to the methods outlined below.

Slides to be analyzed for nannofossils were prepared by the traditional method outlined by Perch-Nielsen (1985a, b). First some extremely thin rock dust (extracted by graving onto a lamina using a sterile needle point injected to the fresh-fractured surface of a fine-grained rock) was distilled in pure water and stirred using a stick until it become mud. It was then spread in the thinnest layer possible onto lamina. Next it was left to dry on a hot-plate heater. Then it was placed onto a lamella heater that deposited distilled

Table 2
Foraminiferal assemblages of Karşıyaka (DH- 5), Bayraklı (DH- 4), İnciraltı (DH-1) and Urla/Çeşmealtı (DH-2).

Foraminifera	Karşiyaka	Bayrakli	Inciralti	Urla	Foraminifera	Karşiyaka	Bayrakli	Inciralti	Urla
Ammodiscus planorbis Höglund	*		*		*Sigmoilinita tenuis* (Czjcek)			*	
Eggerelloides scabrus (Williamson)			*		*Sigmoilopsis schlumbergeri* (Silvestri)			*	
Textularia bocki Höglund	*	*	*		*Parrina bradyi* (Millett)			*	*
Spirillina vivipara Ehrenberg	*				*Coscinospira hemprichii* Ehrenberg				*
Vertebralina striata d'Orbigny	*			*	*Peneroplis pertusus* (Forskal)	*		*	*
Nubecularia lucifuga Defrance	*		*	*	*Peneroplis planatus* (Fichtel ve Moll)	*			*
Adelosina carinata-striata Wiesner	*	*	*	*	*Sorites orbiculus* Ehrenberg				*
Adelosina cliarensis (Heron-Allen ve Earland)	*	*	*	*	*Lagena doveyensis* Haynes	*	*		
Adelosina duthiersi Schlumberger	*		*		*Lagena striata* d'Orbigny			*	
Adelosina intricata (Terquem)	*		*		*Polymorphina* sp.	*		*	
Adelosina mediterranensis (le Calvez J. ve Y.)	*	*	*	*	*Brizalina spathulata* (Williamson)	*		*	
Spiroloculina angulosa Terquem			*		*Rectuvigerina phlegeri* le Calvez	*		*	
Spiroloculina antillarum d'Orbigny	*	*		*	*Bulimina elongata* d'Orbigny	*	*	*	
Spiroloculina dilatata d'Orbigny			*	*	*Bulimina marginata* d'Orbigny	*	*	*	
Spiroloculina excavata d'Orbigny	*	*	*		*Bulimina marginata* d'Orbigny *biserialis* Millet			*	
Spiroloculina ornata d'Orbigny	*	*	*	*	*Reussella spinulosa* (Reuss)	*		*	
Spiroloculina tenuiseptata Brady			*		*Fursenkoina acuta* (d'Orbigny)	*		*	
Siphonaperta agglutinans (d'Orbigny)				*	*Neoeponides bradyi* le Calvez	*	*	*	*
Siphonaperta aspera (d'Orbigny)	*	*	*	*	*Neoconorbina terquemi* (Rzehak)		*		*
Siphonaperta dilatata (le Calvez J. ve Y.)				*	*Rosalina bradyi* Cushman	*	*	*	*
Cycloforina contorta (d'Orbigny)	*	*	*	*	*Rosalina globularis* d'Orbigny			*	
Cycloforina tenuicollis (Wiesner)				*	*Trethomphalus bulloides* (d'Orbigny)	*		*	
Cycloforina villafranca (le Calvez, J. ve Y.)	*	*	*		*Planoglabratella opercularis* (d'Orbigny)				*
Lachlanella bicornis (Walker ve Jacob)	*		*		*Cibicides advenum* (d'Orbigny)	*		*	*
Lachlanella undulata (d'Orbigny)			*		*Lobatula lobatula* (Walker ve Jacob)	*	*	*	*
Lachlanella variolata (d'Orbigny)	*		*	*	*Planorbulina mediterranensis* d'Orbigny	*		*	
Massilina gualtieriana (d'Orbigny)	*		*	*	*Cibicidella variabilis* (d'Orbigny)			*	
Massilina secans (d'Orbigny)	*			*	*Sphaerogypsina globula* (Reuss)			*	
Quinqueloculina berthelotiana d'Orbigny	*	*	*	*	*Asterigerinata mamilla* (Williamson)	*		*	*
Quinqueloculina bidentata d'Orbigny	*	*	*	*	*Nonion depressulum* (Walker ve Jacob)				*
Quinqueloculina disparilis d'Orbigny	*		*	*	*Nonionella turgida* (Williamson)	*	*	*	
Quinqueloculina jugosa Cushman	*	*	*		*Aubignyna perlucida* (Heron-Allen ve Earland)	*	*	*	*
Quinqueloculina laevigata d'Orbigny	*		*	*	*Ammonia compacta* Hofker	*	*	*	*
Quinqueloculina lamarckiana d'Orbigny	*	*	*	*	*Ammonia parkinsoniana* (d'Orbigny)	*		*	*
Quinqueloculina limbata d'Orbigny	*	*			*Ammonia tepida* Cushman	*	*	*	*
Quinqueloculina seminula (Linné)	*	*	*	*	*Challengerella bradyi* Billman, Hottinger ve Oesterle		*		
Miliolinella subrotunda (Montagu)	*	*	*	*	*Cribroelphidium poeyanum* (d'Orbigny)	*	*	*	*
Miliolinella webbiana (d'Orbigny)	*		*	*	*Porosononion subgranosum* (Egger)	*	*	*	
Pseudotriloculina laevigata (d'Orbigny)	*		*	*	*Elphidium aculeatum* (d'Orbigny)	*		*	*
Pseudotriloculina oblonga (Montagu)	*	*	*	*	*Elphidium advenum* (Cushman)	*	*	*	*
Pseudotriloculina rotunda (d'Orbigny)			*	*	*Elphidium complanatum* (d'Orbigny)	*	*	*	*
Triloculina marioni Schlumberger	*	*	*	*	*Elphidium crispum* (Linné)	*	*	*	*
Triloculina plicata Terquem	*	*	*		*Elphidium depressulum* Cushman			*	*
Triloculina tricarinata d'Orbigny	*		*	*	*Elphidium macellum* (Fichtel v e Moll)	*	*	*	
Sigmoilinita costata (Schlumberger)	*	*	*	*	*Elphidium maioricense* Colom				*
Sigmoilinita edwardsi (Schlumberger)	*								

Canada balsam onto the surface and was allowed to stand until the non-persistent gases of the balsam dispersed. The lamella carrying Canada balsam on its top surface in the form of a hot liquid then had to be turned upside down and placed on the lamina coated with dried rock dust. After the dispersion of Canada balsam between the lamina and lamella the slide was taken from the top of the heater and placed onto the table using tweezers. The final stage involved minimizing the air bubbles between lamina and lamella and leaving the result to cool. In order to minimize air bubbles the lamella covering the layer of Canada balsam, which was still in liquid form, was gently pressed and circular movements made. This caused the air bubbles to migrate to the edges and escape from the slide. The preparation process having been concluded anidentification of the rock was made from studying the slides.

The preparations were examined under a polarizing microscope using traditional methods (×20 magnification digital camera with ×40, ×100 magnification lens and ×1, ×5, ×10 magnification ocular).

Perch-Nielsen (1985a ve b), Reinhardt (1972), Romein (1979) ve Sagular (2009) methods were used in microscopy.

Another method was also utilized in the analysis. In this method, using a polarizing microscope, petrographic sections of approximately 20–25 μm thickness were prepared from medium to coarse grained laminated rocks and analyzed. Thair fossil contents were correlated with fossils, collected from accompanying fine-grained rocks (Sagular, 2003).

Samples used for diatom analyses were initially cleaned with 10% HCI then cleaned by applying Entellan and lamella and stuck on to lamina suitable for paleontological analysis. The prepared slides were analyzed using a Leica DM 2500 P brand polarizing microscope and oil-immersion objective with 1600× magnification. The fossil diatom genera and species were identified and photographed.

Paleo-geographical distributions and ecological properties of the diagnosed diatom genera and species were marked with reference to Martini (1971); Krammer-Lange Bertalot (1986, 1988, 1991); van Dam et al. (1994); Tase (2004); Gürel and Yıldız (2006); Round et al. (2007); Taş and Gönülol (2007); Atıcı et al. (2008); Carter (2008); Fluin et al. (2009); Barinova et al. (2011); Koçer and Şen (2012); and are displayed in Tables 6–9 and Figs. 4 and 5).

In all samples, grain size analysis, total organic carbon, total carbonate and heavy metal (11 samples analyzed for Cu, Co, Ni, Zn, Mn, Fe, and 8 samples for Cr, Pb, Al) analyzed were performed.

Table 3
Ostracodal assemblages of Karşıyaka, Bayraklı, İnciraltı and Urla/Çeşmealtı.

Ostrakodlar	Karşiyaka	Bayrakli	Inciralti	Urla
Tribelina raripila (G.W. Mueller)				*
Cytherelloidea sordida (G.W. Mueller)	*	*	*	*
Cytherella alvearium Bonaduce, Ciampo & Masoli	*	*		
C. vulgata Ruggieri	*	*	*	*
Aurila arborescens (Brady)	*		*	*
Aurila convexa (Baird)			*	*
Jugosocythereis prava (Baird)				*
Caudites calceolatus (Costa)				*
Pseudopsammocythere reniformis (Brady)	*	*	*	
Carinocythereis carinata (Roemer)	*	*	*	*
C. rhombica Stambolidis	*	*	*	*
Hiltermannicythere rubra (G.W. Mueller)	*	*	*	*
H. turbida (G.W. Mueller)	*	*	*	*
Pterygocythereis jonesi (Baird)	*	*	*	
Cytheretta adriatica Ruggieri				*
Cytheretta judaea (Brady)	*			
Costa (Cuneocosta) tricostata (Reuss, 1850) Ruggieri, 1992	*			
Bosquetina carinella (Reuss)	*	*	*	
Basslerites berchoni (Brady)	*	*		*
Callistocythere intricatoides (Ruggieri)	*	*	*	*
C. pallida (G.W. Mueller)	*	*		
Leptocythere sps	*	*	*	*
Leptocythere lagunae Hartmann				*
Tyrrhenocythere sp	*			
Urocythereis crenulosa (Terquem)	*		*	*
Pseudocytherura sp.	*			
Semicytherura acuminata (G.W. Mueller)	*			*
S. acuticostata (G.W. Mueller)	*		*	
S. incongruens (G.W. Mueller)	*	*	*	*
S. inversa (Seguenza)	*	*	*	*
S. sulcata (G.W. Mueller),	*			
Paracytheridea depressa G.W. Mueller	*		*	
Bythocythere minima Bonaduce, Ciampo & Masoli	*	*	*	
Palmoconcha agilis (Ruggieri)	*	*	*	
Loxoconcha bairdi (G.W. Mueller)	*	*	*	*
L. elliptica Brady				*
L. gibberosa Terquem	*			
L. tumida Brady	*	*	*	
Hirschmania sp.	*			*
Cushmanidea turbida G.W. Mueller	*			*
Xestoleberis communis (G.W. Mueller)	*	*	*	*
X. depressa Sars	*	*	*	*
Xestoleberis dispar G.W. Mueller	*	*	*	*
Propontocypris sp.	*	*	*	
Paradoxostoma sp.			*	
Paradoxostoma triste G.W. Mueller	*		*	
Cyprideis torosa (Jones)	*	*	*	*
Cytherois sp.	*	*		
Cytheridea acuminata Bosquet	*	*	*	
Cytheridea neapolitana Kollman	*	*	*	
Heterocypris salina (Brady)		*		*
Ilyocypris bradyi (Sars)				*

Organic carbon analysis was conducted using the Walkley-Black titration method frequently employed for sea sediments analysis. This method relies on the oxidation of organic material by potassium dichromate and sulphuric acid (Gaudette et al., 1974). Carbonate detection in total sediments was conducted using the gasometric method. A "Scheibler" gasometric system was remodeled and used (Müller, 1967; Martin, 1972).

In order to ensure control in the total carbonate and organic carbon analysis, the entire range of specimens were analyzed in pairs. Pair samples for each specimen were measured and the average value of the two results were used.

To conduct heavy metal analysis, specimens were dissolved in a mixture of nitric, hydrofluoric and perchloric acid (Agemian and Chau, 1976; UNEP/IAEA, 1986; Loring, 1987; Loring and Rantala, 1988). In these specimens Fe, Cu, Co, Zn, Mn, Ni tests were performed in an air-acetylene flame under an Atomic Absorption Spectrophotometer whereas Cr, Pb and Al were analyzed using an ICP-OES.

Dating of the samples was carried out by the ^{14}C in Beta Analytic Radiocarbon Dating Laboratory (Miami, Florida, USA 33155). To carry out quantitative age detection, young sediment specimens extracted from the deepest levels in drill sites DH-5 (29.00–30.00 m), DH-4 (23.00–24.00 m), DH-1 (26.00–27.00 m), DH-2 (6.00–7.00 m) were utilized.

2. Results: sedimentologic properties of drilling zones

The distribution and thickness of sediments and depth of seawater can be seen in Fig. 8. In the Karşıyaka research zone, starting from the seabed, downwards in varying layers of 2.00–9.00 m thickness, there are darkish grey, high – water content loam layers formed by silt and clay-size sediments.

Table 4
Gastropoda assemblages of Karşıyaka, Bayraklı, İnciraltı and Urla/Çeşmealtı.

Gastropoda	Karşiyaka	Bayrakli	Inciralti	Urla	Gastropoda	Karşiyaka	Bayrakli	Inciralti	Urla
Gibbula adansoni (Payraudeau)		*		*	*Hyala vitrea* (Montagu)	*	*	*	
Gibbula albida (Gmelin)				*	*Truncatella subcylindrica* (Linnaeus)				*
Gibbula turbinoides (Deshayes)			*		*Aporrhais pespelecani* (Linnaeus)	*	*	*	
Clanculus cruciatus (Linnaeus)			*		*Natica hebraea* (Martyn)	*	*	*	*
Tricolia pullus pullus (Linnaeus)	*	*	*	*	*Euspira intricata* (Donovan)			*	
Tricolia tenuis (Michaud)				*	*Bolinus brandaris* (Linnaeus)	*	*		
Cerithium vulgatum Bruguière	*		*	*	*Hexaplex trunculus* (Linnaeus)	*			*
Bittim latreillii (Payraudeau)			*		*Granulina marginata* (Bivona, Ant.)				*
Bittium reticulatum (da Costa)	*	*	*	*	*Pollia scabra* Locard			*	
Bittium submamillatum (de Rayneval ve Ponzi)	*	*	*	*	*Nassarius incrassatus* (Stroem)	*	*		
Potamides conicus (de Blainville)				*	*Nassarius mutabilis* (Linnaeus)				*
Turritella communis Risso	*	*	*	*	*Nassarius pygmaeus* (Lamarck)	*	*	*	
Turritella turbona Monterosato		*			*Nassarius reticulatus* (Linnaeus)	*			
Marshallora adversa (Montagu)			*	*	*Cyclope neritea* (Linnaeus)				*
Monophorus perversus (Linnaeus)	*			*	*Cyclope pellucida* Risso				*
Cerithiopsis tubercularis (Montagu)	*				*Columbella rustica* (Linnaeus)			*	
Epitonium clathrus (Linnaeus)	*				*Conus ventricosus* Gmelin				*
Rissoa auriscalpium (Linnaeus)			*		*Mangelia scabrida* Monterosato	*	*	*	*
Rissoa splendida Eichwald				*	*Mangelia unifasciata* (Deshayes)			*	
Rissoa ventricosa Desmarest	*			*	*Bela brachystoma* (Philippi)	*		*	
Pusillina inconspicua (Adler)	*		*		*Raphitoma mirabilis* (Pallary)			*	*
Pusillina lineolata (Michaud)	*	*	*	*	*Chrysallida ghisottii* (van Aartsen)			*	*
Pusillina marginata (Michaud)			*	*	*Chrysallida* sp.	*	*	*	*
Pusillina radiata (Philippi)		*	*		*Eulimella* sp.		*	*	*
Alvania aspera (Philippi)				*	*Odostomia* sp.	*	*	*	*
Alvania bozcaadaensis Tiselli ve Guinchi				*	*Turbonilla jeffreysii* (Jeffreys)			*	
Alvania cancellata (da Costa)			*		*Turbonilla* sp.	*	*	*	*
Alvania cimex (Linnaeus)			*	*	*Ebala pointeli* (de Folin)		*		
Alvania discors (Allan)				*	*Acteon tornatilis* (Linnaeus)	*			
Alvania geryonia (Nardo)			*	*	*Cylichna cylindracea* (Pennant)			*	
Alvania lanciae (Calcara)				*	*Retusa leptoneilema* (Brusina)	*			
Alvania mamillata Risso			*		*Retusa minutissima* (Monterosato)	*	*	*	
Manzonia crassa (Kanmacher)			*		*Retusa* sp.	*	*	*	*
Obtusella intersecta (Wood S.)				*	*Cylichnina laevisculpta* (Granata-Grillo)	*	*	*	
Obtusella macilenta (Monterosato)				*	*Cylichnina umbilicata* (Montagu)	*			
Rissoina bruguierei (Payraudeau)			*		*Volvulella acuminata* (Brugière)	*			
Caecum trachea (Montagu)		*		*					
Helobia stagnorum (Gmelin)				*					

Table 5
Bivalvia assemblages of Karşıyaka, Bayraklı, İnciraltı and Urla/Çeşmealtı.

