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CONODONT FAUNA AND BIOSTRATIGRAPHY OF THE EARLY-MIDDLE DEVONIAN UNITS IN BEYKOZ, ŞILE AND KURTDOĞMUŞ AREAS, İSTANBUL, TURKEY

Dilek Gülnur SAYDAM-DEMİRAY* and Şenol ÇAPKINOĞLU**

ABSTRACT.- Conodont faunas defining the *delta-pesavis* zones (upper Lochkovian, Lower Devonian) from Beykoz and Karamandere sections of the İstinye Formation (the Yumrukaya Group) and the *laticostatus*, *serotinus*, *patulus* and *partitus* zones (upper Emsian-lower Eifelian, Lower-Middle Devonian) from Büyükdere and Kokarpınar sections of the Kozyatağı member of the Kartal Formation were obtained. A total of 22 species/subspecies were described belonging to the genera *Neopanderodus* (2), *Icriodus* (8), *Pelekysgnathus* (1), *Lanea* (1), *Polygnathus* (4), *Ozarkodina* (2), *Pseudooneotodus* (2) and *Belodella* (2).

Key words: Lower-Middle Devonian, conodont fauna, biostratigraphy, İstinye Formation, Kozyatağı member, İstanbul, Turkey

INTRODUCTION

The first conodont investigations in the İstanbul zone of the Pontides, Turkey were made by Abdüsselamoğlu (1963); followed by Haas (1968), Gedik (1975), Göncüoğlu et al. (2004), and Çapkınoğlu (1997, 2000, 2005*a*, 2005*b*) who described conodont faunas from Paleozoic and Triassic units in the vicinity of İstanbul and Kocaeli, Turkey. A total of 96 limestone samples for conodont were collected, for this study, from four measured stratigraphic sections in Beykoz, Şile and Kurtdoğmuş areas (İstanbul, Turkey) (Figure 1) of the Kozyatağı Member (the Kartal Formation) and the İstinye Formation (the Yumrukaya Group). The Lower-Middle Devonian conodonts were found in 34 samples, which were used to carry out the biostratigraphic zonation of the investigated stratigraphic sections.

Figure 1- Location map of the study area.

MATERIALS AND METHODS

Samples collected for conodonts were broken down pieces in 2-3 cm diameter and processed in plastic buckets using standard acidizing techniques with formic- and/or acetic-acid. In the formic acid method, each kilogram of rock is placed in a solution of 1500 ml formic-acid and 6000 ml water fro 24 hours. In the acetic acid method, a solution of 100 ml acetic acid and 900 ml water, is used per 1 kg of rock.

Residue filtered from the nested sieves of 100 micron and 2 mm was washed by running water until fully clear water flows. The residue on 100-micron sieve was transferred into a porcelain bowl or glass holder and dehydrated in

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an oven at 60°C. Dry residues were screened through nested sieves of 100 micron and 1 mm, and conodonts were picked from the 100 micron to 1 mm fraction under the binocular microscope.

STRATIGRAPHY

The lithostratigraphic units in the İstanbul Paleozoic sequence were given different names (Lower Ordovician–Visean) by different investigators in previous studies (Kaya, 1973; Önalan 1981, 1982; Gedik et al., 2004). In this study, the stratigraphic nomenclature of Gedik et al. (2004) was taken as the basis (Figure 2).

The Dolayoba Formation, the basal unit of the Yumrukaya Group, was first named as "the Dolayoba Limestone" by Kaya (1973), and then, was changed to "the Dolayoba Formation" by Önalan (1981, 1982). It consists mainly of light-gray, sometimes pink to light-brown reefal limestones. Yellow to beige, thin-bedded shales are observed near the bottom. It includes abundant corals, brachiopods, orthoceratids and crinoid stems. The Dolayoba Formation (100 m thick) is conformably bounded by the Gözdağ Formation from the lower and the İstinye Formation from the upper. The İstinye formation, the upper unit of the Yumrukaya Group, was first defined by Kaya (1973). It was subdivided, in ascending order, into three members: the Sedefadası (thinly laminated limestone-shale), Gebze (thin- to medium-bedded limestones), and Kaynarca (coarse nodular limestone–shale) members. The İstinye Formation, about 300 m thick, is conformable and transitional with the underlying Dolayoba Formation and the overlying Kartal Formation.

The Kartal Formation consists of shale, sandstone and limestone alternation. The Kozyatağı Member, the middle part of the Kartal Formation, was first defined by Kaya (1973) as a stratigraphic formation, but was reduced in rank by Gedik et al. (2004) to a member. It is made up of greenish-gray, gray and whitish-beige, thin- to medium-bedded limestone, bioclastic limestone, sandy limestone, laminated limestone and gray carbonated shales, and is both laterally and vertically transitional with other rock types forming the Kartal Formation. It comprises rather dense, reworked brachiopod and crinoid. Nodular limestones and/or nodular limestone-shale alternation are observed at some levels.

BIOSTRATIGRAPHY

The Lower Devonian conodont faunas were obtained from the Beykoz and Karamandere stratigraphic sections of the İstinye Formation (the Yumrukaya Group) (Figures 3, 4) and the Lower–Middle Devonian from the Büyükdere and Kokarpınar stratigraphic sections of the Kozyatağı member of the Kartal Formation (Figure 5).

A direct correlation with common conodont zones of the pelagic biofacies was not possible, because of the lack of conodonts in many samples, the absence of (Klapper and Ziegler, 1979; Johnson et al., 1980; Johnson et al., 1985) zone-defining taxa due to shallow-water biofacies, the restricted diversity of species, and the irregular vertical distributions of the present taxa.

The Beykoz Measured Stratigraphic Section (the İstinye Formation, the Yumrukaya Group)

A total of 35 samples were collected from the Beykoz Section (155 m thick), but only 4 samples produced conodont faunas (Figure 6).

Sample BG28 collected from gray to dark-gray, massive limestone bed, and sample BG34 from the lower part of gray, thick- or thinly-bedded limestones yielded *Lanea eleanorae* (Lane and Ormiston) (Figure 6, Table 1). Sample BG30 from nodular limestone bed produced *Icriodus* cf. *vinearum* Carls, Klapper and Murphy and *Pseudooneotodus* sp., and sample BG32 *Icriodus rectangularis lotzei* (Carls) and *Icriodus* cf. *vinearum* Carls.

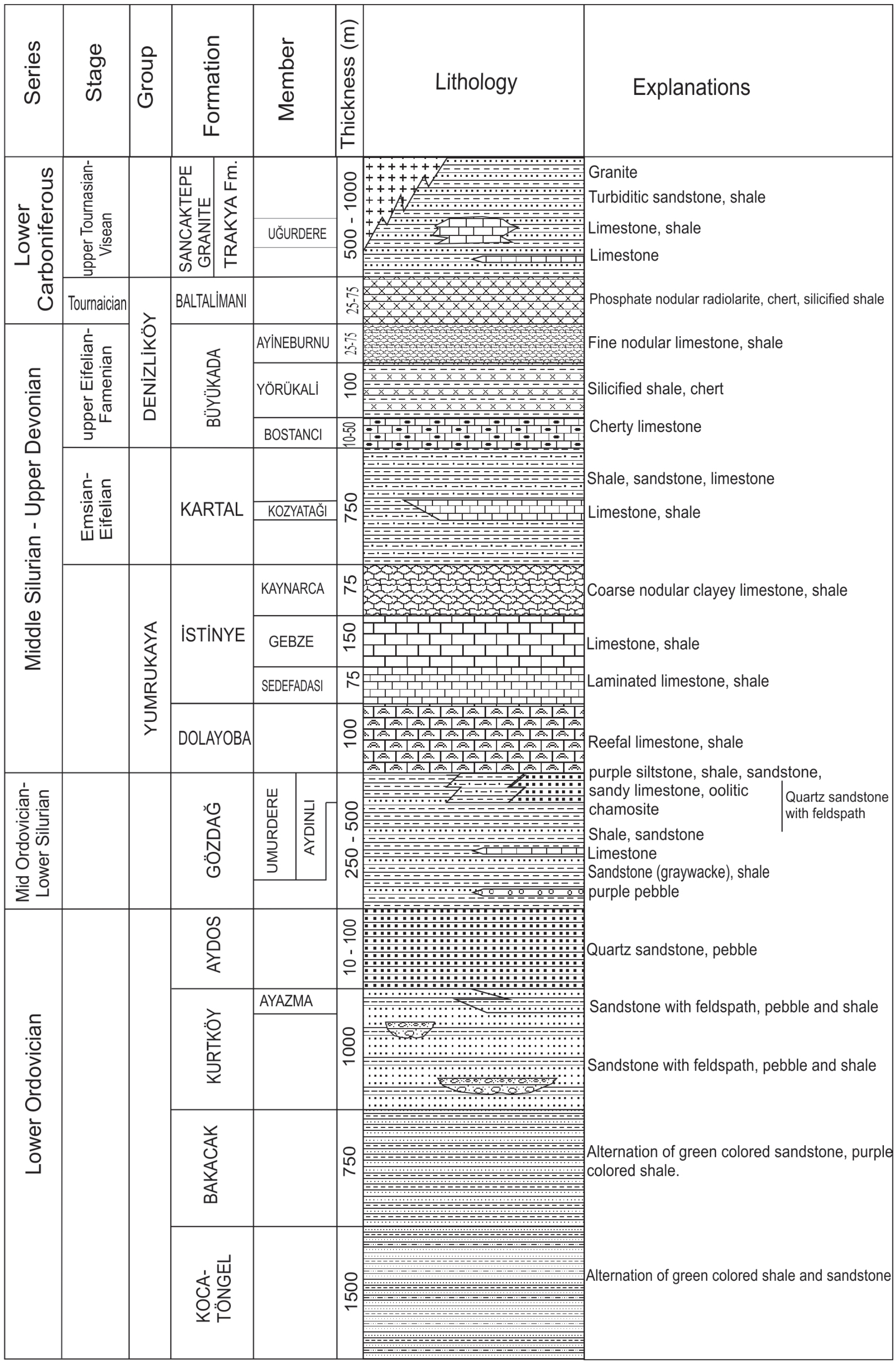

Figure 2- Generalized columnar section of the İstanbul Paleozoic Sequence

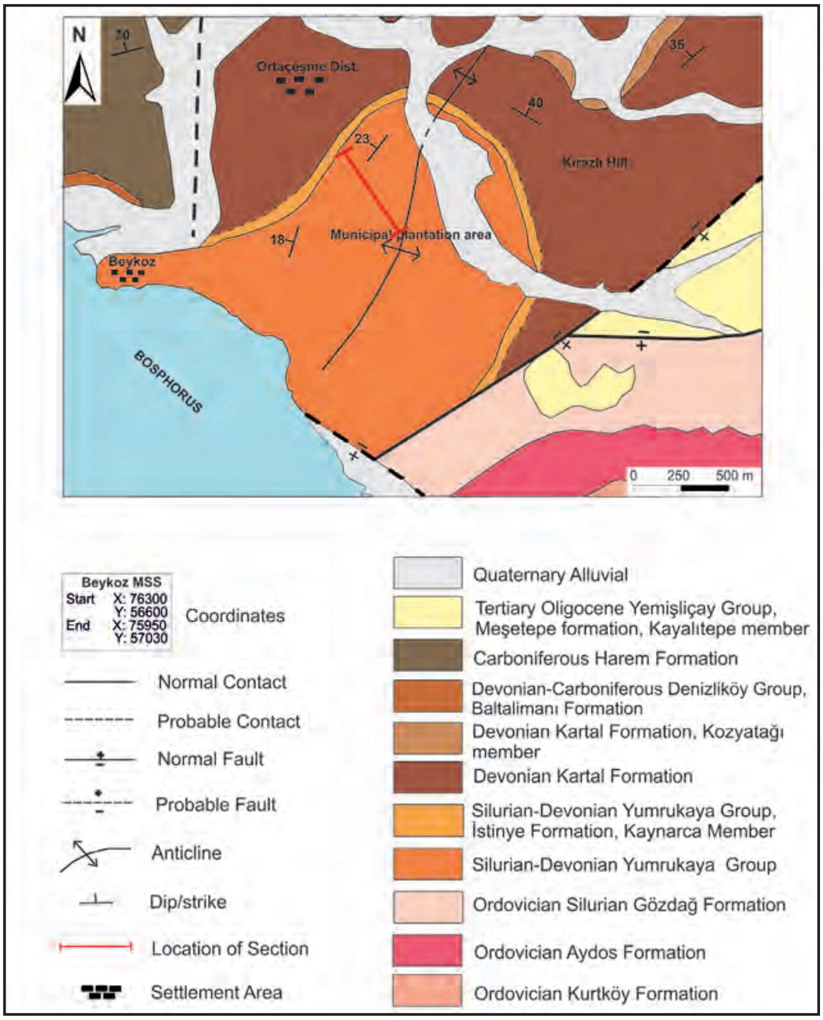

Figure 3- Geological map showing the location of the Beykoz section.

Table 1- Conodont distribution at the Beykoz section.

STAGE	upper Lochkovian			
ZONE	*delta*			
SAMPLE (BG)	28	30	32	34
Lanea eleanorae	1			2
Icriodus rectangularis lotzei			2	
Icriodus cf. *vinearum*		1	2	
Pseudooneotodus sp.		1		

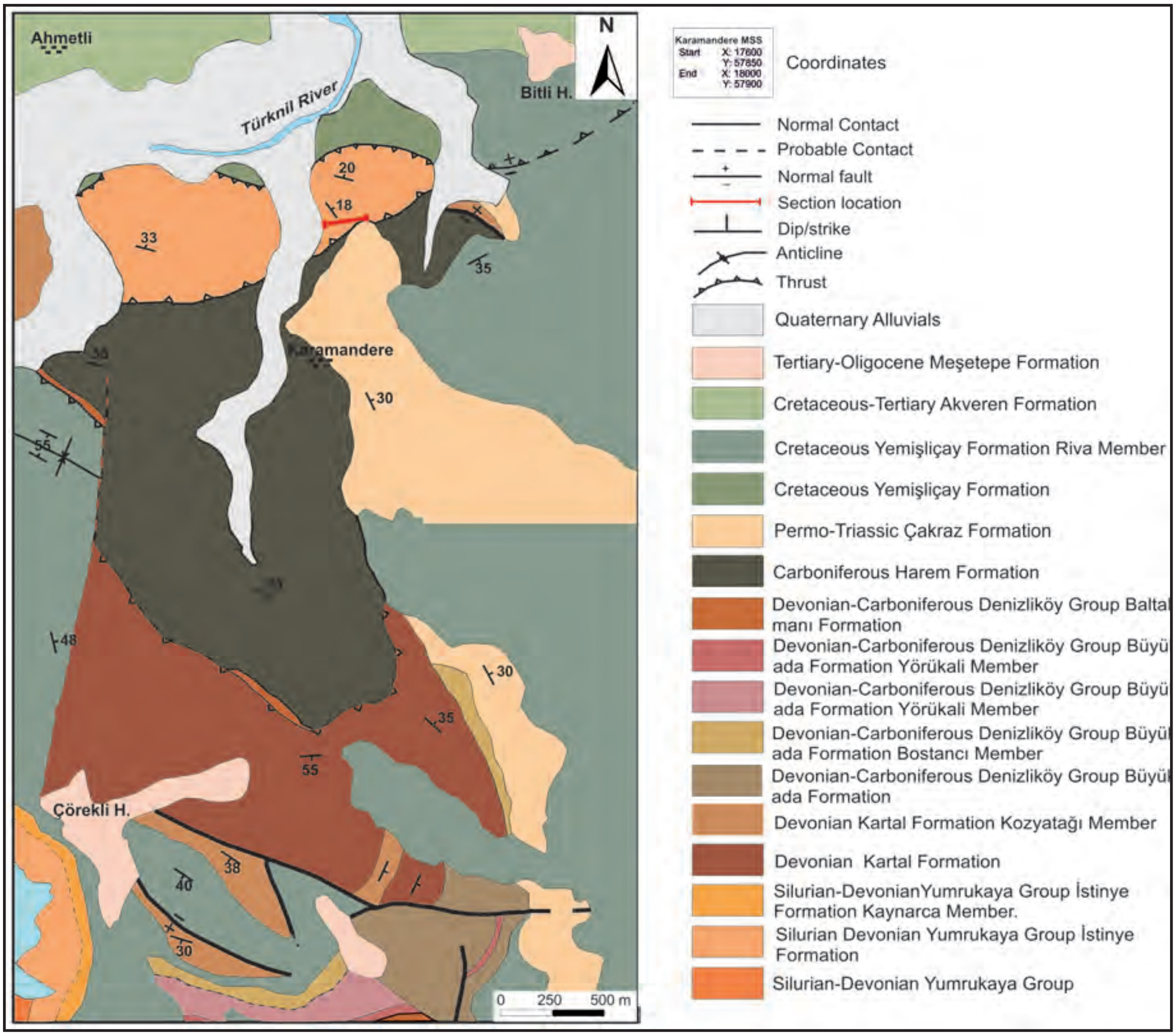

Figure 4- Geological map showing the location of the Karamandere section.

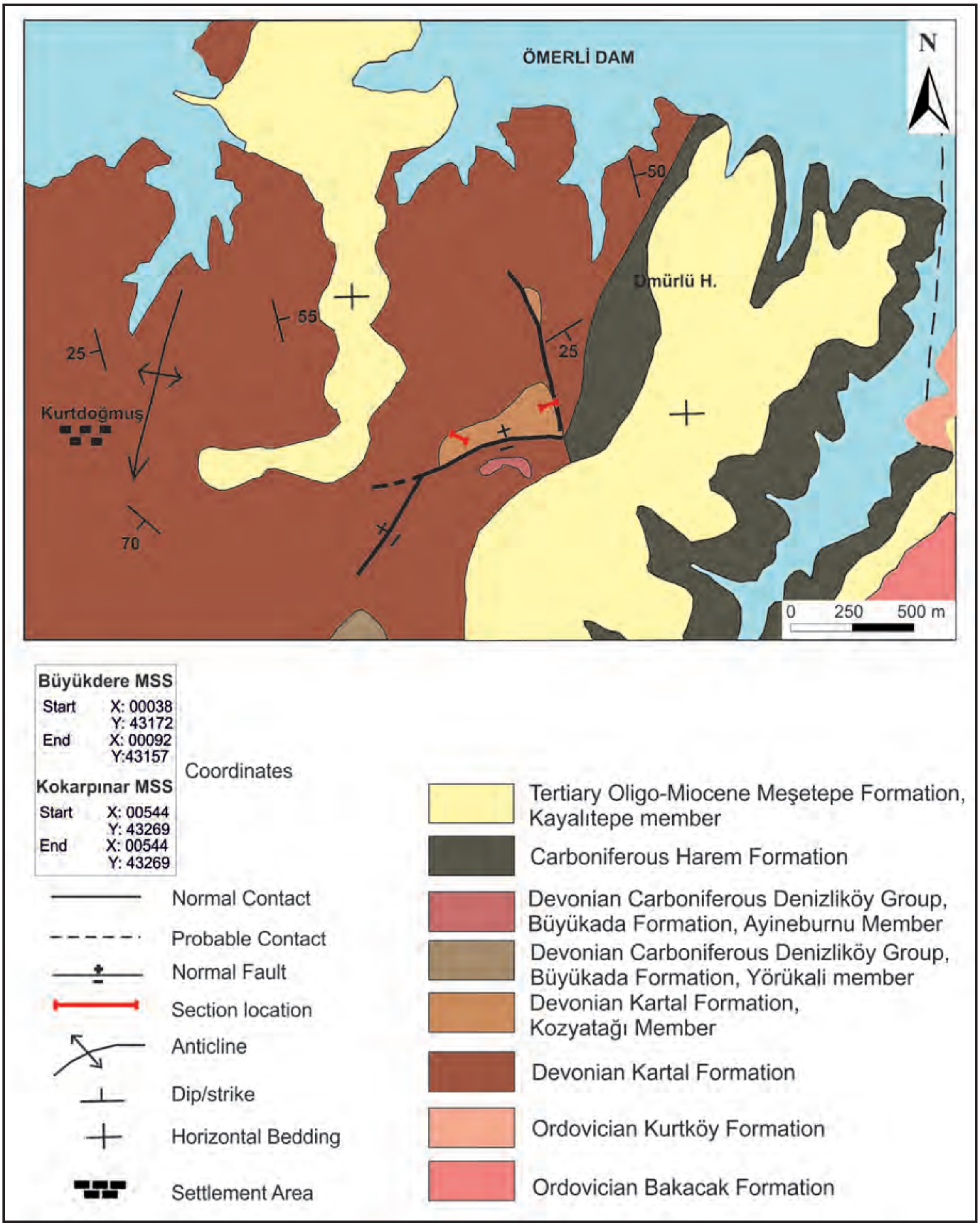

Figure 5- Geological map showing the locations of the Büyükdere and Kokarpınar sections.

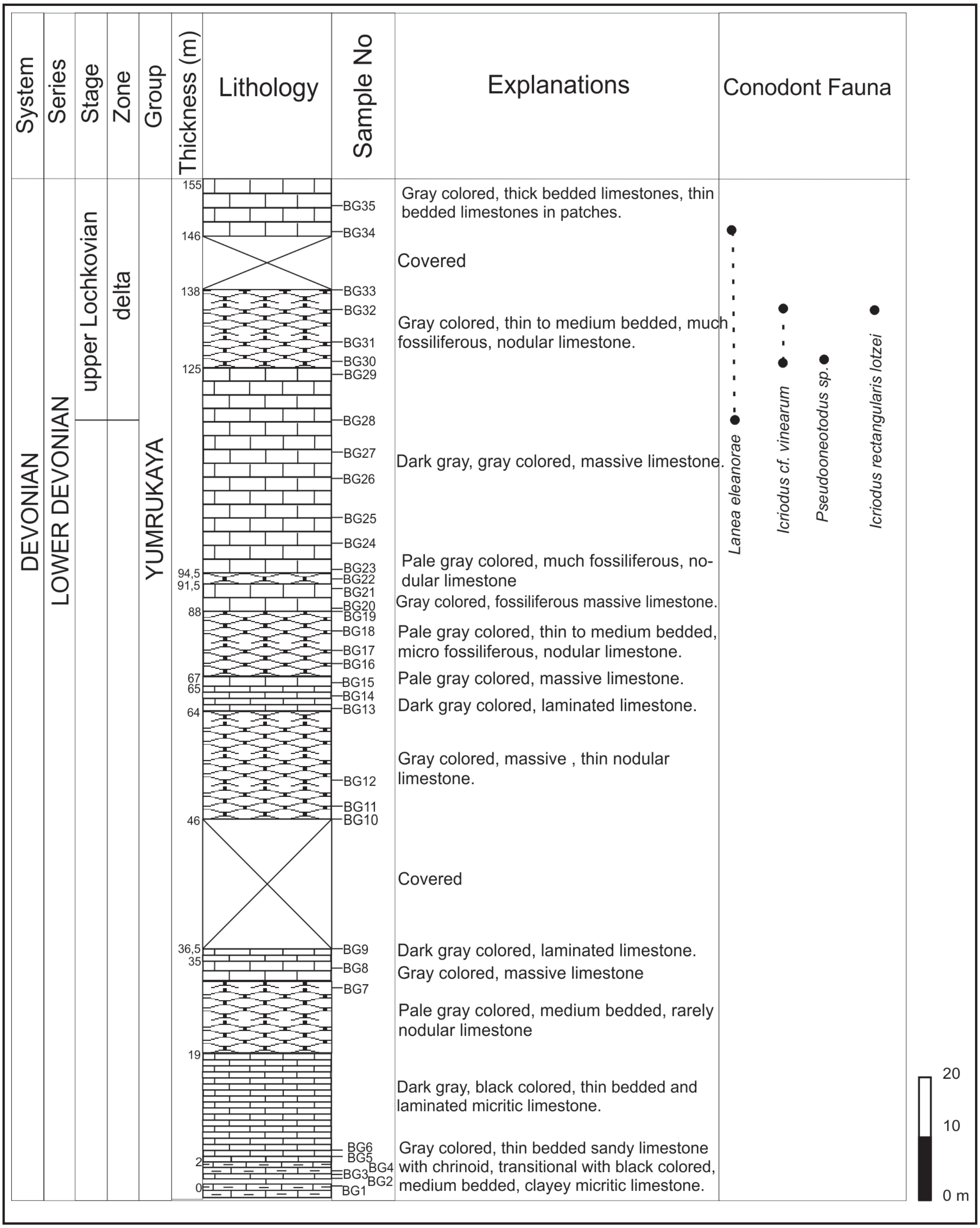

Figure 6- The Beykoz measured stratigraphic section.

Based on the presence of *Lanea eleanorae* (Lane and Ormiston) with a range restricted to the *delta* Zone (upper Lochkovian) (Murphy and Matti, 1983, Figure 4; Murphy and Berry, 1983, Figure 2), samples BG28–BG34 in the Beykoz section are referred to this zone (Table 1).

The Karamandere Measured Stratigraphic Section (the İstinye Formation, the Yumrukaya Group)

Only 7 of 15 samples collected from limestone strata in the Karamandere Section of the İstinye Formation (99.8 m thick) produced conodont faunas (Figure 7). Sample ŞG3 from blackish-gray, thin- to medium-bedded, detrital limestone bed with calcite veins produced *Ozarkodina* sp. Sample ŞG4 from a dark-gray, brachiopod bearing massive limestone bed yielded *Icriodus angustoides alcoleae* Carls and *Icriodus* cf. *vinearum* Carls. *Icriodus angustoides alcoleae* Carls was recovered sample ŞG5 taken from a light-gray, thin- to brachiopod and crinoid bearing medium-bedded limestone bed . Sample ŞG8 produced *Pseudooneotodus beckmanni* (Bischoff and Sannemann) and *Icriodus angustoides alcoleae* Carls. Samples ŞG9-10 and ŞG15 yielded *Icriodus angustoides alcoleae* (Carls and Gandl).

The presence of *Icriodus angustoides alcoleae* Carls and Gandl, identified by Valenzuela-Rios (1994) from the *delta* and *pesavis* zones (upper Lochkovian), indicate that samples ŞG4-ŞG15 in the Karamandere Section are Upper Lochkovian in age (Table 2).

Table 2- Conodont distribution at the Karamandere section.

STAGE	upper Lochkovian						
ZONE	*delta-pesavis*						
SAMPLE (ŞG)	3	4	5	8	9	10	15
Icriodus angustoides alcolea		6	2	3	3	2	2?
Icriodus cf. *vinearum*		1?					
Ozarkodina sp.	2						
Pseudooneotodus beckmanni				1			

The Kokarpınar Measured Stratigraphic Section (the Kozyatağı member, the Kartal Formation)

Only 11 of 19 limestone samples that were collected from the Kokarpınar stratigraphic section (4.65 m thick) produced conodont faunas (Figure 8). The section begins with 25 cm thick, gray, nodular limestone bed. A conodont fauna consisting of *Neopanderodus perlineatus* Ziegler and Lindström, *Belodella resima* (Philip) and *Pseudooneotodus beckmanni* (Bischoff and Sannemann) was recovered from sample KP1 taken from this bed.

The following conodont faunas were obtained from samples collected from limestone strata within greenish-gray to gray, thin- to medium-bedded limestone and shale sequence constituting the majority of the section.

Sample KP10 produced *Neopanderodus perlineatus* (Ziegler and Lindström); sample KP11 *Belodella resima* (Philip); sample KP12, *Neopanderodus transitans* (Ziegler and Lindström); sample KP13 *Neopanderodus perlineatus* Ziegler and Lindström, and *Pseudooneotodus beckmanni* (Bischoff and Sannemann); sample KP13A *Polygnathus linguiformis bultyncki* Weddige beta morphotype, *Neopanderodus perlineatus* (Ziegler and Lindström), *Pseudooneotodus beckmanni* (Bischoff and Sannemann), and *Ozarkodina carinthiaca* (Schulze); sample KP13B *Neopanderodus transitans* Ziegler and Lindström, *Pseudooneotodus beckmanni* (Bischoff and Sannemann); sample KP14 *Neopanderodus transitans* Ziegler and Lindström, and *Belodella resima* (Philip); sample KP15 *Ozarkodina carinthiaca* (Schulze) and *Neopanderodus perlineatus* (Ziegler and Lindström); sample KP16 *Neopanderodus perlineatus* Ziegler and Lindström, and *Belodella resima* (Philip). A fauna containing *Polygnathus linguiformis bultyncki* Weddige alpha morphotype, *Icriodus corniger* subsp., and *Neopanderodus perlineatus* (Ziegler and Lindström) was recovered from sample KP17 collected from a 15 cm thick, gray nodular limestone bed forming the uppermost part of the Kokarpınar section.

Polygnathus linguiformis bultyncki Weddige has a range extending from the base of the *serotinus* Zone to the end of the *costatus* Zone (Klapper et al., 1978, Figure 3). According to

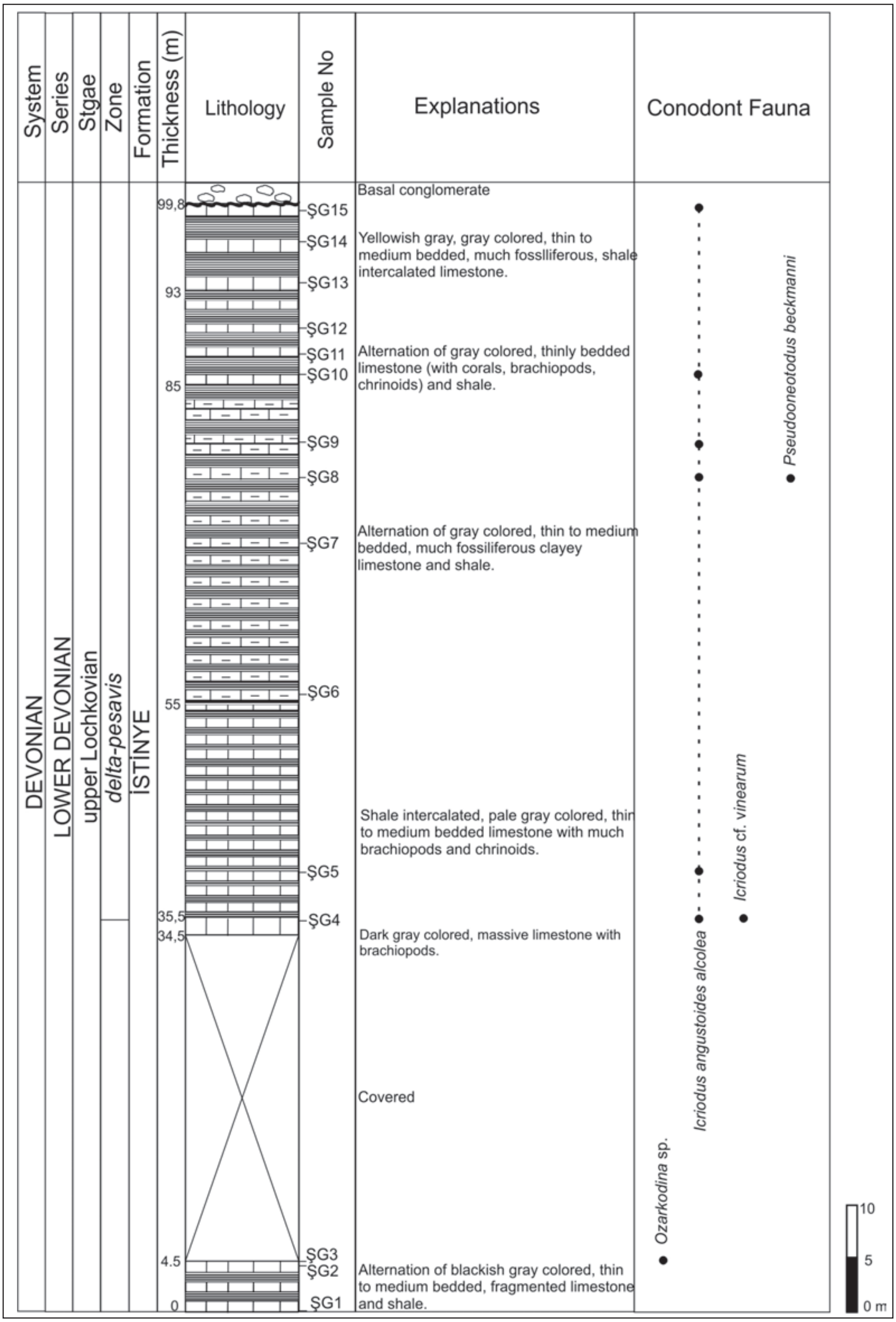

Figure 7- The Karamandere measured stratigraphic section.

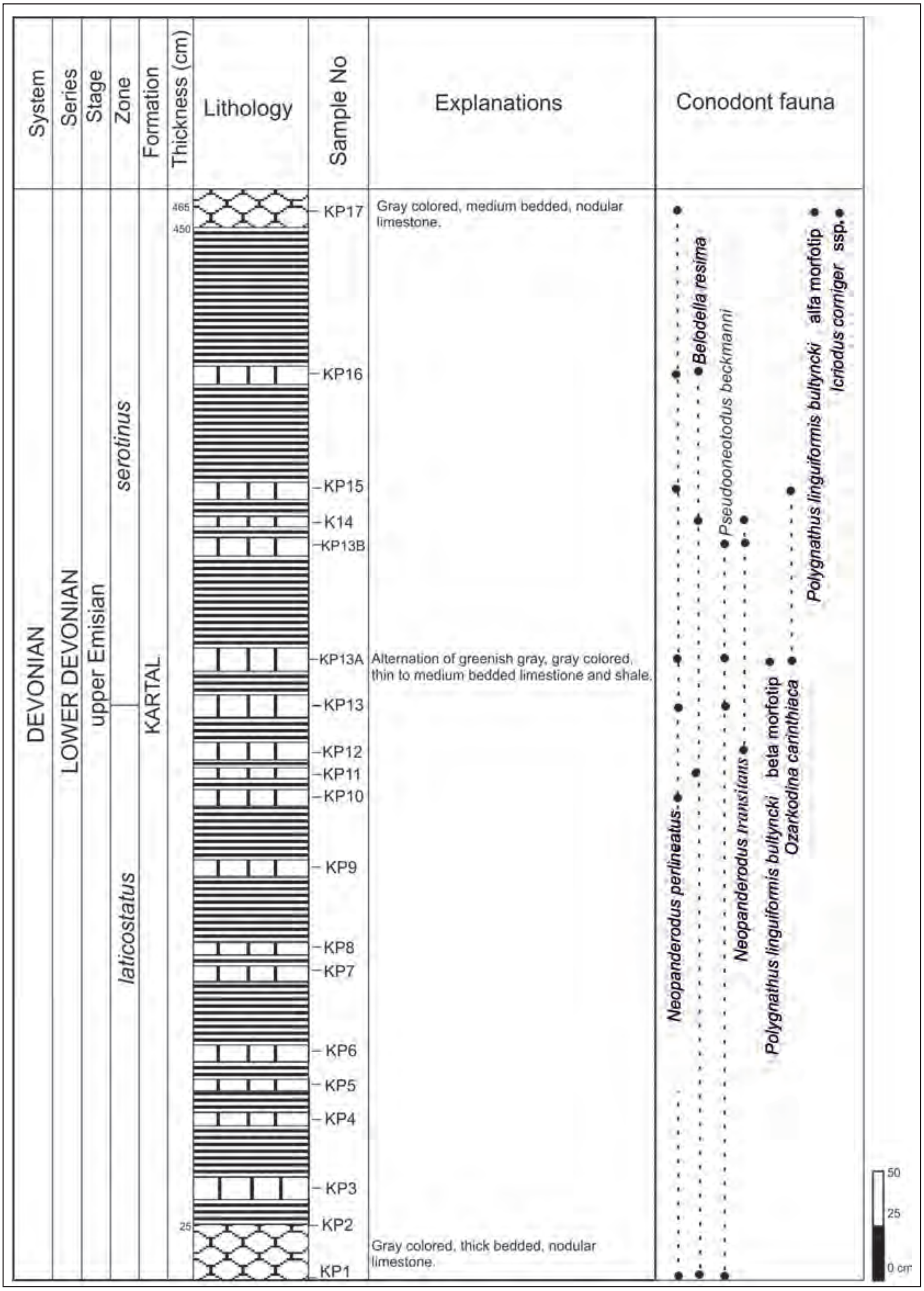

Figure 8- The Kokarpınar measured stratigraphic section.

Wang and Ziegler (1983), alpha and beta morphotypes of this subspecies belong to the *serotinus* Zone. Also, *Ozarkodina carinthiaca* (Schulze) has a range extending from the beginning of the *serotinus* Zone to the end of the *patulus* Zone (Klapper et al., 1978, figure 3). Thereby, samples KP13A-KP17 including collective ranges of these taxa indicated above are within the *serotinus* Zone (upper Emsian) (Table 3). The lower samples (KP1–KP13) most probably belong to the *laticostatus* and older zones.

The Büyükdere Measured Stratigraphic Section (the Kozyatağı Member, the Kartal Formation)

A total of 27 limestone samples were collected from the Büyükdere section (12,25 m thick) of the Kozyatağı member of the Kartal Formation, but only 12 of these samples yielded conodont faunas (Figure 9). *Belodella devonica* (Stauffer), *Belodella resima* (Philip) and *Pseudooneotodus beckmanni* (Bischoff and Sannemann) were recovered from sample BD1 collected from the bottom of the Büyükdere section starting with gray, greenish-gray, thin- to medium-bedded, limestone-shale alternation. The overlying part of the section consists of greenish-gray to gray, thin- to medium-bedded limestone with sometimes laminated limestone and shale alternations. From samples collected from this part, sample BD4 produced *Polygnathus cooperi cooperi* Klapper and *Belodella resima* (Philip); sample BD11 *Ozarkodina carinthiaca* (Schulze) and *Neopanderodus perlineatus* Ziegler and Lindström; sample BD13 *Polygnathus inflexus* Baranov, *Polygnathus linguiformis bultyncki* Weddige alpha morphotype, *Polygnathus linguiformis bultyncki* Weddige beta morphotype, *Ozarkodina carinthiaca* (Schulze), *Pelekysgnathus serratus*, *Icriodus corniger* subsp., *Neopanderodus perlineatus* (Ziegler and Lindström), *Neopanderodus transitans* (Ziegler and Lindström), *Belodella resima* (Philip), and *Pseudooneotodus beckmanni* (Bischoff and Sannemann); sample BD17 *Polygnathus cooperi cooperi* Klapper, *Polygnathus inflexus* Baranov, *Polygnathus linguiformis bultyncki* Weddige beta morphotype, *Polygnathus serotinus* Telford delta morphotype, *Ozarkodina carinthiaca* (Schulze), *Neopanderodus perlineatus* (Ziegler and Lindström), *Neopanderodus transitans* Ziegler and Lindström.

From samples collected from thin-bedded limestones, sample BD18 yielded *Polygnathus cooperi cooperi* (Klapper); sample BD19 *Belodella resima* (Philip); sample BD20 *Polygnathus cooperi cooperi* (Klapper), *Polygnathus inflexus* (Baranov), *Polygnathus linguiformis bultyncki*

Table 3- Conodont distribution at the Kokarpınar section.

STAGE	upper Emsian										
ZONE	*laticostatus*					*serotinus*					
SAMPLE (KP)	1	10	11	12	13	13A	13B	14	15	16	17
Polygnathus linguiformis bultyncki alfa morfotip											1
Polygnathus linguiformis bultyncki beta morfotip						1					
Ozarkodina carinthiaca						1?			2		
Icriodus corniger ssp.											1
Neopanderodus perlineatus	2	2			1	1			3	1	1
Neopanderodus transitans				2			1	1			
Belodella resima	1		1					1		2	
Pseudooneotodus beckmanni	2				2	2	1				

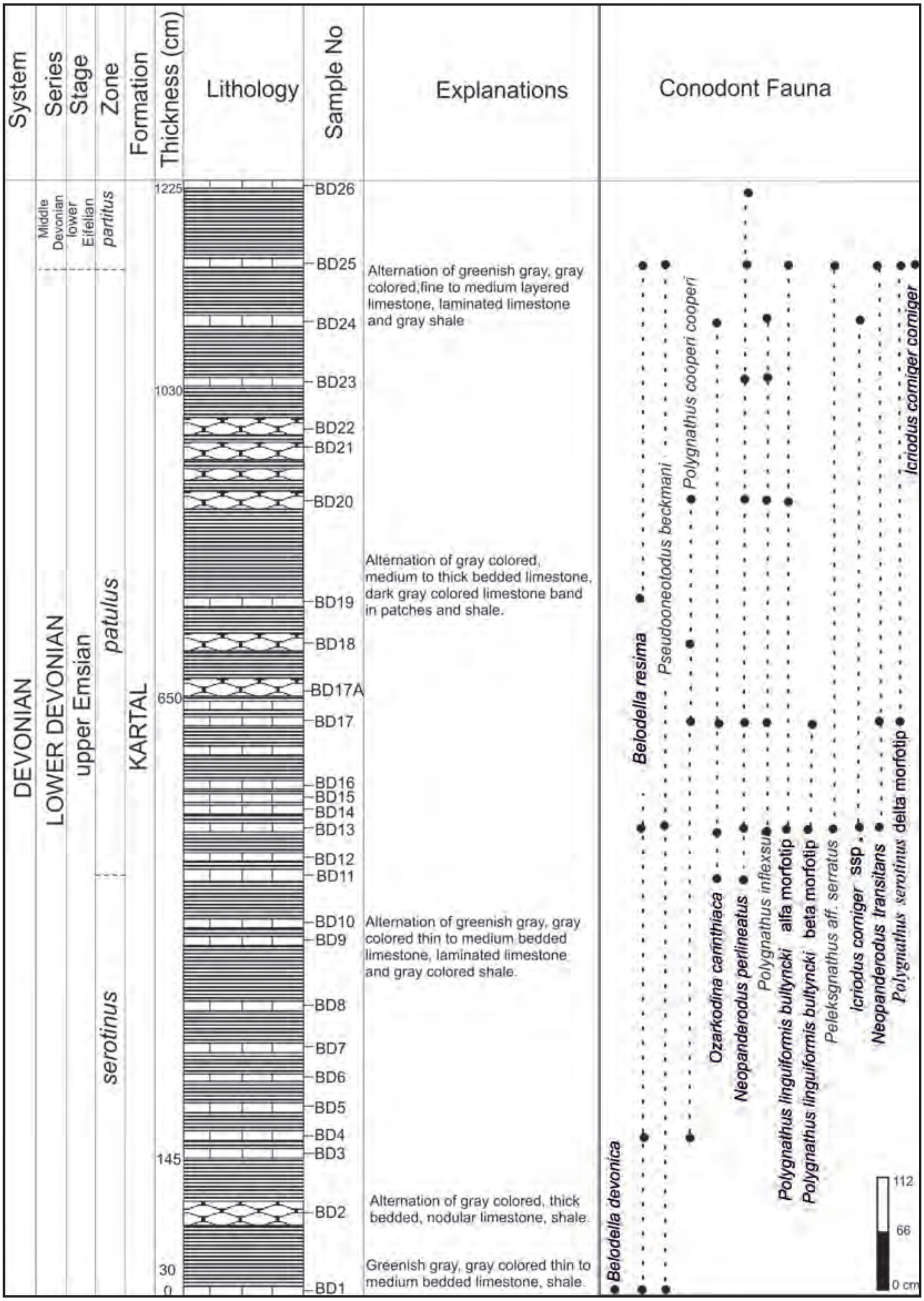

Figure 9- The Büyükdere measured stratigraphic section.

