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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*).

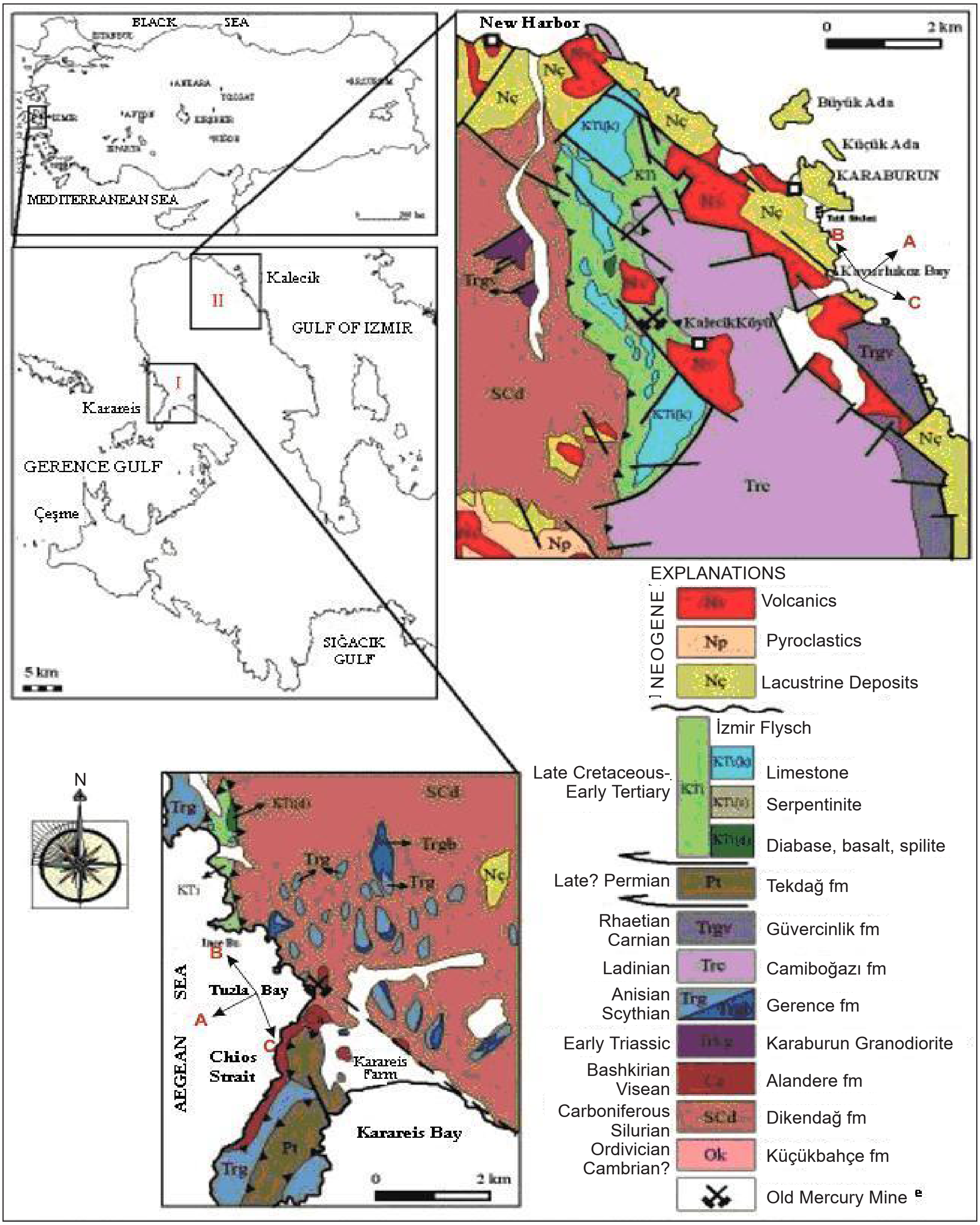

Figure 1- Geological map of Kalecik and Karareis Mercury Deposits and vicinity (taken as simplified from Çakmakoğlu and Bilgin, 2006).

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

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	

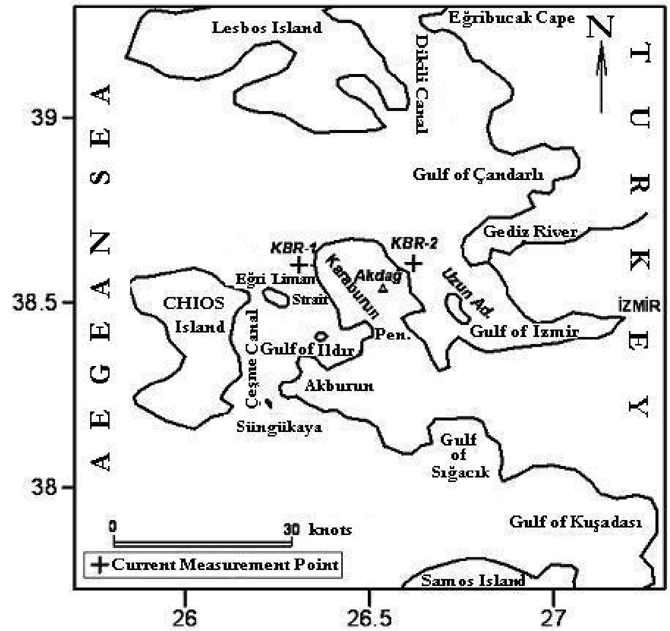

Figure 2- Location of the stations where the current measurement was made.

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).

