Zeitschrift: Eclogae Geologicae Helvetiae
Herausgeber: Schweizerische Geologische Gesellschaft
Band: 95 (2002)
Heft: 1

Artikel: Cuisian orthophragminid assemblages (Discocyclina, Orbitoclypeus and Nemkovella) from the Haymana-Polatli Basin (central Turkey) : Biometry and description of two new taxa

Autor: Özcan, Ercan

DOI: https://doi.org/10.5169/seals-168947

0012-9402/02/010075-23 $1.50 + 0.20/0
Birkhäuser Verlag, Basel, 2002

Eclogae geol. Helv. 95 (2002) 75–97

Cuisian orthophragminid assemblages *(Discocyclina, Orbitoclypeus* and *Nemkovella)* from the Haymana-Polatli Basin (central Turkey): Biometry and description of two new taxa

ERCAN ÖZCAN

Key words: Orthophragminids, *Discocyclina*, *Orbitoclypeus*, *Nemkovella*, biometry, cuisian, central Turkey

Mots-clés: Orthophragminidés, *Discocyclina*, *Orbitoclypeus*, *Nemkovella*, Biometrie, Cuisien, Turquie Centrale

ABSTRACT

The Paleocene – early Lutetian sedimentary succession of the Haymana-Polatli basin (central Anatolia, Turkey) comprises extremely fossiliferous shallow-water units. Some sections of this succession were formerly proposed to serve as reference sections for early Thanetian – early Lutetian Shallow Benthic Zones (SBZ), which developed within the framework of the integrated zonation of the Tethyan Paleogene. The Cuisian – early Lutetian Çayraz Formation, the uppermost unit of the Haymana- Polatli basin, is a thick, shallow-marine clastic – carbonate unit known by its diverse assemblages of nummulitid, alveolinid and orthophragminid foraminifera. The lower part of this unit, considered to be Cuisian in age, was studied for its orthophragminids at its type locality. Orthophragminids identified for the first time in this Anatolian material from the lower part of the Çayraz Formation comprise diverse assemblages of *Discocyclina*, *Orbitoclypeus*, *Nemkovella* and partly *Asterocyclina*, which characterise the early-middle and late Cuisian Shallow Benthic Zones (SBZ 10-11/ 12). Identified taxa belong to the same evolutionary lineages that are present in the northern Mediterranean, from the Pyrenees through Aquitaine, northern Italy and Slovakia, as far as the Crimean Peninsula. Two new subspecies of *Discocyclina* and *Orbitoclypeus*, *Discocyclina fortisi* (d'Archiac, 1850) *cairazensis* n. ssp. and *Orbitoclypeus douvillei* (Schlumberger, 1903) *yesilyurtensis* n. ssp., are introduced from the upper part of the Cuisian section. A sequence of populations of *Discocyclina*, *Orbitoclypeus* and *Nemkovella* has been subjected to biometric analysis of the embryo and equatorial chamberlets. A comparison of these biometric results with previous data from other Tethyan Cuisian localities (mainly in Europe and the Crimea) is also made.

ZUSAMMENFASSUNG

Die vom Paleozän ins frühe Lutetium reichende Sedimentfolge des Haymana-Polatli-Beckens (Zentral-Anatolien, Türkei) enthält extrem fossilreiche Flachwasserablagerungen. Einige Profile in dieser Abfolge wurden seinerzeit als Referenzprofile für die Shallow Benthic Zones (SBZ) vom frühen Thanet bis zum frühen Lutet im Rahmen einer integrierten Zonierung des Paläogens der Tethys vorgeschlagen. Die Çayraz-Formation (Cuisium bis frühes Lutet), die höchste Einheit des Haymana-Polatli-Beckens, ist eine mächtige, flachmeerische karbonatische Einheit, bekannt für ihre artenreichen Assoziationen von Nummuliten, Alveolinen und Orthophragminen. Der untere Teil dieser Einheit, der ins Cuisium gestellt wird, wurde an der Typlokalität auf Orthophragminen untersucht. Die zum ersten Mal in diesem anatolischen Material aus der unteren Çayraz-Formation beobachteten Orthophragminen umfassen verschiedene Assoziationen von *Discocyclina, Orbitoclypeus, Nemkovella* und z.T. auch *Asterocyclina*, die die Shallow Benthic Zones (SBZ 10–11/12) des frühen bis mittleren und späten Cuisiums kennzeichnen. Die beobachteten Taxa gehören zu denselben evolutiven Reihen, wie sie im nordmediterranen Bereich vorkommen, von den Pyrenäen über Aquitaine, Norditalien und Slowakien, bis hin zur Krim. Zwei neue Subspezies von *Discocyclina* und *Orbitoclypeus* werden aus dem oberen Teil Cuisium-Profils beschrieben: *Discocyclina fortisi* (d'Archiac, 1850) *cairazensis* n. ssp. und *Orbitoclypeus douvillei* (Schlumberger, 1903) *yesilyurtensis* n. ssp. Bei einer Abfolge von Populationen von *Discocyclina, Orbitoclypeus* und *Nemkovella* wurden die Embryonen und die äquatorialen Kammern biometrisch-statistisch untersucht. Diese biometrischen Ergebnisse werden mit älteren Daten von anderen Lokalitäten aus dem Cuisium der Tethys (v. a. aus Europa und von der Krim) verglichen.

Introduction

Zonation of shallow- marine, Tethyan Paleocene and Eocene units has been based mainly on alveolinid and nummulitid foraminifera and, with the integration of orthophragminid data in the last decade, twenty Shallow Benthic Zones (SBZ) have been established already in the time span ranging from the beginning of the Paleocene to the end of the Eocene (Serra-Kiel et al. 1998). Orthophragminid foraminifer zonation mainly depends on data from the western extension of the Alpine-Himalayan belt along European sites of the Mediterranean region, Crimea and a few particular sites in India (Less 1987 and 1998). The philosophy of this zonation is based on the subdivision of taxa (lineages) by quickly evolving parameters observed only in the equatorial layer of the test, and type localities of orthophragminid taxa serve as pin- points or as refer-

Department of Geological Engineering, Akdeniz University, Topçular, 07200 Antalya, Turkey. E-mail: eozcan@lab.akdeniz.edu.tr.

ence levels for such a subdivision. Although the existence of orthophragminid foraminifera in the late Paleocene – Eocene sedimentary successions of Turkey had been reported in many publications and reports, there has been no attempt at taxonomic studies. The first systematic study of these benthonic organisms in equatorial sections was carried out by Özcan et al. (2001) in order to improve our understanding of orthophragminids in Turkey in light of their demonstrated applicability for the stratigraphic subdivision of Tethyan deposits (Less 1987 and 1998; Serra-Kiel et al. 1998). This project involved the sampling of six stratigraphic sections (two of which is the subject of the present paper) from different localities in the Haymana-Polatli basin (central Anatolia), and the preparation of an orthophragminid foraminiferal inventory. These two sections, known to be very rich in larger foraminifera, were previously proposed as reference sections for Cuisian – early Lutetian Shallow Benthic Zones (SBZ) in Turkey by the 'Early Paleogene working group' (IGCP n. 286; Serra-Kiel et al. 1998). The benthonic and planktonic foraminifera other than orthophragminids, as well as nannoplankton assemblages in these sections, have been published previously (Dizer 1964 and 1968; Sirel 1976, 1992 and 1998; Sirel & Gündüz 1976; Sirel et al. 1986; Yüksel 1970, and Toker 1980).

The present study aims to focus on describing the orthophragminid foraminifera in well-preserved free specimens from the lower part of the Çayraz Formation and to document their biometric features. *Asterocyclina*, which occurs only in the lower part of the Cuisian section, was not considered in this study. The identified foraminifera, recorded for the first time in Anatolian material, are regarded to be of early – middle/late Cuisian age (SBZ 10-11, 12, proposed by Serra-Kiel et al. 1998). The whole stratigraphic section- consisting of larger foraminifera in rock-forming associations in numerous successive horizons- together with the upper part of the Çayraz Formation, is a very promising target for a multidisciplinary study of larger foraminifera of the Cuisian and early Lutetian.

The occurrence of orthophragminids and other associated benthonic foraminifera in the Çayraz Formation and associated units, and the lithology and age of these units

The Haymana-Polatli basin is an accretionary type of fore-arc basin formed during the destruction of Neo-Tethys in Turkey during the late Cretaceous – middle Eocene time interval (Koçyiğit 1991). The thick sedimentary succession of the basin contains assemblages of orbitoidal foraminifera at a number of horizons in the Cretaceous part, and orthophragminid foraminifera are quite abundant and locally in rock-forming associations in the late Paleocene – early Lutetian part. The Çayraz Formation at its type locality is a thick (about 500 m) shallow-marine carbonate-clastic unit, conformably overlying deep-marine fine siliciclastic units of the Eskipolatli Formation and unconformably overlain by Neogene sediments. Outcrops of this unit are best traced along the northern side of the road between Yeşilyurt and Çayraz villages, a few km north of the town of Haymana, located 70 km SW of Ankara (Fig. 1). At this locality, the Tertiary part of the Haymana-Polatli basin succession is exposed in Ilgınlıkdere and in the conformably overlying Eskipolatli Formations below Çayraz. The sequence of Ilgınlıkdere comprises an approximately 260-m-thick succession of medium- to thick-bedded deep-marine sandstone-shale-siltstone alternations, which is almost devoid of benthonic foraminifera. The age of this sequence has been considered to be Ilerdian (Ünalan et al. 1976). The Eskipolatli Formation (Karahoca Formation of Yüksel 1970 and Toker 1980) is described as an approximately 200-m-thick sequence of thick-bedded to massive deep-marine shale and siltstone at its base, succeeded by an alternation of massive shale-siltstone and sandy 'limestone' horizons with larger benthonic foraminifera in its uppermost horizons. These fragmental 'limestone' horizons in the uppermost part of the sequence contain a well-preserved association of free orthophragminid and nummulitid foraminifera and record the earliest occurrences of orthophragminid taxa in the basin succession. Dizer (1968) described different *Nummulites, Assilina* and *Operculina* from these horizons and from the lowermost part of Çayraz Formation at the same locality and considered this assemblage to be late Ypresian in age. This unit contains moderately diverse planktonic foraminifera and calcareous nannofossils in fine siliciclastic horizons. Yüksel (1970) documented a planktonic foraminiferal assemblage indicating an early Ypresian age for the unit. On the basis of nannoplankton, the age of the Eskipolatli Formation was considered to be late Ypresian by Toker (1980).