(Weddige) alpha morphotype, and *Neopanderodus perlineatus* (Ziegler and Lindström).

From samples collected from limestone strata in the uppermost part made up of greenish gray to gray limestones and laminated limestones with shale intercalations of the Büyükdere section, sample BD23 produced *Polygnathus inflexus* Baranov, and *Neopanderodus perlineatus* (Ziegler and Lindström); sample BD24 *Ozarkodina carinthiaca* (Schulze), *Polygnathus inflexus* Baranov and *Icriodus corniger* subsp.; sample BD25 *Polygnathus linguiformis bultyncki* Weddige alpha morphotype, *Polygnathus serotinus* Telford delta morphotype, *Pelekysgnathus serrratus* Jentzsch, *Icriodus corniger corniger* Weddige, *Neopanderodus perlineatus* Ziegler and Lindström, *Neopanderodus transitans* (Ziegler and Lindström), *Belodella devonica* (Stauffer), *Belodella resima* (Philip), and *Pseudooneotodus beckmanni* (Bischoff and Sannemann); and sample BD26 *Neopanderodus perlineatus* Ziegler and Lindström.

Polygnathus inflexus was identified by Baranov (1992) from the *patulus* Zone. *Ozarkodina carinthiaca* (Schulze) has a range extending from the beginning of the *serotinus* Zone to the end of the *patulus* Zone (Klapper et al., 1978, Figure 3). Thereby, samples BD13–BD24 including the joint occurrence of these two taxa are within *patulus* Zone (upper Emsian), and the overlying samples BD25–BD26 are within the *partitus* Zone (lower Eifelian). *Icriodus corniger corniger* Wittekindt recovered from sample BD25 has a range, which is restricted to the *partitus* and *costatus* zones (Weddige et al., 1979, Figure 4). Sample BD12 and underlying samples are probably within the *serotinus* Zone or older zones (Table 4).

Table 4- Conodont distribution at the Büyükdere section.

STAGE	upper Emsian										lower Eifelian	
ZONE	*serotinus*			*patulus*							*partitus*	
SAMPLE (BD)	1	4	11	13	17	18	19	20	23	24	25	26
Polygnathus cooperi cooperi		1?			2	1		1				
Polygnathus inflexus				3	3			1	1	1?		
Polygnathus linguiformis bultyncki alfa morfotipi				1				1			2	
Polygnathus linguiformis bultyncki beta morfotipi				1	3							
Polygnathus serotinus delta morfotipi					1						1	
Ozarkodina carinthiaca			1	11	12					1		
Pelekysgnathus aff. *serrratus*				1							1	
Icriodus corniger corniger											3	
Icriodus corniger ssp.				1						1?		
Neopanderodus perlineatus			2	21	4			3	1		7	1
Neopanderodus transitans				6	6						5	
Belodella devonica	1											
Belodella resima	2	2		2			1				1	
Pseudooneotodus beckmanni	2			3							2	

SYSTEMATIC PALEONTOLOGY

Family: Icriodontidae MÜLLER and MÜLLER, 1957
Genus: *Icriodus* BRANSON and MEHL, 1938
Type Species: *Icriodus expansus* BRANSON and MEHL, 1938

Icriodus angustoides alcoleae CARLS, 1969

(Plate 1, Figures 8-12, 23)

1969 *Icriodus angustoides alcoleae* CARLS, p. 326-329, Pl.1, Figs. 12, Pl. 2, Figs. 1, 2.
1976 *Caudicriodus angustoides alcoleae* CARLS.- BULTYNCK, p. 34, 35, Pl. 4, Figs. 14, 18-28.
1985 *Icriodus angustoides alcoleae* CARLS.- MASTANDREA, p. 248-250, Pl. 4, Figs. 7-20.
2001 *Icriodus angustoides alcoleae* CARLS.- CORRADINI, LEONE, LOI and SERPAGLI, Pl.1, Fig. 2.
2007 *Icriodus angustoides alcoleae* CARLS.- BONCHEVA, SACHANSKI, LAKOVA and YANEVA, Figs. 5-S

Remarks.- A narrow spindle and a cusp higher than the other denticles are the most distinguishing characteristics of the Pa elements of *Icriodus angustoides alcoleae* Carls. The Pa elements of *Icriodus angustoides angustoides* (Carls and Gandl, 1969) have a stronger and higher cusp.
Age and Range.- Late Lochkovian, *delta–pesavis* Zones (Valenzuela-Rios, 1994).
Material.- 18 Pa elements.

Icriodus corniger ancestralis WEDDIGE, 1977

(Plate 1, Figures 15-20)

1977 *Icriodus corniger ancestralis* WEDDIGE, p. 407, Pl. 1, Figs. 3-6.
1979 *Icriodus corniger ancestralis* WEDDIGE.- ARBIZU et al., Pl. 3, Figs. 13, 14.
1985 *Icriodus corniger ancestralis* WEDDIGE.- WEDDIGE, Pl. 4, Figs. 39-46.

Remarks.- The most distinctive characteristic of Pa elements of *Icriodus corniger* subspecies is that they have a posterior margin of the basal cavity, oblique to the long axis of the element. *Icriodus corniger ancestralis* Weddige differs from the other subspecies of the species by having a lens-shaped platform outline in upper view.
Age and Range.- Late Emsian, the *laticostatus-serotinus* zones (Weddige, 1985).
Material.- 24 Pa elements.

Icriodus corniger corniger WITTEKINDT, 1966

(Plate 1, Figures 13, 14)

1966 *Icriodus corniger* WITTEKINDT, p. 629, Pl. 1, Figs. 9-12.
1977 *Icriodus corniger corniger* WITTEKINDT.- WEDDIGE, p. 407, Pl. 1, Figs. 16-20.
1979 *Icriodus corniger corniger* WITTEKINDT.- ARBIZU et al., p. 123, Pl. 3, Figs. 22, 23.
1981 *Icriodus corniger corniger* WITTEKINDT.- WANG and ZIEGLER, Pl. 1, Fig. 11.

Remarks.- The Pa elements of this subspecies differ from those of *Icriodus corniger ancestralis* Weddige by the shape of the spindle.
Age and Range.- Early Eifelian, the *partitus-costatus* zones (Weddige, 1985).
Material.- 3 Pa elements.

Icriodus corniger subsp.

(Plate 1, Figures 21, 22)

Remarks.- The Pa elements are similar to those of *Icriodus corniger rectirostratus* BULTYNCK. However, the Pa elements of *Icriodus corniger rectirostratus* BULTYNCK have a longer platfrom with more lateral rows of denticles.
Age and Range.- Late Emsian, *serotinus-patulus* zones.
Material.- 3 Pa element.

***Icriodus rectangularis lotzei* CARLS, 1969**
(Plate 1, Figures 1, 2)

1969 *Icriodus lotzei* CARLS, p. 328-330, Pl. 1, Figs. 4-10.
1975 *Icriodus rectangularis lotzei* CARLS.- CARLS, p. 415-416, Pl. 1, Figs. 13, Pl. 3, Figs. 45-47.
1976 *Praelatericriodus rectangularis lotzei* (CARLS).- BULTYNCK, p. 44-45, Pl. 1, Figs. 1-3, 5-11; Pl. 2, Figs. 1-14.

Remarks.- The Pa elements of *Icriodus rectangularis rectangularis* Carls and Gandl have a posterior lateral process perpendicular to the main axis and straight. In the Pa elements of *Icriodus rectangularis lotzei* Carls, the posterior lateral process is slightly curved.
Age and Range.- Late Lochkovian, the *delta* and *pesavis* zones (Valenzuela-Rios, 1994).
Material.- 2 Pa elements.

***Icriodus* cf. *vinearum* CARLS, 1975**
(Plate 1, Figures 4-7)

Remarks.- The Pa elements have a spindle similar to those of *Icriodus vinearum* Carls, but differ in the development of lateral ridges and spur. The basic difference between the Pa elements of *Icriodus postwoscmidti* Mashkova and *Icriodus vinearum* Carls is their shape of the basal cavities. *Icriodus postwoscmidti* has a wider basal cavity and a more distinct spur.
Material.- 4 Pa elements.

Family: Polygnathacea BASSLER, 1925
Type Genus: *Polygnathus* HINDE, 1879
Genus: *Polygnathus* HINDE, 1879
Type Species: *Polygnathus dubius* HINDE, 1879

***Polygnathus cooperi cooperi* KLAPPER, 1971**
(Plate 2, Figures 16-19, 22, 23)

1971 *Polygnathus linguiformis cooperi* KLAPPER, p. 64, Pl. 1, Figs. 17-22, Pl. 2, Fig. 21.
1977 *Polygnathus linguiformis cooperi* KLAPPER.- WEDDIGE, Pl. 5, Figs. 93, 94.
1977 *Polygnathus linguiformis cooperi* KLAPPER.- KLAPPER in ZIEGLER, p. 471-472, *Poygnathus*-Pl. 9, Figs. 2, 3.
1978 *Polygnathus cooperi* KLAPPER.- KLAPPER, ZIEGLER and MASHKOVA, p. 108, Pl. 2, Figs. 21, 22, 29, 30.
1979 *Polygnathus cooperi* KLAPPER.- LANE and ORMISTON, Pl. 3, Fig. 27.
1983 *Polygnathus cooperi cooperi* KLAPPER.- SPARLING, Figs. 10 D, E.
1992 *Polygnathus cooperi cooperi* KLAPPER.- BONCHEVA, p. 34-35, Pl. 1, Figs. 1-4.
2009 *Polygnathus cooperi cooperi* KLAPPER.- BERKYOVA, Figs. 7 A-D.

Remarks.- The Pa elements of *Polygnathus cooperi cooperi* have a weaker posterior transverse ridge development, a few of them completely cross the tongue of platform, as opposed to *Polygnathus linguiformis linguiformis* Hinde gamma morphotype. Generally the posterior third of the outer margin is more sharply deflected inward in *Polygnathus linguiformis linguiformis* (Klapper in Ziegler, 1977; p. 471).
Age and Range.- Late Emsian- early Eifelian, from the upper part of the *serotinus* Zone to the end of the *partitus* Zone (Klapper et al., 1978).
Material.- 7 Pa elements.

***Polygnathus inflexus* BARANOV, 1992**
(Plate 2, Figures 11-15)

1983 *Polygnathus* aff. *trigonicus* BARANOV.- SPARLING, Figs.10 L-P.
1992 *Polygnathus inflexus* BARANOV, p. 175, Pl. 1, Figs. g-m.

Definition.- The Pa element has a narrow and elongated platform with margins ornamented by distinctive nodes. The outer platform is wider than the inner one. The platform margins do not extend to the posterior end of the element. The carina, strongly curved inwardly after the posterior one-third, extends beyond the posterior end of the platform. The free blade is about half of the platform. The basal cavity is oval shaped and close to the anterior part of the platform.

Remarks.- The Pa elements of *Polygnathus zieglerianus* Weddige have a wider platform from those of *Polygnathus inflexus*.

Age and Range.- Early Devonian (Late Emsian), the *patulus* Zone (Baranov, 1992).

Material.- 9 Pa elements.

Polygnathus linguiformis bultyncki WEDDIGE, 1977 alpha morphotype

(Plate 2, Figures 24-26)

1977 *Polygnathus linguiformis bultyncki* WEDDIGE, p. 313-314, Pl. 5, Figs. 91,92.
1979 *Polygnathus linguiformis bultyncki* WEDDIGE.- LANE and ORMISTON, Pl. 7, Figs. 38, 39.
1983 *Polygnathus linguiformis bultyncki* WEDDIGE alpha morphotype.- WANG and ZIEGLER, p. 89, Pl. 5, Fig. 19.
1992 *Polygnathus linguiformis bultyncki* WEDDIGE.- BONCHEVA, p. 39-40, Pl. 5, Fig. 6.
2003 *Polygnathus linguiformis bultyncki* WEDDIGE.- DANIEL, Pl. 4, Fig. 12.

Remarks.- A sharply angular outer margin at the contact with the tongue and the main part of the platform, a relatively long tongue with transverse ridges, and an anterior outer margin distinctly higher than the carina and the inner margin are the most distinguishing characteristics of the delta morphotype Pa element. It differs from the beta morphotype by its angular outer margin and higher anterior outer margin (Wang and Ziegler, 1983; p. 89).

Age and Range.- Late Emsian, the *serotinus* Zone (Wang and Ziegler, 1983).

Material.- 5 Pa elements.

Polygnathus linguiformis bultyncki WEDDIGE, 1977 beta morphotype

(Plate 2, Figures 9, 10, 20, 21)

1977 *Polygnathus linguiformis bultyncki* WEDDIGE, p. 313-314, Pl. 5, Fig. 90.
1977 *Polygnathus linguiformis linguiformis* WEDDIGE.- KLAPPER in ZIEGLER, p. 493, *Poygnathus*-Pl. 9, Figs. 6-8.
1979 *Polygnathus linguiformis bultyncki* WEDDIGE.- LANE and ORMISTON, Pl. 7, Figs. 1, 2, 34; Pl. 8, Figs. 11, 12.
1978 *Polygnathus linguiformis bultyncki* WEDDIGE.- KLAPPER, ZIEGLER and MASHKOVA, Pl. 1, Figs. 21, 22, 26-29.
1983 *Polygnathus linguiformis bultyncki* WEDDIGE beta morphotype.- WANG and ZIEGLER, p. 89, Pl. 5, Fig. 18.
1992 *Polygnathus linguiformis bultyncki* WEDDIGE.- BONCHEVA, p. 33, 45, Pl. 5, Figs. 5-7.
2003 *Polygnathus linguiformis bultyncki* WEDDIGE.- DANIEL, Pl. 4, Figs. 10, 11.
2009 *Polygnathus linguiformis bultyncki* WEDDIGE.- BERKYOVA, Figs. 8 H-I.

Remarks.- Pa elements are distinguished from those of alpha morphotype by having an anterior outer margin at the same height as the carina and the inner margin, and an outer margin rounded at the contact with the tongue and the anterior outer margin.

Age and Range.- Late Emsian, the *serotinus* Zone (Wang and Ziegler, 1983).

Material.- 14 Pa elements.

Polygnathus serotinus TELFORD, 1975 delta morphotype

(Plate 2, Figures 1-8)

1975 *Polygnathus foveolatus serotinus* TELFORD, Pl. 7, Figs. 5-8.
1977 *Polygnathus serotinus* TELFORD.- KLAPPER in ZIEGLER, p. 495-496, *Poygnathus*-Pl. 9, Figs. 4, 5.

1979 *Polygnathus serotinus* TELFORD delta morphotype.- LANE and ORMISTON, p. 63, Pl. 8, Figs. 8-10, 34, 35.
1983 *Polygnathus serotinus* TELFORD delta morphotype.- WANG and ZIEGLER, Pl. 6, Figs. 18.
1987 *Polygnathus serotinus* TELFORD delta morphotype.- MAWSON, p. 280, 282, Pl. 33, Figs. 9-12; Pl. 36, Fig.10.
1992 *Polygnathus serotinus* TELFORD.- BONCHEVA, p. 41-42, Pl. 6, Figs. 5-7.
2003 *Polygnathus serotinus* TELFORD.- DANIEL, Pl. 3, Figs. 1-6.
2009 *Polygnathus serotinus* TELFORD.- BERKYOVA, Fig. 8J.

Remarks.- An outer platform margin with a sharp inward deflection in the beginning of the posterior one-third, and a flange-like anterior outer margin distinctly higher than carina and inner margin are the most distinguishing characteristics of the Pa elements of this morphotype.
Age and Range.- Late Emsian, the *serotinus* Zone– the Lower *costatus* Zone (Klapper et al., 1978).
Material.- 19 Pa elements.

Family: Spathognathodontidae HASS, 1959
Genus: *Lanea* MURPHY and VALENZUELA-RÍOS, 1999
Type Species: *Ozarkodina eleanorae* LANE and ORMISTON, 1979

***Lanea eleanorae* (LANE and ORMISTON, 1979)**
(Plate 3, Figures 22-24)

1979 *Ozarkodina eleanorae* LANE and ORMISTON, p. 55, Pl. 1, Figs. 40, 47; Pl. 2, Figs. 6, 7; Pl. 3, Figs. 7, 8, 11, 12.
1991 *Ancyrodelloides eleanorae* (LANE and ORMISTON, 1979).- KLAPPER in ZIEGLER, p. 17-18, Pl. 2, Figs. 3, 5 (see for further synonymy).
1999 *Lanea eleanorae* (LANE and ORMISTON, 1979).- MURPHY and VALENZUELA-RİOS, p. 328, 330, Pl. 2, Figs. 15-20.
2012 *Lanea eleanorae* (LANE and ORMISTON, 1979).- CORRADINI and CORRIGA, Fig. 6O.

Remarks.- A few badly preserved Pa elements with subequal platform lobes were assigned to this species.
Age and Range.- Late Lochkovian, the *delta* Zone (Klapper and Murphy, 1980).
Material.- 3 Pa elements.

Genus *Ozarkodina* BRANSON and MEHL, 1934
Type Species *Ozarkodina typica* BRANSON and MEHL, 1934

***Ozarkodina carinthiaca* (SCHULZE, 1968)**
(Plate 1, Figures 3-6)

1968 *Spathognathodus carinthiacus* SCHULZE, Pl. 17, Figs. 14, 15, 17.
1973 *Ozarkodina carinthiaca* (SCHULZE).- KLAPPER in ZIEGLER, p. 219, *Ozarkodina*-Pl. 1, Fig. 3.
1978 *Ozarkodina carinthiaca* (SCHULZE).- KLAPPER, ZIEGLER and MASHKOVA, p. 108, Pl. 1, Figs. 1, 8.
1980 *Ozarkodina carinthiaca* (SCHULZE).- KLAPPER and ZIKMUNDOVÁ, p. 231, Pl. 8, Figs. 6, 17, 18.
2009 *Ozarkodina carinthiaca* (SCHULZE).- BERKYOVA, Fig. 9 A

Remarks.- The Pa element is similar to *Ozarkodina eurekaensis* Klapper and Murphy, and *Ozarkodina bidentata* (Bischoff and Ziegler). However, more numerous and thinner denticles and a somewhat narrower basal cavity distinguish the Pa element of *Ozarkodina carinthiaca* from that of *Ozarkodina eurekaensis* Klapper and Murphy. The Pa elements of *Ozarkodina eurekaensis* have relatively broad and closely spaced blade denticles, and a large, elliptical basal cavity occupying slightly more than the posterior half of the unit. The Pa element of *Ozarkodina bidentata* (Bischoff and Ziegler) is distinguished from that of *Ozarkodina carinthiaca* by having a more planar upper surface and absence of the alternating denticles posteriorly.

Age and Range.- Early Devonian (Emsian), from bottom of the *serotinus* Zone to the end of the *patulus* Zone (Klapper et al., 1978, p. 107, Fig. 3).

Material.- 28 Pa elements.

RESULTS

22 species, subspecies and morphotypes of 8 conodont genera were identified from limestone samples collected from the Lower–Middle Devonian outcrops in the vicinity of Beykoz, Şile and Kurtdoğmuş (İstanbul, Turkey).

The conodont fauna of samples BG28-BG34 of the Beykoz section indicates that this interval is in the *delta* Zone (upper Lochkovian). Also, samples ŞG4–ŞG15 from the Karamandere section of the İstinye Formation are in the *delta–pesavis* zones (upper Lochkovian). The conodont faunas from samples KP13A–KP17 from the Kokarpınar section of the Kozyatağı Member, the Kartal Formation define the *serotinus* Zone (upper Emsian). However, the lower samples (KP1-13) most probably belong to the *laticostatus* and older zones.

Samples BD1-BD12 from the Büyükdere section are in probably the *serotinus* Zone (upper Emsian) or older biozones; samples BD13–BD24, in the *patulus* Zone (upper Emsian); and samples BD 25–BD26, in the *partitus* Zone (lower Eifelian).

Based on the occurrence of *Icriodus corniger corniger* Weddige with a range restricted to the *partitus* and *costatus* zones (Weddige et al. 1979, Fig. 4), It can be said that the Kozyatağı member ranges up to lower Eifelian.

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PLATES

PLATE - I

Figures 1, 2. *Icriodus rectangularis lotzei* (CARLS, 1969)
1, 2. Upper and lower views. Sample BG32.

Figure 3. *Icriodus* aff. *rectangularis lotzei* (CARLS, 1969)
3. Upper view. Sample BG32.

Figures 4-7. *Icriodus* cf. *vinearum* (CARLS, 1975)
4. Upper view. Sample BG32.
5. Upper view. Sample BG32.
6. Upper view. Sample BG30.
7. Upper view. Sample ŞG4.

Figures 8-12. *Icriodus angustoides alcoleae* CARLS, 1969
8. Upper view. Sample ŞG5.
9, 10. Upper and lateral views. Sample ŞG4.
11, 12. Upper and lateral views. Sample ŞG9.

Figures 13, 14. *Icriodus corniger corniger* WEDDIGE, 1977
13, 14. Upper and lateral views. Sample BD 25.

Figures 15-20. *Icriodus corniger ancestralis* WEDDIGE, 1977
15, 16. Upper and lower views. Sample BD17.
17, 18. Upper and lower views. Sample BD17.
19, 20. Upper and lower views. Sample BD17.

Figures 21, 22. *Icriodus corniger* subsp.
21. Upper view. Sample KP17.
22. Upper view. Sample BD13.

Figure 23. *Icriodus angustoides alcoleae* CARLS, 1969
23. Upper view. Sample ŞG5.

PLATE - I

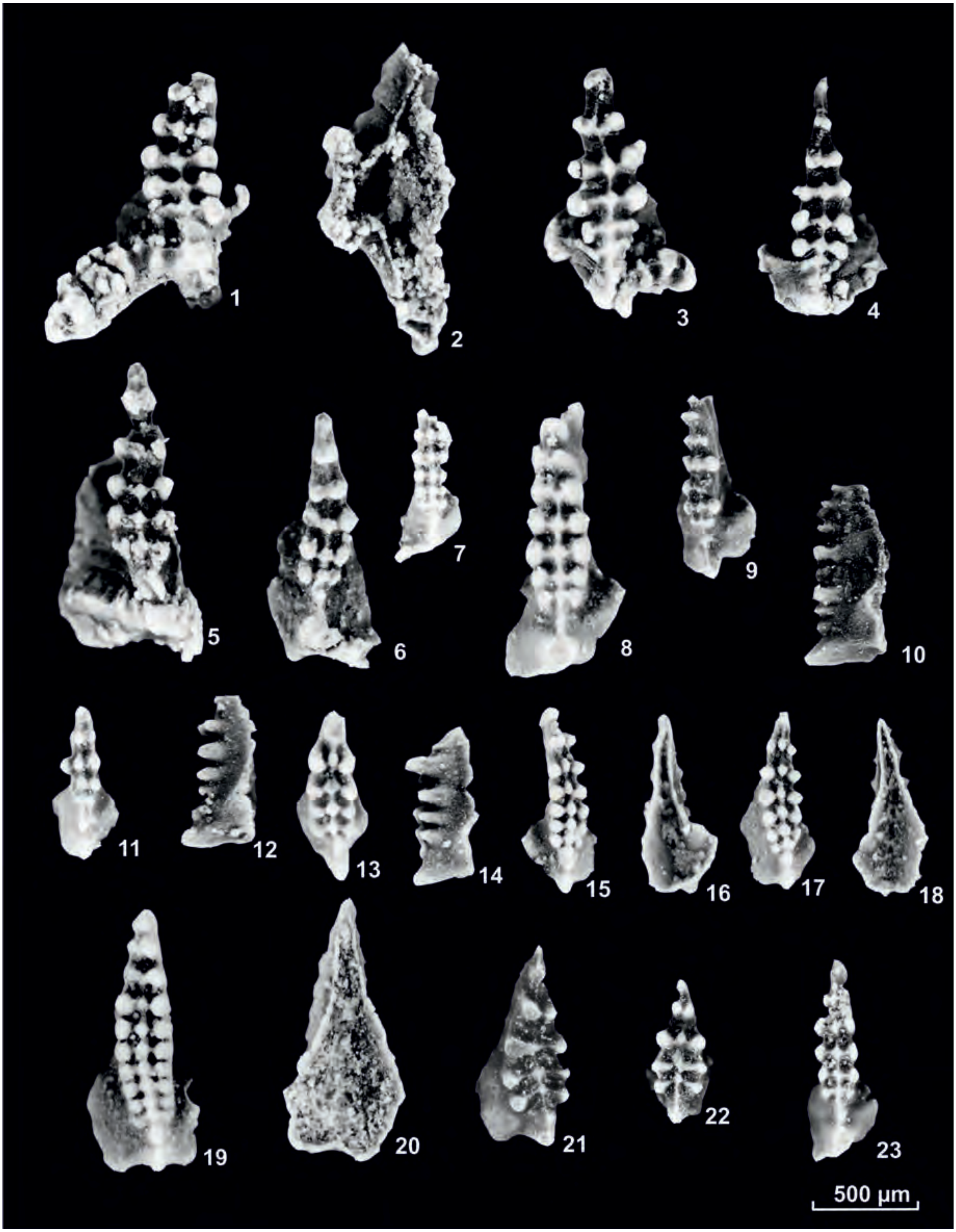


PLATE - II

Figures 1-8. *Polygnathus serotinus* TELFORD, 1975 delta morphotype
1, 2. Upper and lower views. Sample BD17.
3, 4. Upper and lower views. Sample BD17.
5, 6. Upper and lower views. Sample BD17.
7, 8. Upper and lower views. Sample BD25.

Figures 9, 10. *Polygnathus linguiformis bultyncki* WEDDIGE, 1977 beta
9. Upper view. Sample KP13A.
10. Upper view. Sample BD17.

Figures 11-15. *Polygnathus inflexus* BARANOV, 1992
11. Upper view. Sample BD20.
12, 13. Upper and lower views. Sample BD23.
14. Upper view. Sample BD13.
15. Upper view. Sample BD17.

Figures 16-19, 22,23. *Polygnathus cooperi cooperi* KLAPPER, 1971
16. Upper view. Sample KP 13A.
17. Upper view. Sample BD 13.
18. Upper view. Sample BD 20.
19. Upper view. Sample BD 13.
22. Upper view. Sample BD 18.
23. Upper view. Sample BD 17.

Figures 20, 21. *Polygnathus linguiformis bultyncki* WEDDIGE, 1977 beta morphotype
20. Upper view. Sample BD 17.
21. Upper view. Sample BD 13.

Figures 24-26. *Polygnathus linguiformis bultyncki* WEDDIGE, 1977 alpha morphotype
24. Upper view. Sample BD 25.
25. Upper view. Sample BD 25.
26. Upper view. Sample KP 17.

PLATE - II

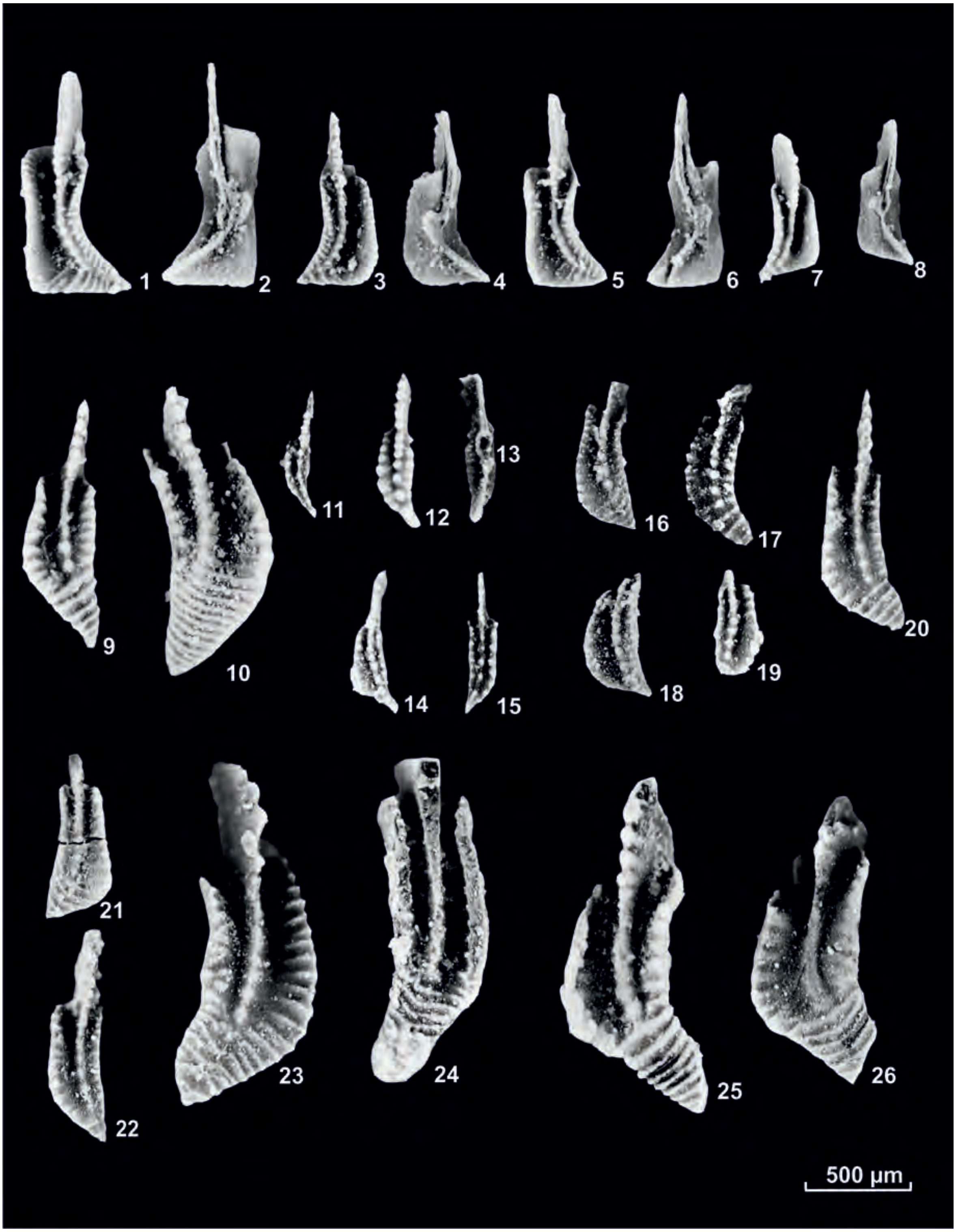


PLATE - III

Figures 1-2. *Ozarkodina* sp.
1, 2. Upper and lower views. Sample ŞG3.

Figures 3-6. *zarkodina carinthiaca* (SCHULZE, 1968)
3, 4. Lateral and upper views. Sample BD17.
5, 6. Lateral and upper views. Sample BD17.

Figure 7. *Pelekysgnathus serrratus* JENTZSCH, 1962
7. Upper view. Sample BD25.

Figures 8-12. *Pseudooneotodus beckmanni* (BISCHOFF and SANNEMANN, 1958)
8, 9. Upper and lateral views. Sample BD25.
10, 11. Lateral and lateral views. Sample BD25.
12. Upper view. Sample BD1.

Figure 13. *Pseudooneotodus* sp. (BISCHOFF and SANNEMANN, 1958)
13. Upper view. Sample BD30.

Figures 14-17. *Neopanderodus transitans* ZIEGLER and LINDSTRÖM, 1971
14, 15. Lateral view. Sample BD17.
16, 17. Lateral view. Sample BD25.

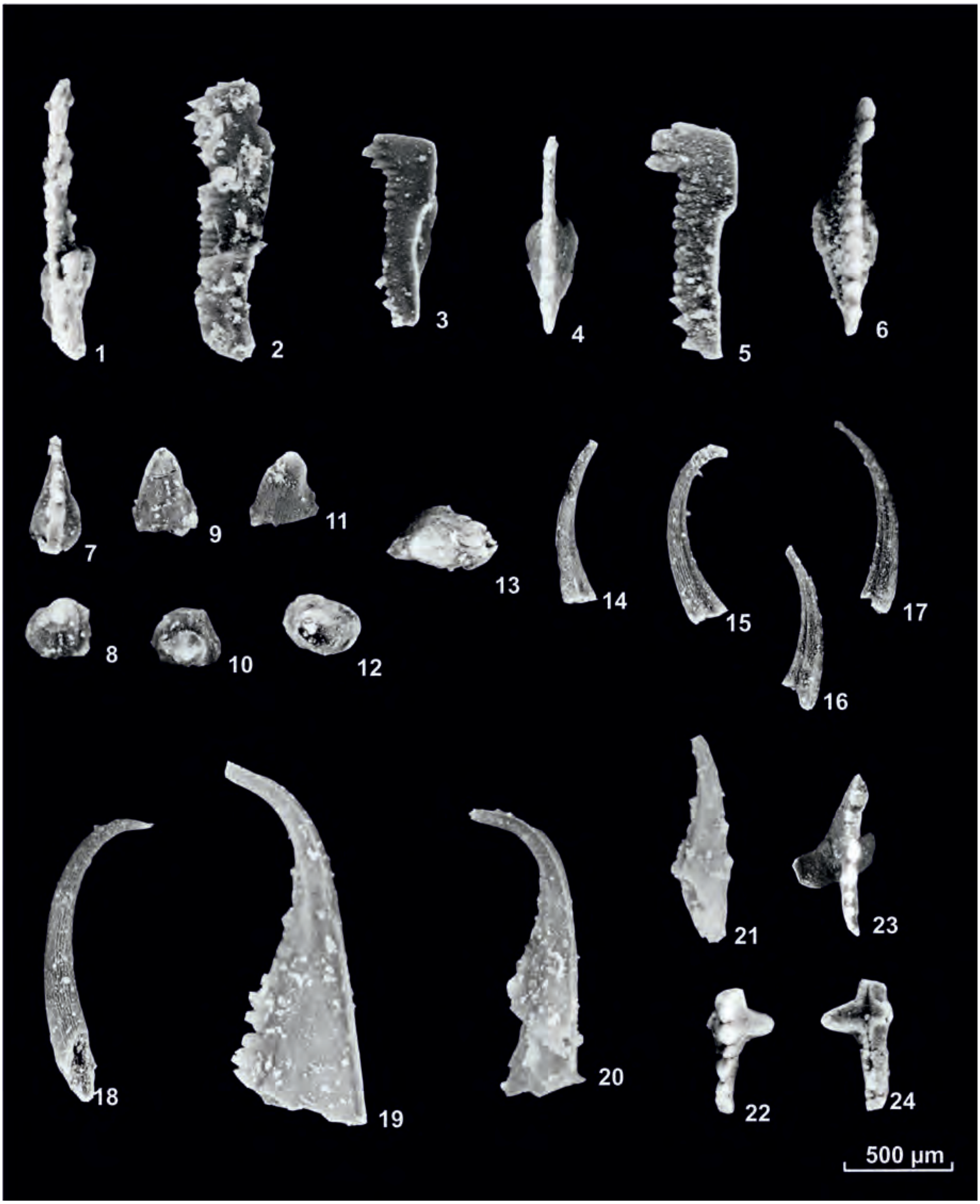
Figure 18. *Neopanderodus perlineatus* ZIEGLER and LINDSTRÖM, 1971
18. Lateral view. Sample BD17.

Figures 19, 20. *Belodella resima* (PHILIP, 1965)
19, 20. Lateral view. Sample BD4.

Figure 21. *Belodella* cf. *devonica* (STAUFFER, 1940)
21. Lateral view. Sample BD1.

Figures 22-24. *Lanea eleanorae* (LANE and ORMISTON, 1979)
22, 24. Upper and lower views. Sample BG28.
23. Upper view. Sample BG34.

PLATE - III



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THE INFLUENCES OF OCEANOGRAPHICAL CHARACTERISTICS OF THE NORTH COASTS OF KARABURUN PENINSULA ON THE BENTHIC FORAMINIFERAL AND OSTRACOD ASSEMBLAGES

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ABSTRACT.- Major differences in benthic foraminifera assemblages have been observed between the east and the west coast of the northern Karaburun Peninsula. In contrast to the rich fauna of the Çeşme Canal on the west coast, a poor assemblage was found on the east coast, which is located in the Gulf of Izmir. A great difference in population sizes have also been observed in *Amphistegina lobifera* Larsen assemblages found on the Aegean coasts of Karaburun Peninsula and Gulf of Izmir. In the framework of this study, 84 foraminifera species were identified. The most abundant species were *Peneroplis pertusus* (Forskal), *P. planatus* (Fichtel and Moll), *Amphistegina lobifera* Larsen, *Elphidium crispum* (Linné). Highest heavy metal pollution was observed in the inner part of the gulf, where least number of foraminifer species observed. 24 ostracod species were identified. Our findings showed that the number of genera and species of ostracods increases with the increasing depth and the distance to the shoreline on the NW of Karaburun Peninsula. *Loxoconcha rhomboidea* (Fischer), *Xestoleberis communis* Müller and *X. depressa* Sars were found to be dominant species on the NW of the peninsula, whereas on the NE of the peninsula *Xesteleberis dispar* Müller dominated the fauna, *Xestoleberis communis* Müller and *X. depressa* Sars were the other abundant species. The aim of this study is to investigate the foraminiferal assemblages of the north coasts of Karaburun Peninsula and assess the effects of mercury mining and other environmental factors on these assemblages. Two mercury mines are found on the north of the peninsula, “Karareis” located on the northwestern of Tuzla Cove and “Kalecik” on the southwestern of Karaburun. Both mines have operated from ancient times until the 1970s. However, mercury minerals have not been observed in the muck found in the vicinity. The piles of muck may have been be washed out during rains, resulting in the transport of the acidic solutions of Hg, As and Fe into the nearby seasonal stream and downstream to the sea. The sea water samples collected from the two locations showed differences in their heavy metals and trace element contents, such as Al, Si, Cr, Mn, Fe, Co, Ni, Cu, Zn and As, but no significant difference was observed in Hg.

Key words: Benthic foraminifera, Karaburun Peninsula, ostracods, *Peneroplis planatus* tests geochemistry, sea water chemistry.

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INTRODUCTION

Hot and cold water seeps occur in both the onshore and offshore parts along the Turkish coast of the Aegean Sea (Çağlar, 1946; Başkan and Canik, 1983). Moreover, it is known that there are numerous mineral deposits. Thus, it is a known fact that ground waters flowing through mineral deposits below the surface or mineral and rare elements carried to the sea by various streams in the surface have influenced benthic foraminifera (Yalçın et al., 2008; Meriç et al., 2009*a*).

The study was made to determine whether mentioned mercury deposits in the northern part of Karaburun Peninsula (Figure 1) have an influence on the recent benthic foraminifera or not. The water samples were taken from Tuzla Bay and the brook mouth in the east of Kepez Hill in SE of Karaburun to determine influences of the Karareis and Kalecik mercury deposits. Heavy metals and rare elements, entering to the sea from nearby environment, such as Fe, Mn, Cu, Co, Ni, Si, Cr, Al, Zn and As, are determined (Tables 1 and 2). Numerous faults trending NW-SE, and N-S and NE-SW occur to the southwest and west of the Karaburun urban area in the northern part of Karaburun Peninsula (Çakmakoğlu and Bilgin, 2006). Both rainfall, which seeps into the subsurface along fractures connected to these faults, and seasonal streams on the surface contribute to the transport of heavy metals and rare elements-to the sea.

MORPHOLOGY AND BATHYMETRIC STRUCTURE

Çeşme Canal, which is situated between Karaburun Peninsula and Chios Island, covers an area within the Turkish inland waters encompassed by Karaburun Peninsula in the north and Ildır Bay and the east of Chios Island in the south (Eryılmaz et al., 1998 *a,b*; Eryılmaz, 2003 *a,b*) (Figure 2).

The bathymetry along Turkish shores in Çeşme Canal drops to 75-79 m in a short distance, similar to the gradient in onshore topography. This region, which was subjected to marine regression and transgression during various geological times, has “submarine rocks or some rises on the sea surface” in the sea. Submarine ridges, islands and islets in the study area and vicinity are topographic forms, generated by the last marine transgression. The coasts extending from Karaburun southward to Ildır Bay are high-relief coasts, and following a narrow shallow sea, 50 m depth is lowered 400-500 m off the coast with a sloping bathymetry. The same bathymetry is also viewed in Büyük Saip Ada (Büyük Ada). This trough-like bathymetry, which is shallower from north to south, rises to 75 meters in front of Küçükbahçe (Figure 3) (Eryılmaz and Aydın, 1998, 2001; Eryılmaz and Yücesoy-Eryılmaz, 1999, 2001, 2003, 2004, 2007 *a,b*).