Bivalvia	Karşiyaka	Bayrakli	Inciralti	Urla	Bivalvia	Karşiyaka	Bayrakli	Inciralti	Urla
Nucula decipiens Philippi	*	*			*Papilliocardium papillosum* (Poli)		*	*	*
Nucula hanleyi Winckworth	*	*	*	*	*Cerastoderma glaucum* (Bruguière)	*			*
Nucula nitidosa Winckworth		*	*		*Mactra glauca* Born	*			
Nucula nucleus (Linnaeus)	*				*Spisula subtruncata* (da Costa)	*	*		
Nuculana pella (Linnaeus)	*	*	*		*Donacilla cornea* (Poli)	*			
Arca noae Linnaeus			*		*Tellina donacina* Linnaeus	*	*		
Anadara transversa (Say)			*		*Tellina pulchella* Lamarck	*	*	*	
Striarca lactea (Linnaeus)			*		*Macoma cumana* (Costa O.G.	*	*	*	*
Flexopecten glaber (Linnaeus)	*		*		*Gastrana fragilis* (Linnaeus)				*
Talochlamys multistriatus (Poli)	*				*Donax trunculus* Linnaeus	*			
Mimachlamys varia (Linnaeus)		*	*		*Donax variegatus* (Gmelin)		*		
Anomia ephippium Linnaeus		*	*		*Gari fervensis* (Gmelin)		*		
Ostrea edulis Linnaeus		*			*Abra alba* (Wood W.)	*			
Glans trapezia (Linnaeus)			*	*	*Abra longicallus* (Scacchi)	*			
Ctena decussata (Costa O.G.)			*		*Abra prismatica* (Montagu)	*	*		
Lucinella divaricata (Linnaeus)	*	*		*	*Solecurtus strigilatus* (Linnaeus)				*
Lucinoma borealis (Linnaeus)	*		*	*	*Chamelea gallina* (Linnaeus)	*	*		
Diplodonta rotundata (Montagu)	*				*Gouldia minima* (Montagu)	*	*	*	
Chama gryphoides Linnaeus			*		*Dosinia lupinus* (Linnaeus)	*	*	*	
Bornia sebetia (Costa O.G.)	*			*	*Pitar rudis* (Poli)	*			
Hemilepton nitidum (Turton)	*				*Ruditapes decussatus* (Linnaeus)	*			
Kurtiella bidentata (Montagu)			*		*Mysia undata* (Pennant)	*			
Acanthocardia paucicostata (Sowerby G. B.II)	*	*			*Corbula gibba* (Olivi)	*	*	*	
Parvicardium exiguum (Gmelin)	*	*	*	*	*Lentidium mediterraneum* (Costa O.G.)	*			
Parvicardium scabrum (Philippi)	*			*	*Hiatella arctica* (Linnaeus)			*	
Parvicardium scriptum (Bucquoy, Dautzenberg ve Dollfus)	*			*					

Table 6
Nannofossils, Diatoma content and their species distribution at Karsiyaka (İzmir Gulf) BH-5 drilling. (R: Rare, F: Few, C: Many, A: Abundant of fossil form).

Chrono-stratigraphy Graphic	Nannofosil species	Rock sample no	BH-5 12.00–12.05	BH-5 12.10–12.15	BH-5 14.00–14.05	BH-5 16.20–16.25	BH-5 20.50–20.55	BH-5 20.70–20.75
Late Pleistocene Holocen	Ceratolithus cristatus Kamptner		Nannofosilce steril			R		
	Emiliania huxleyi (Lohmann)				C	A		
	Gepgyrocapsa ericsonii McIntyre & Be					R		
	Helicosphaera carteri (Wallich)				R	R		
	Helicosphaera hyalina Gaarder			R	R	F		
	Helicosphaera inversa Gartner					F		
	Syracosphaera pulchra Lohmann					F		
	Thoracosphaera granifera Fütterer				R	F		R
	Thoracosphaera heimii (Lohmann)					R		
	Thoracosphaera tuberosa Kamptner				R	R		
	Umbilicosphaera sibogae (Weber-van Bosse)						R	R
Reworked	*Ericsonia ovalis* Black				R			
	Prinsius martinii Perch-Nielsen				R			
	Pseudoemiliania ovata (Bukry)				R			
Biozones				NN21 ACME				
NN21 ACME: *Emiliania huxleyi* Bolluk Zonu				NN21?				
NN21: *Emiliania huxleyi* Zonu								
Other fossil record								
Diatom Species								
Acanthoceras zachariasii (Brun)				F				
Amphora subcapitata (Kisselev)				F			F	F
Hantzschia amphioxys (Ehrenberg)				F				
Nitzschia commutata Grunow				F			F	F
Nitzschia dubia w.Smith				F			F	
Nitzschia gisela Lange-Bertolot				F				
Stenopterobia sigmatella (Gregory)						R		
Stephanodiscus lucens Hustedt				F			F	

Table 7
Nannofossiles, Diatoma content and their species distribution at Bayraklı (İzmir Gulf) BH-4 Drilling. (R: Rare, F: Few, A: Abundant of fossil form).

Chrono-stratigraphy	Nannofossil species	Bayrakli DH-4			
	Rock sample no	BH-4 08.00–08.05	BH-4 13.00–13.05	BH-4 16.10–16.15	BH-4 20.90–20.95
Late Pleistocen – Holocen	*Braarudosphaera bigelowi* (Gran & Braarud)		R		
	Calcidiscus leptoporus (Murray & Blackman)		R		
	Emiliania huxleyi (Lohmann)	F	A		F
	Helicosphaera hyalina Gaarder	F		R	R
	Syracosphaera pulchra Lohmann		R		
	Thoracosphaera granifera Fütterer	F	F	R	F
	Thoracosphaera tuberosa Kamptner	R			
	Umbilicosphaera foliosa (Kamptner)		R	R	
	Umbilicosphaera sibogae (Weber-van Bosse)				R
Biozones					
NN21 ACME: *Emiliana huxleyi* Bolluk Zonu		NN21 ACME			
NN21: *Emiliana huxleyi* Zonu		NN21			
Diatom species					
Fragilaria ulna (Nitzch)		R		R	

In the Bayraklı research zone, starting from the seabed there are darkish grey, high – water content bush layers varied in thicknesses of 3.50–7.00 m. Below this level, of relatively high hardening degrees there is darkish brown silty clayed-sand level rich in organic materials and varied in thicknesses of 2.50–7.00 m. In the utmost bottom part there are lens-shaped sediments predominantly brown, pebbly, sandy and clayed and less intense compared to the higher levels.

As is the case in other zones, in the İnciraltı research zone, in the seabed there are frequent greenish-grey high-water content, sandy clay varied in thicknesses of 3.00–5.50 m. In the zone near the coast the same unit has an abundance of shells. There are 2.00–10.50 m thick greenish grey, average water content, clayed sands. On the bottom there is yellowish-grey sandy clay of thicknesses 4.00–12.00 m. In near-coast zones there are sporadic pebble contents (Fig. 8).

In the Urla (Çeşmealtı) research zone sea, starting from the seabed in varying thicknesses between 0.50 and 6.00 m there is pervasive darkish grey, high-water content, coquinoid sandy clay.

2.1. Micro and macrofauna

2.1.1. Bentic foraminifers

The foraminifer fauna collected from four drill sites yielded a total of 46 genera and 82 species that were identified. A total of 86 species from DH-5 are listed below in systematic order with respect to the foraminifer genera and species:

Ammodiscus planorbis Höglund, *Textularia bocki* Höglund, *Spirillina vivipara* Ehrenberg, *Vertebralina striata* d'Orbigny, *Nubecularia lucifuga* Defrance, *Adelosina carinata-striata* Wiesner, *A. cliarensis* (Heron-Allen ve Earland), *A. duthiersi* Schlumberger, *A. intricata* (Terquem), *A. mediterranensis* (le Calvez J. ve Y.), *Spiroloculina antillarum* d'Orbigny, *S, excavata* d'Orbigny, *S. ornata* d'Orbigny, *Siphonaperta aspera* (d'Orbigny), *Cycloforina contorta* (d'Orbigny), *C. villafranca* (le Calvez J. ve A.), *Lachlanella bicornis* (Walker ve Jacob), *L. variolata* (d'Orbigny), *Massilina gualterian* (d'Orbigny), *M. secans* (d'Orbigny), *Quinqueloculina berthelotiana* d'Orbigny, *Q. bidentata* d'Orbigny, *Q, disparilis* d'Orbigny, *Q. jugosa* Cushman, *Q. laevigata* d'Orbigny, *Q. lamarckiana* d'Orbigny, *Q. limbata* d'Orbigny, *Q. seminula* (Linné), *Miliolinella subrotunda* (Montagu), *M. webbiana* (d'Orbigny), *Pseudotriloculina laevigata* (d'Orbigny), *P. oblonga* (Montagu), *Triloculina marioni* Schlumberger, *T. plicata* Terquem, *T. tricarinata* d'Orbigny, *Sigmoilinita costata* (Schlumberger), *S. edwardsi* (Schlumberger), *Peneroplis pertusus* (Forskal), *P. planatus* (Fichtel ve Moll), *Lagena doveyensis* Haynes, *Polymorphina* sp., *Brizalina spathulata* (Williamson), *Rectuvigerina phlegeri* le calvez, *Bulimina elongata* d'Orbigny, *B. marginata* d'Orbigny, *Reussella spinulosa* (Reuss), *Fursenkoina acuta* (d'Orbigny), *Neoeponides bradyi* le Calvez, *Rosalina bradyi* Cushman, *Trethomphalus bulloides* (d'Orbigny), *Cibicides advenum* (d'Orbigny), *Lobatula lobatula* (Walker ve Jacob), *Planorbulina mediterranensis* d'Orbigny, *Asterigerinata mamilla* (Williamson), *Nonionella turgida* (Williamson), *Aubignyna perlucida* (Heron-Allen ve Earland), *Ammonia compacta* Hofker, *A. parkinsoniana* (d'Orbigny), *A. tepida* Cushman, *Cribroelphidium poeyanum* (d'Orbigny), *Porosononion subgranosum* (Egger), *Elphidium aculeatum* (d'Orbigny), *E. advenum* (Cushman), *E. complanatum* (d'Orbigny), *E. crispum* (Linné), *E. macellum* (Fichtel ve Moll) (Table 2).

75 foraminifer specimens from the DH-4 are listed below:

Textularia bocki Höglund, *Adelosina carinata-striata* Wiesner, *A. cliarensis* (Heron-Allen ve Earland), *A. mediterranensis* (le Calvez J. ve Y.), *Spiroloculina antillarum* d'Orbigny, *S. excavata* d'Orbigny, *S. ornata* d'Orbigny, *Siphonaperta aspera* (d'Orbigny), *Cycloforina contorta* (d'Orbigny), *C. villafranca* (le Calvez J. ve Y.), *Quinqueloculina berthelotiana* d'Orbigny, *Q. bidentata* d'Orbigny, *Q. jugosa*

Table 8
The content of Nannofossil and Diatom with their distribution of species in mud samples at BH-1 (İnciraltı-İzmir). (R: Rare, F: Few, C: Many, A: Abundant of fossil form).

Chrono-stratigraphy	Nannofosil species	Rock sample no	Inciralti DH-1						
			DH-1 12.00–12.10	DH-1 12.60–12.70	DH-1 13.40–13.50	DH-1 13.80–13.90	DH-1 15.90–16.00	DH-1 17.40–17.50	DH-1 17.90–18.00
Late Pleiistocen – Holocen	*Braarudosphaera bigelowii* (Gran & Braarud)		R	R		F	R		
	Coronosphaera binodata (Kamptner)					R			
	Coronosphaera mediterranea (Lohmann)		F	R			R		
	Calciosolenia murrayi Gran					R			
	Emiliania huxleyi (Lohmann)		A	A	A	A	A	C	R
	Gephyrocapsa ericsonii McIntyre & Be			R		F	R		
	Gephyrocapsa oceanica Kamptner		F						
	Gephyrocapsa omega Kamptner			R	F		R	R	
	Helicosphaera carteri (Wallich)		F	C	F				
	Helicosphaera hyalina Gaarder		F	C	C	F	R		
	Helicosphaera inversa Gartner		R	R			R		
	Helicosphaera wallichii (Lohmann)		F	F	R				
	Pontosphaera syracusana Lohmann				R				
	Syracosphaera pulchra Lohmann		F	C	F	F		R	
	Thoracosphaera granifera Fütterer		F	F	R	F	F	F	F
	Thoracosphaera heimii (Lohmann)		R		R		R		
	Thoracosphaera tuberosa Kamptner		R		R		R	F	
Rew	*Er. formosa* Hay & Mohler				R				
	Re. cf. *minutula* (Gartner)				R				
Biozoes									
NN21 ACME: *Emiliana huxleyi* Bolluk Zonu			NN21 (ACME)						
NN21: *Emiliana huxleyi* Zonu			NN21						
Other fossil records									
Ascidian species									
Micrascidites vulgaris VAROL			R						
Diatom species									
Stenopterobia sigmatella (Gregory)				R					

Table 9
The content of Nannofossil, Ascidian spicules and Diatom with their distribution of species in mud samples at BH-2 (Çeşmealtı/Urla-İzmir). (R: Rare, F: Few, C: Many, A: Abundant of fossil form).

Chrono-stratigraphy	Nannofosil species	Çeşmealti - Urla DH-2																	
	Rock sample no	DH-2 03.00 –03.10	DH-2 03.10 –03.20	DH-2 03.20 –03.30	SH-2 03.30 –03.40	DH-2 03.40 –03.50	DH-2 03.50 –03.60	DH-2 03.60 –03.70	DH-2 03.70 –03.80	DH-2 03.80 –03.90	DH-2 03.90 –04.00	DH-2 04.00 –04.10	DH-2 04.10 –04.20	DH-2 04.20 –04.30	DH-2 04.30 –04.40	DH-2 04.40 –04.50	DH-2 04.50 –04.60	DH-2 04.60 –04.70	DH-2 04.70 –04.80
Late Pleiistocen - Holocen	*Braarudosphaera bigelowii* (Gran & Braarud)																		
	Ceratolithus cristatus Norris																		
	Coccolithus pelagicus (Wallich)														R				
	Coronosphaera mediterranea (Lohmann)					R													
	Calciosolenia murrayi Gran												R		R		R		R
	Dctyococcites productus (Kamptner)																		
	Emiliania huxleyi (Lohmann)			R	R	F	R	F	R	F	F	F	F	C	A	F	F	R	F
	Syracosphaera pulchra Lohmann													R					
	Tetralithus sp.																F	F	
	Thoracosphaera granifera Fütterer	F	F	F	F	C	F	F	C	F	C	C	F	F	F	F	F	F	C
	Thoracosphaera heimii (Lohmann)	R			R	R	R			R									
	Thoracosphaera tuberosa Kamptner	F	R	R	R	R	R	R	F	F	F	F	F	F	F	F	F	F	F
	Toracosphaera saxea Stradner	F	R			R	R	R	R	R	F		R		F		R		
	Umbilicosphaera sibogae (Weber-van Bosse)	F																	
	Ericsonia ovalis Black																		
	Fasciculithus tympaniformis Hay & Mohler							R											
	Helicosphaera bramlettei (Müller)					R													
	Micula staurophora (Gardet)																		
Reworked																			
Biozones							NN21 ACME ?												
NN21 ACME: *Emiliania huxleyi* BollukZonu										NN21									
NN21: *Emiliania huxleyi* Zonu																			
Other fossil records																			
Ascidian	*Bonetia truncata* Varol							R		R									R
	Micrascidites vulgaris Varol	R							R	R	R	R				R	R	R	R
	Rigaudia multiradiata Varol									?									
Diatom species																			
Perissonoe cruciata (Janisch & Robenhorst)				R													R	R	
Stenopterobia sigmatella (Gregory)		R	R			R	R		R		R	R							