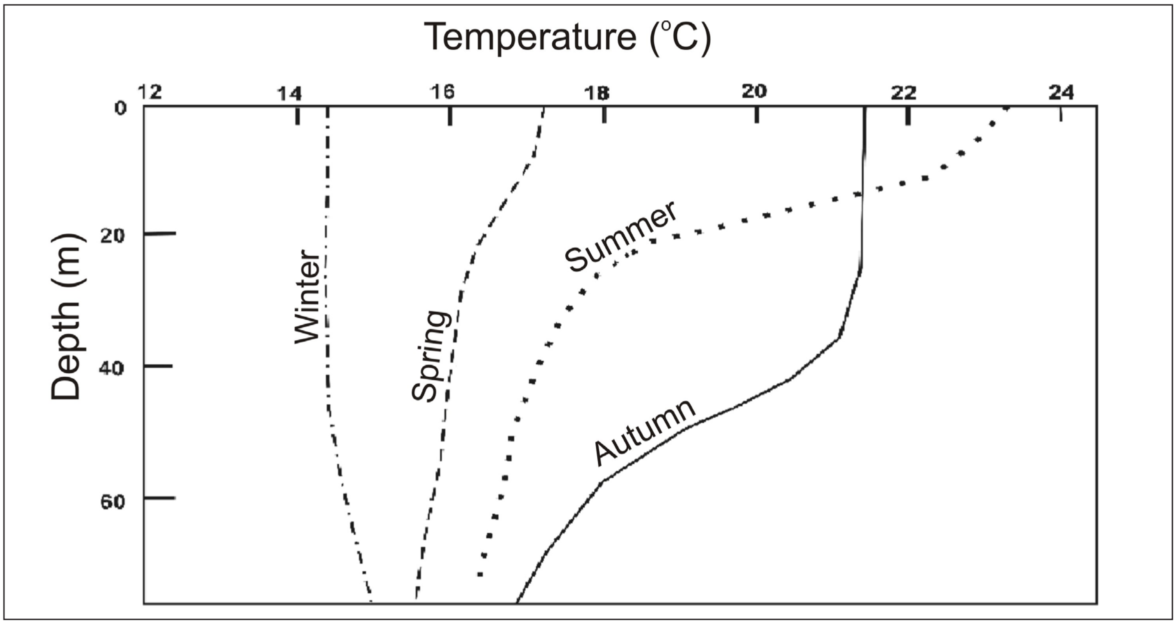

Figure 4- Seasonal averages of seawater temperature with depth in Karaburun Peninsula.

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).

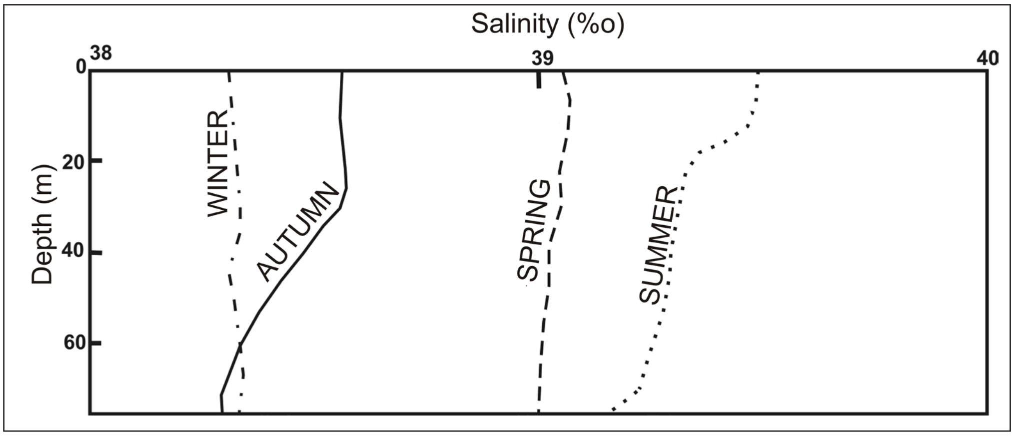

Figure 5- Seasonal averages of seawater salinity with depth in Karaburun Peninsula.

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).

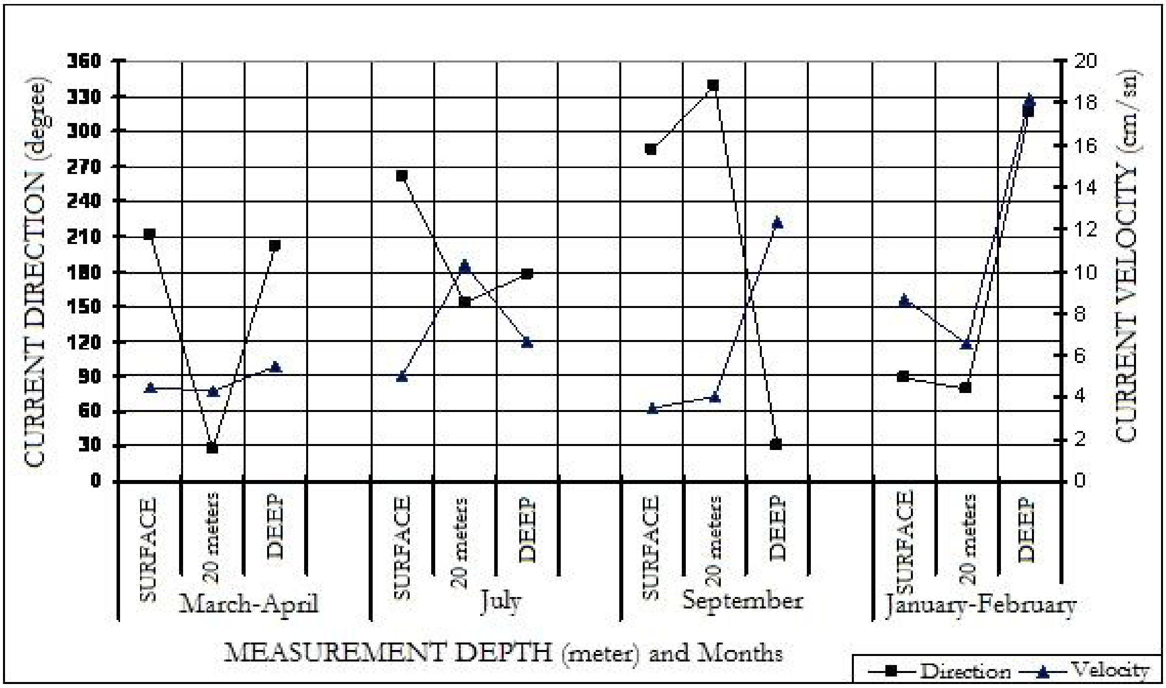

Figure 6- Seasonal current velocities and directions in Çeşme Canal, KBR-1 station.

