BIOSTRATIGRAPHY AND PALEONTOLOGY OF THE MEDİK-EBREME (NW MALATYA) AREA

Sefer ÖRÇEN*

ABSTRACT.— This paper deals with paleontology and biostratigraphy of the sedimentary rocks in the vicinity of Medik-Ebreme area located northwest of Malatya. The age of the formations of the area range from Upper Jurassic to the Quaternary. Horasançay formation, Upper Jurassic to Lower Cretaceous in age, consists essentially of micrites and dolomitic limestones deposited on the open shelf. The unconformably overlying Medik formation is represented by conglomerates with mudstone interbeds deposited in an alluvial fan of Paleocene age. The Medik formation is unconformably overlain by the Tohma formation, Middle-Upper Eocene in age, and consists of conglomerates, sandstones and alternations of limestones and marls deposited in lagoonal, beach and shallow marine (shelf) environments. Çavuş formation consisting of clastic limestones deposited on the shallow shelf, sits unconformably on the Tohma formation and is of Aquitanian age. This sequence is unconformably succeeded by the Ansurçay formation, Burdigalian in age, consisting mainly of clastic limestones, marls and reefal limestones. Mısırdere formation, consisting of conglomerates, sandstones and mudstones, was laid down in environments of alluvial fans and braided streams. The following biozones were defined on the basis of paleontologic data: the *Velates schmiedeli* biozone in Lower Lutetian; the *Nummulites pinfoldi* biozone in Middle Lutetian; the *Nummulites aturicus* biozone and *Nummulites perforatus* subbiozone in Upper Lutetian; the *Nummulites fabianii* biozone and *Chapmanina gassinensis* subbiozone in Lower Priabonian; the *Miogypsinoides complanatus* biozone in Aquitanian; the *Miogypsina irregularis* biozone and *Miogypsina intermedia* biozone in Burdigalian. These biozones were matched, biostratigraphically and chronostratigraphically, with their equivalents in Turkey and in other parts of the world.

INTRODUCTION

Following an elaborate selection of the area (Fig. 1), this investigation was undertaken to solve the stratigraphic problems by means of a detailled examination of paleontologic data and understanding of biozonal relations to reach to a synthesis of paleogeography and ecology (Fig. 2).

The investigated area lies in Eastern Taurids, comprising 1:25 000 scaled map of «Malatya K 40 d_4 and K 39 c_3» covering an area of approximately 240 sq. kms.

The earliest detailed work was carried out by Ayan (1961) in the region. This work investigated the general geology and petroleum potential of the Hekimhan-Ebreme region, north of Malatya.

Akkuş (1971) carried out geologic investigations in the Darende-Balaban basin (ESE of Malatya) defining units of Mesozoic (Jurassic-Cretaceous, Upper Cretaceous) and Quaternary age. He also reports ophiolitic assemblages in addition to volcanism occurring prior to Lutetian and after Burdigalian.

Yoldaş (1972) carried out geologic investigations to understand the petroleum potential of the area north of Malatya. He studied the sedimentary rocks of Paleozoic, Mesozoic (Upper Jurassic-Lower Cretaceous, Maestrichtian) and Cenozoic (Ypresian, Lutetian, Oligocene, Lower Miocene, Upper Miocene and Quaternary) age and distinguished serpentinites and volcanic rocks consisting of trachyandesites, basalts and andesites.

Sirel (1976 a, *b)* defined the microfauna *Rhapydionina malatyaensis* n.sp., *Nummulites heheticus* (Kaufmann), *Fabiania cassis* (Opperiheim), *Orbitolites* sp. in Lutetian rocks and *Nummulites*

fabianii (Prever), *Nummulites incrassatus* de la Harpe, *Chapmanina gassinensis* Silvestri on the overlying Bartonian rocks, sitting unconformably on Orbitoides and Siderolites bearing limestones (Maestrichtian) north of Darende (west of Malatya). The same author also defined *Nummulites aturicus* Joly and Leymerie, *Nummulites helveticus* (Kaufmann), *Fabiania cassis* (Oppenheim), G*yroidinella magna* Le Calvez in Upper Lutetian limestones cropping out in the vicinity of Darende-Gürün; *Eoannularia conica* n.sp., *Eoannularia eocenica* Cole and Bermudez, *Chapmanina gassinensis* Silvestri, *Halkyardia minima* (Liebus) and bentonic microfauna in the upper sections including *Nummulites* cf. *fabianii* (Prever).

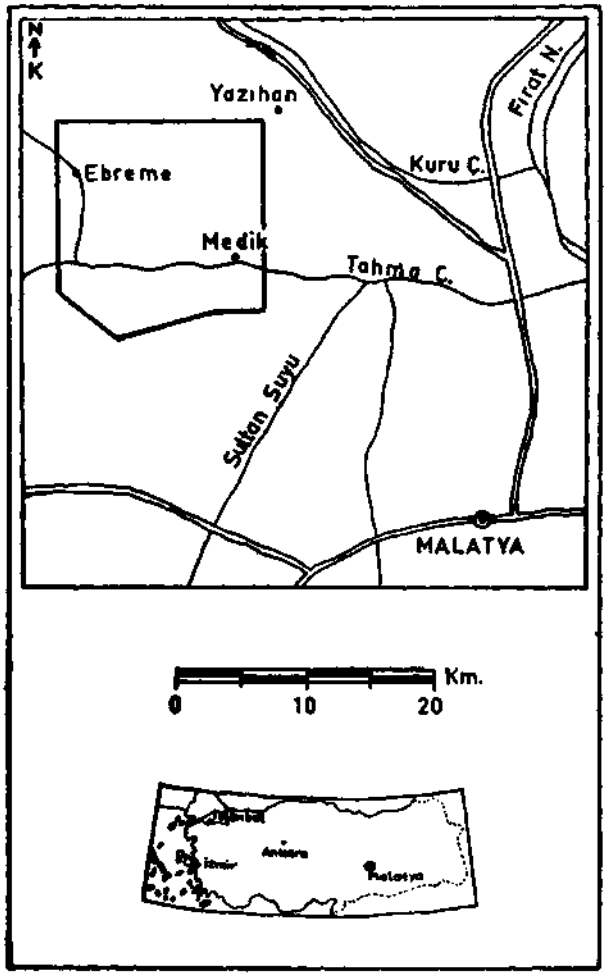


Fig. 1 - Location map of the investigated area.

Kurtman (1978) differentiated Permo-Carboniferous, Mesozoic (Jurassic-Cretaceous, Upper Cretaceous) and Cenozoic (Lutetian. Priabonian Neogene and Quaternary) units in the region in his work entitled «Geology and Tectonic Features of Gürün Region».

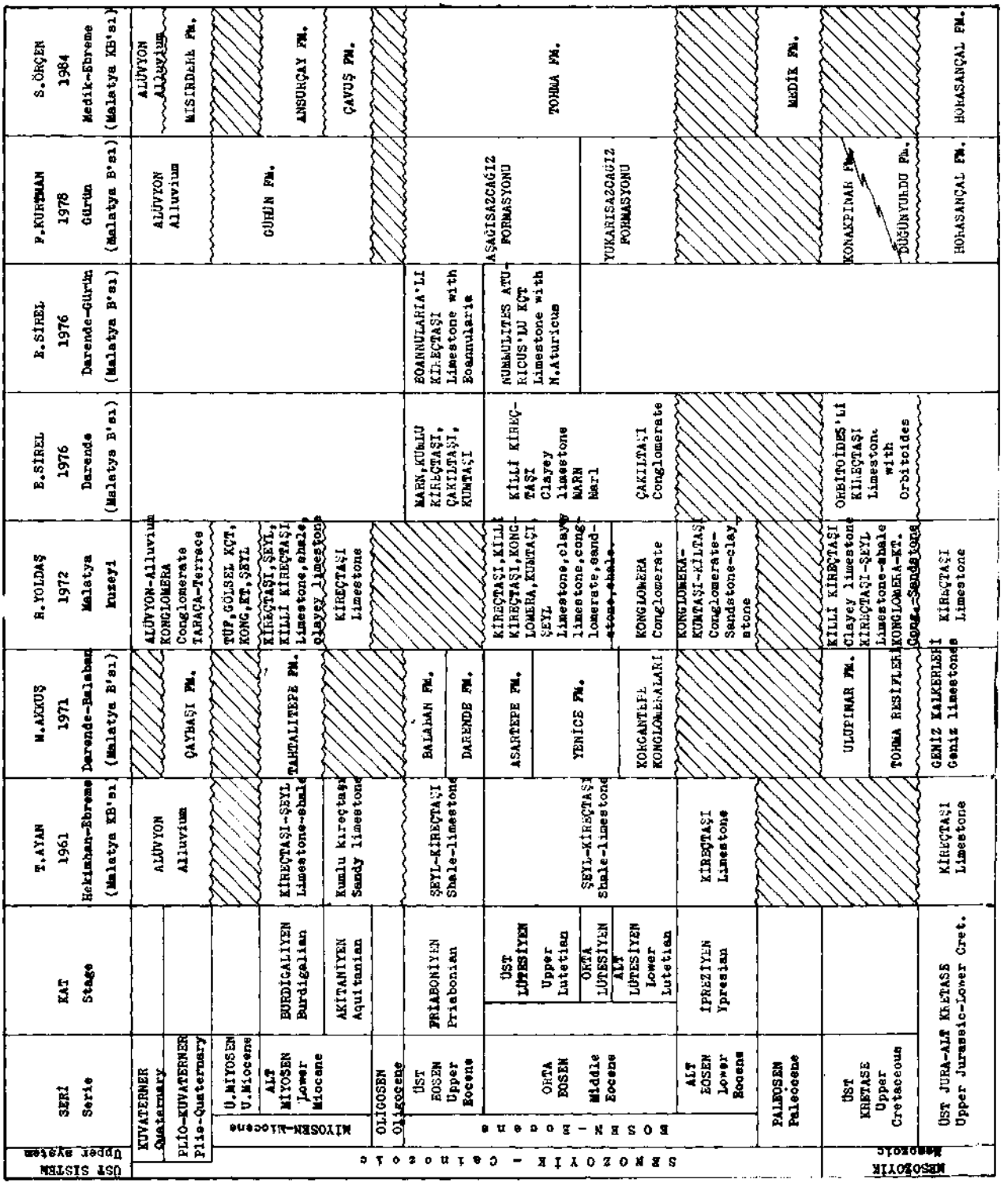


Fig. 2 - Stratigraphic correlation table.

STRATIGRAPHY

The stratigraphy of the region is described in three sections entitled «lithostratigraphy, biostratigraphy and chronostratigraphy». Formations are nomenclated by the author except for the Horasançal fm. (Kurtman, 1978). Paleontologic data is controlled through an elaborate reconsideration of the biostratigraphy.

Lithostratigraphy

The investigated area composed of units of Upper Jurassic-Lower Cretaceous, Paleocene, Middle-Upper Eocene, Lower Miocene and Plio-Quaternary age. These units (lithostratigraphic), their stratigraphic setting and interrelations are shown in Figures 3 and 4.

Horasançal formation. — The type section crops out in the Ebreme and Saravlı creeks (Fig. 5). It consists of light gray, medium to thick bedded micrites in the lower and yellowish gray dolomitic limestones with chert interstratifications in the upper section. The lower boundary does not crop out. The upper boundary is unconformably covered by Medik and Tohma formations respectively in the southern parts of the investigated area and along Tohma valley. The thickness is 300 m.

The lower section of the micrites yields the characteristic fossils of V*alvulinella jurassica* Henson and *Clypeina jurassica* Favre (algae) indicating the age of Upper Jurassic. Dolomitic limestones comprising the upper section are unfossiliferous. Therefore, the age of the formation is considered as Upper Jurassic-Lower Cretaceous. The sedimentary features and the microfauna suggest an open shelf environment of deposition.

Medik formation. — The type locality lies approximately 2.5 km northwest of the Medik village. It consists of parallel or cross-bedded, medium to thick bedded, well-cemented, poorly sorted (angular to rounded pebbles derived from the Horasançal limestone and volcanoclastic units cropping out in the region), reddish-brown conglomerates alternating with red, thin, medium to thick bedded, parallel bedded mudstones. It sits on the Horasan9al formation with an angular unconformity and is unconformably covered by the Tohma formation. Because of faulting and remaining somepart in the Medik dam, to find out exact thickness, was not possible. However, the thickness is estimated 1400 m (data obtained from the Akçadağ well of MTA).

The formation does not contain any fossils. It is considered to be Paleocene in age according to its stratigraphic setting and the pebble content. The sedimentologic parameters indicate an alluvial fan as the environment of deposition.

Tohma formation. — This formation can typically be observed along the road of Çivril village and around Çorak and Yoğunsakız districts (Figs. 6,7). The Tohma formation consists, from base to top;

a. Zeynepoğlu member consisting of alternations of conglomerates, sandstones and mudstones,

b. Yoğunsakız member consisting of conglomerates and sandstones followed by alternations of limestones and marls,

c. Çorak member consisting of alternations of mudstones, sandstones and clayey limestones,

d. Çivril member consisting of alternating marls and limestones,

e. İriağaç member consisting of massive limestones with the lower section containing marl intercalations.