The Çayraz Formation that conformably overlies the Eskipolatli Formation represents a shallow-water sedimentation phase that preceded closure of the basin. Çiner et al. (1996) divided the unit into two shelf systems, lower and upper, which are characterized by the repetition of calcareous mudstones and nummulitic horizons ('nummulitic banks' of these authors). Those authors described four types of cycles, consisting of calcareous or silty mudstone overlain by nummulitic wackestone, packstone and grainstones or calcareous sandstone, each 3-10 m thick, as the smallest repetitive accretion events in each shelf system. In these coarsening-upward cycles, calcareous or silty mudstones which are almost devoid of benthonic foraminifera either pass into nummulitic packstone and grainstone facies containing an extremely rich assemblage of benthonic foraminifera (represented by the genera *Nummulites*, *Assilina*, *Discocyclina*, *Orbitoclypeus*, *Asterocyclina*, *Nemkovella*, *Orbitolites*, *Cuvillierina*, *Lockhartia*, *Idalina*, *Miscelanea*, *Fabiania* and *Smoutina*), or pass into calcareous siltstone, sandstone and conglomerates, mostly barren of foraminifera. In the upper shelf system, these 'nummulitic banks' are poorly developed. Carbonate packages belonging to the lower and upper shelf systems are separated by a 20 to 30 m-thick mudstone-siltstone unit which is almost devoid of benthonic foraminifera. In the upper part of the lower carbonate package, several key horizons ('alveolinid limestone') containing a rich assemblage of alveolinid foraminifera are present (Fig. 1).

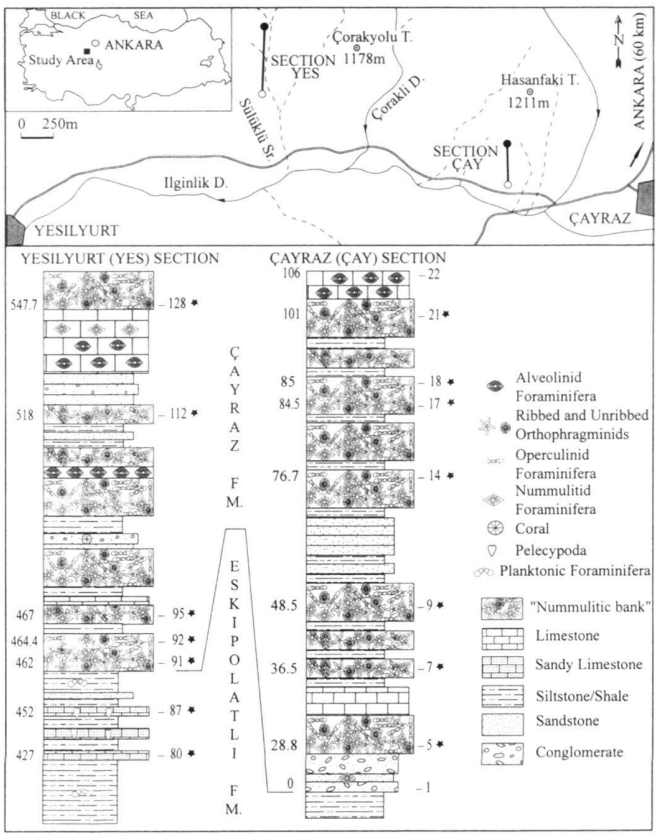


Fig. 1. Stratigraphy of the Yeşilyurt (YEŞ) and Çayraz (ÇAY) sections in the vicinity of Yeşilyurt and Çayraz villages (Haymana, central Anatolia, Turkey). Stars and numbers on the right of each section refer to sample numbers and horizons studied for orthophragminids.

Hottinger (1960) documented *Alveolina canavarii* Checchia-Rispoli, *A.* cf. *schwageri* Checchia-Rispoli and *A. parva* Hottinger from these horizons of the Çayraz Formation and regarded this assemblage as (early) Cuisian in age. Dizer (1968) described *Alveolina canavarii*, *Nummulites irregularis* var. *distans*, *N. uroniensis* and *Assilina pamiri* zones from the same unit and identified different *Alveolina, Nummulites* and *Assilina* in the lower *A. canavarii* zone. Dizer (1968) regarded this assemblage to be of early Lutetian age. Sirel & Gündüz (1976) identified *Alveolina canavarii* Checchia Rispoli, *A. bayburtensis* Sirel, *Nummulites atacicus* Leymerie, *N. planulatus* (Lamarck), *N. irregularis* Deshayes, *N. partschi* de la Harpe and *Assilina placentula* (Deshayes) in the 'alveolinid limestone' and adjacent horizons at the same locality, and considered this part of the unit to be Cuisian in age. However, none of these authors presented detailed stratigraphic sections showing sample horizons. Considering the larger foraminiferal zonation proposed by Serra-Kiel et al. (1998), the lower part of Çayraz Formation, which contains *A. canavarii* Checchia Rispoli, *N. planulatus* (Lamarck), *N. partschi* de la Harpe, *A. placentula* (Deshayes) and other benthonic taxa identified by Hottinger (1960) and Dizer (1968), is thought to correspond to the Cuisian Shallow Benthic Zones.

In the course of this study, two stratigraphic sections, Yeşilyurt (YEŞ) and Çayraz (ÇAY), corresponding to the lower carbonate package of Çayraz Formation and underlying units, were measured and sampled (Fig. 1). The Yeşilyurt section, a 590-m-thick sequence, was sampled along a small creek to the north of the road from Çayraz to Yeşilyurt, north of town of Haymana, and comprises different lithostratigraphic units. Here we present only a part of it, including the Cuisian orthophragminids. The Çayraz section, comprising an approximately 106-m-thick succession belonging only to the lower part of the Çayraz Formation, was sampled along a small hill to the north of the road from Çayraz to Yeşilyurt, very near Çayraz village. The succession mainly comprises thick-bedded 'nummulitic banks' with intervening mudstone and sandstone, and a thick conspicuous 'alveolinid limestone' at the top. The Çayraz section can be correlated with the 462-548 m stratigraphic interval of the Yeşilyurt section, corresponding to the lower carbonate package of the Çayraz Formation.

Paleontology

The terms 'Orthophragminae' or 'orthophragminid foraminifera' are informally used for late Paleocene and Eocene larger foraminifera characterized by a test comprising an median equatorial layer and lateral chamberlets developed on either side of this layer (Brönnimann 1951; Less 1987, 1998; Ferrández-Cañadell 1998a). Mesogean orthophragminids comprise the genera *Discocyclina*, *Orbitoclypeus*, *Nemkovella,* and *Asterocyclina*, and most of the species and/or subspecies were originally described from European sites and Crimea and some from the Tethyan sites in India. In addition to numerous studies related to taxonomy (see Less 1987 for a more complete documentation of previous studies), some also present information on the morphostructure of orthophragminids (Brönnimann 1941, 1946a, b and 1951; Neumann 1972; Ferrández-Cañadell et al. 1992; Ferrández-Cañadell 1998a and b).

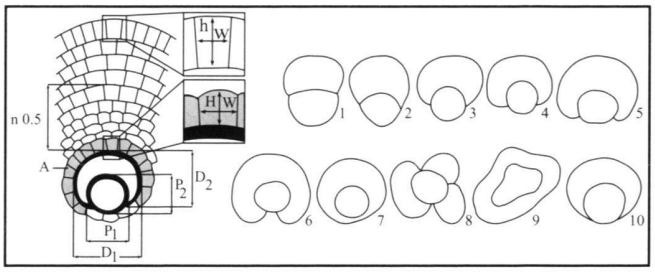


Fig. 2. Parameters for the definition of embryo and equatorial chamberlets in orthophragminids. See explanation in the text. Types of embryos; 1) isolepidine, 2) semi-isolepidine, 3) nephrolepidine, 4) semi-nephrolepidine, 5) trybliolepidine, 6) umbilicolepidine, 7) excentrilepidine, 8) polylepidine, 9) centrilepidine, 10) eulepidine (redrawn from Less, 1987).

Table 1. Numeric data for orthophragminids (see the text for the explanation for abbreviations).