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

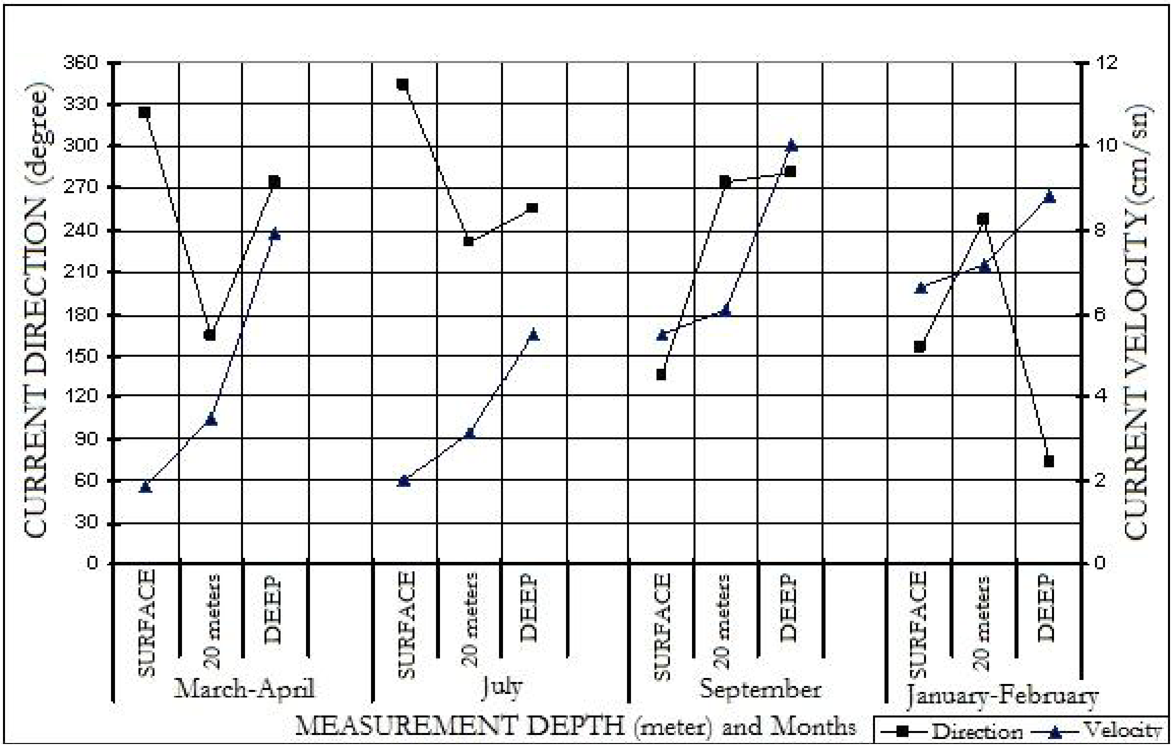

Figure 7- Seasonal current velocities and directions for numbered KBR-2 station in the northwest of Gulf of Izmir.

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°), B (125°) and C (290°), and 45 further samples were taken from SE of the Karaburun urban area in the northeast (Karaburun-II) in the directions of A (80°), B (10°) and C (160°) 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°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, *Xestoloberis 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														

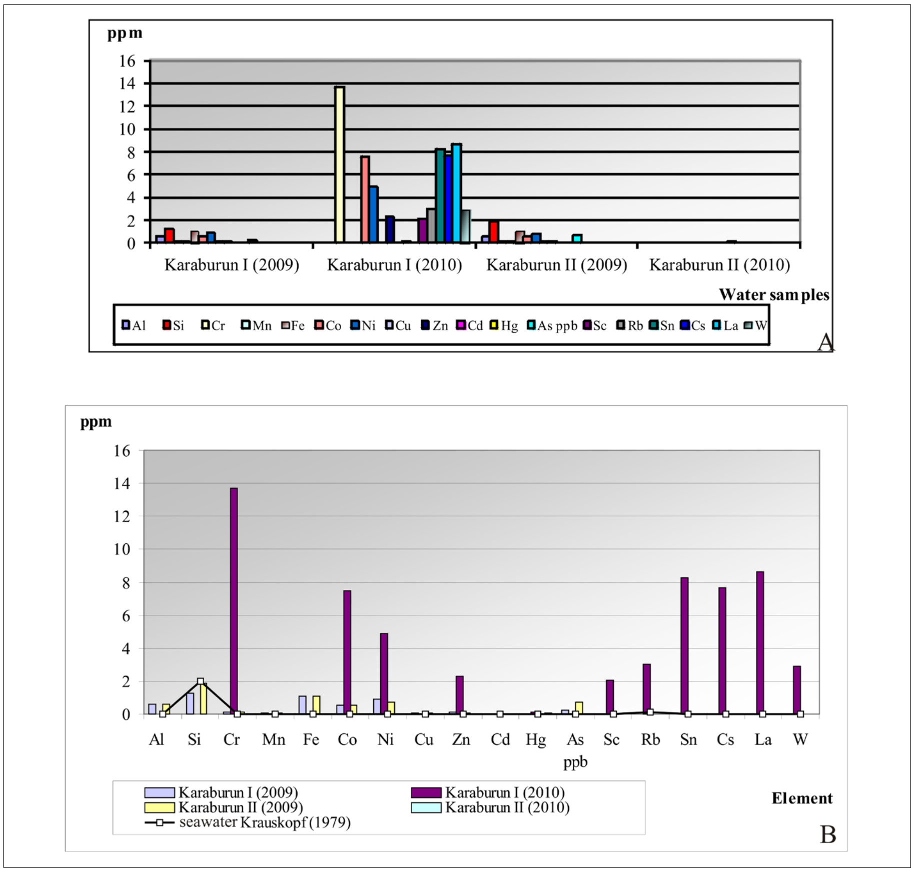

Figure 8- a.Heavy metal and trace element distribution for the water samples of Karaburun I and II.
b. Heavy metal and trace element distribution for the water samples of Karaburun I and II together with Krauskopf's (1979) distribution of sea water reference values.