Chrono-stratigraphy	Nannofossil species	Rock sample no	Çeşmealti - BH-2 (Continued)																		
			BH-2 04.80 –04.90	BH-2 04.90 –05.00	BH-2 05.00 –05.10	BH-2 05.10 –05.20	BH-2 05.20 –05.30	BH-2 05.30 –05.40	BH-2 05.40 –05.50	BH-2 05.50 –05.60	BH-2 05.60 –05.70	BH-2 05.40 –05.50	BH-2 05.80 –05.90	BH-2 05.90 –06.00	BH-2 06.00 –06.10	BH-2 06.10 –06.20	BH-2 06.50 –06.60	BH-2 06.60 –06.70	BH-2 06.70 –06.80	BH-2 06.80 –06.90	BH-2 06.90 –07.00
Late Pleistocen - Holocen	*Braarudosphaera bigelowii* (Gran & Braarud)										R										
	Ceratolithus cristatus Norris										R										
	Coccolithus pelagicus (Wallich)									R	R										
	Coronosphaera mediterranea (Lohmann)		R																		
	Calciosolenia murrayi Gran																				
	Dctyococcites productus (Kamptner)									R											
	Emiliania huxleyi (Lohmann)		F	R					R												
	Syracosphaera pulchra Lohmann																				
	Tetralithus sp.		R			R		R		R	F				R	R					
	Thoracosphaera granifera Fütterer		F	R	R	R	R	R	R	F	F	R	No Nannofociles	No Nannofociles	R	R	No Nannofociles	No Nannofociles		?	No Nannofociles
	Thoracosphaera heimii (Lohmann)																		?		
	Thoracosphaera tuberosa Kamptner		F	F				R	R		R	R									
	Toracosphaera saxea Stradner																				
	Umbilicosphaera sibogae (Weber-van Bosse)																				
Reworked	Er. ovalis Black										R										
	F. tympaniformis Hay & Mohler																				
	He. inversa Gartner																				
	M. staurophora (Gardet)			R																	
Biozones																					
NN21 ACME: *Emiliania huxleyi* BollukZonu												NN21									
NN21: *Emiliania huxleyi* Zonu																					
Other fossil records																					
Ascidian	*Bon. truncata* Varol			R																	
	Mic. vulgaris Varol		R	R	F	R		R	R	R	R		R	R	R						
	Rig. Multiradiata Varol																				
Diatom species																					
Perissonoe cruciata (Janisch & Robenhorst)									R												
Stenopterobia sigmatella (Gregory)			R	R							R					R					

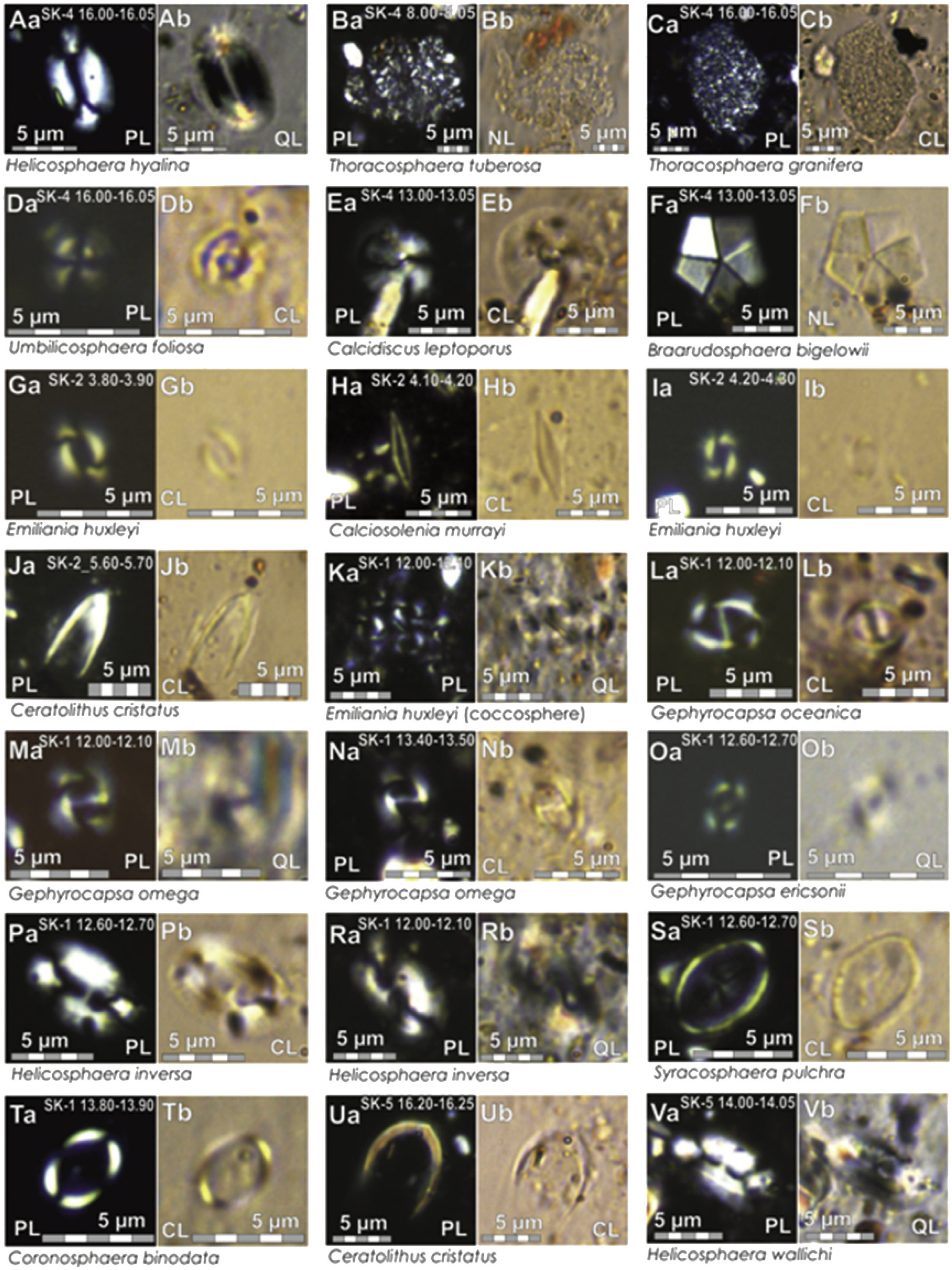


Fig. 4. İzmir Gulf Karşıyaka (DH-5), Bayraklı (DK-4), İnciraltı (DH-1) ve Urla- Çeşmealtı (DH-2) Holocene nannofossil species found in the marine driling samples: **Aa–Ab)** *Helicosphaera hyalina* Gaarder, **Ba–Bb)** *Thoracosphaera tuberosa* Kamptner, **Ca–Cb)** *Th. granifera* Fütterer, **Da–Db)** *Umbilicosphaera foliosa* (Kamptner), **Ea–Eb)** *Calcidiscus leptoporus* (Murray & Blackman), **Fa–Fb)** *Braarudosphaera bigelowii* (Gran & Braarud), **Ga–Gb)** *Emiliania huxleyi* (Lohmann), **Ha–Hb)** *Calciosolenia murrayi* Gran, **Ia–Ib)** *E. huxleyi* (Lohmann), **Ja–Jb)** *Ceratolithus cristatus* Norris, **Ka–Kb)** *E. huxleyi* (Lohmann) "coccosphere", **La–Lb)** *Gephyrocapsa oceanica* Kamptner, **Ma–Mb)** *G. omega* Bukry, **Na–Nb)** *G. omega* Bukry, **Oa–Op)** *G. ericsonii* McIntyre & Be, **Pa–Pb)** *Helicosphaera inversa* (Gartner), **Ra–Rb)** *He. inversa* (Gartner), **Sa–Sb)** *Syracosphaera pulchra* Lohmann, **Ta–Tb)** *Coronosphaera binodata* (Kamptner), **Ua–Ub)** *Ceratolithus cristatus* Norris, **Va–Vb)** *He. wallichii* (Lohmann). Located right or bottom left corner PL: polarized light, NL: In normal light, CL: Contrast light, QL: view the quartz wedge; polarized letters and numbers in the upper right corner of the image in the light, for example, received no drilling. and shows the depth.

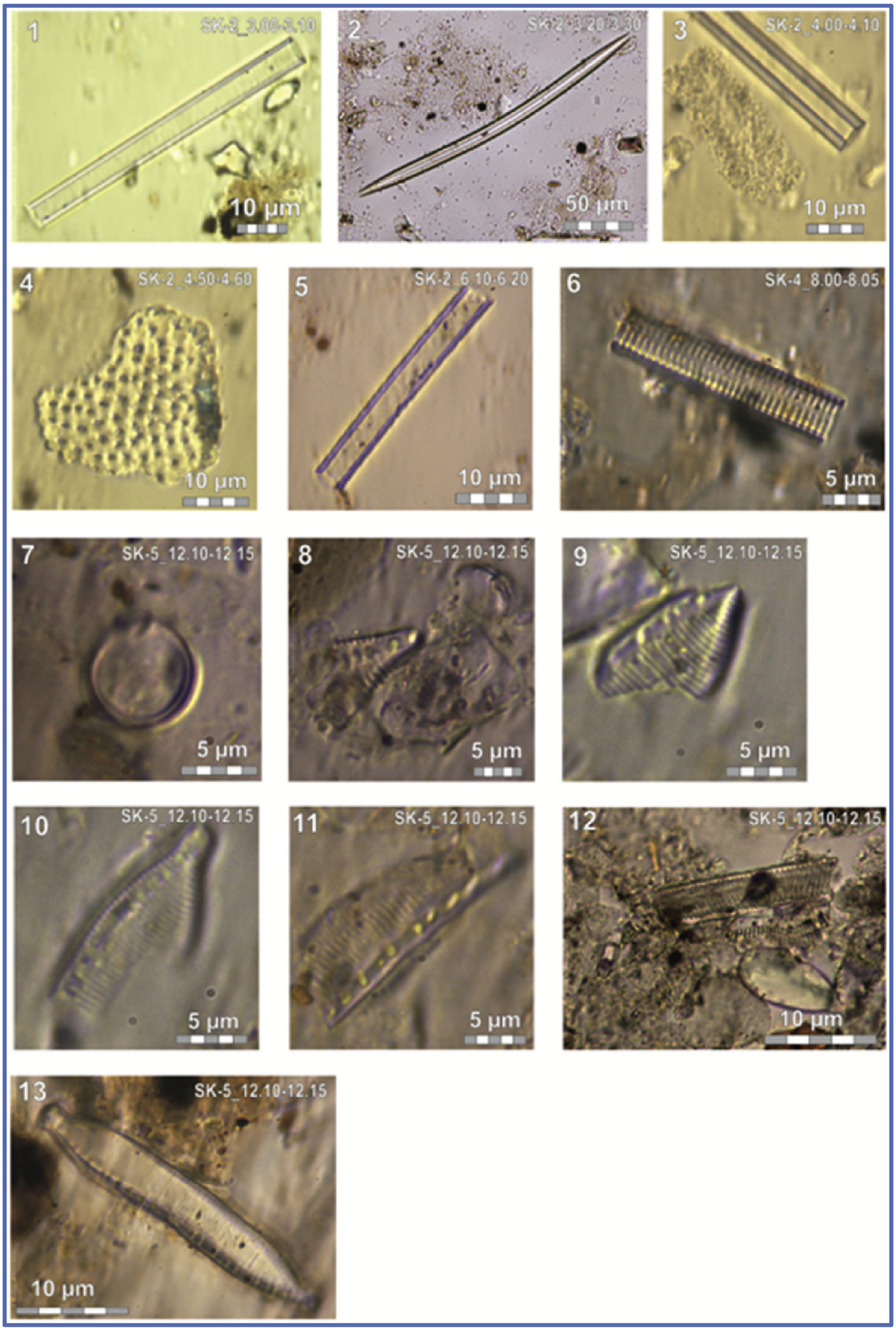


Fig. 5. Holocene diatom species found in drilling samples at Izmir Gulf (Karsiyaka (DH-5), Bayraklı (DH-4), İnciraltı (DH-1) and Urla-Çeşmealtı (DH-2)). 1- ***Stenopterobia sigmatella* (Gregory) Ross,**, Sample No. DH-2 3:00 to 3:10 m. Benthic, epipelic is the freshwater form. in rivers, acid (pH 5.68) in oligotrophic lakes, and limited places (Round vd., 2007; Carter, 2008). 2- ***Stenopterobia sigmatella* (Gregory) Ross**, Sample No. DH-2 3.20–3.3.30 m. Benthic, epipelic is the freshwater form. in rivers, acid (pH 5.68) in oligotrophic lake is located in the limited space (Round et al., 2007; Carter, 2008). **3- *Stenopterobia sigmatella* (Gregory) Ross,** Sample No. DH-2 4:00 to 4:10 m. Benthic, epipelic is the freshwater form. in rivers, acid (pH 5.68) in oligotrophic lake is located in the limited space (Round et al., 2007; Carter, 2008). **4- *Perissonoé cruciata* (Janisch and Robenhorst) Andrewsand Stoeizel,** Sample No. DH-2 4.50–4.60 m. Marine, littoral, is the form of hot water (v Round et al., 2007). **5- *Stenopterobia sigmatella* (Gregory) Ross,** Sample No. DH-2 6:10 to 6:20 m. Benthic, epipelic is the freshwater form. in rivers, acid (pH 5.68) in oligotrophic lake is located in the limited space (Round et al., 2007; Carter, 2008). **6- *Fragilaria ulna* (Nitzsch),** Sample No. DH-4- 8:00 to 8:05 m. Planktonic-benthic, epiphytic, it is a freshwater form (Round et al., 2007; Krammer-Lange Bertalot, 1991, Teil 3, Band 2/3, p. 143–144, 474–575, Fig. 122: 1–8). F. ulna is a common organism as mesotrophic to eutrophic waters (Cox, 1996). Planktonic-benthic, cosmopolitan, oligohalobous-indifferent, temperate-eterm, flat water river, eurysaphrob is β-mesosaphrob form (Barinova et al., 2011). Fragilari spin, freshwater, eutrotropic, mesotropic, oligotropic, eurysaproph, pH <7, pH> 7 and pennate form. Pollution and nutrient-adapted species Fragilari benefited enough from the environment is dirty (eutrophic = nutrient-rich) they show (Krammer-Lange Bertalot, 1991, 3 Teil, band 2/3, p. 113–165; Taş and Gönülol, 2007). **7- *Stephanodiscus lucens* Hustedt,** Sample No. DH-5 12:10 to 12:15 m. Planktonic, eutrophic, elektrolytgehalt (Krammer-Lange Bertalot, 1991; Teil 3, Band 2/3, p.75–76, 386–387, Figs. 4–7). **8- *Nitzschia gisela* Lange-Bertalot,** Sample No. DH-5 12:10 to 12:15 m. Cosmopolitan (Krammer-Lange Bertalot, 1988, 2. Teil, bands 2/2, p.57–58; 300–301, Fig. 42: 7–8). Nitzschia In freshwater is the most common genera, while Nitzschia species nutrients rich and in water contaminated organic oxygen-

Cushman, *Q. lamarckiana* d'Orbigny, *Q. limbata* d'Orbigny, *Q. seminula* (Linné), *Miliolinella subrotunda* (Montagu), *Pseudotriloculina oblonga* (Montagu), *Triloculina marioni* Schlumberger, *T. plicata* Terquem, *Sigmoilinita costata* (Schlumberger), *Lagena doveyensis* Haynes, *Bulimina elongata* d'Orbigny, *B. marginata* d'Orbigny, *Neoeponides bradyi* le Calvez, *Neoconorbina terquemi* (Rzehak), *Rosalina bradyi* Cushman, *Lobatula lobatula* (Walker ve Jacob), *Nonionella turgida* (Williamson), *Aubignyna perlucida* (Heron-Allen ve Earland), *Ammonia compacta* Hofker, *A. tepida* Cushman, *Challengerella bradyi* Billman, Hottinger ve Oesterle, *Cribroelphidium poeyanum* (d'Orbigny), *Porosononion subgranosum* (Egger), *Elphidium advenum* (Cushman) *E. complanatum* (d'Orbigny), *E. crispum* (Linné), *E. macellum* (Fichtel ve Moll) (Table 2).

From southwest of İnciraltı, a total of 60 foraminifer specimens were collected from the DH-1 siteand are listed below:

Ammodiscus planorbis Höglund, *Textularia bocki* Höglund, *Spirillina vivipara* Ehrenberg, *Cornuspira foliacea* Philippi, *Vertebralina striata* d'Orbigny, *Nubecularia lucifuga* Defrance, *Adelosina cliarensis* (Heron-Allen ve Earland), *A. elegans* (Williamson), *A. mediterranensis* (le Calvez J. ve Y.), *Spiroloculina angulosa* Terquem, *S, excavata* d'Orbigny, *Siphonaperta aspera* (d'Orbigny), *Lachlanella bicornis* (Walker ve Jacob), *L. variolata* (d'Orbigny), *Massilina secans* (d'Orbigny), *Quinqueloculina bidentata* d'Orbigny, *Q. jugosa* Cushman, *Q. seminula* (Linné), *Miliolinella labiosa* (d'Orbigny), *M. subrotunda* (Montagu), *M. webbiana* (d'Orbigny), *Pseudotriloculina laevigata* (d'Orbigny), *Triloculina marioni* Schlumberger, *Sigmoilinita costata* (Schlumberger), *Lagena laevis* (Montagu), *Globulina* sp., *Brizalina spathulata* (Williamson), *Rectuvigerina phlegeri* le calvez, *Bulimina aculeata* d'Orbigny, *B. marginata* d'Orbigny, *B. marginata* d'Orbigny *biserialis* Millet, *Reussella spinulosa* (Reuss), *Fursenkoina acuta* (d'Orbigny), *Eponides concameratus* (Williamson), *Neoconorbina terquemi* (Rzehak), *Neoeponides bradyi* (Le Calvez), *Rosalina bradyi* Cushman, *R. floridensis* Cushman, *R. globularis* d'Orbigny, *Lobatula lobatula* (Walker ve Jacob), *Planorbulina mediterranensis* d'Orbigny, *Cibicidella variabilis* (d'Orbigny), *Sphaerogypsina globula* (Reuss), *Asterigerinata mamilla* (Williamson), *Nonionella turgida* (Williamson), *Ammonia compacta* Hofker, *A. parkinsoniana* (d'Orbigny), *Challengerella bradyi* Billman, Hottinger ve Oesterle, *Cribroelphidium poeyanum* (d'Orbigny), *Porosononion subgranosum* (Egger), *Elphidium advenum* (Cushman), *E. complanatum* (d'Orbigny), *E. crispum* (Linné), *E. macellum* (Fichtel ve Moll) (Table 2).