TAXON	Horizon	N	P1			D1			A	n0.5	H	W	h	w
			Min	Max	Mean	Min.	Max.	Mean	Range	Range	Range	Range	Range	Range
D. augustae sourbetensis	**YEŞ.87**	2	80	85	**82.5**	140	155	**147.5**	12-15	14	25-30	25-30	100-105	25-30
	YEŞ.91	2	75	80	**77.5**	115	140	**127.5**	13	14	40	30	60	30
	YEŞ.92	1	-	-	**85.0**	-	-	**125.0**	12	17	20-30	30-35	65	25-30
	ÇAY.5	3	80	105	**90.0**	135	155	**143.3**	12	16	40	20-30	80-90	25-30
	ÇAY.7	1	-	-	**95.0**	-	-	**150.0**	-	-	-	-	-	-
D. 'dispansa' taurica	**YEŞ.87**	4	80	115	**98.7**	170	185	**176.2**	14-15	13-16	30-45	20-35	80-95	20-40
	YEŞ.91	5	80	100	**94.0**	155	190	**175.0**	12-16	11-16	30-45	30-35	60-115	20-30
	ÇAY.5	3	95	115	**108.3**	165	190	**176.6**	14-16	14	35-45	25-30	80-100	25-30
	ÇAY.7	4	95	125	**106.2**	170	210	**188.7**	14-19	14-16	35-50	25-30	75-105	20-30
	ÇAY.9	1	-	-	**105.0**	-	-	**210.0**	21	-	40-55	25-30	100	25
D. trabayensis trabayensis	**YEŞ.87**	1	-	-	**70.0**	-	-	**95.0**	6(7)	19	20-30	-	75-80	20-30
	YEŞ.91	1	-	-	**75.0**	-	-	**115.0**	8	-	25	35	-	-
D. archiaci archiaci	**YEŞ.80**	13	155	275	**203.8**	275	600	**427.3**	29-40	8-12	40-85	25-45	75-100	30-45
	YEŞ.91	10	150	260	**208.0**	325	495	**408.0**	23-38	8-12	40-90	30-50	55-140	25-40
	YEŞ.95	2	185	235	**210.0**	415	430	**422.5**	-	-	65	40-55	-	-
	YEŞ.128	1	-	-	**270.0**	-	-	**530.0**	32	9	60-70	40-65	75	35
	ÇAY.17	2	175	205	**190.0**	430	540	**485.0**	29-38	9-10	55-70	35-55	60	35
D. fortisi fortisi	**YEŞ.91**	7	200	335	**275.0**	455	740	**652.1**	44-51	8-10	60-70	25-60	95-115	25-40
	YEŞ.92	1	-	-	**-**	-	-	**805.0**	-	-	70-75	35	-	-
	YEŞ.95	3	275	520	**397.5**	510	990	**736.6**	44-65	8-11	75-100	35-60	65	35-40
	ÇAY.5	10	225	335	**276.8**	465	770	**544.0**	33-40	7-11	45-80	40-60	90-145	25-50
	ÇAY.7	3	305	330	**305.0**	550	675	**628.3**	52	9-10	50-70	35-50	80-85	40-45
	ÇAY.9	3	250	500	**375.0**	605	930	**820.0**	40-43	8-9	55-70	45-65	70-120	40-45
D. fortisi simferopolensis	**YEŞ.112**	25	260	720	**435.0**	590	1415	**859.0**	44-75	6-8	40-100	35-75	65-100	30-65
D. fortisi n. ssp. *cairazensis*	**ÇAY.14**	14	550	720	**650.0**	1050	1655	**1375.7**	62-85	5-7	55-120	35-85	50-90	25-65
	ÇAY.17	6	565	620	**586.6**	1225	1520	**1362.5**	78	5-8	75-105	45-75	55-70	30-55
	ÇAY.18	6	725	820	**772.5**	1090	1825	**1564.1**	56-71	6-7	70-110	35-75	65-75	40-50
	ÇAY.21	16	505	1200	**760.0**	1170	2400	**1602.8**	63-123	5-8	65-120	40-80	60-100	35-65
	YEŞ.128	13	510	1040	**688.3**	1030	1840	**1281.5**	>65-81	6-7	70-100	-	70-80	30-50
D. 'stratiemanuelis'	**YEŞ.80**	2	-	-	**305.0**	755	910	**832.5**	-	8	90-125	55-70	100	30-35
	YEŞ.87	2	400	510	**455.0**	740	810	**775.0**	-	10	65	60-75	110	35-40
	YEŞ.91	1	-	-	**360.0**	-	-	**765.0**	>40	7	120-125	70-100	65	35-40
N. strophiolata fermonti	**YEŞ.91**	9	70	100	**85.5**	100	150	**123.3**	7-9	19-22	20-30	30-45	60-105	30-35
	YEŞ.92	1	-	-	**80.0**	-	-	**115.0**	8	22	20-25	30	45-50	30
	ÇAY.9	1	-	-	**80.0**	-	-	**105.0**	7	21	20-25	30-40	65-70	25-30
N. evae	**YEŞ.80**	1	-	-	**120.0**	-	-	**175**	7	19	30	45-50	50	35
	YEŞ.91	8	95	170	**118.1**	160	285	**200.6**	9-16	13-18	30-50	30-40	80-100	30-40
O. schopeni suvlukayensis	**YEŞ.80**	8	115	140	**134.0**	205	285	**254.3**	32-34	13-14	35-50	25-30	60-95	25-40
	YEŞ.87	2	130	180	**155.0**	215	350	**282.5**	24-26	13-15	40-45	25-35	85	30-35
	YEŞ.95	1	-	-	**180.0**	-	-	**320.0**	-	-	-	-	-	-
O. varians portnayae	**YEŞ.87**	2	70	70	**70.0**	120	135	**127.5**	11-14	14	25-30	20-35	105-150	40-45
	YEŞ.91	4	70	90	**80.0**	135	150	**146.2**	14-16	-	25-35	30	80-100	30-40
	ÇAY.5	1	-	-	**80.0**	-	-	**135.0**	13(14)	18	-	-	-	-
	ÇAY.7	4	75	75	**75.0**	130	135	**133.7**	12-14	16-19	25-30	20-35	65-80	25-40
O. douvillei douvillei	**YEŞ.95**	1	-	-	**110.0**	-	-	**170.0**	17(19)	16	-	-	65	30-35
	ÇAY.5	8	85	120	**104.3**	160	195	**180.0**	13-19	14-21	25-40	25-50	50-100	25-40
	ÇAY.7	2	105	130	**117.5**	185	210	**197.5**	17-18	14-16	30-40	25-30	55-100	25-50
	ÇAY.9	1	-	-	**100.0**	-	-	**180.0**	17	14	35-50	25-30	-	-
O. douvillei n. ssp. *yesilyurtensis*	**ÇAY.14**	1	-	-	**135.0**	-	-	**255.0**	22	12	50	30-35	-	-
	ÇAY.17	18	90	165	**121.6**	175	300	**223.3**	15-24	11-16	25-55	25-55	50-120	25-45
	ÇAY.18	1	-	-	**150.0**	-	-	**290.0**	24	10	55	35-40	130	30-50
	ÇAY.21	1	-	-	**105.0**	-	-	**185.0**	20	-	25-30	35	-	-
O. munieri munieri	**YEŞ.91**	8	140	175	**157.5**	255	340	**305.6**	30-35	-	30-55	25-50	50-75	25-30
	YEŞ.92	1	-	-	**-**	-	-	**330.0**	-	-	45-50	30-35	-	-
	ÇAY.5	6	115	250	**191.0**	195	425	**315.0**	22-35	-	25-65	25-45	-	-
	ÇAY.7	6	115	240	**175.0**	275	405	**347.5**	29-41	-	40-55	25-45	-	-

It is rather difficult to deal with the taxonomy and the stratigraphy of orthophragminid foraminifera for many reasons. One of these is that most of the original descriptions of orthophragminids are not based upon the equatorial sections, but solely on the basis of outer test morphology (for instance, the cases of *D. fortisi* d'Archiac, 1850; *D. tenuis* Douvillé, 1922 and *D. dispansa* Sowerby, 1840). This situation basically requires the study of topo-type material if the type locality and horizon are known. In some of the original descriptions, more than one taxon have been considered as belonging to the same species and/or sub-species. This is observed, for instance, in the depiction of both discocyclinid and orbitoclypeid taxa in the case of *D. archiaci* (Schlumberger, 1903). In some cases, different denominations have been introduced for the same taxon and the most widely used one has been credited in naming; such as, instead of '*applanata*' of Gümbel, 1870, the widely used '*augustae*' of van der Weijden, 1940 for *D. augustae*. Since the schematization of the concept of 'evolutionary lineages' in orthophragminids is rather new, specific and/or sub-specific attribution of a taxon may require information on the exact age of the type material. The importance of heterochronic homeomorphy in orthophragminids is a well- realised concept in the attribution of, for instance, the primitive members of *D. augustae* and *D. dispansa* during the Cuisian (Less 1987, 1998). Rather it was after Less (1987, 1998) that different evolutionary lineages were established and that the taxa in these lineages were described on the basis of biometry, although the limits were established arbitrarily in most of cases and need refinement.

The present work is completely based on the thin sectioning of megalospheric orthophragminid specimens in equatorial and partly vertical sections. Some sections prepared for microspheric generation were not promising enough to depict the inner structure and, thus, were not included in this study. In addition, some sections illustrating only the pillar-lateral chamberlet architecture have also been prepared. For the quantitative description of embryos and other features related to the equatorial layer, we adopt the terminology proposed by Less (1987) (Fig. 2); P_1 and P_2: outer diameter of protoconch perpendicular and parallel to the P-D axis, D_1 and D_2: outer diameter of deuteroconch perpendicular and parallel to the P-D axis, A: number of auxiliary chamberlets directly arising from the deuteroconch (adauxiliary chamberlets), $n_{0.5}$: number of annuli within 0.5 mm distance measured from the deuteroconch along the P-D axis, H and W: Height and width of the equatorial chamberlets in the first annulus, h and w: height and width of the equatorial chamberlets around the peripheral part of the equatorial layer. We here present the data for P_1, D_1, A, $n_{0.5}$, H, W, h and w (Table1). In the text, the diameter of protoconch and the deuteroconch designated by P and D corresponds to P_1 and D_1, and D_{mean} stands for the population average of D_1. For different configurations of embryos, we adopt the terminology proposed by Less (1987) (Fig. 2).

Systematics

In the taxonomy, we basically define our taxa in specific/subspecific rank, adopting Less's (1987, 1998) systematic schemes. However, there are some differences between these schemes because some taxa considered valid in Less (1987) were later considered invalid in Less (1998), both in generic and specific and/or subspecific rank. Statistical data related to the parameters for each population are presented in Table 1. Holo- and paratypes of the new subspecies have been deposited in Marine Micropaleontology Research Center of Middle East Technical University in Ankara.

Order FORAMINIFERIDA Eichwald, 1830
Family DISCOCYCLINIDAE Galloway, 1928
Genus *Discocyclina* Gümbel, 1870
Discocyclina trabayensis trabayensis Neumann, 1955
Pl. 1/8-10, text figure 3D

1955 *Discocyclina trabayensis* n. sp.- Neumann, p. 130, Pl. 6, figures 2-4, Pl. 7, figures 2-3.

1958 *Discocyclina trabayensis* Neumann- Neumann, p. 111-112, Pl. 24, figures 1(?), 4–7.

1987 *Discocyclina trabayensis trabayensis* Neumann- Less, p. 171, Pl. 17, figures 1-3, 5-9, 13, text figure 27α.

Description. Small (only two specimens measuring up to 3.2 mm in diameter), thin and almost flat forms with pillars hardly observable in the elevated central part. The pillars, other than central part are small and even indistinct. Embryos are characterized by small protoconchs measuring from 70 to 75 microns, and slightly larger deuteroconchs measuring from 95 to 115 microns and are of semi-isolepidine configuration (Table 1). Adauxiliary chamberlets, which are very few in number (A: 6?,7-8), are low and narrow (H: 20-30 microns, W: 35 microns) and conspicuously arcuate ('varians' type of Less, 1987) in their outer parts. In the early stages of development, chamberlets are very low and narrow ($n_{0.5}$: 19-20), and are high and narrow and typically rectangular in the peripheral parts (h: 75-80 microns, w: 20-30 microns) of the equatorial layer.