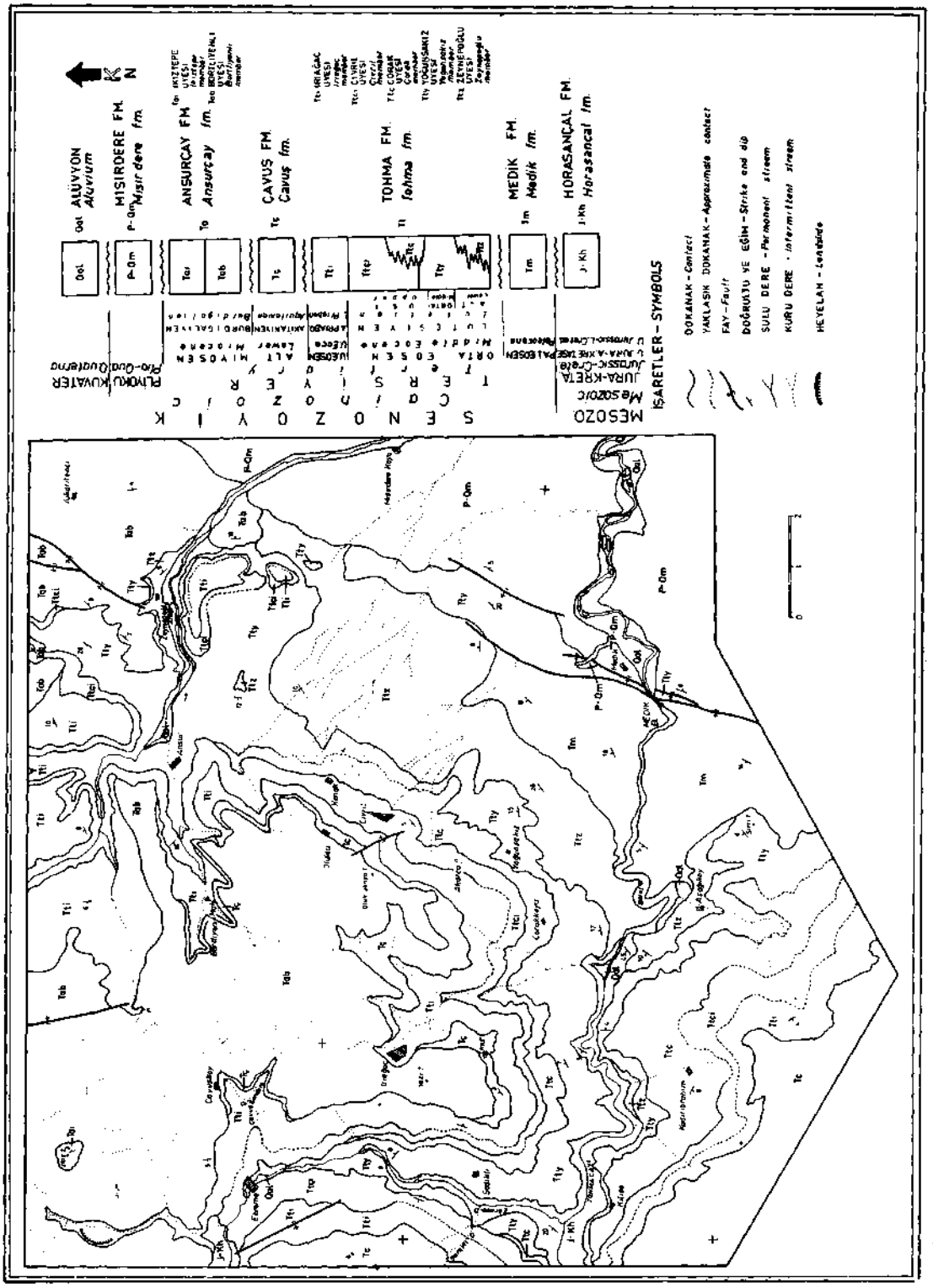


Fig. 3 - Geologic map of the Medik-Ebreme area.

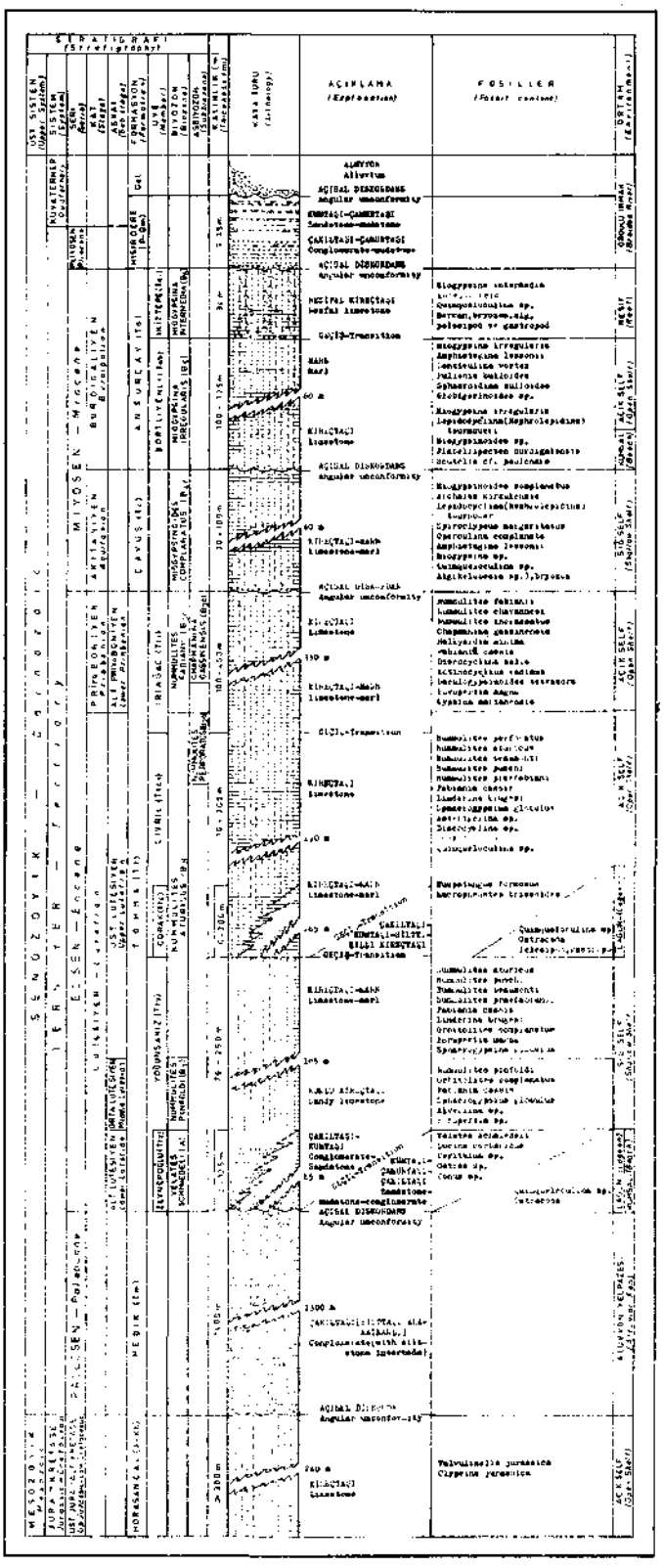


Fig. 4 – Generalised columnar section of the Medik-Ebreme area.

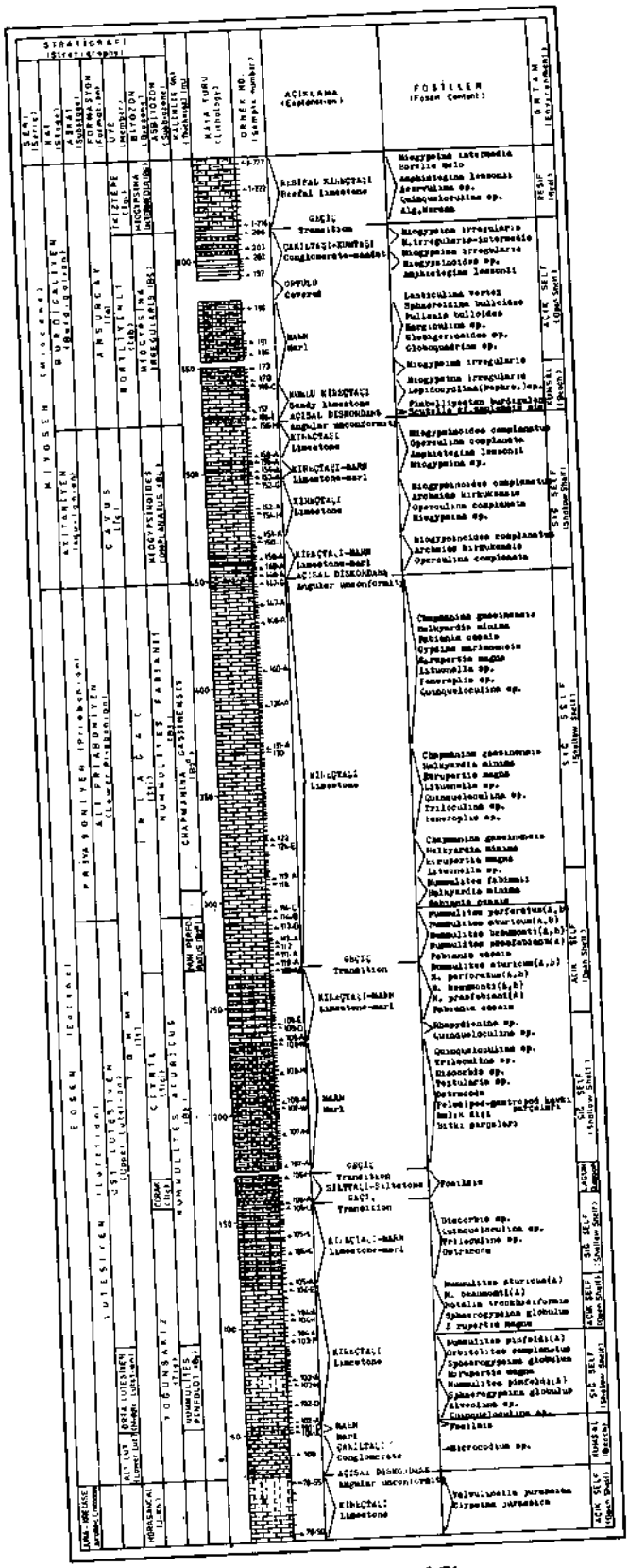


Fig. 5 - Measured stratigraphic section of Ebreme.

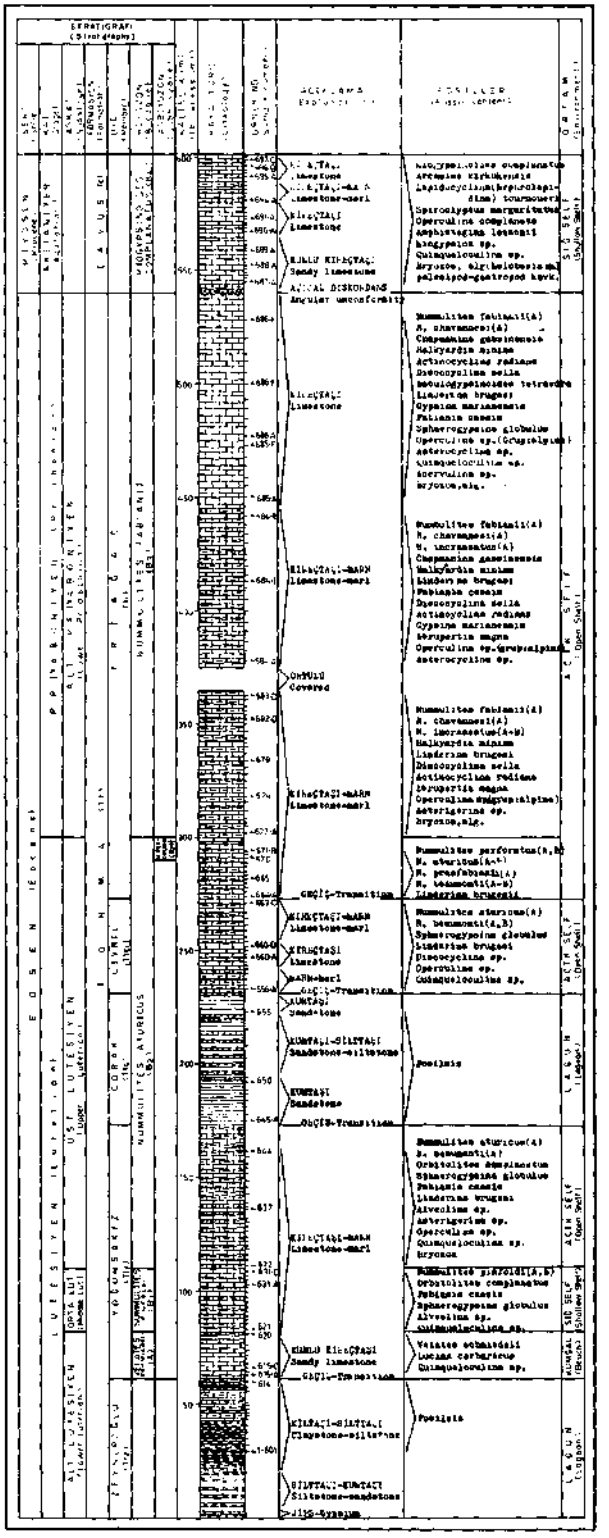


Fig. 6 - Measured stratigraphic section of Çivril-Akarca.

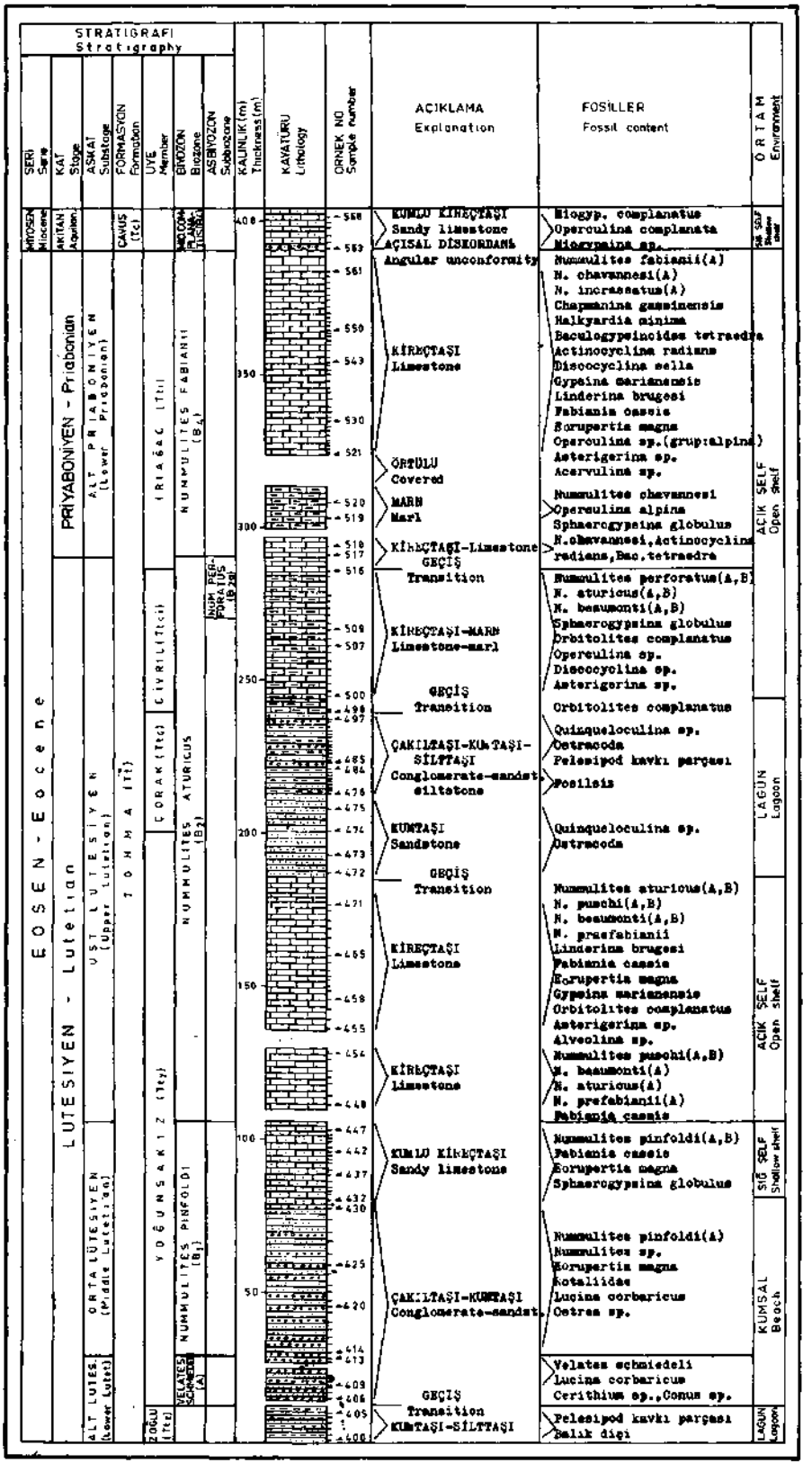


Fig. 7 - Measured stratigraphic section of Aşağıköy.

