BIVALVIA FAUNA OF ANTALYA MIOCENE BASIN

Yeşim İSLAMOĞLU* and Güler TANER*

ABSTRACT.- In this study, coverage of Bivalvia fauna and its systematic specialties in Antalya Miocene basin have been explained. In the basin, 30 species of Bivalvia class obtained from Oymapınar limestone, Altınkaya formation and Aksu formation have been determined. As well as systematically classification of species, stratigraphic levels and paleogeographic distributions of them have been put forward too. According to this, species of *Glossus (Cytherocardia)* cf. *deshayesi perlongata* (Kutassy 1928) and *Pelecyora (Cordiopsis) polytropa nysti* (d'Orbigny 1852) are peculiar to Middle Miocene and species of *Cardiocardita* cf. *monilifera* (Dujardin 1837) is peculiar to Lower Miocene. In the study area, as well as species, characteristic for Tethys such as species such as *Chlamys (Aequipecten) scabrella bollenensis* (Mayer 1876), *Pecten fuchsi* Fontannes 1878, species such as *Crassostrea gryphoides* (Schlotheim 1813), *Loripes (Loripes) dujardini* (Deshayes 1850), *Carditamera (Lazariella)* (Sacco 1899), *Megaxinus bellardianus* (Mayer 1864), *Acanthocardia (Acanthocardia) turonica* (Mayer 1861), *Sanguinolaria (Soletellina) labordei* (Basterot 1825) and *Pitar (Pitar) rudis* (Poli 1795) widespreading both into Tethys and into marine stages of Central Paratethys have been found. It is striking to be met by chance firstly in the study area with species such as *Glossus (Cytherocardia)* cf. *deshayesi perlongata* (Kutassy 1928), *Pelecyora (Cordiopsis) polytropa nysti* (d'Orbigny 1852 and *Irus (Paphirus) gregarius gregarius* Partsch, 1823 known beforehand to be only Central Paratethys. In the study area whereas determined species belonging to Lower and Middle Miocene are able to be correlated with Tethys on the other hand Central Paratethys fauna belonging to Upper Miocene are only able to correlated with Tethys fauna.

GASTROPODA FAUNA OF ANTALYA MIOCENE BASIN

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ABSTRACT.- With this study, totally 51 gastropod species taken from Oymapınar limestone, Altınkaya formation and Aksu formation, into the Antalya Miocene basin, have been determined. After the description, in addition to the species have been classificated as systematically, their stratigraphic levels have been revealed. In the examin ed fauna, besides the species peculiar to Tethys such as *(Cingula (Peringiella) ventricosella* (Cerulli- Irelli, 1914), *Terebralia subcorrugata* d'Orbigny 1852, *Cerithium (Thericium) vulgatum miocenicum* Vignal, 1910, *Cerithium (Tiaracerithium) pseudotiarella* d'Orbigny 1852, *Triphora adversa miocenica* Cossmann ve Peyrot 1924), some species peculiar to only Central Paratethys such as *(Hydrobia) frauenfeldi frauenfeldi* (Hoernes 1856), *Pirenella gamlitzensis gamlitzensis* (Hilber, 1879) have been found. The investigated species, during Lower - Middle Miocene, are able to correlated both Tethys and Central Paratethys, while during Upper Miocene these species are only able to corraleted Tethys.

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A NOTE ON THREE ABNORMAL SAMPLES OF BENTHIC FORAMINIFERS FROM THE DİKİLİ BAY (TURKEY) IN THE NORTHEASTERN AEGEAN SEA: ***Peneroplis planatus*** (Fichtel and Moll), ***Rosalina*** sp., and ***Elphidium crispum*** (Linne)

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ABSTRACT.- Three of nine foraminifer samples collected from the Dikili Bay in the northwestern Aegean Sea yielded three species demonstrating aberrance in development: *Peneroplis planatus* (Fichtel and Moll), *Rosalina* sp. and *Elphidium crispum* (Linne). We suggest that the cause for such abnormalities may well be thermal springs, which are known to exist in the regions of the Dikili Bay and the Island of Lesbos to the west, and correspondingly high proportion of certain elements in the waters.

INTRODUCTION

The area of the NE Aegean from which the samples are collected is shown in figure 1. Dikili Bay is situated on the western coast of Anatolia between the Gulf of Edremit (to the N) and the Gulf of Çandarlı (to the S), just opposite the Greek Island of Lesbos.

Along the western coast of Turkey, the temperature of the Aegean has been recorded as varying from 9 to 26 °C, with an oxygen content ranging from 4 to10 ml/l (Artüz 1970, Benli and Küçüksezgin 1988, Ergin et al., 1993a). It is thus a relatively warm and well-aerated environment.

In the Middle Miocene, posterior to the collision of the Arabian and Anatolian plates the region began to expand (Şengör and Yılmaz, 1981), shifted westward between two faults: the Northern and Western Anatolian faults. Consequently, an E-W graben system developed (Arpat and Şaroğlu, 1975; McKenzie, 1977; Turgut, 1987; Mascle and Martin, 1990; Yılmaz, 1990) with thermal springs-judging from the existence of those known-likely to appear along the fault lines (Şaroğlu et al., 1992).

The purpose of this paper is to suggest that the quality and quantity of the chemical trace elements supplied by the thermal springs are related to the fault activity in the area that cause aberrant formations in the species of various benthic foraminifer in the Dikili Bay.

FACILITIES AND METHOD OF RESEARCH

In 1996, the research vessel Sismik-1 of the MTA equipped with a Van Veen Grab scoop was able to sample various areas of the seabed in the bay (Fig. 1). Although the coordinates and depth were specified, we had no record of the submarine environment (i.e., temperature, salt content, pH and oxygen content). The depth of the seabed from which the nine samples were recovered ranges from 16 to 49 m.

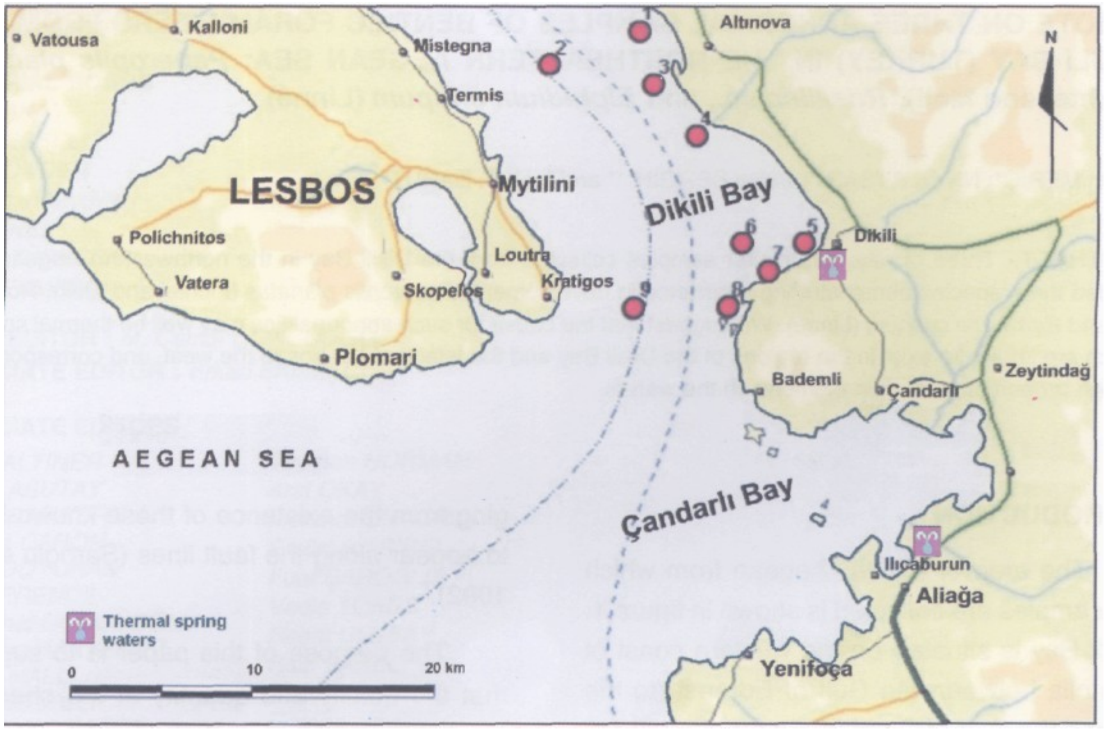

Fig. 1- Location map of the Dikili Bay (Northeastern Aegean Sea) and sampled localities.

THE EVIDENCE

The nine samples inspected for present-day foraminifers in the Dikili Bay (Samples 1-9, Fig.1) proved both plentiful and informative. From depths of 16 to 49 m, we were able to identify 86 benthic foraminifers of at least 50 separate species (Table 1). The literature most helpful in identifying the species includes Cimerman and Langer, 1991; Hatta and Ujiie, 1992; Sgarella and Moncharmont-Zei, 1993; Hottinger et al., 1993; Loeblich and Tappan, 1994; Meriç et al., 1995; Hayward et al., 1999; Meriç and Avşar, 2000 and 2001; Avşar and Meriç 2001 *a-b,* Meriç et al., 2002a, 2003 and 2004; we have attempted to include the most recent sources.

Of note among this benthic life in general are the verification of the foraminifer species *Peneroplis pertusus* (Forskal) at sites 3 and 5, and the presence of progeny of *Cibicidella variabilis* (d'Orbigny) with their unusual shell formations at sites 1, 5, 7 and 8.

Specific to the subject under discussion are single examples of *Peneroplis plantus* (Fichtel and Moll), *Rosalina* sp., and *Elphidium crispum* (Linne) that demonstrate aberrant morphology. The *Peneroplis planatus* (Fichtel and Moll) individual from site 2 displays two abnormal cylindrical protuberances toward the tip (one to the left and one to the right on the second and third units and from the end), both of which most obviously incorporate a mouth. A break at the very tip suggests that there may have been a third protuberance as well (Fig. 2a). While other individuals of *Peneroplis planatus* (Fichtel and Moll) and *P.pertu-*

sus (Forskal) from the neighbouring waters displayed no such abnormalities, aberration was also encountered in the shell formation of sample No. 3 (*Rosalina* sp.), which demonstrates four protuberances-two very prominent-at the sides/along the lateral walls (Fig. 2b). Because of this irregularity in shape, we remain hesitant to assign this individual to any particular species. Sample number 2, an individual of *Elphidium crispum* (Linne), also represents pronouncedly aberrant development as abnormal swellings apparent on the contour (Fig. 2c).