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).

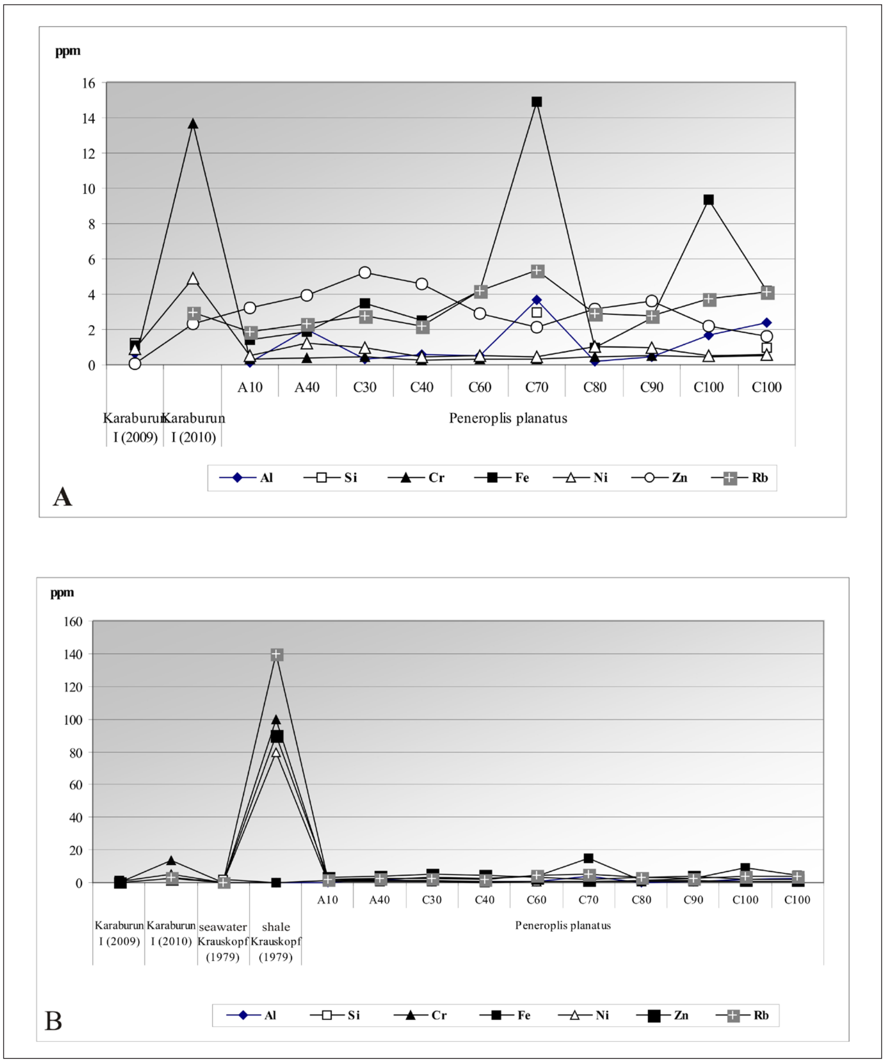

Figure 9- a. Heavy metal and trace element distribution of Karaburun I water sample and of colored Peneroplis planatus shells in some samples of Karaburun I.
b. The comparison of heavy metal and trace element distribution of Karaburun I water sample and of colored Peneroplis planatus shells in some samples 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.

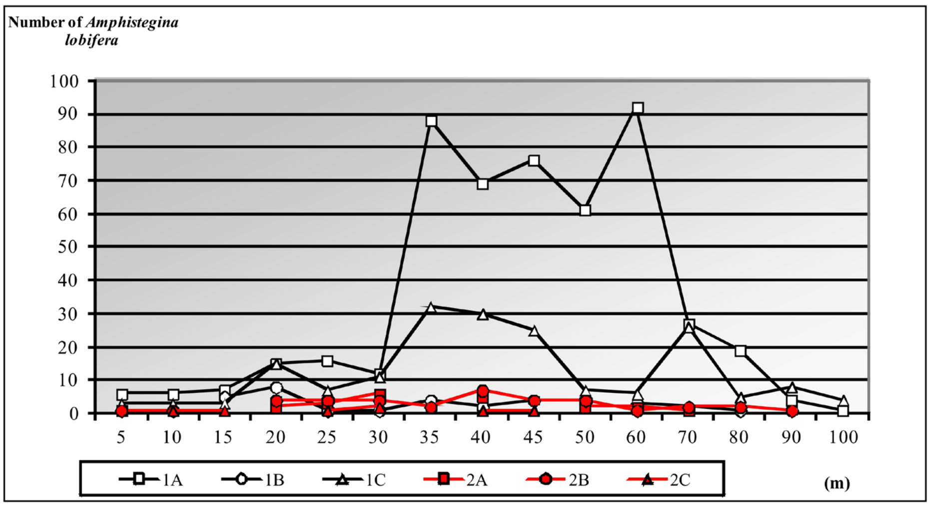

Figure 10- The distribution of *Amphistegina lobifera* Larsen populations in A, B and C lines of Karaburun I and II.