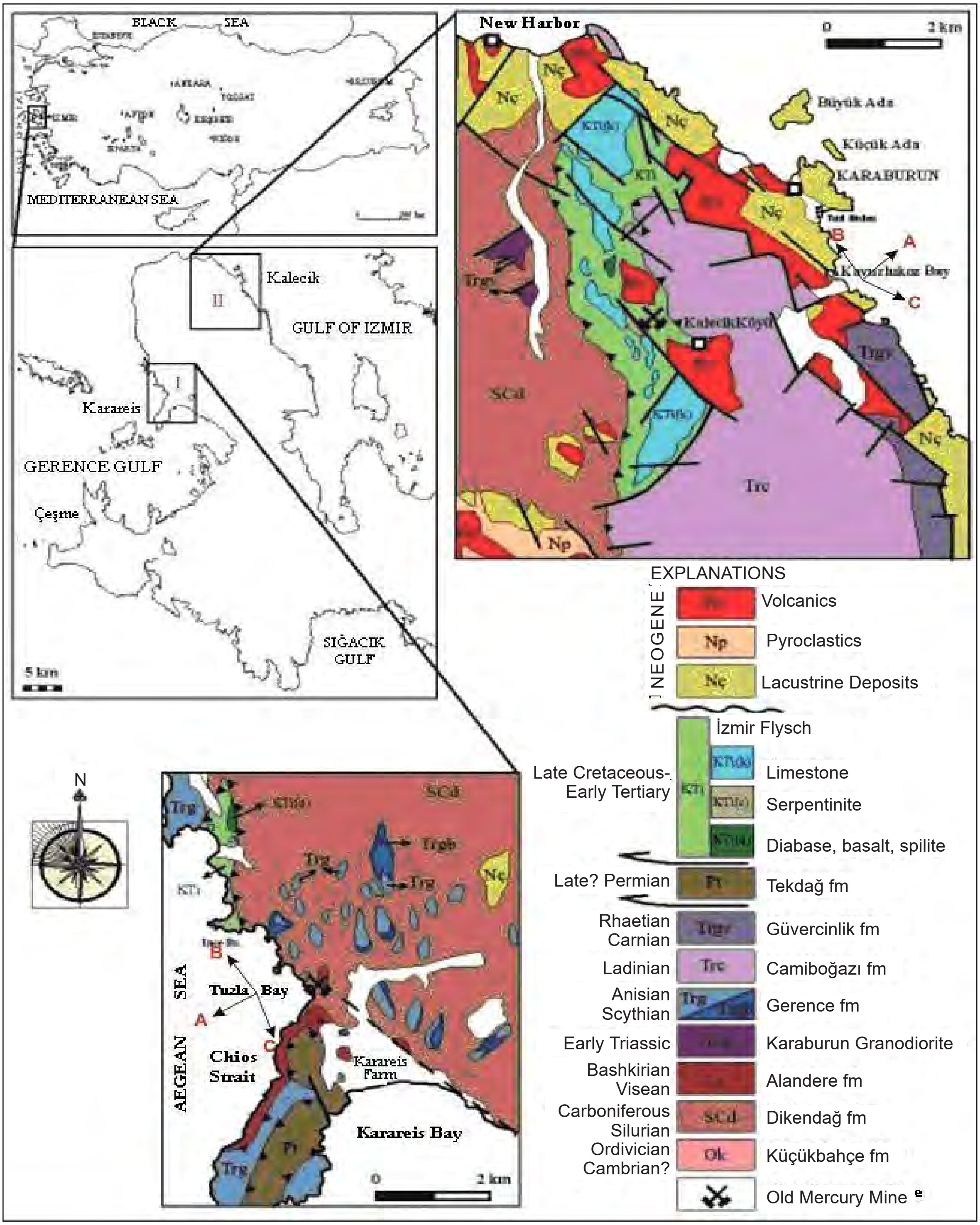

Figure 1- Geological map of Kalecik and Karareis Mercury Deposits and vicinity (taken as simplified from Çakmakoğlu and Bilgin, 2006).

Table 1- Coordinate, distance from the source, depth and temperature values for sampling sites.

Karaburun I			Karaburun II		
UTM		Tarih	UTM		Tarih
0448465 D		07.11.2008	0458535 D		07.11.2008
4261268 K			4276724 K		
A Line (Yön: 210°)			**A Line (Yön: 80°)**		
Distance (m)	Depth (m)	Water Temperature °C	Distance (m)	Depth (m)	Water Temperature °C
5	1.0	17.8	5	1.0	16.7
10	1.1	17.6	10	1.0	16.7
15	1.8	17.6	15	1.2	16.7
20	2.5	17.6	20	1.4	16.7
25	3.2	17.2	25	1.6	16.6
30	3.8	17.2	30	2.0	16.6
35	4.9	17.0	35	2.5	16.5
40	6.6	17.0	40	3.2	16.5
45	7.6	16.8	45	3.7	16.5
50	9.1	16.8	50	3.8	16.5
60	11.8	16.8	60	5.4	16.5
70	13.9	16.8	70	5.6	16.5
80	15.3	16.7	80	5.6	16.5
90	17.5	16.7	90	5.6	16.5
100	19.3	16.7	100	5.7	16.5
B Line (Yön: 125°)			**B Line (Yön: 10°)**		
Distance (m)	Depth (m)	Water Temperature °C	Distance (m)	Depth (m)	Water Temperature °C
5	1.0	17.6	5	1.0	16.6
10	1.0	17.6	10	1.0	16.6
15	1.0	17.6	15	1.2	16.6
20	1.0	17.6	20	1.4	16.6
25	1.0	17.4	25	1.5	16.6
30	1.2	17.2	30	1.9	16.6
35	1.2	17.2	35	1.9	16.6
40	1.2	17.2	40	2.2	16.6
45	1.4	17.0	45	2.1	16.6
50	1.4	17.0	50	2.5	16.6
60	1.6	17.0	60	2.6	16.6
70	2.0	17.0	70	2.9	16.5
80	1.9	17.0	80	3.2	16.5
90	2.3	17.0	90	2.8	16.5
100	2.4	17.0	100	3.7	16.5
C Line (Yön: 290°)			**C Line (Yön: 160°)**		
Distance (m)	Depth (m)	Water Temperature °C	Distance (m)	Depth (m)	Water Temperature °C
5	1.2	17.2	5	1.0	16.8
10	1.4	17.1	10	1.0	16.8
15	1.7	17.1	15	1.7	16.8
20	2.0	17.1	20	1.6	16.7
25	2.3	16.9	25	2.0	16.7
30	2.3	16.9	30	2.2	16.7
35	2.4	16.9	35	2.7	16.7
40	2.5	16.9	40	2.5	16.6
45	2.7	16.9	45	2.5	16.6
50	3.1	16.9	50	1.9	16.6
60	3.4	16.9	60	2.6	16.6
70	3.5	16.9	70	2.4	16.6
80	3.1	16.9	80	2.3	16.6
90	2.9	16.9	90	2.4	16.6
100	2.7	16.9	100	2.5	16.6

Table 2a- The distribution of benthic foraminifer genera and species for the stations of 1A line taken in the northwest of Karaburun Peninsula.

FORAMINIFERAS	STATIONS (m)														
	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Eggerelloides scabrus											1				
Textularia bocki										1	1			5	2
Verteberalina striata						1	9	15	8	8	2	12	21		12
Wiesnerella auriculata										1					
Nubecularia lucifuga							1	1	3	5	23	37	67	70	45
Adelosina carinata-striata							1	1	1				3	1	2
Adelosina cliarensis								9	19	23		12	5		
Adelosina duthiersi														1	
Adelosina mediterranensis													3		5
Spiroloculina depressa									1						
Spiroloculina excavata							1					1		3	1
Spiroloculina ornata			3				1	5	6	2	7	8	14	12	18
Siphonaperta agglutinans													3		
Siphonaperta aspera	1	1					8	20	12	20	16	7	11	3	9
Cycloforina contorta								16	6	6	1	10	7	5	4
Cycloforina villafranca								4	7	1	2	1	2	2	4
Lachlanella undulata														1	
Lachlanella variolata										1					
Massilina gualteriana										1		1			
Quinqueloculina berthelotiana	2	2	3	3			4	8	6	8	4	4	2	9	7
Quinqueloculina bidentata	2	3	1	2			3		12	3	4		2		1
Quinqueloculina disparilis								1		1					
Quinqueloculina lamarckiana		1	1				7	2	4	4	3	8	6	6	5
Quinqueloculina seminula															1
Quinqueloculina vulgaris	1														
Miliolinella elongata							1								
Miliolinella semicostata	1														
Miliolinella subrotunda	1	1		1			1	2	2			5	8	5	3
Miliolinella webbiana												1			1
Pseudotriloculina laevigata							2		2	1	1		1		5
Pseudotriloculina oblonga	1									5	5	5	8	3	6
Pseudotriloculina sidebottomi							4		1	1		2	1	3	7
Triloculina fichteliana								1							
Triloculina marioni						1	5	12	11	10	29	28	33	34	29
Triloculina scheriberiana										1					
Sigmoilinita costata							1	1	8		2	2	8	6	
Sigmoilinita edwardsi								1					4	2	1
Articulina carinata													1		6
Laevipeneroplis karreri											1			2	1
Peneroplis arietinus							2								
Peneroplis pertusus	11	8	5	2	5	2	45	18	41	11	2	5	9		4
Peneroplis planatus	6	4	4	4	1		9	22	16	12	6	4	3	1	5
Sorites orbiculus							1								
Polymorphina sp. 3												1		1	
Reussella spinulosa															1
Eponides concameratus							1							1	
Neoeponides bradyi	2						3	1					1	2	
Neoconorbina terquemi									3		6	3			
Rosalina bradyi							7	21	21	17	29	40	37	47	17
Pararosalina cf. dimorphiformis												2			
Pararosalina sp.													8		13
Conorbella imperatoria							3								
Cibicides advenum				1											
Lobatula lobatula					1		9	11	16	17	19	38	32	31	26
Planorbulina mediterranensis				1			7	6	6	6	7	13	23	23	51
Cibicidella variabilis								2				1	1	3	1
Cymbaloporetta plana		1	1						1					5	1
Asterigerinata mamilla								2	1		1		5	2	
Amphistegina lobifera	6	6	7	15	16	12	88	69	76	61	92	27	19	4	1
Ammonia compacta							1	4	2		6	9	17	12	14
Ammonia parkinsoniana										2	7	11	12	9	16
Ammonia tepida								7	5	3	2	4	1	3	1
Challengerella bradyi								3	10	5					
Cribroelphidium poeyanum											3				
Elphidium aculeatum							4	16	12	11	8	20	16	13	4
Elphidium advenum							1		1	2	2	4	6	2	5
Elphidium complanatum								7	7	9		3	1		
Elphidium crispum	5	2	4	1			5	18	39	26	29	28	35	33	19
Elphidium depressulum			1				3	6	13	5	7	10	17	6	9

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Table 2b- The distribution of benthic foraminifer genera and species for the stations of 1B line taken in the northwest of Karaburun Peninsula.

FORAMINIFERAS	STATIONS (m)														
	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Textularia bocki	1														
Vertebralina striata			1	3		1					1				
Adelosina carinata-striata										1					
Adelosina cliarensis	2														
Spiroloculina angulosa										1					
Spiroloculina ornata		1	1			1									
Siphonaperta aspera	1	3	1			1		1							
Cycloforina contorta	1														
Massilina gualteriana			1										1		
Quinqueloculina berthelotiana		1								1					
Quinqueloculina bidentata		2	3					2			1				
Quinqueloculina lamarckiana	2		9					1		1	1				
Miliolinella subrotunda		1	1					1							
Pseudotriloculina oblonga			1										2		
Pseudotriloculina rotunda									1						
Triloculina marioni	1														
Sigmoilinita edwardsi								1							
Peneroplis pertusus	3	5	10	2	1	1	2	1	1		2				
Peneroplis planatus		4	2	7		1	1					1			1
Rosalina bradyi					2						1				
Cibicides advenum			1												
Lobatula lobatula							1								
Sphaerogypsina globula			1												
Asterigerinata mamilla			1												
Amphistegina lobifera	1		5	8	1	1	4	2	4		3	2	1		
Ammonia parkinsoniana	1														
Ammonia tepida											2				
Challengerella bradyi		1													
Elphidium crispum	1	3	3		1					1			1		
Elphidium depressulum	2		1												

Table 2c- The distribution of benthic foraminifer genera and species for the stations of 1C line taken in the northwest of Karaburun Peninsula.

FORAMINIFERAS	STATIONS (m)														
	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Rhabdammina abyssorum														1	
Textularia bocki						2	1	1		3	1	1		1	1
Vertebralina striata		1	1	1	1	1	2	1	1	1	2		5	3	3
Nubecularia lucifuga												2	1		
Adelosina cliarensis				1							2		4	2	1
Spiroloculina ornata						2		2	2	1	1	3		11	6
Siphonaperta agglutinans															1
Siphonaperta aspera		1		3	3	11	3	9	6	4	3	7	10	5	15
Cycloforina contorta								1			1	2	2	1	2
Cycloforina villafranca														1	
Massilina gualteriana								2					1		
Massilina secans							1								
Quinqueloculina berthelotiana				1	4	7		5	4		4	13	13	10	8
Quinqueloculina bidentata			1				1	2					2		
Quinqueloculina disparilis															2
Quinqueloculina lamarckiana				1	3	4	2	4	4	5	3	7	13	9	7
Miliolinella elongata														1	1
Miliolinella subrotunda		1		4	1	1						3	4		1
Miliolinella webbiana						1									
Pseudotriloculina oblonga								1		1		1		1	
Pseudotriloculina sidebottomi						1						3			2
Pyrgo elongata		1													
Triloculina fichteliana													1	2	
Triloculina marioni				1	1	1	2	1			1	1	3		
Triloculina plicata									1						
Sigmoilinita costata												1		1	
Sigmoilinita edwardsi															2
Euthymonacha polita															1
Laevipeneroplis karreri											2				1
Peneroplis pertusus		4	3	5	9	35	29	22	14	13	28	60	42	37	47
Peneroplis planatus	2			1	5	23	7	8	6	8	5	19	40	27	23
Sorites orbiculus													1		
Neoeponides bradyi											1				
Neoconorbina terquemi											1		1	2	
Rosalina bradyi		1				2	2	2	1	1	3	2	4	3	9
Rosalina obtusa										1	2			1	
Cibicides advenum												1	2		1
Lobatula lobatula						1	2				3	3	1	2	2
Planorbulina mediterranensis											2	2	3	11	10
Cymbaloporetta plana											2		2		
Cymbaloporetta squammosa												1	1	1	1
Asterigerinata mamilla															2
Amphistegina lobifera	3	3	3	15	7	11	32	30	25	7	6	26	5	8	4
Nonion depressulum								2		1	1		4	4	3
Ammonia tepida					1										
Porosononion subgranosum										2					
Elphidium aculeatum					1	5	1	2	1		1	3	3	4	2
Elphidium advenum										1		1	1	4	
Elphidium crispum	1	3	1	1		10	1	3	2	2	10	10	13	12	27
Elphidium depressulum								1				3	1	4	

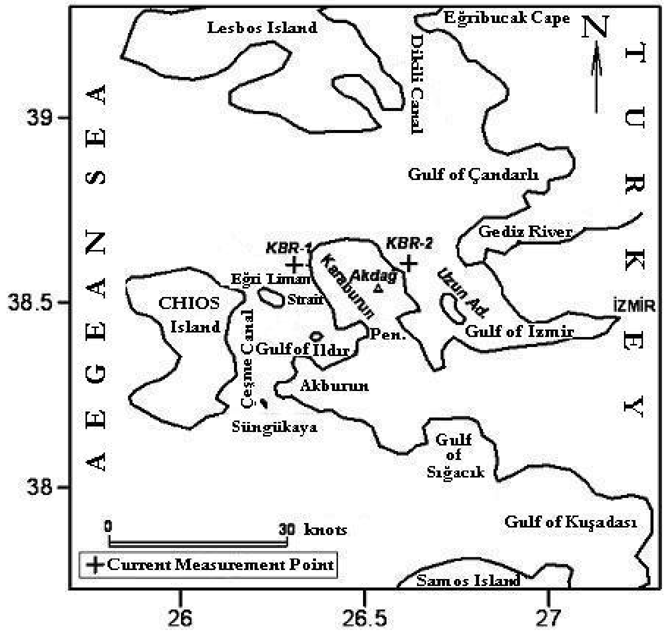

Figure 2- Location of the stations where the current measurement was made.

Figure 3- Bathymetric map of the northern part in Karaburun Peninsula.

The bathymetry towards Lesbos Island in the north falls to 500 m. The Gulf of Izmir, located to the east of Karaburun Peninsula, is one of the shallow marine areas in the Aegean Sea. The Gulf is 25 m deep in average. The deepest part in the Gulf of Izmir is the opening to the Aegean Sea.

In the northeast of Karaburun Peninsula there are cliff type coastal landforms. Abrasion platforms are common to the south, towards Uzunada. Karaburun Peninsula has a narrow coastline. It rises to 1000 m elevation 5-6 km inshore (Akdağ 1218 m). Steep short valleys occur along the eastern slopes of Karaburun Peninsula (Eryılmaz et al., 1998 *a,b*; Eryılmaz, 2003*a, b*; Eryılmaz and Yücesoy-Eryılmaz, 1999).

CLIMATE

The region has a mild Mediterranean climate. It remains under the influence of Icelandic low pressure and related front systems in the winter. In the summer it is under the influence of North African-origin high pressure areas and related front systems. The air temperature in average is 10.4°C in the winter, 15.3°C in the spring, 24.5°C in the summer and 18.1°C in the autumn. Total rainfall amount per year is 640.5 mm in the region. Dominant wind direction is north and northeast in the region. Winds in both directions blow mostly in the summer months. Average wind speed per year is 7.4 knots (Eryılmaz and Yücesoy-Eryılmaz, 2003, 2004; Yücesoy-Eryılmaz et al., 2002, 2004, 2005).

SEAWATER CHARACTERISTICS

Temperature, salinity and current

The variation of average seasonal seawater temperature with the depth in the region is shown in figure 4. The bottom water temperature in average is 15.52°C in the spring, 16.38°C in the summer, 16.85°C in the autumn and 15.03°C in the winter. The difference between average surface water temperature and average bottom water temperature is measured as 1.75°C in the spring, 6.80°C in the summer, 4.59°C in the autumn and 0.62°C in the winter. Surface water temperature and thickness vary in the study region with the seasons (Eryılmaz and Yücesoy-Eryılmaz, 2003).

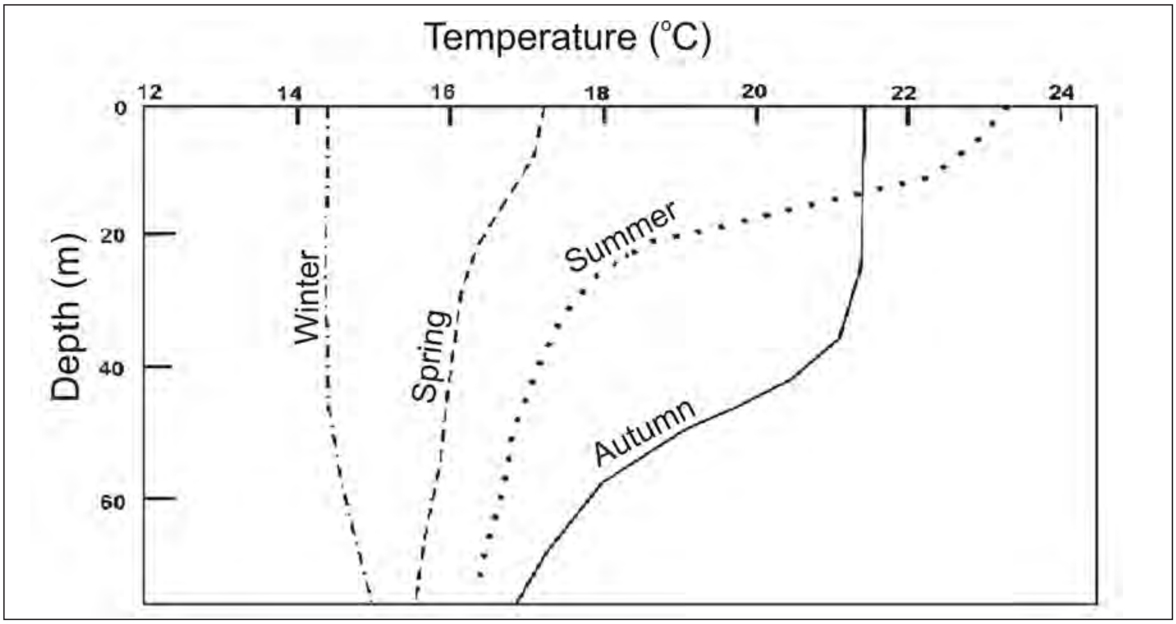

Figure 4- Seasonal averages of seawater temperature with depth in Karaburun Peninsula.

The variation of average seasonal seawater salinity with the depth (Figure 5) is seen in the spring as ‰39.04 in the surface, ‰39.02 at 75 m depth; in the summer as ‰39.51 in the surface, ‰39.18 at 75 m depth; in the autumn as ‰38.56 in the surface, ‰38.32 at 75 m depth and in the winter as ‰38.33 in the surface and ‰38.38 at 75 m depth (Eryılmaz and Yücesoy-Eryılmaz, 2003; Yücesoy-Eryılmaz et al., 2005).

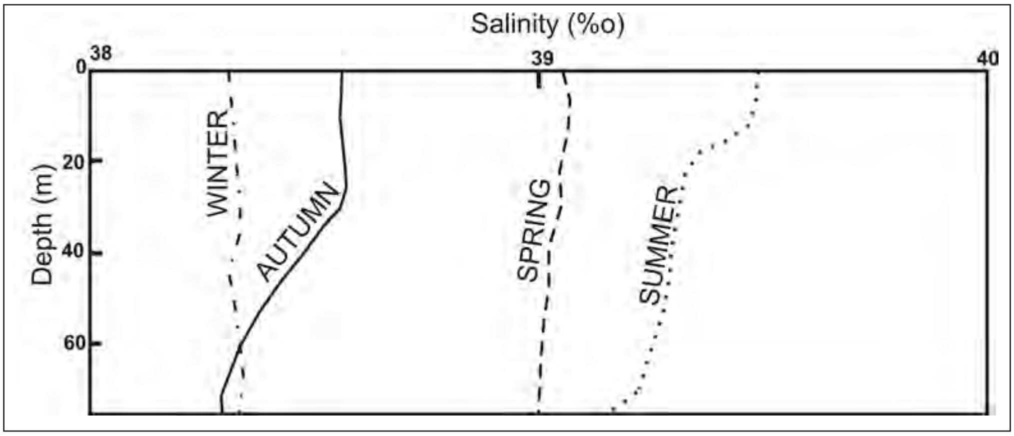

Figure 5- Seasonal averages of seawater salinity with depth in Karaburun Peninsula.

In the northeast (inlet to the Gulf of Izmir) and northwest (Çeşme Canal) parts of the study area, seasonal current measurements were carried out in 2 stations (Figure 2) at -5 m (surface), -20 m and -40 m (deep) depths (Figure 6).

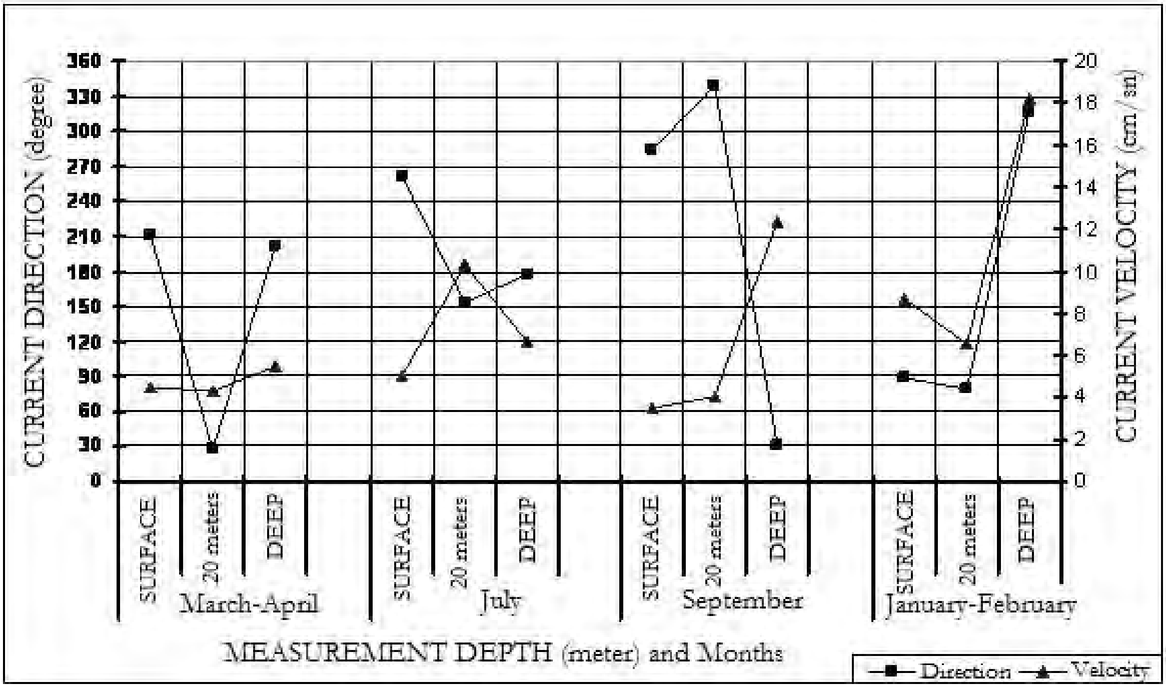

Figure 6- Seasonal current velocities and directions in Çeşme Canal, KBR-1 station.

Current station KBR-1 is located in the Çeşme Canal, a narrow strait between Chios Island and Karaburun Peninsula. Hence, it supplies the water flow between northern and southern sea areas (Eryılmaz, 2003 *a, b*; SHOD Report 249), and there is no significant current system (Figure 6). According to the current dynamics in Aegean Sea, there is a very slow water mass movement from south to north in the winter (Eryılmaz and Aydın, 1998, 2001; Eryılmaz and Yücesoy-Eryılmaz, 2003, 2004, 2007 *a,b*; Yücesoy-Eryılmaz et al., 2005). This movement has an increasing or fixed trend because of the meteorological conditions (such as wind, pressure, air temperature). Local currents flow from north to south under the influence of southerly winds. In conclusion, despite there are no available data it is considered reasonable that strong surface currents may occur in the Eğri Liman Strait in the north and around Süngükaya Island in the south owing to the squeezing of water masses. Variable currents within Ildır Bay are generated in relation to local conditions.

Current station KBR-2 is located to the east of Karaburun Peninsula, in the Gulf of Izmir. The Gulf of Izmir is connected to the Aegean Sea in the north, resulting in the flow of a surface current into the gulf (from north to south) and a counter-current, from the gulf to the Aegean Sea (from south to north) at 20 m depth (Figure 7). The important factors influencing general current circulation in the region are long-term blowing winds and related local currents together with seasonal discharge of the Gediz River. Besides, water masses alternate towards inner part of the Gulf in the summer and out of the Gulf in the winter, and generate local currents. Southwesterly and westerly winds in the region push the water toward the

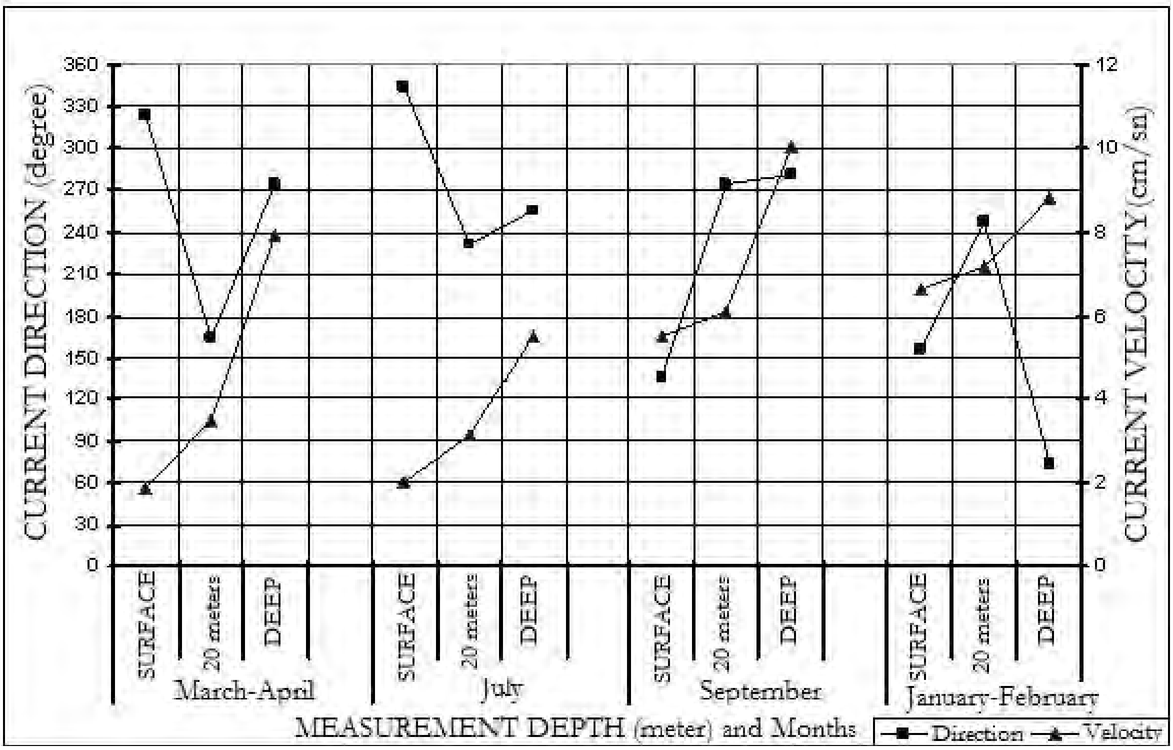

Figure 7- Seasonal current velocities and directions for numbered KBR-2 station in the northwest of Gulf of Izmir.

eastern coasts of the Gulf, and contribute to the counterclockwise currents that wash out Gulf. W-NW trending sea breeze winds in the region, occur in the summer afternoons in, and generate short-term shore currents.

MINERAL DEPOSITS OF KARABURUN PENINSULA

On Karaburun Peninsula the mercury deposits of “Kalecik” in the southwest of Karaburun district and “Karareis” ca. 300 m northeast of Tuzla Bay on the west coast of the peninsula, have been economically exploited since historical times. Mining activity lasted until 1970s, when the toxicity of mercury metal on the human health became widely known. Höll (1966) and Sözen (1977) proposed that the Kalecik mercury deposit was emplaced as exhalative-sedimentary beds into the clastic sediments from upwelling volatiles and fluids during and after submarine volcanic activity. No outcrop of the mineralization remains in the Kalecik mercury deposit. However, entrances to old production shafts and slag piles have been observed. Fresh samples in the slag do not show visible mercury minerals. Previous studies reported that the high grade ores were observed under the silicified caprock and within siliceous zones of the deposit. The association of ore with siliceous zones reinforces the assumption that the mineralization of Kalecik deposit resulted from Neogene alkaline intrusions similar to other regions of western Anatolia (Alibey-Maden Islands, Dora and Savaşçın, 1982; Ovacık, Yılmaz et al., 2007; Yamalar, Sayılı and Gonca, 1999; Efemçukuru, Oyman et al., 2000; Kadıkalesi-Girenbelen, Pişkin, 1980). Detailed studies on the Neogene basaltic-andesitic volcanic complex, may reveal new findings.

The Kalecik mine workings cover a vast area. The distance between silicified caprock (“flint”) and the gallery opening of the lowermost level is 500 m. At a level of ca. 20 m below the lowermost gallery, an old mercury ore melting plant was found at the intersection of two streams. Previous studies recorded that the Kalecik mercury deposit was exploited between 1903 and 1906 with some interruptions (Ryan, 1960), and produced 20.750 bottles of mercury metal, i.e. 715 t of Hg. Currently there are unprocessed low grade ore and melting waste piles located next to the ruins of the processing plant. The tranport of acidic solutions of Hg, As and Fe from the waste piles through the brook into the bay south of Karaburun and into the sea is very likely. Local people observed that in an area where the brook discarges into the sea, and close to where summer houses are situated, the sea in an extensive area in a bay turned to a brownish red color after heavy summer rainfall. Discolouration in the water disappeared only several days later.

The Karareis mercury deposit is exposed in a 30-40 m high ridge about 300 m inshore north of a settlement known as “Karareis Farm” on the west coast of Karaburun Peninsula and northeast of Tuzla Bay, (Figure 1). The deposit lies within the Silurian-Carboniferous monotonous detrital Dibekdağı Formation (Çakmakoğlu and Bilgin, 2006). The detrital unit is composed of sandstone, mudstone, green-black chert and radiolarite, some olistostromal levels and lenses of turbiditic limestone. According to Höll (1966), the detrital unit has a Middle Silurian age and comprises tuff layers, indicating submarine volcanism related to ore-bearing levels. Thus, it is likely that the Karareis mercury deposit was generated by exhalative-sedimentary (submarine volcanic) processes. The ore includes mainly cinnabar, pyrite and marcasite minerals. Rarely, disseminated very fine grains of arsenopyrite and chalcopyrite were observed. As was observed in Kalecik deposit, cinnabar at Karareis is also enriched in siliceous zones. Some high grade zones show up to 60% Hg grade, as reported in previous works. However, there are no geological data clearly defining genesis of the deposit related with Karareis deposit. Thus, we suppose that to relate genesis of the this deposit with younger alkaline intrusions of Neogene in West Anatolia will be the most reasonable approach, akin to Kalecik Mercury Deposit located in 14.00 km northeast.

It is known that the Karareis mercury deposit has been mined since 1909 despite some interruptions. From 1955 to 1964 mercury ore with 2% grade was continuously extracted and melted on site. 3 t of Hg metal was produced per month in 1964 (Höll, 1966). During the visit to this mine in 1973, Prof Ozcan Dora sadly observed that during mercury production melting wastes were disposed of in an unconscious way. During the life of the mine it may be assumed that about 500 t of Hg metal was produced. The observed ore and melting waste volumes, however, are very few on the abandoned minesite. It is considered that all wastes were washed and drifted to the sea because the mine is located on the ridge at a distance of only a few hundred meters from the sea.

MATERIALS AND METHODS

Of total 90 samples taken on 07.11.2008, 45 were taken from the SW part of Karaburun Peninsula (Karaburun-I) on lines A (210^{o}), B (125^{o}) and C (290^{o}), and 45 further samples were taken from SE of the Karaburun urban area in the northeast (Karaburun-II) in the directions of A (80^{o}), B (10^{o}) and C (160^{o}) at water depths of 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90 and 100 m (Figure 1; Tables 3 and 4). Analyses on foraminifera and ostracods in sediment samples were made based on to Babin *(1980) and* Bignot (1985). Wet samples were treated with of 10% H_2O_2, each of which is 5 gr in weight, for 24 hours and then washed using 0.063 mm size by pressured water, and finally they were selected on 2.00, 1.00, 0.500, 0.250, 0.125 mm sieves after drying in a sterilizer at 50^{o}C. Foraminifera and ostracods from the samples were identified under a binocular microscope.

For the analyses of heavy metals and trace elements in seawater 2 ml HCl was added to each 0.5 l polyethylene sampling pot, and then sent to the Geochemistry Laboratory at Çukurova University, Faculty of Engineering and Architecture, Department of Geological Engineering. Since the sample is liquid, the analyses were performed by an Atomic Absorption Spectrometry (AAS) 700 instrument without any dissolution. Hg measurements were performed at the Institute of Istanbul University Marine Sciences and Management, Marine Chemistry Laboratory using a Shimatzu 6701 AAS Hydride Unit.

Elemental chemical analyses were measured on solid, liquid and gas samples as either ppm or, if enriched before, ppb by means of Wavelength Dispersed X-Ray Fluorescence Analysis Spectrometry (WDXRF) at Çekmece Nuclear Research and Training Center (ÇNAEM). Qualitative and quantitative analyses were made for the elements between boron (B) and uranium (U) in this system using x-ray tube, crystals varied in character (LiF220, PX10, GeIII-C, PE 202-C), two sensors, various colimators in size and character.

In preparation for total alpha and beta particle couning, sediment samples were ground to 200 mesh size before drying. Preserved in a desiccator, the sample is 12 gr in weight, and then mixed with wax of 3 gr and put into a 40 mm-diameter mold, and finally became as a pellet under the pressure of 35 tonnes. To quantitatively analyse the chemical composition of the microfossil shells, a Jeol 733 electron microprobe instrument and online quantitative analysis program were used.

BENTHIC FORAMINIFERA OF THE NORTHERN COAST AREA IN KARABURUN PENINSULA

FORAMINIFERAL ASSEMBLAGE

The following foraminifera genera and species were observed in 45 samples collected from Tuzla Bay in SW of Karaburun Peninsula, and in 45 samples taken from SE of Karaburun settlement area in NE of Karaburun Peninsula: *İridia diaphana* Heron-Allen and Earland, *Rhabdammina abyssorum* Sars, *Eggerelloides scabrus* (Williamson), *Textularia bocki* Höglund, *Vertebralina striata* d’Orbigny, *Wiesnerella auriculata* (Egger), *Nodopthalmidium antillarum* (Cushman), *Nubecularia lucifuga* Defrance, *Adelosina carinata-striata* Wiesner, *A. cliarensis* (Heron-Allen and Earland), *A. duthiersi* Schlumberger, *A. mediterranensis* (Le Calvez J. and Y.), *Spiroloculina angulosa* Terquem, *S.*

depressa d'Orbigny, *S. excavata* d'Orbigny, *S. ornata* d'Orbigny, *Siphonaperta agglutinans* (d'Orbigny), *S. aspera* (d'Orbigny), *Cycloforina contorta* (d'Orbigny), *C. villafranca* (Le Calvez J. and Y.), *Lachlanella undulata* (d'Orbigny), *L. variolata* (d'Orbigny), *Massilina gualteriana* (d'Orbigny), *M. secans* (d'Orbigny), *Quinqueloculina berthelotiana* d'Orbigny, *Q. bidentata* d'Orbigny, *Q. disparilis* d'Orbigny, *Q. lamarckiana* d'Orbigny, *Q. seminula* (Linné)**,** *Q. vulgaris* d'Orbigny, *Miliolinella elongata* Kruit, *M. semicostata* (Wiesner), *M. subrotunda* (Montagu), *M. webbiana* (d'Orbigny), *Pseudotriloculina laevigata* (d'Orbigny), *P. oblonga* (Montagu), *P. rotunda* (d'Orbigny), *P. sidebottomi* (Martinotti), *Pyrgo elongata* (d'Orbigny), *Triloculina* cf. *bermudezi* Acosta, *T. fichteliana* d'Orbigny, *T. marioni* Schlumberger, *T. plicata* Terquem, *T. scheriberiana* d'Orbigny, *Sigmoilinita costata* (Schulmberger), *S. edwardsi* (Schlumberger), *Articulina carinata* Wiesner, *Euthymonacha polita* (Chapman), *Laevipeneroplis karreri* (Wiesner), *Peneroplis arietinus* (Batsch), *P. pertusus* (Forskal), *P. planatus* (Fichtel and Moll), *Sorites orbiculus* Ehrenberg, *S. variabilis* Lacroix, *Polymorphina* sp.3, *Reussella spinulosa* (Reuss), *Eponides concameratus* (Williamson), *Neoeponides bradyi* Le Calvez, *Neoconorbina terquemi* (Rzehak), *Rosalina bradyi* Cushman, *R. obtusa* d'Orbigny, *Pararosalina* cf. *dimorphiformis* McCulloch**,** *Pararosalina* sp., *Conorbella imperatoria* (d'Orbigny), *Discorbinella bertheloti* (d'Orbigny), *Cibicides advenum* (d'Orbigny), *Lobatula lobatula* (Walker and Jacob), *Planorbulina mediterranensis* d'Orbigny, *Cibicidella variabilis* (d'Orbigny), *Cymbaloporetta plana* (Cushman), *C. squammosa* (d'Orbigny), *Sphaerogypsina globula* (Reuss), *Asterigerinata mamilla* (Williamson), *Amphistegina lobifera* Larsen, *Nonion depressulum* (Walker and Jacob), *Ammonia compacta* Hofker, *A. parkinsoniana* (d'Orbigny), *A. tepida* Cushman, *Challengerella bradyi* Billman, Hottinger and Oesterle, *Cribroelphidium poeyanum* (d'Orbigny), *Porosononion subgranosum* (Egger), *Elphidium aculeatum* (d'Orbigny), *E. advenum* (Cushman), *E. complanatum* (d'Orbigny), *E. crispum* (Linné), *E. depressulum* (Cushman) (Meriç and Avşar, 2001; Meriç et al., 2002*a* and *b*; 2003*a*; 2004; 2008*a* and *b*; 2009*a*, *b* and *c*; 2010 *a* and *b*; Avşar et al., 2009) (Tables 2 a, b, c and 3 a, b, c)..

Table 3a- The distribution of benthic foraminifer genera and species for the stations of 2A line taken in the northeast of Karaburun Peninsula.