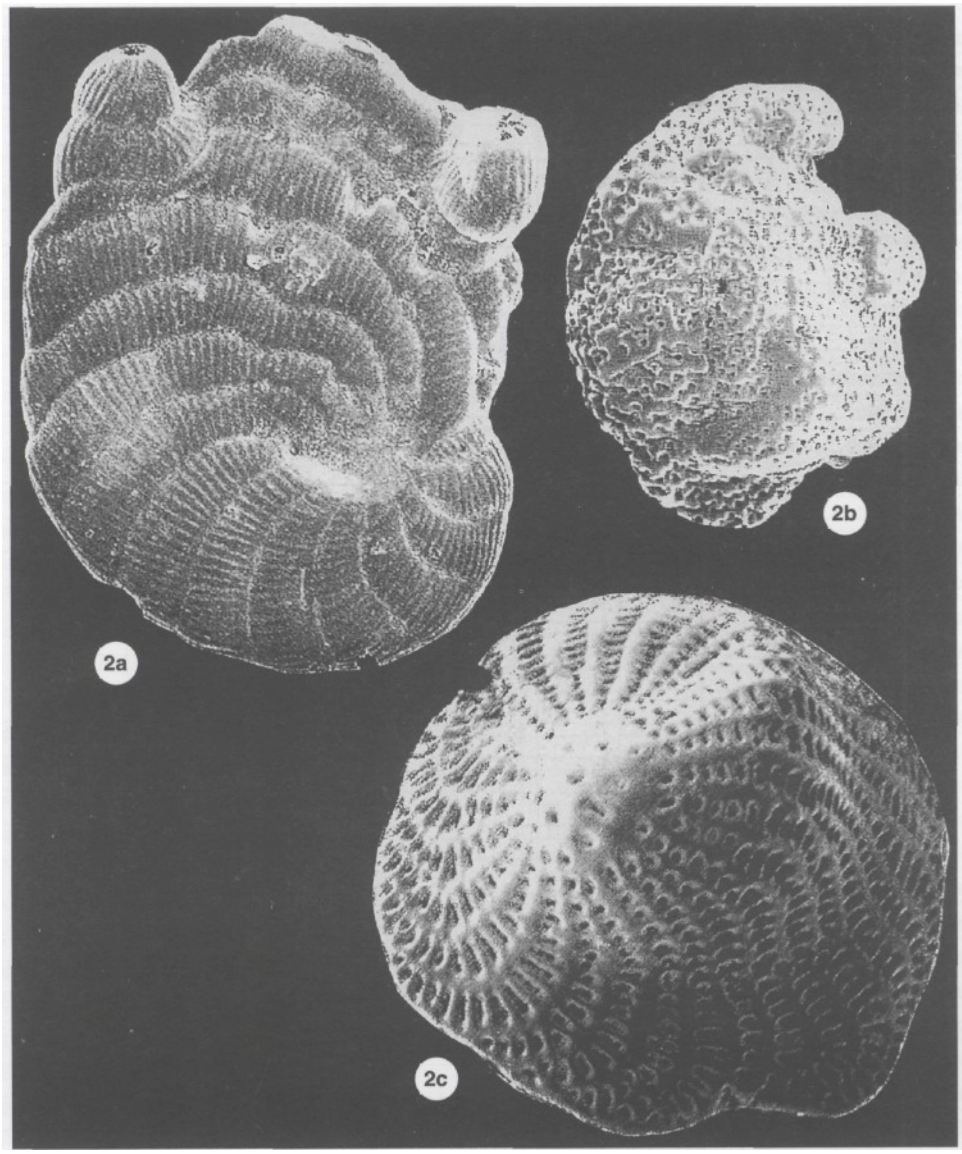

Fig. 2- External views of tests, displaying abnormal morphologies;
2a: *Peneroplis planatus* (Fichtel and Moll), x100;
2b: *Rosalina* sp., x100 ve
2c: *Elphidium crispum* (Linne) x100

Table. 1- Distributions of benthic foraminiferal genera and species from recent samples at the Dikili Bay.

FORAMINIFERA	STATIONS								
	DC1	DC2	DC3	DC4	DC5	DC6	DC7	DC8	DC9
Depths (meter)	**16.00**	**39.50**	**18.50**	**18.50**	**18.00**	**34.00**	**35.00**	**35.80**	**49.00**
Lagenammina fusiformis		★	★					★	
Labrospira subglobosa	★								
Discammina compressa			★					★	
Spiroplectinella sagittula		★						★	★
Ammoglobigerina globigeriniformis								★	
Eggerelloides scabrus	★		★	★	★			★	
Textularia bocki	★	★	★		★	★	★	★	★
Textularia truncata		★						★	
Connemarella rudis									★
Vertebralina striata	★		★		★			★	
Nubecularia lucifuga	★				★			★	
Cornuspira foliacea								★	
Adelosina cliarensis	★	★	★		★	★	★	★	★
Adelosina duthiersi		★	★			★	★	★	
Adelosina mediterranensis	★	★	★		★	★	★	★	★
Adelosina partschi		★	★			★	★	★	★
Adelosina pulchella		★	★		★		★	★	★
Spiroloculina angulosa		★							
Spiroloculina dilatata		★	★		★				
Spiroloculina excavata	★	★	★		★	★	★	★	
Spiroloculina ornata	★	★	★		★	★	★	★	★
Siphonaperta aspera	★	★	★		★	★	★	★	★
Cycloforina contorta	★	★	★		★		★	★	★
Cycloforina rotunda						★			
Cycloforina villafranca		★	★		★	★	★	★	★
Lachlanella bicornis	★		★		★		★	★	★
Lachlanella undulata	★	★						★	
Lachlanella variolata					★			★	
Massilina gualtierina	★		★		★				
Quinqueloculina berthelotiana	★	★	★		★	★		★	
Quinqueloculina bidentata	★	★			★	★	★	★	★
Quinqueloculina disparilis			★		★				
Quinqueloculina jugosa		★			★	★	★		★
Quinqueloculina lamarckiana	★	★	★		★			★	★
Quinqueloculina limbata		★	★						
Quinqueloculina seminula	★	★	★	★				★	★
Miliolinella elongata								★	
Miliolinella semicostata		★			★			★	
Miliolinella subrotunda	★	★	★		★	★	★	★	★
Miliolinella webbiana	★	★	★		★			★	
Pseudotriloculina laevigata	★	★	★		★		★	★	★
Pseudotriloculina oblonga	★	★	★		★		★	★	★
Pseudotriloculina rotunda	★	★	★		★		★	★	★

Continue to Table 1.

FORAMINIFERA	STATIONS								
	DC1	DC2	DC3	DC4	DC5	DC6	DC7	DC8	DC9
Depths (meter)	16.00	39.50	18.50	18.50	18.00	34.00	35.00	35.80	49.00
Pseudotriloculina sidebottomi	★								
Pyrgo inornata		★							
Triloculina marioni	★	★	★	★	★		★	★	★
Triloculina plicata		★			★			★	
Triloculina schreiberiana		★		★	★			★	
Triloculina tricarinata	★				★			★	★
Sigmoilinita costata	★	★	★		★	★	★	★	★
Sigmoilinita edwardsi					★		★		
Articulina carinata								★	
Parrina bradyi		★			★			★	
Peneroplis pertusus			★		★				
Peneroplis planatus			★		★				
Lenticulina cultrata								★	
Valvulineria bradyana								★	
Polymorphina sp 1		★	★					★	
Reussella spinulosa								★	
Eponides concameratus		★						★	★
Neoeponides bradyi		★	★		★	★	★	★	★
Neoconorbina terquemi					★				
Rosalina bradyi	★	★		★	★	★	★	★	★
Rosalina floridensis								★	
Rosalina globularis		★							
Pararosalina dimorphiformis					★		★	★	
Planoglabratella opercularis		★						★	★
Discorbinella bertheloti		★					★		
Lobatula lobatula	★	★	★		★	★	★	★	★
Planorbulina mediterranensis	★	★	★		★			★	
Cibicidella variabilis	★				★		★	★	
Acervulina inhaerens					★			★	
Sphaerogypsina globula									★
Asterigerinata mamilla		★	★		★	★		★	★
Astrononion stelligerum	★	★	★		★	★	★	★	★
Melonis pompilioides								★	
Ammonia compacta	★	★	★	★	★	★	★	★	★
Ammonia parkinsoniana	★	★	★	★	★	★	★	★	★
Ammonia tepida	★	★	★	★	★		★	★	
Chalangerella bradyi		★	★				★		★
Cribroelphidium poeyanum					★		★	★	
Porosonion subgranosum		★	★	★	★	★	★	★	
Elphidium aculeatum	★	★	★		★			★	
Elphidium advenum	★	★	★	★	★		★	★	★
Elphidium complanatum	★		★		★			★	

EVALUATION

Both Associate Professor Gültekin Tarcan (Dokuz Eylül Univercity) and Dr. Levent Çetiner (of the MTA Aegean Directorate) agree that the abnormalities in the specimens presented here (personal communications, June 2002) might well be the result of thermal springs activated by the faults in the region (Fig. 1). Particularly of note here are the hot springs on the mainland and the seabed at Bademli (along the coastal road between Dikili and Çandarlı) and on the promontory of Ilıcaburun (Türkiye Madensuları 3: Ege Bölgesi, 1974; Türkiye Mineralli Su Kaynakları 1: Ege-Bolgesi, 1999). Analyses from these sources are shown in table 2.

Furthermore, along the east coast of Island of Lesbos facing the Gulf to the west we have scattered series of thermal springs introducing water of various temperatures into the environment, most of these reflecting the chemical contents of the seawater. (Meriç et al., 2002b). Considering the existence of such sources on or near the mainland, we would suggest that there might well be hot marine springs affecting the environment in which samples 3 and 5 have been recovered. Such marine sources, with either over- or under-balance of N, I, Va, Li, Fe, Nb, Rb, Zn, Co, P, Mo, Cd or Hg might have easily affected the shell development of these two benthic organisms (Ivanoff, 1972; Tait, 1981; Meriç et al., 2002c). Likewise, the appearance of distinctly

Table 2- Chemical composition of the thermal mineral waters of southern part of Dikili Bay and vicinity of Çandarlı Bay (Türkiye Maden suları (3), Ege Bölgesi, 1974; Türkiye Mineralli Su Kaynaklan (1), Ege Bölgesi, 1999).

Physical and chemical compositions		DİKİLİ-BADEMLİ(1974)	DİKİLİ-BADEMLİ(1995)	ALİAĞA - ILICABURUN(1995)
Temperature (°C)		42	59	51,4
PH		6,24	6,61	6,72
EC (μs/cm)		10500	25000	48400
Rn^{222} (Bekerel)		767,75		
NH_4^+	(mg/l)		6,250	4,34
Na^+	(mg/l)	2634,1	2630,1	6322,25
K^+	(mg/l)	246,5	187,68	262,75
Ca^{2+}	(mg/l)	251,29	128	701,6
Mg^{2+}	(mg/l)	82,76	72,9	643,95
Fe^{2+}	(mg/l)	0,65	2,16	0,79
Al^{3+}	(mg/l)	0,39	0,24	0,1
Cl^-	(mg/l)	4433,2	4115,75	11436,91
I^-	(mg/l)	0,15	0,15	0,8
Br^-	(mg/l)		0,012	14,5
Fl^-	(mg/l)	2,16	2,15	2,45
SO_4^{2-}	(mg/l)	200	262,5	1625
NO_3^-	(mg/l)	0,27	0,33	4,2
CO_3^-	(mg/l)	-	0	0
HCO_3^-	(mg/l)	683,2	694,36	798
$HAsO_4^{2-}$	(mg/l)	0,12	0,11	0,012
H_2SiO_3	(mg/l)	150,8	122,38	1,1
HBO_2	(mg/l)	95,07	93,14	4,8

coloured Peneroplis shells found S and SE of Bozcaada and off the E coast of Lesbos, as well as the remarkably large proportions of the shells of the same species recovered from a depth of 2.5 m in the warm environment (59 °C) of the Ilıca Bay near Çeşme, have been accredited to recent-and perhaps still productive-thermal springs in the seabed (Meriç 1986; Meriç and Avşar 2000; Avşar and Meriç 2001b; Meriç et al., 2002a and b; Yalçın et al., 2003).

Evidence of shell deformation in 30% of the benthic foraminifer (217 species) is noted from the Bay of Haifa in Israel (Yanko et al., 1998). These anomalies have been linked to the presence of heavy metals in the water (see Yanko et al., 1999 for further speculation). The presence of heavy metals has also been suggested as a possible cause of anomalies in the shell structure of foraminifera in the area of the French Isle of You. (Debenay etal., 2001).

The geological characteristics of the region discussed above reflect the gradual movement of the western Anatolian plate, characterized first by the N-S compression of paleotectonic evolution, but later (during neotectontic development) by N-S expansion. The primary faults and graben system in western Anatolia developed during this latter period. Most of the thermal springs appear along these faults and grabens. The marble and limestone schist in the metamorphic rocks of the Menderes massif (marble, quartzite, and limestone schist, and as well as other schist and gneiss) provided convenient passage for the major thermal aquifer, thus providing input for the underground reservoirs in the Bayındır region of Izmir (Barut et al., 2003). Recent hydro-geological research and studies carried out by various scholars suggest that the Kozak region northeast of Dikili is the source of much of the water collected in the Bayındır reservoirs. This model postulates a route transporting surface water deep underground, where it is heated in the graben and other tectonic zones (facilitating its movement through the bedrock) and eventually forms a geothermal reservoir (Barut et al., 2003).

Studies have shown that the source of all thermal springs is surface water that has penetrated the ground and been heated by geothermal/tectonic phenomena, eventually returning to the earth's surface through faults and cracks (Erişen et al., 1996).