The formation lies unconformably on the Medik formation southeast of the investigated area and on the Horasançal formation along the Tohma valley. The-upper boundary is defined by the angular unconformities represented by the bases of Çavuş and Ansurçay formations. The thickness varies between 350-850 m.

The sandstone and sandy limestone alternation in the lowermost section of the Tohma formation contains a rich macrofauna of *Velates schmiedeli* Chemnitz, *Lucina corbaricus* Leymerie indicating a Lower Lutetian age. Limestones at the lower section contains a benthonic association of foraminifera of *Nummulites pinfoldi* Davies, *Orbitolites complanatus* Lamarck and *Fabiania cassis* (Oppenheim) of Middle Lutetian age. The marl-limestone alternation in the medial section is characterised by an Upper Lutetian microfauna comprising of *Nummulites aturicus* Joly and Leymerie, *Nummulites perforatus* (De Montfort), *Nummulites puschi* D'Archiac and Haime, *Nummulites praefabianii* Varentsof and Menner, *Assilina exponens* (Sowerby), *Linderina brugesi* Schlumberger. The limestones in the uppermost section contains a benthonic microfauna of Lower Priabonian age, consisting of *Nummulites fabianii* (Prever), *Nummulites incrassatus* De La Harpe, *Nummulites chavannesi* De La Harpe, *Chapmanina gassinensis* Silvestri, *Halkyardia minima* (Liebus), *Baculogypsinoides tetraedra* Gümbel. The environment of deposition of the Tohma formation is believed to be lagoonal, beach and shallow-open shelf according to the dwelling organisms and sedimentary features.

Çavuş formation. — It can typically be seen along Gendere and approximately 1 km southwest of Olukkaya peak (Fig. 6). It consists of yellow thin to medium bedded, well-cemented clastic limestones and yellowish-white, thin bedded clayey limestones as interbeds. It unconformably overlies the Tohma formation. It is unconformably overlain by the Ansurçay formation. The thickness of the unit varies between 50-100 m.

A microfauna consisting of benthonic foraminifera was determined from the collected samples: *Miogypsinoides complanatus* (Schlumberger), *Archaias kirkukensis* Henson, *Lepidocyclina (Nephrolepidina) tournoueri* (Lemoine and Douville), *Spiroclypeus margaritatus* (Schlumberger), *Operculina complanata* (Defrance) and *Miogypsina* sp. An Aquitanian age was assigned to the unit in accordance with this microfauna. It was deposited on the shallow shelf.

Ansurçay formation. — It is typically observed in Gendere and at İkiz peak (Fig. 5). It consists, from base to top, of thin to medium bedded, horizontal or cross-bedded, yellowish brown clastic limestone; gray, horizontal and medium to thick bedded an poorly cemented marls (Bortliyenli member) and yellowish white, indurated, very thick bedded to massive reefal limestones (İkiztepe member) based by a conglomerate horizon in the uppermost section, which overlies unconformably Tohma and Çavuş formations. It is unconformably covered by Mısırdere formation. The thickness of the unit is approximately 150 m.

Foraminifers obtained from the detrital limestone and marl of the Lower and Middle parts of Ansurçay formation such as *Miogypsina irregularis* (Michelotti), *Lepidocyclina (Nephrolepidina) tournoueri* (Lemoine and Douville), *Miogypsinoides* sp., *Amphistegina lessonii* d'Orbigny. *Lenticulina vortex* (Fichtel and Moll), *Sphaeroidina bulloides* d'Orbigny, *Globigerinoides* sp., *Globoquadrina* sp., *Globigerina* sp., *Flabellipecten burdigalensis* Lamarck, *Flabellipecten* cf. *solarium* Lamarck, *Clamys* cf. *scabrella* Lamarck, *Scutella* cf. *paulensis* indicate an age Burdigalian. The following microfossils have been found in the reefal limestone of the upper most level of the Ansurçay formation *Miogypsina intermedia* Droger, *Borelis melo* Fichtel and Moll, *Quinqueloculina* sp. coral, algae and pelecypoda according to these fossils Burdigalian age has been assumed for the upper most level of Ansurçay formation which has been deposited on a shallow marine, open shelf and reefal environment.

Mısırdereformation. — It can be observed typically in the northern section of Tohma stream. From base to top, it consists of reddish brown, poorly sorted, parallel bedded mudstones with thin intercalations of conglomerates followed by gray, poor to wellsorted, with eroded bottoms of bedding, parallel or cross-bedded conglomerates and yellowish gray, cross-bedded sandstones. It rests unconformably on the Ansurçay formation and is covered by recent alluvium. The thickness of the unit varies between 20-40 m.

This unit does not contain neither micro nor macrofossils. It was deposited in alluvial fans and braided streams.

Biostratigraphy

Biostratigraphic units (biozones) were observed according to the fossil content and distribution in the sediments of the area. Biozones are defined on the abundance of micro and macrofossils or according to the fauna defining a given stratigraphic horizon. «The International Stratigraphic Guides» (Hedberg, 1975) was used as a guide for distinction of the biozones.

Six benthonic foraminifera and one gastropoda biozones were defined in the Eocene-Miocene series. A biozone map was prepared to show the distribution and relations (Fig. 8).

Velates schmiedeli abundance biozone. — It is a macrofossil zone characterized by the *Velates schmiedeli* species of the Neritidae family. It occurs dominantly in the lower section of the Yoğunsakız member of the Tohma formation. It contains other macrofossils such as *Lucina corbaricus, Cerithium* sp., *Conus* sp., *Ostrea* sp. in addition to its typical constituent. It is dated as Lower Lutetian.

Nitmmulites pinfoldi abundance biozone. — It is a benthonic foraminifera biozone characterized by the *Nummulites pinfoldi* species of the Nummulitidae family. It dominates in the medial section of the Yoğunsakız member of the Tohma formation. In addition to the main component of the unit, the benthonic foraminifera species of *Orbitolites complanatus, Fabiania cassis, Eorupertia magna, Sphaerogypsina globulus, Aheolina* sp. and *Quinqueloculina* sp. are present. It is dated as Middle Lutetian.

Nummulites aturicus range biozone. — It is a benthonic foraminifera biozone characterized by the *Nummulites aturicus* species of the Nummulitidae family. The zone is limited at the base by the disappearance of *Nummulites pinfoldi* and appearance of *Nummulites aturicus.* It is limited at the top by the disappearance of *Nummulites aturicus* and appearance of *Nummulites fabianit.* It is dominant in the uppermost section of Yoğunsakız member, Çivril, Çorak members and in the lower section of İriağaç member of the Tohma formation. In addition to the main species of the biozone, the following benthonic foraminifera also occur in these units: *Nummulites perforatus, Nummulites beaumonti, Nummulites puschi, Nummulites praefabianii, Assilina exponens, Fabiania cassis, Linderina brugesi, Sphaerogypsma globulus, Asterigerina* sp., *Rhapydionina* sp., *Discorbis* sp.,*Quinqueloculina* sp. A subbiozone, namely *Nummulites perforatus* abundance subbiozone, was distinguished in the uppermost section of the *Nummulites aturicus* range biozone. *Nummulites aturicus* range biozone is of Upper Lutetian age.

Nummulites fabianii range biozone. — It is a benthonic foraminifera zone characterized by the *Nummulites fabianii* species of the Nummulitidae family. The lower boundary of the biozone is limited by the disappearance of *Nummulites aturicus* and appearance *of Nummulitesfabianii.* The upper limit can not be determined due to the incomplete nature of the sequence. It is dominant in the uppermost section of the İriağaç member of the Tohma formation. The benthonic foraminifera of *Nummulites chavannesi, Nummulites incrassatus, Chapmanina gassinensis, Halkyardia minima, Fabiania*

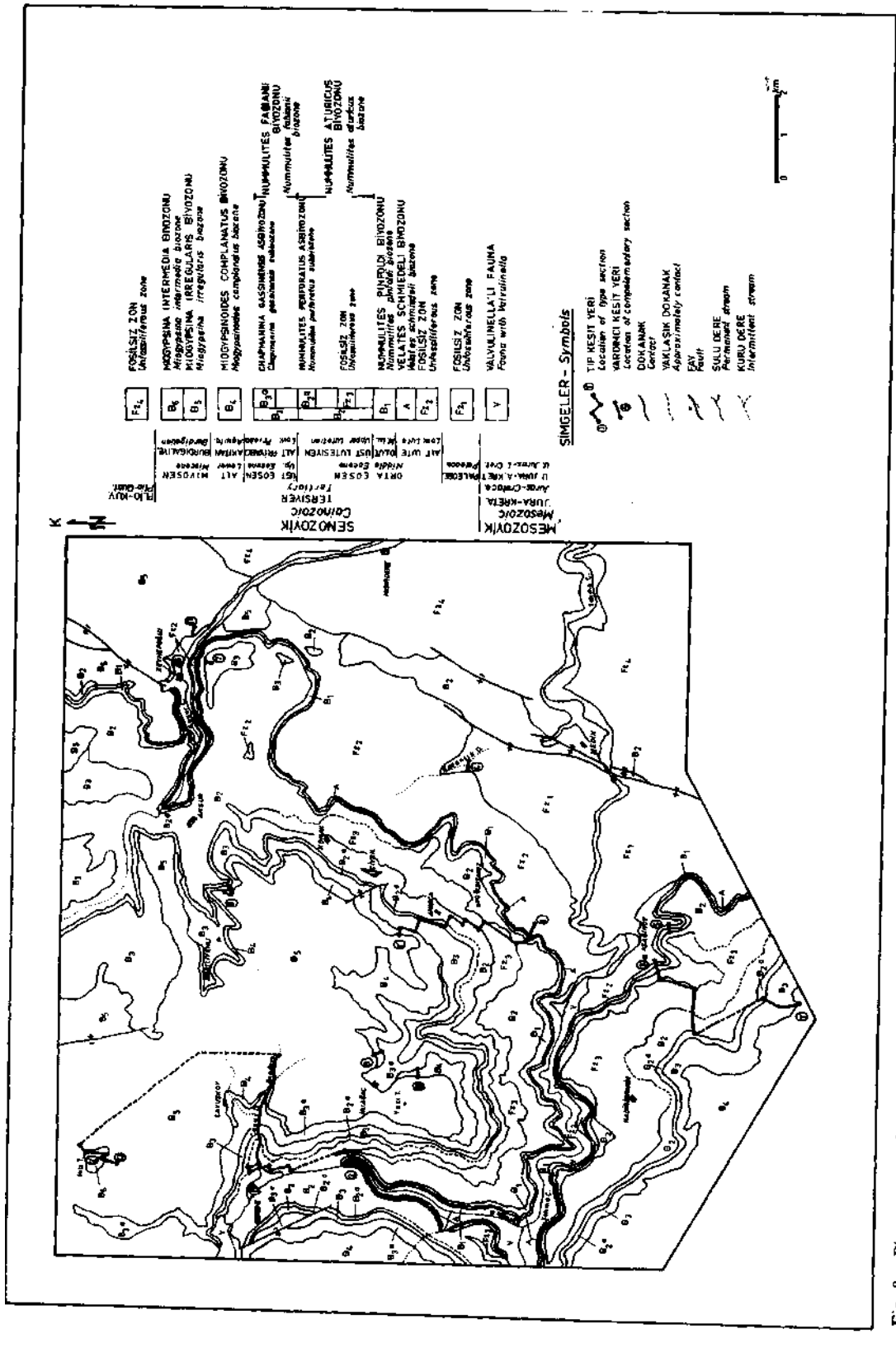


Fig. 8 - Biozone map of the Medik-Ebreme area.

cassis, Linderina brugesi, Baculogypsinoides tetraedra, Eorupertia magna, Discocyclina sella, Actinocyclina radians, Gypsina marianensis, Operculina alpina, Lituonella sp., *Peneroplis* sp. are associated to the main species of the biozone. An abundance subbiozone characterized by the *Chapmanina gassinensis* in the uppermost section of the *Nummulites fabianii* range biozone. *Nummulites fabianii* range biozone is dated as Lower Priabonian.

Miogypsinoides complanatus abundance biozone. — It is a zone of benthonic foraminifera characterized by *Miogypsinoides complanatus* sp. of the Miogypsinidae family. It is dominant in the sediments of the Çavuş formation. The benthonic foraminifera of *Archaias kirkukensis, Lepidocyclina (Nephrolepidina) tournoueri, Spiroclypeus margantatus, Operculina complanata, Amphistegina lessonii, Miogypsina* sp., *Pararotalia* sp. are associated to the main species of the biozone. It is dated as Aquitanian.