Remarks. Specimens characterized by their small and flat tests having a centrally elevated umbo were encountered only in the uppermost part of the Eskipolatli and lower part of the Cuisian portion of the Çayraz Formation. These specimens exclusively yielded small embryos with semi-isolepidine-nephrolepidine configurations. Although other internal test parameters are very similar, *D. trabayensis* is differentiated from *D. augustae* and *D. dispansa* only by having low and arcuate adauxiliary chamberlets. The deuteroconch of this species also seems to be smaller than *D. augustae* and *D. dispansa* (Less 1987, 1998). Although the figures illustrating the embryo and surrounding chamberlets do not reflect the arcuateness of adauxiliary chamberlets by Neumann (1958), we consider *D. trabayensis* as basically valid in light of the figures and data presented from the Cuisian, Lutetian and especially

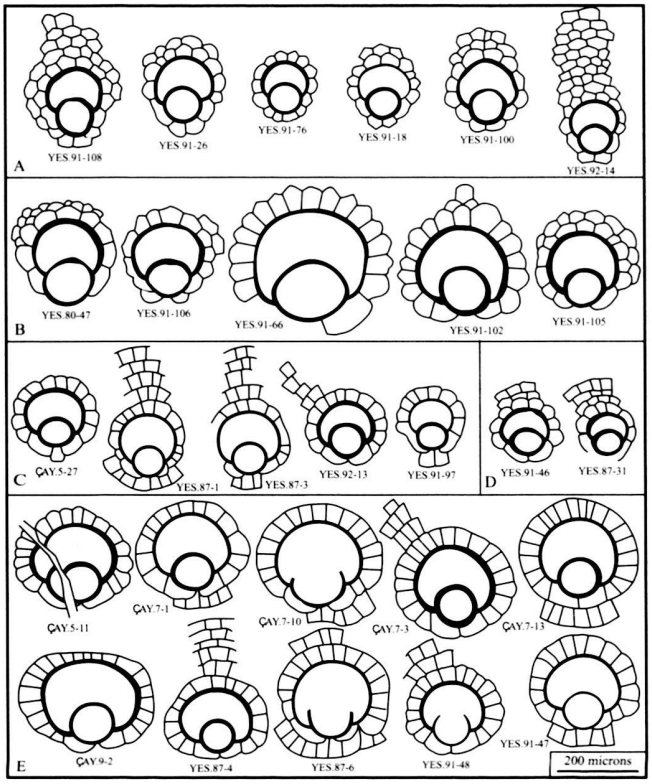


Fig. 3. Megalospheric embryo, early chamberlets and their variation in A- *N. strophiolata* (Gümbel, 1868) *fermonti* Less, 1987, B- *N. evae* Less, 1987, C- *D. augustae* van der Weijden, 1940 *sourbetensis* Less, 1987, D- *D. trabayensis trabayensis* Neumann, 1955, E- *D. 'dispansa'* (Sowerby, 1840) *taurica* Less, 1987.

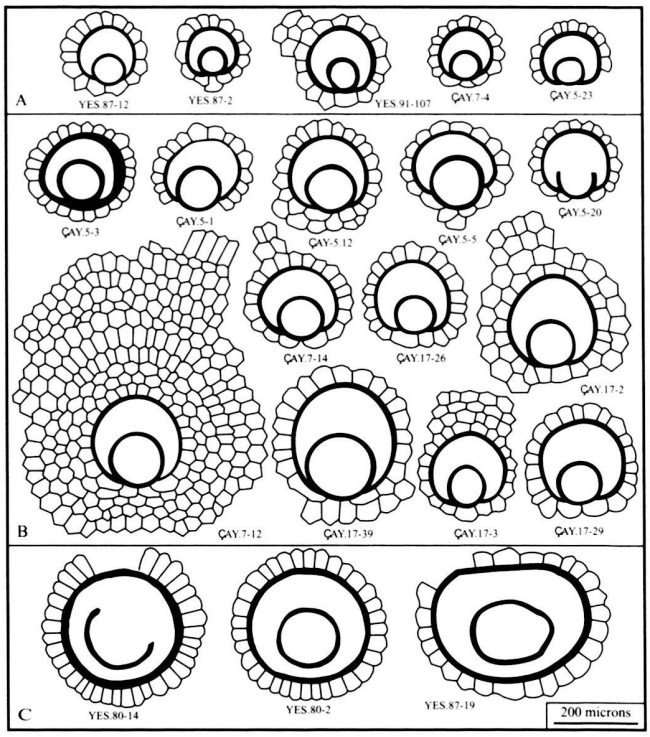


Fig. 4. Megalospheric embryo, early chamberlets and their variation in A- *O. varians* (Kaufmann, 1867) *portnayae* Less, 1987, B- *O. douvillei douvillei* (Schlumberger, 1903) (specimens from sample ÇAY.5 and 7) and *O. douvillei* (Schlumberger, 1903) *yesilyurtensis* n. ssp. (specimens from sample ÇAY.17), C- *O. schopeni* (Checcihia-Rispoli, 1908) *suvlukayensis* Less, 1987.

from the Priabonian by Sirotti (1978) and Less (1987, 1999). The diameter of embryo of our specimens with D=95 and 115 microns is within the limit (D_{mean}<125 microns) set for *D. trabayensis trabayensis* by Less (1998).

Discocyclina augustae van der Weijden, 1940 *sourbetensis* Less, 1987

Pl. 1/11-12?, Pl. 2/1-3, text figure 3C

1987 *Discocyclina augustae* van der Weijden, 1940 *sourbetensis* n. ssp.- Less, p. 152-153, Pl. 9, figures 7, 9-12, Pl. 10, figure 1, text figure 27f.

Description. Test flat, thin, circular in outline and slightly inflated in the central part. External diameters range from 1.63 to 3.62 mm. Pillars are sub-circular to circular, evenly distributed over the test surface and are slightly coarser in the central part of the test. The embryo is characterized by a small protoconch (75–105 microns) and slightly larger deuteroconch (115–155 microns) (Table 1) and presents a nephrolepidine-semi-isolepidine configuration. Adauxiliary chamberlets are low and narrow (H: 20–40 microns, W: 20-35 microns) with almost flat outer parts ('archiaci type'), and their number varies from 12 to 15. In the early portion of equatorial layer, the chamberlets are typically square in shape, and low (n0.5: 14–17), and in the later ontogenetic stage they progressively grow higher toward the peripheral part of the test and are typically rectangular in shape. The height of the peripheral chamberlets may reach up to 105 microns (Pl. 2, fig. 2).

Remarks. Thin and flat, small (size of the specimens varies from 1.5 to 4.37mm) forms with a small central umbo having small, indistinct pillars encountered only in the lowermost part of the Çayraz Formation, have invariably similar (and different from *D. trabayensis*) internal and external features. The diameters of the deuteroconchs of these specimens, which are exclusively semi-isolepidine-nephrolepidine and semi-nephrolepidine, vary from 115 to 210 microns. Less (1998), described two coevolving species; *D. augustae sourbetensis* with D_{mean}<145 microns, and *D. dispansa taurica* with D_{mean}=160-230 microns having similar internal and external features but differentiated mainly by the size of embryo from Cuisian. Since the diameters of the deuteroconchs for both species are similar, distinction of these species seems rather difficult. Following Less (1998), the specimens in the same horizons, having comparatively smaller embryos with nephrolepidine- semi-isolepidine configurations, were attributed to *D. augustae*, and larger embryos with semi-nephrolepidine configurations to *D. dispansa*. The diameters of embryos and the number of adauxiliary chamberlets of *D. augustae* specimens in our material fit the sub-specific limits (D_{mean}<165 microns) set for *D. augustae sourbetensis*.

Discocyclina 'dispansa' (Sowerby, 1840) *taurica* Less, 1987
Pl. 2/4–6, text figure 3E

1987 *Discocyclina dispansa* (Sowerby), 1840 *taurica* n ssp.- Less, p. 159-160, Pl. 12, figures 1-6, text figure 29m.

Description. Test flat, thin, circular in outline and slightly inflated in the central part. External diameter ranges from 1.5mm to 4.37mm. Pillars small, hardly observable and evenly distributed over the test surface and are slightly coarser over the well-marked central umbo in the median part of the test. Embryos are characterized by small protoconchs measuring 80-125 microns, and larger deuteroconchs measuring 155-210 microns (Table 1) and are of nephrolepidine- semi-nephrolepidine configurations. Adauxiliary chamberlets are low and narrow (H: 30-55 microns, W: 20-35 microns) with almost flat or slightly arcuate outer parts, and their numbers vary from 12 to 21. In the earliest parts of their equatorial layers, the chamberlets are typically square, low ($n_{0.5}$: 11-16) and in the later ontogenetic stages, they grow progressively higher and are typically rectangular. The heights of the peripheral chamberlets may reach up to 115 microns (Pl. 2, fig. 4).

Remarks. Topotype material of *D. dispansa* studied from the Middle – Upper Eocene of India by Sen Gupta (1963) reveals a large trybliolepidine embryo, the diameter of the deuteroconch of which measures up to 430 by 520 microns. Considering the *D. dispansa* and *D. augustae* lineages of Less (1998), the specimens (from among the specimens with closely similar internal structures) with larger embryos having invariably semi-nephrolepidine or nephrolepidine configurations in the lower part of studied sections were provisionally attributed to *D. 'dispansa'*, quotation marks denoting hesitation in the validity of species. The size of embryo and the number of adauxiliary chamberlets of *'dispansa'* specimens in our material fit the sub-specific limits (D_{mean}=160-230 microns) set for *D. dispansa taurica* by Less (1998).

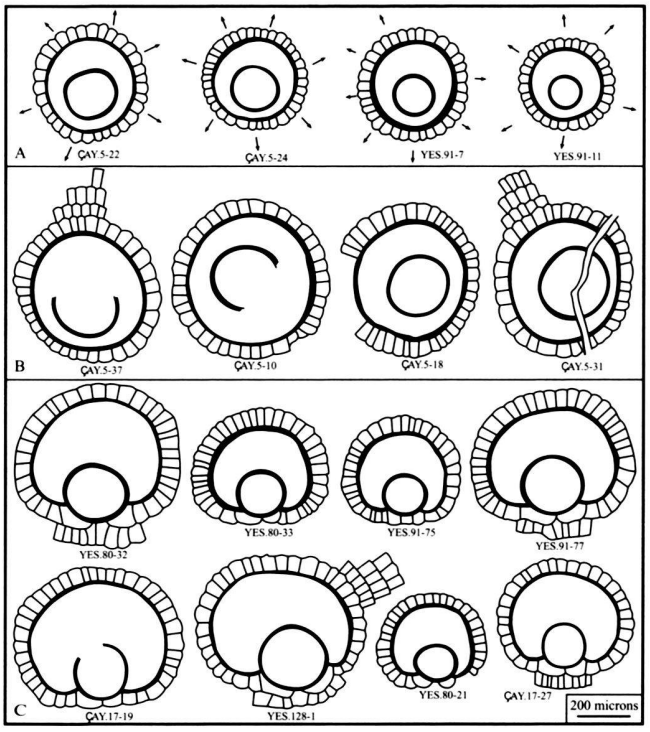


Fig. 5. Megalospheric embryo, early chamberlets and their variation in A- *O. munieri munieri* (Schlumberger, 1904), B- *D. fortisi fortisi* (d'Archiac, 1850), C- *D. archiaci archiaci* (Schlumberger, 1903).