Figure 3 tabulates the chemical composition of the mineral waters of the region evaluated on the basis of a Piper diagram (Piper, 1953). In this figure, it is seen that water rich in Mg with a generally very high proportion of Na and K, as well as of carbonates and sulfates; the carbonate component, registers particularly high. Elements characteristic of alkali soils (Ca + Mg) register comparatively low. The best-represented cations are Na, C and K; the best-represented anions Cl, HCO_3, and SO_4. These represent values appropriate for water that has penetrated limestone.

Another factor significant to the region is the many thermal springs scattered throughout the SE peninsula of Lesbos (east of the Bay of Kalloni and just across the channel from Dikili). The salty thermal springs of the small spa are also located on the island of Lesbos at Thermi (46.9 °C), slightly northward along the east coast, and at Polychnitos (39.7 °C) 45.80 km westward from the administrative center Mytilene, as well as the salt waters of the nearby Lisvario spa (41.50 km from Mytilene), one of the warmest thermal springs in Europe with a temperature of 69 °C. The salty hot springs of Methymna (43.5-46.5 °C) lie at the north of the island and the spa of Therma is noted for its mixture of fresh and salt waters (39.7 °C) only eight kilometers from Mytilene. Considering the above, it would be reasonable to postulate the further existence of thermal sources off the east coast of the Island of Lesbos (Meriç et al., 2002b).

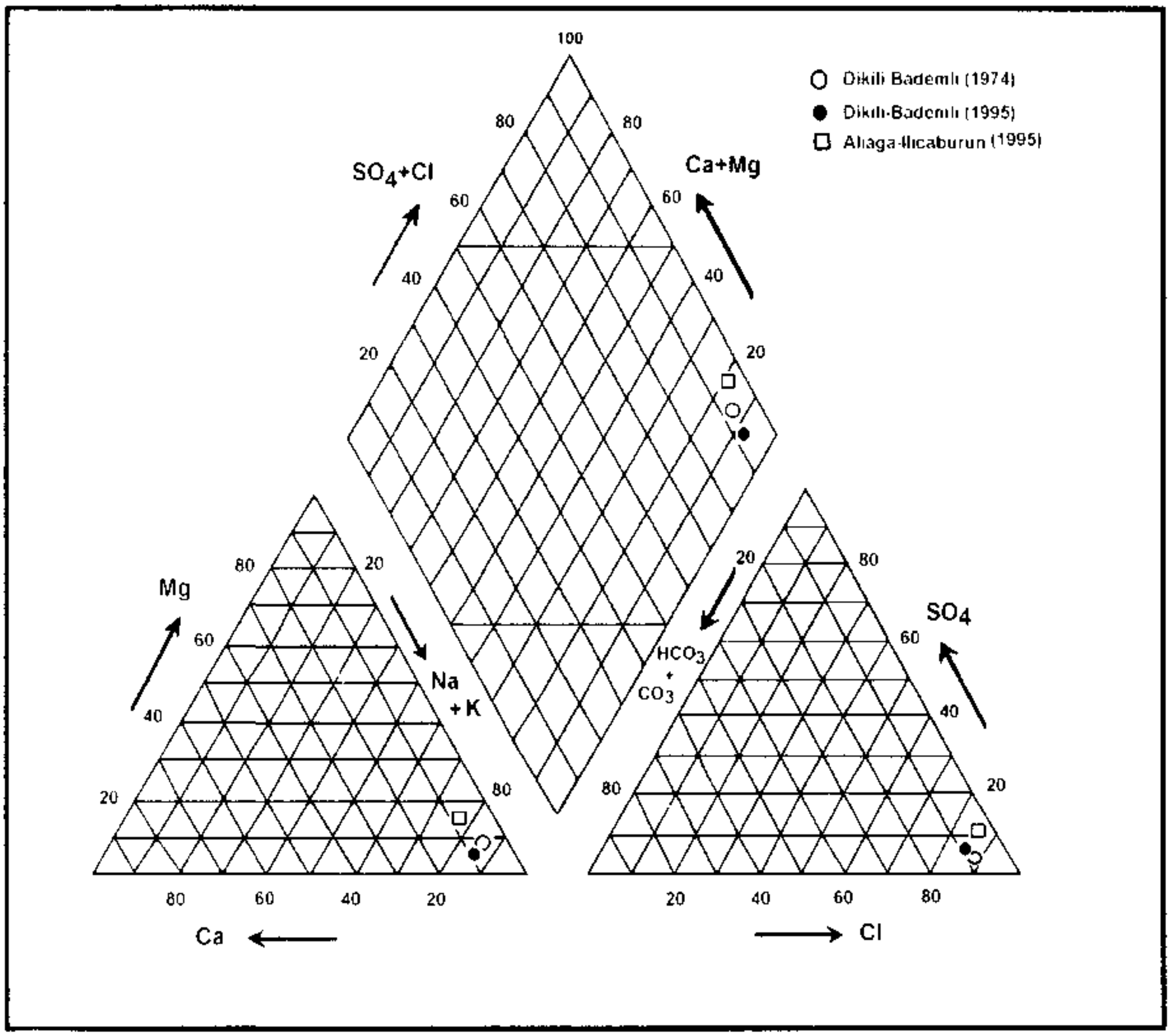

Fig. 3- Geochemical classification, Piper diagram, of the thermal mineralwaters at southern part of Dikili Bay and vicinity of Çandarlı Bay.

Returning to the various samples collected in the Dikili Bay, we should note that five of these contain traces of heavy metals: Pb, Cr, Ni, Cu, Co, Mn and Fe (Table 3). In Samples 3 and 5, although no Fe is reported, Pb is present, and the amounts of Cr, Ni, Cu, Co and Mn recorded-if below the threshold limits (Krauschopf, 1985)-are worthy of note. Samples 2, 4 and 8 contain a notabl proportion of Mn, Cr and Cu, and Sample 5 reveals the highest proportions of Mn, Cr, Cu and Ni. Comparing the values at the stations sites 3 and 5 shown in figure 4a, the values of Mn, Cu and Cr are relatively higher at site 3. The value of Mn is seen to increase at the two sites shown in figure 4b. Although all values aside from that of Co remain under the threshold limit at site 5, the presence of these metals should still be considered significant. A comparison among the values in the Dikili Bay and those from the Çandarlı Bay to the south show us that Co, Cu, and Cr rise above the threshold values in the northern waters, whereas Fe, Mn, and Ni in the southern waters.

Table. 3- Heavy metal concentrations in bottom 5 sediment samples from the Dikili Bay.

Stations	Pb µg/L	Cr µg/L	Ni µg/L	Cu µg/L	Co µg/L	Mn µg/L	Fe µg/L
2	---	6.657	0.060	1.053	0.582	59.003	1401.143
3	0.734	8.992	3.700	5.286	1.797	73.652	---
4	---	6.392	4.750	6.662	7.982	23.748	2971.835
5	0.473	17.641	5.711	29.569	1.776	87.248	---
8	0.030	9.810	2.546	4.284	1.495	56.577	2686.906

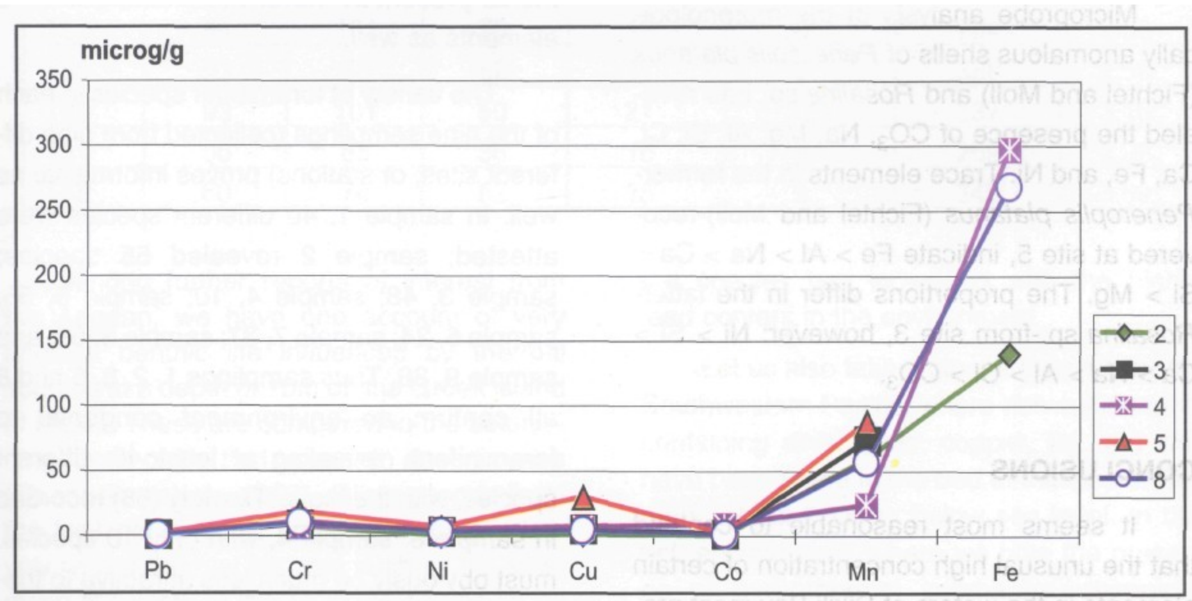

Fig. 4a- Comparison of the heavy metal concentrations with number of stations 2, 3, 4 and 8

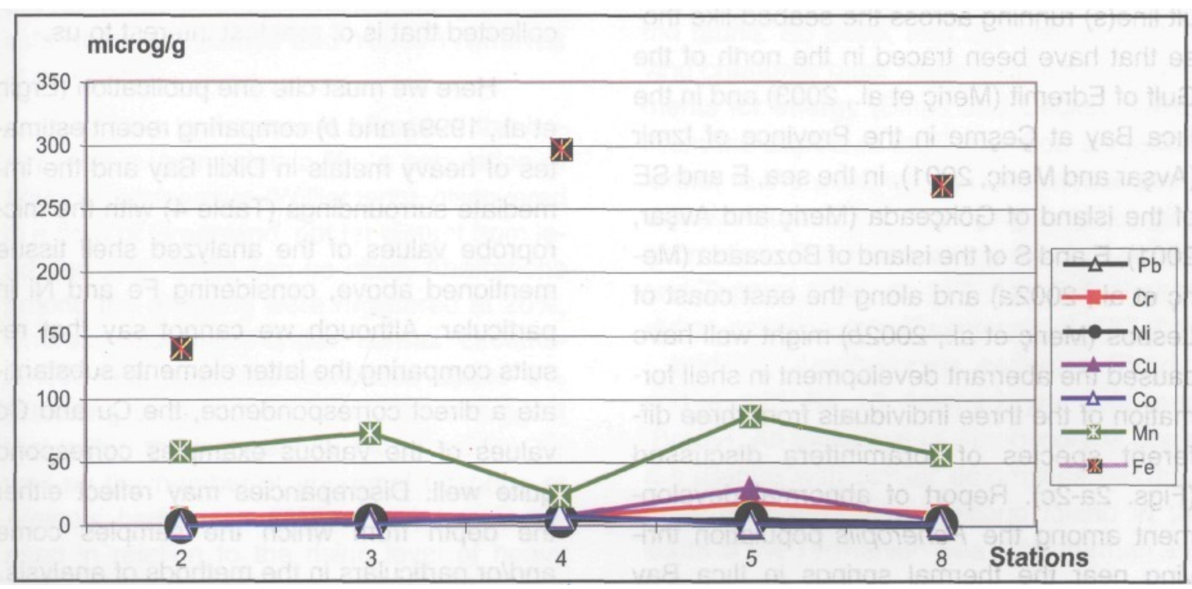

Fig. 4b- Distributions of the abundance of the heavy metal concentrations at the of stations 2, 3, 4 and 8

Aside from the stream known as the Madra Çay (north of Dikili), there is no surface drainage capable of introducing any appreciable sediment into the bay. The relative abundance of heavy metals in the offshore waters would therefore postulate some aquifers opening directly into the seabed. Many hot springs in the north east of the island of Lesbos likewise support this premise.

Microprobe analysis of the morphologically anomalous shells of *Peneroplis platanus* (Fichtel and Moll) and *Rosalina* sp. has revealed the presence of CO_3, Na, Mg, Al, Si, Cl, Ca, Fe, and Ni. Trace elements in the former-*Peneroplis platanus* (Fichtel and Moll)-recovered at site 5, indicate Fe > Al > Na > Ca > Si > Mg. The proportions differ in the latter-*Rosalina* sp.-from site 3, however: Ni > Si > Ca > Na > Al > Cl > CO_3.