In the Urla (Çeşmealtı) DH-2 driling, clayey interbedded Miocene sandstone overlied by young sediments, in 6.50 m thick. The 36 specimens extracted from the young sediments are: *Vertebralina striata* d'Orbigny, *Nubecularia lucifuga* Defrance, *Adelosina cliarensis* (Heron-Allen ve Earland), *A. mediterranensis* (le Calvez J. ve Y.), *Spiroloculina angulosa* Terquem, *Siphonaperta aspera* (d'Orbigny), *Lachlanella variolata* (d'Orbigny), *Massilina secans* (d'Orbigny), *Quinqueloculina seminula* (Linné), *Miliolinella labiosa* (d'Orbigny), *Pseudotriloculina laevigata* (d'Orbigny), *Triloculina marioni* Schumberger, *Coscinospira hemprichii* Ehrenberg, *Peneroplis pertusus* (Forskal), *P. planatus* (Fichtel ve Moll), *Sorites orbiculus,* Ehrenberg, *Rosalina bradyi* Cushman, *Lobatula lobatula* (Walker ve Jacob), *Ammonia compacta* Hofker, *A. parkinsoniana* (d'Orbigny), *A. tepida* Cushman, *Porosononion subgranosum* (Egger), *Elphidium aculeatum* (d'Orbigny), *E. advenum (C ushman), E. complanatum* (d'Orbigny), *E. crispum* (Linné), *E. maioricense* Colom. This is a foraminifer group that lacks genera and species diversity and the most noticeable property for this group is the abundancy of *Coscinospira hemprichii* (Ehrenberg), *Peneroplis pertusus* (Forskal), *P. planatus* (Fichtel and Moll) species. In particular, *Coscinospira hemprichii* (Ehrenberg) could only collected throughout the entire gulf in this zone (Table 2).

2.1.2. Ostracods

Of the drilling samples, 86 specimens in Karşıyaka, 40 specimens in Bayraklı, 60 specimens in İnciraltı and 40 specimens in Çeşmealtı (Urla) contained ostracod. In the identification of ostracod genera and species the following provided reference points: van Morkhoven, 1963; Mostafawi and Matzke-Karasz, 2006; Hartmann and Puri, 1974; Bonaduce et al., 1975; Breman, 1975; Yassini, 1979; Guillaume et al., 1985; Athersuch et al., 1989; Zangger and Malz, 1989; Joachim and Langer, 2008 and http://www.marinespecies.org/ostracoda/website.

Of the drilling samples 34 genera and 53 species were identified as ones frequently distributed throughout the Mediterranean and Aegean Sea. They are: *Tribelina raripila* (G.W. Mueller), *Cytherelloidea sordida* (G.W. Mueller), *Tribelina raripila* (G.W. Mueller), *Cytherelloidea sordida* (G.W. Mueller), *Cytherella alvearium* Bonaduce, Ciampo & Masoli, *C. vulgata* Ruggieri, *Aurila arborescens* (Brady), *A. convexa* (Baird), *Jugosocythereis prava* (Baird), *Caudites calceolatus* (Costa), Pseudopsammocythere reniformis (Brady), *Carinocythereis carinata* (Roemer), *C. rhombica* Stambolidis, *Hiltermannicythere rubra* (G.W. Mueller), *H. turbida* (G.W. Mueller), *Pterygocythereis jonesii* (Baird), *Cytheretta adriatica* Ruggieri, *C. judaea* (Brady), *Costa (Cuneocosta) tricostata* (Reuss) Ruggieri, *Bosquetina carinella* (Reuss), *Basslerites berchoni* (Brady), *Callistocythere intricatoides* (Ruggieri), *C. pallida* (G.W. Mueller), *Leptocythere* sps., *Leptocythere lagunae* Hartmann *Tyrrhenocythere* sp., *Urocythereis crenulosa* (Terquem), *Pseudocytherura* sp., *Semicytherura acuminata* (G.W. Mueller), *S. acuticostata* (G.W. Mueller), *S. incongruens* (G.W. Mueller), *S. inversa* (Seguenza*), S. sulcata* (G.W. Mueller), *Paracytheridea depressa* G.W. Mueller, *Bythocythere minima* Bonaduce, Ciampo & Masoli, *Palmoconcha agilis* (Ruggieri), *L. elliptica* Brady, *Loxoconcha bairdi* (G.W. Mueller), *L. gibberosa* Terquem, *L. tumida* Brady, *Hirschmania* sp., *Pontocythere turbida* G.W. Mueller, *Xestoleberis communis* (G.W. Mueller), *X. depressa* Sars, *X. dispar* G.W. Mueller, *Propontocypris* sp., *Paradoxostoma triste* G.W. Mueller, *Paradoxostoma* sp., *Cyprideis torosa* (Jones), *Cytherois* sp., Cytheridea neapolitana Kollman, *Heterocypris salina* (Brady), *Ilyocypris bradyi* (Sars)'dir (Table 3).

In the Karşıyaka zone the ostracod groups show the richest variety of genera and species found during the course of this research: throughout the whole core (12.00 m and 19.55 m) the number of species varied from 7 to 17. In the Bayraklı ostracod contents, specimens were analyzed via vertical distribution. Between 8.00 and 8.65 m hard water/brahic types *Cyprideis torosa and Heterocypris salina* were found; between 8.70 and 10.55 m marine ostracods genera quantity varied between 2 and 6 and starting from 10.90 until 13.55 m types of marine ostracods changed between 4 and 11. Although it was still feasible to observe marine ostracods between 13.60 and 14.75 m, genera quantity went down and varied between 2 and 5. Not a single ostracod was observed between 15

poor is said to be the richest species (van Dam et al., 1994). **9- *Nitzschia dubia* w.Smith, Sample** No. DH-5 12:10 to 12:15 m. Cosmopolitan (Krammer-Lange Bertalot, 1988, 2. Teil, bands 2/2, p.54–55, 298–299, Fig. 41: 1–3). In Nitzschia fresh water is said to be the most common breeds. Nitzschia had been remarked richest genus in the polluted water (van Dam et al., 1994). Nutrient-rich and oxygen-poor water contaminated by organic terms. **10- *Nitzschia commutata* Grunow,** Sample No. DH-5 12:10 to 12:15 m. Cosmopolitan (Krammer-Lange Bertalot, 1988, 2. Teil, bands 2/2, p.56–57; 300–301, Fig. 42: 1–6). **11- *Amphora subcapitata* (Kisselev) Hustedt,** Sample No: DH-5- 12.10–12.15 m. (Krammer-Lange Bertalot, 1986, 1. Teil, band 2/1, p.351–352; 748–749, Fig. 153: 1–9). **12- *Acanthoceras zachariasii* (Brun) Simonsen, Sample No: BH-5- 12.10–12.15 m**. *Acanthoceras* is Planktonic and fresh water form (Round vd., 2007). **13- *Hantzschia amphioxys* (Ehrenberg) W.Smith,** Sample No: DH-5- 12.10–12.15 m.

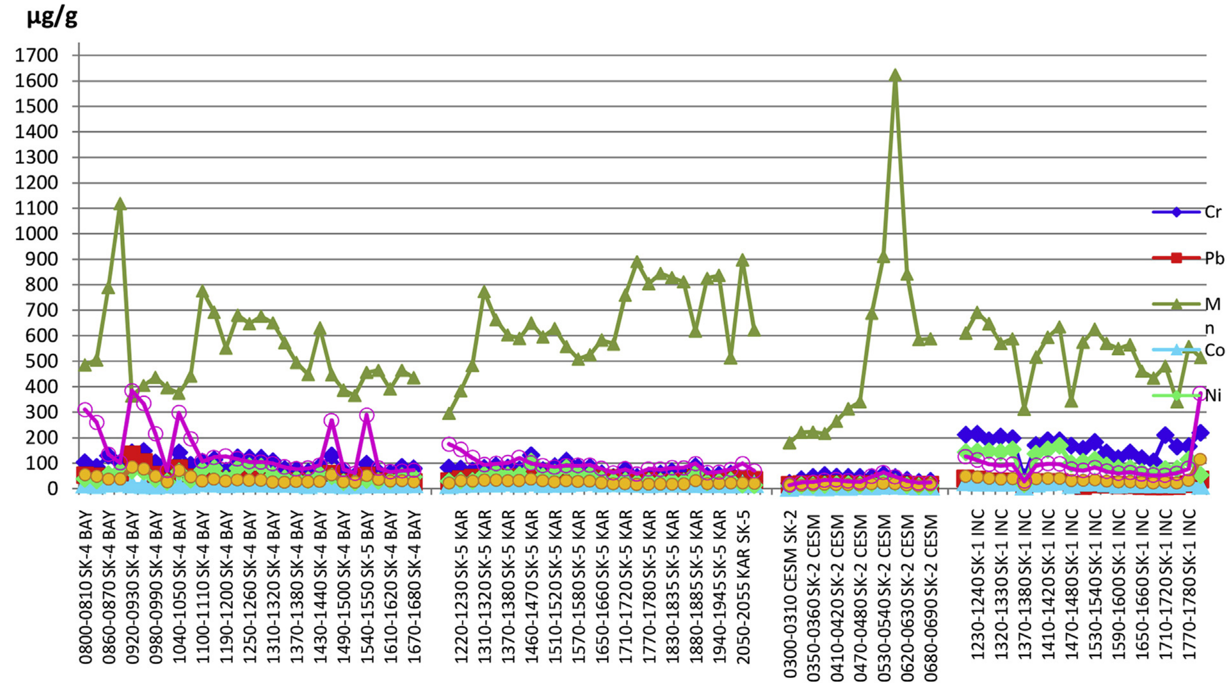


Fig. 6. Distribution of heavy metals (Cr, Pb, Mn, Co, Ni, Cu and Zn) in Drilling Samples of Karşıyaka, Bayraklı, İnciraltı and Çeşmealtı.

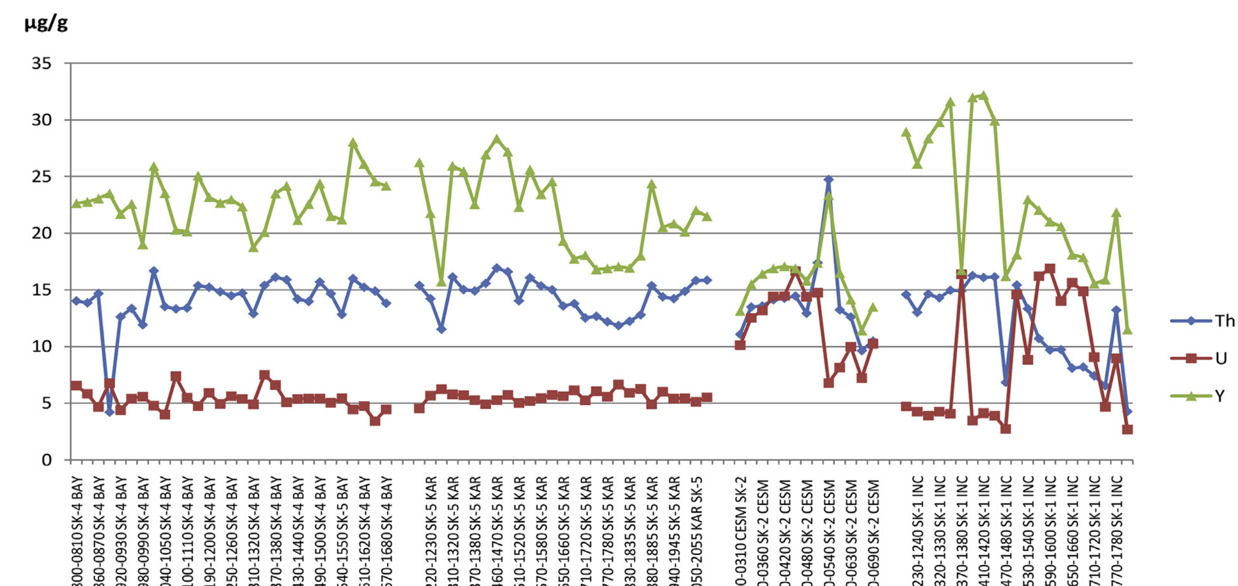


Fig. 7. Graphic of Th, U and Y elements in Drilling Samples of Karşıyaka, Bayraklı, İnciraltı and Çeşmealtı.

and 16 m, but the quantity of marine ostracods climbed once more at the level between 17.00 and 18.00 m.

An analysis of İnciraltı ostracods revealed that between depths of 12.00 and 13.75 m below the sea bed the number of marine ostracod types varied between 4 and 17 m. However, between 13.80 and 14.45 m below the sea bed the number of types fell to between 1 and 6. Between depths of 14.50 and 17.25 m there was once again an increase in the quantity of marine ostracod types to between 5 and 11. An overall analysis manifested that marine ostracods are pervasive in the zone. An analysis of ostracods in the Urla zone revealed that between depths of 3.00 and 4.85 m marine ostracod types varied in number between 9 and 17. Between 4.90 and 6.85 m hard water/brahic and lagoon types viz. *Cyprideis torosa, Heterocypris salina, Loxoconcha elliptica* emerged to the surface.

2.1.3. *Mollusks*

In all of specimens analyzed in the 4 drillings there were gastropod and bivalvia types. The gastropod types had a greater

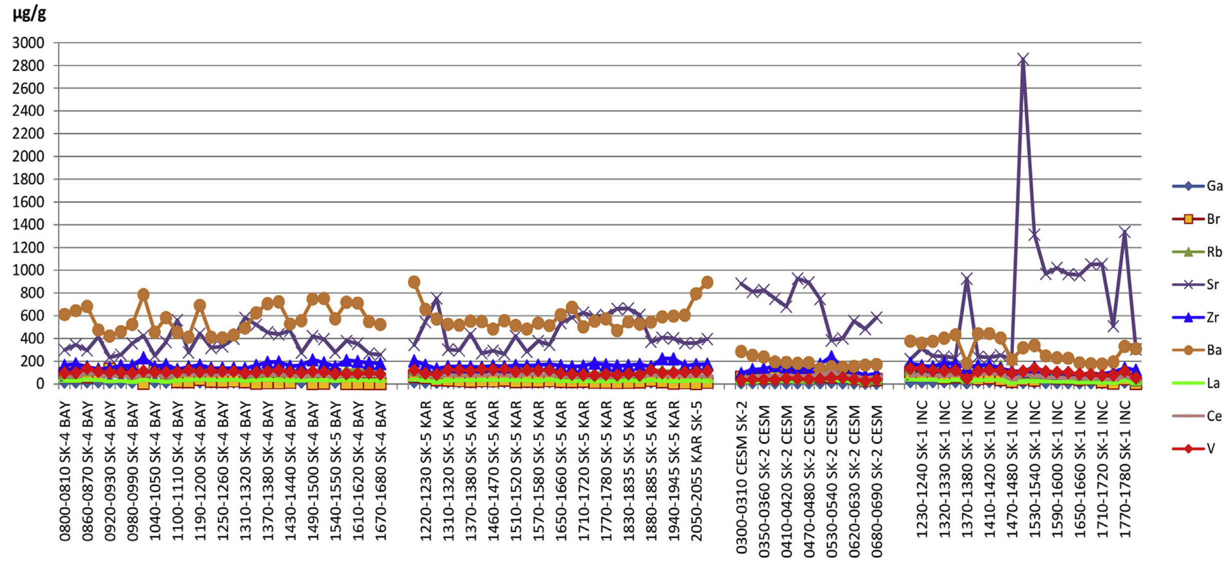


Fig. 8. Graphic of elements (Ga, Br, Rb, Sr, Zr, Ba, La, Ce, V) in drilling Samples of Karşıyaka, Bayraklı, İnciraltı and Çeşmealtı.

variation than the bivalvia types. The Karşıyaka drilling constitutes the richest zone formollusk fauna while the Urla zone constitutes the poorest mollusk fauna. It is believed that the sampled types represent the typical mollusk fauna of the Aegean Sea (Öztürk et al., 2014). In addition to the gastropod and bivalvia types, the *Antalis dentalis* type (Linne) of Scaphapoda, was observed in all drillings except Urla, while the *Fustiaria rubescens* (Deshayes) type was only observed in Karşıyaka drilling (Tables 4 and 5).