Mwgypsina irregularis abundance biozone. — It is a benthonic foraminifera zone characterized by the *Miogypsina irregularis* species of the Miogypsinidae family. It is dominant in the sediments of the Bortliyenli member of the Ansurçay formation. The benthonic and planctonic foraminifera of *Lepidocyclina (Nephrolepidina) tournoueri, Amphistegina lessonii, Lenticulina vortex, Pullenia bulloides, Sphaeroidina bulloides, Miogypsinoides* sp., *Globigerinoides* sp., *Globoquadrina* sp., *Globigerina* sp. and macrofossils of *Flabellipecten burdigalensis, Flabellipecten* cf. *solarium, Chlamys* cf. *scabrella, Scutella* cf. *paulensis* are found in addition to the main species. It is dated as Burdigalian.

Miogypsina intermedia abundance biozone. — It is a benthonic foraminifera zone characterized by *Miogypsina intermedia* species of the Miogypsinidae family. It occurs dominantly in the İkiztepe member of the Ansurçay formation. The following foraminifera typically occur with the main component of the biozone: *Borelis melo, Amphistegina lessonii, Gypsina* sp. *Acervulina* sp. corals, bryozoa, pelecypoda and gastropoda are additionally occurring macrofossils. The age interval is defined as Upper Burdigalian.

The correlation of the defined biozones are shown in a table (Fig. 9).

Chronostratigraphy

The fossils have been valuable guides in definition of the chronostratigraphic units. Chronostratigraphic units were constructed to correspond to the biozones. The aim of this section is to define the relative ages indicated by the paleontological data yielded by the Mesozoic and Cenozoic sediments.

Era : Mesozoic

Period : Jurassic - Cretaceous

Upper Jurassic - Lower Cretaceous-series: This unit is differentiated through the benthonic microfauna comprising *Valrulinella jurassica* and *Clypeina jurassica*

Era : Cenozoic

System : Tertiary

Subsystem : Paleogene

Paleocene series: It is considered to correspond to the process of formation of the continental sediments of the Medik formation.

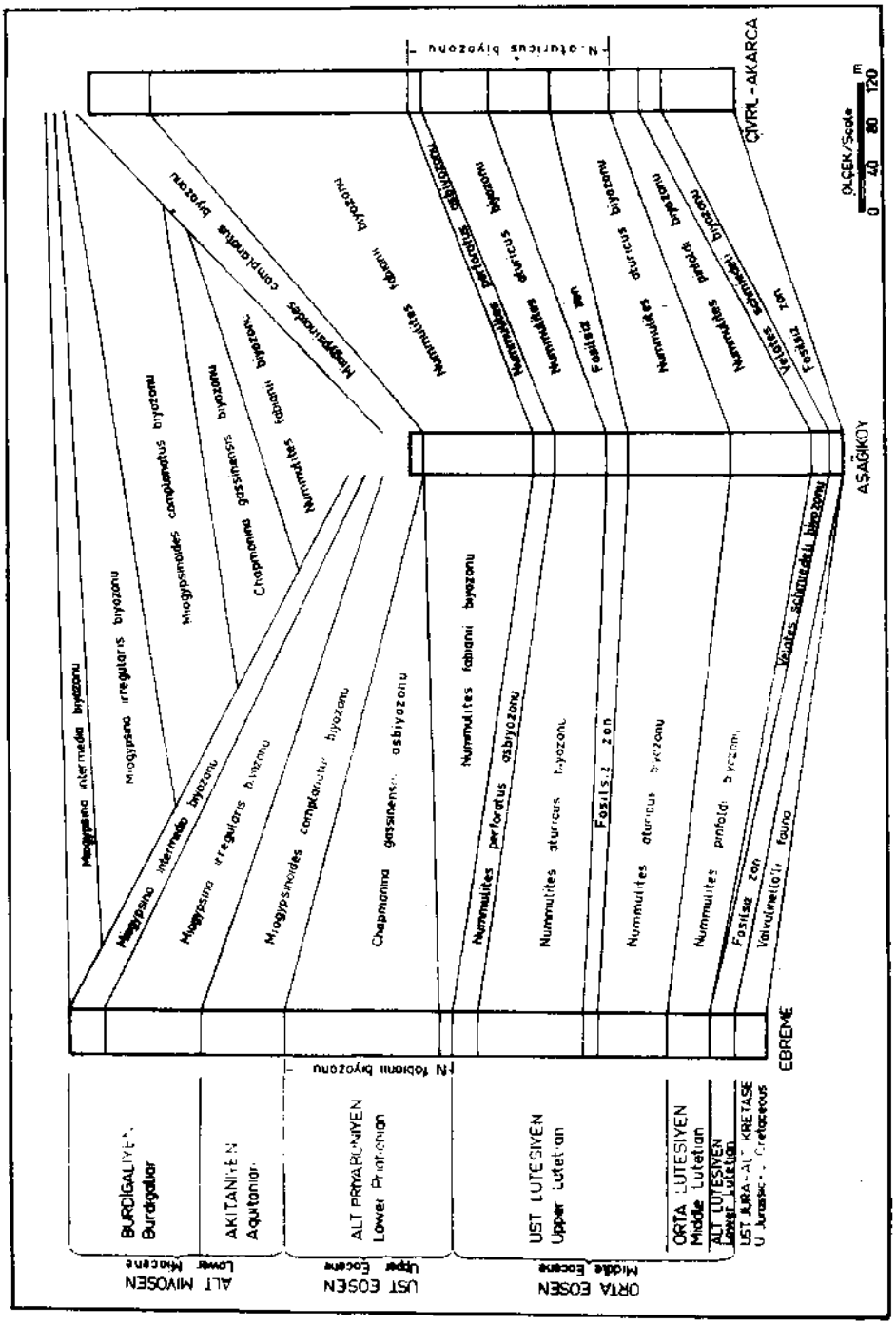


Fig. 9 - Biozone correlation table.

Eocene series: It is subdivided into subseries of Middle and Upper Eocene. The Middle Eocene subseries is represented by the Lutetian stage. The Lutetian stage is further subdivided into substages of Lower Lutetian (*Velates schmiedeli* biozone), Middle Lutetian *(Nummulites pinfoldi* biozone) and Upper Lutetian *(Nummulites aturicus* biozone). Upper Eocene subseries is represented by the Priabonian (Lower Priabonian) stage.

Subsystem : Neogene

Miocene series: It is represented by the Miocene subseries. This is subdivided into substages of Aquitanian *(Miogypsinoides complanatus* biozone) and Burdigalian *(Miogypsina irregularis* and *Miogypsina intermedia* biozones).

Sediments of the Mısırdere formation are considered to have been deposited during the large time interval of Pliocene and Quaternary.

The relations between lithostratigraphic, biostratigraphic and chronostratigraphic units are shown in Fig. 10.

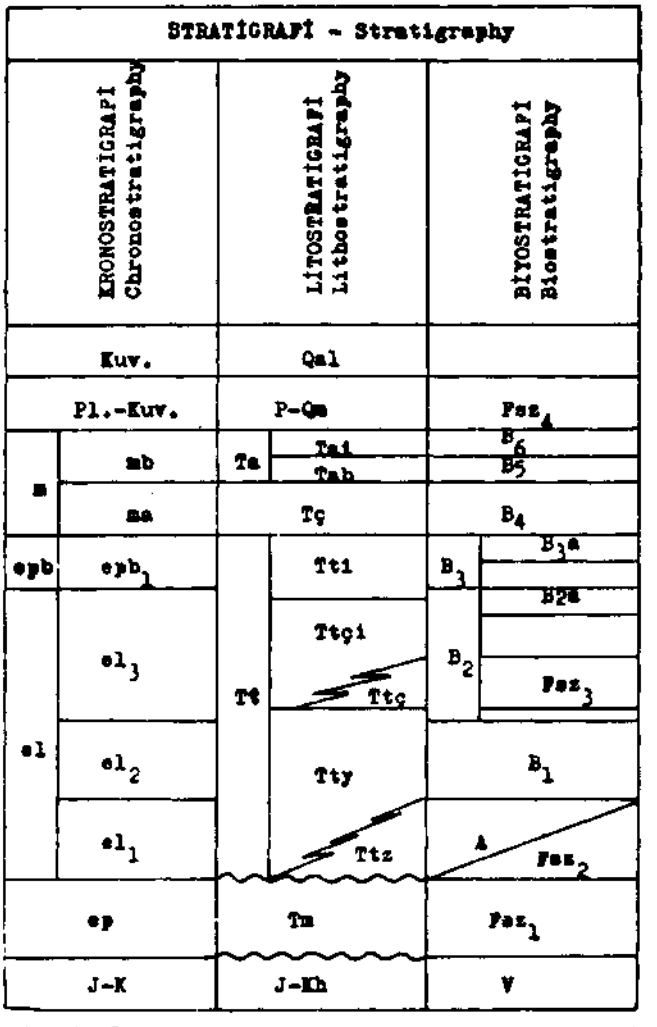


Fig. 10 - Relation between the lithostratigraphic, biostratigraphic and chronostratigraphic units defined for the investigated area. (The explanation of symbols is given in figures 3,8 and 12).

A complete harmony of correlation of the biozones, biostratigraphic and chronostratigraphic, are shown to exist (Fig. 11) with those of Turkey (İstanbul, Ankara, Denizli, Kastamonu, Malatya, Sivas, Muş regions) carried out by Dacı (1951), Dacı and Dizer (1953), Dizer (1962 a,b), Sirel and Gündüz (1976), Sirel (1976), Sakınç (1982), and Dizer (1982) and of the world (France, Italy, Greece, Yugoslavia, Romania, Hungary, Soviet Union, Iran, India and various regions of America) investigated by Veillon (1964), Blondeau et al. (1968), Plaziat and Renzi (1968), Bignot et al. (1968), Cavelier (1968), Castellarin and Cita (1969), Cita (1969), Dudich et al. (1968), Bombita and Moisescu (1968), lonesi (1971), Nemkov (1964, 1968), Hottinger et al. (1964), Schaub (1981), Akers and Drooger (1957), Mohan (1958), Rahaghi (1974), Raju (1974) and Mulder (1975).

PALEONTOLOGY

Large foraminifera such as Nummulitidae, Discocyclinidae, Lepidocyclinidae, Miogypsinidae families and species of these families are described in this section.

The stratigraphic distributions of the collected micro and macrofossils are shown in a table (Fig. 12) via realization of the paleontologic systematic.

Description of species

Ordo : Foraminiferida Eichwald, 1830

Family : Nummulitidae De Blainville, 1825

Genus : Nummulites Lamarck, 1801

Nummulites pinfoldi Davies, 1940
(Plate I, fig. 1-2)

1940 *Nummulites pinfoldi* Davies, Davies, p. 209

1976 *Nummulites pinfoldi* Davies, Sirel and Gündüz, p. 31-44

Description: Macrospheric figure : The shell is 2 mm in diameter and is 1.1 - 1.2 mm thick. Form of the shell: Lenticular, the central part is bulbed with a white patch; the division lines are thick and form a radiating pattern of divisions. The planspiral has four tours with wide coiling; is 50-70 microns thick. The divisions are slightly inclined to straight and height of the chambers slightly exceeds the width. The first chambre is isolepidine and is 70 microns in diameter.

Microspheric figure: The measured diameter and thickness of the shell are respectively 1.7-2.15 mm and 0.85-1.35 mm. The outer features are the same as described for the macrospheric figure. The planspiral has five tours with wide coiling and is 50-70 microns thick. The first chamber is small.

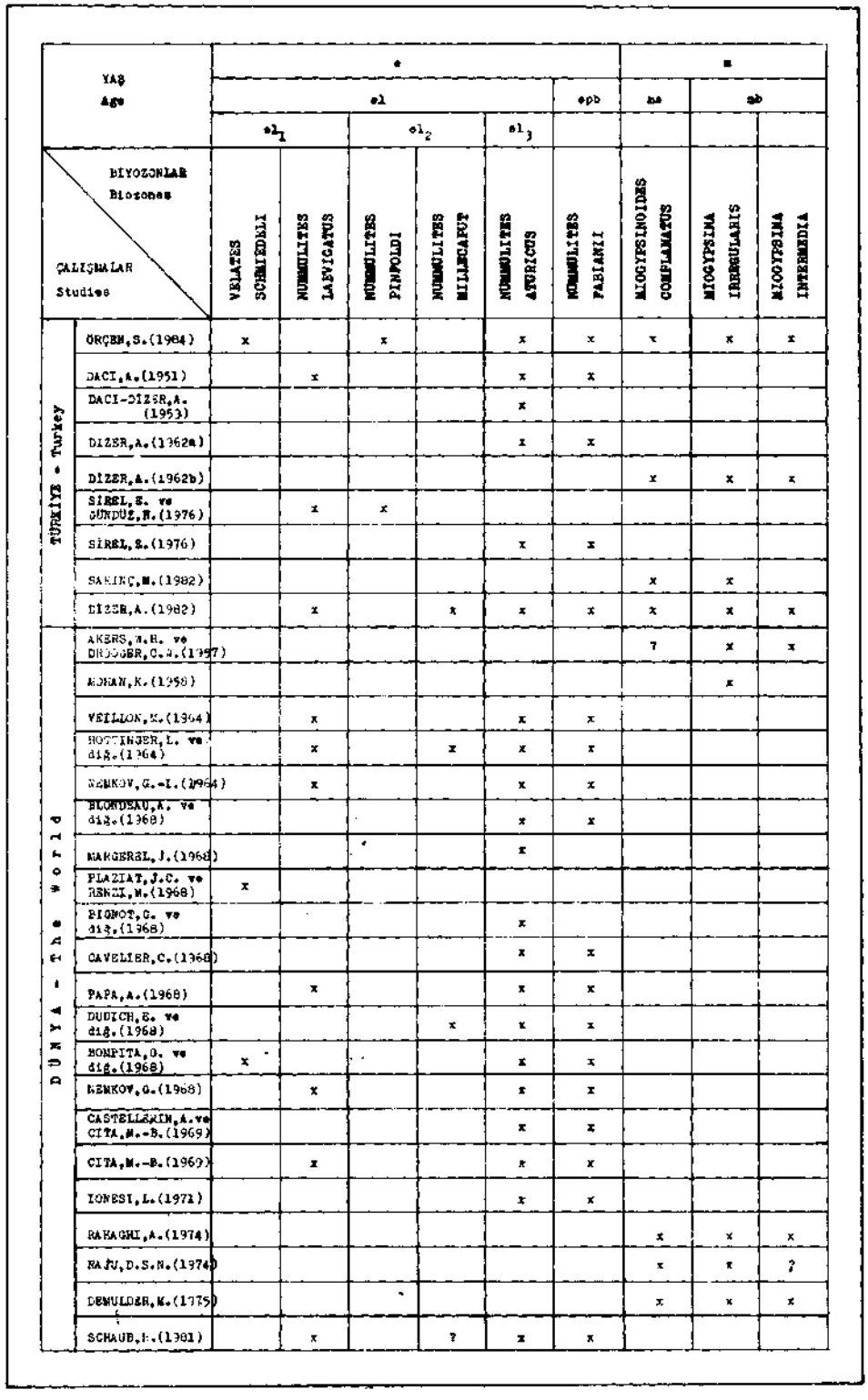
Stratigraphic distribution: Middle Lutetian.