FORAMINIFERAS	STATIONS (m)														
	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Textularia bocki		1		2	8	9	2	1		1				1	
Vertebralina striata		1				2	1						1		
Nodopthalmidium antillarum													1		
Adelosina mediterranensis													2		
Siphonaperta agglutinans													1		
Siphonaperta aspera						1	2	1	1	1	8				
Quinqueloculina berthelotiana				1			1								
Quinqueloculina bidentata											2				
Quinqueloculina disparilis				1							2				
Quinqueloculina lamarckiana			1			4	5	1			2				
Miliolinella subrotunda														1	
Triloculina cf. bermudezi							1		1						
Triloculina marioni											2				
Sigmoilinita costata													1		
Peneroplis pertusus		2	1	2	1	5	11			2	5		4	2	1
Peneroplis planatus					1	1	4			1	1				
Pararosalina cf. dimorphiformis					1			1							
Discorbinella bertheloti											1		1		1
Lobatula lobatula											1				
Planorbulina mediterranensis		1					1				1				
Amphistegina lobifera	1			2	3	6		5		2	2	1			
Elphidium depressulum			1												

Table 3b- The distribution of benthic foraminifer genera and species for the stations of 2B line taken in the northeast of Karaburun Peninsula.

FORAMINIFERAS	STATIONS (m)														
	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Iridia diaphana													2		
Textularia bocki	1	6	1	1		4		2	2	2	3	5	85	17	11
Verteberalina striata							1				2		10	3	5
Nubecularia lucifuga													2		
Adelosina cliarensis													2	1	
Adelosina duthiersi												1			
Adelosina mediterranensis													2		
Spiroloculina ornata							1				2			2	6
Siphonaperta agglutinans														1	
Siphonaperta aspera											1	2	22		
Cycloforina contorta											2				
Lachlanella variolata													2		
Massilina gualteriana													2	1	1
Massilina secans													1		
Quinqueloculina berthelotiana		1											7	2	
Quinqueloculina bidentata			1										9		3
Quinqueloculina disparilis		1						1		1			16	2	9
Quinqueloculina lamarckiana				1		1	1	1			1	5	40	10	16
Miliolinella subrotunda											3		1		
Miliolinella webbiana													1		
Pseudotriloculina laevigata														1	
Pseudotriloculina oblonga											1		2		
Triloculina fichteliana													4		
Triloculina marioni													6		1
Sigmoilinita costata											1		1		1
Sigmoilinita edwardsi														1	1
Laevipeneroplis karreri													4		1
Peneroplis pertusus		1		2			1			3	19		60	12	10
Peneroplis planatus		1		1			1				3	1	69	7	4
Sorites orbiculus											1				
Sorites variabilis														1	
Neoconorbina terquemi													4		1
Rosalina bradyi		1									1	1	5	8	6
Pararosalina cf. dimorphiformis														1	1
Discorbinella bertheloti											1				
Cibicides advenum											1				
Lobatula lobatula			1		1						1		12	1	5
Planorbulina mediterranensis													2		5
Cibicidella variabilis													2		
Amphistegina lobifera	1	1		4	4	4	2	7	4	4	1	2	2	1	
Elphidium aculeatum													1		
Elphidium crispum												2	8	4	8

Table 3c- The distribution of benthic foraminifer genera and species for the stations of 2C line taken in the northeast of Karaburun Peninsula.

FORAMINIFERAS	STATIONS (m)														
	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Textularia bocki	2	1					3	4							1
Vertebralina striata		1				1	1								
Adelosina cliarensis				1											
Siphonaperta aspera						1		1							
Cycloforina contorta							1								
Quinqueloculina berthelotiana															1
Quinqueloculina disparilis							1								
Quinqueloculina lamarckiana				1		1	1	1							
Miliolinella subrotunda							1								
Miliolinella webbiana						1									
Triloculina marioni						1				1					
Peneroplis pertusus		1			3	4	2	1	1				1		
Peneroplis planatus					1	3	4	1							
Lobatula lobatula					1			1					1		
Cibicidella variabilis						1									
Amphistegina lobifera		1	1		1	2		1	1						
Elphidium crispum						1									

FORAMINIFERAL ASSEMBLAGES AND DISTRIBUTION

84 benthic foraminifera species of 27 families, 22 subfamilies, and 48 genera are identified along the sampling lines in the study area (Tables 2 a, b, c and 3 a, b, c). 3 dominant foraminifera assemblages are observed in the region with respect to these data.

Assemblage 1: Dominant genus and species is *Amphistegina lobifera* Larsen in Karaburun 1A Line. The genera and species such as *Nubecularia lucifuga* Defrance, *Elphidium crispum* (Linné), *Lobatula lobatula* (Walker and Jacob), *Triloculina marioni* Schlumberger, *Planorbulina mediterranensis* d'Orbigny and *Siphonaperta aspera* (d'Orbigny) are determined together with *A. lobifera* Larsen in 3 stations with depths varying between 4.90, 7.60 and 17.50 m (35, 45 and 60 m). *Amphistegina lobifera* Larsen is dominant species in 1B Line again. In two separate sites with 1.00 m deep (15 and 20 m) *Peneroplis pertusus* (Forskal), *P. planatus* (Fichtel and Moll), *Quinqueloculina lamarckiana* d'Orbigny and *Elphidium crispum* (Linné) are found.

Assemblage 2: The assemblage, in which *Peneroplis pertusus* (Forskal) is dominant and is observed in 1C Line, is observed in 5 stations with depths varying between 2.30 and 3.50 m (30, 70, 80, 90, 100 m). The genera and species such as *Amphistegina lobifera* Larsen, *Peneroplis planatus* (Fichtel and Moll), *Siphonaperta aspera* (d'Orbigny), *Quinqueloculina berthelotiana* d'Orbigny, and *Q. lamarckiana* d'Orbigny are found in the assemblage. The dominant species is *Peneroplis pertusus* (Forskal) in 2A Line again. *Textularia bocki* Höglund, *Amphistegina lobifera* Larsen, *Siphonaperta aspera* (d'Orbigny) and *Quinqueloculina lamarckiana* d'Orbigny are identified in 5 samples taken from depths varying between 3.20 and 11.80 m (25, 30, 35, 40, 60 m).

Assemblage 3: *Textularia bocki* Höglund is the dominant genus and species in 2B Line. *Peneroplis pertusus* (Forskal), *P. planatus* (Fichtel and Moll), *Quinqueloculina lamarckiana* d'Orbigny and *Amphistegina lobifera* Larsen are observed in 3 sites with 16.50 m depth (80, 90 and 100 m). Although 2C Line is not very rich in benthic foraminifera, *Peneroplis pertusus* (Forskal) seems as dominant relative to the determined genera and species. *Textularia bocki* Höglund, *Peneroplis planatus* (Fichtel and Moll) and *Amphistegina lobifera* Larsen are identified in 2 locations at depths varying between 2.20 and 2.70 m (30 and 35 m).

OSTRACODS OF THE NORTHERN COAST AREA IN KARABURUN PENINSULA

OSTRACOD ASSEMBLAGES

From 45 smaples collected in Tuzla Bay in the SW of Karaburun Peninsula, and from 45 samples taken from SE of Karaburun settlement area in NE of Karaburun Peninsula 19 genera and 24 species were indientified: *Neonesidea inflata* (Norman), *Cytherella alvearium* Bonaduce, Ciampo and Masoli, *Pontocypris acuminata* (Müller), *Pontocypris mytiloides* (Norman), *Callistocythere intricatoides* (Ruggieri), *Tenedocythere prava* (Baird), *Aurila convexa* (Sars), *Acantocythereis hystrix* (Reuss), *Carinocythereis carinata* (Roemer), *Hiltermannicythere rubra* (Müller), *Costa batei* (Brady), *Costa edwardsii* (Roemer), *Cytheretta adriatica* Ruggieri, *Pontocythere elongata* (Brady), *Neocytherideis bradyi* Athersuch, *N. subulata* (Brady), *Urocythereis oblonga* (Brady), *Bosquetina carinella* (Reuss), *Paracytheridea depressa* Müller, *Semicytherura acuta* (Müller), *Semicytherura sp., Loxoconcha rhomboidea* (Fischer), *Paradoxostoma triste* Müller, *Xestoleberis communis* Müller, *Xestoleberis depressa* Sars, *Xestoleberis dispar* Müller (Van Morkhoven, 1963; Hartman and Puri, 1974; Breman, 1975; Yassini, 1979; Guillaume et al., 1985; Joachim and Langer, 2008) (Tables 4 a, b, c and 5 a, b, c).

Table 4a- The distribution of ostracod genera and species for the stations of 1A line taken in the northwest of Karaburun Peninsula.

OSTRACODAS	STATIONS (m)														
	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Neonesidea inflata					1				1	3		7	12	9	14
Cytherella alvearium									1						
Pontocypris acuminata									1				2		
Pontocypris mytiloides							1							1	2
Callistocythere intricatoides								2	9					2	
Tenedocythere prava								1	1	1	1	2	3	4	8
Aurila convexa														1	
Acantocythereis hystrix														1	13
Carinocythereis carinata							1	3	4	7	4	5	4	3	6
Costa batei													4	2	3
Costa edwardsii												2	3	3	4
Pontocythere elongata							1	6							
Neocytherideis bradyi										1					
Urocythereis oblonga	1							1							
Bosquetina carinella													4	4	7
Paracytheridea depressa							4			1					
Semicytherura sp.								1				1			
Semicytherura acuta									1						
Loxoconcha rhomboidea	5		1			1	5	27	17	17	29	12	36	43	26
Paradoxostoma triste													2		
Xestoleberis communis	1		1	1			2	12	31	19	11	16	31	6	24
Xestoloberis depressa	2	1	1				2	2	8	4	8	8	14	9	11
Xestoleberis dispar									2						

Table 4b- The distribution of ostracod genera and species for the stations of 1B line taken in the northwest of Karaburun Peninsula.

OSTRACODAS	STATIONS (m)										
	5	10	15	20	25	45	50	60	70	90	100
Urocythereis oblonga										2	
Pontocythere elongata									2		
Cytheretta adriatica									1	1	
Neocytherideis subulata								1			
Semicytherura sp.							1				
Loxoconcha rhomboidea		1		1	2	1	1				1
Xestoleberis communis	1	1	2								
Xestoloberis depressa			7		1						
Xestoleberis dispar				1							

Table 4c- The distribution of ostracod genera and species for the stations of 1C line taken in the northwest of Karaburun Peninsula.

OSTRACODAS	STATIONS (m)													
	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Neonesidea inflata													1	
Cytherella alvearium														1
Pontocypris mytiloides		2		2									2	
Callistocythere intricatoides									1		1		2	1
Aurila convexa				1							2			
Hiltermannicythere rubra				1										
Urocythereis oblonga				1							1	1		
Paracytheridea depressa							1	1		1	1			
Loxoconcha rhomboidea				3	10	1	1				3		7	3
Xestoleberis communis	1		1		2	2	1	3		1	2	6	4	3
Xestoloberis depressa					6	1	2	2			6	6	4	
Xestoleberis dispar				2								1	1	

Table 5a- The distribution of ostracod genera and species for the stations of 2A line taken in the northeast of Karaburun Peninsula.

OSTRACODAS	STATIONS (m)				
	15	30	40	90	100
Xestoleberis communis	2	1		1	1
Xestoleberis depressa			2		

Table 5b- The distribution of ostracod genera and species for the stations of 2B line taken in the northeast of Karaburun Peninsula.

OSTRACODAS	STATIONS (m)							
	10	20	50	60	70	80	90	100
Neonesidea inflata							1	
Pontocypris mytiloides							2	
Callistocythere intricatoides					1			
Tenedocythere prava								1
Paracytheridea depressa								1
Loxoconcha rhomboidea						1	2	
Xestoleberis communis		2	2			1		
Xestoloberis depressa				1			3	1
Xestoleberis dispar	1			2			3	1

Table 5c- The distribution of ostracod genera and species for the stations of 2C line taken in the northeast of Karaburun Peninsula.

OSTRACODAS	STATIONS (m)		
	5	20	40
Xestoleberis communis		1	
Xestoloberis depressa			1
Xestoleberis dispar	2		

OSTRACOD ASSEMBLAGES AND DISTRIBUTION

24 species of 19 genera are identified in the study area and samples (Tables 4 a, b, c and 5 a, b, c). Based on available data 2 dominant ostracod assemblages are determined. The carapaces of ostracod species are counted in the studied samples, and considerations on the abundancy zones are given below by a relative comparison. Also, as the water depth and horizontal distance in the lines taken from the northwest of Karaburun Peninsula increases, it is observed that there is an increase in the population size of ostracod genera and species.

Assemblage 1: The dominant genus and species is *Loxoconcha rhomboidea* (Fischer) in 1A line taken from the northwest of Karaburun Peninsula. In addition to *Loxoconcha rhomboidea* (Fischer), *Xestoleberis communis* Müller and *X. depressa* Sars are found in 9 stations with water depths varying between 6.60 and 19.30 m (40, 45, 50, 60, 70, 80, 90 and 100 m), and *Xestoleberis communis* Müller and *X. depressa* Sars are found together with *Loxoconcha rhomboidea* (Fischer) in 6 samples taken from same region in 1 B Line at water depths varying between 1.00 and 2.40 m and horizontal distances varying between 5 and 100 m. In 1C line the state is also same.

Assemblage 2: The dominant genus and species is *Xestoleberis dispar* Müller in 2B Line taken from the northeastern part of Karaburun Peninsula. Besides the mentioned ostracod species, *Xestoleberis depressa* Sars is determined in this line at water depths ranging between 1.00 and 3.70 m.

Xestoleberis communis Müller and *X. depressa* Sars are determined as 1 genus and 2 species in 5 samples with water depths varying between 1.20 and 5.70 m and horizontal distances varying between 15 and 100 m in 2A line taken from the northeast of Karaburun Peninsula. *Xestoleberis communis* Müller, *X. depressa* Sars and *X. dispar* Müller are widespread species in 8 samples at water depths varying between 1.00 and 3.70 m and horizontal distances ranging between 1 and 100 m in 2B line taken from same region. *Xestoleberis communis,* Müller, *X. depressa* Sars and *X. dispar* Müller are found in 3 samples at water depths between 1.00 and 2.50 m and horizontal distances between 5 and 40 m in 2C line even though these occurred in very low numbers. The 3 species of *Xestoleberis* mentioned above are widespread in the gulf waters of the peninsula.

RESULTS OF CHEMICAL AND RADIOACTIVE ANALYSES OF SEAWATER

The results on chemical and radioactive analysis of water samples taken from Karaburun I and II sampling areas are shown in table 6. The chemical contents of Karaburun I and II water samples taken in 2009 are overall similar, but As and Si are higher in Karaburun II, while Cr, Ni, Zn and Hg values are higher in Karaburun I (Figure 8a). In comparison with Krauskopf's (1979) seawater reference values (Figure 8b), it is noteworthy that only the Si value is low, other measured heavy metal and rare elements are high. The significant differences, which were observed between analyses of Karaburun in 2009 and 2010, may be associated with the time when the sampling was made. Al, Si, Fe, Br, Sn and rare element La, radioactive Cs and W elements are to be higher than Krauskopf's (1979) seawater and shale reference values.

Table 6- Chemical (ppm) and radioactivity (Bq/L) characteristics of the water samples taken from Karaburun I and II together with microprobe analyses on colored Peneroplis planatus shells taken from various depths of Karaburun I.

	Karaburun I (2009)	Karaburun I (2010)	Karaburun II (2009)	Karaburun II (2010)	Sea water-Krauskopf (1979)	Shale- Krauskopf (1979)	*Peneroplis planatus* kavkıları									
							IA10	IA40	IC30	IC40	IC60	IC70	IC80	IC90	IC100	IC100
Al ppm	0.625		0.625		0.002	9.2×10^{-4}	0.16	1.98	0.35	0.55	0.51	3.69	0.18	0.47	1.66	2.38
Si ppm	1.25		1.88		2	23.8×10^{-4}						2.97				0.96
Cr ppm	0.15	13.7	0.1		0.0003	100	0.33	0.36	0.45	0.27	0.35	0.34	0.44	0.5	0.47	0.49
Mn ppm	0.067		0.067		0.0002	850										
Fe ppm	1.1		1.1		0.002	4.7×10^{-4}	1.4	1.88	3.51	2.51	4.18	14.91	0.99	2.67	9.35	4.22
Co ppm	0.545	7.5	0.545		0.00005	20										
Ni ppm	0.88	4.9	0.75		0.0017	80	0.49	1.25	0.98	0.42	0.52	0.47	1.03	1	0.54	0.59
Cu ppm	0.05		0.05		0.0005	50										
Zn ppm	0.093	2.3	0.067		0.0049	90	3.21	3.93	5.2	4.56	2.93	2.14	3.19	3.63	2.2	1.64
Cd ppm	0		0		1×10^{-6}	0.3										
Hg ppm	0	0.1	0	0.09	3×10^{-5}	0.3										
As ppb	0.218		0.695		0.0037	10										
Sc ppm		2.05			6×10^{-7}	15										
Br ppm		21.26			67	5										
Rb ppm		3			0.12	140	1.84	2.3	2.77	2.2	4.22	5.36	2.93	2.79	3.76	4.14
Sr ppm		187			8	400										
Sn ppm		8.25			1×10^{-5}	6										
Cs ppm		7.65			4×10^{-4}	7										
La ppm		8.65			3×10^{-6}	40										
W ppm		2.9			1×10^{-4}	1.8										
Total Alpha (Bq)		0.051±0.006														
Total Beta (Bq)		19.243±1.058														

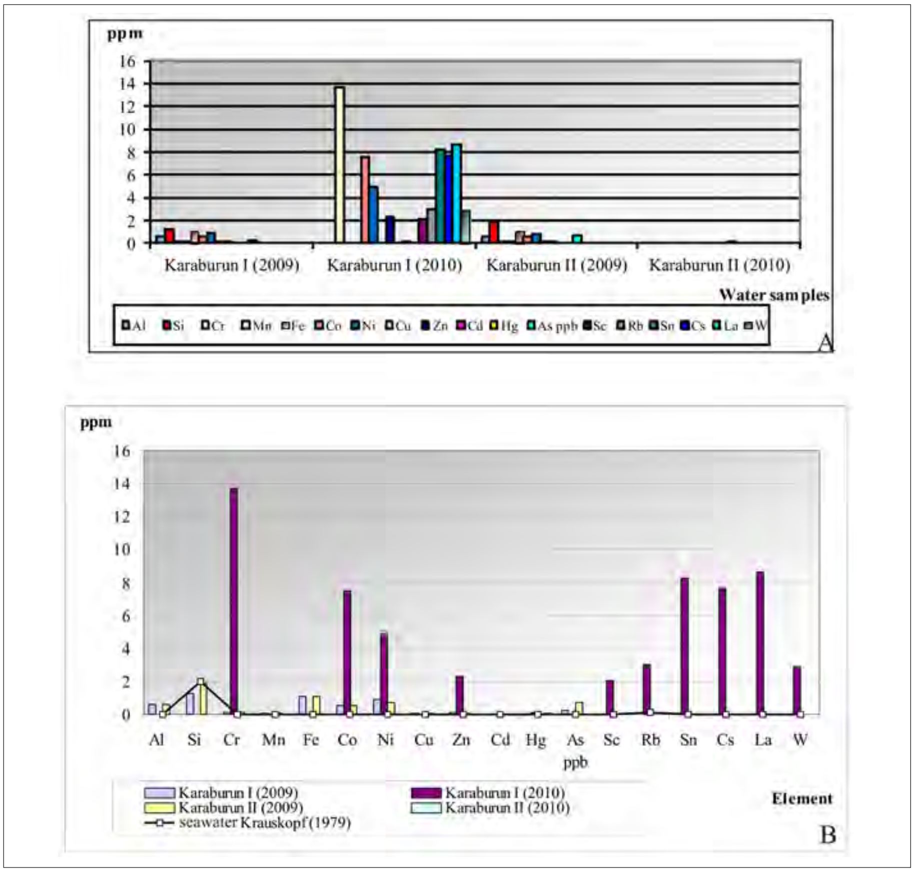

Figure 8- a.Heavy metal and trace element distribution for the water samples of Karaburun I and II.
b. Heavy metal and trace element distribution for the water samples of Karaburun I and II together with Krauskopf's (1979) distribution of sea water reference values.

Total alpha value of 0,051±0,006 Bq and total beta value of 19,243±1,058 Bq are determined in Karaburun I in our study (13/05/2010). According to the radioactivity measurements of Çeşme hyperthermal-hypertonic mineral waters from various locations along the southwest coast of Karaburun peninsula, the total alpha values are 4.41188±19.6 Bq, total beta is 4.37081±9.21 Bq, Rn^{222} is 25.9 Bq, and Ra^{226} is 1.64428 Bq (Yenal et al., 1975). According to the radioactivity analyses made on mineral waters of Şifne Spa, which is located in the western part of Karaburun, the values of total alpha are 3.94383±9.8 Bq, total beta is 2.62885±11.16 Bq, Rn^{222} as 31.45 Bq, and Ra^{226} is 0.59348 Bq(Yenal et al., 1975). In conclusion total beta values in Karaburun I are high, while total alpha values are low.

GEOCHEMICAL CHARACTERISTICS OF *Peneroplis planatus* (Fichtel and Moll) SHELLS

Taking into consideration the results of microprobe analysis (Table 6) made on *Peneroplis planatus* shells, which were taken from A10, A40 and C30, C40, C60, C70, C80, C90 and C100 m samples of Karaburun I, the highest Ni in A40, the highest Zn in C30, the highest Al, Fe and Rb in C70 and the highest Cr in C90 are observed between themselves. The lowest elements are determined as Al and Rb in A10, Mn and Ni in C40, Fe in C80 and Zn in C100.

The highest Zn in C30 and the highest Fe in C70 and C100 (Figure 9a) are viewed in the distribution of heavy metals and rare elements of colored *Peneroplis planatus* shells in general. In comparison with the Karaburun I water sample, the metal and rare earth element concentrations in the shells are high in Al, Cr, Fe, Zn, Rb. Concentrations are also strikingly high in comparison with Krauskopf's (1979) seawater reference values. Al, Fe and Rb are also found at higher concentrations in the shells when compared to Krauskopf's (1979) shale reference values (Figure 9b).

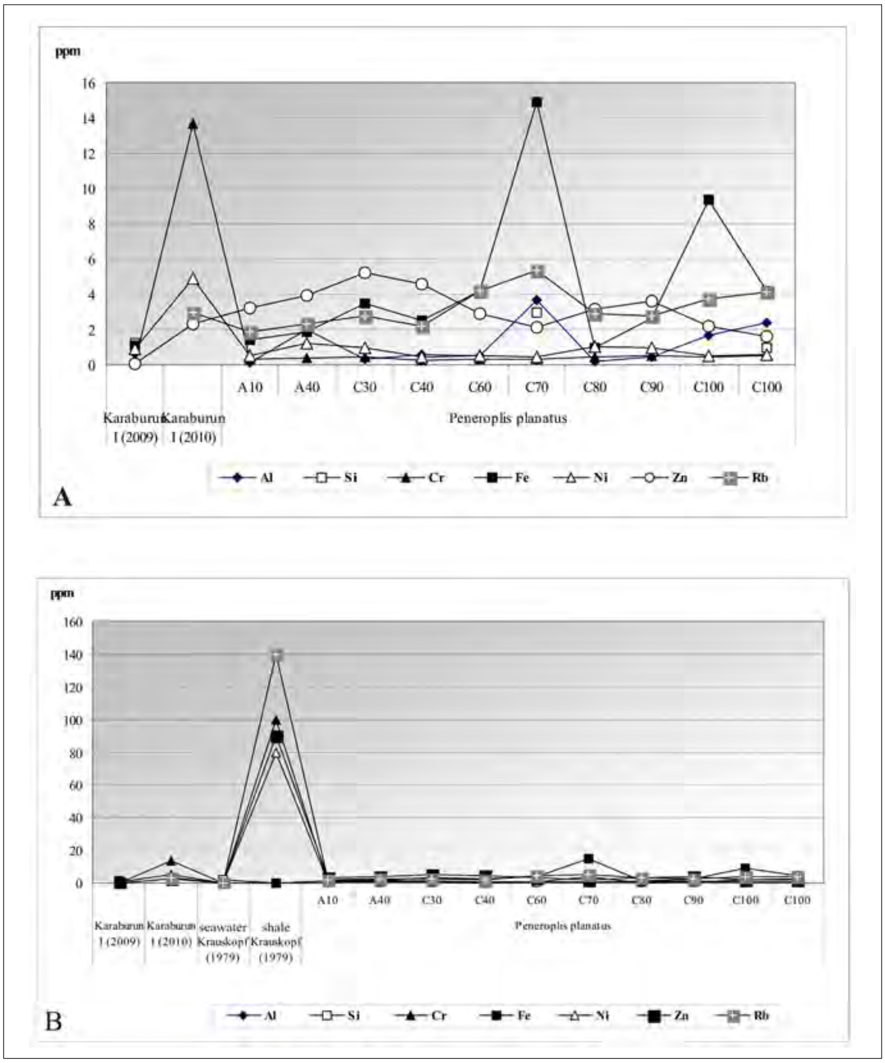

Figure 9- a. Heavy metal and trace element distribution of Karaburun I water sample and of colored Peneroplis planatus shells in some samples of Karaburun I.
b. The comparison of heavy metal and trace element distribution of Karaburun I water sample and of colored Peneroplis planatus shells in some samples of Karaburun I with Krauskopf's (1979) seawater and shale reference values.

CONCLUSIONS AND DISCUSSION

Major differences in benthic foraminiferal assemblages have been observed between the east and west coasts of the northern Karaburun Peninsula. In contrast to the rich fauna of the west coast (Table 2 a, b, c), a poor assemblage was found on the eastern coast, which is located in the Gulf of Izmir (Table 3 a, b, c). A great difference in population sizes has also been observed in *Amphistegina lobifera* Larsen assemblages found on the Aegean coasts of Karaburun Peninsula and Gulf of Izmir (Figure 10; Tables 2 a, b, c and 3 a, b, c). This observation has also been made in another study carried out previously in the Gulf of Izmir (Bergin et al., 2006). 67 species of foraminifera were identified in the above mentioned study, and the most abundant species were *Ammonia tepida* Cushman, *Elphidium crispum* (Linné), *Ampicoryna scalaris* (Batsch), *Nonionella turgida* (Williamson), and *Nonion depressulum* (Walker and Jacob). Highest heavy metal pollution was observed in the inner part of the gulf, where least number of foraminifer species observed. In the same study, it was encountered that some individuals of *Ammonia tepida* and *Adelosina mediterranensis* had shell deformities. The reason that organic pollutants are a factor in the distribution of foraminifer assemblages and many genera and species were observed in Gülbahçe Bay is associated with the discharge area of Gediz River.

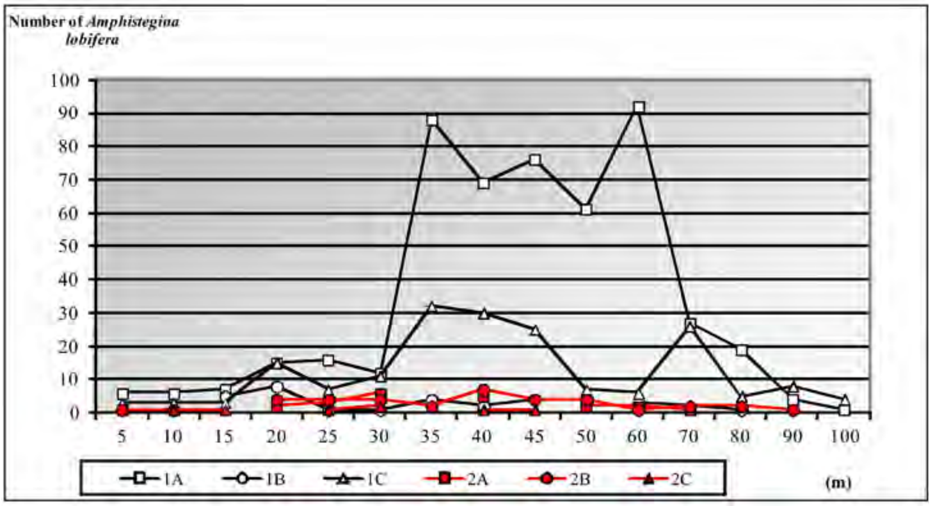

Figure 10- The distribution of *Amphistegina lobifera* Larsen populations in A, B and C lines of Karaburun I and II.

In our study there are many populations, which vary from orange-brown to black in color, in the samples bearing peneroplids and hauerinids at 5th and 10th m in 1A line, at 10th, 15th, 25th and 30th m in 1B line, 40th, 45th, 50th, 60th, 70th, 80th and 100th m in 1C line. Nevertheless, the samples taken from the gulf coast of peninsula are relatively different and only a few peneroplids and hauerinids show colorization in the samples taken from 70th, 80th, 90th and 100th m in 2B line. This situation is similar to observed peculiarities in Kuşadası, Lesbos, Ayvalık and Dardanelles (Meriç et al., 2002 *a* and *b*; 2009 *a*, *b*; *c*).

Morphological deformations observed in many *Peneroplis pertusus* (Forskal) and *P. planatus* (Fichtel and Moll) populations were often found in the samples collected from Karaburun I A, B and C lines. The same observation was also made in some Karaburun II samples that had colorization characteristics. (2A 35th m; 2B 10th m and 80th m).

In addition to these two mentioned features, it is noteworthy that there was an unusual increase in the population of *Nubecularia lucifuga* Defrance (Table 2a) and on the contrary a decrease in the population of *Amphistegina lobifera* Larsen (Table 3a, b and c) from 60th m in 1A line for the study area. Besides these findings, apertures in some *Vertebralina striata* d'Orbigny populations in Karaburun 1C line show morphological variations that were firstly observed in this area according to the available previous works.

That Atlantic origin *İridia diaphana* Heron-Allen and Earland are often found in this part together with Red Sea and Pacific Ocean origin genera and species such as *Nodopthalmidium antillarum* (Cushman), *Triloculina fichteliana* d'Orbigny, *Euthymonacha polita* (Chapman), *Peneroplis arietinus* (Batsch), *Sorites orbiculus* Ehrenberg, *S. variabilis* Lacroix, *Cymbaloporetta plana* (Cushman), *C. squammosa* (d'Orbigny), and *Amphistegina lobifera* Larsen, between benthic foraminifera of the west coast area is a striking feature for the study area.

The ostracod assemblage in the study area in the NW part of Karaburun Peninsula is very rich in genus and species content, which cannot be said for foraminifera (Table 4 a, b, c). The NE coast area of the peninsula is very poor in both genera and species variability with population size (Table 5 a, b, c).

Hg concentration obtained in the study is measured as 0.1 µg/l in Karaburun I water sample, 0.8 µg/l in sediment sample, and as 0.09 µg/l in Karaburun II water sample. Gemici and Oyman (2003) reported that Hg value of surface waters in the Hg mine outlet was measured in the range of 0.01 - 0.99 µg/l. Hg value is measured in the range of 0.05-1.3 µg/l in the sediments for another study conducted between 1996 and 2002 in the Gulf of Izmir (Küçüksezgin, 2001). According to USEPA (U.S. Environmental Protection Agency), standardized Hg concentration is 12 ng/l for aqueous environments, 0.01-1.2 µg/l for ground waters and acidic mine waters. According to Krauskopf (1979) it is $3x10^{-5}$ µg/l in seawater, 0.3 µg/l in shale.

The highest mercury concentration was measured at the port in the inner part of the Gulf (1.3 µg/g dry weight) in 2000 (Küçüksezgin 2001), and it is stated that this was due to industrial pollution, particularly by a chlorine alkali plant). Mercury values vary in the range of 0.12-1.3 µg/g within inner and central parts of the Gulf in 1997-2002, and between 0.05 and 0.99 µg/g in the outer part. High mercury values are detected in sediments at some sampling sites located outside the Gulf because of the mercury deposits in Karaburun (Küçüksezgin, 2001). The measured reference level is 0.34 µg/g in Mediterranean Sea (MAP, 1987), the measured concentrations is near to the reference level in the outer and central parts of the Gulf. Mercury levels decreased in 2002 in all stations where the measurements were made (Küçüksezgin et al., 2004).

The Karareis and of Kalecik mercury mines were gradually abandoned in the 1990s due to the increasing environmental concern about. However, our results show that acid mine drainage and mine tailings from the two Hg mines located nearby contribute to potential environmental pollution problems.

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PLATES

PLATE - I

Karaburun, İzmir.

1. *Textularia bocki* Höglund. Twin specimens, external view, 2B, 80.00 m.
2. *Vertebralina striata* d'Orbigny. External view, 1A, 80.00 m.
3. *Vertebralina striata* d'Orbigny. External view, 1A, 80.00 m.
4. *Vertebralina striata* d'Orbigny. External view, unusually grown specimen, 2B, 80.00 m.
5. *Adelosina carinata striata* Wiesner. External view, 1A, 80.00 m.
6. *Adelosina cliarensis* (Heron-Allen and Earland). External view, 1A, 80.00 m.
7. *Adelosina cliarensis* (Heron-Allen and Earland). External view, 1A, 80.00 m.
8. *Adelosina mediterranensis* (le Calvez, J. and Y.). External view, 1A, 100.00 m.
9. *Adelosina mediterranensis* (le Calvez, J. and Y.). External view, young specimen, 1A, 100.00 m.
10. *Spiroloculina excavata* d'Orbigny. External view, 1A, 90.00 m.
11. *Spiroloculina excavata* d'Orbigny. External view, 1A, 100.00 m.
12. *Spiroloculina ornata* d'Orbigny. External view, 1A, 80.00 m.
13. *Spiroloculina ornata* d'Orbigny. External view, 1A, 80.00 m.
14. *Siphonaperta aspera* (d'Orbigny). External view, 1A, 80.00 m.
15. *Siphonaperta aspera* (d'Orbigny). External view, 1A, 80.00 m.
16. *Cycloforina contorta* (d'Orbigny). External view, 1A, 90.00 m.
17. *Cycloforina contorta* (d'Orbigny). External view, 1A, 90.00 m.
17. *Cycloforina contorta* (d'Orbigny). External view, 1A, 90.00 m.

PLATE - I

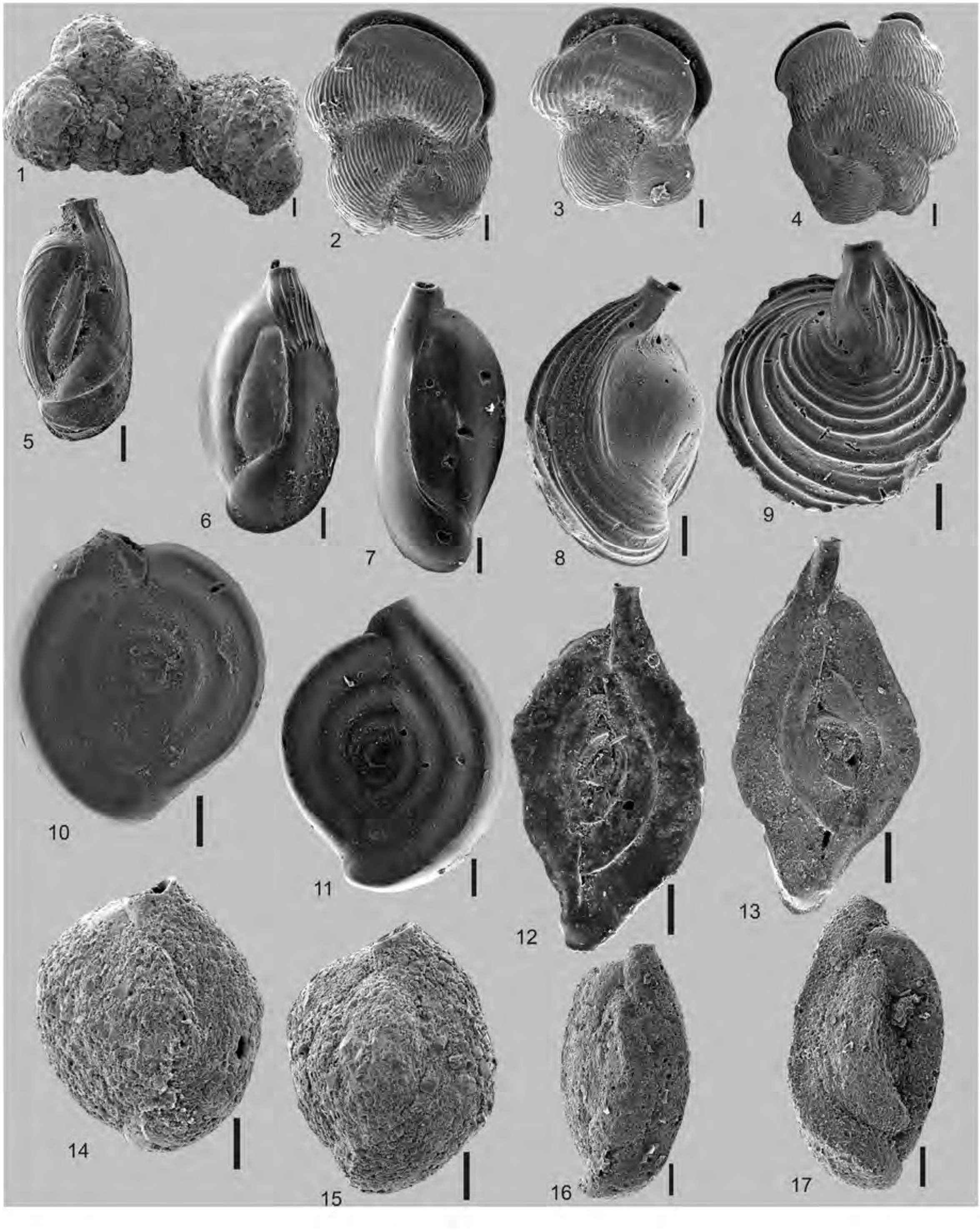


PLATE - II

Karaburun, İzmir.

1. *Cycloforina villafranca* (le Calvez J. and Y.). External view, 1A, 90.00 m.
2. *Cycloforina villafranca* (le Calvez J. and Y.). External view, 1A, 90.00 m.
3. *Lachlanella undulata* (d'Orbigny). External view, 1A, 90.00 m.
4. *Quinqueloculina berthelotiana* d'Orbigny. External view, 1A, 90.00 m.
5. *Quinqueloculina berthelotiana* d'Orbigny. External view, 1A, 90.00 m.
6. *Quinqueloculina lamarckiana* d'Orbigny. External view, 1A, 90.00 m.
7. *Quinqueloculina lamarckiana* d'Orbigny. External view, 1A, 90.00 m.
8. *Pseudotriloculina oblonga* (Montagu). External view, 1A, 90.00 m.
9. *Pseudotriloculina oblonga* (Montagu). External view, 1A, 90.00 m.
10. *Pseudotriloculina sidebottomi* (Martinotti). External view, 1A, 100.00 m.
11. *Pseudotriloculina sidebottomi* (Martinotti). External view, 1A, 100.00 m.
12. *Pseudotriloculina sidebottomi* (Martinotti). External view, 1A, 100.00 m.
13. *Triloculina marioni* Schlumberger. External view, 1A, 80.00 m.
14. *Triloculina marioni* Schlumberger. External view and aperture, 1A, 80.00 m.
15. *Triloculina marioni* Schlumberger. External view, 1A, 80.00 m.
16. *Sigmoilinita costata* (Schlumberger). External view, 1A, 80.00 m.

PLATE - II

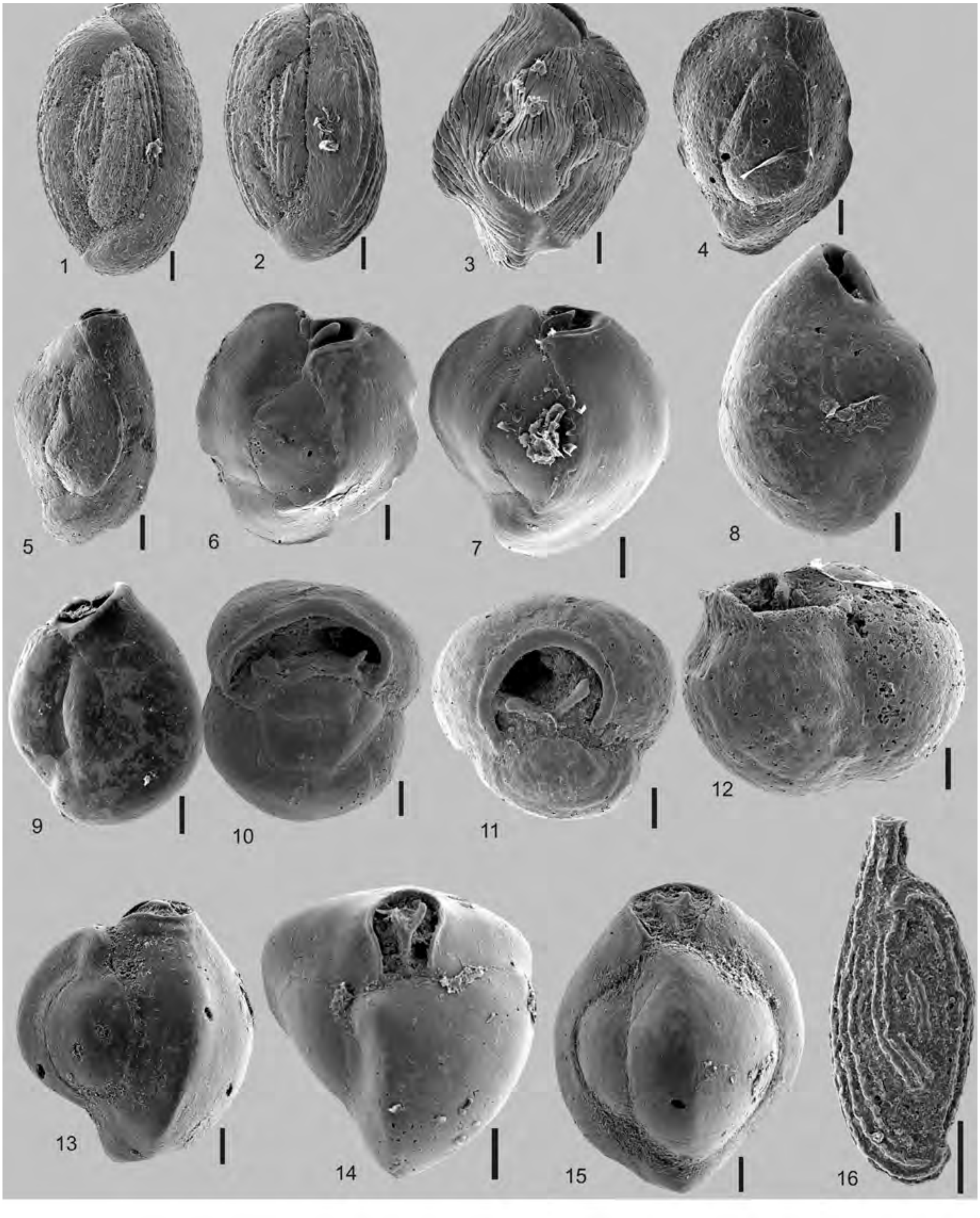


PLATE - III

Karaburun, İzmir.