CONCLUSIONS

It seems most reasonable to contend that the unusual high concentration of certain elements in the waters of Dikili Bay most probably a result of thermal springs along the fault line(s) running across the seabed-like those that have been traced in the north of the Gulf of Edremit (Meriç et al., 2003) and in the Ilıca Bay at Çeşme in the Province of Izmir (Avşar and Meriç, 2001), in the sea, E and SE of the island of Gökçeada (Meriç and Avşar, 2001), E and S of the island of Bozcaada (Meriç et al., 2002a) and along the east coast of Lesbos (Meriç et al., 2002b>)-might well have caused the aberrant development in shell formation of the three individuals from three different species of foraminifera discussed (Figs. 2a-2c). Report of abnormal development among the *Peneroplis* population thriving near the thermal springs in Ilıca Bay (Meriç, 1986; Avşar and Meriç, 200l) also supports our contention, as does the morphology of other aberrant instances of this species (Sözeri, 1966; de Civrieux, 1970). Indeed, the number of abnormal shell formations among *Peneroplis planatus* (Fichtel and Moll) from environs fed by thermal springs is quite striking. It seems essential that we consider not only the major and minor chemical elements present in the environment, but trace elements as well.

The variety of foraminifer species in each of the nine samplings (collected from nine different sites, or stations) proves informative as well. In sample 1, 40 different species were attested; sample 2 revealed 55 species; sample 3, 48; sample 4, 10; sample 5, 56; sample 6, 24; sample 7, 37; sample 8, 68; and sample 9, 36. Thus samplings 1, 2, 3, 5 and 8 all confirm an environment congenial to foraminifera, revealing at least 40 different species, with the highest variety (68) recorded in sample 8. sample 4, with only 10 species, must obviously be much less attractive to these benthic species. It is the ecology at the sites from which samplings 2, 3, 5 and 8 were collected that is of greatest interest to us.

Here we must cite one publication (Ergin et al., 1999a and *b)* comparing recent estimates of heavy metals in Dikili Bay and the immediate surroundings (Table 4) with the microprobe values of the analyzed shell tissue mentioned above, considering Fe and Ni in particular. Although we cannot say that results comparing the latter elements substantiate a direct correspondence, the Cu and Co values of the various examples correspond quite well. Discrepancies may reflect either the depth from which the samples come and/or particulars in the methods of analysis.

Table. 4- Heavy metal concentrations in surface sediments from the Dikili and Çandarlı bays (from Ergin et al., 1993)

Stations	Zn µg/L	Cr µg/L	Ni µg/L	Cu µg/L	Co µg/L	Mn µg/L	Fe %
T52	19	9	13	3	2	103	0.59
T53	27	32	30	6	7	172	1.18
T54	37	42	36	11	5	441	2.20
T55	81	73	43	34	9	352	3.07
T56	58	58	35	14	12	377	3.58
T57	98	103	118	27	19	716	4.23
T58	84	161	70	16	12	704	2.98
T59	53	68	62	11	9	388	2.58
T80	93	101	50	21	12	337	3.16
T81	56	65	36	16	9	269	2.99
T82	60	74	52	18	9	343	3.69

Among further reports of interest from the Aegean, we have one account of very unusual benthic life influenced by thermal sources at a depth of 10m off the Greek island of Melos. These are compared to the astonishing forms of life that appear in desert oases (Thiermann et al., 1997). Other reports from the Hellenic volcanic crescent include relatively recent thermal sources such as the spas along the inlets of the Methana peninsula on the west of the Greek Peloponnesus, as well the hot-water springs identified along the coasts of Melos, Samos and Yialos (Varnavas etal., 1999).

Relative to the recent affects of the heavy metals upon benthic life, a population of *Melonis barleeanus* (Williamson) discovered in a fiord of Greenland, not far distant from lead and zinc mines can be cited. Aberrations among the offspring were registered at 20%, whereas elsewhere-under normal circumstances-they have not numbered above 5% (Elberling et al., 2003). The authors suggest that within the last century the proportion-as well as the number-of abnormal offspring of *Melonis barleeanus* (Williamson) has increased in relation to the rising level of heavy metal pollution and shell deformation within the species has increased with the higher lead content in the environment.

Let us also take a glance deep under the Southwestern Pacific, where rich sulfide beds containing silver, gold, copper, tin, and zinc have been found in the bed of the Sea of Bismark, about 2000 m below sea level. In this rich environment, where we note the presence of hydrothermal submarine 'chimneys' emitting dark smoke, benthic life flourishes, with gastropods representing the majority of the fauna. So deep, and deprived of light, living creatures must depend on chemical elements for energy (Binns and Decker, 1998). From the depths of the Timor Sea somewhat further to the west, we can cite various populations of foraminifer displaying morphological anomalies. Examples are given in Loeblich and Tappan 1994, pl. 117, figs. 7-8: *Pyramidulina pauciloculata* (Cushman); pl. 127, figs. 5 and 10, *Amphycoryna separans* (Brady); and pl. 128, fig. 13 *Amphycoryna sublineata* (Brady). An individual of *Amphycoryna scalarus* (Batch) with similar deformities has also been recovered near Volcano Island in the south of the Tyrrhenian Sea (Cimmerman and Langer, 1991: pl. 54, fig. 6).

In conclusion, these three foraminifer samples representing morphological anomalies (Figs. 2a-2c) most probably owe their deformities to disproportional content of heavy metals in the sea and considered as no anthropogenic phenomenon, but introduced into the ecosystem by natural thermal springs in the seabed. The pollution traces at Çandarlı Bay due to the Aliağa Petroleum Raffinary is important at the north of the gulf (because of the current). Among the five samples collected at this region the morphological abnormalities of foraminifers aren't observed. (Meriç et al., 2004) The evidence in Dikili Bay does not constitute a high proportion of aberrance among the population as is seen in the Bay of Haifa (Yanko et al., 1998). In the explanation of the morphological abnormalities in this area offered in the reports (Yanko et al., 1998, Debenay et al., 2001), there is no mention of either marine thermal springs in the environs or heavy metals in the water. The different researchers talk about of possible cancerogenic affects from the heightened proportion of the gas Rn^{222} along fault lines (Choubey and Ramola, 1997; Shirav (Schwartz) and Vulkan, 1997). The value of Rn^{222} in the hot mineral springs in the environs of Dikili measures Rn^{222} = 8510- 76775 Bekerel (Türkiye Madensulan-3, Ege Bölgesi, 1974). It seems reasonable to assume that natural marine springs would reflect a similar worth; therefore, possible affects of the gas Rn^{222} on the life of one-celled benthic fauna should not be overlooked.

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TRACE FOSSILS IN THE WESTERN FAN OF THE CİNGÖZ FORMATION IN THE NORTHERN ADANA BASIN (Southern Turkey)

Huriye DEMİRCAN* and Vedia TOKER

ABSTRACT.- In this study, the trace fossils in the Lower-Middle Miocene turbiditic Cingöz formation cropping out around the Karaisalı - Catalan - Eğner regions have been examined for the first time. The trace fossils occur in a sequence, identified as submarine fan deposits. Based on their morphological characteristics, nineteen trace fossils have been identified; eleven of them are ichnospecies and eighteen ichnogenus.

INTRODUCTION

The investigated area is situated on the northern part of the Adana basin, which is bounded by the Ecemiş fault to the west, the Taurus orogenic belt in the north and Amanos Mountain in the east. The basement of the Adana basin is represented by Paleozoic and Mesozoic elastics, carbonates and tectonically transported ophiolitic rocks during and after the Maaestrichtian. Karsanti, Gildırli, Kaplankaya, Karaisalı, Cingöz, Güvenç, Kuzgun formations of Tertiary age rest unconformable on these Paleozoic and Mesozoic rocks. The Cingöz formation was examined by Schmidt (1961) for the first time. Gürbüz (1993) suggested the presence of two submarine fan systems in the west and in the east (Fig. 1). In the western fan, the inner fan sediments at the bottom are composed of large-scale, cross-bedded conglomerate, conglomeratic sandstone and amalgamated coarse sandstone. The middle fan deposits consist of less gravelly sandstone and sandstone-shale alternations. The uppermost of the unit is represented by outer fan sediments, which are composed of thin-bedded sandstone and shale alternations.

ICHNOTAXONOMY

The classification of trace fossils is based on morphological criteria interpreted by Hantzschel (1975), Ksiazkiewicz (1977), Seilacher (1977), Fillon and Pickerill (1990), Crimes and Crossley (1991) and Uchman (1995).

Simple structure

a) Planolites group

This group embraces relatively small, rarely branched, horizontal or oblique burrows.

Planolites beverleyensis Billings 1862

(Plate 1,fig. 1)

1862 *Planolites beverleyensis* (n.sp.)-Billings: p.97, text-fig.8b.

1977 *Sabularia ramosa* n.ichnosp.-Ksiazkiewicz: p.71, text-fig.8, 9a-d.

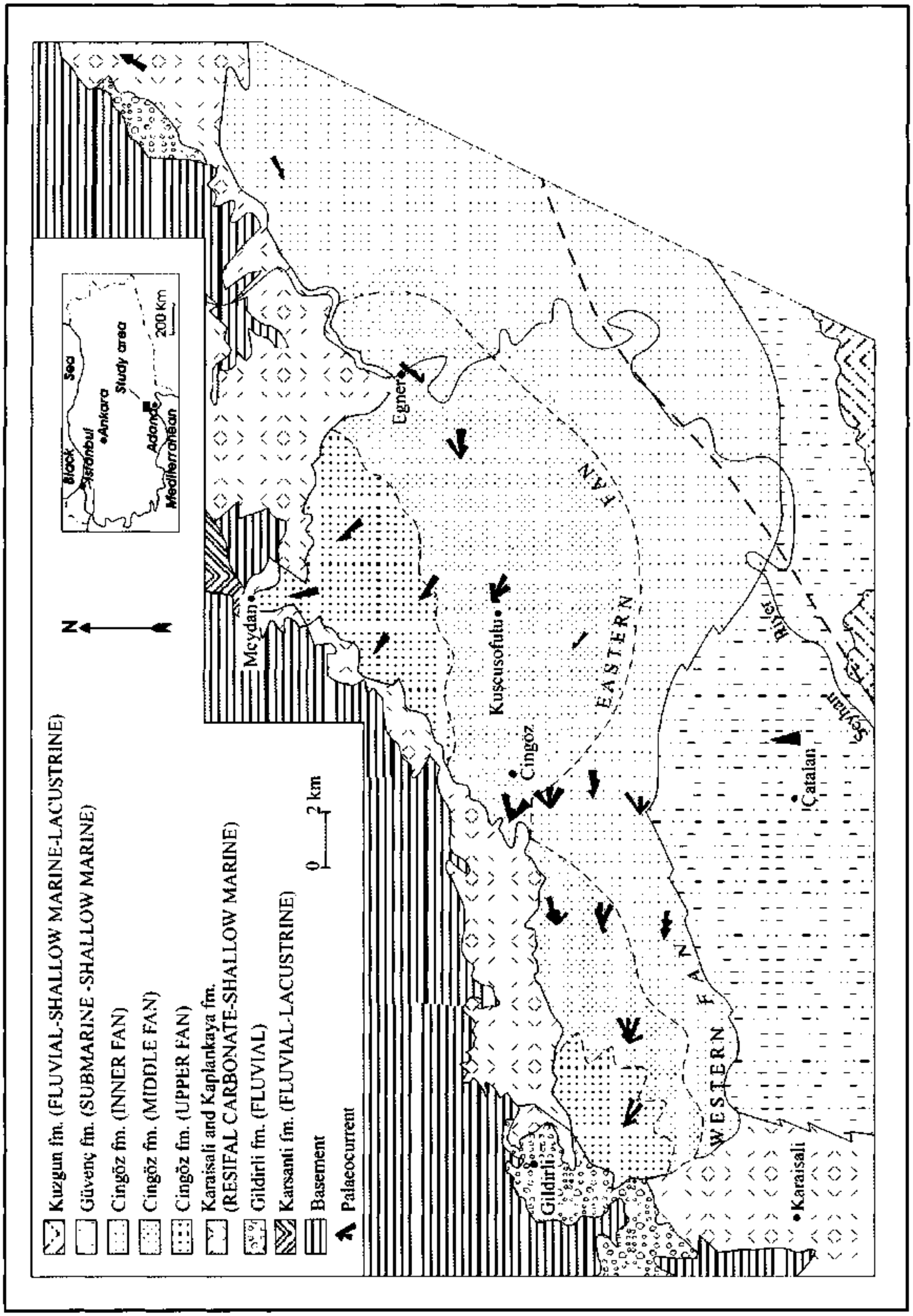

Fig. 1- Geological map showing distribution of Tertiary facies associations in the northern part of the Adana Basin (Gürbüz, 1993)

Description.- Hypichnial, short ridges in fine-grained turbiditic sandstone (Fig. 2a). The burrows are 2.5-4.4 mm in width.