2.2. Microflora

2.2.1. Nannofossil, ascidian and diatoms

The Karşıyaka DH-5 drilling 12.00–12.05 m level was sterile in terms of nannofossil, ascidian and diatoms. At DH-5 14.00–14.05 and DH-5 16.20–16.25 (m) levels there was an abundance/extreme abundance of *Emiliania huxleyi* (Fig. 4). Furthermore the presence of sporadic *Helicosphaera* spp. types, in addition to *Emiliania* types, might be indicative of the connection with the open-sea. In addition to that the presence of rich diatom groups such as *Acanthoceras zachariasii, Amphora subcapitata, Hantzschia amphioxys Nitzschia* spp., *Stenopterobia sigmatella and Stephanodiscus lucens* could be interpreted as indicative of the environmental conditions of shallow sea and fresh water entry (Table 6). *E. huxleyi* in 14.00–14.05 and 16.20–16.25 m levels of the samples drilling pointed to the NN21 *E. huxleyi* zone. It is thus reasonable to conclude that specimens in the 16.20–16.25 m levels at minimum reflected a sediment formation in the N21 *E. huxleyi* ACME subzone (0.09 my-current).

At Bayraklı DH-4, *Emiliania huxleyi* was encountered at 08.00–00.05, 13.00–13.05, and 20.90–20.95 m levels. *Emiliania huxleyi* specimens is largely available at 13.00–13.05. Aside from *Emiliania* types there were sporadic *Helicosphaera hyalina*, *Umbilicosphaera* spp. Types, which could be as accounted for beceuse of its the connection with open sea; also the existence of meso-eutropic diatoms such as *Fragilaria ulna* can be construed as a sign of environmental pollution (Table 7).

The İnciraltı DH-1 drillings showed distinctive specimens were compiled at 12.00–12.10, 12.60–12.70, 13.40–13.50, 13.80–13.90, 15.90–16.00, and 17.40–17.50 m. In these specimens *Emiliania huxleyi*, *Gephyrocapsa* spp. and *Helicosphaera* spp. open/deep-sea nannofossil groups were identified. In 17.40–17.50 m. Specimens, however, there was a significant decrease in the quantity of nannofossils. Nevertheless at the 12.60–12.70 m lavel sample planktic foraminifer, and in 13.80–13.90 m sample *Stenopterobia sigmatella,* one fresh-water diatom was identified (Table 8).

In the specimens extracted from Urla-Çeşmealtı DH-2 drilling levels of 03.20–03.30, 03.30–03.40, 03.40–03.50, 03.50–03.60, 03.60–03.70, 03.70–03.80 03.80–03.90, 03.90–04.00, 04.00–04.10, 04.10–04.20 04.20–04.30 04.30–04.40, 04.40–04.50, 04.50–04.60, 04.60–04.70, 04.70–04.80, 04.80–09.90, 04.90–05.00, 05.40–05.50 m just as was identified in other drillings, *Emiliania huxleyi* was detected. This form is generally less pervasive in rock specimens whilst it largely pervades 04.30–04.40 no. specimens. In the levels where *Emiliania* types are fewer but *Thoracosphaera* spp. types are high in number, there are large quantities of ascidian spicules such as *Bonetia truncata, Micrascidites vulgaris Rigaudia multiradiata* which brings one to assume that this zone is representative of shallow sea/tide environment. Besides the presence of *Perissonoe cruciata* representing lithoral environment and *Stenopterobia sigmatella* fresh water diatoms (Fig. 5) are supportive of the said environmental interpretation (Table 9).

2.3. Chemical properties of sediment specimens in the Gulf of İzmir

As the heavy metals (Cr Mn, Zn, Co, Ni, Cu, Zn) contained by sediment specimens of the Gulf of Izmir were examined (Fig. 6), it is found that they Bayraklı, Karşıyaka and İnciraltı sediment specimens were high in Mn while in the Urla (Çeşmealtı) specimens heavy metals become higher only as the depth increased. Cr and Ni were high at İnciraltı but lower at Urla (Çeşmealtı). Zn exhibited a fluctuating course in Bayraklı and İnciraltı. Amid Karşıyaka specimens they were inversely proportional to depth and as depth increased the ratio conversely decreased. Pb was detected in the near-surface locations of Bayraklı, but it exhibited a fluctuating course. Samples from Bayraklı, İnciraltı and Urla (Çeşmealtı) showed visible changes such as immediate decreases or high-value measurements. Compared to İnciraltı and Karşıyaka, Bayraklı was more affected by heavy metal pollution, while Urla (Çeşmealtı) in comparison was less affected.

Values of rare elements (Ba, Sr) varied in the specimen groups. In İnciraltı specimens Sr values were high. Distribution of radioactive elements was equal to one another in Bayraklı and Karşıyaka specimens while it differed in Urla (Çeşmealtı) and İnciraltı

Plate 1. 1. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Karşıyaka DH-5, 15.30–15.35. m. 2. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Karşıyaka DH-5, 16.30–16.35. m. 3. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Karşıyaka DH-5, 17.60–17.65. m. 4. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Karşıyaka DH-5, 17.70–17.75. m. 5. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Karşıyaka DH-5, 18.00–18.05. m. 6. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Karşıyaka DH-5, 18.00–18.05. m. 7. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Karşıyaka DH-5, 18.20–18.25. m. 8. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Karşıyaka DH-5, 18.20–18.25. m. 9a. *Peneroplis planatus* (Fichtel and Moll). Side view, Urla (Çeşmealtı) DH-2, 3.00–3.05 m. 9b. *Peneroplis planatus* (Fichtel and Moll). Enlargement of side view, Urla (Çeşmealtı) DH-2, 3.00–3.05m. 10a. *Peneroplis planatus* (Fichtel and Moll). Side view, Urla (Çeşmealtı) DH-2, 3.00–3.05 m. 10b. *Peneroplis planatus* (Fichtel and Moll). Enlargement of side view, Urla (Çeşmealtı) DH-2, 3.00–3.05 m. 11. *Peneroplis planatus* (Fichtel and Moll). Side view, Urla (Çeşmealtı) DH-2, 3.00–3.05 m. 12. *Peneroplis planatus* (Fichtel and Moll). Side view, Karşıyaka DH-5, 16.60–16.65 m. 13. *Rosalina bradyi* Cushman. Side view, spiral side, İnciraltı DH-1, 15.80–15.85 m. 14. *Rosalina bradyi* Cushman. Side view, spiral side, İnciraltı DH-1, 15.80–15.85 m. 15. *Rosalina bradyi* Cushman. Side view, spiral side, İnciraltı DH-1, 16.30–16.35 m. 16. *Lobatula lobatula* (Walker and Jacob). Side view, spiral side, İnciraltı DH-1, 15.50–15.55m. 17. *Lobatula lobatula* (Walker and Jacob). Side view, umbilical side, İnciraltı DH-1, 15.50–15.55 m. 18a. *Lobatula lobatula* (Walker and Jacob). Side view, spiral side, İnciraltı DH-1, 15.60–15.65m. 18b. *Lobatula lobatula* (Walker and Jacob). Detail view of the test, İnciraltı DH-1, 15.60–15.65m.

specimens (Figs. 7 and 8). Çeşmealtı foraminifera tests did not lead to color and morphological changes. But foraminifera tests taken from Karşıyaka, Bayraklı and İnciraltı locations returned to black (Plates 4–6). However, concentration of heavy metals (Ni, Cr and Mn) obtained from sediments of Karşıyaka, Bayraklı and İnciraltı locations were higher than in the Çeşmealtı examples. High

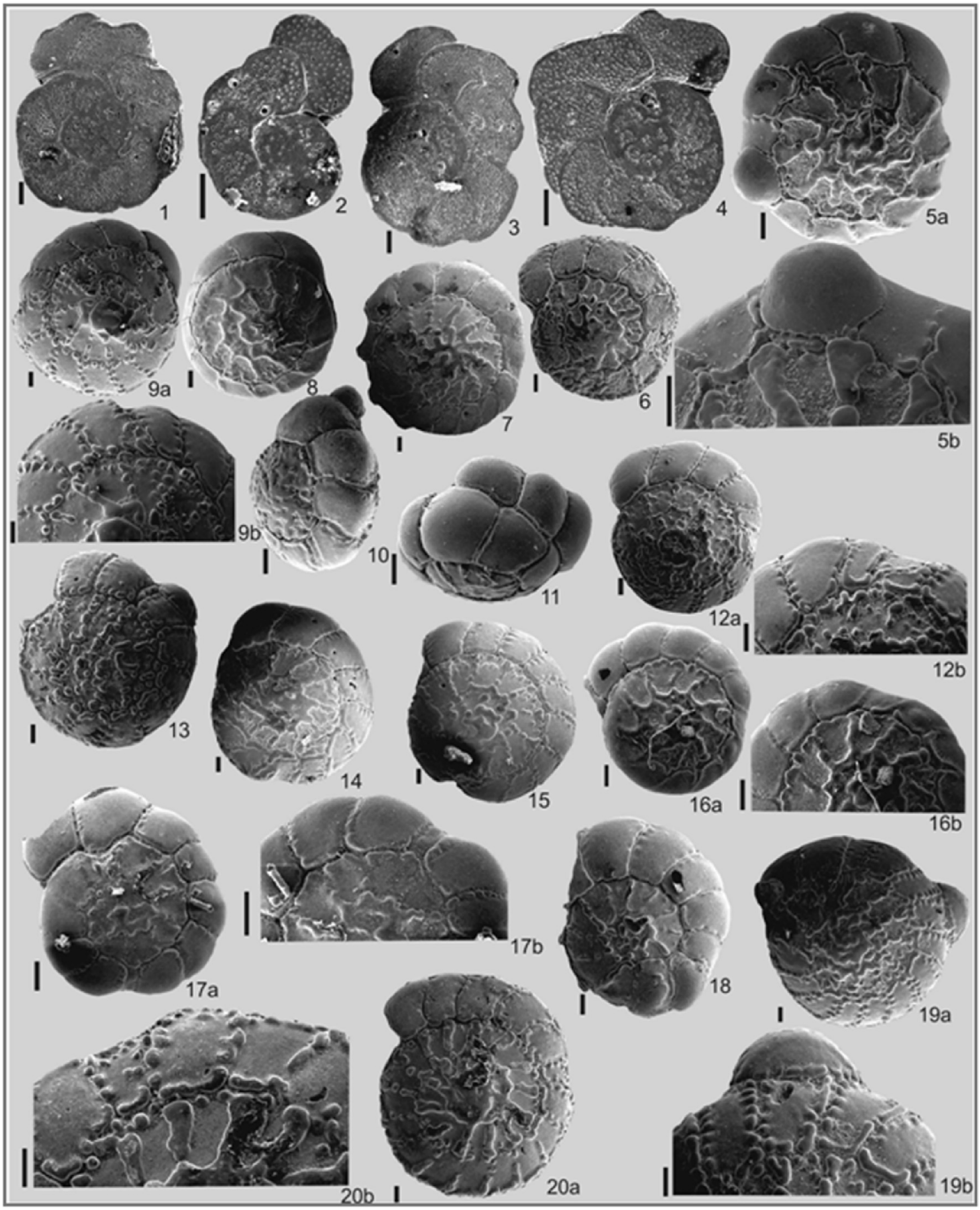


Plate 2. 1. *Lobatula lobatula* (Walker and Jacob). Side view, spiral side, İnciraltı DH-1, 15.80–15.85 m. 2. *Lobatula lobatula* (Walker and Jacob). Side view, spiral side, İnciraltı DH-1, 16.00–16.05 m. 3. *Lobatula lobatula* (Walker and Jacob). Side view, spiral side, İnciraltı DH-1, 16.40–6.45 m. 4. *Lobatula lobatula* (Walker and Jacob). Side view, spiral side, İnciraltı DH-1, 16.60–16.65 m. 5a. *Ammonia compacta* Hofker. Side view, spiral side, Urla (Çeşmealtı) DH-2, 3.00–3.05 m. 5b. *Ammonia compacta* Hofker. Detail view of the test, Urla (Çeşmealtı) DH-2, 3.00–3.05 m. 6. *Ammonia compacta* Hofker. Side view, spiral side, Urla (Çeşmealtı) DH-2, 3.00–3.05 m. 7. *Ammonia parkinsoniana* (d'Orbigny). Side view, spiral side, Urla (Çeşmealtı) DH-2, 4.60–4.65 m. 8. *Ammonia compacta* Hofker. Side view, spiral side, Urla (Çeşmealtı) DH-2, 4.60–4.65 m. 9a. *Ammonia compacta* Hofker. Side view, spiral side, İnciraltı DH-1, 14.70–14.75 m. 9b. *Ammonia compacta* Hofker. Detail view of the test, İnciraltı DH-1, 14.70–14.75 m. 10. *Ammonia compacta* Hofker. Side view, spiral side, İnciraltı DH-1, 12.40–12.45 m. 11. *Ammonia compacta* Hofker. Abnormal individu, edge view, İnciraltı DH-1, 13.20–13.25 m. 12a. *Ammonia compacta* Hofker. Side view, spiral side, Bayraklı DH-4, 12.60–12.65 m. 12b. *Ammonia compacta* Hofker. Side view, Bayraklı DH-4, 12.60–12.65 m. 13. *Ammonia compacta* Hofker. Side view, spiral side, Bayraklı DH-4, 12.70–12.75 m. 14. *Ammonia compacta* Hofker. Side view, spiral side, Bayraklı DH-4, 12.90–12.95 m. 15. *Ammonia compacta* Hofker. Side view, spiral side, Bayraklı DH-4, 13.10–13.15 m. 16a. *Ammonia compacta* Hofker. Side view, spiral side, Karşıyaka DH-5, 16.60–16.65 m. 16b. *Ammonia compacta* Hofker. Detail view of the test, Karşıyaka DH-5, 16.60–16.65 m. 17a. *Ammonia compacta* Hofker. Side view, spiral side, Karşıyaka DH-5, 17.00–17.05 m. 17b. *Ammonia compacta* Hofker. Detail view of the test, Karşıyaka DH-5, 17.00–17.05 m. 18. . *Ammonia compacta* Hofker. Side view, spiral side, Karşıyaka DH-5, 17.60–17.65 m. 19a. *Ammonia compacta* Hofker. Side view, spiral side, Karşıyaka DH-5, 18.20–18.25 m. 19b. *Ammonia compacta* Hofker. Detail view of the test, Karşıyaka DH-5, 18.20–18.25 m. 20a. *Ammonia compacta* Hofker. Side view, spiral side, Karşıyaka DH-5, 19.40–19.45 m. 20b. *Ammonia compacta* Hofker. Detail view of the test, Karşıyaka DH-5, 19.40–19.45 m.