Discocyclina archiaci archiaci (Schlumberger, 1903)
Pl. 4/12, text figure 5C.

1903 *Orthophragmina archiaci* n. sp.- Schlumberger, p. 277, Pl. 8, figures 5, 6?, 11.

1958 *Discocyclina archiaci* (Schlumberger)- Neumann, p. 81-84, Pl. 1, figures 1-2, 3(?), 4–8, text figure 20.

1987 *Discocyclina archiaci archiaci* (Schlumberger)- Less, p. 132-133, Pl. 1, figure 13, Pl. 2, figures 1-2, 6, Pl. 3, figures 1-2, 8-9, 12, text figure 26d.

Description. Test almost flat or lenticular, circular in outline. In each flat specimen, a centrally located poorly developed umbo is observed. External diameters range from 1.65mm to 5.65mm. Pillars of medium size are evenly distributed over test surfaces and are slightly coarser over the central boss in the median part of the tests. Embryos are characterized by protoconchs measuring from 150 to 275 microns and larger deuteroconchs measuring from 275 to 600 microns (Table 1). The relation of protoconch and deuteroconch is invariably of trybliolepidine or semi-nephrolepidine configuration. Adauxiliary chamberlets are high and wide (H: 40-90 microns, W: 25-55 microns) with flat outer parts. The number of adauxiliary chamberlets varies from 23 to 40. In the earliest portion of the equatorial layer, the chamberlets are typically rectangular and high ($n_{0.5}$: 8-12). The heights of the next cycles do not change or slightly increase toward the periphery, although in some specimens the heights of the chamberlets may reach up to 140 microns around the edges.

Remarks. In the original description of *D. archiaci*, Schlumberger (1903) depicted an equatorial section revealing an excentrilepidine embryo (which most probably belongs to *Orbitoclypeus*), and external view of a specimen suggesting that it belongs to the genus *Discocyclina*. Considering the common use of the specific name 'archiaci' for *Discocyclina* (Neumann 1958; Samuel et al. 1972; Less 1987, 1998; Ferrández-Cañadell et al. 1992), we attribute the above specimens to *D. archiaci.* Specimens of this species are frequently encountered in the lower parts of the studied sections, whereas they occur only very sporadically in the upper parts, where *D. fortisi* is abundant. Biometric aspects of these populations, with D_{mean}= ranging from 408.0 to 485.0 microns, are quite similar to those of populations described from the early – middle? Cuisian localities of the Crimea (D_{mean}= CRIPA: 416.7 microns) and France (D_{mean}= Gan-Berdoulou-GANBD: 423.4, Gan-Tuilerie-GANTU: 426.5, Horsarrieu-HORSX: 433.8 and Bos d'Arros-BOSDA: 436.4 microns) (Less 1998). These values fit the limits (D_{mean}=390-600 microns) set by Less (1998) for *D. archiaci archiaci.*

Discocyclina fortisi fortisi (d'Archiac, 1850)

Pl. 4/5-6, 11, text figure 5B.

1850 *Orbitolites fortisii* n. sp.- d'Archiac, p. 404, Pl. 8, figures 10-12.

1987 *Discocyclina fortisi fortisi* (d'Archiac)- Less, p. 145-146, Pl. 7, figures 8-9, text figure 26s.

Description. Test large almost flat or lenticular, circular in outline. In flat specimens, a well-developed central umbo is diagnostic. External diameters range from 2.65mm to 9.1mm. Pillars of medium size are evenly distributed over the test and are slightly coarser and closer to each other over the central umbo in the median part of the test. Embryos are conspicuously large and, in most specimens, the relation of protoconch and deuteroconch is of centrilepidine or excentrilepidine configuration; that is, the wall of the deuteroconch encompasses the whole of protoconch. In the majority of specimens, both embryonic chambers are not spherical but rather irregular in shape. In some specimens, the wall of the deuteroconch tends to touch the wall of protoconch at many points. Since the inner part of the embryo is recrystallised in many cases, the relation of these prolongations with the protoconch is not well observed. The diameter of the protoconch varies from 200 to 520 microns and that of the deuteroconch from 455 to 990 microns (Table 1). Adauxiliary chamberlets are high and wide (H: 45-100 microns, W: 25-65 microns) with flat outer parts. And their number varies from 33 to 65. In the earliest portion of the equatorial layer, the chamberlets are typically rectangular and high ($n_{0.5}$: 7-11). The height of succeeding cycles does not change or slightly increases toward the periphery, whereas in some specimens the height of the chamberlets may reach up to 145 microns around the edges.

Remarks. Discocyclinid foraminifera in the studied sections are mostly represented by specimens with large embryos of mostly centrilepidine configuration, and *D. fortisi* is the most abundant discocyclinid foraminifer in the studied part of the Çayraz Formation. Its existence and abundance in many horizons allows the recording of morphological changes especially concerning the diameter of embryos, number of adauxiliary chamberlets and other features. An overall increase in both the diameter of embryos and number of adauxiliary chamberlets is evident. The mean values of deuteroconch size of the populations in the lower part of the succession (D_{mean}=YEŞ. 91: 652.1; YEŞ.92: 805.0; YEŞ.95: 736.6, ÇAY.5: 544.0, ÇAY.7: 628.3 and ÇAY.9: 820.0 microns) fit the limits D_{mean}< 850 microns set by Less (1998) for *D. fortisi fortisi,* which characterize the lower Cuisian (SBZ 10). YEŞ.112 with D_{mean}= 859.0 microns has an intermediate stratigraphic position in the Yeşilyurt (YEŞ) section and represents a further stage of evolution of the species (a transitional stage between *D. fortisi fortisi* and *D. fortisi simferopolensis*). The populations YEŞ.128, ÇAY.14, 17, 18 and 21, corresponding to the upper part of Cuisian section of the Çayraz unit, have very high mean values for deuteroconchs (D_{mean}> 1200 microns). These populations represent a further stage of development of *D. fortisi* documented for the first time in this study and attributed to *Discocyclina fortisi cairazensis* n. ssp. The remarkable gap in mean deuterococh values between ÇAY.9 and ÇAY.14 could be explained by the fact that ÇAY.14 was sampled about 28 meters above ÇAY.9, an interval mostly represented by clastic units with sporadic benthonic foraminifera.

Discocyclina fortisi (d'Archiac, 1850) *simferopolensis* Less, 1987

1987 *Discocyclina fortisi* (d'Archiac) 1850 *simferopolensis* n. ssp.- Less, p. 146-147, Pl. 7, figures 10-14, Pl. 8, figures 1-2, 3?, text figure 26t-u.

Description. Test large, almost flat or lenticular, and circular in outline. External diameter ranges from 3.1 mm to 10.2 mm or more. Pillars of medium size are evenly distributed over the test surface and are slightly coarser and closer to each other over the central umbo in the median part of the test. Embryo is conspicuously large and in most of the specimens, the relation of protoconch and deuteroconch is of centrilepidine or excentrilepidine configuration. In the majority of the specimens, both embryonic chambers are not spherical but rather irregular in shape. In some specimens, the wall of the deuteroconch tends to touch the wall of the protoconch at some points. The diameter of the protoconch varies from 260 to 720 microns, and that of the deuteroconch from 590 to 1415 microns (Table 1). Adauxiliary chamberlets are high and wide (H: 40-100 microns, W: 35-75 microns) with flat and occasionally arcuate outer parts. Their number varies from 44 to 75. In the earliest portion of the equatorial layer, the chamberlets are typically rectangular in shape and high ($n_{0.5}$: 6-8). The height of succeding cycles does not change at all toward the periphery.

Remarks. YEŞ.112, having an intermediate stratigraphic position in the measured part of the Yeşilyurt section yielded *D. fortisi* specimens representing an intermediate stage of development between *D. fortisi fortisi* and *D. fortisi simferopolensis*. These specimens were attributed to *D. fortisi simferopolensis* considering the limits (D_{mean}>850 microns) set by Less (1998). *D. fortisi simferopolensis* has been described by Less (1998) in the material from the Crimea (CRINU: D_{mean}=940.3 and CRIDL: 980.6 microns) and France (Horsarrieu-HORSX: D_{mean}=915.8 microns) characterizing Shallow Benthic Zone 11, which corresponds to the middle part of the Cuisian. Our specimens, having lower values for these parameters, may be considered to represent the early evolutive stage in *D. fortisi simferopolensis* during the middle (?) Cuisian.

Discocyclina fortisi (d'Archiac, 1850) *cairazensis* n. ssp.

Pl. 4/8-9

Derivation of the name. Named after the type locality.

Holotype. Specimen ÇAY.21-18, Pl. 4, fig. 8.

Paratype. Specimen illustrated in Pl. 4, fig. 9.

Type locality. West of Çayraz village, (north of Haymana, Ankara, central Anatolia).

Type level. late Cuisian/ ? early Lutetian. In stratigraphic horizons containing *O. douvillei* (Schlumberger, 1903) *yesilyurtensis* n. ssp.

Diagnosis. *D. fortisi* populations with D_{mean} more than 1100 microns.