Remarks.- *Planolites* extends from the Precambrian to the recent (Hantzschel, 1975).

Branched structures

a) Chondrites group

Chondrites isp.

(Plate 1, fig. 2b)

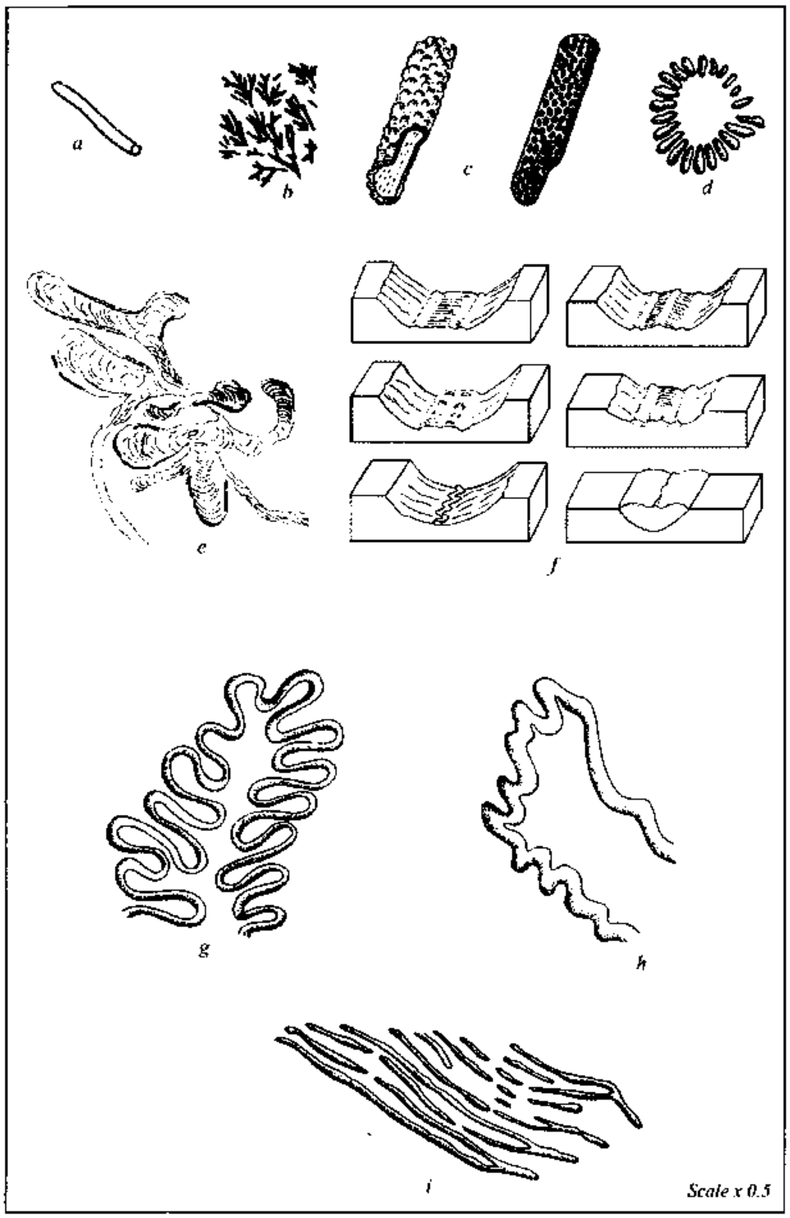

Fig. 2- Schematic view of the trace fossils in the study area
a. Planolites beverleyensis, b. Chondrites isp, c. *Ophiomorpha isp.,* d. *Capodistria vettersi, e. Zoophycos* isp., f. *Scolicia vertebralis, g. Cosmorhaphe sinuosa, h. Helminthopsis* isp. İ. *Urohelminthopsis* isp.

Description.- It appears in the form of small, circular, elliptical spots (Fig. 2b), 1 mm in diameter.

Remarks.- *Chondrites* is a feeding trace of unknown trace makers. According to Kotake (1991 *a, b),* this ichnotaxon is produced by surface ingestors, packing their faecal pellets inside burrows. According to Seilacher (1990), the trace-maker of *Chondrites* may be able to live under anaerobic conditions as a chemo symbiotic organism.

b) Ophiomorpha group

This group embraces large horizontal and vertical branching burrows. Mostly, they have been interpreted as crustacean burrows.

Ophiomorpha isp.

(Plate 1,fig. 3)

Description.- Hypichnial to endichnial, cylindrical trace fossil covered with sub circular knobs in fine-grained turbiditic sandstone (Fig. 2c). The trace fossils are about 10 mm in width and 49 mm in length. The knobs are 3-5 mm in width and 5-7 mm in length preserved in full relief.

Remarks.- When *Ophiomorpha* isp. is horizontal or vertical resembles *Thalassinoides* (e.g. Kern and Warme, 1974). *Sabularia rudis* (Ksiazkiewicz, 1977) including the holotype, also strongly resembles *Ophiomorpha* (Uchman, 1991 a) and may be regarded as a synonym of the latter. *Ophiomorpha, Thalassinoides, Spongeliomorpha* and *Gyrolithes* have been regarded as differing in their position in a burrow system that is produced by the same trace-maker (Kenedy, 1967; Fursich, 1973; Bromley and Frey, 1974).

In Mesozoic-Cenozoic sediments, *Ophiomorpha* is produced mainly by shrimps as Recent *Callianassa major* (e.g. Weimer and Hayt, 1964; Frey et al., 1978). *Callianassids* are partly suspension, partly deposit feeders,, (e.g. Pryor, 1975; Bromley, 1990).

Ophiomorpha annulata (Ksiazkiewicz 1977)

(Plate 1,fig. 4)

1962 Granularia-Seilacher: p.299, pl.1, fig.4.

1977 *Arthropyhcus annulatus* n.ichnosp.-Ksiazkiewicz: p.56, pl.1, fig.8-10

1977 *Sabularia simplex* n.ichnosp.-Ksiazkiewicz: p.68, pl.2, fig.2; text-fig.9e.

1982 *Ophiomorpha annulata-Frey* and Howard: fig.2B, 4A.

Description.- It embraces mainly horizontal, covered with elongate pellets, cyclindrical burrows. It is observed as exichnial cylindrical lined burrows in the field and 4-7 mm in diameter.

Remarks.- This ichnotaxon has been described as *Granularia.* It was also described by Ksiazkiewicz (1977) as *Sabularia simplex (Tunis* and Uchman, 1996a, *b).*

Ophiomorpha rudis (Ksiazkiewicz 1977)

(Plate 1, fig. 5)

1977 *Sabularia rudis* n.ichnosp.-Ksiazkiewicz: p.70-71, pl. 2, fig. 4; text-fig.7.

Description.- Mainly vertical, near vertical cylindrical lined or unlined, rarely branched, sand filled burrows, which are 8-16 mm in diameter and 28 cm in length.

Remarks.- This ichnotaxon has been described as *Granularia.* It was also described by Ksiazkiewicz (1977) as *Sabularia rudis* (Tunis and Uchman, 1996 a, b).

Thalassinoides Ehrenberg 1944

(Plate 1, fig. 6)

Description.- It has three dimensional burrow systems. Branches are Y or T shaped.

Remarks.- Thalassinoides is *a* facies-crossing form, very typical of shallow-marine environments, and is produced mainly by Crustaceans (e.g. Frey et al., 1984). Origin and palaeoenvironmental meaning of *Thalassinoides were* summarized by Ekdale (1992). According to Follmi and Grimm (1990), Crustaceans producing *Thalassinoides* may survive in turbidity currents and produce burrow under anoxic conditions.

Apart from widespread Mesozoic and Cenozoic occurrences, *Thalassinoides* has also been recorded in the Paleozoic shallow water sediments (Palmer, 1978; Archer and Maples, 1984; Sheehan and Schiefelbein, 1984; Stanistreet, 1989; Kulkov, 1991).

Radialstructures

a) Lorenzinia group

This group presents radial structures as morphological criteria.

Capodistria vettersi Vialov 1968

(Plate 2, fig. 1)

1910 *Hieroglyph aus* - Vetters: 131, fig.a.
1968 *Capodistria vettersi*- Vialov: 337, fig.4
1977 *Capodistria vettersi* - Vialov - Ksiazkiewicz: 99, pl.7, fig.12; text-fig. 13a-b.
1990 *Capodistria moldavica* n.ichnosp. - Brustur and lonesi: 39, fig.2; pl.1, fig.1.

Description.- It is defined by its central area, which is surrounded by small hypichnial radiating ridges (Fig. 2d). The central area is 2 mm in diameter. Eight short radiating ridges are 0.1-0.5 mm in diameter.

Remarks.- The description of *Capodistria vettersi* is based on figured but unnamed material of Vetters (1910). The specimen illustrated by Vetters (1910) has nine radiating ridges and one central knob. The forms illustrated by Ksiazkiewicz (1977) have one or three central knobs. However, Brustur and lo nesi (1990) distinguished *Capodistria moldavica* ichnospeices by presence of double central simple knobs.

Lorenzinia pustulosa (Ksiazkiewicz 1977)

(Plate 2, fig. 2)

1977 Sublorenzinia pustulosa n.ichnosp. - Ksiazkiewicz: 97. pl.7, fig.9; text-fig.13s.t.

Description.- Hypichnial, short ridges which surround central area in fine-grained turbiditic sandstone. The central is about 17 mm in width. 12 very short radiating ridges are 3-5 mm in width and 3-10 mm length.

Remarks.- Ksiazkiewicz (1977) indicated in his diagnosis that *Lorenzinia pustulosa* was preserved in full relief. The form displays a great morphological variability (Ksiazkiewicz, 1977). It occurs in flysch deposits ranging from the Cenomanian to the Miocene (Ksiazkiewicz, 1977) in age.

Spreitenstructures

a) Zoophycos group

This group embraces three dimensional spreite structures with helicoidal elements (Hantzschel, 1975).

Zoophycos Massalongo 1855

(Plate 2, fig. 3)

Description.- It is observed as endichnial to epichnial spreite structure in fine-grained turbiditic sandstone (Fig. 2e). The spreite lamellae 1-5 mm wide and comprised of numerous small, more or less "U" or "J" - shaped protrusive burrows. The structure is bordered by a marginal tunnel, which is 5 mm wide.

Remarks.- Different ichnogenera and/or species have been described under the name *"Zoophycos"* (Hantzschel, 1975). Recently, the origin of members of the Zoophycos group has been extensively discussed (Bromley, 1991; Wetzel, 1992; Gaillard and Olivero, 1993; Olivero, 1994). This group is to be revised.

Zoophycos is generally assumed to be the trace of unknown deposit feeding organism. Their producers are possibly found sipunculoids (Wetzel and Werner, 1981), polychaete annelids, arthropods (Ekdale and Lewis, 1991 a, *b),* and hemicordates.

According to Kotake (1989, 1991), *Zoophycos* is produced by surface ingestors of organic detritus. But, the origin of this form is still not clear.

Echinospira Girotti 1970

(Plate 2, fig. 4)

1869 *Buthotrepsis radiata* Ludwing - Ludwing: 114, pl.19, fig.1,1.

1877 *Taonurus procerus* Heer - Heer: 123, pl.48, fig.3-5.

1968 *'Zoophycos'* -Stevens: fig.9,11.

1970 *Zoophycos* - Lewis: 295, fig.1 -8.