1. *Sigmoilinita costata* (Schlumberger). External view, 1A, 80.00 m.
2. *Euthymonacha polita* (Chapman). External view, 1C, 100.00 m.
3. *Euthymonacha polita* (Chapman). Detailed view of shell, Karaburun, 1C, 100.00 m, İzmir.
4. *Euthymonacha polita* (Chapman). Detailed view of aperture and last chambers, 1C,100.00 m.
5. *Peneroplis pertusus* (Forskal). External view, 1A, 80.00 m.
6. *Peneroplis pertusus* (Forskal). External view, 1A, 80.00 m.
7. *Peneroplis pertusus* (Forskal). Unusual specimen, external view, 1A, 80.00 m.
8. *Peneroplis planatus* (Fichtel and Moll). External view, 1A, 90.00 m.
9. *Peneroplis planatus* (Fichtel and Moll). External view, 1A, 100.00 m.
10. *Peneroplis planatus* (Fichtel and Moll). External view, 1A, 100.00 m.
11. *Peneroplis planatus* (Fichtel and Moll). Unusual specimen, external view, 2B, 80.00 m.
12. *Peneroplis planatus* (Fichtel and Moll). Unusual specimen, external view, 2B, 80.00 m.
13. *Peneroplis planatus* (Fichtel and Moll). External view, 2B, 80.00 m.
14. *Peneroplis planatus* (Fichtel and Moll). Unusual specimen, external view, 2B, 80.00 m.
15. *Peneroplis planatus* (Fichtel and Moll). Unusual specimen, external view, 2B, 80.00 m.
16. *Rosalina bradyi* Cushman. External view, spiral side, 1A, 80.00 m.
17. *Rosalina bradyi* Cushman. External view, spiral side, 1A, 80.00 m.

PLATE - III

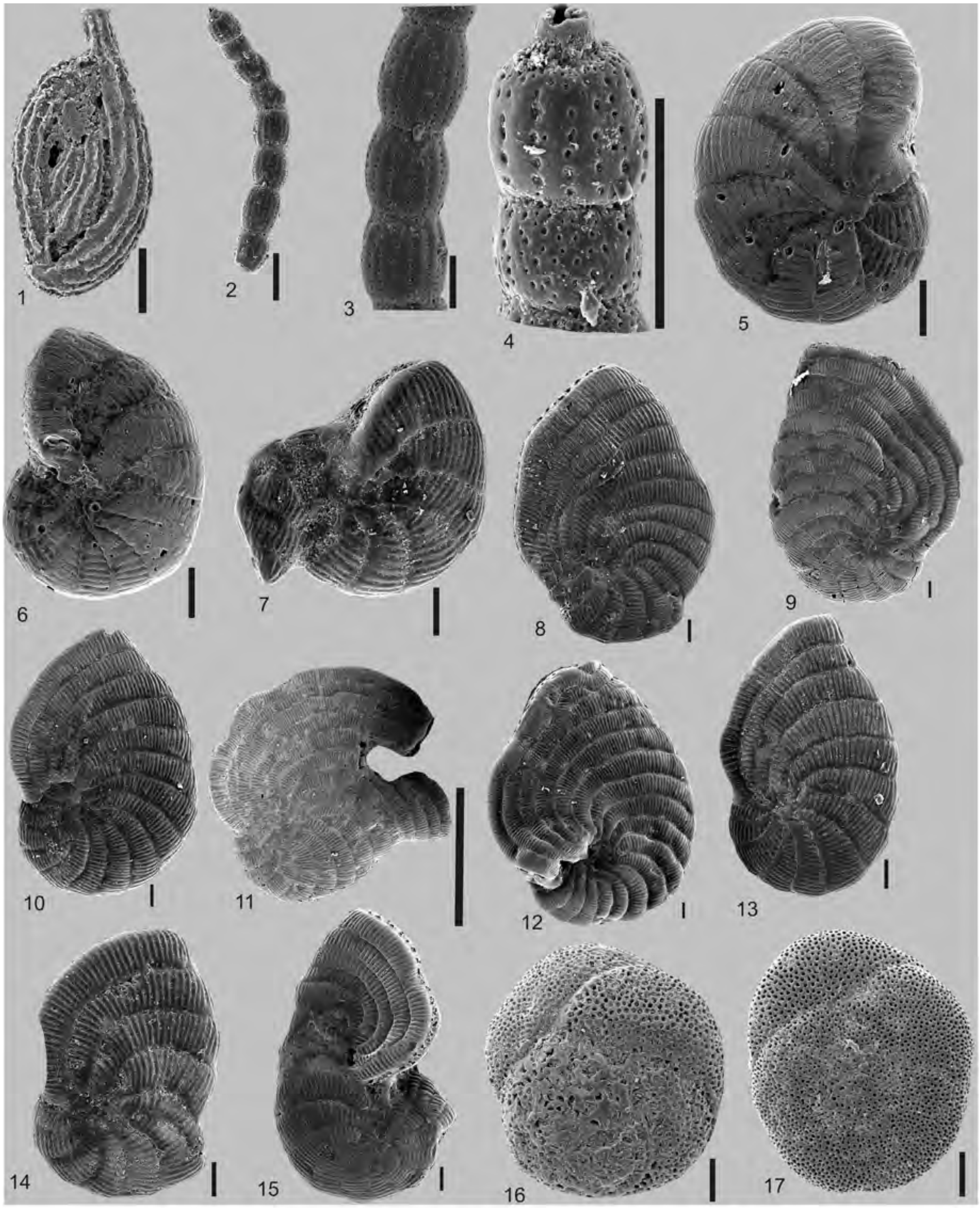


PLATE - IV

Karaburun, İzmir.

1. *Lobatula lobatula* (Walker and Jacob). External view, spiral side, 1A, 80.00 m.
2. *Lobatula lobatula* (Walker and Jacob). External view, umbilical side, 1A, 80.00 m.
3. *Planorbulina mediterranensis* d'Orbigny. External view, attached surface, 1A, 80.00 m.
4. *Planorbulina mediterranensis* d'Orbigny. External view, free surface, 1A, 80.00 m.
5. *Cibicidella variabilis* (d'Orbigny). Unusual specimen, external view, spiral side, 2B, 80.00 m.
6. *Asterigerinata mamilla* (Williamson). External view, spiral side, 1A, 90.00 m.
7. *Amphistegina lobifera* Larsen. External view, 1A, 80.00 m.
8. *Amphistegina lobifera* Larsen. External view, 1A, 80.00 m.
9. *Ammonia compacta* Hofker. External view, spiral side, 1A, 80.00 m.
10. *Ammonia compacta* Hofker. External view, umbilical side, 1A, 80.00 m.
11. *Ammonia parkinsoniana* (d'Orbigny). External view, spiral side, 1A, 80.00 m.
12. *Ammonia parkinsoniana* (d'Orbigny). External view, umbilical side, 1A, 80.00 m.
13. *Ammonia tepida* Cushman. External view, spiral side, 1A, 90.00 m.
14. *Ammonia tepida* Cushman. External view, spiral side, 1A, 90.00 m.
15. *Elphidium aculeatum* (d'Orbigny). External view, 1A, 80.00 m.
16. *Elphidium aculeatum* (d'Orbigny). External view, 1A, 80.00 m.
17. *Elphidium crispum* (Linné). External view, 1A, 80.00 m.
18. *Elphidium crispum* (Linné). External view, 1A, 80.00 m.
19. *Elphidium depressulum* Cushman. External view, 1A, 90.00 m.

PLATE - IV

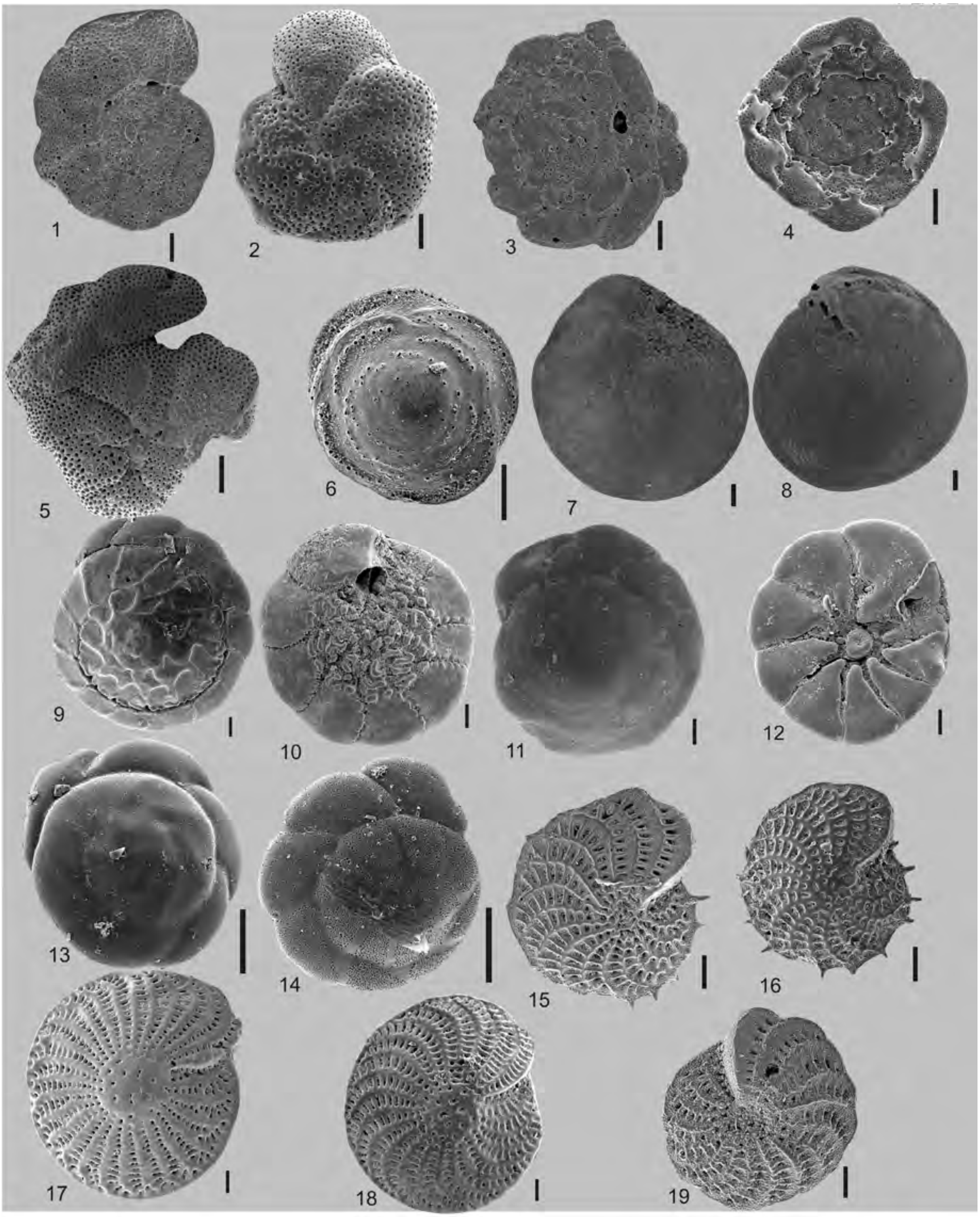


PLATE - V

Karaburun, İzmir.

1. *Adelosina mediterranensis* (Le Calvez J. and Y.). External view, 1A, 5.00 m.
2. *Cycloforina villafranca* (Le Calvez J, and Y.). External view, 1A, 5.00 m.
3. *Siphonapernta aspera* (d'Orbigny). External view, 1A, 50.00 m.
4. *Siphonapernta aspera* (d'Orbigny). External view, 1C, 30.00 m.
5. *Siphonaperta aspera* (d'Orbigny). External view, 1C, 80.00 m.
6. *Quinqueloculina bidentata* d'Orbigny. External view, 1C, 30.00 m.
7. *Quinqueloculina bidentata* d'Orbigny. External view, 1C, 100.00 m.
8. *Quinqueloculina bidentata* d'Orbigny. External view, 1C, 70.00 m.
9. *Quinqueloculina bidentata* d'Orbigny. External view, 1C, 70.00 m.
10. *Quinqueloculina lamarckiana* d'Orbigny. External view, 1C, 80.00 m.
11. *Quinqueloculina lamarckiana* d'Orbigny. External view, 2B, 100.00 m.
12. *Quinqueloculina lamarckiana* d'Orbigny. External view, 1C, 80.00 m.
13. *Quinqueloculina lamarckiana* d'Orbigny. External view, 1C, 100.00 m.
14. *Quinqueloculina lamarckiana* d'Orbigny. External view, 2B, 100.00 m.
15. *Quinqueloculina lamarckiana* d'Orbigny. External view, 1C, 100.00 m.
16. *Sigmoilinita costata* (Schlumberger). External view, 1A, 35.00 m.
17. *Sigmoilinita edwardsi* (Schlumberger). External view, 1C, 80.00 m.
18. *Peneroplis pertusus* (Forskal). External view, 1A, 10.00 m.
19. *Peneroplis pertusus* (Forskal). External view, 1A, 35.00 m.
20. *Peneroplis pertusus* (Forskal). External view, 1B, 5.00 m.
21. *Peneroplis pertusus* (Forskal). External view, 1C, 10.00 m.
22. *Peneroplis pertusus* (Forskal). External view, 1C, 30.00 m.
23. *Peneroplis pertusus* (Forskal). External view, 1C, 50.00 m.
24. *Peneroplis pertusus* (Forskal). External view, 1C, 50.00 m.
25. *Peneroplis pertusus* (Forskal). External view, 1C, 100.00 m.

PLATE - V

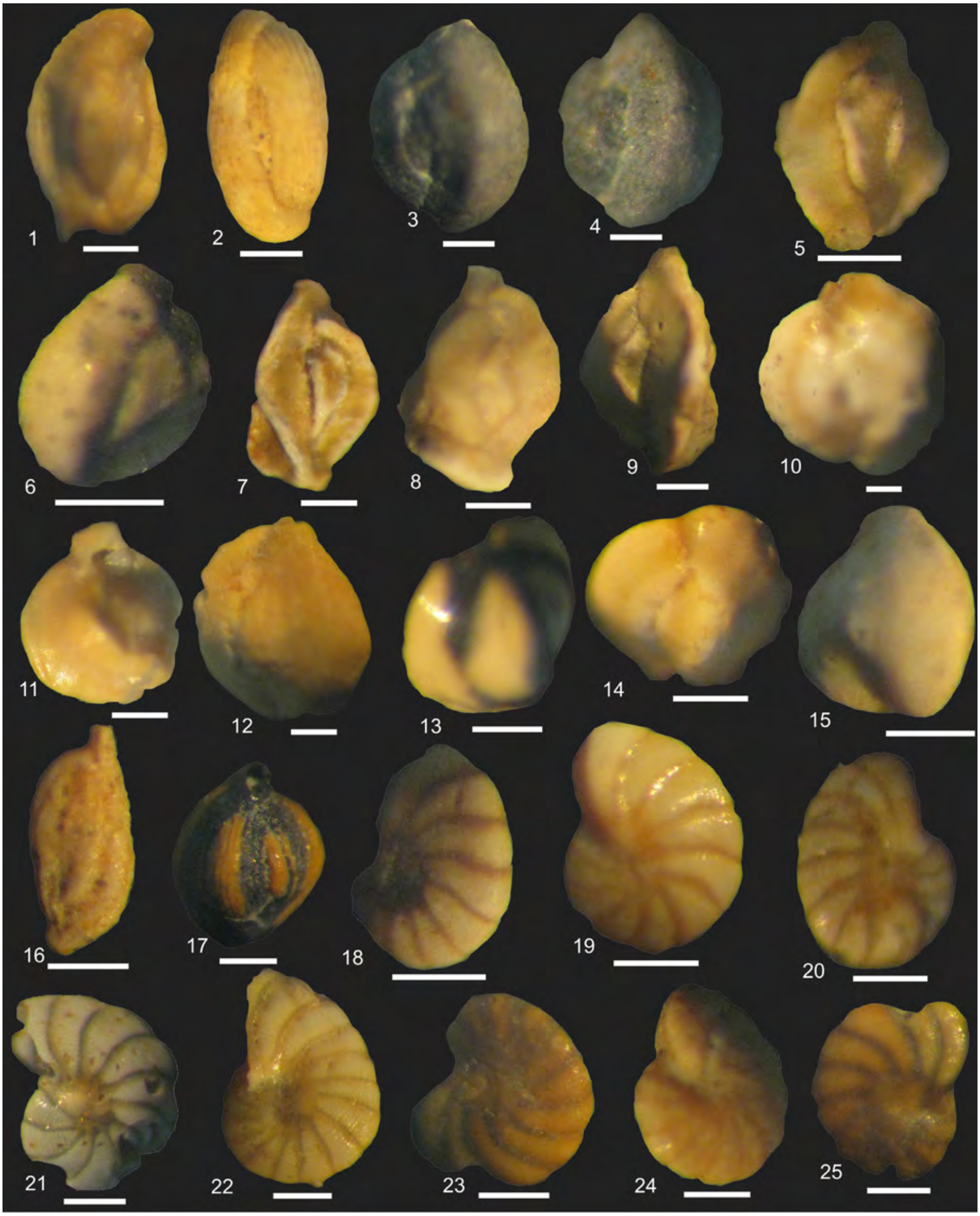


PLATE - VI

Karaburun, İzmir.

1. *Peneroplis pertusus* (Forskal). External view, 1C, 60.00 m.
2. *Peneroplis pertusus* (Forskal). External view, 1C, 80.00 m.
3. *Peneroplis pertusus* (Forskal). External view, 1C, 80.00 m.
4. *Peneroplis pertusus* (Forskal). External view, 1C, 90.00 m.
5. *Peneroplis pertusus* (Forskal). External view, 1C, 100.00 m.
6. *Peneroplis planatus* (Fichtel and Moll). External view, 1C, 60.00 m.
7. *Peneroplis planatus* (Fichtel and Moll). External view, 1C, 60.00 m.
8. *Peneroplis planatus* (Fichtel and Moll). External view, 1C, 80.00 m.
9. *Peneroplis planatus* (Fichtel and Moll). External view, 1C, 80.00 m.
10. *Peneroplis planatus* (Fichtel and Moll). External view, 1C, 90.00 m.
11. *Peneroplis planatus* (Fichtel and Moll). External view, 1C, 90.00 m.
12. *Peneroplis planatus* (Fichtel and Moll). External view, 1C, 100.00 m.
13. *Peneroplis planatus* (Fichtel and Moll). External view, 1C, 100.00 m.
14. *Peneroplis planatus* (Fichtel and Moll). Unusual specimen, external view, 1C, 100.00 m.
15. *Peneroplis planatus* (Fichtel and Moll). Unusual specimen, external view, 1C, 90.00 m.
16. *Rosalina bradyi* Cushman. External view, spiral side, 1A, 40.00 m.
17. *Rosalina bradyi* Cushman. External view, umbilical side, 1A, 50.00 m.
18. *Ammonia parkinsoniana* (d’Orbigny), External view, spiral side, 1A, 60.00 m.
19. *Ammonia parkinsoniana* (d’Orbigny), External view, umbilical side, 1A, 60.00 m.
20. *Elphidium aculeatum* (d’Orbigny). External view, 1C, 45.00 m.
21. *Elphidium crispum* (Linné). External view, 1C, 30.00 m.
22. *Elphidium crispum* (Linné). External view, 1A, 40.00 m.
23. *Elphidium crispum* (Linné). External view, 1C, 90.00 m.
24. *Elphidium complanatum* (d’Orbigny). External view, 1A, 50.00 m.

PLATE - VI

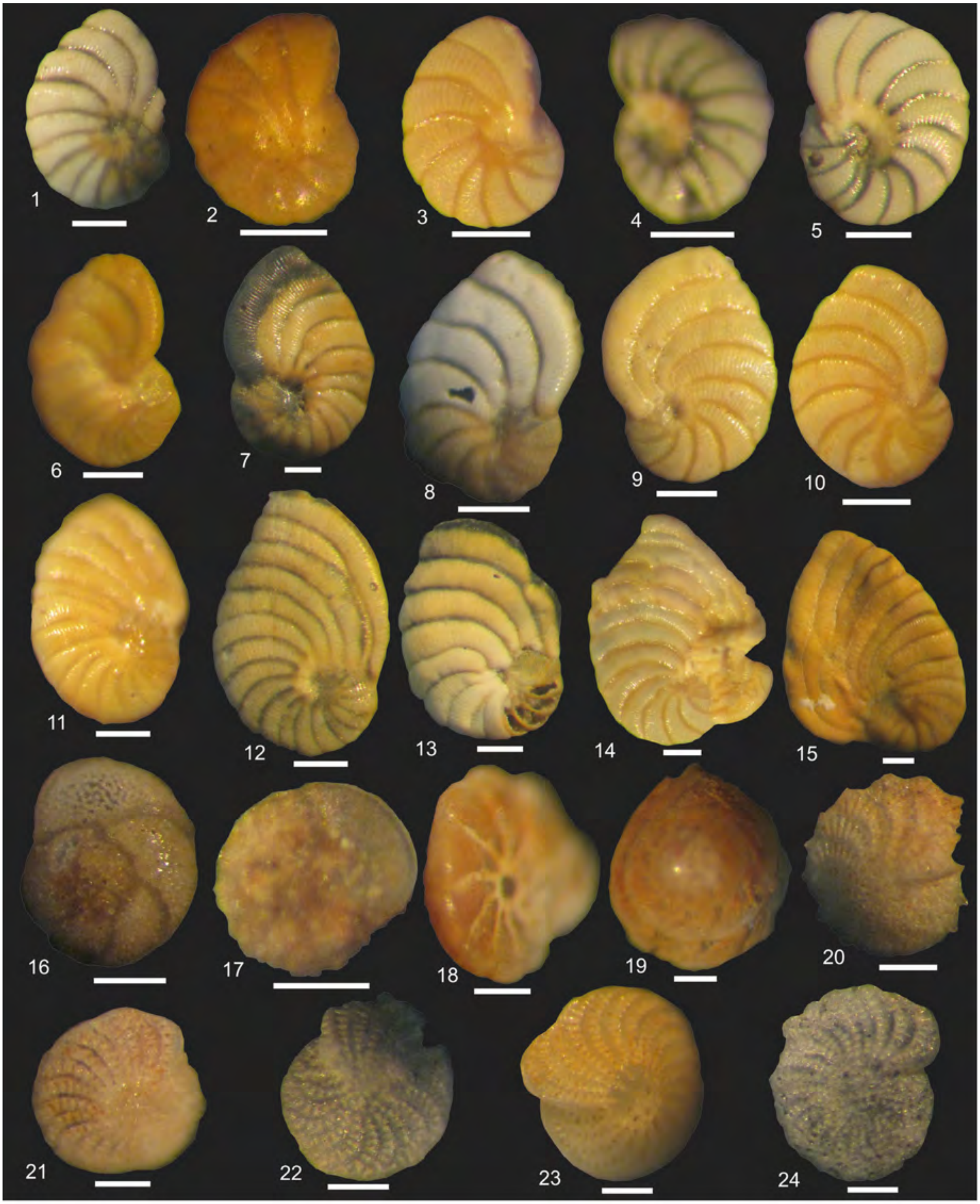
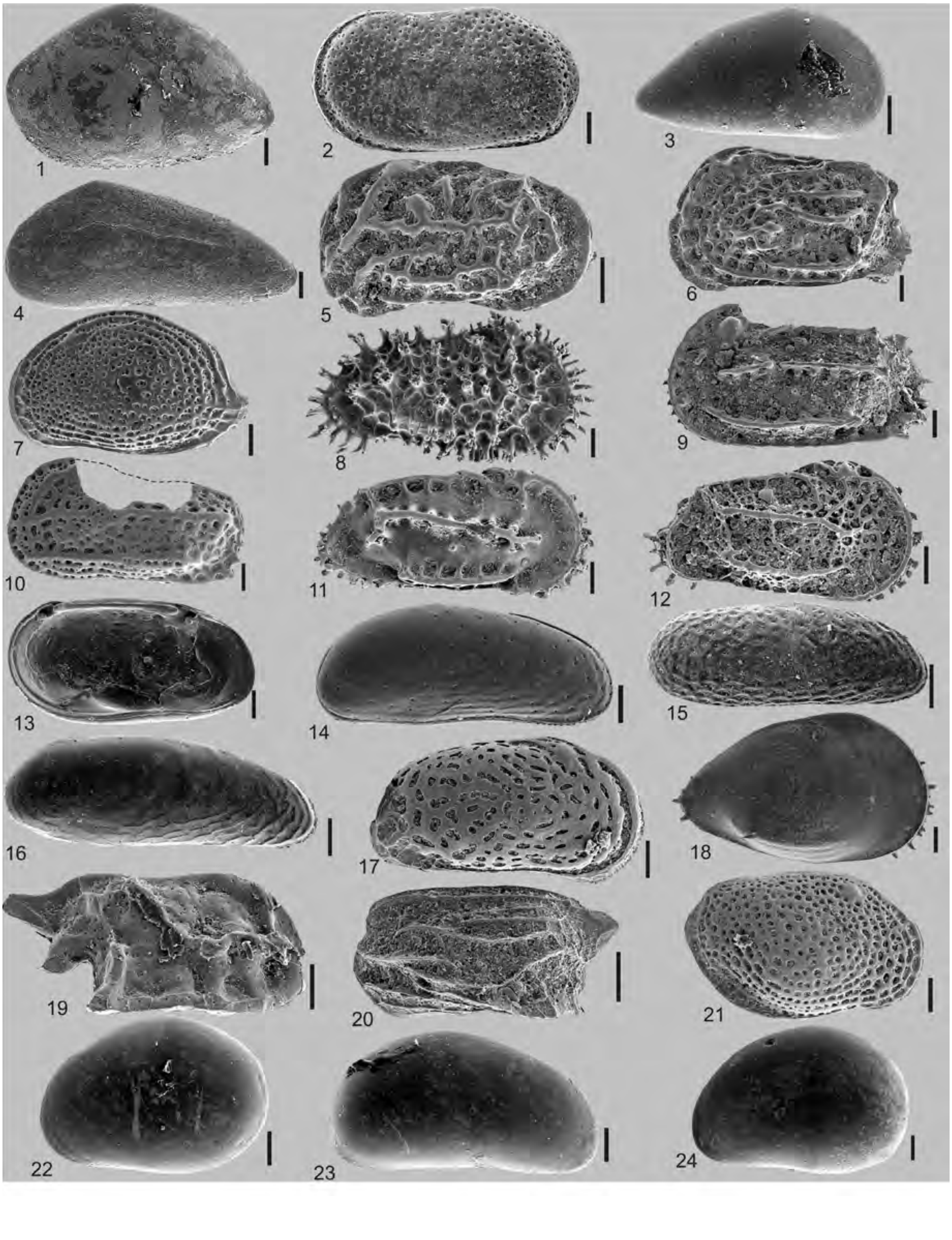


PLATE - VII

Karaburun, İzmir.

1. *Neonesidea inflata* (Norman). Left valve, 1A-70.00 m.
2. *Cytherella alvearium* Bonaduce, Ciampo and Masoli. Left valve, 1C-100.00 m.
3. *Pontocypris acuminata* (Müller). Right valve, 1A-45.00 m.
4. *Pontocypris mytiloides* (Norman). Left valve, 1A-90.00 m.
5. *Callistocythere intricatoides* (Ruggieri). Left valve, 1A-45.00 m.
6. *Tenedocythere prava* (Biard). Left valve, 1A-90.00 m.
7. *Aurila convexa* (Sars). Left valve, 1A-90.00 m.
8. *Acantocythereis hystrix* (Reuss). Right valve, 1A-90.00 m.
9. *Carinocythereis carinata* (Roemer). Left valve, 1A-50.00 m.
10. *Hitermannicythere rubra* (Müller). Left valve, 1C-25.00 m.
11. *Costa batei* (Brady). Right valve, 1A-80.00 m.
12. *Costa edwardsii* (Roemer). Right valve, 1A-70.00 m.
13. *Cytheretta adriatica* Ruggieri. Right valve internal view, 1B-70.00 m.
14. *Pontocythere elongata* (Brady). Left valve, 1B-90.00 m.
15. *Neocytherideis bradyi* Athersuch. Left valve, 1A-50.00 m.
16. *Neocytherideis subulata* (Brady). Left valve, 1B-60.00 m.
17. U*rocythereis oblonga* (Brady). Right valve, 1C-70.00 m.
18. *Bosquetina carinella* (Reuss). Right valve, 1A-90.00m.
19. *Paracytheridea depressa* Müller. Right valve, 1A-35.00 m.
20. *Semicytherura acuta* (Müller). Left valve, 1A-45.00 m.
21. *Loxoconcha rhomboidea* (Fischer). Right valve, 1A-45.00 m.
22. *Xestoleberis communis* Müller. Left valve, 1A-70.00 m.
23. *Xestoloberis depressa* Sars. Right valve, 1A-45.00 m.
24. *Xestoleberis dispar* Müller. Left valve, 2B-90.00 m.

PLATE - VII



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THE CHARACTERIZATION STUDIES OF THE NORTHWEST ANATOLIAN HALLOYSITES/KAOLINITES

Saruhan SAKLAR,* Haşim AĞRILI,* Okan ZİMİTOĞLU,* Bülent BAŞARA* and Uğur KAAN*

ABSTRACT.- The extraction and characterization studies were carried out on representative samples which were taken from iron bearing parts of halloysite, halloysite/kaolin deposits located in the vicinity of Çanakkale and Balıkesir in Northwest Anatolia. Halloysites in these samples are generally in the form of hydro halloysite (10 Å) and kaolinite could also be encountered in some parts. The primary impurities in halloysite and kaolin deposits are limonite (geothite) and muscovite. These deposits might contain quartz, feldspar, gibbsite, smectite group clay minerals and anatase in their structures. The iron content of the clays can be reduced significantly by hydrochloric or oxalic acid treatments. Transmission electron Microscope (TEM) and Scanning Electron Microscope (SEM) analyses on halloysite samples were carried out and it was noticed that halloysite tubes were in cylindrical shape, and in some cases; pores on their surfaces could be observed as a structural feature. In samples studied, tube lengths were measured up to 5 µm by means of SEM analyses, however; TEM analyses have indicated that internal diameters of tubes could decrease down to 5nm and their average diameters ranged in between 40 – 50 nm.

Key words: Halloysite, kaolinite, characterization, leaching.

INTRODUCTION

Halloysite is a double layered aluminosilicate clay is similar to kaolinite but contains cylindrical structures in different nanometer sizes. Diameters of the cylindrical tubes are less than 300 up to 50 µm long. However; their dimensions and shapes could change due to the condition of deposition and formation. Double tubes, structures such as; partly rolled, spherical like, rod like and etc. could also be encountered (Joussein, et al., 2005). Halloysites; as inner sides of their nano tubes are often empty become a subject of investigation in various areas such as; drug, polymer and advanced ceramics (Aguzzi, et al., 2007; Ramirez, et al., 2009; Liu, et al., 2009). There are two different purposes in these investigations. The first is to store special materials into the tubes and the second is to provide stiffening to polymers or ceramics.

Halloysite naturally occurs in two different structures (Churchman, et al., 1972). The first one is the hydrated form which bears water among its layers having a chemical formula of $Al_2Si_2O_5(OH)_4.2H_2O$. The distance between layers is 1 nm (10Å) and is called the “10Å structure”. The atomic structure of two molecules of hydrate halloysite ($2{\cdot}(Al_2Si_2O_5(OH)_4.2H_2O)$) is observed in figure1-a (Murray, 2007). The water between layers withdraws irreversibly in temperatures above 35 -40°C and the interlayer distance decreases to 0.7 nm. 7Å structure is the same as kaolinite. In figure 1b; the XRD pattern for hydrate and dehydrate forms of the halloysite sample between 5°-15° were given which had been taken from the halloysite mine in Balıkesir Gönen region. The dehydrate halloysites could easily be mixed up with kaolinite in XRD analysis, therefore; intercalation methods are necessary for these halloysites to be distinguished by XRD analysis (Joussein, et al., 2007; Nicolini, et al., 2009). Formamide is the first special reagent which transforms dehydrate halloysite into hydrate halloysite (Churchman and Theng, 1984; Churchman et al., 1984; Churchman, 1990). Other reagents such as; dimethyl sulfoxide, potassium acetate, hydrazine could also be used

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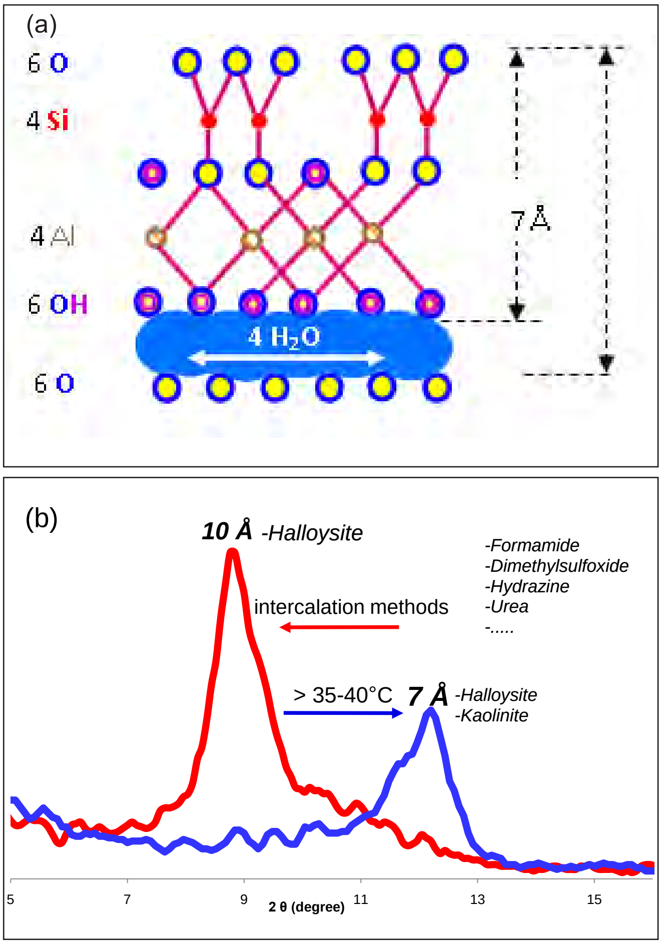


Figure 1- (a) The atomic structure of halloysite (Murray, 2007),
(b) XRD pattern (Saklar, 2011*a*).

(Churchman and Carr, 1973; Mellouk, et al., 2009; Horvath, et al., 2011). In order to distinguish halloysites (7Å structure) from kaolinite, the compatibility of methods like XRD, DTA and SEM were investigated and the most accurate result could be achieved by electron microscope (Churchman and Carr, 1975).

Halloysite formations are observed in America, Asia, Africa and Europe, economically important deposits are encountered only in a few countries (Uygun, 1999; Levis and Deasy, 2002). Almost all halloysite world production is provided by New Zealand and shows resemblances with northwestern Anatolian halloysite deposits with respect to the features of formation and mineral contents (Murray, 2007). It was claimed that, northwestern Anatolian halloysite deposits were hydrothermally formed by low pH, silica and aluminum rich solutions (Laçin and Yeniyol, 2006; Ece and Schroeder, 2007). Similar results were also observed in investigations which General Directorate of Mineral Research and Exploration had carried out (Akçay et al., 2008; Dönmez et al., 2008; Duru et al., 2007).

Although halloysites theoretically contain only aluminum, silicate and water (%46.55 SiO_2, %39.49 Al_2O_3, %13.96 H_2O) in their structures (Anthony et al., 1995), Traces of iron, titan, calcium, potassium and sodium may be present. As also seen in table 1, products that have contents close to theoretical values were used in commercial halloysite from New Zelland and Turkey.

Table 1- Commercial product contents of halloysites from New Zelland and Turkey.

	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	Na_2O	L.O.I
New Zelland	49.50	35.50	0.29	0.09	Trace	Trace	Trace	Trace	13.80
Turkey	46.22	37.30	1.02	0.21	0.26	Trace	0.23	Trace	14.38

In this study, a sequence of enrichment and characterization was carried out on representative samples (Figure 2) taken from iron bearing parts of Balıkesir-Gönen-Alacaoluk (BGL) halloysite deposit, Çanakkale-Yenice-Kırıklar (ÇYK) hallloysite/kaolin deposit and Çanakkale-Gökçeada-Tepeköy (ÇG) kaolin deposits in northwest Anatolia. In addition to removal of iron, it was aimed at producing data by X-ray diffraction (XRD), scanning electron microscope (SEM), energy dispersive X-ray spectrometer point analyses (EDS), transmission electron microscope (TEM) and X-ray fluorescence (XRF) for the description, crystal structure and morphology of clay and accompanying minerals.

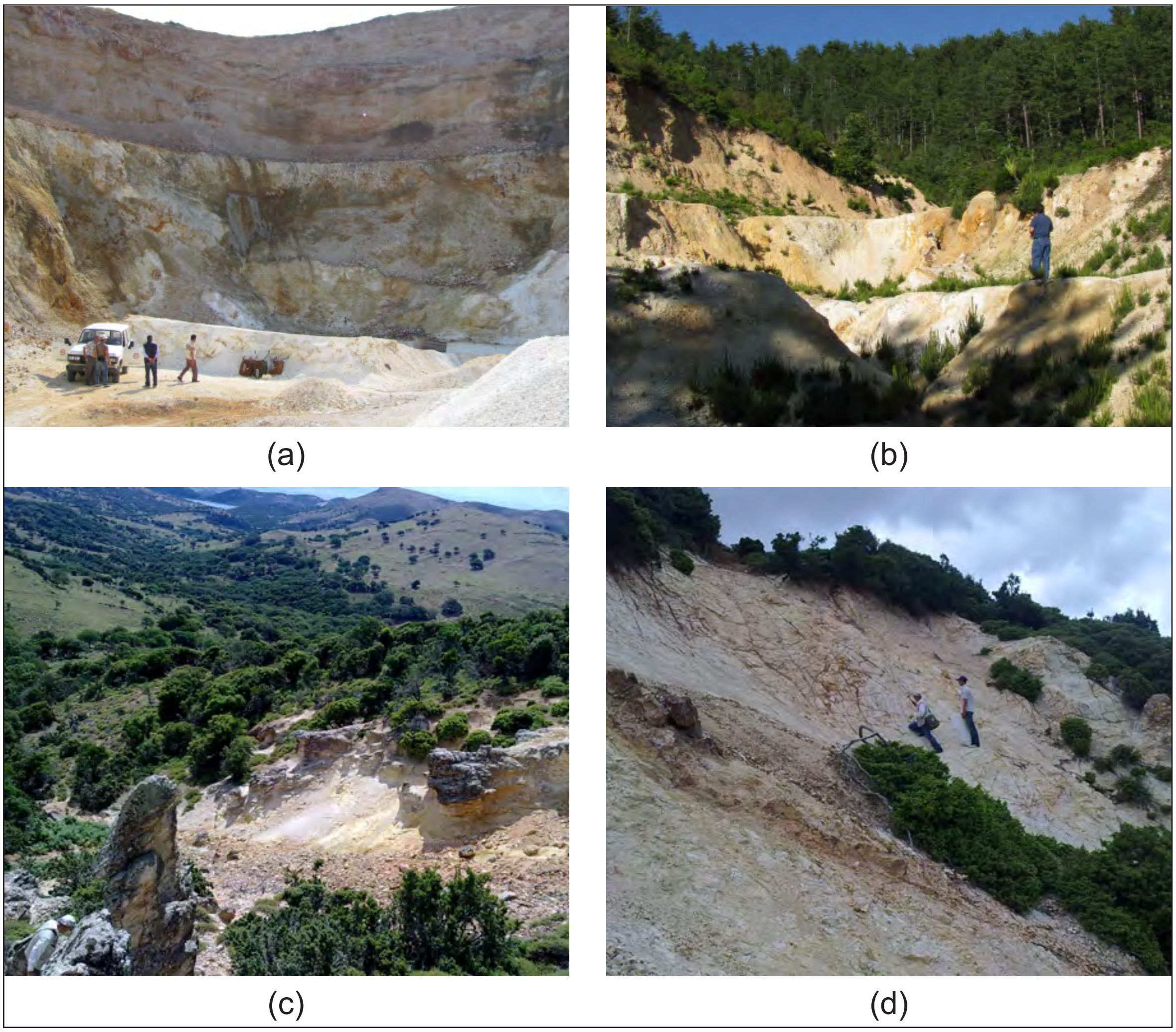


Figure 2- Clay deposits investigated (a): Balıkesir-Gönen-Alacaoluk halloysite deposit; (b): Çanakkale-Yenice-Kırıklar hallloysite/kaolin deposit; (c-d): ÇG: Çanakkale-Gökçeada-Tepeköy kaolin deposit).