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

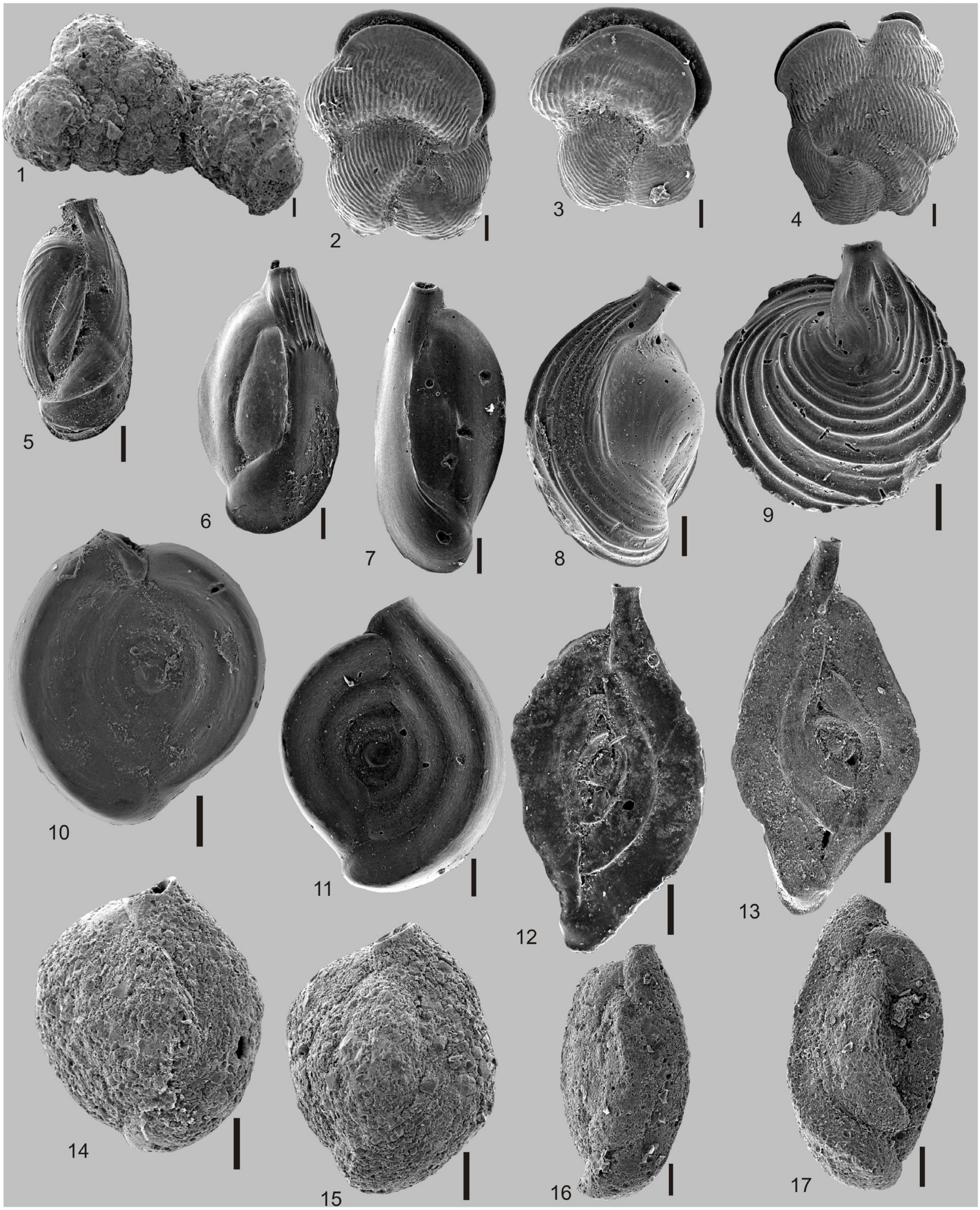

PLATE - II

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.