Description. Test large, almost flat, with slightly elevated umbonal part or lenticular circular in outline. External diameter ranges from 3.2 mm to 14.0 mm. Embryo is quite large and, in most specimens, the relation of protoconch and deuteroconch is of centrilepidine configuration. In the majority of specimens, both embryonic chambers are not spherical but rather irregular in shape. It is noted that in non-spherical embryos, the shape of the irregular protoconch in most cases conforms to the outline of deuteroconch, and the long axis of the protoconch also corresponds to the long axis of the deuteroconch. In some specimens, the wall of the deuteroconch form prolongations to join the protoconch. The diameter of the protoconch varies from 505 to 1200 microns, and that of the deuteroconch from 1030 to 2400 microns (Table 1). Adauxiliary chamberlets are high and wide (H: 55-120 microns, L: 35-85 microns) with mostly flat ('archiaci' type) outer parts, and are numerous in number. However, some sections reveal adauxiliary chamberlets and chamberlets in succeeding annuli with arched outer walls ('varians type'). The number of adauxiliary chamberlets varies from 56 to 123. In the earliest portion of the equatorial layer, the chamberlets are typically rectangular and very high ($n_{0.5}$: 5-8). The height of succeeding cycles either does not change at all, or peripheral chamberlets are even lower than the earlier ones. The heights and widths of the chamberlets in the later parts range from 50 to 100 and from 25 to 65 microns, respectively.

Remarks. Based on biometry, Less (1998) differentiated *D. fortisi fortisi* (d'Archiac, 1850) with $D_{mean}<850$ from *D. fortisi* (d'Archiac, 1850) *simferopolensis* Less, 1987 with $D_{mean}>850$ microns. The populations ascribed to *D. fortisi simferopolensis* from Horsarrieu-HORSX (western Aquitaine, France), CRINU and CRIDL (Crimea) populations with D_{mean}=915.8, 940.3 and 980.6 microns, respectively, represent the highest values for deuteroconchs measured from the *D. fortisi* lineage. Considering both the diameters of the deuteroconchs and the number of adauxiliary chamberlets, these values are considerably lower than those of the populations introduced here from YEŞ.128, ÇAY.14, 17, 18 and 21. The diameters of deuteroconchs in Less' material range from 610 to 1440 microns, whereas in our material they range from 1050 to 2400 microns. It is evident that our material represents a further stage of development in the *D. fortisi* lineage in light of the measurements of deuteroconchs. Our populations, corresponding to the upper parts of the studied sections, with D_{mean}=YEŞ.128: 1281.5, ÇAY.14: 1375.7, ÇAY.17: 1362.5, ÇAY.18: 1564.1 and ÇAY.21: 1602.8 microns, are thought to deserve a new sub-specific status in the *D. fortisi* lineage and are thus attributed to *D. fortisi* (d'Archiac, 1850) *cairazensis* n. ssp. This taxon is accompanied by *O. douvillei* (Schlumberger, 1903) *yesilyurtensis* n. ssp. in these horizons.

Discocyclina 'stratiemanuelis' Brönnimann, 1942
Pl. 4/7

1942 *Discocyclina strati-emanuelis* n. sp.- Brönnimann, p. 307-314, Pl. 22, figure 8.

1987 *Discocyclina stratiemanuelis* Brönnimann, 1942- Less, p. 147-148, Pl. 8, figures 5-9, text figure 26v-x.

Description. Test large, almost flat, with well-defined umbonal part. External diameters range from 5.1 mm to 5.5 mm. Embryo is large and the relation of protoconch and deuteroconch is of centrilepidine configuration. Both embryonic chambers are not spherical but rather irregular in shape. The diameter of the protoconch varies from 400 to 510 microns and that of the deuteroconch from 740 to 910 microns (Table 1). Adauxiliary chamberlets are high and wide (H: 60-125 microns, W: 55-100 microns) with flat ('archiaci' type) or slightly arched outer walls. The number of adauxiliary chamberlets is more than 40. The most conspicuous feature of this species is that the height and the width of the adauxiliary chamberlets exceed the parameters of chamberlets of the succeeding annuli ('pratti type'). Disregarding the adauxiliary chamberlets, no notable difference in height between the early, typically rectangular ($n_{0.5}$: 7-10), and late chamberlets is observed. The heights and lengths of chamberlets in the outer annuli range from 65 to 110, and from 30 to 40 microns, respectively.

Remarks. The specimens ascribed to this species are basically differentiated from *D. fortisi* by the height and width of the adauxiliary chamberlets, notably larger than those of successive annuli ('pratti' configuration of Less 1987). Less (1998) described this species from the late Cuisian – early Lutetian of the Crimea (CRIDU: D_{mean}=1028.8 and CRIPO: D_{mean}= 1115.0 microns) and Bavaria (Kressenberg-KRESS: D_{mean}= 1263.3 microns). In our material, we encountered a few specimens of this species only in the lower part of the studied section, which represents the lower part of the Cuisian. Those of our specimens having lower values for the diameter of the embryo (D ranging from 740 to 910 microns) may represent a more primitive evolutive stage of this taxon during the early Cuisian. Nevertheless, its association with *D. fortisi* and the close similarity of embryos of these two species still raises the question about the validity of this taxon. Since our material contains only a few specimens of this species, we cannot derive taxonomic results and provisionally attribute these specimens to *D. 'stratiemanuelis'*, the quotation marks denoting hesitation on the validity of the taxon.

Discocyclina sp.1
Pl.4/10, 13

Description. Several discocyclinid specimens have embryos in nephrolepidine-trybliolepidine configuration, with adauxiliary chamberlets strongly arcuate to wedge-like in their outer parts. Although these specimens are very similar to *D. archiaci archiaci*, they are here provisionally treated separately due to the different shape of the adauxiliary chamberlets.

Genus *Nemkovella* Less, 1987

Nemkovella strophiolata (Gümbel, 1868) *fermonti* Less, 1987

Pl. 1/1-2, 4–7, text figure 3A.

1987 *Nemkovella fermonti* n. sp.- Less, p. 187-188, Pl. 24, figures 5-6, text figure 29b.

Description. Test is small, flat and elevated in the central part, with test diameter less than 4.5 mm. Embryo is small and of semi-isolepidine configuration, with the deuteroconch being slightly larger than the protoconch. The diameters of the protoconchs vary from 70 to 100 microns, and that of the deuteroconchs from 100 to 150 microns (Table 1). Adauxiliary chamberlets are few in number (A: 7-9), and typically low and wide (H: 20-30 microns, W: 30-45 microns). Outer parts of these chamberlets, which are elongated in annular direction, are typically arcuate or wedge-shaped. In some specimens, a few cycles following the adauxiliary chamberlets are lower than the adauxiliary chamberlets ('strophiolata' configuration of Less, 1987). The chamberlets are very low in the early part ($n_{0.5}$: 19-22), high and narrow in the late stages (H: up to 105 microns and w: 25-35 microns), and typically hexagonal.

Remarks. Nemkovella specimens, encountered only in the lower part of the studied sections, display a wide range of deuteroconch diameters, varying from 100 to 285 microns. *N. fermonti* is differentiated from *N. evae* in having a much smaller embryo and lower adauxiliary chamberlets (Less 1987). The adauxiliary chamberlets, which are arcuate or wedge-shaped in *N. fermonti*, are truncated-arcuate in shape and may be succeeded by a few annuli with very low arcuate chamberlets in *N. evae*. Less (1998) identified *N. fermonti* from late Cuisian – early Lutetian sections in the Crimea and France (CRIDU: D_{mean}=146.0 and Saint-Barthélémy-STBAR: D_{mean}=148.3 microns respectively) and from the lower part of the Cuisian section in France (Horsarrieu-HORSX: D_{mean}=130.7 microns). *Nemkovella* specimens in YEŞ.91 (D_{mean}=123.3 microns), YEŞ.92 and ÇAY.9 with deuteroconch diameters varying from 100 to 150 microns and with very low adauxiliary chamberlets were attributed to *N. strophiolata fermonti*, considering the limit (D_{mean}<150 microns) set for this species by Less (1998).

Nemkovella evae Less, 1987

Pl. 1/3, text figure 3B.

1987 *Nemkovella evae* n. sp.- Less, p. 184–187, Pl. 23, figures 1-7, 9-12; Pl. 24, figures 1-4, text figure 29a.

Description. Small-sized flat forms with inflated central parts or inflated lenticular forms. Test diameter up to 3 mm. Pillars are coarse, very close to each other in the central part and partly polygonal in shape. Embryos are characterized by small protoconchs measuring from 95 to 170 microns, and larger deuteroconchs measuring from 160 to 285 microns (Table 1) in nephrolepidine- semi-nephrolepidine configurations. Adauxiliary chamberlets are low (of moderate height) and narrow (H: 30-50 microns, W: 30-50 microns), with arcuate or typically truncated-arcuate outer parts. Adauxiliary chamberlets vary in number from 7 to 16. In the earliest part of the equatorial layer, the chamberlets are low ($n_{0.5}$: 13-19), and in the later ontogenetic stage they progressively grow higher toward the peripheral part of the test and are typically hexagonal. Heights of peripheral chamberlets may reach up to 100 microns.

Remarks. Less (1998) presented the biometric aspects of *N. evae* over a wide stratigraphic interval, from Ilerdian to Lutetian (SBZ 7-14). The biometric features of the populations described from the Cuisian (D_{mean} ranging from 205.0 to 231.0 microns) are not much different from those described from the Lutetian. In our material, *Nemkovella* specimens having a large embryo with comparatively high adauxiliary chamberlets were ascribed to *N. evae*, following the species limits set for this taxon by Less (1998).

Family ORBITOCLYPEIDAE Brönnimann, 1946

Genus *Orbitoclypeus* Silvestri, 1907

Orbitoclypeus douvillei douvillei (Schlumberger, 1903)

Pl. 2/10-12, Pl. 3/6, text figure 4B (specimens from sample ÇAY.5 and 7).

1903 *Orthophragmina douvillei* n. sp.- Schlumberger, p. 283-284, Pl. 9, figures 21-24.

1958 *Discocyclina douvillei* (Schlumberger) 1903- Neumann, p. 92-93, Pl. 11, figures 4–9, text figure 26B.

1987 *Orbitoclypeus douvillei* (Schlumberger) 1903- Less, p. 205-206, Pl. 27, figures 7-9, text figure 30i-k.