GENERAL GEOLOGY

The study area is located in Biga Peninsula in Northwest Anatolia (Figure 3). Pre Tertiary units in Biga Peninsula are observed as tectonic zones trending NE-SW. These zones are the İzmir Ankara zone, Sakarya zone, Çetmi melange and Ezine zone. The Sakarya zone contains Paleozoic and Mesozoic metamorphic units overlain Devonian, Permian, early – late Triassic magmatic, sedimentary and volcanic units.

Ezine zone consists of Late Cretaceous metamorphic units, whereas the Çetmi melange is composed of Maestrichtian – Paleocene flysch and ophiolitic units (Duru et al., 2012).

Tertiary units, however; consist of Eocene to Quaternary sedimentary and volcanic units (Ilgar et al., 2012). Halloysite formations in the region are observed in Paleogene volcanic units composed of andesitic and basaltic lavas and pyroclastics.

Northwest halloysite deposits were typically embedded in partially faulted boundaries between andesitic volcanites and Jurassic dolomite limestones and formed due to the effects of supergene acidic solutions or hypogene hydrothermal solutions on latite and rhyodacite (Uygun, 1999). It was also claimed that halloysites had been formed as a result of hydrothermal effects that were associated with fault zones in low pH environment (2- 3) due to the solution-suspension metasomatism of andesitic tuffs (Erdoğan et al., 2012).

MATERIAL AND METHOD

Hand specimens, collected representatively from iron bearing parts of clay deposits (approximately 100 kg), were kept in between 27 - 29°C temperatures and dried for a few days the preserve the water content between layers. In the next stage; coarse clay pellets were decreased to a size less than 5 mm by conical and roll crushers. To decrease the size was necessary in order to take representative sample and to easily disperse it by water in Denver D-12 flotation cell. The dispersion was made by batch experiments in every 30 min intervals at 15-20% solid ratio. The dispersed clay was then prepared at different fractions by wet sieving.

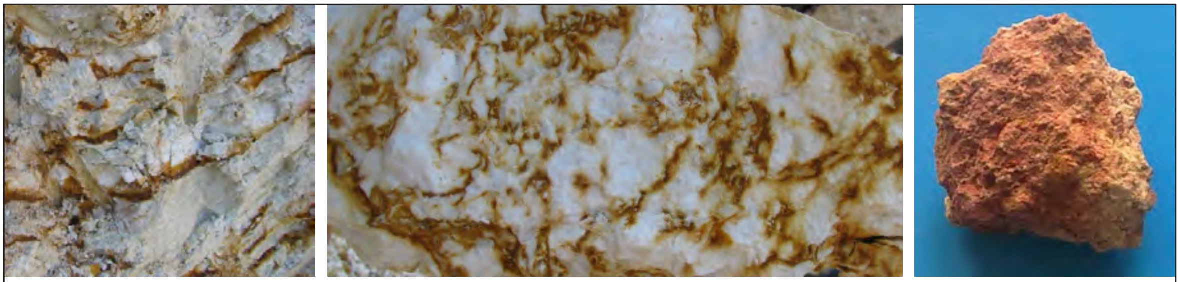
Figure 3- Location map.

Chemical analyses were carried out for whole rock sample and grain size fractions. In terms of clay content, it was noticed that the ÇG sample was condensed at a size finer than 10 µm and test samples were prepared by wet sieving in this size. However; test samples were prepared carrying out wet sieving at 90 µm which was relatively a coarse size as there had been no fractional differentiations in BGL and ÇYK samples. Water in clay samples that had been wet sieved was then drained out, oven dried and the dry pellets were then disintegrated by short grinding. Representative homogenous clay samples in dry and powder forms were obtained for each clay beds (Saklar, 2011*a*).

In order for clay contents of samples to be more sensitively studied by XRD analysis, parts of whole rock samples finer than 2 µm were prepared by decantation method using Stokes' equation (Wills, 2006).

Chemical analyses, on the other hand, were carried out by using Philips Axios XRF spectrometry. XRD analyses were performed by Bruker D8 Advance X Ray diffractometer using Cu-Kα radiation, at 2 -70° 2θ interval, 40 kV resistance and at a current of 40 mA. Scanning Electron Microscope (SEM) analyses were performed by FEI Quanta 400 MK2 instrument on gold/palladium coated samples. 300 kV FEI Tecnai G2 F30 model Transmission Electron Microscope (TEM) were used in order to analyze crystal morphologies of the samples. Samples were dispersed by ultrasonic bath in ethanol before analysis and the ethanol was evaporated in open air.

To detect coloring minerals in samples by XRD analysis, tests were made by wet magnetic separator with high field strength (Master Magnet 500) under a magnetic field of 20,000 Gauss. Nevertheless; no result has been obtained in BGL and in ÇG samples, but a very little magnetic fraction in ÇYK sample. Therefore; samples necessary for XRD analyses of coloring minerals were obtained by chiseling with a needle from brown/red colored parts of hand specimens (Figure 4).



(a) (b) (c)

Figure 4- Hand specimens containing coloring minerals in (a) ÇYK, (b) BGL and (c) ÇG samples (dark areas indicate iron oxide/hydroxide colorings on samples).

Characterization experiments, in addition to whole rock samples, were performed also on samples which had been cleaned by extraction experiments. Fe_2O_3 contents of the whole rock samples were extracted using hydrochloric and oxalic acid (HCl ve $(COOH)_2$) at specific time (150 min), temperature (80°C) and concentration values (Table 2) (Saklar, 2011*a*).

Table 2- Concentration values used in extraction

Sample	Molarity (M)	
	HCl	$(COOH)_2$
ÇYK	1.17	0.59
ÇG	0.84	0.42
BGL	1.28	0.84

Solid/liquid mixtures containing 10% solid in weight which had been prepared with distilled water then kept for 10 minutes were used to measure the pH values of samples, (TS2326, 1997).

FINDINGS

Natural pH, density and chemical content values of whole rock samples were presented in tables 3 and 4, and their related XRD results were given in figure 5. Each of the three clay samples is acidic in character and their pH and density values do not show much difference with their sizes (Table 3). ÇG sample have lower pH and higher density values compared to other samples. The reason for having the high density originates from much silicate content in ÇG sample.

Table 3- Density and pH values of whole rock samples

Sample	BGL		ÇG		ÇYK	
	Whole rock sample	<90 µm	Whole rock sample	<10 µm	Whole rock sample	<90 µm
Density	2.50	2.50	2.63	2.60	2.47	2.48
pH	4.80	4.85	3.50	3.70	4.15	4.10

Table 4- Chemical contents of whole rock samples

Sample	SiO_2	Na_2O	MgO	Al_2O_3	P_2O_5	K_2O	CaO	TiO_2	Fe_2O_3	SO_3	L.O.I.
BGL (whole rock sample)	44.14	0.08	0.21	37.66	0.15	0.21	0.02	0.09	2.05	0.12	15.10
BGL (<90 µm)	44.53	0.07	0.21	37.53	0.16	0.22	0.05	0.12	2.10	0.14	14.65
ÇG (whole rock sample)	66.51	0.23	0.82	18.00	0.15	3.50	0.08	0.58	2.17	1.59	6.10
ÇG (<10 µm)	60.84	0.18	0.92	22.15	0.18	3.78	0.10	0.58	2.14	1.55	7.30
ÇYK (whole rock sample)	43.77	<0.01	0.41	34.82	0.69	0.36	0.16	0.35	3.33	0.36	15.20
ÇYK (<90 µm)	43.55	<0.01	0.48	35.34	0.74	0.37	0.18	0.43	3.58	0.39	14.65

*MnO was detected in trace amount.

The chemical content of BGL sample is very close to the theoretical content of halloysites but contains 2% Fe_2O_3. Results of the chemical analyses of the portion finer than 90 µm in width are almost the same as the whole rock sample. XRD results also show that BGL sample is a pure hydrate halloysite. During tests run both for the whole rock sample and for <2 µm, regular halloysite peaks were obtained; besides, a very large 10Å peak at <2 µm fraction was obtained (Figure 5 a, b). In Figures 5c and 5d, it is seen that hydrate halloysites turned into dehydrate (7Å) structure as these were dried up (>60°C) after being extracted by HCl and $(COOH)_2$. Traces of crystobalite were rarely seen to accompany the halloysite.

XRD analysis for ÇYK sample without dehydration showed clear 10Å halloysite and 7Å kaolinite peaks (Figure 5a). In Table 4, there was not found any serious chemical difference between the whole rock sample and <90 µm portion. The 10Å peak intensity in <2 µm fraction is more than that of the whole rock sample. However; 7Å kaolinite peak in <2 µm fraction is less than the whole rock sample. Therefore halloysite ratio in ÇYK sample is relatively higher than that of kaolinite. Since HCl and $(COOH)_2$ samples of dehydrated halloysites give only 7Å peak, the peaks in diffractograms were detected as halloysite+kaolinite. This phenomenon indicates how significant the intercalation is for the detection of dehydrated halloysites by XRD method and the importance of preservation of

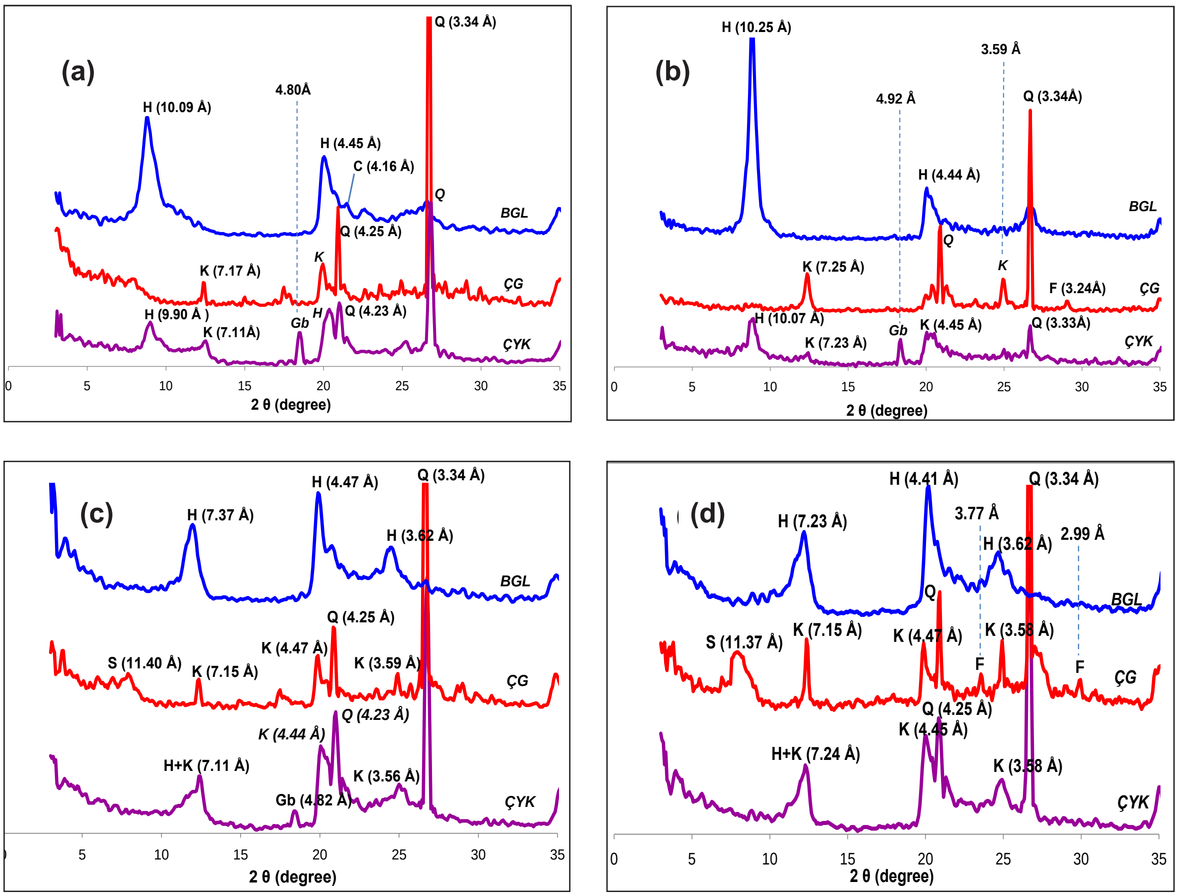


Figure 5- XRD diffractograms of (a) whole rock sample, (b) <2 µm fraction, (c) HCl extraction product, (d) (COOH)2 extraction product (H: halloysite, Q: quartz, C: crystobalite, S: smectite clay group, F: feldspar, Gb: gibbsite)

the hydrate form Gibbsite was detected in the whole rock sample and in XRD analyses of <2 µm and HCl concentrate.

The ÇG sample, in addition to kaolinite peaks, gives a classically silicified kaolinite XRD pattern with broader quartz peak with respect to BGL and ÇYK. Despite the weak kaolinite peak obtained in the whole rock sample, a relatively broader kaolinite peak was detected in the <10 µm fraction. Chemical analysis results support this. Fire loss, alumina and silica ratios indicate that the <10 µm portion contains more kaolinite (Table 4). Similar results were frequently seen in silicified kaolin deposits (Saklar, 2011*a*).

The chemical contents of extraction products obtained for size fractions of whole rock samples were given in Table 5 and 6. It was observed that HCl or $(COOH)_2$ extraction processes cause a decrease in Fe_2O_3 content of all samples especially the BGL. Decreasing Al_2O_3 proportions in BGL and ÇYK samples indicate that these caused Al^{+3} ions at high temperature to dissolve. As a result, the decrease in Al_2O_3 content caused a spontaneous increase in SiO_2 content as Si/Al ratio increased. The reasons why this result has not been taken in ÇG sample is the use of less acidic concentration and less consistence of clay relative to other samples.

The extraction process does not cause a change in crystal structure as seen in XRD results in figure 4. Differences in the crystal structure form only at very high acidic concentrations (>3M) and a transformation into amorphous structure could occur (Mako, et al., 2006; Panda et al., 2010).

Table 5- Concentration contents of HCl extraction experiments

Sample	SiO_2	Na_2O	MgO	Al_2O_3	P_2O_5	K_2O	CaO	TiO_2	Fe_2O_3	SO_3	L.O.I.
BGL	48.63	<0.01	0.19	35.59	0.03	0.22	0.02	0.12	0.17	0.03	14.88
ÇG	64.32	0.16	0.88	22.80	0.13	4.02	0.08	0.67	0.43	0.50	5.75
ÇYK	54.86	<0.01	0.47	30.53	0.10	0.44	0.15	0.49	1.07	0.05	11.65

Table 6- Concentration contents of (COOH)2 extraction experiments

Sample	SiO_2	Na_2O	MgO	Al_2O_3	P_2O_5	K_2O	CaO	TiO_2	Fe_2O_3	SO_3	L.O.I.
BGL	55.51	<0.01	0.19	29.22	0.02	0.24	0.03	0.14	0.16	0.03	14.35
ÇG	65.53	0.18	0.84	21.28	0.12	3.97	0.09	0.70	0.38	0.54	6.10
ÇYK	52.99	<0.01	0.50	30.24	0.08	0.42	0.12	0.51	0.98	0.06	13.82

XRD analyses of samples prepared in order to understand the coloring minerals were given in figure 6. Limonite (Geothite) could be detected in all samples even at small peaks. Again, small peaks of muscovite were observed in ÇYK and BGL samples. Feldspar as the alkaline source was detected in ÇG sample. Since TiO_2 encountered in chemical analyses were at very low proportions, it could not be detected which mineral it had been originated from in XRD anal-

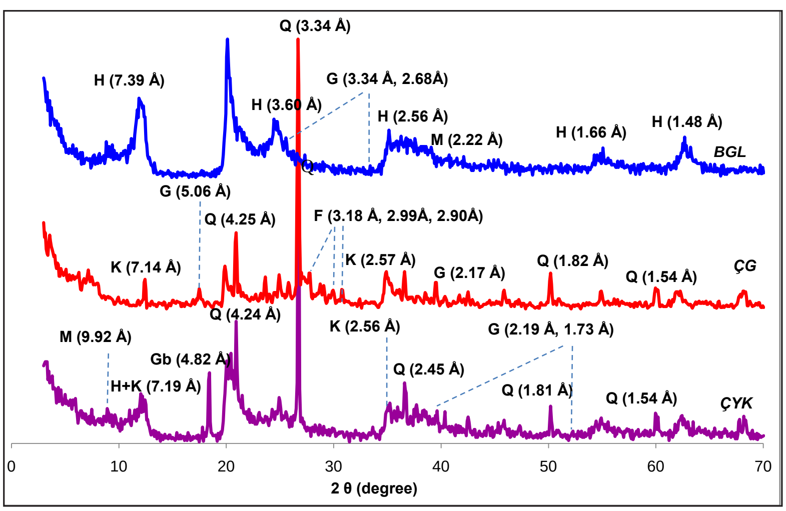


Figure 6- XRD diffractograms belonging to coloring minerals (H: halloysite, K: kaolinite, Q: quartz, G: goethite, M: muscovite F: feldspar, G: gibbsite).

ysis because XRD method can not detect minerals that have proportions less than 5% (Saka, 1997). Nonetheless; previous studies carried out at another Balıkesir – Gönen halloysite deposit with sulphur which has relatively higher TiO_2 proportion indicated that TiO_2 source were anatase mineral, and vermiculite could accompany in some cases (Saklar et al., 2010; Saklar, 2011*a*).

Results of scanning electron microscope (SEM) confirm XRD results (Figure 7). It is understood that BGL sample was halloysite that formed completely as cylindrical tubes. Cylinders have regular and homogenous size distributions. In all portions of ÇG sample in which the analysis had been performed, classical kaolinite plates were observed in a couple of µm sizes. As for the ÇYK sample, halloysite tubes were observed between kaolinite plates. It is not possible to understand the halloysite kaolinite proportion in a sample by electron microscope; however, this proportion could be understood by intercalation using XRD method (Joussein, et al., 2007).

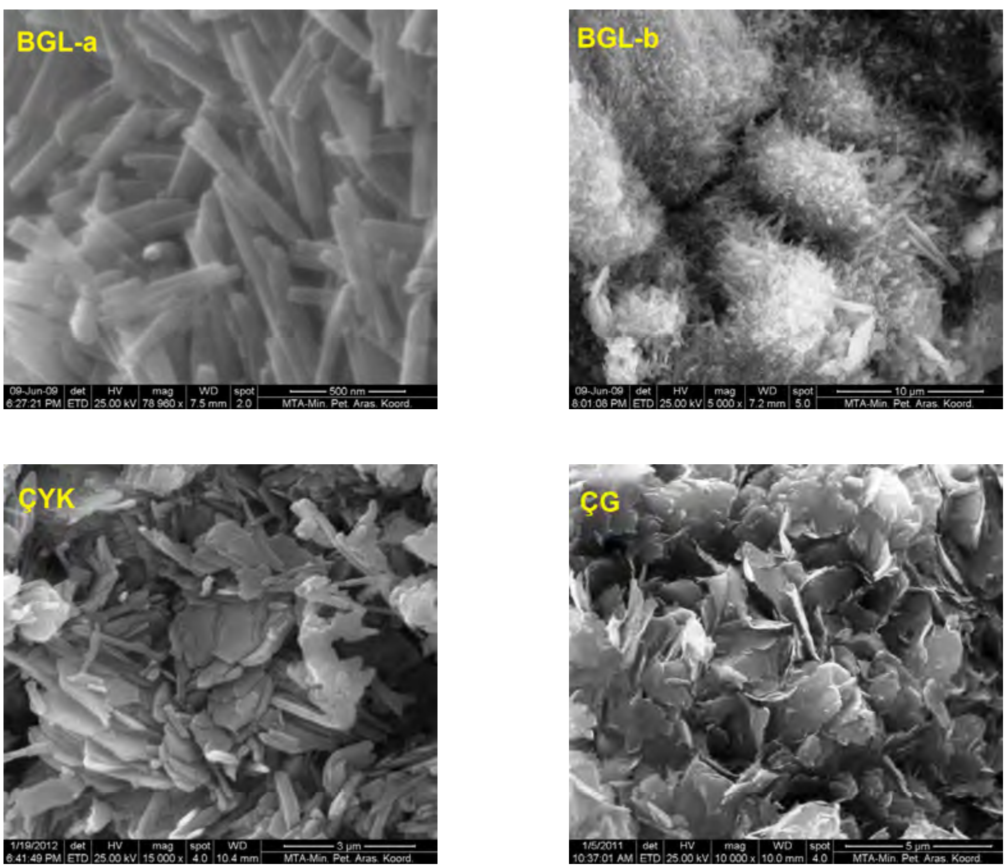


Figure 7- Scanning electron microscope views of Gönen, Yenice and Gökçeada samples (BGL-a: tubular halloysite crystals; BGL-b: pelleted tubular halloysite crystals; ÇYK: Tubular halloysite crystals between and on sheet like kaolinite crystals; ÇG: Sheet like kaolinite crystals)

In figure 8, very tiny iron oxide pellets, in ÇYK sample, are observed. EDS point analysis data also indicate that these are iron oxide, but the results are insufficient to understand with which mineral these iron oxides might be associated. XRD results shown in figure 6, indicate that these are goethite mineral. Tiny iron oxide/hydroxide pellets detected by SEM method in ÇYK sample could not be monitored by SEM although they were detected by the results of XRD and EDS analyses. It might be due to that, iron oxide/hydroxide minerals, in the form of extremely fine grained particles in submicron size, might have remained among clay minerals or attached to halloysite tubes –kaolinite plates.

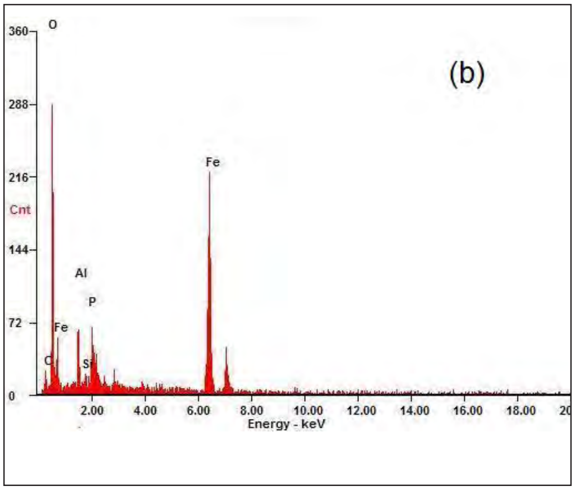


Figure 8- Electron microscope view of iron oxide/hydroxide minerals in ÇYK sample ((a): +: point of EDS analysis) and (b): graph of EDS point analysis).

TEM analyses were performed in order to investigate the morphology of tubes on BGL sample which is a characteristic halloysite. It was also noticed that almost all halloysite grains were in the form of cylindrical tubes and inner sides of cylinders were mostly empty. It was observed that diameters of tubes in investigated samples had decreased down to 5 nm and averaged between 40 -50 nm. It was found that the length of tubes in some samples could be up to 5 µm in SEM analysis (Figure 7). However; shorter tube lengths were detected by TEM results (Figure 9, 10). Pores on cylindrical tubes were detected independent from being hydrate/dehydrate of the sample (Figure 9 b, e) (Churchman, et al., 1995).

TEM analyses were performed also on HCl and $COOH_2$ concentrates which were obtained by the extraction process and were given in figure 10. It is seen that, tube views obtained are more accurate, and cylindrical tubes were not affected by high temperature (80ºC) and by concentrated acid solutions. There are some pores on tubes and their resemblances are present in native forms of samples as seen in Figure 9. So; it is thought that these pores were originated from acid treatment.

DISCUSSION AND CONCLUSIONS

Characterization studies were made for halloysite, kaolin/halloysite and kaolin deposits observed in Çanakkale-Balıkesir vicinities in northwestern Anatolia. Halloysites of the region are in the form of hydrohalloysite (10 Å) as it is in Balıkesir – Gönen (BGL) sample, and kaolinite could also enter their structures as it occurred in Çanakklae – Yenice (ÇYK) sample. When similarities in formational and mineralogical features are taken into consideration, it could be said that

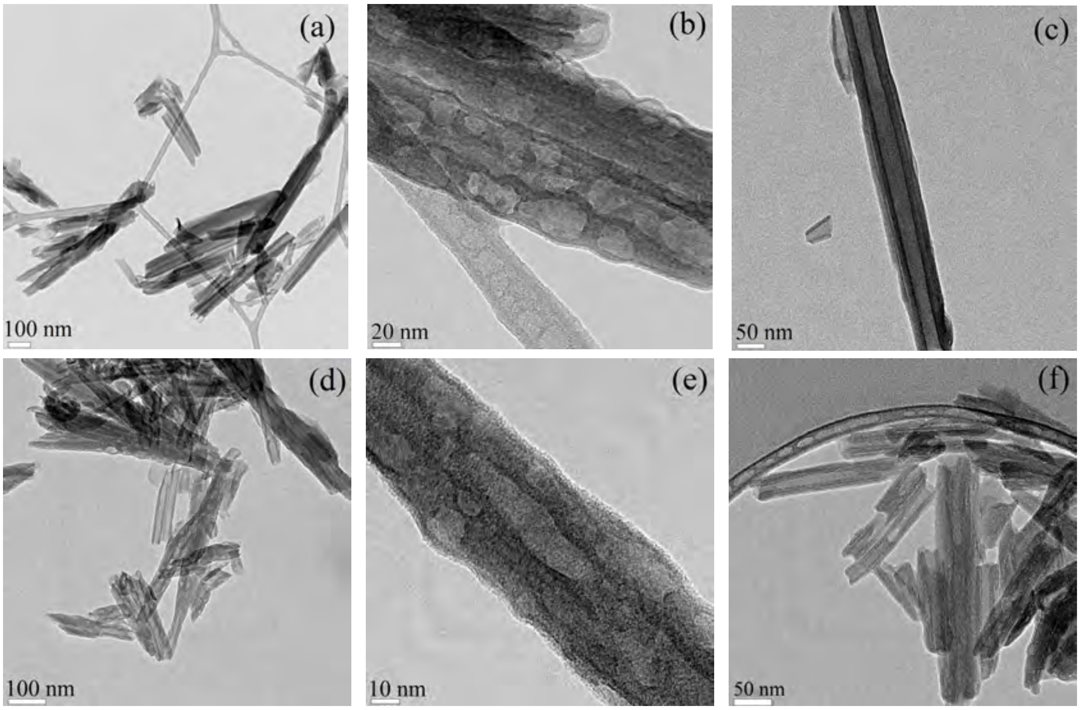


Figure 9- (a), (b), (c): hydrate; (e), (f), (g): dehydrate halloysite TEM views of the BGL sample.

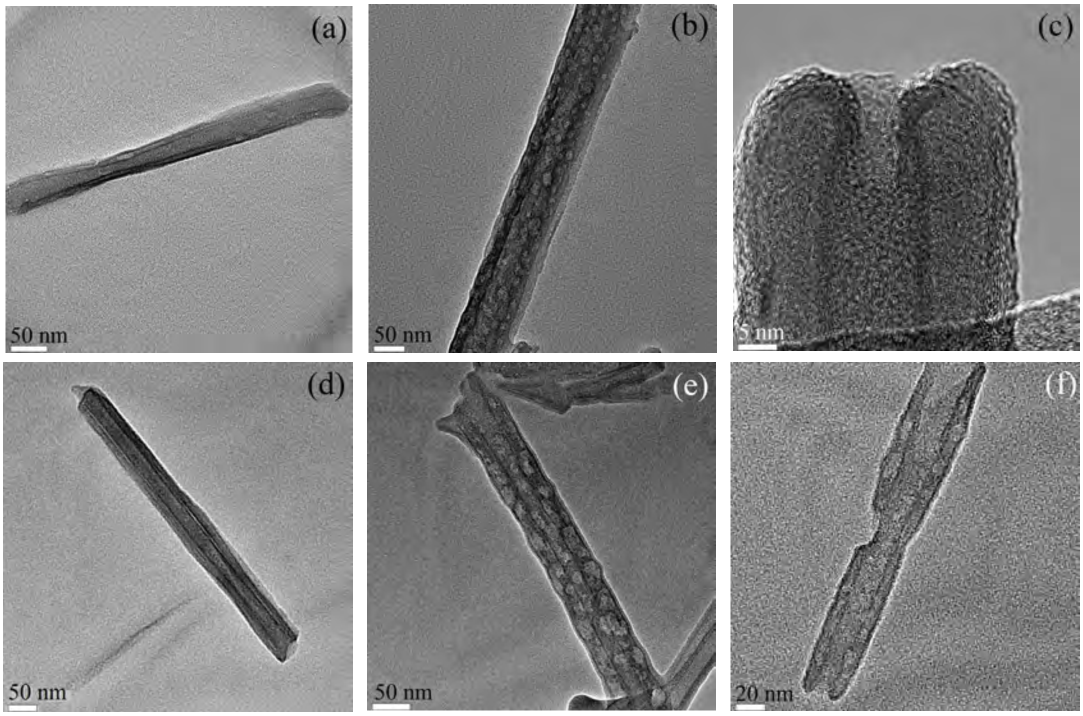


Figure 10- TEM views of extraction concentrates of HCl (a, b, c) and $(COOH)_2$ (d, e, f) for BGL halloysite sample.

there is a possibility of occurrence of halloysite in other kaolin deposits present in northwest Anatolia.

In order to fully understand the differentiation of halloysite/kaolinite, the use of an electron microscope is necessary. However; XRD analysis is preferred as it is simpler and a more general method to apply in clay mineralogy. The application of the intercalation method is necessary in XRD analysis if halloysite loses water between its layers, because the halloysite mineral in dehydrate structure gives the same peak value as kaolinite 7Å (001). The necessity of intercalation in XRD method appears when interlayer waters are lost in temperatures above 40ºC and easily turns into dehydrate structure.

Deposits in the region show similarities also in terms of coloring minerals that they contain. If goethite (limonite) which was detected as the primary contaminant is in thin dimension, it has a strong coloring effect in clay deposits. The anatase that had been detected in previous studies in very close clay deposits (BGL 100 m) is considered also to be the source of TiO_2 in studied deposits. Gibbsite and smectite were also encountered sometimes.

Northwest Anatolian halloysites are chemically very close in content with that of New Zealand halloysites. It was investigated that diameters of cylinders could decrease to 5 nm but are 40 -50 nm in average in studied samples. Tubes which could reach 5 µm in length by SEM analyses were detected less than 1µm in others by TEM analyses.

Another significant finding is that the halloysite tubes were not affected by the treatment of concentrated acid (1.28M HCl and 0.84M (COOH)2) at high temperature (80°C) in long time period (2.5 hours). In spite of the fact that some pores were detected in tubes by TEM analyses, it was also determined that these pores had been in their unprocessed and in native forms.

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ILICA BAY (ÇEŞME-İZMİR) BENTHIC FORMINIFER-OSTRACOD ASSEMBLAGES AND PACIFIC OCEAN – RED SEA ORIGINATED FORAMINIFERA AND ABNORMAL INDIVIDUALS

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ABSTRACT.- In order to define contemporaneous benthic foraminifera series in surface sediments collected from the surroundings of hot spring locating at 2.50 m depth to the southeast of the Yıldız Cape, Ilıca Bay (Çeşme-İzmir), a total of 38 samples were collected from the three different transects. The Pacific Ocean and Red Sea originated benthic foraminifera species found in this study are; *Nodopthalmidium antillarum* (Cushman), *Spiroloculina antillarum* d'Orbigny, *Triloculina fichteliana* d'Orbigny, *Euthymonacha polita* (Chapman), *Coscinospira acicularis* (Batsch), *Peneroplis arietinus* (Batsch), *Amphisorus hemprichii* Ehrenberg, *Sorites orbiculus* Ehrenberg, *Cymbaloporetta plana* (Cushman). In addition to these species, *Peneroplis arietinus* (Batsch), *Spiroloculina antillarum* d'Orbigny, *Triloculina* cf. *fichteliana* d'Orbigny and *Cymbaloporetta plana* (Cushman) which were recorded on the southwest coasts of Antalya were also found in this region. *Euthymonacha polita* (Chapman) which was first recorded in Kuşadası Bay is also abundant in Ilıca Bay. This observation shows a northward distribution of this species. *Coscinospira acicularis* (Batsch) is a southwest Pacific originated species which is also found in Gulf of Aqaba, north of Red Sea. It is a typical alien species inhabiting the Ilıca Bay. This is the first record of this species both for the Mediterranean and Aegean Seas. *Amphistegina lobifera* Larsen was abundantly found around two submarine springs in Kuşadası Bay, situating at the south of Ilıca Bay. It was also recorded on the northwestern coasts of Karaburun Peninsula to the north of the study area. Meanwhile, the absence of *Amphistegina lobifera* Larsen in Ilıca Bay is the most striking feature of this study. Si, Mg and Mo concentrations of some of the colored *Peneroplis planatus* (Fichtel ve Moll) individuals are high but the concentration of rare earth elements, such as Tc, Pa, Ru and Mo were obtained from the shells in some of the sampling points.

Key words: Eastern Aegean Sea, Alien foraminifera, colored tests, Ilıca Bay, immigrant foraminifera, ostracod, thermal spring water.

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INTRODUCTION

Numerous thermal springs are located in submarine and on land regions along the coastal region of Aegean Sea of Turkey (Çağlar, 1946; Başkan and Canik, 1983). Ilıca Bay, situating at the western part of Karaburun Peninsula has a hot spring at a depth of 2.5 m beneath the sea level (Figure 1) (Çağlar, 1946; Başkan and Canik, 1983).

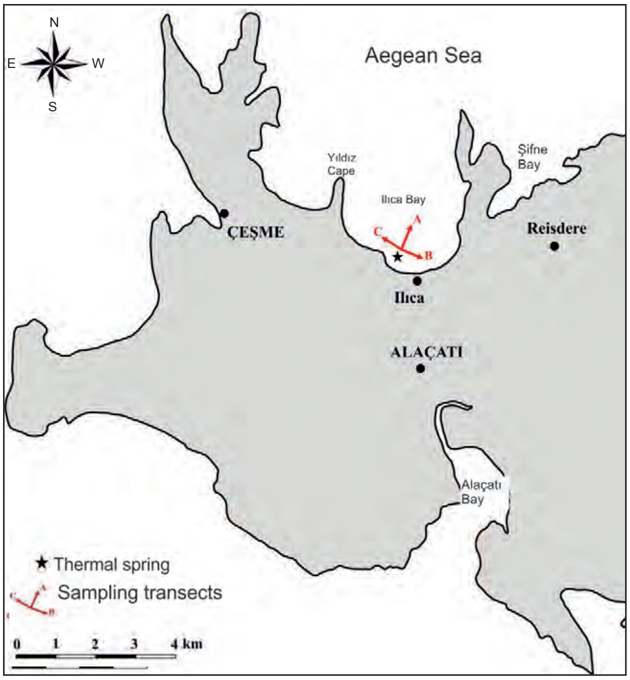


Figure 1- Location of the Çeşme-Ilıca submarine spring.

The aim of this study is to investigate the effect of this hot spring on the benthic foraminiferal assemblages. Results obtained have revealed the abundance of *Spiroloculina antillarum* d'Orbigny, *Peneroplis pertusus* (Forskal), *P. planatus* (Fichtel and Moll) and *Coscinospira hemprichii* (Ehrenberg) on the foraminiferal assemblage in this area. However, the most important coincidence is the presence of Pacific originated benthic foraminifera species (Loeblich and Tappan, 1994) which shows a distribution to the Red Sea (Hottinger et al., 1993), such as; *Nodopthalmidium antillarum* (Cushman), *Euthymonacha polita* (Chapman), *Coscinospira acicularis* (Batsch), *Peneroplis arietinus* (Batsch). Of these; *Euthymonacha polita* (Chapman), *Nodopthalmidium antillarum* (Cushman) and *Spiroloculina antillarum* d'Orbigny were found along Aegean coastal regions apart from Kuşadası Bay the second time; as for the *Peneroplis arietinus* (Batsch) was encountered for the first time again in this region after southwestern coasts of Antalya. Nonetheless; *Coscinospira acicularis* (Batsch) is the first defined genus and species on coasts of Turkey. Other than these; *Cymbaloporetta plana* (Cushman) was first found in this region after southwest Antalya coasts and Kuşadası Bay. Except the alien foraminifera known in Aegean Sea and in Mediterranean Sea (Zenatos et al., 2008), a strange foraminiferal assemblage was observed for the Mediterranean Sea and for the Aegean Sea around the spring in Ilıca Bay. Despite that; in recent years, there has not been any finding related to foraminifera mentioned on studies carried out in the region by Sözeri (1966), Sellier de Civrieux (1970), Meriç (1986), and by Avşar and Meriç (2001).

Thermal springs in submarine and on land exhibit remarkable features according to their radioactivity and their heavy metal and trace element contents (Erişen et al., 1996). Similarly, the samples from spring water in the study area are known to contain heavy metals such as; As, Fe, Mn, Cu, Co, Ni, Si, Cr, Al and Zn (Yenal et al., 1975). Accordingly, foraminiferal shells having various colors can be result from the metal content of the samples. For instance, peneroplis and hauerinids having yellow, orange, bluish green and black colored shells are the evidence of that. There are thermal spring waters originating from fault both in sea and on land due to fault lines in and around the study area cause on the east of the study area faults trending in NW-SE and NE-SW had developed as it was in Karaburun Peninsula (Çakmakoğlu and Bilgin, 2006).

MATERIAL AND METHOD

Total of 38 samples were collected on three transects in A (210^o), B (120^o) and C (290^o) directions and at distances of 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90 and 100 meters in Ilıca Bay on November the 6th in 2008 and spring water temperature was measured as 28.4°C (Table 1). Sampling could not be made after 40 meter due to pier in transect A. UTM coordinates of the center point are 0444185E and 4240949N (Figure 1, Table 1). Foraminifer and ostracod analyses in sediment samples were made according to Babin (1980) and Bignot (1985). H_2O_2 with a concentration of 10% were added on 5 gr. wet samples, kept 24 hours then were washed under a pressured water on a 0.063 mm size sieve. After samples were then dried on oven at 50°C, they were sieved on 2.00, 1.00, 0.500, 0.250, 0.125 mm size sieves. These samples were then studied under binocular microscope and foraminifera they contain were determined.

According to elementary chemical analyses carried out in ÇNAEM, the measurements were made in ppm range by the Wavelength Dispersive X ray Fluorescence Analysis Spectrometer (WDXRF) for solid, liquid and gas samples, but were detected in ppb range after pre enrichment had been made. In the system which qualitative and quantitative analyses for the elements between Boron (B) and Uranium (U) were made; X0 ray tube, crystals (LiF220, PX10, GeIII-C, PE 202-C) in various features, 2 sensors, climators in various sizes and features, and a PC program was used to perform the analysis.

Table 1- Temperatures and depths measured for samples collected from the Çeşme-Ilıca submarine spring.

Çeşme (Ilıca) **UTM:** 0444185 D 4240949 K **Temperature of submarine spring:** 28.4 °C **Date:** 06.11.2008						
Horizontal distance (m)	**Transect-A (210°)**		**Transect-B (120°)**		**Transect-C (290°)**	
	Depth (m)	T °C	Depth (m)	T °C	Depth (m)	T °C
5	3.2	17.9	3.3	17.9	2.5	18.7
10	3.0	17.9	3.8	17.6	2.0	17.6
15	3.1	17.9	4.1	17.6	1.8	17.6
20	3.0	17.5	4.0	17.5	1.5	17.6
25	3.2	17.5	4.1	17.5	1.6	17.6
30	2.5	17.5	4.1	17.5	1.1	17.6
35	2.2	17.5	4.1	17.5	1.0	17.6
40	2.0	17.5	4.1	17.5	1.0	17.7
45			4.1	17.5	1.0	18.1
50			4.1	17.5	1.0	18.1
60			4.1	17.2	1.3	17.8
70	**PIER**		4.0	17.2	1.4	17.7
80			3.7	17.2	1.5	17.7
90			3.8	17.2	1.6	17.6
100			3.9	17.2	1.6	17.6

During the preparation of samples for counting, the material was first pulverized to be in 200 mesh size then were dried. The sample kept in desiccator was weighted in 12 gr., mixed with 3 gr. wax, then was placed into 40 mm. diameter mold and was turned into pellet exerting 35 tons of pressure. Electron microprobe quantitative analyses were carried out using computerized Jeol-733 electron microprobe device and online ZAFM quantitative analysis program.

Microprobe analyses of colored *Peneroplis planatus* (Fichtel ve Moll) shells were carried out using SEM (Jeol. JSM-6390) in TPAO Research Center.