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PLATE - II

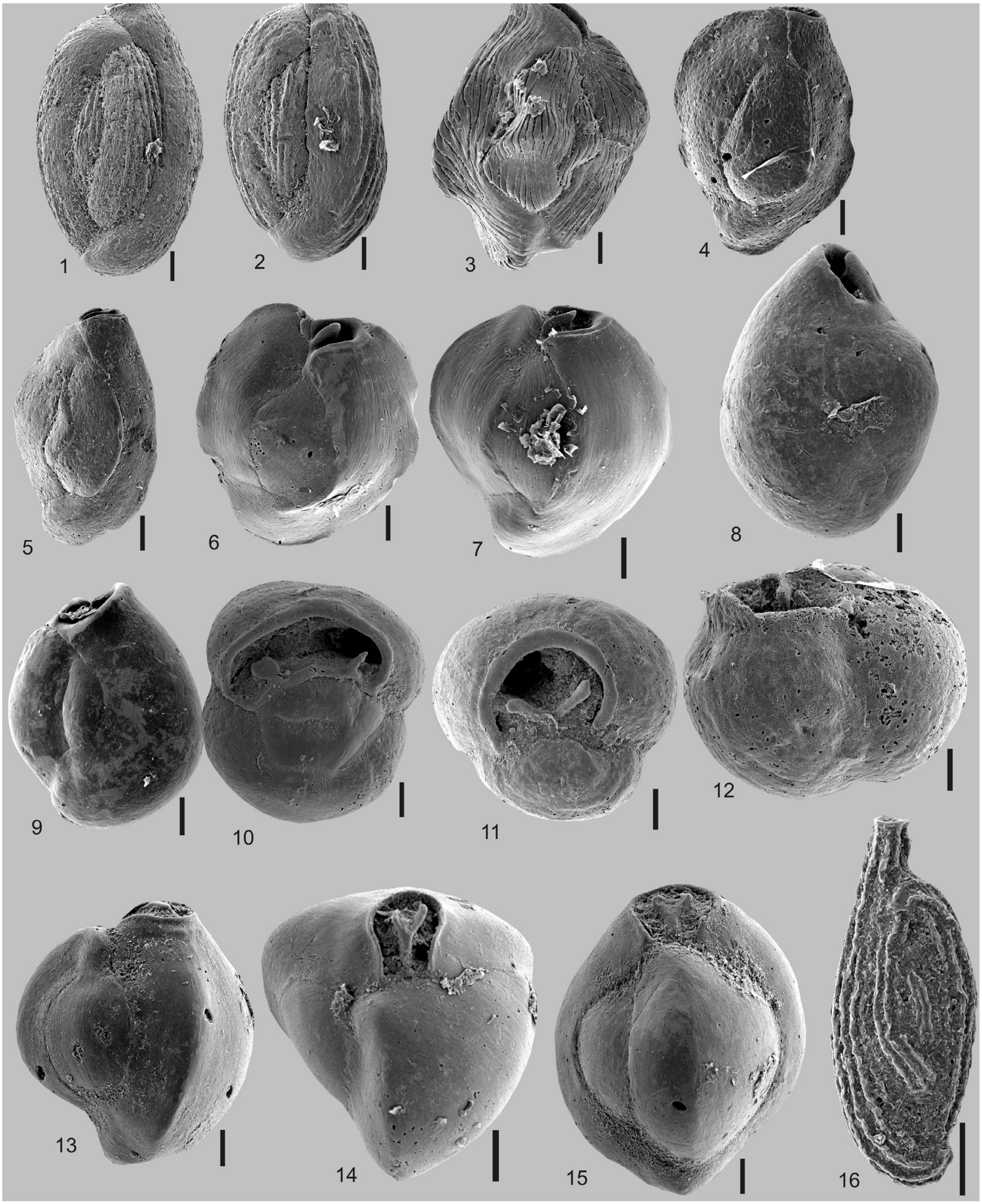

PLATE - III

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

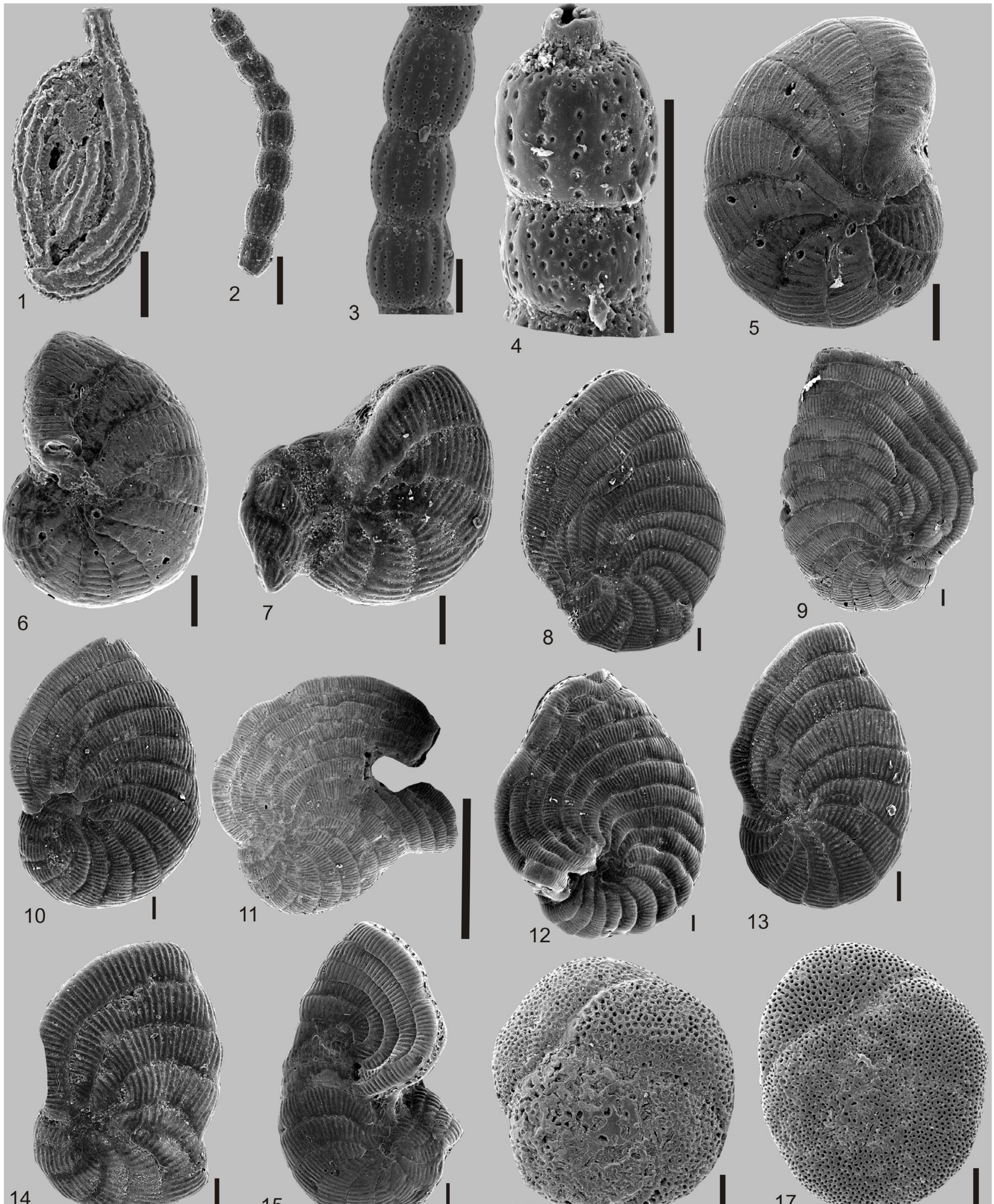

PLATE - IV

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