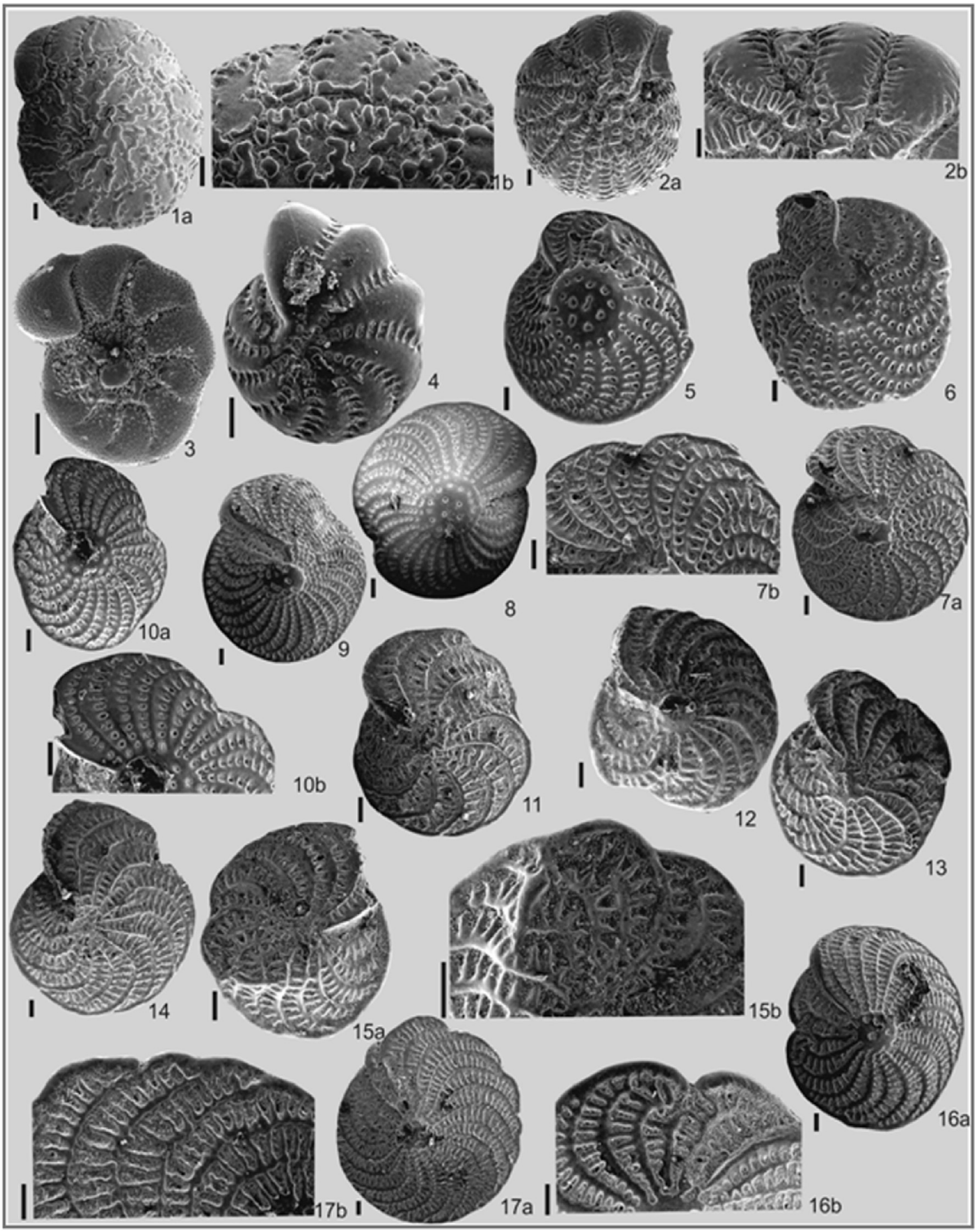


Plate 3. 1a. *Ammonia compacta* Hofker. Side view, spiral side, Karşıyaka DH-5, 19.50–19.55 m. 1b. *Ammonia compacta* Hofker. Detail view of the test, Karşıyaka DH-5, 19.50–19.55 m. 2a. *Challengerella bradyi* Billman, Hottinger and Oesterle. Side view, umbilical side, Karşıyaka DH-5, 17.70–17.75 m. 2b. *Challengerella bradyi* Billman, Hottinger and Oesterle. Detail view of the test, umbilical side, Karşıyaka DH-5, 17.70–17.75 m. 3. *Porosononion subgranosum* (Egger). Side view, İnciraltı DH-1, 15.00–15.05 m. 4. *Elphidium advenum* (Cushman). Side view, İnciraltı DH-1, 15.70–15.75 m. 5. *Elphidium crispum* (Linné). Side view, İnciraltı DH-1, 15.80–15.85 m. 6. *Elphidium crispum* (Linné). Side view, İnciraltı DH-1, 15.80–15.85 m. 7a. *Elphidium crispum* (Linné). Side view, İnciraltı DH-1, 15.80–15.85 m. 7b. *Elphidium crispum* (Linné). Detail view of the test, İnciraltı DH-1, 15.80–15.85 m. 8. *Elphidium crispum* (Linné). Side view, İnciraltı DH-1, 15.00–15.05 m. 9. *Elphidium crispum* (Linné). Side view, İnciraltı DH-1, 15.50–15.55 m. 10a. *Elphidium crispum* (Linné). Side view, İnciraltı DH-1, 16.40–16.45 m. 10b. *Elphidium crispum* (Linné). Detail view of the test, İnciraltı DH-1, 16.40–16.45 m. 11. *Elphidium macellum* (Fichtel and Moll). Side, Karşıyaka DH-5, 16.20–16.25 m. 12. *Elphidium macellum* (Fichtel and Moll). Side view, Karşıyaka DH-5, 16.30–16.35 m. 13. *Elphidium macellum* (Fichtel and Moll). Side view, Karşıyaka DH-5, 16.90–16.95 m 14. *Elphidium macellum* (Fichtel and Moll). Side view, Karşıyaka DH-5, 17.60–17.65 m 15a. *Elphidium macellum* (Fichtel and Moll). Side view, Karşıyaka DH-5, 17.60–17.65 m 15b. *Elphidium macellum* (Fichtel and Moll). Detail view of the test, Karşıyaka DH-5, 17.60–17.65 m. 16a. *Elphidium macellum* (Fichtel and Moll). Side view, Karşıyaka DH-5, 18.20–18.25 m. 16b. *Elphidium macellum* (Fichtel and Moll). Detail view of the test, Karşıyaka DH-5, 18.20–18.25 m. 17a. *Elphidium macellum* (Fichtel and Moll). Side view, Karşıyaka DH-5, 18.70–18.75 m. 17b. *Elphidium macellum* (Fichtel and Moll). Detail view of the test, Karşıyaka DH-5, 18.70–18.75m.

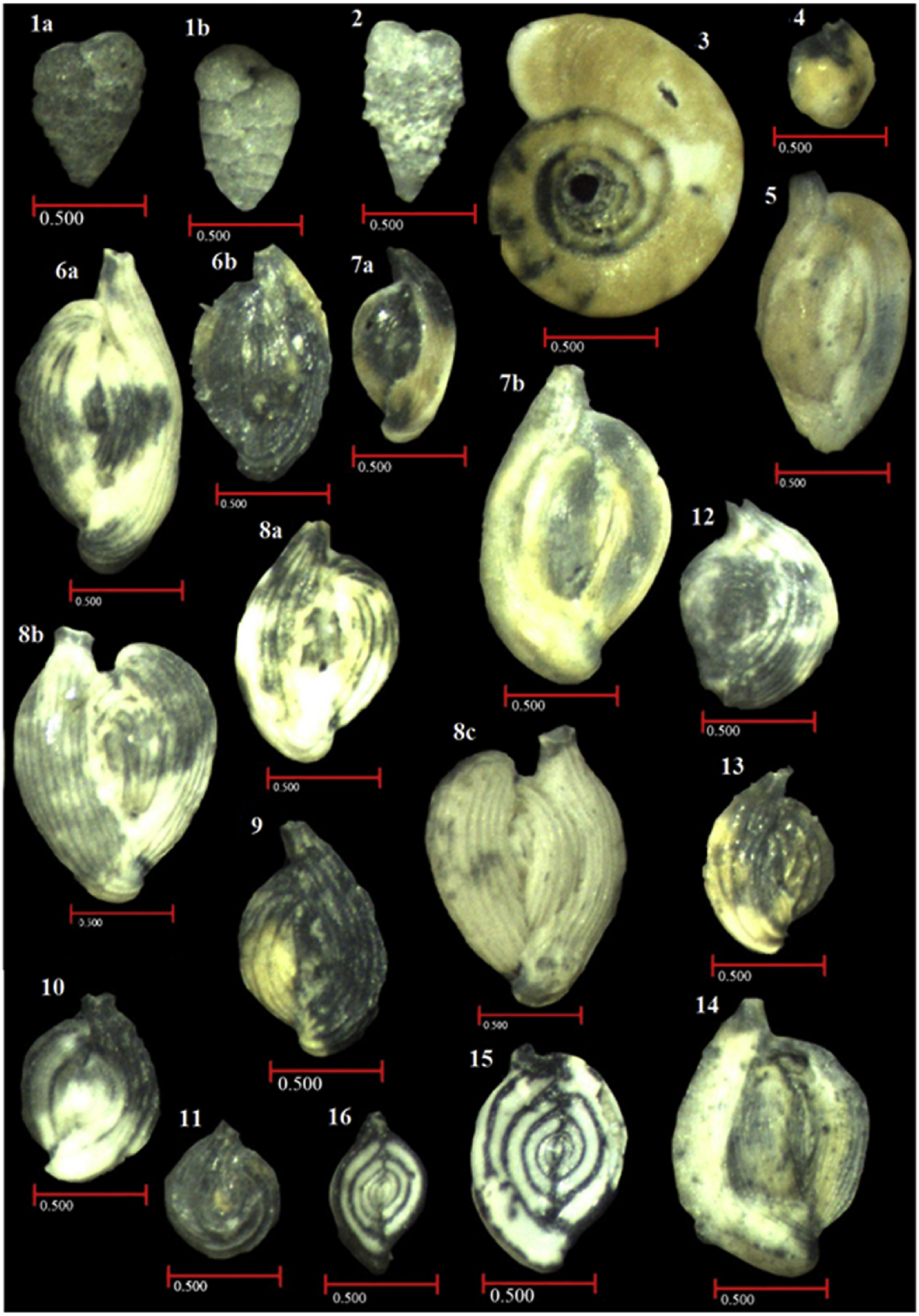


Plate 4. 1. *Textularia bocki* Höglund. Side view, Bayraklı, DH-4, a, 12.80–12.85 m; b, 13.10–13.15 m. 2. *Textularia bocki* Höglund. Side view, İnciraltı. DH-1, 15.60–15.65 m. 3. *Cornuspira foliacea* Philippi. Side view, İnciraltı DH-1, 15.50–15.55 m. 4. *Adelosina cliarensis* (Heron-Allen and Earland). Young individu, side view, İnciraltı DH- 1, 16.20–16.25 m. 5. *Adelosina duthiersi* Schlumberger. Side view, Bayraklı DH-4, 10.90–10.95 m. 6. *Adelosina duthiersi* Schlumberger. Side view, Bayraklı DH-4, a ve b, 11.00–11.05 m. 7. *Adelosina duthiersi* Schlumberger. Side view, Bayraklı DH-4, a, 13.10–13.15 m and b, 17.90–17.95 m. 8. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Bayraklı DH-4, a, b and c, 11.00–11.05 m, b and c, abnormal individu. 9. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Bayraklı DH-4, 12.60–12.65 m. 10. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Bayraklı DH-4, 13.00–13.05 m. 11. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Bayraklı DH-4, young individu, 14.10–14.15 m. 12. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Bayraklı DH-4, 17.90–17.95 m. 13. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, Bayraklı DH-4, 18.00–18.05 m. 14. *Adelosina mediterranensis* (le Calvez J. and Y.). Side view, İnciraltı DH-1, 15.50–15.55 m. 15. *Spiroloculina excavata* d'Orbigny. Side view, Karşıyaka DH-5, 14.90–14.95 m. 16. *Spiroloculina excavata* d'Orbigny. Side view, İnciraltı DH-1, 15.50–15.55 m.

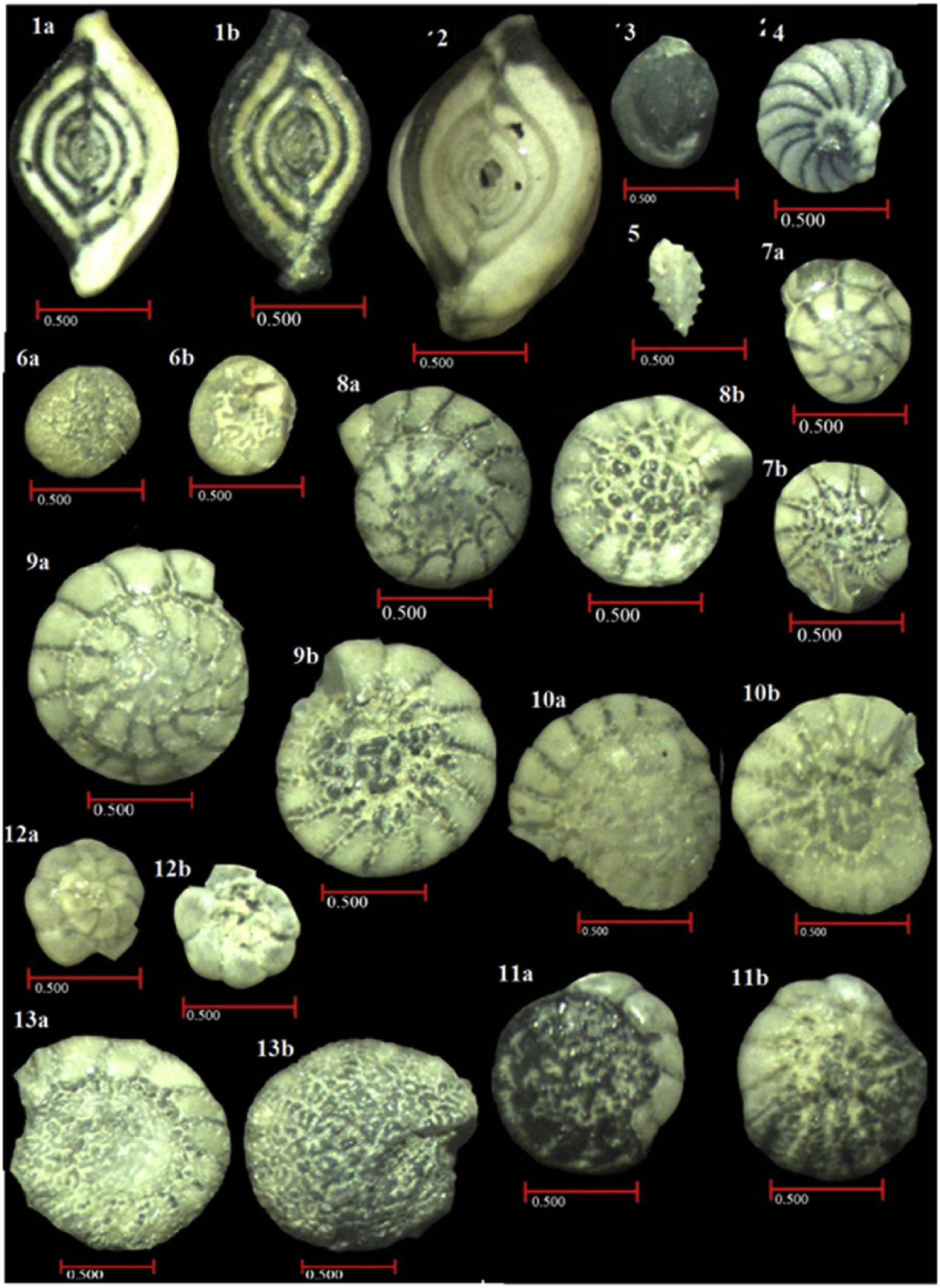


Plate 5. 1. *Spiroloculina excavata* d'Orbigny. Side view, İnciraltı DH-1, a and b, 15.60–15.65 m. 2. *Spiroloculina excavata* d'Orbigny. Side view, İnciraltı DH-1,16.20–16.25 m. 3. *Triloculina marioni* Schlumberger. Side view, Bayraklı DH-4, 11.00–11.05 m. 4. *Peneroplis pertusus* (ForDHal). Side view, Karşıyaka DH-5, 17.90–17.95 m. 5. *Reussella spinulosa* (Reuss). Side view, İnciraltı DH-1, 14.70–14.75 m. 6. *Rosalina bradyi* Cushman. Side views, spiral and umblical sides, İnciraltı DH-1, 14.60–14.65 m. 7. *Ammonia compacta* (Hofker). Side views, Karşıyaka DH-5, a spiral and b umbilical sides, 14.90–14.95 m. 8. *Ammonia compacta* (Hofker). Side views, Karşıyaka DH-5, a spiral ve b umbilical Sides, 18.10–18.15 m. 9. *Ammonia compacta* (Hofker). Side views, Karşıyaka DH-5, a spiral and b umbilical sides, 18.20–18.25 m. 10. *Ammonia compacta* (Hofker). Side views, abnormal individu, Bayraklı DH-4, a spiral and b umbilical sides, 11.00–11.05 m. 11. *Ammonia compacta* (Hofker). Side views, İnciraltı DH-1, a spiral and b ombilical sides, 14.80–14.85 m. 12. *Ammonia tepida* (Cushman). Side views, İnciraltı DH-1, a spiral and b umbilical sides, 14.60–14.65 m. 13. *Challengerella bradyi* Billman, Hottinger and Oesterle. Side views, Karşıyaka DH-5, a spiral and b umbilical sides, 18.00–18.05 m.