1984 *Echinospira pauciradiata* Girotti - Belloti and Valeri: fig.4

1991 *Zoophycos* - Ekdale and Lewis: 183, fig.3-8.

Description.- It occurs generally at the top of fine-grained, medium bedded, parallel laminated sandstones, as composite, elongate lobes, which are 30 cm in length. In most cases, the trace fossil displays a narrow proximal part, and a wide, lobate distal part. The proximal part passes into the lobes of the distal part. The proximal part is incised up to 5 cm in the sandstone bed and forms a wide "U" in the vertical plane. They resemble Phycodes at the first look.

Remarks.- *Echinospira* isp. belongs to the Zoophycos group and is commonly described as a synonym of *Zoophycos* (e.g. Seilacher, 1986; Ekdale and Lewis, 1991 a). According to Ekdale (1992), the traces of *Echinospira* present characteristic features which differ from other members of the Zoophycos group.

Plicka (1968) and Girotti (1970) regarded *Echinospira* as an imprint of polychaetes and used a terminology. No diagnosis was given by Girotti (1970), based on morphologic parameters, indicated *Zoophycos.*

Rhizocorallium isp.

(Plate 2, fig. 5)

Description.- *Rhizocorallium* is characterized by lateral to horizontal, oblique "U" shaped burrows with spreite. This structure is about 15 cm in length. Its marginal tunnel is 3-4 mm in width.

Remarks.- This ichnogenus was discussed on morphological and ethological model by Uchman (1992b) and Uchman and Demircan (1999).

Winding and meandering structures

a) Scolicia group

This term "Scolicia group" was used by Hantzschel (1975). This group embraces bilobate and trilobate traces which have been related to Mesozoic and Cenozoic echinoid burrows (Smith and Crimes, 1983). All members of the group are included in the ichnogenus *Scolicia* by Seilacher (1986).

Scolicia vertebralis Ksiazkiewicz 1970

(Plate 2, fig. 6)

Description.- Epichnial, three lobed, winding and meandering in medium-grained turbiditic sandstone (fig. 2f). The furrow is 10 mm in width, and 7 mm in depth. The side lobes are covered with perpendicular ribs which are asymmetric in cross-section. The ribs are 2 mm in width.

Remarks.- *Scolicia vertebralis* is less frequently observed than *Scolicia plana* and *Scolicia prisca* (Ksiazkiewicz, 1970; 1977).

Scolicia prisca De Quatrafages 1849
(Plate 3, fig. 1)

1849 *Scolicia prisca* A. De Qv.- De Quatrafages: 265 (illustration).

1888 *Nemertilites miocenica* Sacco - Sacco: pl.1,fig.15-16.

1888 *Nemertilites pedemontana* Sacco - Sacco: pl.1, fig. 17.

1895 *Fahrte...* -Fuchs: pl.3, fig.3.

1932 *Palaeobullia* - Götzinger and Becker: 379, text-fig.4.1-4.4; pl.7, fig.c,8,ş.b.

1933 *Scolicia prisca* Quatrafages - Azpeita Moros: pl.11, fig.23.

1934 *Paleobullia* - Götzinger and Becker: p1.1, 3a, 4.1-7, 5-6.

1934 *Paleobullia* - Götzinger and Becker: 4.8.9.

1935 *Bullia fahrten* - Abel: ş.202, 203, 206, 208.

1951 *Palaeobullia* - Götzinger: 223, pl.18, 20.

1954 *Scolicia* - Gomez De Larena: pl.34, fig.1;pl.43, fig.1.

1958 Hieroglyph of the *Paleobullia* tip - Ksiazkiewicz: pl.3, fig.1.

1964 *Scolicia prisca* Quatrefages - Farres Mialian: 97, pl.7, fig.1.

1970 *Scolicia* sp. - Frey and Howard: 163, fig.7g.

1970 *Scolicia prisca* De Quatrefages - Ksiazkiewicz: 289, pl. 14.

1971 *Scolicia* sp.-Tanaka: 17, pl.11, fig.2.

1971 *Scolicia* prisca De Quatrefages - Chamberlain: 225, pl.I, fig.13; text-fig.4P-R.

1972 *Paleobullia* - Hanisch: fig.8.

1977 *Scolicia prisca* De Quatrefages - Ksiazkiewicz: 126, pl.I; fig.12; pl.14, fig.8; pi.15, fig.6.

1982 *Scolicia prisca* De Quatrefages - Plicka: pl.57-60.

1983 *Scolicia* sp. - Smith and Crimes: 90, fig.SE, 6A-B.

1988 *Scolicia* De Quatrefages - Plaziat and Mahmoudil: 225, pl.I, fig.A.E.

1992 *Scolicia* - Leszczynski: pl.11, fig.2 (non pl .1, fig.1; pl.5, fig.1, pl., fig.1).

Description.- Epichnial, three lobed, winding trace fossil in medium-grained turbiditic sandstone. The furrow is 10 mm in width and 3-5 mm in depth. The median lobe is the lower ridge on the floor of the furrow. It is 6 mm in width. The side lobes are covered with oblique asymmetric ribs. The ribs are about 2 mm in width.

Remarks.- Ksiazkiewicz (1970, 1977) described *Scolicia plana* which was characterized by a flat bottom divided by a longitudinal median trench or crest. The parallel strings are produced by drainage of spantangoid echinoids. Densely packed ribs at the bottom are probably produced by locomotion organs of the producer. The asymmetric thicker ribs on both sides are remnants of backfill menisci. This ichnotaxon is generally preserved in the middle part of turbidities at the transition from sandstone to mudstone. The lowermost part of the burrow is preserved. The upper part, consisting of backfill structures, remains usually at the top, shale section of the turbidite bed.

Scolicia strozzii (Savi and Meneghini 1850)

(Plate 3, fig. 2)

1850 *Nemertilites strozzii* nob. - Savi and Meneghini: 421.

1877 *Helminthopsis magna* HR. - Heer: 116, pl.47, fig. 1-2.

1887 *Helminthopsis magna* HR. - Maillard: pl.1,fig.1.

1888 *Taphrhelminthopsis auricularis* Sacco - Sacco: 24, pl.2, fig.3.

1888 *Taphrhelminthopsis recta* Sacco-Sacco: 24, pl.1, fig.20.

1888 *Taphrhelminthopsis pedemontana* Sacco - Sacco: 25.

1895 *Eophytonartige Sculptur* - Fuchs: pl.3 fig.1.

1925 *Nemertilites strozzi* - Caterini: 309 pl.1.

1932 *Maanderfahrte* - Götzinger and Becker pl.7, fig.a-b.

1946 *Subphyllochorda (Scolicia)* - Gomez De Larena: 124, pl.2, fig.7.

1946 *Subphyllochorda* - Gomez De Larena: 124, pl.2, fig.5.

1958 Trace of... gastropod from the *Subphylolochorda* Ksiazkiewicz.

1964 *Taphrhelminthopsis? Simplex* noc. isp. - Farres Milian: 95, fig.2.

1964 *Scolicia prisca* Quatrefages-Farres Milian: 97, pl.7, fig.1.

1968 *Taphrhelminthopsis* Sacco, sp. ind. - Ksiazkiewicz: 8, pl.6, fig.3.

1970 *Taphrhelminthopsis subauricularis* sp. nov. - Chiplongar and Badve: 7, pl.2, fig.5.

1970 *Nereites* sp .- Crimes: pl.1 b.

1970 *Taphrhelminthopsis* aff. *recta* Sacco - Ksiazkiewicz: 290-292, pl.2a-d.

1970 *Taphrhelminthopsis auricularis* Sacco - Ksiazkiewicz: 292, pl.2e-g.

1972 *Taphrhelminthopsis convoluta* Heer-Hanisch: fig.3-5,7.

1977 *Taphrhelminthopsis* Sacco and Ksiazkiewicz: 137, pl. 17, fig. 1-3; text-fig.26a-j.

1977 *Taphrhelminthopsis vagans* n. ichnosp.-Ksiazkiewicz: 17, fig.4-5; text-fig.261-s.

1977 *Taphrhelminthopsis recta* Sacco-Ksiazkiewicz:139, I . text-s. 261.

1977 *Taphrhelminthoida convoluta* n.ichnosp. - Ksiazkiewicz: pl.22, fig.1; pl.23, fig.5.

1977 *Taphrhelminthoida plana* (Ksiazkiewicz) - Ksiazkiewicz: pl.22, fig.2-3.

1977 *Taphrhelminthopsis circularis* n. ichnosp. - Crimes: 125, pl.8a-e.

1977 *Taphrhelminthopsis* isp. - Crimes: pl.3, fig.6a-b.

1977 *Taphrhelminthopsis* isp. - Pendon: pl.2, fig.5-6.

1977 *Taphrhelminthopsis auricularis* Sacco - Roniewiz and Pienkowski: pl.3a.

1977 *Taphrhelminthopsis recta* Sacco - Roniewicz and Pienkowski: 287, pl.3c.

1978 *Taphrhelminthopsis* Sacco - Kern: 253, fig.9B.

1980 *Taphrhelminthopsis convoluta* (Heer) - Badve and Ghare: 126, fig.5; text-fig.4.

1980 *Taphrhelminthopsis recta* Sacco - Badve and Ghare: fig.3; text-fig.5.

1983 *Taphrhelminthopsis* Sacco - Singh and Rai: 76, pl.4, fig.28; pl.7, fig.75.

1983 *Taphrhelminthopsis* isp. - Smith and Crimes: fig.7A,D.

1983 *Taphrhelminthopsis* isp.-Raina et al.: 93, pl .2, fig.4.

1983 *Helminthoida crassa* Schafhautl-Tchoumatchenco: pl.2, fig.3.

1984 *Scolicia* isp. Fillion and Pickerill: 38, fig.7c.

1984 *Taphrhelminthopsis auricularis* Sacco-Belloti and Valeri: fig.6.

1985 *Taphrhelminthopsis circularis* Crimes, Legg, Arboleya-Fritz and Crimes: 16, pl.1, fig.4.

1986 *Taphrhelminthoida* Ksiazkiewicz - Pienkowski Westwalewicz-Mogilska: 58, fig.5C.

1986 *Taphrhelminthopsis* Sacco-Pienkowski Westwalewicz-Mogilska: 58,62, fig.5A-B, D-G.

1986 *Taphrhelminthopsis maginensis* ichnosp. n. - Yang: 157, pl.2, fig.7.

1987 *Taphrhelminthoida auricularia* Ksiazkiewicz - Micu et al.: 82, fig.2.

1987 *Taphrhelminthopsis circularis* - Narbonne et al.: fig.6f.

1987 *Taphrhelminthopsis auricularis* Sacco - Plicka: 165, text-fig.23, 43; fig.3-7, pl.44, fig.4; pl.45, fig.6.

1987 *Taphrhelminthopsis meandriformis* n. ichnosp. - Plicka:166, fig.25; pl.44, fig.3.

1988 *Taphrhelminthopsis circularis* Crimes et al. - Li-Ri Hui and Yang: 169, fig.5.

1988 *Taphrhelminthopsis* Sacco - Plaziat and Mahmoudi: 227, pl.2, fig.D.

1988 *Scolicia strozzii* (Savi and Meneghini) - Ragaini: 224, pl.1-2.

1990 *Taphrhelminthopsis* ichnosp. - Mikulas: 337, text-fig.2B; pl.4, fig.2.

1990 *Taphrhelminthopsis* sp. - Pickerill and Peel: 33, fig.13c

1991 *Taphrhelminthopsis* isp. - Crimes and Crossley: 40, fig.6g-h.

1992 *Taphrhelminthopsis* isp. - Crimes et al.: 68, fig.5D.

1992 *Taphrhelminthopsis auricularis* Leszczynski: pl.1, fig.2.

1992 *Taphrhelminthopsis* isp. - Leszczynski pl.8, fig.2; pl.10, fig.1.

1992b *Taphrhelminthopsis* sp. - Mikulas: 26, pl.8, fig.6 (non pl.15, fig.1).

1993b *Taphrhelminthopsis auricularis* Sacco - Miller: 24, fig.4A.

Description.- Hypichnial, bilobate ridge with median groove in fine-grained turbiditic sandstone. The ridge is 13 mm in width, and 3-5 mm in height. The median groove is narrow and shallow.