ASSEMBLAGE OF BENTHIC FORAMINIFER

The samples collected around the spring Çeşme-Ilıca Bay contains 45 genera and 80 species of foraminifera, including 9 genera and 9 species originated from Pacific and Red Sea (Table 2, Plates 1-8; linear scale: 100 micron) (Meriç and Avşar, 2001; Meriç et al., 2002 *a* and *b*, 2003 *a* and *b*, 2004, 2008 *a* and *b*, 2009 *a*, *b* and *c*, 2010 *a* and *b*, 2011; Avşar et al., 2009). These are *Textularia bocki* Höglund, *Spirillina vivipara* Ehrenberg, *Vertebralina striata* d'Orbigny, *Nodopthalmidium antillarum* (Cushman), *Nubecularia lucifuga* Defrance, *Adelosina carinata-striata* Wiesner, *A. cliarensis* (Heron-Allen and Earland), *A. mediterranensis* (Le Calvez J. and Y.), *Spiroloculina angulosa* Terquem, *S. antillarum* d'Orbigny, *S. ornata* d'Orbigny, *Siphonaperta agglutinans* (d'Orbigny), *S. aspera* (d'Orbigny), *Cycloforina contorta* (d'Orbigny), *C. villafranca* (Le Calvez J. and Y.), *Lachlanella variolata* (d'Orbigny), *Massilina gualteriana* (d'Orbigny), *M. secans* (d'Orbigny), *Quinqueloculina berthelotiana* d'Orbigny, *Q. bidentata* d'Orbigny, *Q. jugosa* Cushman, *Q. laevigata* d'Orbigny, *Q. lamarckiana* d'Orbigny, *Q. seminula* (Linné), *Miliolinella elongata* Kruit, *M. labiosa* (d'Orbigny), *M. subrotunda* (Montagu), *M. webbiana* (d'Orbigny), *Pseudotriloculina laevigata* (d'Orbigny), *P. oblonga* (Montagu), *P. rotunda* (d'Orbigny), *P. sidebottomi* (Martinotti), *Triloculina bermudezi* Acosta, *T. fichteliana* d'Orbigny, *T. marioni* Schlumberger, *T. scheriberiana* d'Orbigny, *Sigmoilinita costata* (Schlumberger), *S. edwardsi* (Schlumberger), *Articulina carinata* Wiesner, *Parrina bradyi* (Millet), *Euthymonacha polita* (Chapman), *Coscinospira acicularis* (Batsch), *C. hemprichii* Ehrenberg, *Laevipeneroplis karreri* (Wiesner), *Peneroplis arietinus* (Batsch), *P. pertusus* (Forskal), *P. planatus* (Fichtel and Moll), *Amphisorus hemprichii* Ehrenberg, *Sorites orbiculus* Ehrenberg, *Polymorphina* sp.3, *Polymorphina* sp.5, *Polymorphina* sp.7, *Brizalina spatulata* (Williamson), *Reussella spinulosa* (Reuss), *Neoeponides bradyi* Le Calvez, *Gavelinopsis praegeri* (Heron-Allen and Earland), *Neoconorbina terquemi* (Rzehak), *Rosalina bradyi* Cushman, *R. globularis* d'Orbigny, *Pararosalina* cf. *dimorphiformis* McCulloch, *Planoglabratella opercularis* (d'Orbigny), *Cyclocibicides vermiculatus* (d'Orbigny), *Lobatula lobatula* (Walker ve Jacob), *Planorbulina mediterranensis* d'Orbigny, *Cibicidella variabilis* (d'Orbigny), *Cymbaloporetta plana* (Cushman), *C. squammosa* (d'Orbigny), *Miniacina miniacea* (Pallas), *Asterigerinata mamilla* (Williamson), *Nonion depressulum* (Walker and Jacob), *Ammonia compacta* Hofker, *A. parkinsoniana* (d'Orbigny), *A. tepida* Cushman, *Challengerella bradyi* Billman, Hottinger and Oesterle, *Cribroelphidium poeyanum* (d'Orbigny), *Porosononion subgranosum* (Egger), *Elphidium aculeatum* (d'Orbigny), *E. advenum* Cushman, *E. complanatum* (d'Orbigny), *E. crispum* (Linné) and *E. depressulum* (Cushman).

Table 2- Distribution of transects A, B and C from the Çeşme-Ilıca Bay, and genus and species of benthic foraminifera recorded at each station.

FORAMINIFER	TRANSECT-A								TRANSECT-B															TRANSECT-C														
	5	10	15	20	25	30	35	40	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Textularia bocki	*		*	*	*			*	*			*				*		*		*	*	*	*	*	*	*		*		*					*	*	*	*
Spirillina vivipara																	*																					
Vertebralina striata	*	*	*	*	*			*	*	*		*	*	*		*	*	*		*	*	*	*	*	*	*	*	*	*	*		*		*	*			*
Nodopthalmidium antillarum	*	*	*						*		*	*	*		*			*			*			*		*	*	*	*	*				*	*		*	*
Nubecularia lucifuga									*															*														
Adelosina carinata-striata					*																												*					
Adelosina cliarensis	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*							*
Adelosina mediterranensis					*			*	*		*	*		*	*	*	*	*		*	*	*	*	*	*	*		*								*	*	
Spiroloculina angulosa	*	*	*	*			*	*	*	*		*		*		*			*		*		*		*	*	*		*					*	*		*	
Spiroloculina antillarum	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Spiroloculina depressa																							*															
Spiroloculina ornata	*	*	*	*	*	*		*	*	*	*	*	*		*	*		*	*	*		*	*	*		*	*	*		*	*	*		*	*	*		*
Siphonaperta agglutinans	*		*						*	*	*		*	*	*	*		*		*			*	*	*	*	*	*							*		*	*
Siphonaperta aspera	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Cycloforina contorta	*	*		*	*	*		*	*	*	*	*	*			*	*	*			*	*	*		*	*	*	*	*	*			*	*	*		*	*
Cycloforina villafranca						*										*				*	*		*							*			*					
Lachlanella variolata					*		*								*	*				*	*		*			*			*						*		*	*
Massilina gualteriana					*								*													*	*	*	*				*	*				
Massilina secans	*																								*													*
Quinqueloculina berthelotiana	*	*	*	*		*	*	*	*			*		*	*			*					*	*	*	*	*	*	*	*			*	*	*	*		*
Quinqueloculina bidentata	*	*	*		*		*		*			*	*	*		*	*		*						*	*	*	*	*	*		*		*	*	*	*	*
Quinqueloculina jugosa																						*	*			*												
Quinqueloculina laevigata					*				*				*	*	*	*			*			*		*			*							*				
Quinqueloculina lamarckiana	*					*				*				*				*							*	*		*		*		*			*	*	*	*
Quinqueloculina seminula	*								*										*		*		*	*		*		*	*			*	*		*	*	*	
Miliolinella elongata																	*																					
Miliolinella labiosa												*																										
Miliolinella subrotunda		*	*		*		*	*	*			*				*								*						*				*				
Miliolinella webbiana	*																																					
Pseudotriloculina laevigata	*		*	*										*																								
Pseudotriloculina oblonga	*	*	*		*	*			*		*		*	*	*	*						*		*		*	*	*	*					*	*			*
Pseudotriloculina rotunda									*	*						*			*							*	*		*					*				
Pseudotriloculina sidebottomi															*																							
Triloculina bermudezi		*	*		*				*																					*				*				
Triloculina cf. *fichteliana*																					*		*	*		*			*								*	
Triloculina marioni	*		*	*	*	*			*	*		*	*	*	*		*	*	*		*	*		*	*	*	*	*		*				*		*		
Triloculina scheriberiana	*	*	*												*					*	*		*			*												*
Sigmoilinita costata	*	*	*	*	*		*		*	*	*	*	*	*	*			*				*		*						*				*		*		
Sigmoilinita edwardsi						*			*	*				*										*														*
Articulina carinata	*	*		*								*		*	*	*						*																
Parrina bradyi	*					*									*	*						*		*		*			*			*			*			*
Euthymonacha polita	*								*	*			*					*																				
Coscinospira acicularis	*						*	*	*					*	*	*		*		*		*	*	*		*	*	*	*				*	*			*	

Table 2 (cont.).

FORAMINIFER	TRANSECT-A								TRANSECT-B															TRANSECT-C														
	5	10	15	20	25	30	35	40	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Coscinospira hemprichii	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Laevipeneroplis karreri		*	*		*	*		*										*						*		*		*				*		*				
Peneroplis arietinus	*			*	*		*	*			*			*	*	*		*			*	*			*	*	*		*							*	*	*
Peneroplis pertusus	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Peneroplis planatus	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Amphisorus hemprichii		*																		*			*	*		*												
Sorites orbiculus	*	*	*		*				*	*				*		*	*	*		*	*	*	*	*		*	*	*	*	*			*	*	*	*	*	*
Polymorphina sp.3	*	*	*																															*				
Polymorphina sp.5																					*					*	*			*				*				
Polymorphina sp.7														*				*		*	*																	
Brizalina spatulata																	*							*														*
Reussella spinulosa																								*														
Neoeponides bradyi	*		*			*					*				*		*					*	*					*										
Gavelinopsis praegeri		*	*																																			
Neoconorbina terquemi		*	*		*		*	*							*	*	*		*			*							*									
Rosalina bradyi	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*			*	*	*			*	*	*	*	*		*
Rosalina globularis														*			*						*			*			*									
Pararosalina cf. *dimorphiformis*	*				*		*	*	*				*							*		*	*		*	*	*					*		*	*		*	
Planoglabratella opercularis			*	*																																		
Cyclocibicides vermiculatus																										*												
Lobatula lobatula				*	*					*				*				*							*							*						
Planorbulina mediterranensis	*		*	*	*	*	*	*	*	*		*	*	*	*		*				*	*	*	*		*	*		*	*				*				
Cibicidella variabilis		*						*	*											*						*												
Cymbaloporetta plana		*	*		*					*	*			*	*					*	*	*		*				*	*					*				
Cymbaloporetta squammosa																														*								
Miniacina miniacea																																		*				
Asterigerinata mamilla					*					*		*	*	*			*																	*			*	
Nonion depressulum			*										*	*																								
Ammonia compacta						*						*	*			*	*	*				*				*					*							
Ammonia parkinsoniana		*	*	*		*	*	*	*	*	*		*	*				*		*	*	*	*		*	*	*	*	*	*	*	*	*		*		*	*
Ammonia tepida	*	*	*	*	*	*	*	*	*			*		*					*		*		*	*	*		*							*				
Challengerella bradyi			*			*	*	*	*			*					*	*		*	*	*	*	*	*					*						*		
Cribroelphidium poeyanum												*	*		*									*			*		*			*		*				
Porosononion subgranosum		*							*		*			*					*								*											
Elphidium aculeatum		*											*		*			*				*	*			*											*	
Elphidium advenum					*																																	
Elphidium complanatum											*																											
Elphidium crispum	*	*			*	*			*	*		*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*			*		*	*		*	*
Elphidium depressulum	*		*						*	*	*	*	*	*	*	*		*																				

ABNORMAL BENTHIC FORAMINIFERAL ASSEMBLAGE

Peneroplis' are dominant in benthic foraminiferal assemblage in the studied samples. Genera and species' belonging to the group showing morphological distortions form the great majority of the assemblage as illustrated on plates in appendix. *Vertebralina striata* d'Orbigny, *Spiroloculina angulosa* Terquem, *Coscinospira acicularis* (Batsch), *C. hemprichii* Ehrenberg, *Laevipeneroplis karreri* (Wiesner), *Peneroplis arietinus* (Batsch), *P. pertusus* (Forskal), *P. planatus* (Fichtel and Moll), *Sorites orbiculus* Ehrenberg, *Lobatula lobatula* (Walker and Jacob), *Cibicidella variabilis* (d'Orbigny) individuals collected from the three transects (A, B and C) in 38 samples around the spring are the examples of these forms. Although, there are 8 genera and 11 species, the dominant genus observed are *Coscinospira* and *Peneroplis,* the dominant species are *Coscinospira acicularis* (Batsch), *C. hemprichii* Ehrenberg and *Peneroplis arietinus* (Batsch), *P. pertusus* (Forskal), *P. planatus* (Fichtel and Moll).

The common morphological defection in these forms is interpreted as change in locular evolution and the irregularity in the sequence, resulting from evolution (Plate 1, figure 3; Plate 2, figures 15, 17-21; Plate 3, figures 9, 11, 12, 14-16 and 19-20; Plate 4, figures 4-5 and 7-8; Plate 5, figures 7-16; Plate 6, figures 1-13; Plate 7, figures 3-5, 8-12 and 15; Plate 8, figures 1, 3-5). Nevertheles, features such as the presence of two mouth (Plate 1, figures 4a, b and c, 14a and b; Plate 5, figure 12), changes in the form of mouth (Plate 7, figures 16, 17), collective species (Plate 6, figures 14a, b, c), abrupt changes around the shells (Plate 3, figures 8, 10, 13; Plate 4, figures 1-3) and the color of shells (Plate 9, figures 1-25; Plate 10, figures 1-28; Plate 11, figures 1-25) are the most remarkable irregularities for the study area as it is at the Alibey and Maden Islands and in Kuşadası Bay (Meriç et al., 2009 *a* and *b*).

OSTRACOD ASSEMBLAGES AND THEIR DISTRIBUTION

Van Morkhoven, 1963; Hartman and Puri, 1974; Breman, 1975; Yassinsi, 1979; Guillaume et al., 1985; Joachim and Langer, 2008 were used to describe 22 genera and 27 species of ostracodes. Defined ostracodes are; *Aurila convexa* (Sars), *Callistocythere intricatoides* (Ruggieri), *Carinocythereis carinata* (Roemer), *Costa batei* (Brady), *Cyprideis torosa* (Jones), *Cytherella alvearium* Bonaduce, Ciampo and Masoli, *Cytherelloidea sordida* (GW Müller), *Cytheretta judea* (Brady), *Hitermannicythere rubra* (Müller), *Hiltermannicythere turbida* (GW Müller), *Leptocythere* sp., *Loxoconcha rhomboidea* (Fischer), *Neocytherideis bradyi* Athersuch, *Neonesidea corpulenta* (Müller), *Neonesidea inflata* (Norman), *Paracytheridea depressa* Müller, *Pontocypris mytiloides* (Norman), *Pontocypris rara* (Müller), *Pontocythere turbida* (GW Müller), *Semicytherura inversa* (Seguenza), *Tenedocythere prava* (Baird), *Tribelina* sp., *Urocythereis crenulosa* (Terquem), *Urocythereis oblonga* (Brady), *Xestoleberis communis* Müller, *Xestoleberis dispar* Müler.

In transect A, a total of 14 genera and 16 species were described in 8 ostracod samples collected at distances varying between 5 to 40 meters (Table 3a). Of these species; *Xestoleberis communis* and *Urocythereis oblonga* were observed at 8 and (widely) 7 stations, respectively, whereas; *Tribelina* sp., *Cyprideis torosa*,

Table 3a- Distribution of the ostracod genus and species from the A transect in Çeşme-Ilıca Bay.

OSTRACOD	TRANSECT-A							
	5	10	15	20	25	30	35	40
Aurila convexa	*		*	*	*			*
Callistocythere intracatoides	*	*	*		*		*	*
Carinocythereis carinata	*		*	*	*		*	*
Cyprideis torosa		*						
Leptocythere sp.		*	*	*	*			
Loxoconcha rhomboidea	*		*			*	*	*
Neonesidea corpulenta				*	*			
Neonesidea inflata	*							
Paracytheridea depressa		*		*			*	
Pontocythere turbida	*							
Semicytherura inversa		*	*					
Tenedocythere prava	*		*		*			
Triebelina sp.		*						
Urocythereis oblonga	*	*	*		*	*	*	*
Xestoleberis communis	*	*	*	*	*	*	*	*
Xestoleberis dispar			*	*	*		*	

Pontocythere turbida and *Neonesidea inflata* were observed only at 1 station.

In transect B, a total of 19 genera and 23 species were identified in 15 ostracod samples collected at distances varying between 5 to 100 meters (Table 3b). In this transect; *Xestoleberis communis*, *Urocythereis oblonga*, *Loxoconcha rhomboidea*, *Callistcoythereis intracatoides*, *Aurila convexa* are abundantly observed species. In the same transect, *Eucytherura mistrettai*, *Pontocypris rara*, *Cytherella alvearium*, *Cyprideis torosa*, *Neocytherideis bradyi* were observed only at one station.

Table 3b- Distribution of the ostracod genus and species from the B transect in Çeşme-Ilıca Bay.

OSTRACOD	TRANSECT-B														
	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Aurila convexa	*		*	*	*	*	*	*	*	*		*		*	*
Callistocythere intracatoides	*	*	*		*	*	*	*	*			*		*	*
Carinocythereis carinata		*		*	*	*	*	*	*	*					
Cyprideis torosa		*													
Cytherella alvearium								*							
Cytherelloidea sordida						*									
Cytheretta judea					*					*	*	*			
Eucytherura mistrettai						*									
Hiltermannicythere rubra				*	*	*			*						
Hiltermannicythere turbida							*							*	*
Leptocythere sp.			*				*								
Loxoconcha rhomboidea	*	*		*	*	*	*	*	*	*	*	*	*	*	*
Neocytherideis bradyi							*								
Neonesidea corpulenta				*			*			*					
Paracytheridea depressa						*	*	*	*	*				*	
Pontocypris rara					*										
Pontocythere turbida				*	*				*				*	*	
Semicytherura inversa	*		*			*		*						*	*
Tenedocythere prava	*		*	*	*	*	*	*	*			*			*
Urocythereis crenulosa									*	*					
Urocythereis oblonga	*	*	*	*	*	*	*		*	*	*	*	*	*	*
Xestoleberis communis	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Xestoleberis dispar	*	*					*	*	*	*		*	*	*	

In transect C, a total of 19 genera and 22 species were identified at distances varying between 5 to 100 meters (Table 3c). In this transect; *Aurila convexa, Xestoleberis communis*, *Urocythereis oblonga*, *Loxoconcha rhomboidea* are abundant species. *Pontocypris mytiloides*, *Urocythereis crenulosa*, *Hiltermannicythere rubra*, *Cytherella alvearium*, *Cytherelloidea sordida* and *Costa batei* were observed only at one station.

Table 3c- Distribution of the ostracod genus and species from the C transect in Çeşme-Ilıca Bay.

OSTRACOD	TRANSECT-C														
	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Aurila convexa	*	*		*	*	*	*		*		*	*		*	
Callistocythere intracatoides		*	*	*								*			
Carinocythereis carinata	*										*	*			
Costa batei												*			
Cytherella alvearium					*										
Cytherelloidea sordida			*												
Cytheretta judea	*		*												
Hiltermannicythere rubra			*												
Leptocythere sp.					*										
Loxoconcha rhomboidea		*	*		*	*	*		*		*	*		*	*
Neonesidea corpulenta	*						*				*				
Neonesidea inflata	*		*	*	*						*	*			
Paracytheridea depressa					*						*			*	
Pontocythere turbida									*					*	
Pontocypris mytiloides				*											
Semicytherura inversa	*		*								*				
Tenedocythere prava	*			*							*				
Triebelina sp.					*	*					*				
Urocythereis crenulosa					*										
Urocythereis oblonga	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Xestoleberis communis	*	*	*	*	*	*	*				*	*			*
Xestoleberis dispar		*		*	*	*					*	*		*	

HYDROGEOCHEMICAL AND RADIOACTIVITY CHARACTERISTICS OF ÇEŞME (ILICA) MINERALIZED WATERS

There are several submarine water springs along the southwestern coast of Karaburun, excluding the springs locating on land. Topan and Hamidiye are the most significant springs among them. It was determined that; Topan spring is chemically similar to that of onshore springs nearby. The water samples have thermal sodium chlorure, ranging between 42 - 55°C (Yenal et al., 1975; Barut et al., 2004). These mineralized waters are determined as saline waters since their salinity is close to that of sea water. However, they contain high sulphate and soil alkalinity with 27 gr. salt/lt (Yenal et al., 1975).

It is remarkable that; Fe, Br and Sr values are high and there is a good linearity between the concentrations of elements of Çeşme (Ilıca) spring (Table 4, figure 2 a and b). The amount of Br is higher than sea water (Krauskopf, 1979) and has the highest concentration in transect B.

In contrast, the concentration of Fe and Sr are highest in transect A. There was an increase in Si and Fe concentrations relative to the analyses carried out in 2009 in Ilıca spring. There are also differences in the compositions of water samples from transects A, B and C.

In our study, radioactive alpha and beta readings were recorded for the mineralized waters from Çeşme-Ilıca spring. According to these results, the distribution in transects A, B and C are close to each other. From radioactive determinations made in Çeşme Ilıca spring, which belongs to hyperthermal and hypertonic class, total alpha: 4.41188±19.6 Bq; total beta: 4.37081±9.21 Bq; Rn^{222} : 25.9 Bq; Ra^{226}: 1.64428 Bq values were found based on the study of Yenal et al., (1975). When results of the study carried out in 1975 were compared with today's results, it has been seen that total alpha values had decreased a lot, while total beta values had increased as inversely proportional showing that characteristics of radioactivity had roughly changed (Table 4).

Table 4- Repeated chemical analyses of samples from the Çeşme-Ilıca Bay in 1975, 2009 and 2010, and total alpha and beta radioactive values of the sea water in A, B and C transects measured during 2010.

ÇEŞME-ILICA BAY						
	Submarine Spring			A (50 m)	B (50 m)	C (50m)
	Krauskopf (1979) Seawater	Yenal et al., 1975	2009	2010		
Al ppm	0.002	0.14	0.625			
Si ppm	2	5.41	6.25			
Ti ppm	0.001			31.5	17.9	10.5
Cr ppm	0.0003		0.1	19.3	11.1	7.8
Mn ppm	0.0002		0.067	4.8	3.4	1.3
Fe ppm	0.002	0.22	1	308.8	107.7	76.5
Co ppm	0.00005		0.364	7.8	1.9	15
Ni ppm	0.0017		0.75	1.3	0.8	2.9
Cu ppm	0.0005		0.075	3.8	1.3	2.6
Zn ppm	0.0049	0.83	0.047	1.5	0.4	0.5
As ppb	0.0000037		16.45			
Hg ppb	1x10-6		yok			
Pb ppm	3x10-5		eser			
CaO ppm				16400	7378.5	15289.2
Sc ppm	0.0000006			1.7	1.2	2.2
Br ppm	67	0.12		1026.5	1506.8	958.2
Rb ppm	0.12			3.3	2.8	5.3
Sr ppm	8			206.4	169.7	180
Sn ppm	0.00001			4.4	2.8	6.7
La ppm	0.000003			4.9	5.6	5.8
W ppm	0.0001			4.2	5.2	1
Total Alpha (Bq)		4.41188±19.6		0.207±0.013	0.227±0.013	0.225±0.013
Total Beta (Bq)		4.37081±9.21		19.589±1.047	18.727±1.03	18.782±1.03

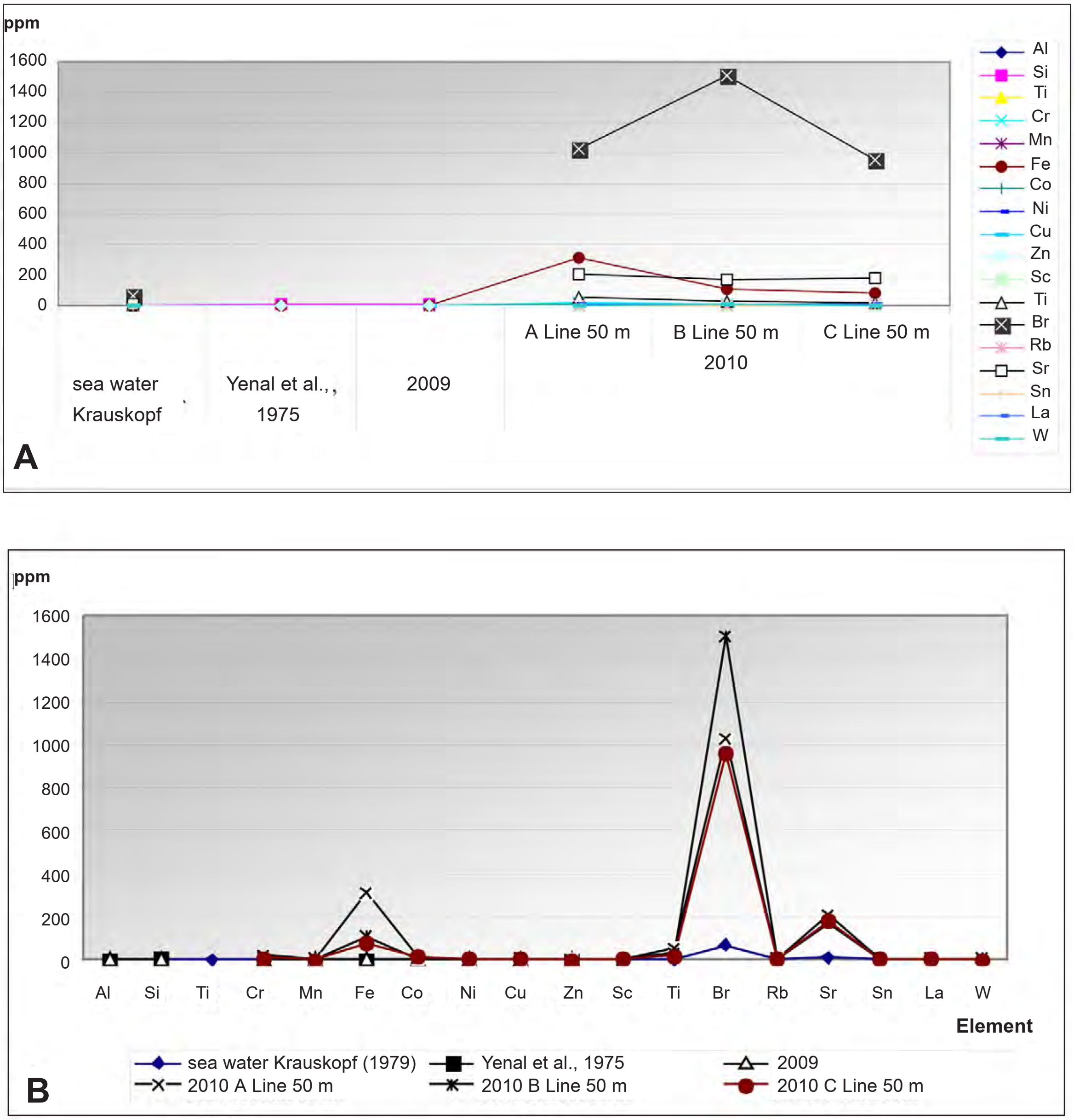


Figure 2- Geochemical samples from the Çeşme-Ilıca submarine spring.

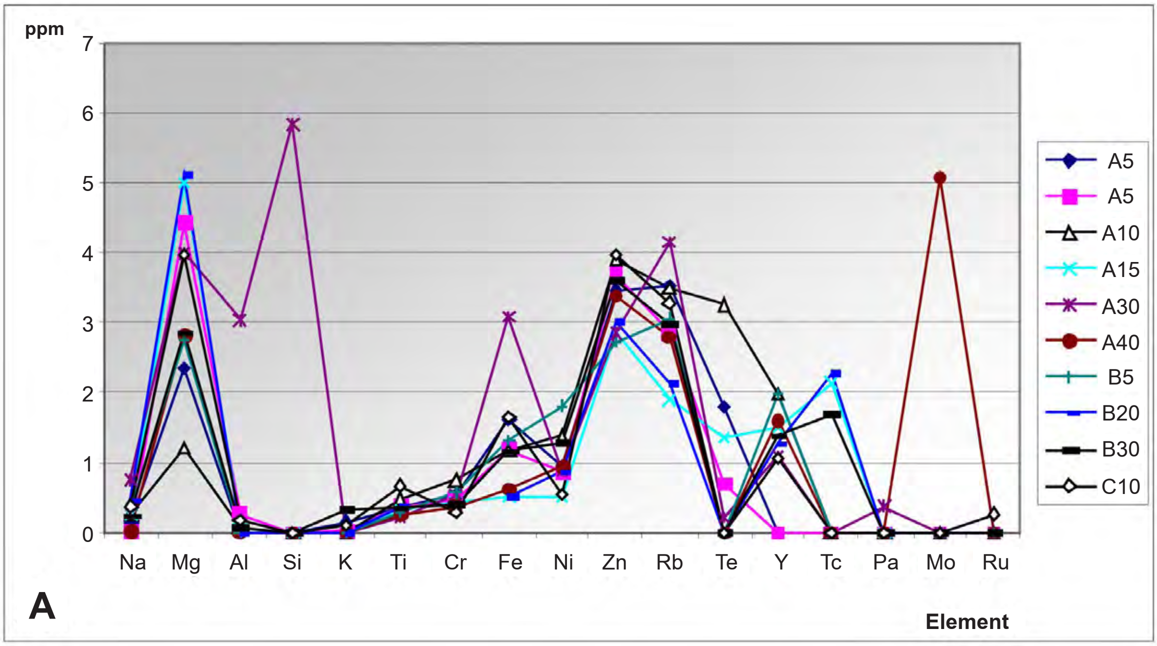
GEOCHEMICAL CHARACTERISTICS of *Peneroplis Planatus* (FICHTEL AND MOLL) SHELLS

The microprobe analysis of *Peneroplis planatus* (Fichtel and Moll) shells in samples A5, A10, A15, A30, A40, B5, B20, B30 and C10 in Çeşme Ilıca (Table 5) indicate elevated Mg, Si, Fe, Zn, Rb, Y, Tc and Mo contents (Figure 3a). The concentration of Mg and Tc in A5 and B20; Si, Fe and Rb in A30, and Mo in A40 were found to be the highest values. Lowest elements, however; were detected in all shells except A30 (Al and Si) and B30 (K).

The distribution of heavy metal and trace elements of colored *Peneroplis planatus* (Fichtel and Moll) shells it was measured that the concentration of Ti, Cr, Te and Y in A10; Na, Al, Si, Fe, Fe, Rb and Pa in A30; Mo in A40; Ni and Y in B5; Mg and Tc in B20; K in B30, and Zn and Ru in C10 have highest values (Figure 3b). Ti, Cr and Fe concentrations are higher in the shells in comparison to those of water samples from Çeşme Ilıca. When these were compared with Krauskopf (1979) seawater reference values; Mg, Al, Si, (in A30), Ti, Cr, Fe, Ni, Zn, Rb and Y were remarkably found to be the high in concentration. When geochemical results of these shells were compared with shale reference values of Krauskopf (1979), Al, Si, Fe and Mo (A40) were found to be high i concentration (Table 5). Another important thing in shell analyses, the rare earth elements such as; Pa (A30), Mo (A40) and Ru (C10) were encountered only on shells in single sampling points.

Table 5- Results of geochemical analysis of purple shells of Peneroplis planatus (Fichtel ve Moll) in the Çeşme-Ilıca Bay samples.

ppm	***Peneroplis planatus*** **(Fichtel ve Moll) coloured shells**										Shale Krauskopf (1979)	Sea water Krauskopf (1979)
	A5	**A5**	**A10**	**A15**	**A30**	**A40**	**B5**	**B20**	**B30**	**C10**		
Na	0.15	0.04	0.26	0.27	**0.76**	0.03	0.33	0.47	0.25	0.37	9000	10770
Mg	2.36	4.41	1.21	4.99	3.98	2.81	2.78	**5.09**	2.86	3.96	14000	1.29
Al	0.01	0.27	0.09	0.07	**3.05**	0	0	0	0.09	0.2	0.00092	0.002
Si	0	0	0	0	**5.83**	0	0	0	0	0	0.00238	2
K	0.15	0.04	0	0	0	0	0	0	**0.33**	0.1	25000	380
Ti	0.39	0.37	**0.49**	0.32	0.23	0.28	0.3	0.37	0.34	0.68	4500	0.001
Cr	0.53	0.5	**0.75**	0.44	0.54	0.39	0.57		0.41	0.29	100	0.0003
Fe	1.63	1.2	1.18	0.52	**3.1**	0.63	1.32	0.52	1.17	1.65	0.00047	0.002
Ni	0.94	0.88	1.39	0.51	0.9	0.94	**1.82**	0.86	1.3	0.54	80	0.0017
Zn	3.48	3.7	3.9	2.85	2.85	3.38	2.7	3.02	3.6	**3.95**	90	0.0049
Rb	3.52	2.85	3.49	1.91	**4.15**	2.8	3.07	2.13	2.99	3.27	140	0.12
Te	1.78	0.7	**3.25**	1.35	0.21	0	0	0	0	0		
Y	0	0	**1.99**	1.53	1.1	1.61	**1.99**	1.27	1.39	1.07	35	0.000001
Tc	0	0	0	2.15	0	0	0	**2.28**	1.69	0		
Pa	0	0	0	0	**0.37**	0	0	0	0	0		
Mo	0	0	0	0	0	**5.08**	0	0	0	0	2	0.01
Ru	0	0	0	0	0	0	0	0	0	**0.28**		



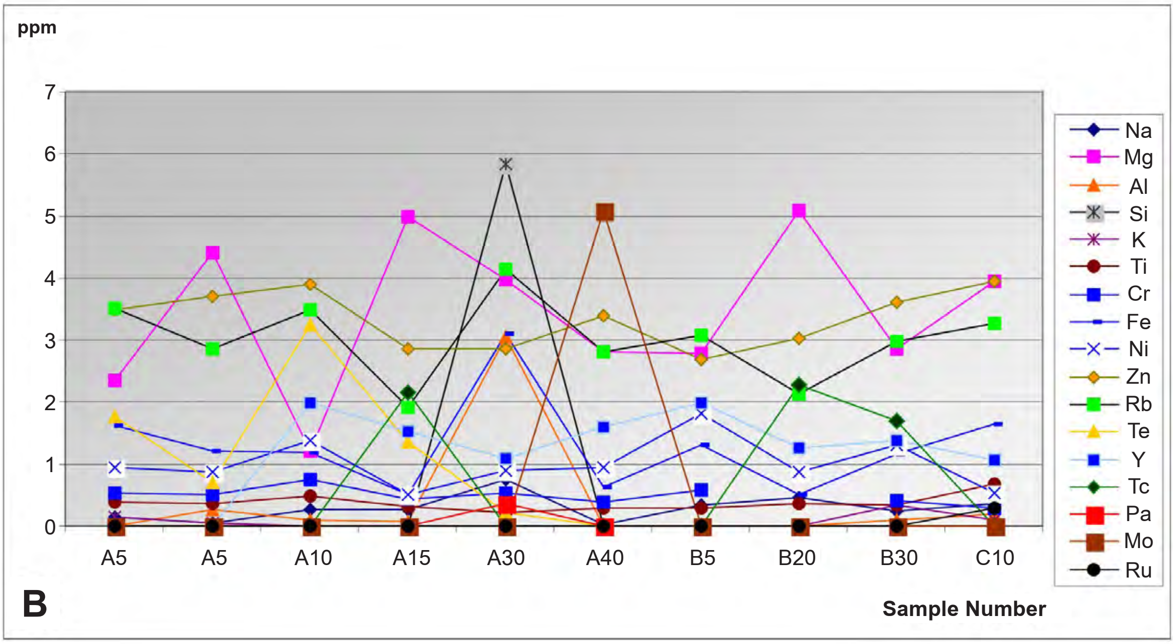


Figure 3- Geochemical analyses of coloured Peneroplis planatus (Fichtel ve Moll) shells.

DISCUSSIONS AND RESULTS

Apart from the İskenderun and Kuşadası Bays, a large number of *Nodopthalmidium antillarum* (Cushman) which is Pacific Ocean in origin have been found in the study area. However; *Spiroloculina antillarum* d'Orbigny and *Triloculina fichteliana* d'Orbigny have been identified in the Kuşadası and Çeşme Ilıca Bays. *Euthymonacha polita* (Chapman) was first observed around the springs in Kuşadasi Bay and Ilıca Bay along the Turkey coast. This species has also been found along the northwestern coasts of the Karaburun Peninsula. There is not any record whether this genus or species was present in the Red Sea. Despite that; *Coscinospira acicularis* (Batsch) was first observed along the Mediterranean and Aegean coasts. The number of individuals which were 9 in three samples around spring (A, B and C transects) exceeds 30 in total. This was defined as *Monalysium acicularis* (Batsch) in Gulf of Aqaba, north of the Red Sea (Hottinger et al., 1993). However; *Peneroplis arietinus* (Batsch) was largely observed around Kekova, on the coast of southwestern Antalya. However, although there had been no evidence for the presence of any genus or species along the coastline between Kalkan and Çeşme, these species were observed there in remarkable amounts. Ilıca Bay, though seldom, is the northernmost point where *Amphisorus hemprichii* Ehrenberg was encountered. *Cymbaloporetta plana* (Cushman) extends from the southwestern Antalya to the Kuşadası Bay and the northwestern coastal area of the Karaburun Peninsula. In addition to these characteristics, *Amphistegina lobifera* Larsen, which had been observed in minor amounts in Marmaris, Datça, Gökova Bays and southeast of Gökçeada is commonly present around the spring in Kuşadası Bay and on the northwestern coast of the Karaburun Peninsula. However; there is no evidence for the presence of this genus and species on the northern part of the Kuşadası Bay (Sözeri, 1966; Sellier de Civrieux, 1970; Meriç, 1986; Avşar and Meriç, 2001). It was also observed in only 1 of 16 samples studied in another investigation carried out at the southwestern part of the Dilek Peninsula located on the northern side of Kuşadası Bay (Avşar et al., 2009).

Koukousiora et al. (2010) have mentioned about the presence of alien foraminifera such as; *Triloculina fichteliana* d'Orbigny, *Coscinospira hemprichii* Ehrenberg, *Sorites orbiculus* Ehrenberg, *Planogypsina acervalis* Brady, *Cymbaloporetta plana* (Cushman) and *Amphistegina lobifera* Larsen in their study at the western coasts of the Aegean Sea and at different locations but, they do not mention the presence of submarine thermal springs in investigated areas.

In 28 of 38 studied samples, the abundance of *Peneroplis pertusus* (Forskal*), P. planatus* (Fichtel and Moll), *Coscinospira hemprichii* Ehrenberg and *Sorites orbiculus* Ehrenberg individuals having yellow, orange, bluish green and black colored shells reveals the effect of various heavy metal and trace elements in the composition of thermal water on the foraminiferal living around spring. Besides, the presence of shells having morphological defections in almost all samples indicates that various heavy metal, trace and radioactive elements were effective on the life around the spring. In a study carried out along the coast of Andros Island in western Aegean Sea (Triantaphyllou et al., 2005), some benthic foraminiferal shells have been observed that also have morphological defects. Besides; in some studies that was made on coasts of the western Aegean Sea, the presence of submarine thermal springs were also dealt with (Thierman et al., 1997; Varnavas et al., 1999).

Additionally, the observation of *Peneroplis planatus* (Fichtel and Moll), *Sorites orbiculus* Ehrenberg and *Ammonia compacta* Hofker individuals that are larger than 1 mm in 10 of the samples indicate the presence of $CaCO_3$ in this region. Moreover, the presence of *Euthymonacha polita* (Chapman) and *Coscinospira acicularis* (Batsch) in 18 of all samples are indicative for the diversity of the ecological conditions of the study area with compared to other locations of the Aegean Sea.

It was seen that ostracodes in the study area show similarity to those observed by other investigations carried out in Mediterranean and

Aegean Sea and there is no difference in communities belonging to 3 transects. The other important thing observed is that there was no coloring on the ostracod shells.

Consequently, due to diverse ecological features especially around submarine springs at some locations of the Aegean Sea, certain foraminiferal genera and species got the chance to survive. But, some foraminiferal species such as *Amphistegina lobifera* Larsen could not survive in these areas due to excess amount of radioactivity around high temperature thermal waters.

In our investigation, high values of Ca, Fe, Br and Sr in the Çeşme-Ilıca spring were detected and in geochemical assessment of colored *Peneroplis planatus* (Fichtel and Moll) shells encountered at some sampling points, shells at single sampling points like; Pa (A30), Mo (A40) and Ru (C10) among rare earth elements make us think that the source of these elements are orogenic and volcanic origin. Approximately 160000 years ago, volcanic materials such as ash, tuff and pumice spreaded to coastal areas of Turkey following the eruption of santorini Volcano on Thera Island. This was accompanied by changes in sea currents resulting in the formation of young surface terrains. Over 20 islands/islets were formed as called the “12 Islands”. The resultant permanent traces on peninsulas and bays along the coast also affect the human settlement of southwestern Anatolia (Aitken et al., 1988; Greaves, 2003; Piper et al., 2005).

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PLATES

PLATE - I

Ilıca Bay, Çeşme, İzmir.

1. *Vertebralina striata* d'Orbigny. Normal Individual, external view, B-10.00 m.
2. *Vertebralina striata* d'Orbigny. Abnormal Individual, external view, A-25.00 m.
3. *Vertebralina striata* d'Orbigny. Double mouth Individual, external view, B-35.00 m.
4. *Vertebralina striata* d'Orbigny. a. abnormally developed double mouth individual; b, detailed view of mouths and c, detailed view of second mouth, C-15.00 m.
5. *Vertebralina striata* d'Orbigny. a, external view of three mouth individual and b, detailed views of mouths, C-60.00 m.
6. *Nodopthalmidium antillarum* (Cushman). External view, A-5.00 m.
7. *Nodopthalmidium antillarum* (Cushman). External view, A-10.00 m.
8. *Nodopthalmidium antillarum* (Cushman). External view, B-35.00 m.
9. *Nodopthalmidium antillarum* (Cushman). External view, B-80.00 m.
10. *Nodopthalmidium antillarum* (Cushman). External view, C-20.00 m.
11. *Adelosina cliarensis* (Heron-Allen ve Earland). a and b, external views, A-5.00 m.
12. *Spiroloculina angulosa* Terquem. External view, A-15.00 m.
13. *Spiroloculina antillarum* d'Orbigny. a and b, External views, A-5.00 m.
14. *Spiroloculina ornata* d'Orbigny. a and b, abnormally developed double mouth individuals. a, B-40.00 m and b, C-60.00 m.
15. *Siphonaperta aspera* (d'Orbigny). a and b, external views, A-25.00 m.

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PLATE - I

PLATE - II

Ilıca Bay, Çeşme, İzmir.