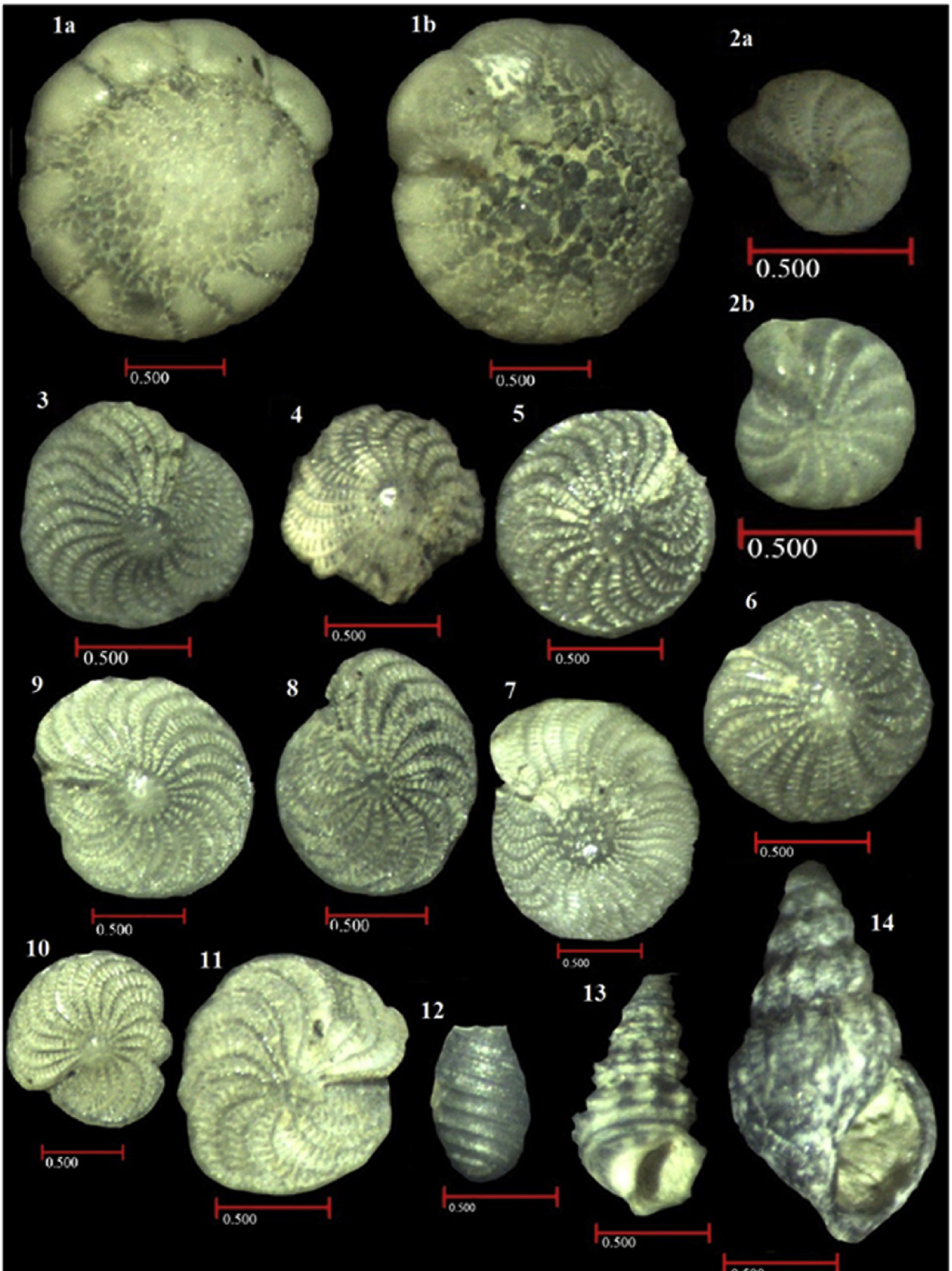


Plate 6. 1. *Challengerella bradyi* Billman, Hottinger and Oesterle. Side views, Bayraklı DH-4, a spiral and b umblical sides, 13.10–13.15 m. 2. *Elphidium advenum* (Cushman). Side view, Karşıyaka DH-5, a 14.90–14.95 and b 16.10–16.15 m. 3. *Elphidium crispum* (Linné). Side view, Karşıyaka DH-5, 18.10–18.15 m. 4. *Elphidium crispum* (Linné). Side view, İnciraltı DH-1, 14.50–14.55 m. 5. *Elphidium crispum* (Linné). Side view, İnciraltı DH-1, 14.60–14.65 m. 6. *Elphidium crispum* (Linné). Side view, İnciraltı DH-1, 14.70–14.75 m. 7. *Elphidium crispum* (Linné). Side view, İnciraltı DH-1, 14.80–14.85 m. 8. *Elphidium macellum* (Fichtel and Moll). Side view, Karşıyaka DH-5, 18.00–18.05 m. 9. *Elphidium macellum* (Fichtel and Moll). Side view, abnormal individu, Karşıyaka DH-5, 18.20–18.25 m. 10. *Elphidium macellum* (Fichtel and Moll). Side view, abnormal individu, Karşıyaka DH-5, 18.50–18.55 m. 11. *Elphidium macellum* (Fichtel and Moll). Side view, abnormal individu, İnciraltı DH-1, a ve b 14.60–14.65 m. 12. *Chara* sp. Side view, Bayraklı DH-4, 13.00–13.05 m. 13. *Rissoina bruguieri* (Payraudeau). Side view, İnciraltı DH-1, 15.50–15.55 m. 14. *Bittium reticulatum* (da Costa). Side view, İnciraltı DH-1, 15.50–15.55 m.

Table 10
^{14}C analysis (Aging analysis) results of drilling samples in Izmir Gulf.

Location	Drill hole	Lab. Sample no.	Core depth (m)	Sample Weight (g)	Sample kind (g)		^{14}C Dating
					Sediment	Shell	
Karşıyaka	DH5	IKP-1	20.0	184.4	180.5	3.9	4150 ± 30 BP
Bayraklı	DH4	IKP-2	18.50	191.4	187.7	3.7	7690 ± 30 BP
Çeşmealtı	DH2	IKP-3	7.0	91.4	87.4	4.0	8890 ± 30 BP
İnciraltı	DH1	IKP-4	18.0	204.2	200	4.2	4460 ± 30 BP

concentration of these elements, may be the cause of the color change seen in the foraminifera tests. The analysis of ostracod carapaces variability of two different genera and species reveals that the Mg content of the code No: 1356 ostracoda "*Bosquetina carinella* (Reuss)" is lower than that of the 1357 "*Bosquetina carinella* (Reuss)." The heavy metal sequence of the No: 1357 ostracoda is Si > Al > Fe > Mg. However, K, Cl and N are observed in the shell content at the 1357. an Fe > Si > Mg > Al sequence is observed in the shell content of 1358 "Cytheridea neapolitana Kollman" and 1359 "*Cytheridea neapolitana* Kollman" at the 1357. This species can be said to be tolerant.

2.4. Digital age values of sediment specimens in the Gulf of İzmir

After the ageing process conducted via ^{14}C method, the oldest value was measured in the Çeşmealtı specimen extracted from the lowest depth. The youngest value was measured in the deepest level of Karşıyaka. Because Bayraklı is larger in comparison to the Karşıyaka Basin and also with a greater potential for water transfer to the Gulf region, transferred materials accumulated in this zone are in larger quantities. It is however also evident that sedimentation thickness in Karşıyaka and age are inversely proportional. Similarly because basin zone and stream potential are the lowest in the İnciraltı zone, even a much younger age could be measured hereby (Table 10).

3. Conclusion

Current sediments in the Gulf of Izmir demonstrate a heterogenic distribution on the seabed. As shown in the sediment distribution map the dominant unit in the Gulf region is clayed silt. Other units observed in the region are muddy, sandy pebble, silty sand, clayed sand and sandy mud. Biogenic materials observed are test/carapace particles, flora wastes etc. In high energy coastal zones with waves, currents, tide movements etc, and in underwater scarps, the dominant formations were categorized as clastic and non-cohesive materials. Fine grained materials were deposited in the relatively deeper and less energetic zones. Units are generally arranged in narrow bands, parallel to the coast.

Based on the data obtained from the underwater morphology of the Izmir Gulf and the sediment distribution shaping this morphology, the results below emerged:

- In the interior and central Gulf, depths of less than 10 m, mud, silty clayed and clayed silt are present, and at these levels deep-current velocity is near stable.
- In the zone between Kırdeniz Harbor and Çilazmak Fishery, which are characterized by sand and silty sand, delta sediments are eroded by southern winds, powerful waves and currents during autumn and winter and these effect the formation of Kırdeniz, Homa and Çilazmak Natural Fisheries.

Karşıyaka DH-5 drilling samples show a lack of rich foraminifer fauna. Dominant genera and spesies are identified as *Ammonia compacta* Hofker and *Elphidium crispum* (Linné) and *E. macellum* (Fichtel and Moll). *Nonionella turgida* (Williamson) individuals are also quite common. Aside from that almost all specimens contain the ubiquitous and abundant *Aubignyna perlucida* (Heron-Allen and Earland) in the parts where streams empty to the sea; thus it is a finding that verifies the existence of streams in the vicinity of a drilling point (Murray, 1968, 1973, Meriç and Sakınç, 1990). Indeed five streams running towards the gulf, as displayed in Fig. 2, may be recognized as the preliminary evidence backing up this finding. In addition, as widely observed in nearly all specimens, generally blue and dark *Peneroplis pertusus* (Forskal) and *P. planatus* (Fichtel and Moll) individuals and *Ammonia compacta* Hofker, *Elphidium complanatum* (d'Orbigny), *E. crispum* (Linné) and *E. macellum* (Fichtel and Moll), of which tests show morphological abnormities also prove that heavy metal and trace elements transferred by streams to the sea have all been effective in the shaping of this particular zone for a long period of time. Aside from that in certain specimens presence of *Ammonia* and *Elphidium* with a diameter above 1 mm indicates that $CaCO_3$ input towards this zone has been frequent during the past years.

Sediments in Bayraklı DH-4 drilling samples do not contain a rich variety of genera and species. *Ammonia compacta* Hofker and *Elphidium macellum* (Fichtel and Moll) are the dominant genera and species. *Peneroplis pertusus* (Forskal) and *P. planatus* (Fichtel and Moll) previously observed in Karşıyaka DH-5 drilling samples were absent in this zone, which indicates a unique property of the analyzed Gulf Region. In addition the existence of *Ammonia* and *Elphidium* with a diameter above 1 mm verifies that as was seen around Karşıyaka DH-5 drilling, there was an extreme amount of $CaCO_3$ input in this zone.

İnciraltı DH-1 drilling, however, showe dominant genera and species are in keeping with the properties of Karşıyaka DH-5 drilling samples. One of the most crucial properties for this zone is that *Peneroplis pertusus* (Forskal) and *P. planatus* (Fichtel and Moll) individuals were never observed in Bayraklı DH-4 samples. Another significant point about the zone is there are large quantities of *Cladocora caespitosa* (Linné) between 14.70 and 15.45 m. The presence of this coral, normally surviving under 2.00–30.00 m of depth, indicates that there is one or a few hot water outlets inside the sea (Meriç et al., 2003). In a different study that searched geothermal potential in Gülbahçe Bay the very same organism was detected (Pekçetinöz et al., 2009). In addition the presence of *Bairdia* ostracod individuals widely encountered in such specimens also emphasizes that sea level gradually deepens. In these levels both foraminifer and ostracod & mollusk groups demonstrate a marked change. Another noticeable result is detecting few quantities of Hauerinids on the 1 mm sift, aside from the detection of *Ammonia* and *Elphidium* types. It is also surprising that between 15.30 and 16.90 m of depth there were large quantities of *Rosalina bradyi* Cushman. Once again large quantities of dark-grey color *Elphidium* and *Ammonia* are the other critical properties of this zone, also largely true in terms of ostracod carapaces. Furthermore, certain gastropod shells also demonstrate identical properties. In addition, between 17.30 and 17.95 m of depth there is an infrequent foraminifer group and there exists a globally renowned Balçova Thermal near the south of the drilling site. This supports data that in the sea likely there are hot water outlets stemming from fault lines. These may have come about as a result of the great earthquake that broke in and around İzmir at the end of the 18th century.

The Foraminifer group of Urla (Çeşmealtı) specimens, as seen in the İnciraltı zone, fails to offer a rich variety. The key property of this zone is that aside from *Peneroplis pertusus* (Forskal) and *P. planatus* (Fichtel and Moll) observed in Karşıyaka specimens, there are large quantities of young and old *Coscinospira hemprichii* Ehrenberg individuals. Besides the heavy presence of non-coloring individuals, tests preserving their normal properties and abundance of individuals above 1 mm diameter reveal that in this zone, there are $CaCO_3$ containing fresh-water outlet/outlets. Indeed between 3.30 and 3.80 m, 4.50–5.70 m and 6.40–6.50 m, infrequent charophytes and between 5.70 and 6.40 m, quite high numbers of charophytes, were measured.

Next to the data listed above, in the coastal line of Kuşadası (Aydın) District and northern coasts of the Karaburun Peninsula, *Amphistegina lobifera* Larsen individuals are quite high in quantity. This foraminifer was not ever present in Çeşme Ilıca Bay (Meriç et al., 2012). The same condition holds true for the specimens extracted from 4 drillings and this result is another vital property for the drilling zones inside interior and exterior gulf (Figs. 1 and 2).

The rate of Mn is high in the samples from Bayraklı, Karşıyaka and İnciraltı, and as the depth increases, the rate of Mn in the samples from Urla (Çeşmealtı) increases. The analysis also reveals that the rates of Cr and Ni are high in the samples from İnciraltı while low in those from Urla (Çeşmealtı). The rate of Zn in the samples from Bayraklı and İnciraltı follows a variable course while it is inversely proportional to the depth in those from Karşıyaka. The rate of Pb is high only at near-surface levels of Bayraklı, yet it follows a variable course. Some significant changes were observed between the levels of drilling samples from Bayraklı, İnciraltı and Urla (Çeşmealtı) such as sudden low or high values. Consequently, we can state that Bayraklı is affected by heavy metal contamination more than İnciraltı and Karşıyaka while Urla (Çeşmealtı) is little affected. Foraminifera tests taken from Karşıyaka, Bayraklı and İnciraltı locations have returned to black (Plates 4–6). However, concentration of some heavy metals (Ni, Cr and Mn) obtained from sediments of Karşıyaka, Bayraklı and İnciraltı locations are higher than from the Çeşmealtı examples. High concentration of these elements, may be the cause of the color change of the foraminifera tests.

As ostracod genera and species of the four drilling zones are compared, it can be concluded that they are significantly identical. Nonetheless it also becomes evident that for genera and species Karşıyaka is the richest zone in the entire Gulf Region. In Karşıyaka and Bayraklı specimens *Bosquetina carinella, Pterygocythereis jonesi, Semicytherura* types; in Çeşmealtı/Urla zone *Cyprideis torosa;* in İnciraltı *Pseudopsammocythere reniformis* and in the four zones *Loxoconcha* and *Xestoleberis* types were observed ranged in relative frequencies. It is also noteworthy that in the Çeşmealtı/Urla zone, there is a vertical directional differentiation. Marine ostracods are pervasive in the drilling specimens extracted from 3 m of water depth, but after 4 m of depth there exists the cosmopolitan and euryhaline type *Cyprideis torosa* followed by *Heterocypris salina* and *Loxoconcha elliptica* indicating that over time, environmental conditions have changed. Goodman et al. in their 2008 and 2009 dated archeological excavations focused on the sea level changes in the Liman Tepe Iskele, Izmir), İskele Gulf (Port Gulf) situated on the east of the Urla zone and the authors stated that during the Early Bronze Age (~4800–3800 BP) lagoon conditions existed. Our study of ostracod, foraminifer and charophytes groups in the Çeşmealtı/Urla zone as evaluated with respect to environment (Corillon, 1975; Riveline and Meriç, 1995; Meriç et al., 2009) is an accord with this previous study.

As nannoplankton content of drilling specimens is examined, the presence of *E. huxleyi* in specific levels of Karşıyaka DH-5 drilling sample and in all levels of specimens in Bayraklı DH-4 drilling indicate a NN21 *E. huxleyi* zone. It is thus safe to claim that at least N21 *E. huxleyi* of the specimens pertaining to 13.00–13.05 m of depth reflects a sediment that is formed within the ACME subzone (0.09 my-current).

Ubiquitous in all levels of İnciraltı DH-1 drillings specimens and originally seen in the Middle Pleistocene (0.291 my) the *E. huxleyi* indicates a NN21 *E. huxleyi* zone. It first emerged in the *Gephyrocapsa oceanica* NN19 (1.93 my) zone and has survived to the modern day. Also the emerging *Gephyrocapsa omega* was identified as seen for the last time 0.01 my before (Young, 1998). Hence it is feasible that 12.00–12.10 no. specimen is Holocene, and the remaining specimens are Middle/Late Pleistocene. Berggren et al. (1995) reported that a N21 *E. huxleyi* ACME subzone marked with the gradual-increase in the quantity of *E. huxleyi* type started 0.09 my before, while Stant et al. (2004) claimed that it commenced 0.085 my before. It can thus be claimed that rock specimens analyzed till 17.40–17.50 m of depth reflect the hardening in the analyzed 0.09 my at least.

E. huxleyi present in all the levels of the Urla-Çeşmealtı DH-1 drilling core and originally observed during Middle Pleistocene (0.291 my) indicates a NN21 *E. huxleyi* zone. Hence it can be argued that specimens present up to 04.30–04.40 m of depth reflect a sediment that formed in a N21 *E. huxleyi* ACME subzone (0.09 my-current) at least.

It is concluded that in the analyzed zones, age values in different depths are explainable by the material transferred to the zone via surface waters and drainage network and also to the velocity of storage. Thus, based on the insight that the Bayraklı and Karşıyaka drillings existed in the interior Gulf, İnciraltı existed in the central Gulf and Çeşmealtı (Urla) existed in the exterior Gulf it became evident that they all were deposited during the Late Quaternary (Holocene) period.