Occurrence: Northwestern Malatya, vicinity of Medik-Ebreme.

Nummulites beamonti D'Archiac and Haime, 1853
(Plate I, fig. 7-10)

1853 *Nummulites beamonti* D'Archiac and Haime, Archiac and Haime, p. 133

1951 *Nummulites sub-beamonti* De La Harpe, Dacı, p. 215



	YAŞ / Age	e						m		
		e1					e1b	m1	m2	
		$e1_1$		$e1_2$		$e1_3$				
	BİYOZONLAR / Biozones / ÇALIŞMALAR / Studies	VELATES SCHMIEDELI	NUMMULITES LAEVIGATUS	NUMMULITES PINFOLDI	NUMMULITES MILLECAPUT	NUMMULITES AFURICUS	NUMMULITES PARISIENSIS	MIOGYPSINOIDES COMPLANATUS	MIOGYPSINA IRREGULARIS	MIOGYPSINA INTERMEDIA
TÜRKİYE - Turkey	ÖRÇEN,S.(1964)	x		x		x	x	x	x	x
	DACI,A.(1951)		x			x	x			
	DACI-DİZER,A. (1953)					x				
	DİZER,A.(1962a)					x	x			
	DİZER,A.(1962b)							x	x	x
	SİREL,S. ve GÜNDÜZ,N.(1976)		x	x						
	SİREL,S.(1976)					x	x			
	SAKINÇ,M.(1982)							x	x	
	DİZER,A.(1982)		x		x	x	x	x	x	x
DÜNYA - the world	AKERS,W.H. ve DROOGER,C.W.(1957)							?	x	x
	ADAM,K.(1958)								x	
	VEILLON,M.(1964)		x			x	x			
	HOTTINGER,L. ve diğ.(1964)		x		x	x	x			
	NEMKOV,G.-I.(1964)		x			x	x			
	BLONDEAU,A. ve diğ.(1968)					x	x			
	MARGEREL,J.(1968)					x				
	PLAZIAT,J.C. ve RENZI,M.(1968)	x								
	PIGNOT,G. ve diğ.(1968)					x				
	CAVELIER,C.(1968)					x	x			
	PAPA,A.(1968)		x			x	x			
	DUDICH,E. ve diğ.(1968)				x	x	x			
	MONPITA,G. ve diğ.(1968)	x				x	x			
	NEMKOV,G.(1968)		x			x	x			
	CASTELLARIN,A.ve CITA,M.-B.(1969)					x	x			
	CITA,M.-B.(1969)		x			x	x			
	IONESI,L.(1971)					x	x			
	RAHAGHI,A.(1974)							x	x	x
	NAJU,D.S.N.(1974)							x	x	?
	DEMULDER,M.(1975)							x	x	x
	SCHAUB,H.(1981)		x		?	x	x			

Fig. 11 - Correlation of the defined biozones with that of Turkey and of localities in other parts of the world.

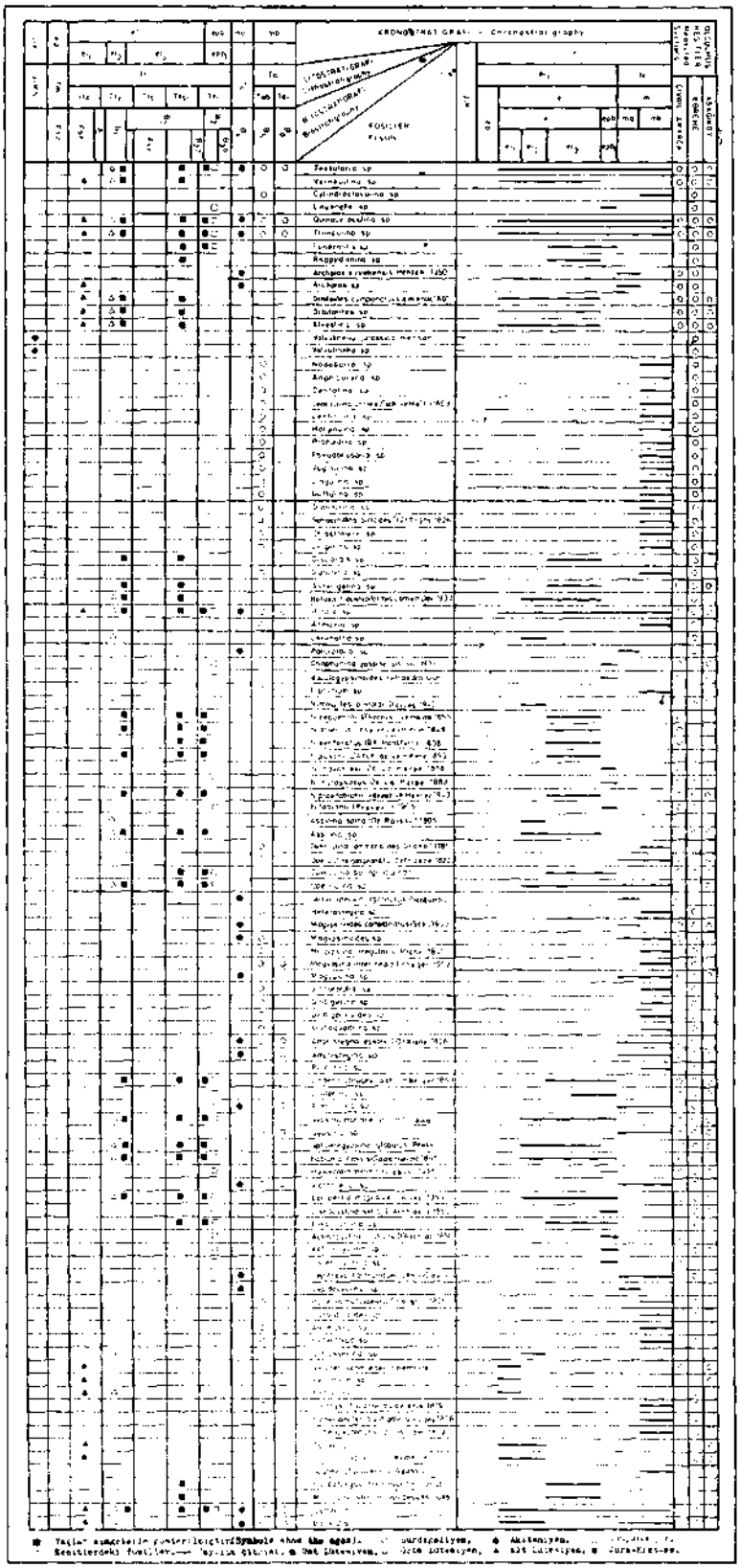


Fig. 12 – Stratigraphic distributions of the described fossils of the investigated area.
J-K - Upper Jurassic - Lower Cretaceous; T - Tertiary; Plj - Paleogene; N - Neogene; e - Eocene; m - Miocene; ep - Paleocene; el - Lutetian; el_1 - Lower Lutetian; el_2 - Middle Lutetian; el_3 - Upper Lutetian; epb - Priabonian; epb_1 - Lower Priabonian; ma - Aquitanian; mb - Burdigalian.

Description: Macrospheric figure: The measured diameter and thickness of the shell are respectively 2-6.1 mm and 0.8-3 mm. Lenticular, the margins are sharp and the central part is bulbed with a white patch. The division lines are turbinate in the centre and is arched towards the edges. There is a transversal trabecule in the margin of the shell. The planspiral has 4 to 8 tours with wide coiling with a thickness of 60-150 microns. The divisions are thin, slightly inclined and straight. The height of the chamber is greater than the width. The first chamber is isolepidine with a diameter of 0.15-0.30 mm.

Microspheric figure: The diameter of the test varies between 5.9-9.75 mm, the thickness of the test ranging from 2.8 mm to 4.2 mm. External characters of the shell are the same as in the macrospheric form. It is counted 11-16 whorl within the shell. The thickness of the spire is 75-200 μ. The septa are thin, slightly inclined and straight. The height of the chambers are greater than the width of the chambers. The proluculus is very small.

Stratigraphic distribution: Upper Lutetian.

Occurrence: Northwest of Malatya, vicinity of Medik-Ebreme.

Nummulites puschi D'Archiac, 1850
(Plate II, fig. 4-6)

1850 *Nummulina puschii* D'Archiac, Archiac, p. 241

Description: Macrospheric figure: The measured diameter and thickness of the shell are respectively 7-7.4 mm and 2.2-2.4 mm. The shape of the shell is lenticular, flattened, the margins are sharp and the central part is slightly bulbed. The division lines are thick and distinct in the margins of the shell and are reticuled. There is a granule coating on the surface of the shell. The planspiral has 8 tours, the coiling is wide initially with transitional lightning and has a thickness of 100 microns. The divisions are thin and short, slightly inclined and arched. The width of the chamber is greater than the height. The first chamber is subspherical with a diameter of approximately 1.4 mm.

Microspheric figure: The measured thickness and diameter of the shell are 5-5.2 mm and 29.5-30 mm respectively. The outer features are as described in the macrospheric figure. The planspiral has 28 tours with wide coiling and has a thickness of 150-250 microns. The divisions are thin, short, and slightly arched and inclined. The width of the chamber is greater than the height. The first chamber is very small.

Stratigraphic distribution: Upper Lutetian.

Occurrence: Northwest of Malatya, vicinity of Medik-Ebreme.

Nummulites aturicus Joly and Leymerie, 1848
(Plate I, fig. 14-17)

1848 *Nummulites aturica* Joly and Leymerie, Joly and Leymerie, p. 171, 218

1953 *Nummulites aturicus* Joly and Leymerie, Dacı and Dizer, p. 270-299, Plate 8, fig. 9

1963 *Nummulites aturicus* Joly and Leymerie, Schaub, p. 285

Description: Macrospheric figure: The measured diameter and thickness of the shell are 4.6-7 mm and 2.4-3.75 mm respectively. The shape of the shell is lenticular with fairly sharp edges. The division lines are radiating, thin and slightly undulatory. The granules are large in the centre fining towards the margins with a nonuniform distribution. The planspiral has 6-7 tours with wide coiling. The thickness is approximately 120-200 microns. The divisions are thin to medium, short, inclined, arched and occasionally unqulatory. The width of the chambers is greater than the height. The first chamber is subspherical and has a diameter of 0.5-1 mm.

Microspheric figure: The measured diameter and thickness of the shell are 10.1-12.9 mm and 2.85-5.8 mm respectively. The division system are meandering with meandering, undulatory and thin division lines. The granules, fairly large in the centre and fine in the margins, are on and between the division lines. The planspiral has 12-19 tours with wide coiling and a thickness of 100-200 microns. The divisions are inclined, arched, occasionally subhorizontal and undulatory. The width of the chambers is greater than the height. The first chamber is very small.

Stratigraphic distribution: Upper Lutetian.

Occurrence: Northwest of Malatya, vicinity of Medik-Ebreme.

Nummulites perforatus (De Montfort), 1808
(Plate II, fig. 1-3)

1911 *Nummulites perforatus* Denys De Montfort, Boussac, p. 15-16, 29-30, plate VI, fig. 1,8; plate XXII, fig. 1; plate VI, fig. 5

1972 *Nummulites perforatus* Montfort, Blondeau, p. 161, Plate XXXIV, fig. 6-11

Description: Macrospheric figure: The measured diameter and thickness of the shell are 5.3-7.75 mm and 2.35-4.15 mm respectively. The shape of the shell is lenticular, bulbed with fairly sharp edges. The division system is radiating with thin and slightly undulating division lines. The granules, fairly large in the centre and fine grained in the margins, occur on and between the division lines. The planspiral has 5-6 tours with wide coiling and a thickness of 100-180 microns. The divisions are thin to thick, short, inclined, arched, occasionally subhorizontal and undulatory. The first chamber is nonuniform, elypsoidal with a diameter varying between 0.85-1.5 mm.

Microspheric figure: The measured diameter and thickness of the shells are 18.2-29 mm and 8.4-15.2 mm respectively. The shape of the shell is lenticular, extremely bulbed with rounded edges. The division system is meandering. There are fine meanders on the division lines. There are fine to medium grained granules of a nonuniform distribution on and between the division lines. The planspiral has 25-45 tours. The system of coiling has a three stage development in the well-evolved individuals. Coiling is tight for the initial 6-7 tours slackening for the eight-nineteenth and becoming extremely tight for the twentieth-forty-fifth. The gap between tours is extremely small for the latest stage of coiling, with rare twinning. The thickness of the planspiral is about 150-250 microns. The divisions are slanted, arched, extremely slanted and undulatory. The width of the chambers exceeds the height. The first chamber is very small.

Stratigraphic distribution: Upper Lutetian.

Occurrence: Northwest of Malatya, vicinity of Medik-Ebreme.

Nummulites preafabianii Varentsof and Menner, 1933
(Plate I, fig. 18-20)

1933 *Nummulites praefabianii* Varentsof and Menner, Varentsof-Menner, p. 104

Description: Macrospheric figure: The measured diameter and thickness of the shells are 1.8-2.5 mm and 0.8-1.3 mm respectively. The shape of the shell is lenticular and flattened with fairly sharp edges. The division system is reticuled. The division lines are thick and are distinct at the margins. There is a large granule in the centre circled by a set of uniform and fine grained granules. The planspiral has 4-6 tours with slack coiling and a thickness of 50-100 microns. The divisions are thick, slanted, arched and the edges are thick. The first chamber is isolepidine and has a diameter of 0.1-0.15 mm.

Microspheric figure: The measured diameter and thickness of the shells are 2.8-4.6 mm and 1.3-1.65 mm respectively. The outer features are as described in the macrospheric figure. The planspiral has 8 tours with slack coiling and a thickness of about 160-200 microns. The divisions are thick, slanted and slightly arched. The width of the chambers exceeds the height. The first chamber is very small.

Stratigraphic distribution: Upper Lutetian.