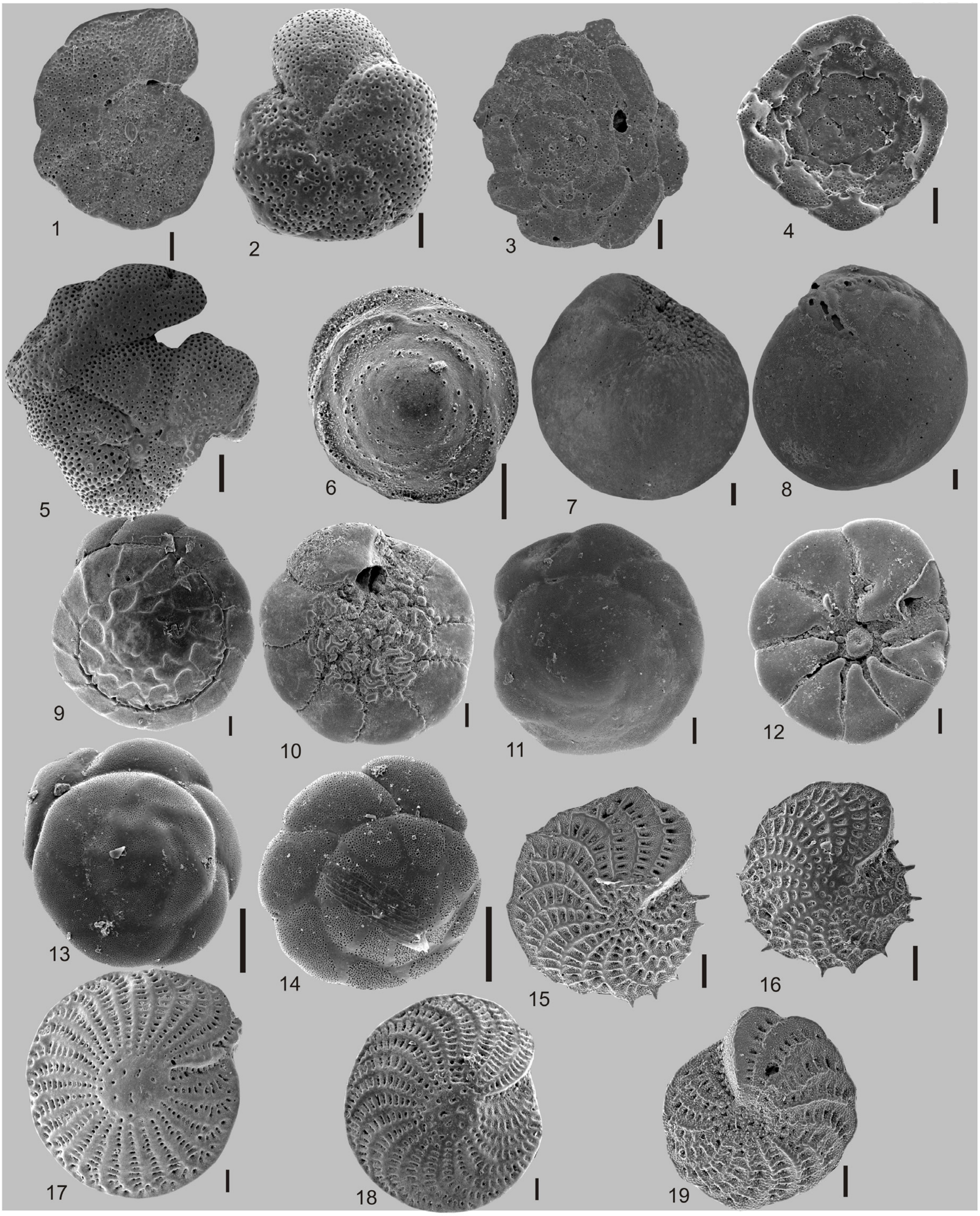

PLATE - V

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

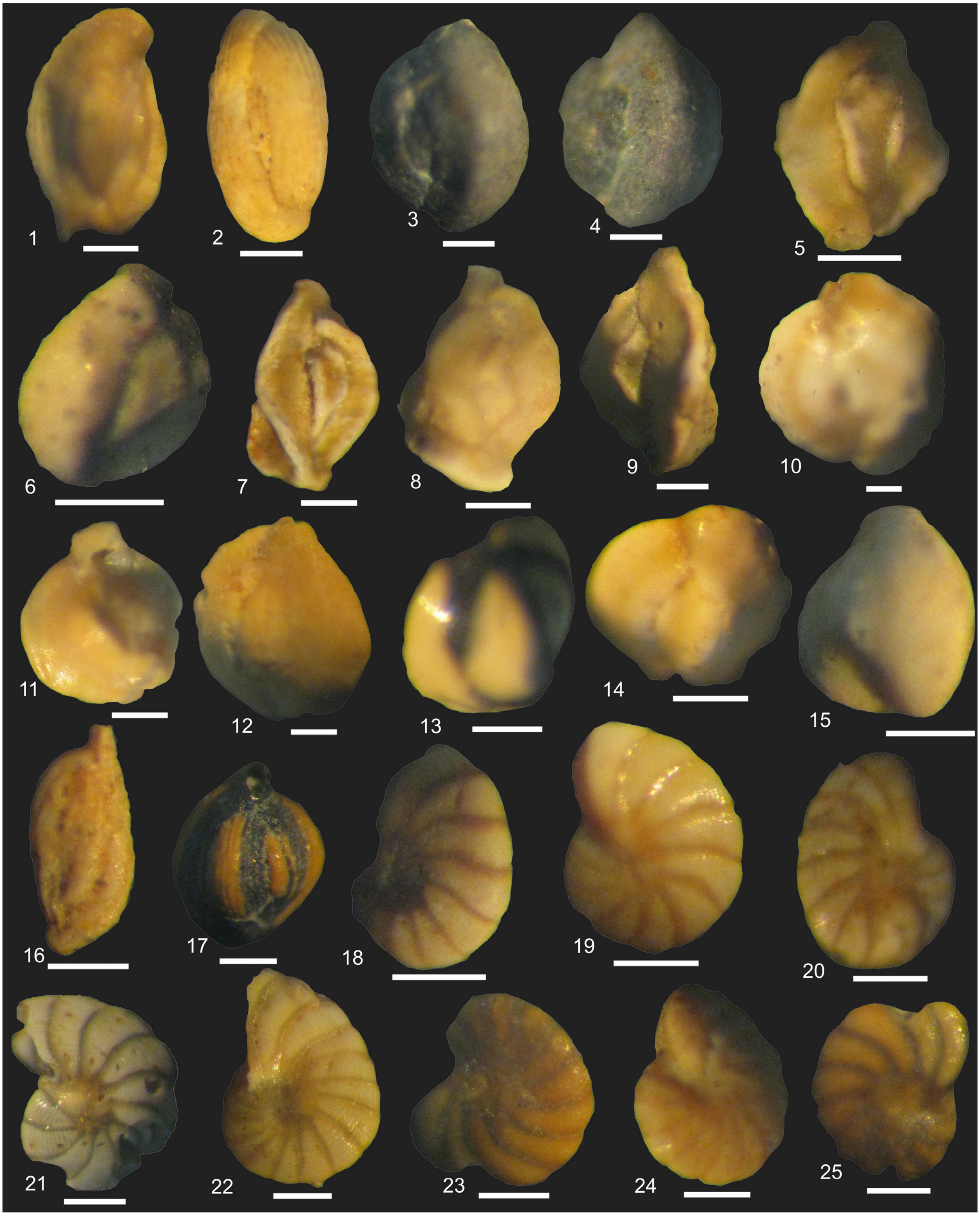

PLATE - VI

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

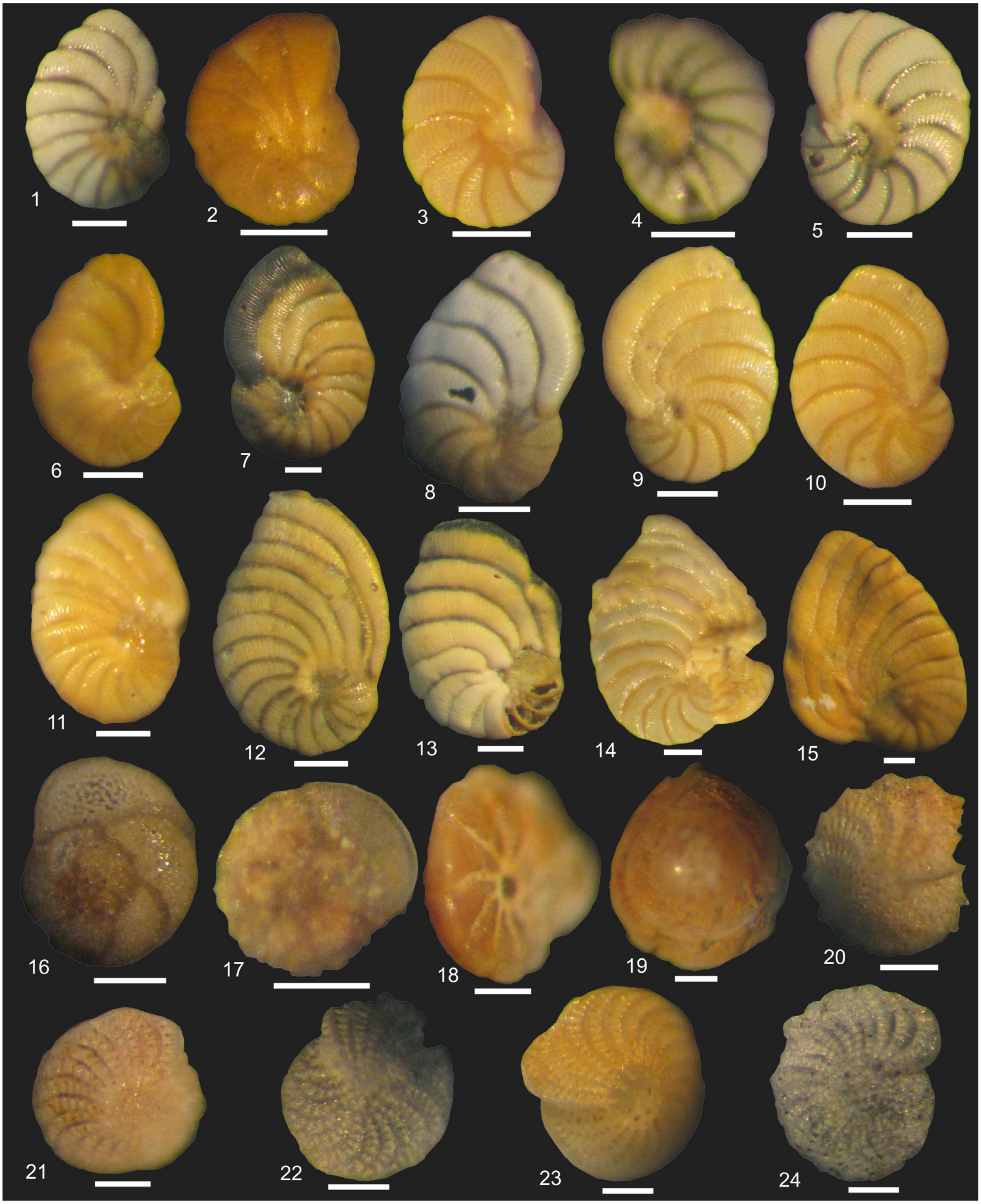

PLATE - VII

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.

Engin MERİÇ, Niyazi AVŞAR, Atike NAZİK, Baki YOKEŞ, Özcan DORA,
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Halim TAŞKIN, Asiye BAŞSARI, Cüneyt BİRCAN and Aysun KAYGUN

PLATE - VII