Description. Test small (external diameter varies from 1.55 to 4.25mm), lenticular, inflated to strongly inflated and circular in outline. Sub-circular to circular piles are thicker in the elevated central part of the test than those in the peripheral part, and their thicknesses may reach up to 150 microns. Peripheral pillars are comparatively small and even indistinct. Pillars in the most central part are usually surrounded by 8 lateral chamberlets, whereas, adjoining ones are surrounded usually by 4–5 open lateral chamberlets having straight walls. Embryos are small, characterized by spherical protoconchs measuring from 85 to 130 microns, and deuteroconchs measuring from 160 to 210 microns, with invariably eulepidine configuration. Annuli are almost circular in outline in the central part and may be slightly undulated in the peripheral part. The distal parts of equatorial chamberlets in the first and successive annuli are typically arcuate or wedge-like. Chamberlets in the first annulus are numerous, and 13-19 chamberlets arising directly from the deuteroconch are present. Equatorial chamberlets, which are usually 25-50 microns high around the embryo, rapidly grow long and may range up to 100 microns toward the peripheral part of the equatorial layer.

Remarks. In our material, *O. douvillei* is one of the dominant orthophragminid taxa and is frequently associated with *D. fortisi*. In section ÇAY, *O. douvillei* occurs in association with *D. fortisi fortisi*, *D. archiaci archiaci* and *O. munieri munieri* in the lower part of the succession, and with *D. fortisi*

cairazensis n ssp. in the uppermost part. The specimens with typically eulepidine configuration and with D_{mean}<200 microns in the lower section were attributed to *O. douvillei douvillei* (Schlumberger, 1903).

Orbitoclypeus douvillei (Schlumberger, 1903) *yesilyurtensis* n. ssp.

Pl. 3/2-5, 7, 13, text figure 4B (specimens from sample ÇAY.17).

Derivation of the name. Named after Yesilyurt village, near the type locality.

Holotype. Specimen ÇAY.17-2, Pl. 3, fig. 3-4 (text figure 4B).

Paratypes. Specimens illustrated in Pl. 4, fig. 2, 7,13.

Type locality. West of Çayraz village, (north of Haymana, Ankara, central Anatolia).

Type level. late Cuisian/?early Lutetian. In the stratigraphic horizons containing *D. fortisi* (d'Archiac, 1850) *cairazensis* n. ssp.

Diagnosis. *O. douvillei* populations with D_{mean} more than 200 microns.

Description. Test is robust with an undulated collar. Embryo is characterized by a spherical protoconch (ranging from 90 to 165 microns) and a deuteroconch (ranging from 175 to 300 microns) with invariably eulepidine–tryblilepidine configuration. Chamberlets in the first annulus are numerous, and 15-24 chamberlets arise directly from the deuteroconch. Equatorial chamberlets, which are usually 25-55 microns high around the embryo, rapidly grow long and may range up to 130 microns toward the peripheral part of the equatorial layer.

Remarks. In the Çayraz (ÇAY) section, in addition to an increase in test size, the specimens of *O. douvillei* in the upper part of section (ÇAY.17 and 18) display more developed parameters for diameter of embryo and a greater number of adauxiliary chamberlets than those in the lower part (ÇAY.5 and 7). These robust specimens in the upper part of the succession, having comparatively larger embryos (D_{mean}: ÇAY.17=223.3 microns) with eulepidine–trybliolepidine configuration are thought to deserve a new status and are attributed to *O. douvillei* (Schlumberger, 1903) *yesilyurtensis* n. ssp.

Orbitoclypeus varians (Kaufmann, 1867) *portnayae* Less, 1987

Pl. 3/1, 8-10, text figure 4A.

1987 *Orbitoclypeus portnayae* n. sp.- Less, p. 207, Pl. 27, figures 10-12, text figure 30l.

Description. Test small (external diameter varies from 1.3 to 2.6mm), lenticular, inflated to strongly inflated and circular in outline. Embryo is small, characterized by a spherical protoconch (70 to 90 microns) and a deuteroconch (120 to 150 microns) and displays invariably eulepidine configuration. The annuli are undulated in the central part. The distal parts of equatorial chamberlets in the first and successive annuli are typically arcuate or wedge-like. Adauxiliary chamberlets vary in number from 11 to 16. Equatorial chamberlets, which are usually 25-35 microns high around the embryo, rapidly grow long and may reach up to 150 microns toward the peripheral part of the equatorial layer.

Remarks. These specimens, externally very similar to *O. douvillei douvillei*, were ascribed to *O. varians* only because of the wavy aspect of the equatorial annuli and very small embryo. The embryo values characteristic of these specimens have not been recorded for any orbitoclypeid taxa from the Cuisian. Considering the *O. varians* lineage of Less (1998), these specimens may represent the primitive specimens of *O. varians* in the early-middle Cuisian. However, we are hesitant about the taxonomic value of undulation in the annuli since this aspect is also observed in *O. douvillei douvillei.*

Orbitoclypeus schopeni (Checcihia-Rispoli, 1908) *suvlukayensis* Less 1987

Pl. 2/7-9, text figure 4C

1987 *Orbitoclypeus ramaraoi* (Samanta), 1967 *suvlukayensis* n. ssp.- Less, p. 199, Pl. 26, figures 3-4, text figure 30d.

Description. Test is small (less than 4 mm), lenticular and circular in outline. Pillars, of slightly polygonal shape, are coarse in the central part of the test and very small in the peripheral part of the test. The embryonic apparatus consists of an almost spherical protoconch and a spherical to sub-spherical deuteroconch. Considering the relation of protoconch and deuteroconch, two types of configuration have been identified. In some of the specimens, deuteroconch encompasses the protoconch with a restricted surface of contact in between. In the others, both embryonic chambers have no adjoining wall and the protoconch is an eccentric position. The diameter of the protoconch varies from 115 to 180 microns, and the diameter of the deuteroconch varies from 205 to 350 microns (Table 1). The equatorial chamberlets are arranged in concentric annuli, almost circular in outline. The distal parts of equatorial chamberlets in the first and successive annuli are typically arcuate or wedge-like. Chamberlets in the first annulus are numerous, and 24–32 (34) chamberlets arise directly from the deuteroconch. Equatorial chamberlets, which are usually 35-50 microns high around the embryo, may be as high as 95 microns towards the peripheral part.

Remarks. Unribbed orbitoclypeid specimens with excentrilepidine configuration are frequently encountered in late Thanetian, Ilerdian, and Cuisian horizons of the Haymana-Polatli basin succession (Özcan et al. 2001). Less (1998) described *O. suvlukayensis* in the late Ilerdian (Shallow Benthic Zone 8-9) with the species limit D_{mean}=240-300 microns, and *O. crimensis* in the Cuisian and Lutetian (Shallow Benthic Zone 10-13, 14?) and assigned the limits D_{mean}=300-(390)- (500) microns. Sample YEŞ.80 containing *D. archiaci archiaci* and *N. evae* is thought to be of early Cuisian age. The *Orbitoclypeus* population in this sample (with D_{mean}=254.3 microns) is attributed to *O. suvlukayensis* following the limits set by Less (1998) for this taxon. The same taxon studied in the lower Cuisian

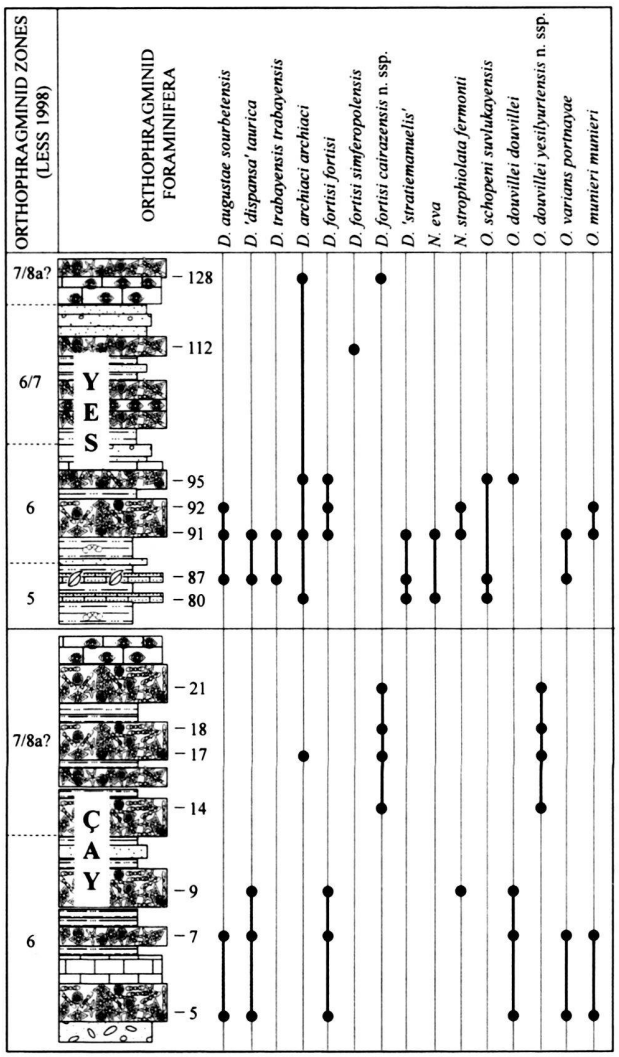


Fig. 6. Stratigraphic distribution of orthophragminid species/subspecies identified in the Cuisian section (Yesilyurt-YES and Çayraz-ÇAY sections) of the Çayraz Unit.

part of the Sakarya section from Haymana-Polatli basin revealed similar values for diameters of the deuteroconchs (Özcan et al. 2001). Thus, the upper limit for the stratigraphic range of this subspecies should be elevated to the lower part of the Cuisian.

Orbitoclypeus munieri munieri (Schlumberger, 1904)
Pl. 3/11-12, Pl. 4/1-2, 3-4, text figure 5A.

1904 *Orthophragmina munieri* n. sp.- Schlumberger, p. 125, Pl. 3, figure 12.
1987 *Orbitoclypeus bayani* (Munier-Chalmas), 1891- Less, p. 203, Pl. 27, figures 5-6.

Description. Test large (external diameter varies from 4.6 to 9.8 mm) with inflated to strongly inflated central part from which 6 to 8 thick radial ribs develop. Embryo is rather large, characterized by a spherical protoconch (115 to 250 microns) and an almost spherical deuteroconch (195 to 425 microns) (Table 1), with invariably excentrilepidine configuration. However, slightly oblique sections may have a trybliolepidine configuration as well. Except for the early stage, annuli are strongly undulated in the ribs. The distal parts of equatorial chamberlets in the first and successive annuli are typically arcuate or wedge-like. The number of adauxiliary chamberlets vary from 11 to 16. Equatorial chamberlets, which are usually 25–65 microns high around the embryo, are larger than those in inter-rib areas.