Occurrence: Northwest of Malatya, vicinity of Medik - Ebreme.

Nummulites fabianii (Prever),1905
(Plate I, fig. 21)

1911 *Nummulites fabianii* Prever, Boussac, p. 79-84, plate I, fig. 6,13; plate IV, fig. 9,10

1938 *Nummulites fabianii* Prever in Fabianii, Flandrin, p.48-51, plate III, fig. 71-76

1951 *Nummulites fabianii* Prever, Dacı, p. 206

1972 *Nummulites fabianii* (Prever), Blondeau, p. 156, plate III, fig. 1-5

Description: Macrospheric figure: The measured diameter and thickness of the shells are 1.8-2.5 mm and 0.8-1 mm respectively. The shape of the shell is lenticular and flattened with sharp edges. The divisional system is reticulised with thick division lines intersecting on the spirs. There is a large granule in the centre encircled by circles made up by fine grained granules. The planspiral has 5-6 tours with slack coiling and a thickness of 80-100 microns. The divisions are thin, slightly slanted and arched, and the edges are thick. The width of the chamber is greater than the height. The first chamber is isolepidine with a diameter varying between 0.1-0.12 mm.

Microspheric figure: The measured thickness and diameter of the shell are 1.2-1.5 mm and 4.2-4.5 mm respectively. The shape of the shell is flattened with sharp edges. The divisional system and the granuhzation are the same as that described for the macrospheric figure. The planspiral has 7-8 tours with slack coiling and a thickness of 60-65 microns. The divisions are thin, arched, occasionally extremely slanted and the edges are thick. The width of the chambers is greater than the height. The first chamber is very small.

Stratigraphic distribution: Lower Priabonian.

Occurrence: Northwest of Malatya, vicinity of Medik-Ebreme.

Nummulites chavannesi De La Harpe, 1878
(Plate I, fig. 11-13)

1911 *Nummulites chavannesi* De La Harpe, Boussac, p.69, plate XVII, fig. 10

1938 *Nummulites chavannesi* De La Harpe, Flandrin, p.254-255, plate XIV, fig. 15

1951 *Nummulites chavannesi* De La Harpe, Dacı, p.210, plate II, fig. 9

1972 *Nummulites chavannesi* De La Harpe, Blondeau, p. 146, plate XXII, fig. 1-3

Description: Macrospheric figure: The measured diameter and thickness of the shell are 2.5-4.5 mm and 0.85-2.1 mm respectively. The shape of the shell is lenticular with a bulbed centre and sharp edges. The divisional system is radiating; the lines of divisions are thin, close to one another and are slightly curved towards the edges of the shell. There is inconspicous patch in the central part. The planspiral has 4-6 tours with tight coiling and a thickness averaging 60 microns. The divisions are thin, long, slightly slanted, initially straight getting arched later on. The height of the chambers are greater than the width. The first chamber is unisolepidine with a diameter varying between 0.11-0.15 mm.

Microspheric figure: The measured diameter and the thickness of the shells are 4.0-5.5 mm and 0.85-2 mm respectively. The outer features are-the same as the macrospheric figure. The planspiral has 6-7 tours with tight coiling and a thickness of 60 microns. The divisions are thin, close and slightly arched. The height of the chambers are greater than the width. The first chamber is very small.

Stratigraphic distribution: Lower Priabonian.

Occurrence: Northwest of Malatya, vicinity of Medik-Ebreme.

Nummulites incrassatus De La Harpe, 1883
(Plate I, fig. 3-6)

1883 *Nummulites vasca* var. *incrassata* et var. *tenuispira* De La Harpe, De La Harpe, plate VII, fig. 27, 28, 29, 32

1911 *Nummulites incrassatus* De La Harpe, Boussac, p. 32-34

1938 *Nummulites incrassatus* De La Harpe, Flandrin, p. 40-42, plate III, fig. 24, 50

1951 *Nummulites incrassatus* De La Harpe, Dacı, p. 207-209, plate II, fig. 5, 6

Description: Macrospheric figure: The measured diameter and thickness of the shell are 1.9-3.3 mm and 0.85-1.9 mm respectively. The shape of the shell is lenticular, bulbed in the centre and has sharp edges. The divisional system is radiating. The division lines are thick, starts as straight lines from the centre slightly curving towards the exterior. There is a white button in the centre of the shell. The planspiral has 4-5 tours with slack coiling and a thickness of 50-100 microns. The height of the chamber is greater than the width. The first chamber is isolepidine and unisolepidine and has a diameter of 0.15-0.20 mm.

Microspheric figure: The measured thickness and diameter of the shells are 1.8 mm (average) and 3.2-2.75 mm respectively. The outer features are the same as that of the macrospheric figure. The planspiral has 6-7 tours with slack coiling and has an average thickness of 120 microns. The divisions are thin, slanted, slightly arched and closely spaced. The height of the chambers exceeds the width. The first chamber is very small.

Stratigraphic distribution: Lower Priabonian.

Occurrence: Northwest of Malatya, vicinity of Medik-Ebreme.

Genus: Assilina D'Orbigny, 1839
Assilina exponens (Sowerby)
(Plate II, fig. 7-8)

1840 *Nummulites exponens* Sowerby, Sowerby, p. 719, plate XII, fig. 14

1911 *Assilina exponens* (Sowerby), Boussac, p. 100

1938 *Assilina mamillata* (D'Archiac), Flandrin, p. 79-80, plate VIII, fig. 6-16

1953 *Assilina mamillata* (D'Archiac), Dacı-Dizer, p.267-268, plate IX, fig. 5-6

1976 *Assilina exponens* (Sowerby), Sirel ve Gündüz, p. 39-40, plate X, fig. 9; plate XI, fig. 1-9

Description: Macrospheric figure: The measured diameter and thickness of the shells are 9.1 mm and 1.7-1.85 mm respectively. The shape of the shell is a lentiform of extremely flattened habit with rounded edges. Spirs and divisions are distinct on the surface of the shell. There are a few granules in the central part of the shell. The planspiral has six tours with slack coiling and has an approximate thickness of 200-300 microns. The divisions are thin, slightly slanted and aligned perpen-

dicular to the tours. The chambers are roughly quadrangular whose height is greater than its width. The first chamber is unisolepidine and oval shaped with a diameter of about 0.38 X 0.70 mm.

Stratigraphic distribution: Upper Lutetian.

Occurrence: Northwest of Malatya, vicinity of Medik-Ebreme.

Family: Discocyclinidae Galloway, 1928

Genus : Discocyclina Gümbel, 1870
Discocyclina sella (D'Archiac), 1850
(Plate II, fig. 9-11)

1850 *Orbitolites sella* D'Archiac, Archiac, p. 405, plate VIII, fig. 10-12

1903 *Orthophragmina sella* D'Archiac, Schlumberger, p. 278, plate IX, fig. 14-16, 25

1951 *Discocyclina sella* D'Archiac, Dacı, p. 228-229

1958 *Discocyclina sella* (D'Archiac), Neumann, p.106-109, plate XXII, fig. 1; plate XXVI, fig. 2-4

Description: Macrospheric figure: The measured diameter and thickness of the shell are 2.5-5.5 mm and 1.1-1.8 mm respectively. The shape of the shell is lenticular with a bulbed centre and thin-sharp edges. The granules have a diameter averaging 120-130 microns in the central part. They are smaller in the exterior parts and are encircled by rosettes with 7-8 petals. The embroyonic organism is of the eudoscoidine type. The protoconc is spherical with a diameter of approximately 125 microns. The deuteroconc has not fully encircled the protoconc. It has a diameter of 290 X 330 microns and has flattened edges. The periembryonic chambers are in two lines. The first line contains 26 chambers. The equatorial chambers are initially close to a square (40 X 45 microns) and become quadrangular in shape (35 X 60, 55 X 85 microns). The wall of the chambers has a thickness of about 17-20 microns.

Stratigraphic distribution: Lower Priabonian.

Occurrence: Northwest of Malatya, vicinity of Medik-Ebreme.

Genus: Actinocyclina Gümbel, 1870
Actinocyclina radians (D'Archiac), 1850
(Plate III, fig. 1-3)

1850 *Actinocyclina radians* (D'Archiac), Archiac, p. 397-456, plate VIII, fig. 15, 16

1951 *Actinocyclina radians* D'Archiac, Dacı, p. 232-233, plate IV, fig. 17,21

1958 *Actinocyclina radians* (D'Archiac), Neumann, p. 106-109, plate XXII, fig. 1-8; plate XXVI, fig. 5-7; plate XXXVI, fig. 2-4, 33

Description: Macrospheric figure: The measured diameter of the shell averages 8.4 mm. The shape of the shell is extremely flattened and the central part is bulbed. The granules on the central bulb and radial cods are relatively larger. The embroyonic organism is of the nephrodiscoidine type. The protoconc is spherical with a diameter of approximately 145 x160 microns. Deuteroconc has not entirely encircled the protoconc and has a diameter of 340x480 microns. The equatorial chambers are initially close to a square (30 X 40 microns) and become quadrangular in shape (60 x140 microns).

Stratigraphic distribution: Lower Pnabonian.

Occurrence: Northwest of Malatya, vicinity of Medik-Ebreme.

Family : Lepidocyclinidae Scheffen, 1932

Genus : Lepidocyclina Gümbel, 1870

Subgenus : Nephrolepidina H.Douville, 1911

Lepidocyclina (Nephrolepidina) tournoueri Lemoine and Douville), 1904
(Plate III, fig. 4)

1904 *Lepidocyclina tournoueri* Lemoine and Douville, Lemoine and Douville, p.19, plate 1, fig. 5, plate II, fig. 2,14; plate III, fig. 7

1962 *Lepidocyclina (Nephrolepidina) tournoueri* (Lemoine and Douville, Dizer, p.73-74, plate VIII, fig. 4-6

1975 *Lepidocyclina (Nephrolepidina) tournoueri* Lemoine and Douville, Mulder, p.64-66, plate 3, fig. 10; plate 4, fig. 1-3

1982 *Lepidocyclina (Nephrolepidina) tournoueri* (Lemoine and Douville), Sakınç, p. 257-258

Description: Macrospheric figure: The measured diameter and thickness of the shells are 1.7 mm and 0.85-1.15 mm respectively. The shape of the shell is lenticular with the central part bulbed and thin edges. There are 3-5 granules in the central part of the shell. The nucleoconc is of the nephrolepidine type. The protoconchas an elypsoidal shape with a diameter of approximately 290-420 microns. Deuteroconc has a diameter varying between 420-530 microns partially encircling the protoconc. The nepionic chambers are aligned around the nucleoconc. The neanic chambers have an hexagonal shape.

Stratigraphic distribution: Aquitanian, Burdigalian.

Occurrence: Northwest of Malatya, vicinity of Medik-Ebreme.

Family : Miogypsinidae Vaughan, 1928

Genus : Miogypsinoides Yabe and Hanzawa, 1928

Miogypsinoides complanatus (Schlumberger), 1900
(Plate III, fig. 5-6)

1900 *Miogypsina complanata* Schlumberger, Schlumberger, p. 330, plate 2, fig. 13-16; plate 3, fig. 18-21

1957 *Miogypsinoides complanatus* (Schlumberger), Hanzawa, p. 92

1959 *Miogypsina (Miogypsinoides) complanata* (Schlumberger), Drooger and Magne, p.273, fig. 6-9, plate 3, fig. 3-7

1962 *Miogypsina (Miogypsinoides) complanata* (Schlumberger), Dizer, p.76, plate 6, fig. 4

1974 *Miogypsinoides (Miogypsinoides) complanata* Schlumberger, Raju, p.78, plate 1, plate 2, fig.1-3

1982 *Miogypsinoides complanatus* (Schlumberger), Sakınç, p. 259-260

Description: Macrospheric figure: The measured thickness and diameter of the shell are 0.5 mm (mean value) and 1.5 mm respectively. The shape of the shell is fanlike, the apex is bulbed and the surface is covered by large granules. The embryo-nepionic section lies in the apex of the shell. The protoconc is spherical with a diameter of 155 microns. Deuteroconc is nonuniform and elypsoidal and its diameter was measured as 140x180 microns. The embryo-nepionic section consists of a 1.5 tour spiral having 10-14 nepionic chambers. The angle between the apexal frontal and medio-embryonic lines is negative and obtuse. The neanic chambers have thick walls and are of a rhombic shape that are initially short lengthening later. Lateral chambers are incipient.

Stratigraphic distribution: Aquitanian.

Occurrence: Northwest of Malatya, Medik-Ebreme region.

Genus: Miogypsina Sacco, 1893
Miogypsina irregularis (Michelotti), 1841
(Plate III, fig. 7-8)

1900 *Miogypsina irregularis* (Michelotti), Schlumberger, p. 328, plate II, fig. 1-7,9,10; plate III

1940 *Miogypsina irregularis* (Michelotti), Bronnimann, p. 88-94, plate 8, fig. 1-11; plate 10, fig. 6-11; plate II, fig. 4

1952 *Miogypsina (Miogypsina) irregularis* (Michelotti), Drooger, p.54, plate II, fig. 25,29

1958 *Miogypsina (Miogypsina) irregularis* (Michelotti), Mohan, p. 378-380, plate 1, fig. 1-18

1959 *Miogypsina (Miogypsina) irregularis* (Michelotti), Drooger and Magne, p. 277

1962 *Miogypsina (Miogypsina) irregularis* (Michelotti), Dizer, plate IV, fig. 4; plate VI, fig 7

1982 *Miogypsina irregularis* (Michelotti), Sakınç, plate VII, fig. 3-7

Description: Macrospheric figure: The measured diameter and thickness of the shell are 1.5-2.4 mm and 0.5-0.75 mm respectively. The shape of the shell is biconvex, flattened and the apex is conspicous. There are granules large in the apex and small in the margins. The spherical protoconc with a diameter of 110-235 microns is partially encircled by the subspherical deuteroconc with a diameter of 155-340 microns in the embryo-nepionic section. The nepionic spiral has 1/2 tour with 5-6 chambers. The angle y is acute and positive. The neanic chambers have thin walls, ogeval shaped after the nepionic spiral and ogeval-rhombic shaped towards the margin of the shell.

Stratigraphic distribution: Burdigalian.