Remarks.- This ichnotaxon is a cast of the furrow formed after erosion of the *Scolicia* burrow. Height, depth of the median ridge, and wide of the trace depend on small differences in depth of burrowing, depth and strength of erosion, and properties of substrate. If the burrow is cut by erosion in the middle part, its cast gets higher and wider, the sides of the ridge become gentler, and the median groove seems to be narrower. If erosion cuts the base of the burrow, its cast gets lower, the median groove becomes shallow and wide, and the prominent part of the ridge becomes narrow. Indistinct longitudinal ridges or strige typical of *Taphrhelminthopsis recta* are most probably such tool marks. However, some differences in burrow shapes depend on biological factors. Preservation factors seem to dominate the shape of the ridge. In the past, such criteria were used for distinguishing taxa of *Taphrhelminthopsis.*

Ksiazkiewicz (1977) differentiated there forms; 1) gently winding, usually single *Taphrhelminthopsis vagans,* 2) usually gregariously occurring *Taphrhelminthopsis auricularis,* and 3) tightly meandering *Taphrhelminthoida.* The first form corresponds to locomotion activity (repichnia) and the latter to feeding activity (pascichnia). However, some transitional forms occur among them (e.g. Ksiazkiewicz, 1977; pl. 17, fig.2: Crimes, 1977; pl.6b). *Scolicia prisca* and *Subphyllochorda (Scolicia* isp.) commonly display meanders, which may be preserved as *Taphrhelminthopsis* or *Taphrhelminthoida (=Scolicia strozzii).* The tendency to meandering depends on the nutrient content of the substrate. Thus, differentiating between meandering and non-meandering forms is problematic at the species level.

Scolicia strozzii was produced at shallow tiers as deduced from the co-occurrence of *Paleodictyon strozzii.* Its Mesozoic-Cenozoic producers *(spantangoid echinoids)* can not be excluded. The Paleozoic forms are probably casts of washed out burrows of *Cruziana* and *Curvolithus.* There are no diagnostic features, which allow Paleozoic and past Paleozoic forms.

Scolicia plana Ksiazkiewicz 1970

(Plate 3, fig. 3)

1970 *Scolicia plana* ichnosp. n. - Ksiazkiewicz: 289, pl.1c.

1970 *Subphyllochorda striata* ichnosp. n. - Ksiazkiewicz: 290, pl.1f.

1970 *Subphyllochorda granulata* ichnosp. n. - Ksiazkiewicz: 289, pl.1g.

1977 *Scolicia plana* Ksiazkiewicz - Ksiazkiewicz: 127, pl.14, figs.2,5,7.

1977 *Subphyllochorda granulata* Ksiazkiewicz - Ksiazkiewicz: 131, pl.15, figs.3,5.

1977 *Subphyllochorda striata* Ksiazkiewicz - Ksiazkiewicz: 132, pl.15, fig.1; text-fig.24a.

1977 *Subphyllochorda rudis* n. ichnosp. - Ksiazkiewicz: 133, pl.1, fig.2; text-fig.24d, 25.

Description.- Hypichnial, three lobed, winding and meandering trace fossil. Side lobes are narrow with median groove in fine-grained turbiditic sandstone. The furrow is 9 mm in width, and side lobes are covered with perpendicular ribs which are 1.5 mm in width. The narrow side lobes are 2.6 mm in width.

Remarks.- It is typical for Mesozoic and Cenozoic deposits (Ksiazkiewicz, 1977).

b) Cosmorhaphe group

Cosmorhaphe sinuosa
Azpeitia Moros 1933
(Plate 3, fig. 4)

1933 *Helminthopsis sinuosa* Azpeitia n.sp. - Azpeitia Moros: 45, fig.24B.

1935 *Spirorhaphe* - Abel: fig.263.

1954 *Helminthopsis sinuosa* Azpeitia - Gomez De Llarena: pl.46, fig.1.

1959 *Helminthopsis sinuosa* - Seilacher: tab.1,fig.8.

1964 *Cosmorhaphe sinuosus* Azpeitia - Farres Milian: 86, pl.5, fig.1.

1967 *Cosmorhaphe* - Macsotay: 27, pl.6, fig.22.

1970 *Cosmorhaphe sinuosa* (Azpeitia) - Ksiazkiewicz: 292, text-fig.2a, 3a.

1970 *Cosmorhaphe fuchsi* ichnosp. nov. - Ksiazkiewicz: 294, text-fig.3b.

1977 *Cosmorhaphe sinuosa* (Azpeitia) - Ksiazkiewicz: 153, pl. 19, fig.3-5; text-fig.33g-j.

1977 *Cosmorhaphe fuchsi* Ksiazkiewicz - Ksiazkiewicz: 154, pl.19, fig.7; text-fig.33n-s.

1978 *Cosmorhaphe sinuosa* - Montenat and Seilacher: fig.Ic.

1980 *Cosmorhaphe sinuosa* (Azpeitia) - Alexandrescu and Brustur: pl.6, fig.3-4.

1991 a *Cosmorhaphe* - Leszczynski: fig.9-10.

1991 *b* *Cosmorhaphe* - Leszczynski: fig.5.

1991 *Cosmorhaphe sinuosa* (Azpeitia Moros) - Seilacher: 296, fig.3-6,8.

1992 *Cosmorhaphe sinuosa* - Leszczynskil: pl.3, fig.2.

1992a *Cosmorhaphe ichnosp.* - Uchman: fig.4.4.

1993 *Cosmorhaphe* ef. *sinuosa* - Leszczynski and Uchman: fig.7.

1994 *Cosmorhaphe sinuosa* Azpeitia Moros - Tunis and Uchman: fig.6F, 8D.

1995 *Cosmorhaphe sinuosa* (Azpeitia Moros) - Han and Pickerill: fig.4G.

1995 *Cosmorhaphe sinuosa* (Azpeitia Moros) - Uchman: 40, pl.11, fig.4.

Description.- Hypichnial, convex, meandering string in fine-grained turbiditic sandstone (fig. 2h). It is preserved in semi-relief. The string is 1.3 mm in width. The meanders are 10-11 mm in width.

Remarks.- *Cosmorhaphe* isp. is a graphoglyptid burrow, common in flysch deposits since the Ordovician (Hantzschel, 1975). Fossil forms have been present since the Cambrian (Narbonne et al., 1987).

c) Miscellaneous group

In this group, ichnogenera display unique behaviour.

Helminthopsis Heer 1877

(Plate 3, fig. 5)

Description.- Hypichnial, convex, loosely meandering, smooth, string-like, no branched forms in fine-grained turbiditic sandstone. The string is 4 mm in width.

Remarks.- Examination of the type material of Helminthopsis has revealed that the type species *Helminthopsis magna* is in fact *Taphrhelminthopsis* Sacco, and that *Helminthopsis labyrintica* is identical to *Spirocosmorhaphe* Seilacher. These types of traces are probably produced by polychaetes or pripulid (Ksiazkiewicz, 1977; Fillon and Pickerill, 1990). *Helminthopsis* occurs in the time interval ranging from the Cambrian (Crimes, 1987) to the Recent (Swinbanks and Murray, 1981; Wetzel, 1983a,b).

Branched, winding and meandering structures

a)Urohelminthoida group

Urohelminthoida isp.

Description.- Burrow system is usually preserved in string size, deep, hypichnial meanders. Lateral appendages protrude outwardly from the curved segments of the meanders (fig.2/).

Remarks.- *Urohelminthoida* is a typical graphoglyptid burrow (Seilacher, 1977). Post depositional *Urohelminthoida* (Ksiazkiewicz, 1977) was not confirmed by Kern (1980). Apart from numerous flysch occurrences, it was not found in Mesozoic shallow-water deposits (Fursich and Heinberg, 1983; Gierlowski-Kordesch and Ernst, 1987). Modern traces of *Urohelminthoida* were recorded on the deep-sea floor by Gaillard (1991). Its stratigraphic interval ranges from the Jurassic (Fursich and Heinberg, 1983) to the Miocene (D'Alessandro, 1980).

Urohelminthoida dertonensis

(Plate 3, fig. 6)

1888 *Urohelminthoida dertonensis* Sacco - Sacco: 36, pl.2, fig.8,16.

Description.- Hypichnial meanders in fine-grained turbiditic sandstone. The meanders are 5 mm in width. The string is 2 mm in diameter. The appendages are 32-40 mm in length.

Remarks.- *Urohelminthoida dertonenisis* is a typical graphoglyptid burrow (Seilacher, 1977).

RESULTS

19 trace fossils, morphologically 6 groups are described in Karaisalı-Çatalan-Eğner regions. 11 of these traces are composed of ichnospecies and 8 of them are in ichnogenus level. Most of the traces are observed as horizontal, pascichnial and agrichnia. Groups with simple structures mostly represent the inner fan, spreiten-radial ones belong to middle fan and winding-meandering belong to outer fan. As a result, fans are determined as inner fan: *Skolithos-Curuziana* ichnofacies and displays eutrophic conditions, middle fan: *Skolithos-Curiziana, Nereites* ichnofacies and mixed assemblages where display eutrophic and oligotrophic conditions, outer fan: *Nereites* ichnofacies and display oligotrophic conditions in very high diversity.

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PLATES

PLATE-I

Fig. 1 - *Planolites beverleyensis*
Endichnial full-relief in fine grained sandstone.
Cingoz formation, Inner fan - Middle fan.

Fig. 2- *Chondrites* isp. and *Scolicia* isp.
Endichnial full-relief in medium-fine grained sandstone.
Cingoz formation, Middle fan.

Fig. 3- *Ophiomorpha* isp.
Endichnial full-relief in coarse-medium grained sandstone.
Cingöz formation, Inner fan.

Fig. 4- *Ophiomorpha* annulata
Endichnial full-relief in medium-fine grained sandstone.
Cingöz formation, Slope - Middle fan.

Fig. 5- *Ophiomorpha* rudis
Endichnial full-relief in medium-fine grained sandstone.
Cingöz formation, Fan fringe.

Fig. 6- *Thallassinoides* isp.
Endichnial full-relief in medium grained sandstone.
Cingöz formation, Middle fan.

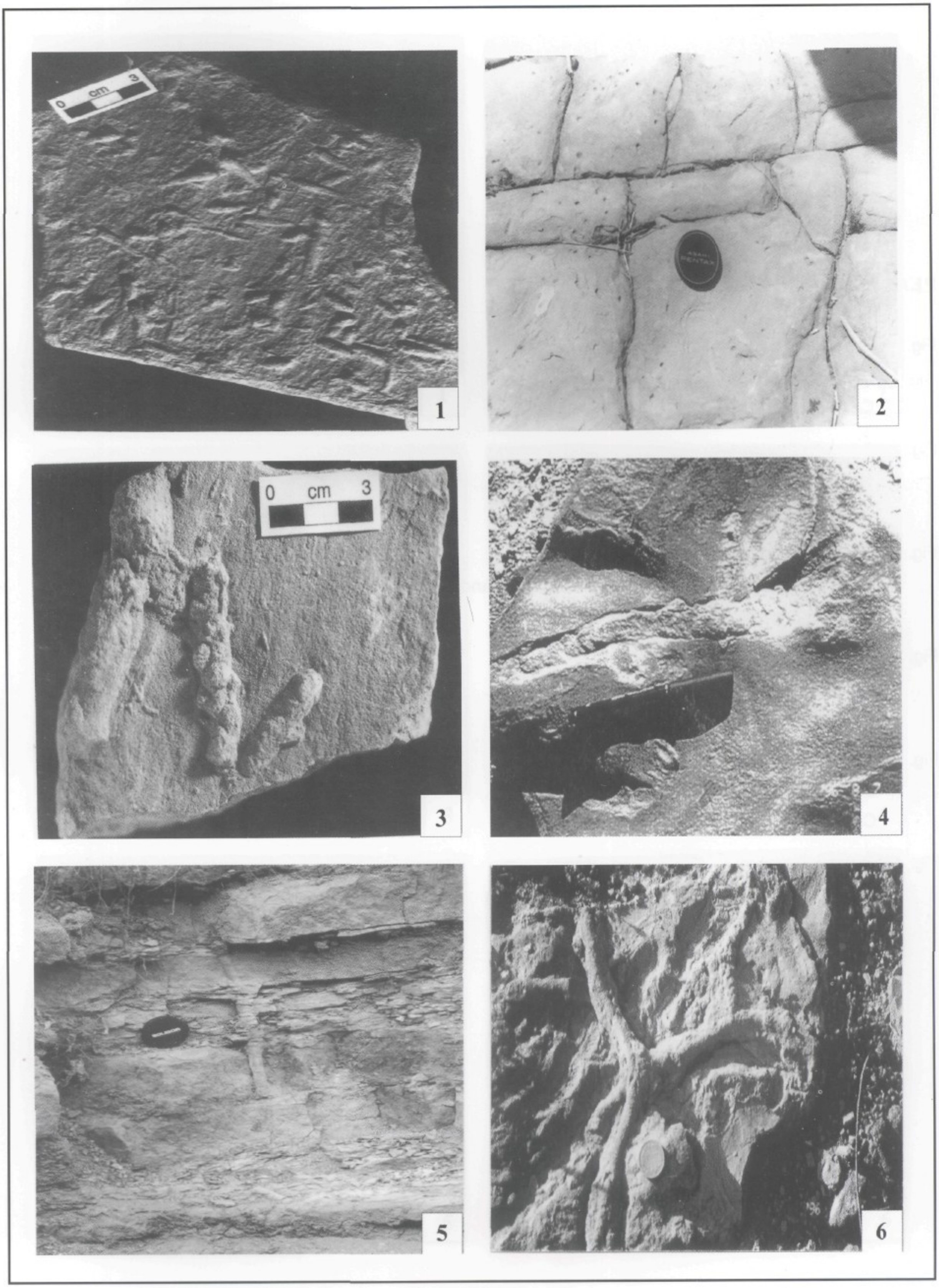
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PLATE-II

Fig.1 *Capodistria vettersi*
Hypichnial semi-relief in fine grained sandstone.
Cingöz formation, Middle fan - Outher fan.