1. *Siphonaperta* cf. *aspera* (d'Orbigny). Abnormally developed twin individuals. B-80.00 m.
2. *Lachlanella variolata* (d'Orbigny). External view, A-35.00 m.
3. *Pseudotriloculina laevigata* (d'Orbigny). External view, A-5.00 m.
4. *Pseudotriloculina oblonga* (Montagu). a and b, External views, A-5.00 m.
1. *Articulina carinata* Wiesner. External view, A-10.00 m.
6. *Articulina carinata* Wiesner. External view, B-35.00 m.
7. *Articulina carinata* Wiesner. External view, B-35.00 m.
8. *Articulina carinata* Wiesner. External view, B-35.00 m.
9. *Articulina carinata* Wiesner. External view, B-40.00 m.
10. *Articulina carinata* Wiesner. External view, C-15.00 m.
11. *Parrina bradyi* (Millet). External view, A-5.00 m.
12. *Euthymonacha polita* (Chapman). a, detailed view of the mouth and b, External view, B-10.00 m.
13. *Euthymonacha polita* (Chapman). External view, B-10.00 m.
14. *Coscinospira acicularis* (Batsch). External view, C-15.00 m.
15. *Coscinospira acicularis* (Batsch). Abnormally developed individual, External view, A-35.00 m.
16. *Coscinospira acicularis* (Batsch). External view, B-30.00 m.
17. *Coscinospira acicularis* (Batsch). Abnormally developed individual, External view, B-90.00 m.
18. *Coscinospira acicularis* (Batsch). Abnormally developed individual, External view, B-10.00 m.
19. *Coscinospira acicularis* (Batsch). Abnormally developed individual, External view, C-20.00 m.
20. *Coscinospira acicularis* (Batsch). Abnormally developed individual, External view, C-60.00 m.
21. *Coscinospira acicularis* (Batsch). Abnormally developed individual, External view, C-90.00 m.
22. *Coscinospira hemprichii* Ehrenberg. External view, A-35.00 m.
23. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, External view, A-35.00 m.

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PLATE - II

PLATE - III

Ilıca Bay, Çeşme, İzmir.

1. *Coscinospira hemprichii* Ehrenberg. Young individual, external view, A-35.00 m.
2. *Coscinospira hemprichii* Ehrenberg. Mature individual, external view, A-5.00 m.
3. *Coscinospira hemprichii* Ehrenberg. Young individual, external view, A-10.00 m.
4. *Coscinospira hemprichii* Ehrenberg. Detailed view of the mouth, A-30.00 m.
5. *Coscinospira hemprichii* Ehrenberg. Young individual, external view, A-35.00 m.
6. *Coscinospira hemprichii* Ehrenberg. Young individual, external view, A-35.00 m.
7. *Coscinospira hemprichii* Ehrenberg. Young individual, external view, A-35.00 m.
8. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, external view, A-40.00.
9. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, external view, B-80.00 m.
10. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, external view, B-90.00 m.
11. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, external view, B-90.00 m.
12. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, external view, B-90.00 m.
13. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, External view, B-90.00 m.
14. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, External view, B-100.00 m.
15. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, External view, C-15.00 m.
16. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, External view, C-15.00 m.
17. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, External view, C-50.00 m.
18. *Coscinospira hemprichii* Ehrenberg. Detailed view of the mouth, C-25.00 m.
19. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, External view, C-30.00 m.
20. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, External view, C-35.00 m.

PLATE - III

PLATE - IV

Ilıca Bay, Çeşme, İzmir.

1. *Coscinospira hemprichii* Ehrenberg. Abnormal individual, external view, C-50.00 m.
2. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individual, external view, C-70.00 m.
3. *Coscinospira hemprichii* Ehrenberg. Abnormally developed individuals, external view, C-90.00 m.
4. *Laevipeneroplis karreri* (Wiesner). External view, A-25.00 m.
5. *Laevipeneroplis karreri* (Wiesner). Abnormal individual, external view, A-40.00 m.
6. *Laevipeneroplis karreri* (Wiesner). External view, B-10.00 m.
7. *Laevipeneroplis karreri* (Wiesner). Abnormal individual, external view, C-25.00 m.
8. *Laevipeneroplis karreri* (Wiesner). Abnormal individual, external view, C-80.00 m.
9. *Peneroplis arietinus* (Batsch). External view, C-30.00 m.
10. *Peneroplis arietinus* (Batsch). a, External view and b, detailed view of the mouth,C-30.00 m.
11. *Peneroplis arietinus* (Batsch). Abnormal individual, external view, C-60.00 m.
12. *Peneroplis arietinus* (Batsch). External view, A-20.00 m.
13. *Peneroplis arietinus* (Batsch). External view, C-35.00 m.
14. *Peneroplis arietinus* (Batsch). External view, A-40.00 m.
15. *Peneroplis arietinus* (Batsch). Young individual, external view, A-25.00 m.
16. *Peneroplis arietinus* (Batsch). Young individual, external view, A-25.00 m.
17. *Peneroplis arietinus* (Batsch). Young individual, external view, A-40.00 m.

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PLATE - IV

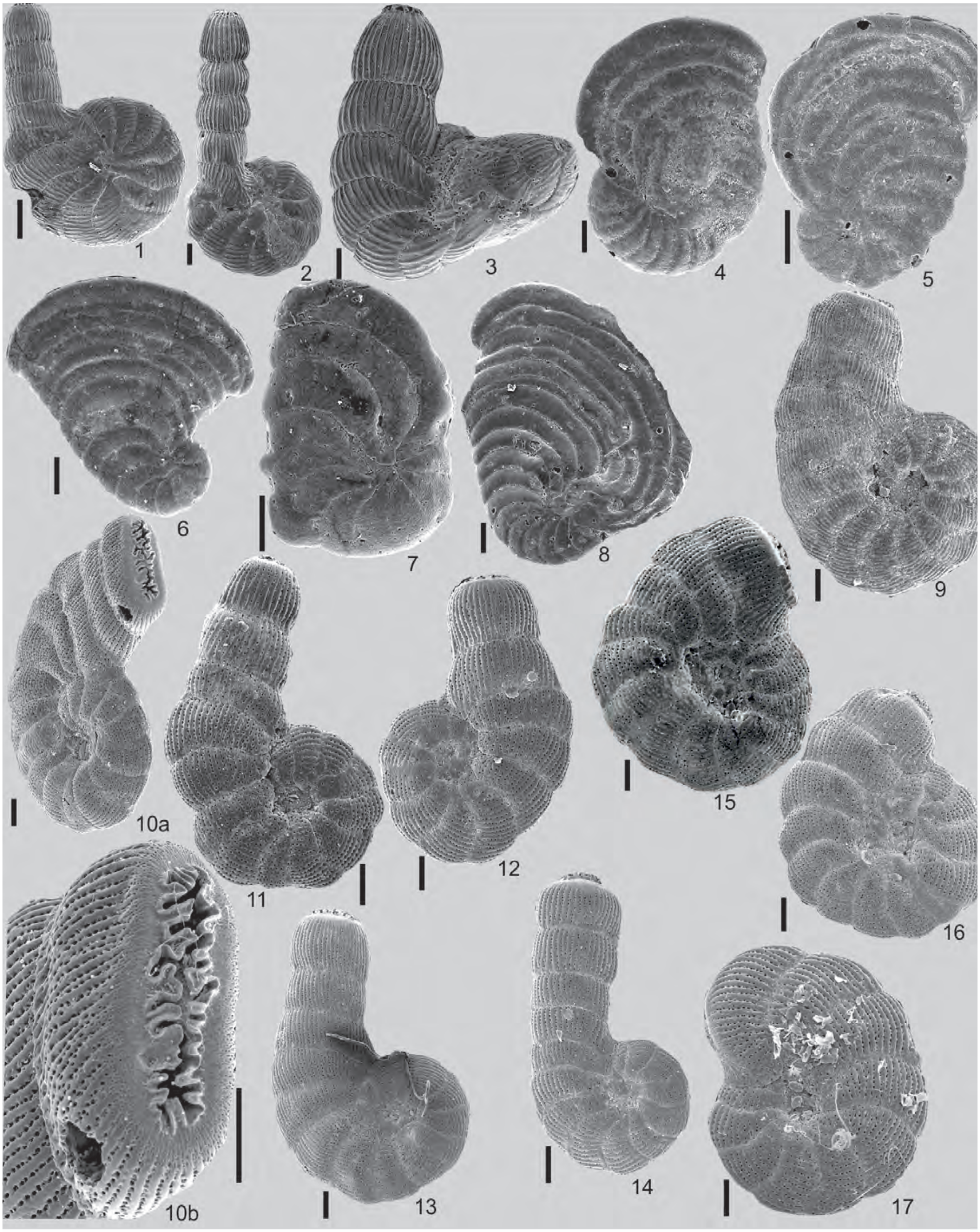

PLATE - V

Ilıca Bay, Çeşme, İzmir.

1. *Peneroplis arietinus* (Batsch). External view, B-35.00 m.
   Peneroplis arietinus (Batsch). Young individual, external view, B-50.00 m.
2. *Peneroplis arietinus* (Batsch). External view, B-50.00 m.
2. *Peneroplis arietinus* (Batsch). External view, C-30.00 m.
4. *Peneroplis pertusus* (Forskal). External view, A-5.00 m.
5. *Peneroplis pertusus* (Forskal). External view, A-5.00 m.
6. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, A-20.00 m.
7. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, A-30.00 m.
8. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, A-40.00 m.
9. *Peneroplis pertusus* (Forskal). Stuck twin, external view, B-35.00 m.
10. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, B-45.00 m.
11. *Peneroplis pertusus* (Forskal). Double mouth abnormal individual, external view, B-20.00 m.
12. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, B-50.00 m.
13. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, A-50.00 m.
14. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-15.00 m.
15. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-15.00 m.
16. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-15.00 m.

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Cüneyt BİRCAN and Aysun KAYGUN

PLATE - V

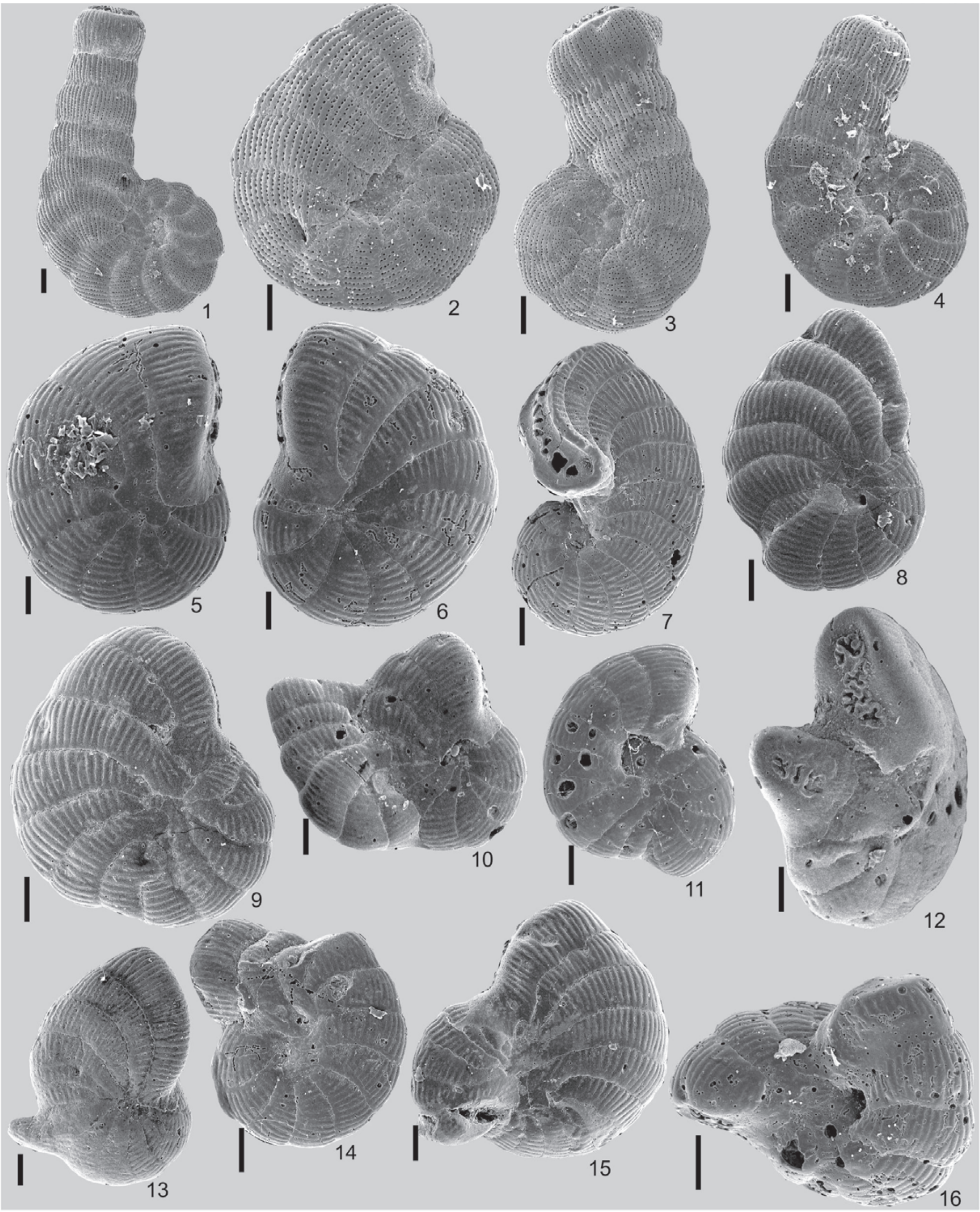

PLATE - VI

Ilıca Bay, Çeşme, İzmir.

1. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-15.00 m.
2. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-15.00 m.
3. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-25.00 m.
4. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-25.00 m.
5. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-25.00 m.
6. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-30.00 m.
7. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-30.00 m.
8. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-30.00 m.
9. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-50.00 m.
10. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-50.00 m.
11. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-60.00 m.
12. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-60.00 m.
13. *Peneroplis pertusus* (Forskal). Abnormal individual, external view, C-60.00 m.
14. Community of abnormal individuals, and the association of *Peneroplis pertusus* (Forskal) and *Peneroplis planatus* (Fichtel ve Moll). a, external view; b, *Peneroplis planatus* (Fichtel and Moll); c. *Peneroplis pertusus* (Forskal), C-90.00 m.

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Cüneyt BİRCAN and Aysun KAYGUN

PLATE - VI

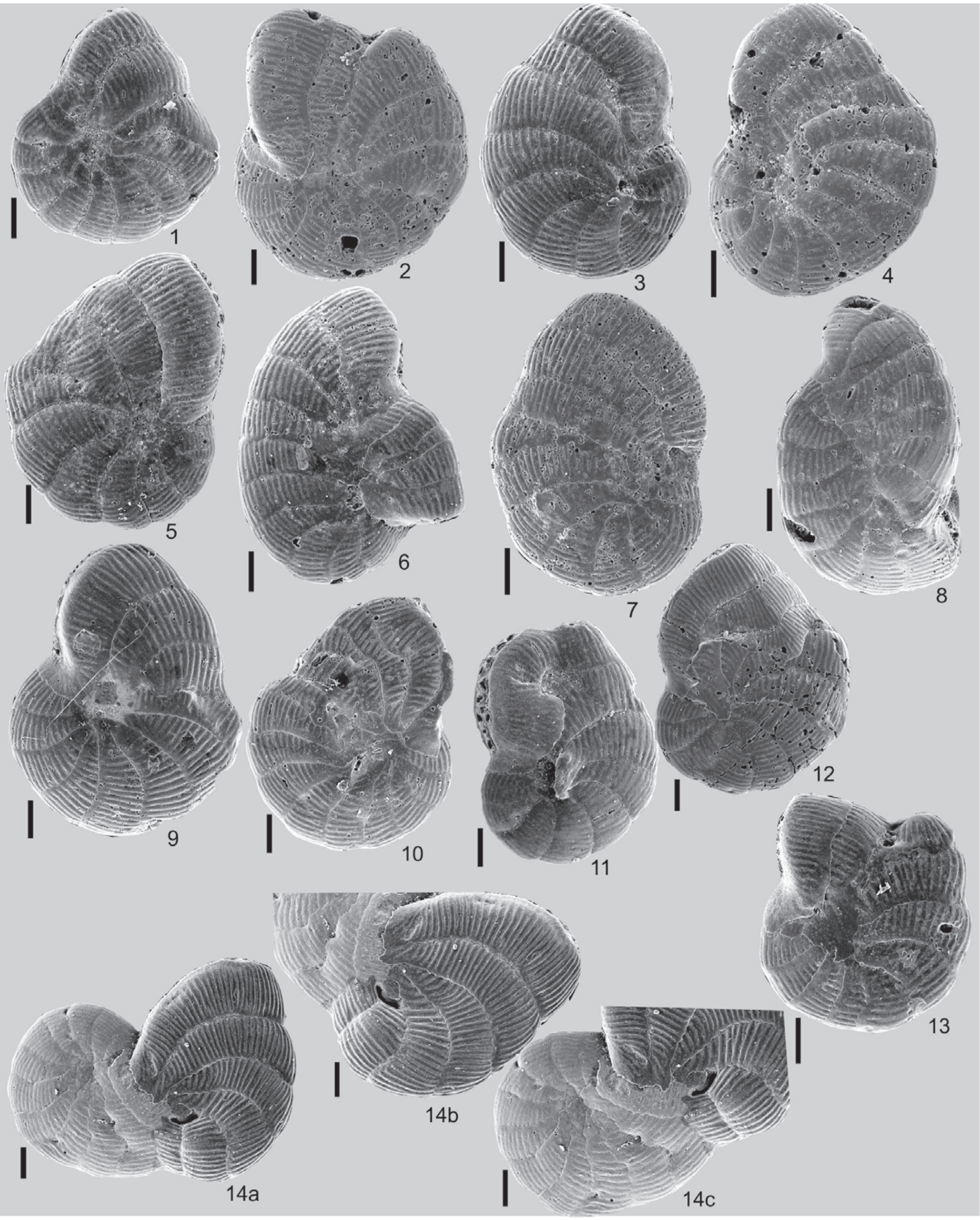

PLATE - VII

Ilıca Bay, Çeşme, İzmir.

1. *Peneroplis planatus* (Fichtel ve Moll). External view, C-80.00 m.
2. *Peneroplis planatus* (Fichtel ve Moll). External view, A-5.00 m.
3. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, B-10.00 m.
4. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, B-20.00 m.
5. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, B-90.00 m.
6. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, B-100.00 m.
7. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-25.00 m.
8. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, B-35.00 m.
9. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-25.00 m.
10. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-25.00 m.
11. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-25.00 m.
12. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-25.00 m.
13. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-35.00 m.
14. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-35.00 m.
15. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-35.00 m.
16. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, B-25.00 m.
17. *Peneroplis planatus* (Fichtel ve Moll). Abnormally developed mouth, C-35.00 m.

PLATE - VII

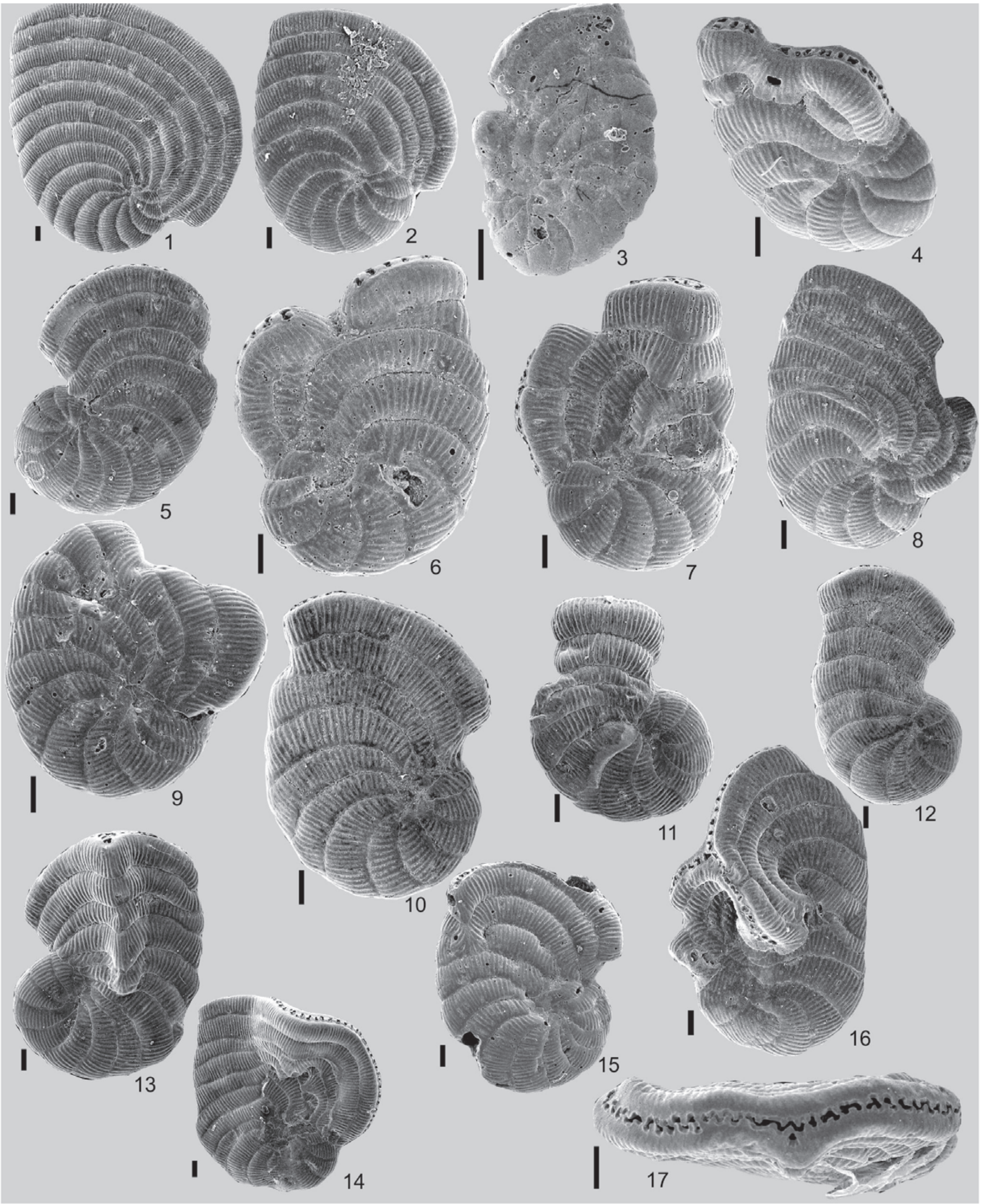

PLATE - VIII

Ilıca Bay, Çeşme, İzmir.

1. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-35.00 m.
2. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-35.00 m.
3. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-35.00 m.
4. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-35.00 m.
5. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-90.00 m.
6. *Peneroplis planatus* (Fichtel ve Moll). Abnormal individual, external view, C-70.00 m.
7. *Sorites orbiculus* Ehrenberg. External view, A-15.00 m.
8. *Sorites orbiculus* Ehrenberg. Abnormal individual, external view, B-10.00 m.
9. *Sorites orbiculus* Ehrenberg. Abnormal individual, external view, C-90.00 m.
10. *Planorbulina mediterranensis* d'Orbigny. External view, free surface, A-15.00 m,
11. *Cibicidella variabilis* (d'Orbigny). External view, spiral side, B-40.00 m.
12. *Cibicidella variabilis* (d'Orbigny). External view, spiral side, A-10.00 m.
13. *Cibicidella variabilis* (d'Orbigny). External view, spiral side, B-25.00 m.
14. *Cibicidella variabilis* (d'Orbigny). External view, umbilical side, B-35.00 m.
15. *Cymbaloporetta plana* (Cushman). External view, umbilical side, C-15.00 m.
16. *Cymbaloporetta plana* (Cushman). Side view with capsule, C-20.00 m.
17. *Cymbaloporetta plana* (Cushman). External view, spiral side, C-20.00 m.
18. *Cymbaloporetta plana* (Cushman). Side view with capsule, C-20.00 m.
19. *Cymbaloporetta plana* (Cushman). Side view, C-20.00 m.
20. *Ammonia parkinsoniana* (d'Orbigny). External view, umbilical side, A-30.00 m.
21. *Elphidium crispum* (Linne). External view, A-5.00 m.
22. *Elphidium* sp. External view, A-10.00 m.

PLATE - VIII

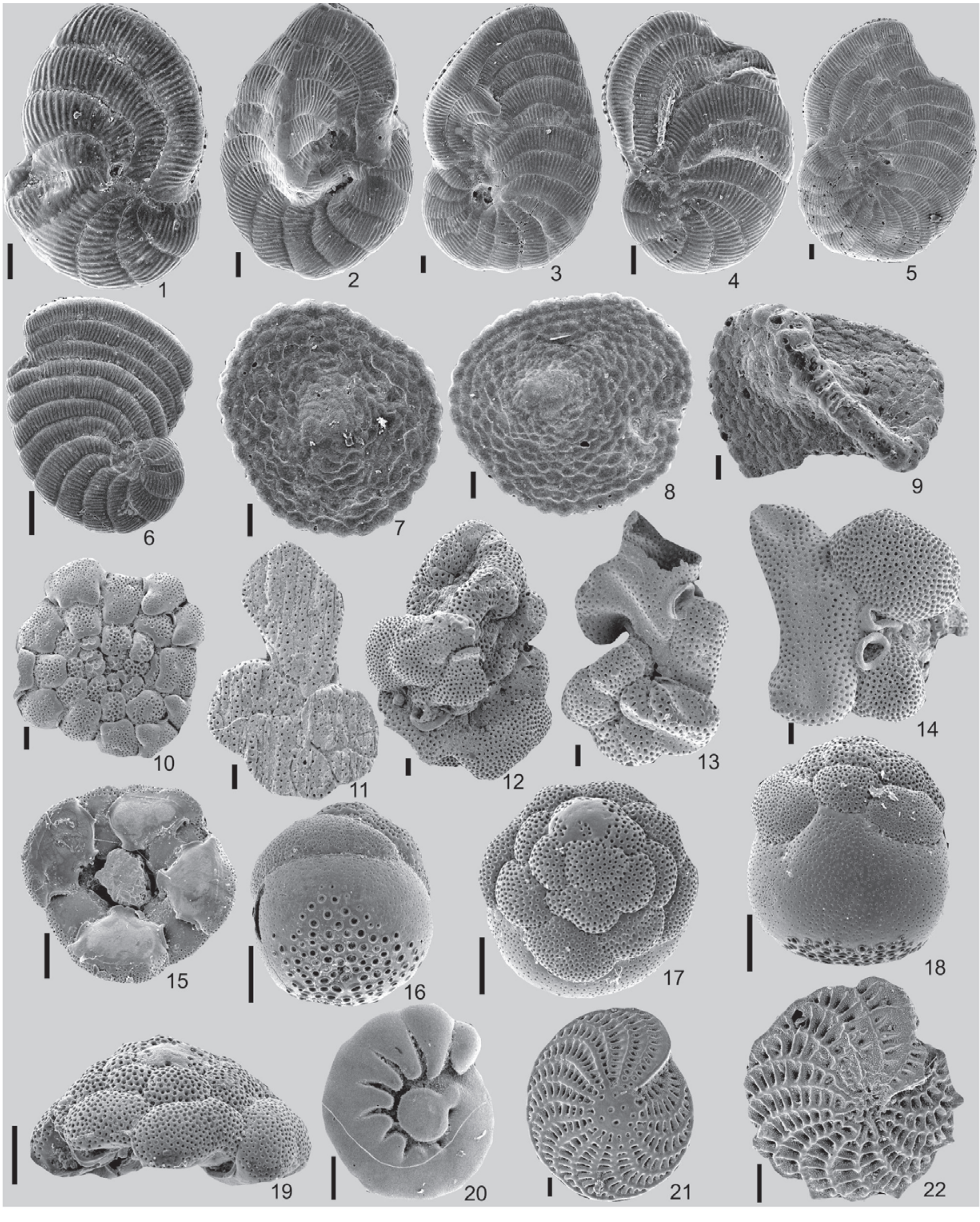

PLATE - IX

Ilıca Bay, Çeşme, İzmir.

1. *Textularia bocki* Höglund. External view, C-25.00 m.
2. *Vertebralina striata* d'Orbigny. External view, abnormally developed individual, C-20.00 m.
3. *Vertebralina striata* d'Orbigny. External view, abnormally developed individual, C-30.00 m.
4. *Adelosina cliarensis* (Heron-Allen ve Earland**).** External view, B-80.00 m.
5. *Adelosina mediterranensis* (Le Calvez J. ve Y.) External view, B-80.00 m.
6. *Spiroloculina angulosa* Terquem. External view, A-5.00 m.
7. *Spiroloculina angulosa* Terquem**.** External view, C-5.00 m.
8. *Spiroloculina angulosa* Terquem**.** External view, C-5.00 m.
9. *Spiroloculina angulosa* Terquem. External view, C-20.00 m.
10. *Spiroloculina antillarum* (d'Orbigny). External view, A-20.00 m.
11. *Spiroloculina antillarum* (d'Orbigny). External view, A-40.00 m.
12. *Siphonaperta aspera* (d'Orbigny). External view, C-80.00 m.
13. *Cycloforina rugosa* (d'Orbigny). External view, A-35.00 m.
14. *Cycloforina rugosa* (d'Orbigny). External view, C-20.00 m.
15. *Massilina secans* (d'Orbigny). External view, C-25.00 m.
16. *Quinqueloculina bidentata* d'Orbigny**.** External view, C-90.00 m.
17. *Triloculina marioni* Schlumberger. External view, A-15.00 m.
18. *Coscinospira acicularis* (Batsch). External view, C-15.00 m.
19. *Coscinospira acicularis* (Batsch). External view, C-25.00 m.
20. *Coscinospira hemprichii* Ehrenberg. External view, A-5.00 m.
21. *Coscinospira hemprichii* Ehrenberg. External view, young individual, A-15.00 m.
22. *Coscinospira hemprichii* Ehrenberg. External view, young individual, A-20.00 m.
23. *Coscinospira hemprichii* Ehrenberg. External view, A-35.00 m.
24. *Coscinospira hemprichii* Ehrenberg. External view, young individual, A-40.00 m.
25. *Coscinospira hemprichii* Ehrenberg. External view, B-10.00 m.

PLATE - IX

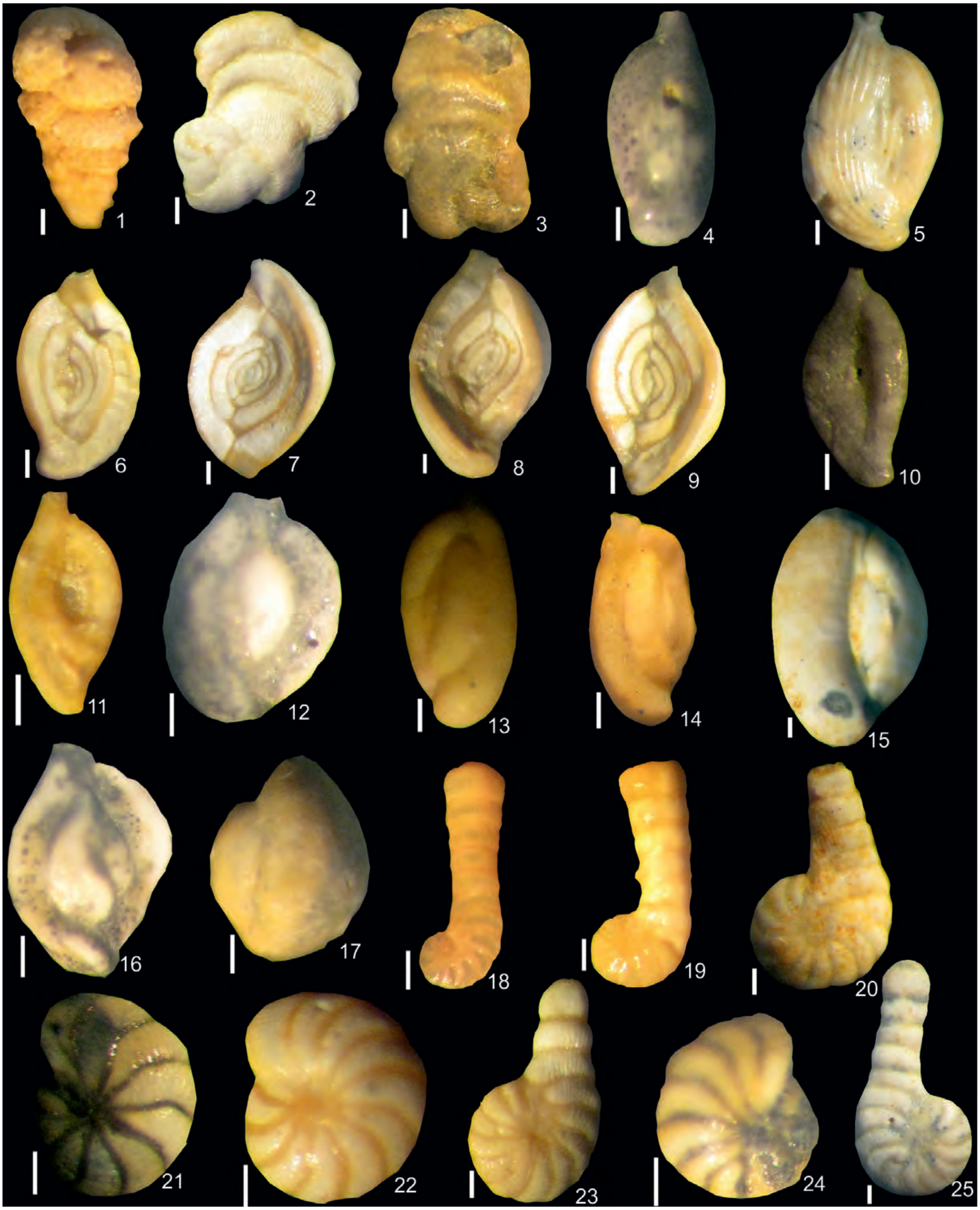

PLATE - X

Ilıca Bay, Çeşme, İzmir.

1. *Coscinospira hemprichii* Ehrenberg. External view, young individual, B-90.00 m.
2. *Coscinospira hemprichii* Ehrenberg. External view, C-25.00 m.
3. *Coscinospira hemprichii* Ehrenberg. External view, C-35.00 m.
4. *Coscinospira hemprichii* Ehrenberg. External view, young individual, C-70.00 m.
5. *Coscinospira hemprichii* Ehrenberg. External view, C-70.00 m.
6. *Coscinospira hemprichii* Ehrenberg. External view, young individual, C-80.00 m.
7. *Peneroplis pertusus* (Forskal). External view, A-5.00 m.
8. *Peneroplis pertusus* (Forskal). External view, A-10.00 m.
9. *Peneroplis pertusus* (Forskal). External view, abnormally developed individual, A-15.00 m.
10. *Peneroplis pertusus* (Forskal). External view, A-30.00 m.
11. *Peneroplis pertusus* (Forskal). External view, abnormally developed individual, A-35.00 m.
12. *Peneroplis pertusus* (Forskal). External view, A-40.00 m.
13. *Peneroplis pertusus* (Forskal). External view, A-40.00 m.
14. *Peneroplis pertusus* (Forskal). External view, B-10.00 m.
15. *Peneroplis pertusus (Forskal).* External view, C-5.00 m.
16. *Peneroplis pertusus* (Forskal). External view, C-5.00 m.
17. *Peneroplis pertusus* (Forskal). External view, abnormally developed individual, C-10.00 m.
18. *Peneroplis pertusus* (Forskal). External view, C-10.00 m.
19. *Peneroplis pertusus* (Forskal). External view, C-20.00 m.
20. *Peneroplis pertusus* (Forskal). External view, C-20.00 m.
21. *Peneroplis pertusus* (Forskal). External view, C-20.00 m.
22. *Peneroplis pertusus* (Forskal). External view, abnormally developed individual, C-20.00 m.
23. *Peneroplis pertusus* (Forskal). External view, C-25.00 m.
24. *Peneroplis pertusus* (Forskal). External view, C-30.00 m.
25. *Peneroplis pertusus* (Forskal). External view, C-30.00 m.

PLATE - X

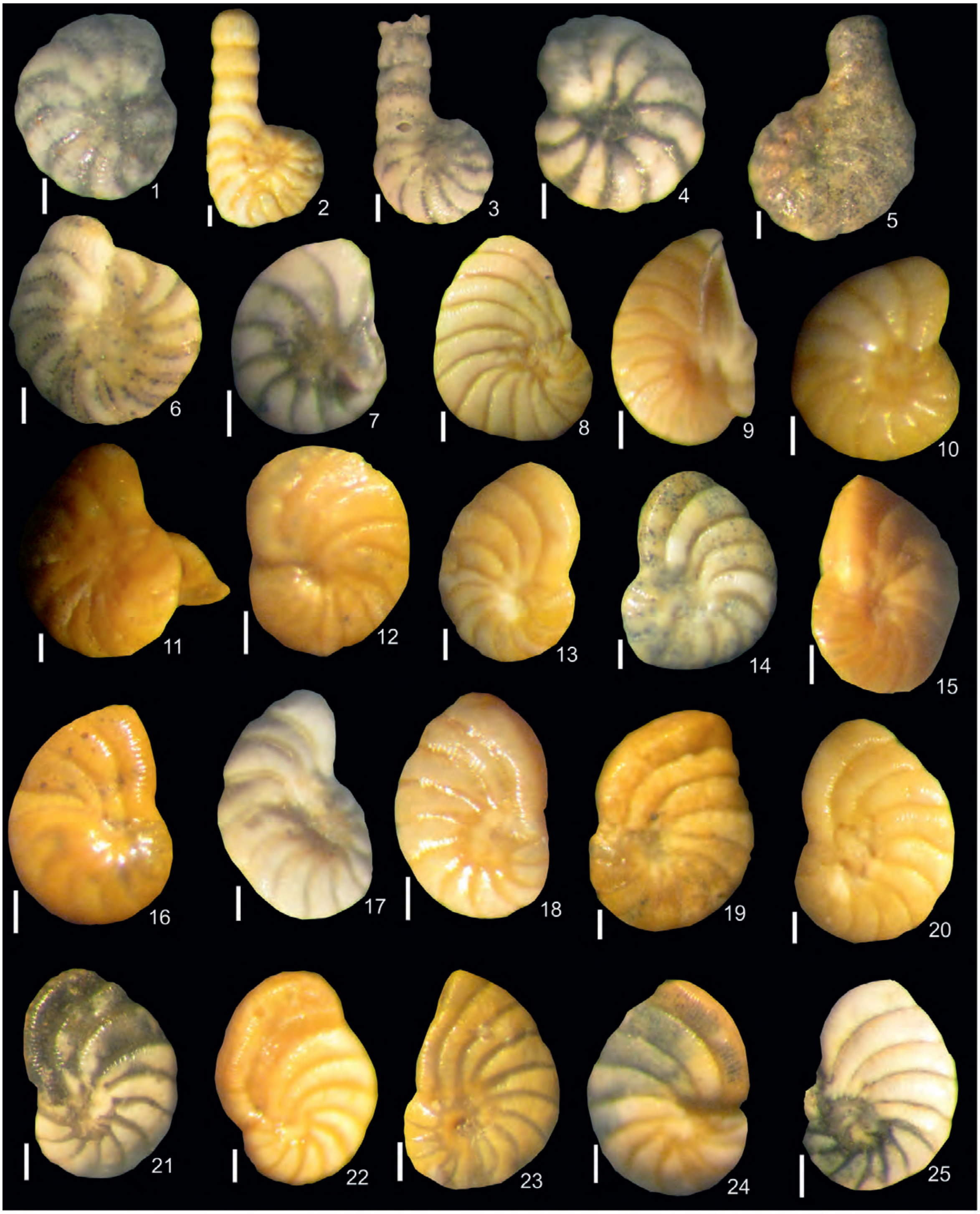

PLATE - XI

Ilıca Bay, Çeşme, İzmir.

1. *Peneroplis pertusus* (Forskal). External view, A-20.00 m.
2 *Peneroplis pertusus* (Forskal). External view, C-70.00 m.
3. *Peneroplis planatus* (Fichtel ve Moll). External view, A-5.00 m.
4. *Peneroplis planatus* (Fichtel ve Moll). External view, A-5.00 m.
5. *Peneroplis planatus* (Fichtel ve Moll). External view, A-5.00 m.
6. *Peneroplis planatus* (Fichtel ve Moll). External view, A-25.00 m.
7. *Peneroplis planatus* (Fichtel ve Moll). External view, A-35.00 m.
8. *Peneroplis planatus* (Fichtel ve Moll). External view, A-35.00 m.
9. *Peneroplis planatus* (Fichtel ve Moll). External view, A-40.00 m.
10. *Peneroplis planatus* (Fichtel ve Moll). External view, B-30.00 m.
11. *Peneroplis planatus* (Fichtel ve Moll). External view, B-50.00 m.
12. *Peneroplis planatus* (Fichtel ve Moll). External view, B-50.00 m.
13. *Peneroplis planatus* (Fichtel ve Moll). External view, C-80.00 m.
14. *Peneroplis planatus* (Fichtel ve Moll). External view, C-5.00 m.
15. *Peneroplis planatus* (Fichtel ve Moll). External view, C-10.00 m.
16. *Peneroplis planatus* (Fichtel ve Moll). External view, C-15.00 m.
17. *Peneroplis planatus* (Fichtel ve Moll). External view, C-30.00 m.
18. *Peneroplis planatus* (Fichtel ve Moll). External view, C-30.00 m.
19. *Peneroplis planatus* (Fichtel ve Moll). External view, C-35.00 m.
20. *Peneroplis planatus* (Fichtel ve Moll). External view, C-80.00 m.
21. *Peneroplis planatus* (Fichtel ve Moll). External view, C-80.00 m.
22. *Peneroplis planatus* (Fichtel ve Moll). External view, C-90.00 m.
23. *Ammonia compacta* Hofker. External view, spiral side, B-90.00 m.
24. *Ammonia compacta* Hofker. External view, umbilical side, A-35.00 m.
25. *Ammonia parkinsoniana* (d'Orbigny). External view, umbilical side, C-20.00 m.

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PLATE - XI

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