Occurrence: Northwest of Malatya, Medik-Ebreme region.
Miogypsina intermedia Drooger, 1952
(Plate III, fig. 9-10)

1952 *Miogypsina intermedia* Drooger, Drooger, p. 54-55

Description: Macrospheric figure: The measured diameter and thickness of the shell are 1.4-2 mm and 0.45-0.6 mm respectively. The shape of the shell is fanlike, planoconvex and the surface is covered by fine granules. The embryo-nepionic section lies in the apex. The spherical protoconc has a ,diameter of 145-175 microns. The nepionic spiral has 1/2 tours with 4-5 chambers. The angle *y* is positive and acute. The neanic chambers are ogeval in the first phase and become rhombic towards the margins. There are three sets of lateral chambers in the axial section.

Stratigraphic distribution: Burdigalian.

Occurrence: Northwest of Malatya, Medik-Ebreme region.

PALEOECOLOGY

The organisms collected from various units defined in this investigation constitute faunal associations dwelling in various environments for the periods of Jurassic-Cretaceous and specially Tertiary. These associations and environments of dwelling are shown in a table (Fig. 13).

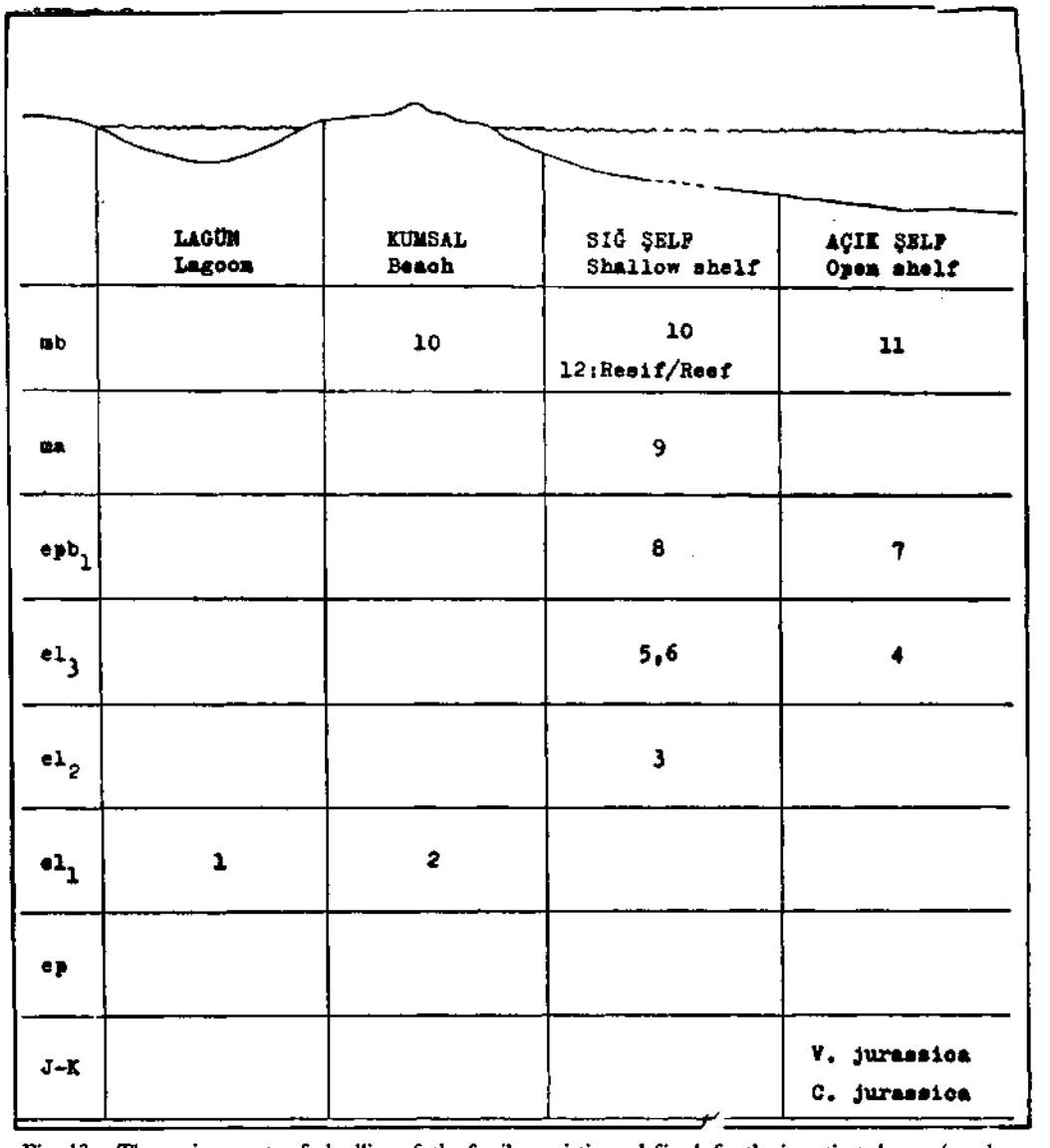


Fig. 13 - The environments of dwelling of the fossil associations defined for the investigated area (numbers indicate the association numbers given in the text).

The association (1) *Valvulinella Jurassic a* and *Clypeina Jurassic a* dwelled in the open shelf environment during the time interval of Upper Jurassic-Lower Cretaceous.

The benthonic association (2) of Quinqueloculina, ostracods, pelycypods and gastropods dwelled in lagoonal and the benthonic association of *Velates schmiedelli, Lucina corbaricus,* Cerithium, Conus, Ostrea, Quinqueloculina and Triloculina dwelled in beach environments during the time interval of Lower Lutetian.

The benthonic association (3) of *Nummulites pinfoldi, Orbitolites complanatus, Fabiania cassis, Sphaerogypsina globulus,* Alveolina, Quinqueloculina lived in a shallow shelf in depths not exceeding 20-30 m during the time interval of Middle Lutetian.

The benthonic association of (4) *Nummulites aturicus, Nummulites perforatus, Nummulites beaumonti, Nummulites puschi, Nummulites praefabianii, Fabiania cassis, Linderina brugesi,* Discocyclina, Operculina and echinids lived in the open shelf environment of depth 30-50 m; the association (5) Discorbis, ostracoda and thin shelled pelycypods lived in shallow marine; and the benthonic association of (6) Quinqueloculina, Textularia, Rhapydionina, Peneroplis, Orbitolites dwelled in the shallow shelf environment of depth 10-20 m for the time interval of Upper Lutetian.

The benthonic association (7) of *Nummulites fabianii, Nummulites chavannesi, Nummulites incrassatus, Fabiania cassis, Linderina brugesi, Chapmanina gassinensis, Halkyardia minima, Baculogypsinoides tetraedra, Discocyclina sella, Actinocyclina radians,* Operculina lived in the open shelf with depths of approximately 30-40 m and the benthonic association of (8) *Quinqueloculina* (ample) *Chapmanina gassinensis, Fabiania cassis, Gypsina marianensis Eorupertia magna,* Lituonella, Peneroplis dwelled in shallow shelf environment in depths of 20-30 m. for the time interval of Lower Priabonian.

The benthonic association of (9) *Miogypsinoides complanatus, Archaias kirkukensis, Operculina complanata, Spiroclypeus margaritatus, Lepidocyclina (Nephr.) tournoueri, Amphistegina lessonii,* bryozoa and algae dwelled in shallow shelf environment in depths of 20-35 m for the time interval of Aquitanian.

The association of (10) comprising the foraminifera *Miogypsina irregularis, Amphistegina lessonii,* Quinqueloculina, Textularia and the macrofossils *Flabellipecten burdigalensis, Flabellipecten* cf. *solarium, Chlamys* cf. *scabrella, Scutella* cf. *paulensis* lived in the beach or shallow shelf; the benthonic association of foraminifera (11) *Miogypsina irregularis, Lepidocyclina (Nephr.) tournoueri, Lenticulina vortex, Amphistegina lessonii, Sphaeroidina bulloides, Pullonia bulloides,* Uvigerina, Heterostegina and the planctonic foraminifera of Globigerinoides, Globoquadrina and Globigerina dwelled in the open shelf of depths 50-80 m; the association (12) formed by the macrofossils of corals, algae, pelycypoda, and gastropoda and the benthonic foraminifera *Miogypsina intermedia, Borelis melo,* Quinqueloculina, Textularia and Aceryulina lived in reefal environments for the time interval of Burdigalian.

The fact that the texts by Henson (1950), Blondeau (1972) and Dizer (1982) were most useful in interpretations of the environments of dwelling, must gratefully be acknowledged.

PALEOGEOGRAPHIC EVOLUTION

Upper Jurassic-Lower Cretaceous period, during which the Horasan9al formation was deposited, the area of investigation was represented by an open shelf. Sedimentation might have continued until Paleocene; however, this section was most probably eroded away.

The deposits of these aluvial fans were tilted by tectonic movements during Late Paleocene (?) and Lower Eocene resulting in a new depositional environment during Lower Lutetian. Alluvial fans and braided streams continued their deposition contemparanous to the transgression during Lutetian resulting in formation of lagoonal environments on these continental sediments. The sediments laid down in braided streams and alluvial fans was followed by sediments (Zeynepoğlu member) deposited along the shore of and in a lagoonal environment prior to deposition of beach sands and shallow marine carbonates (Yoğunsakız member) with progression of the transgression. Along with this first transgression in the region, shallow, marine organisms (mainly Miliolidae) were abundant, although they were soon replaced by organisms of the open shelf such as Nummulites, and Operculina as there were no obstacles (such as reefs) on the off-shore area. A temporary period of regression, implied by the Çorak member (Upper Lutetian) was proceeded by a lagoonal environment, that

previously represented a marine environment, covering a large area, also resulting in formation of a positive area further north. Çorak member was not deposited on this positive area, thus Çivril member was deposited unconformably on the Yoğunsakız member via the transgression following a temporary period of regression. Çivril member, on the other hand, was deposited on the lagoonal Çorak member. This section is followed by a continous transgressive section during Eocene. The İriağaç member overlying Çivril member consists of shelf carbonates in contrast to the shallow marine environment prevailing in the north. This picture is compatible with the topographic inclination expected for the period of regression, Thus it seems very likely, that the northern parts of the area of investigation was relatively higher and deepening of the environment was increasing towards south, southeast and east. The Tohma formation, of Middle-Upper Eocene age, emerged during Oligocene, was tilted and partly eroded.

The region was a positive area during Oligocene. This nondepositional period is implied by the absence of any sedimentation during this epoch. However, continental Oligocene was reported (Yoldaş, 1972) in the N, outside the investigated area, in the vicinity of the villages of Dostal and Katilköy.

During the period of Miocene, the first transgression occurred during Aquitanian. This transgression, responsible for the deposition of the shallow marine Çavuş formation, was extremely rapid implied by formation of a thin horizon of basal conglomerates sharply transitional to shallow marine carbonates. The Çavuş formation emerged, tilted was partly eroded during late Aquitanian indicated by the angular unconformity basing the Burdigalian sediments. Bortliyenli member is the first product of the last Tertiary transgression. A wide beach full of elastics of carbonates was formed at the beginning of this process. The same area was converted to a shelf on which deposition of marls was realised. This shelf, on which benthonic foraminifera were dwelling with the planctonic, gradually emerged resulting in formation of set reefs (İkiztepe member). These reefs contain abundant algae and corals; in fact, some are made up of these organisms. The evolution of post-Burdigalian is not known as there is no overlying unit in the area of investigation.

The last depositional period in the area is Plio-Quaternary. The alluvial fans and braided streams of this period laid down the sediments of the Mısırdere formation. The Plio-Quaternary basin of Malatya is bounded by faults, resulting in generation of alluvial fans towards the interior parts and a braided stream, most probably having the same course with the current Tohma stream, has left its sediments in the stream bed excavated in these alluvial fans.

CONCLUSIONS

The area of investigation was mapped lithostratigraphically at the scale of 1:25 000 and six formations and seven members were differentiated. The Horasançal formation of Upper Jurassic-Lower Cretaceous age is unconformably overlain by the Medik formation of Paleocene age. There is an angular unconformity at the base of the overlying Tohma formation whose İriağaç member comprises the conformable transition of Upper Lutetian and Lower Priabonian. There are angular unconformities at the bases of Çavuş and Ansurçay formations, respectively of Aquitanian and Burdigalian age. Mısırdere formation, Plio-Quaternary in age, overlies all the units exposed in the area with an angular unconformity.

The range biozones of *Nummulites aturicus* and *Nummulitesfabianii* the abundance biozones of *Velates schmiedeli, Nummulites pinfoldi, Miogypsinoides complanatus, Miogypsina irregularis, Miogypsina intermedia* and the abundance subbiozones of *Nummulites perforatus* and *Chapmanina gassinensis*

were distinguished in the area for the first time. 552 thin sections and 311 wash samples were examined in detail. The samples were collected from three type sections and nine complementary measured stratigraphic sections. A biozone map showing the distribution of the biozones and locations of the measured stratigraphic sections was prepared. These biozones were matched, biostratigraphically and chronostratigraphically with their equivalents in Turkey and in other parts of the world.

16 species of the families Nummulitidae, Discocyclinidae, Lepidocyclinidae, Miogypsinidae were systematically described in the paleontology section.

12 faunal associations of Middle-Upper Eocene and Miocene series deposited in lagoonal, beach, reefal, shallow and open shelf environments are described with their paleoecologic settings.

The paleogeographic evolution of the region was interpreted through a thorough evaluation of the lithostratigraphic, biostratigraphic and paleontological characteristics of the sediments examined by field and laboratory methods.