Fig. 2- *Lorenzinia pustulosa*
Hypichnial semi-relief in fine grained sandstone.
Cingöz formation, Middle fan - Outher fan.

Fig. 3- *Zoophycos* isp.
Endichnial semi-relief in medium-fine grained sandstone.
Cingöz formation, Slope - Middle fan.

Fig. 4- *Echinospira* isp.
Endichnial semi-relief in fine grained sandstone.
Cingöz formation, Middle fan.

Fig. 5- *Rhizocorallium* isp.
Endichnial semi-relief in fine grained sandstone.
Cingöz formation, Middle fan.

Fig. 6- *Scolicia vertebralis*
Epichnial full-relief in fine grained sandstone.
Cingöz formation, Middle fan.

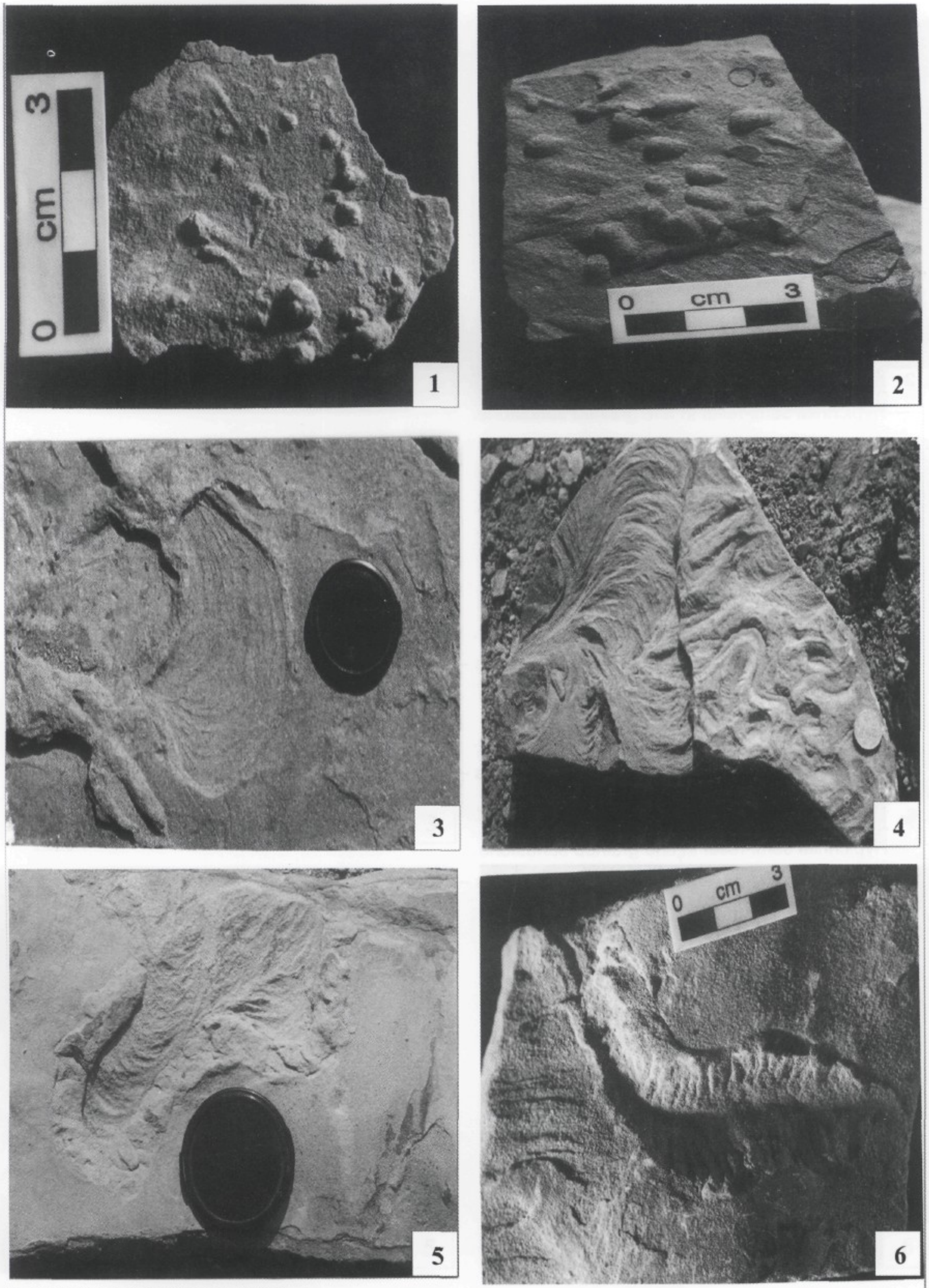
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PLATE-III

Fig. 1- *Scolicia prisca*
Epichnial full-relief in fine grained sandstone.
Cingöz formation, Middle fan - Fan fringe.

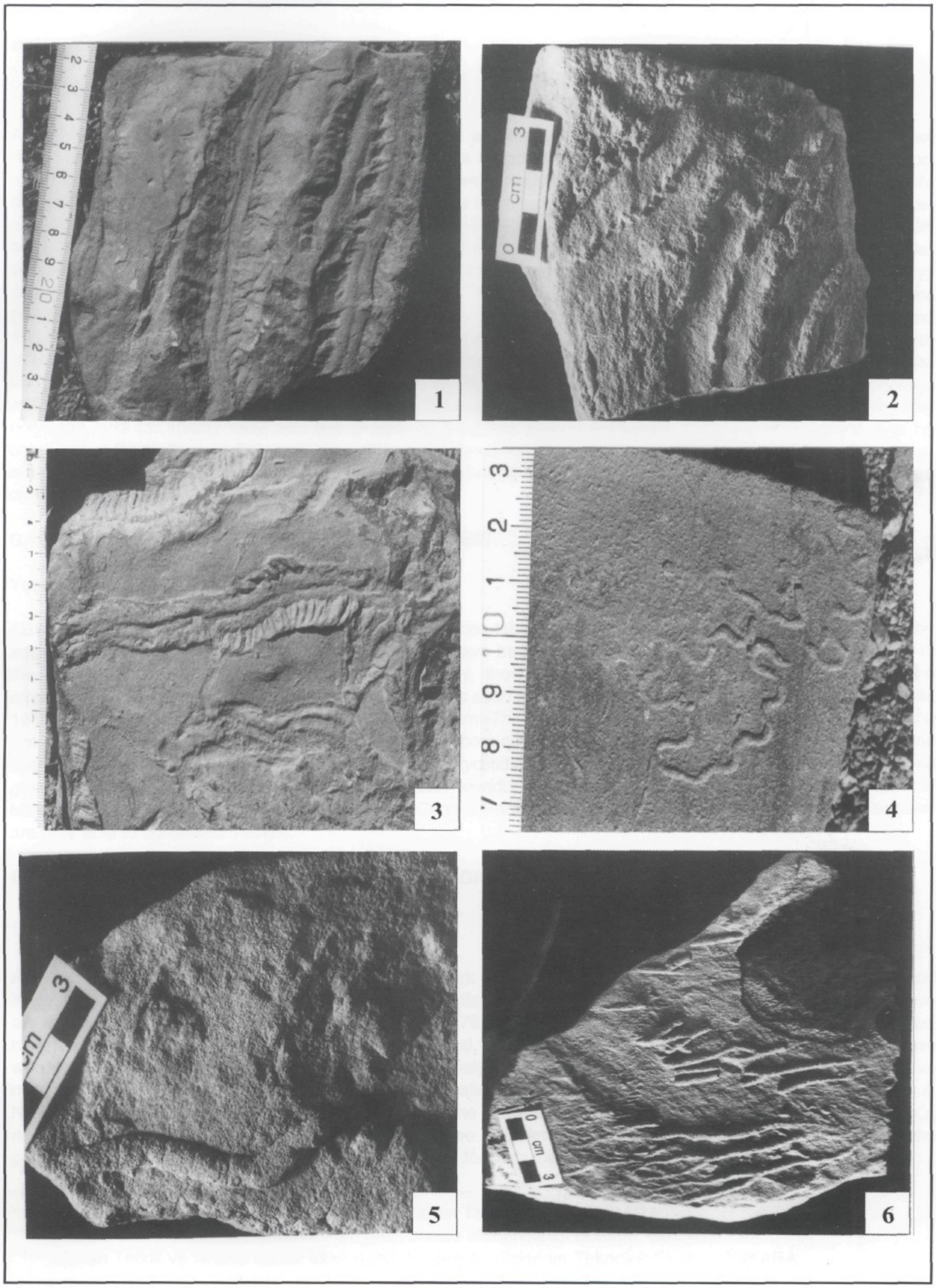
Fig. 2- *Scolicia strozzii*
Hypichnial semi-relief in fine grained sandstone.
Cingöz formation, Middle fan - Outher fan.

Fig. 3- *Scolicia plana*
Epichnial full-relief in fine grained sandstone.
Cingöz formation, Middle fan - Fan fringe.

Fig. 4- *Cosmorhaphe sinuosa*
Hypichnial semi-relief in fine grained sandstone.
Cingöz formation, Outher fan depositional lobes - Fan fringe.

Fig. 5- *Helminthopsis* isp.
Hypichnial semi-relief in fine grained sandstone.
Cingöz formation, Outher fan depositional lobes - Fan fringe.

Fig. 6- *Urohelminthoida dertonensis*
Hypichnial semi-relief in fine grained sandstone.
Cingöz formation, Outher fan depositional lobes - Fan fringe.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BENEFICATION OF FELDSPAR FROM YOZGAT REGION GRANITES

Saruhan SAKLAR*** and Ceynur OKTAY***

ABSTRACT.- In this study, a feldspar beneficiation work was performed of the granite deposits of Sanhacih and Kayabağı samples found in Yozgat region. Main impurities in these granitic rocks are mica and iron-oxide minerals which cause iron contents to increase (2.37 and 1.76 % Fe_2O_3). For decreasing the iron content of granites, magnetic separation and flotation methods were applied. After magnetic separation, the iron contents of granites were reduced down to 0.22 and 0.20 % Fe_2O_3 respectively. Flotation tests were carried out in two stages that were mica and oxide flotation. In mica flotation, amine type cationic collector and in oxide flotation anionic collectors i.e. Na-oleate and sulphonate were tried. Iron contents of the samples were reduced down to 0.08 % and 0.12 Fe_2O_3 respectively by flotation method. Firing button tests were also performed on the concentrates at 1250 °C and the products had satisfactorily bright and white color tones for both methods.