In addition, the data above the location of the artificial passage that connected 2.350 years ago the Karantina Isle and the coast currently under the sea and likewise the presence of Roman Empire artifacts in deep sea levels demonstrate that earthquakes of the near past led or could have led to the sedimentation of certain zones in the Gulf Region (Goodman et al., 2008, 2009). Likewise the presence of numerous faults in different directions passing over and limiting the Gulf of Izmir is supportive of this claim (Kaya, 1979).

References

Agemian, H., Chau, A.S.Y., 1976. Evaluation of extraction techniques for the determination of metals in aquatic sediments. Analyst 101, 761–767.

Akgün, F., 1995. "İzmit Körfezi (Hersek Burnu – Kaba Burun) Kuvaterner İstifinin Palinolojik İncelemesi. In: Meriç, E. (Ed.), İzmit Körfezi'nin Kuvaterner İstifi", pp. 179–199 ([In Turkish]).

Athersuch, J., Horne, D.J., Whittaker, J.E., 1989. Marine and brackish water ostracods. Synopses Br. Fauna (New Series) 43, 1–343.

Atıcı, T., Özçelik, N., Korkmaz, B., Uğurlu, E., Selçuk, A., 2008. Çanıllı Baraj Gölü (Ankara) Mikroalgleri. Biyol. Bilim. Araştırma Derg. 1 (2), 45–48.

Barinova, S.S., Nevo, E., Bragina, T.M., 2011. Ecological assessment of wetland ecosystems of northern Kazakhstan on the basis of hydrochemistry and algal biodiversity. Acta Bot. Croat. 70 (2), 215–244.

Bergin, F., Küçüksezgin, F., Uluturhan, E., Barut, İ.F., Meriç, E., Avşar, N., Nazik, A., 2006. The response of benthic foraminifera and ostracoda to heavy metal pollution in Gulf of İzmir (Eastern Aegean Sea). Estuar. Costal Shelf Sci. 66, 368–386.

Berggren, W.A., Kent, D.V., Swisher III, C.C., Aubry, M.P., 1995. A revised Cenozoic geochronology and chronostratigraphy. In: Berggren, W.A., Kent, D.V., Aubry, M.-P., Hardenbol, J. (Eds.), Geochronology, Time Scales and Global Stratigraphic Correlation. Spec. Publ. Soc. Econ. Paleontol. Mineral. (Soc. Sediment. Geol.), vol. 54, pp. 129–212.

Bonaduce, G., Ciampo, G., Masoli, M., 1975. Distribution of ostracoda in the Adriatic Sea. Pubbl. Staz. Zool. Napoli 40 (Suppl), 1–304.

Breman, E., 1975. The Distribution of Ostracodes in the bottom sediments of the

Adriatic Sea. Vrije Universiteit te Amsterdam, Krips Repro, Meppel, p. 165.
Carter, T., 2008. Fossil Freshwater Diatoms from Cherryfield (Maine).
Corillon, R., 1975. Flore des Charophytes du Massif Armoricain et des contrées voisines d'Europe Occidenetale (Paris, Jouve éditeur, IV).
Cox, E.J., 1996. Identification of Freshwater Diatoms from Live Material. Chapman and Hall, London, Melbourne, Madras, p. 158.
Erdoğan, M., 2009. Monitoring And Statistical Assessment of Heavy Metal Pollution in Sediments Along Izmir Bay Using ICP-MS. PhD Tesis. Izmir Institute of Technology.
Eryılmaz, M., Aydın, Ş., 1998. Türkiye, İzmir Körfezi, yüzey sediment dağılım haritası (tane büyüklüğüne göre). Ölçek 1, 75, 000, Dz.K.K. Sey. Hid. ve Oşi. Dairesi Başkanlığı, Reporting Date: June 1998, İstanbul. [In Turkish].
Eryılmaz, M., Aydın, Ş., 2001. Türkiye, Ege Denizi, yüzey sediment dağılım haritası (tane büyüklüğüne göre). Scale 1, 100, 000, Dz.K.K. Sey. Hid. ve Oşi. Dairesi Başkanlığı, May 2001, İstanbul. [In Turkish].
Eryılmaz, M., Aydın, Ş., Türker, A., 2002. Ege Denizi'nin güncel çökel dağılım haritası. In: 55. Turkey Geological Congress, Abstracts Book. Room Chamber of Geological Engineers, 11-15 March 2002, 91–92, Ankara. [In Turkish].
Fluin, J., Tibby, J., Gell, P.A., 2009. Testing the efficacy of electrical conductivity (EC) reconstructions from the lower Murray River (SE Australia): a comparison between measured and inferred EC. J. Paleolimnol. http://dx.doi.org/10.1007/s10933-009-9333-8.
Folk, R.L., 1974. Petrology of Sedimentary Rocks. Hemphill Publishing Co., Austin, TX.
Gaudette, H., Flight, W., Toner, L., Folger, D., 1974. An inexpensive titration method for the determination of organic carbon in recent sediments. J. Sediment. Petrology 44, 249–253.
Goodman, B., Reinhardt, E., Dey, H., Boyce, J., Schwarcz, H., Sahoglu, V., Erkanal, H., Artzy, M., 2008. Evidence for Holocene marine transgression and shorline progradation due to barrier development in İskele, Bay of Izmir, Turkey. J. Costal Res. 24 (5), 1260–1280.
Goodman, B.N., Reinhardt, E.G., Dey, H.W., Boyce, J.I., Schwarcz, H.P., Sahoglu, V., Erkanal, H., Artzy, M., 2009. Multi-proxy geoarchaeological study redefines understanding of the paleocoastlines and ancient harbours of Liman Tepe (Iskele, Turkey). Terra Nova 21 (2), 97–104.
Guillaume, M.C., Peypouquet, J.P., Tetart, J., 1985. Quaternaire et actuel. Atlas des Ostracodes de France, Ed: H.J. Oertli. Bull. Centres Rech. Explor. Prod. Elf-Aquitaine. Mém. 9, 337–377.
Gürel, A., Yıldız, A., 2006. Diatom communities, lithofacies characteristics and paleoenvironmental interpretation of Pliocene diatomite deposits in the Ihlara-Selime plain (Aksaray, Central Anatolia, Turkey). J. Asian Earth Sci. 30, 170–180.
Hartmann, G., Puri, H., 1974. Summary of Neontological and paleontological Classification of ostracod. Mitt. Hambg. Zool. Must. Inst. 20, 7–73.
Joachim, C., Langer, M.R., 2008. The 80 Most Common Ostracods from the Bay of Fetovaia Elba Island (Mediterranean Sea). Universität Bonn, p. 29.
Kaya, O., 1979. Ortadoğu Ege çöküntüsünün (Neojen) stratigrafisi ve tektoniği. TJK Bülteni 22, 35–58.
Koçer, M.A.T., Şen, B., 2012. The seasonal succession of diatoms in phytoplankton of a soda lake (Lake Hazar, Turkey). Turk J. Bot. 36, 738–746.
Krammer-Lange Bertalot, 1986. Bacillariophyceae, 1 Teil, band 2/1 pp.84–236; 300–342; 352–379.
Krammer-Lange Bertalot, 1988. Bacillariophyceae, 2. Teil. Band 2/2. Gustav Fischer Verlag Stuttgart, New York. P. 145–157, 168–172.
Krammer-Lange Bertalot, 1991. Bacillariophyceae, 3 Teil, band 2/3 pp.19–40; 113–165; 169–229.
Loring, D.H., 1987. Reliability of trace metal analyses of marine sediments-Am ICES interaction study (I/TM/MS). In: Lindberg, S.E., Hutchinson, T.C. (Eds.), Proceedings of the Sixth International Conference on Heavy Metals in the Environment, 15–18 September, New Orleans, LA. CEP Limited Publishers, Edinburgh, UK, pp. 352–356.
Loring, D.H., Rantala, R.T.T., 1988. An intercalibration exercise for trace metals in marine sediments. Mar. Chem. 24, 13–28.
Martin, D.F., 1972. Marine chemistry. Marcel Dekker Inc, New York xi+389p.
Martini, E., 1971. Standard tertiary and quaternary calcareous nannoplankton zonation. In: Farinacci, A. (Ed.), Proceedings II. Planktonic Conference, Roma, 1970, pp. 739–785.
Meriç, E., Sakınç, M., 1990. In: Meriç, E. (Ed.), Foraminifera. in: İstanbul Boğazı güneyi ve Haliç'in Geç Kuvaterner (Holosen) dip tortulları, pp. 15–41 (İstanbul. [In Turkish]).
Meriç, E., Kerey, İ.E., Avşar, N., Tuğrul, A.B., Suner, F., Sayar, A., 2003. Haliç (İstanbul) kıyı alanlarında (Unkapanı-Azapkapı) gözlenen Holosen çökelleri hakkında yeni bulgular. J. H.Ü. Earthsci. 28, 9–32. Ankara. ([In Turkish]).
Meriç, E., Avşar, N., Mekik, F., Yokeş, B., Barut, İ.F., Dora, Ö., Suner, F., Yücesoy-Eryılmaz, F., Eryılmaz, M., Dinçer, F., Kam, E., 2009a. Alibey ve maden Adaları (Ayvalık-Balıkesir) Çevresi Genç Çökellerinde Gözlenen Bentik Foraminifer Kavkılarındaki Anormal Oluşumlar ve Nedenleri. Geol. Bull. Turk. 52 (1), 31–84 (Ankara. [In Turkish]).
Meriç, E., Avşar, N., Barut, İ.F., Yokeş, M.B., Taş, S., Eryılmaz, M., Dinçer, F., Bircan, C., 2009b. Kuşadası (Aydın) Deniz Dibi Mineralli Su Kaynağı Çevresi Bentik Foraminifer Topluluğu Hakkında Görüş ve Yorumlar. In: 13. Underwater Science and Technology Meeting (SBT 2009) 7–8 November 2009, Lefkoşa/KKTC, Proceedings, pp. 80–92 ([In Turkish]).
Meriç, E., Avşar, N., Barut, İ.F., Yokeş, B., Dinçer, F., 2009c. Doğu Ege Denizi Kiyi Alanlarindaki termal Mineralli Su Kaynaklarinin Bentik Foraminifer Toplulukларina Etkisi. J. Earth Sci. İstanbul Univ. 22 (2), 163–174 ([In Turkish]).
Meriç, E., Avşar, N., Nazik, A., Yokeş, B., Barut, İ.F., Eryılmaz, M., Kam, E., Taşkın, H., Başsarı, A., Dinçer, F., Bircan, C., Kaygun, A., 2012. Ilıca koyu (Çeşme-İzmir) Bentik Foraminifer-Ostrakod Toplulukları ile Pasifik Okyanusu ve Kızıldeniz Kökenli Göçmen Foraminifer ve Anormal Bireyler. J. MTA. 145, 62–78. Ankara. [In Turkish].
Meriç, E., Perinçek, D., Avşar, N., Nazik, A., Yücesoy-Eryılmaz, F., Barut, İ.F., Dinçer, F., 2009d. Yenikapı (Güney İstanbul) eski kıyılarında 5-12. yüzyıllar arasındaki çevre kirliliğinin bentik foraminiferlerle belirlenmesi. Bull. TPJD 21 (1), 1–21 (Ankara. [In Turkish]).
Mostafawi, N., Matzke-Karasz, R., 2006. Pliocene ostracoda of Cephalonia, Greece. The Unrevised species of Uliczny (1969). Rev. Española Micropaleontol. 38 (1), 11–48.
Murray, J.W., 1968. Living foraminifers of lagoons and estuaries. Micropaleontology 14 (4), 435–455.
Murray, J.W., 1973. Distribution and Ecology of Living benthic Foraminiferids. Heinemann Educational Books, London, pp. 1–272.
Müller, G., 1967. Methods in sedimentary Petrology. The Hafner Publishing Company, Germany, p. 216.
Öztürk, B., Doğan, A., Bitlis-Bakır, B., Salman, A., 2014. Marine molluscs of the Turkish coasts: an updated checklist. Turkish J. Zool. 38, 832–879.
Pekçetinöz, B., Kayseri, M.S., Eftelioğlu, M., Özel, E., 2009. Gülbahçe Körfezi'ndeki hidrotermal aktivitenin yüksek ayırımlı sığ sismik ve palinolojik çalışmalar ile belirlenmesi. Geol. Bull. Turk. 52 (3), 325–365 (Ankara. [In Turkish]).
Perch-Nielsen, K., 1985a. Mesozoic calcareous nannofossils. In: Bolli, H.M., Saunders, J.B., Perch-Nielsen, K. (Eds.), Plankton Stratigraphy, Cambridge Earth Science Series, pp. 329–426.
Perch-Nielsen, K., 1985b. Cenozoic calcareous nannofossils. In: Bolli, H.M., Saunders, J.B., Perch-Nielsen, K. (Eds.), Plankton Stratigraphy, Cambridge Earth Science Series, pp. 427–554.
Reinhardt, P., 1972. Coccolithen. Kalkiges nannoplankton seit jahmillionen. Neue Brehm Bücherei 453, 1–99.
Reuss, A.E., 1850. Neue Foraminiferen aus den Schichten des Österreichischen Tertiärbeckens, K. Akad. Wiss Wien Math.-naturw. Kl. 1, 365–390.
Riveline, J., Meriç, E., 1995. In: Meriç, E. (Ed.), İzmit Körfezi (Hersek Burnu-Kaba Burun) kuvaterner istifinin karofit florası. Izmit Bay Quaternary Sequences, pp. 201–205 (İstanbul. [In Turkish]).
Romein, A.J.T., 1979. Lineages in early paleogene calcareous nannoplankton. Utrecht Micropaleoniol Bull. 22, 1–231.
Round, F.E., Crawford, R.M., Mann, D.G., 2007. The Diatoms Biology and Morphology of the Genera. Cambridge University Pres, p. 747.
Ruggieri, G., 1992. Considerazioni tassonomiche su ostracodi neogenici e pleistocenici risultate dalla revisione di vecchi lavori dello scrivente. Boll. della Soc. Paleontol. Ital. 31, 175–188.
Sagular, E.K., 2003. Nannofosil verilerinin stratigrafik yaş ve ortamsal tanımlamalarda kullanımına ilişkin yeni bir inceleme yöntemi. Süleyman Demirel Univ. J. Inst. Sci. Technol. (special Issue) 7 (2), 25–36 ([In Turkish]).
Sagular, E.K., 2009. Fossil didemnid ascidian spicule records in the Plio-Quaternary marine clastics of the Antalya basin (Eastern Mediterranean) and their stratigraphic calibration to new nannofossil data. Geosciences J. 13 (2), 121–131.
Stant, S.A., Lara, J., McGonigal, K.L., Ladner, B.C., 2004. Quaternary nannofossil biostratigraphy from ocean drilling Program Leg 189, Tasmanian Gateway. In: Exon, N.F., Kennett, J.P., Malone, M.J. (Eds.), Proc. ODP, Sci. Results, vol. 189, pp. 1–26.
Tase, M.D., 2004. Overview on Diatoms from Ohrid Lake, Ohrid. FY Republic of Macedonia, pp. 25–29.
Taş, B., Gönülol, A., 2007. Derbent Baraj gölü (Samsun, Türkiye)'nün planktonik algleri. J. Fish. Sci. 1 (3), 111–125 ([In Turkish]).
UNEP/IAEA, 1986. Determination of Total Iron in Marine sediments by Flame Atomic Absorption spectrophotometry. Reference Methods for Marine Pollution Studies. No. 37-39, Vienna.
van Dam, H., Mertens, A., Sinkeldam, J., 1994. A coded checklist and ecological indicator values of freshwater diatoms from The Netherlands. Neth. J. Aquat. Ecol. 28, 117–133.
van Morkhoven, F.P.C.M., 1963. Post Palaeozoic Ostracoda, vol. 2. Elsevier Amsterdam, p. 478.
Yassini, I., 1979. The littoral system ostracodes from the Bay of bou, ismail, Algeries. Algeria Rev. Espanola Micropaleontol. XI (3), 353–416.
Young, J.R., 1998. Neogene. In: Bown, P.R. (Ed.), Calcareous Nannofossil Biostratigraphy. British Micropalaeontological Society Publications Series. Chapman &Hall, London, pp. 225–265.
Yücesoy-Eryılmaz, F., Eryılmaz, M., 2000. Derin Deniz Güncel çökellerinin sedimantolojik ve jeokimyasal özelliklerine Ege Denizi Çukurluğu. Yerbilimleri (Geosound) Science and Technology Bulletin on Earth Science, Offical Publication of the Associtation Geological Engineering and Mining Engineering of Çukurova University Turkey. [In Turkish].
Zangger, E., Malz, H., 1989. Late Pleistocene,Holocene, and recent ostracods from the Gulf of Argos, Greece. Cour. Forsch. Inst. Senckenberg 113, 159–175.