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P L A T E S

PLATE - I

Nummulites pinfoldi Davies

Fig. 1 - Outer appearance, macrospheric figure, (437), X 10

Fig. 2 - Equatorial section, macrospheric figure, (1-624), X 17

Nummulites incrassatus De La Harpe

Fig. 3 - Outer appearance, microspheric figure, (1-684/İ), X 5

Fig. 4 - Outer appearance, macrospheric figure, (I-684/İ), X 5

Fig. 5 - Equatorial section, microspheric figure, (I-674), X 6

Fig. 6 - Equatorial section, macrospheric figure, (I-684/G), X 7

Nummulites beaumonti D'Archiac and Haime

Fig. 7 - Outer appearance, microspheric figure, (508), X 5

Fig. 8 - Equatorial section, microspheric figure, (508), X 5

Fig. 9 - Outer appearance, macrospheric figure, (I-662/B), X 6

Fig. 10 - Equatorial section, macrospheric figure, (I-664/A), X 5

Nummulites chavannesi De La Harpe

Fig. 11 - Outer appearance, microspheric figure, (I-684/P), X 7

Fig. 12 - Outer appearance, macrospheric figure, (I-684/A), X 6

Fig. 13 - Equatorial section, macrospheric figure, (I-684/P), X 6

Nummulites aturicus Joly and Leymerie

Fig. 14 - Outer appearance, microspheric figure, (1-670), X 4

Fig. 15 - Equatorial section, microspheric figure, (1-670), X 4

Fig. 16 - Outer appearance, macrospheric figure, (I-660/B), X 5

Fig. 17 - Equatorial section, macrospheric figure, (I-660/A), X 5

Nummulites praefabianii Varentsof and Menner

Fig. 18 - Outer appearance, microspheric figure, (109/S), X 6

Fig. 19 - Equatorial section, microspheric figure, (1-670), X 4

Fig. 20 - Equatorial section, macrospheric figure, (1-669), X 8

Nummulites fabianii (Prever)

Fig. 21 - Equatorial section, microspheric figure, (I-682/C), X 5

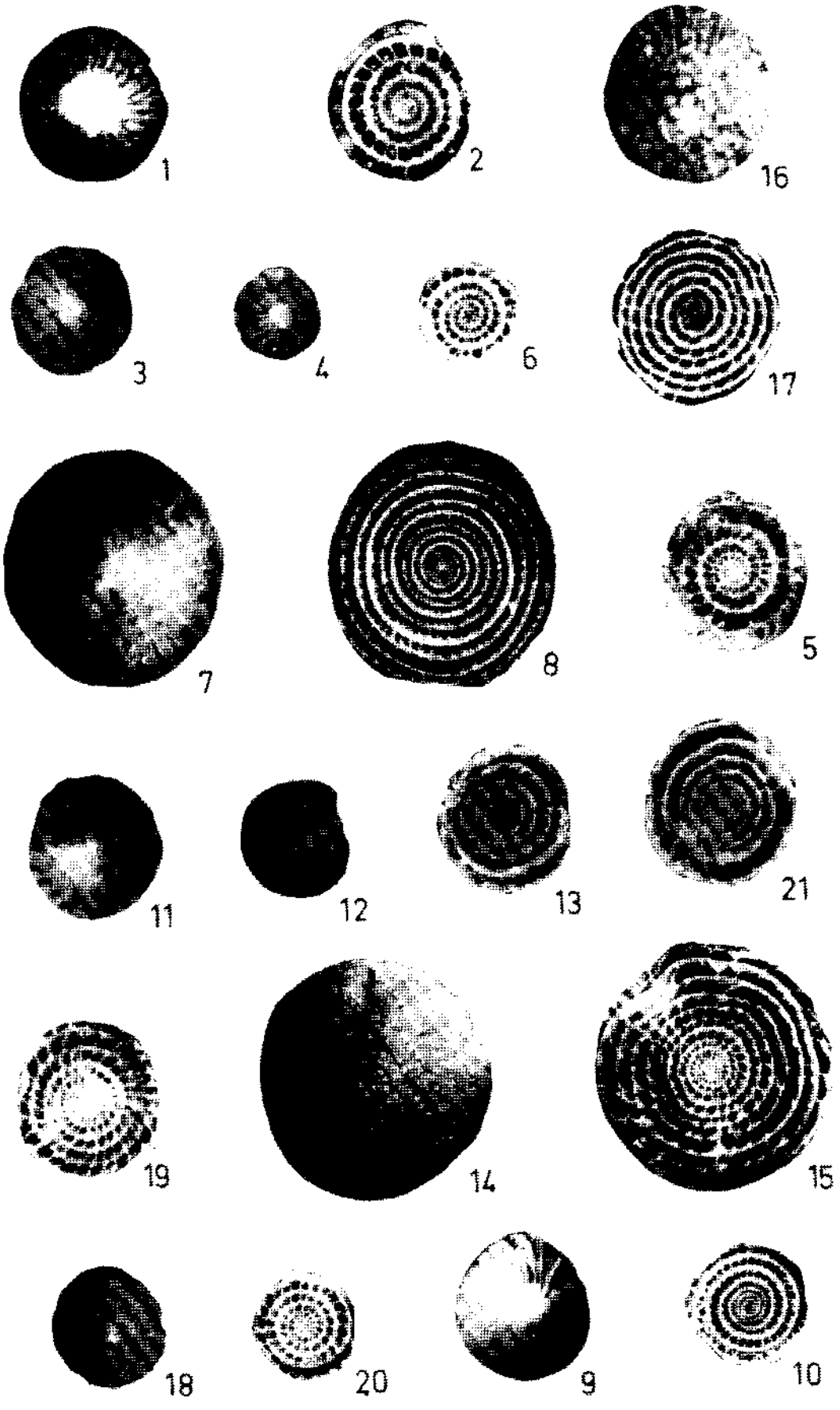
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PLATE - II

Nummulites perforatus (De Montfort)

Fig. 1 - Equatorial section, microspheric figure, (I-684/A), X 4

Fig. 2 - Outer appearance, macrospheric figure, (I-676), X 5

Fig. 3 - Equatorial section, macrospheric figure, (114/A), X 6

Nummulites puschi D'Archiac and Haime

Fig. 4 - Equatorial section, microspheric figure, (453), X 3

Fig. 5 - Outer appearance, macrospheric figure, (453), X 5

Fig. 6 - Equatorial section, macrospheric figure, (453), X 5

Assilina exponens (Sowerby)

Fig. 7 - Outer appearance, macrospheric figure, (507), X 4

Fig. 8 - Equatorial section, macrospheric figure, (507), X 4

Qiscocyclina sella (D'Archiac)

Fig. 9 - Outer appearance, macrospheric figure, (I-684/J), X 22

Fig. 10 - Equatorial section, macrospheric figure, (I-684/J), X 25

Fig. 11 - Embryonic section, equatorial section, macrospheric figure, (I-684/J), X 100

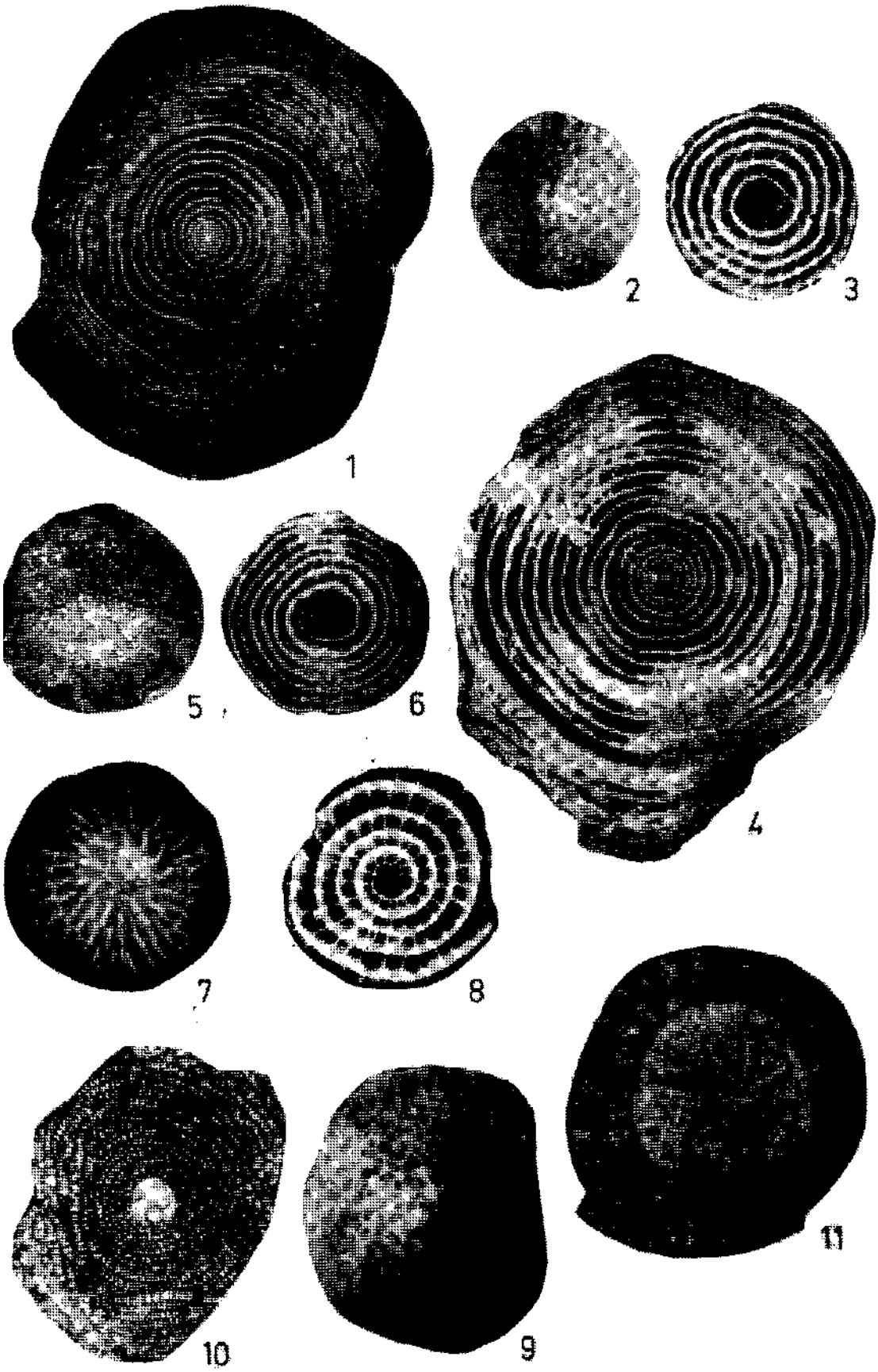
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PLATE - III

Actinocyclina radians (D'Archiac)

Fig. 1 - Outer appearance, macrospheric figure, (I-684/İ), X 8

Fig. 2 - Equatorial section, macrospheric figure, (I-684/İ), X 12

Fig. 3 - Embryonic section, equatorial section, macrospheric figure, (I-684/İ), X 29

Lepidocyclina tournoueri (Lemoine and Douville)

Fig. 4 - Equatorial section, macrospheric figure, (I-690/D), X 25

Miogypsinoides complanatus (Schlumberger)

Fig. 5 - Equatorial section, macrospheric figure, (156/1), X 28

Fig. 6 - Equatorial section, macrospheric figure, (I-688/D), X 40

Miogypsina irregularis (Michelotti)

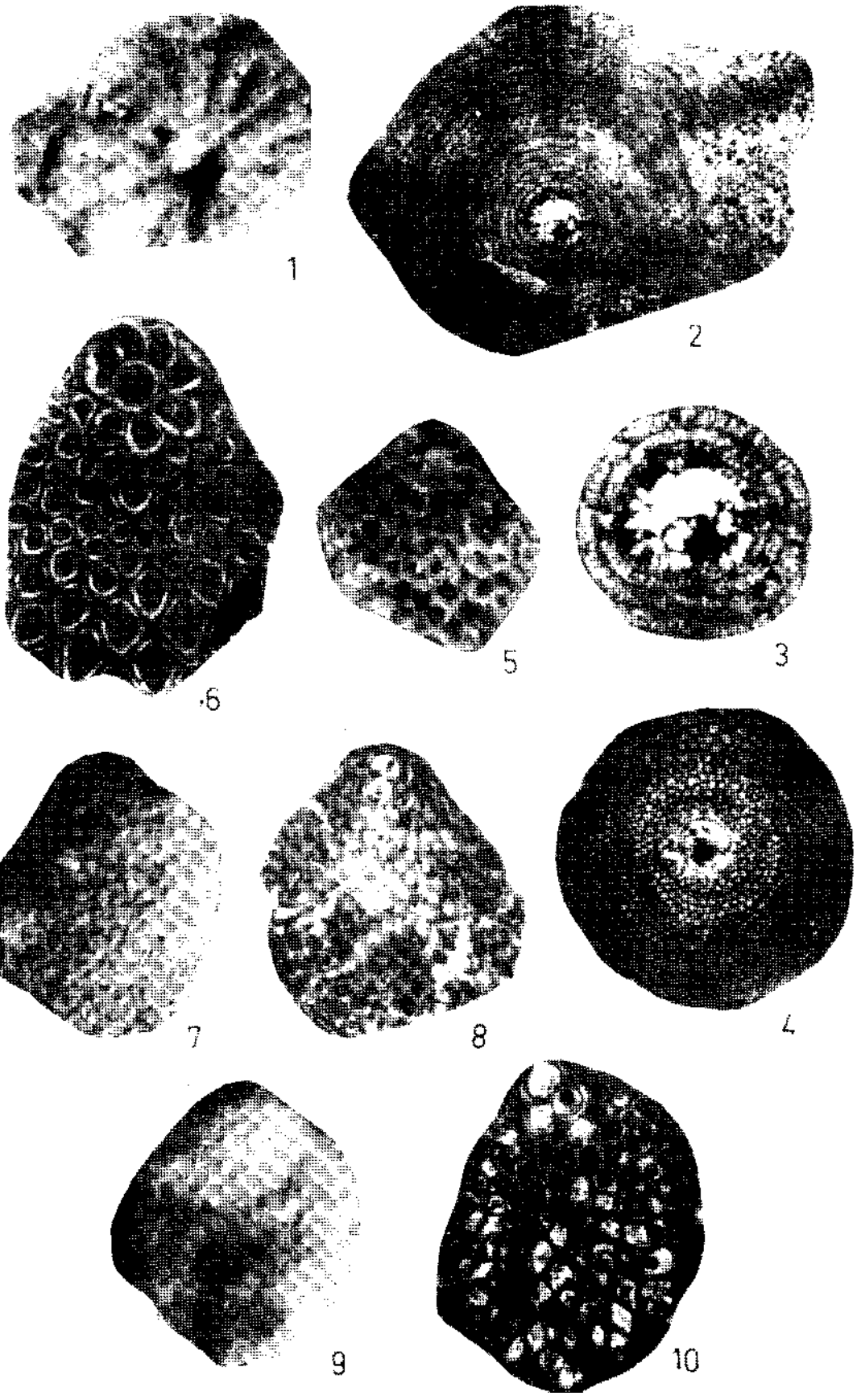
Fig. 7 - Outer appearance, macrospheric figure, (201), X 20

Fig. 8 - Equatorial section, macrospheric figure, (201), X 21

Miogypsina intermedia Drooger

Fig. 9 - Outer appearance, macrospheric figure, (İ-203), X 23

Fig. 10 - Equatorial settion, macrospheric figure, (İ-203), X 27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