Remarks. Ribbed *Orbitoclypeus* specimens with 6 to 8 ribs were encountered only in the lower part of the Çayraz section. However, one 4–ribbed specimen with a small eulepidine embryo was also sectioned (Pl.4, figs 3-4). Our specimens (with D_{mean}=305.6, 315.0 and 347.5 microns) were attributed to *O. munieri* (Schlumberger) 1904 considering the limits (D_{mean}>280 microns) set by Less (1998) for this taxon, which is a diagnostic ribbed orthophragminid for the Cuisian. The specimens attributed to *O. furcata* n. ssp. Horsarrieu by Less (1998) from the Cuisian have much smaller embryos, with diameter of the deuteroconch ranging from 158 to 230 microns (D_{mean}= 185.2 microns). These forms have not been illustrated and described yet.

Summary and Conclusions

The Çayraz section, a well-known locality for its benthonic foraminifera, constitutes the uppermost stratigraphic unit of the Haymana-Polatli basin in central Anatolia. This succession, proposed as a reference section for the Cuisian and early Lutetian Shallow Benthic Zones in Turkey, contains abundant free specimens of orthophragminids accompanied by nummulitid and partly alveolinid foraminifera in numerous successive horizons. The orthophragminid foraminifera identified in the lower part of this unit show a close resemblance to those Tethyan assemblages described from the Cuisian of the northern Mediterranean-Crimean region, and also include two new orbitoclypeid and discocyclinid taxa. The biometric data documented here for the first time in Anatolian material contribute to the previously available information and constitute more detailed information with respect to the variation and evolution of morphologic parameters in successive horizons during the Cuisian.

The lower part of the Cuisian section contains comparatively small tests of *Discocyclina*, *Orbitoclypeus*, *Nemkovella* and *Asterocyclina,* and the upper part contains comparatively larger tests of *Discocyclina* and *Orbitoclypeus*. In the lowermost part (samples YEŞ.80 and 87), transitional beds between the basinal siliciclastics and 'nummulitic banks' of the Çayraz unit contain orthophragminids, represented by an assemblage of *D. archiaci archiaci* (Schlumberger, 1903), *O. schopeni* (Checcihia-Rispoli, 1908) *suvlukayensis* Less, 1987, *N. evae* Less, 1987 and *Discocyclina* sp.1. (Fig. 6). This assemblage is thought to be of early Cuisian age (orthophragminid zone 5 of Less 1998) considering the identification of *D. archiaci archiaci*. A disagreement with Less (1998) with respect to the

stratigraphic range of *O. schopeni suvlukayensis* arises considering the rather small embryos of this taxon in this part. In accord with the biometric limits set by that author, the upper limit for the stratigraphic range of this taxon needs to be reconsidered and possibly elevated to the early Cuisian (in the sense of Serra-Kiel et al. 1998).

The lower part of the 'nummulitic banks' of the Çayraz section (samples YEŞ.91, 92, 95 and ÇAY.5, 7, 9) contains a more diverse assemblage of orthophragminids (Fig.6). Small and flat specimens with characteristic umbos in the central part of the tests have revealed invariably bilocular, small embryos with semi-isolepidine, nephrolepidine or semi-nephrolepidine configurations, and equatorial chamberlets with flat distal walls. Among these, specimens having comparatively larger embryos with semi-nephrolepidine configurations were ascribed to *D. 'dispansa'* (Sowerby, 1840) *taurica* Less, 1987 and those having smaller embryos with typically nephrolepidine configurations to *D. augustae* van der Weijden, 1940 *sourbetensis* Less, 1987. Being very sporadic, the specimens having arcuate adauxiliary chamberlets with semi-isolepidine embryo configurations were attributed to *D. trabayensis trabayensis* Neumann, 1955. In this part of the Çayraz unit, both unribbed and ribbed specimens of *Orbitoclypeus* occur abundantly as free specimens in some horizons. Unribbed specimens having an easily recognizable, small and inflated tests with eulepidine embryo configurations, and equatorial chamberlets distinctly arcuate or wedge-like in their outer margins, were noted to represent two distinct taxa. The most common one is characterized by a typically eulepidine embryo, the diameter of the deuteroconch ranging from 160 to 210 microns. Equatorial chamberlets are low to medium-high in the early stage, but very high especially along the peripheral part of the equatorial layer. Annuli in some specimens may have a faint wavy structure in their equatorial layers. These specimens are attributed to *O. douvillei douvillei* (Schlumberger, 1903). Specimens of the second category yield small embryo (diameter of deuteroconch varying from 120 to 150 microns) with eulepidine configuration, succeeded by adauxiliary chamberlets, which are low in number. A wavy pattern of the equatorial layer, which has notably high chamberlets in the peripheral part, is recognised. These specimens were attributed to *O. varians* (Kaufmann, 1867) *portnayae* Less, 1987. Although undulation in the equatorial layer of the orthophragminid foraminifera is proposed to have a taxonomic value (*O. 'varians'* lineage of Less 1998), we are presently hesitant on this after having observed wavy features in other orbitoclypeid foraminifera. Ribbed *Orbitoclypeus* is characterized by large tests having 6 to 8 ribs; however one specimen yielded only 4 ribs. These specimens, except for the 4–ribbed specimen with a rather small, eulepidine embryo, possess large embryos (D_{mean}=305.6, 315.0 and 347.5 microns) with invariably excentrilepide configuration and were assigned to *O. munieri munieri* (Schlumberger, 1904). In these horizons, small, flat to inflated specimens, comprising semi-polygonal pillars very close to each other in the central part of the test, belong to *Nemkovella*. These specimens have invariably nephrolepidine and semi-nephrolepidine embryo configurations and possess low equatorial chamberlets with arcuate, truncated arcuate or wedge-like outer margins. Two distinct types were recognized; specimens with comparatively small nephrolepidine embryos, followed by rather low adauxiliary chamberlets, and specimens with considerably larger embryos with semi-nephrolepidine configuration were ascribed to *N. strophiolata* (Gümbel, 1868) *fermonti* Less, 1987 and *Nemkovella evae* Less, 1987, respectively. *Nemkovella* specimens were not encountered in the upper parts of the studied sections. In these horizons, in the lower part of Çayraz unit, large discocyclinid tests mainly comprise specimens with large non-spherical embryos having invariably centrilepidine embryonic configurations. The chamberlets in the first annuli are rather high in number and height, and may be slightly arched in their outer margins. Equatorial chamberlets with almost flat outer margins in successive annuli do not grow long and are even lower in the peripheral part. These specimens (with D_{mean}= 544 to 820 microns), are considered to represent *D. fortisi fortisi* (d'Archiac, 1850). A few specimens having high and wide adauxiliary chamberlets ('pratti' type of Less 1987) with internal structures similar to *D. fortisi fortisi* are provisionally attributed to *D. 'stratiemanuelis'* Brönnimann, 1942. These foraminifera in the lower part of the Çayraz unit are accompanied by *D. archiaci archiaci* (Schlumberger, 1903) and *Asterocyclina* sp. This part of the section is thought to correspond to orthophragminid zone 6 (SBZ 10/11).

The upper part of the studied section (samples YEŞ.112, 128 and ÇAY.14, 17, 18, 21) is characterized by the abundance of large specimens of the discocyclinid and orbitoclypeid genera. Discocyclinid specimens in the lower horizons of the upper section (YEŞ.112) yielded invariably centrilepidine embryos and are very similar to the *D. fortisi fortisi* recorded in stratigraphically lower horizons but with higher values for the measurements of the embryos. This population, with D_{mean}= 859.0 microns, represents an intermediate stage in the *D. fortisi* lineage that has been attributed to an early stage of *D. fortisi simferopolensis* Less, 1987. This horizon is thought to correspond to orthophragminid zone 6/7. The discocyclinid foraminifera below the 'alveolinid limestone' horizon (reported to contain typical Cuisian *Alveolina* and *Nummulites*), are represented mainly by large specimens of *D. fortisi*. The values related to the size of the embryos and to the number of adauxiliary chamberlets of the taxon are not comparable with those documented in previous studies. These populations, with D_{mean}=1281.5, 1375.7, 1362.5, 1564.1 and 1602.8 microns, are thought to represent a further stage of development of *D. fortisi* in the Cuisian. We think that these specimens deserve a new subspecific status in the *D. fortisi* lineage and are attributed to *D. fortisi* (d'Archiac, 1850) *cairazensis* n. ssp. It is apparent from the biometric data that *D. fortisi* constitutes a fast evolving lineage during the the Cuisian. This foraminifer is accompanied by robust *O. douvillei* specimens, which are more evolved (diameters of deuteroconch varying from 175 to 300 microns) than specimens of the same taxon in the lower part of the studied section. *O. douvillei* in these horizons yield com-

paratively larger embryos, with eulepidine and trybliolepidine configurations. The measurements of the embryos of these specimens are very close to those reported from late Cuisian populations (Less 1998). These evolved *O. douvillei* populations (with $D_{mean>}$ 200 microns) are attributed to *O. douvillei* (Schlumberger, 1903) *yesilyurtensis* n. ssp. This part of the succession is thought to correspond to orthophragminid zone 7/8a (?) (late Cuisian- lowermost Lutetian?).

Acknowledgements

This research was supported by the Scientific and Technical Council of Turkey (Project No. TÜBITAK-YDABÇAG 198Y046). All laboratory work, microscope studies and photography were carried out in the facilities of the Department of Geological Engineering, Middle East Technical University (Ankara). I thank Dr. Ercüment Sirel (Ankara University) for kindly providing information helpful in my fieldwork and Sinan Çolakoğlu (Niğde University) for drawings. I am also indebted to both Dr. G.Y. Less (Magyar Állami Földtani Intézet, Budapest) and Dr. C. Ferrández-Cañadell (Barcelona University), who critically read the first draft of this manuscript and suggested a number of useful changes. I also gratefully acknowledge the English editorial work of Dr. S.K. Mittwede (Müteferrika Consulting Ltd., Ankara).

REFERENCES

BRÖNNIMANN, P. 1941: Zur Kenntnis des Embryonalapparates von *Discocyclina* s.s. Eclog. geol. Helv. 33, 2, 252–274.

BRÖNNIMANN, P. 1942: Eine *Discocyclina* mit multilocularen Embryonalapparat aus dem Eocaen von Kressenberg. Eclog. geol. Helv. 34, 305–318.

BRÖNNIMANN, P. 1946a: Zur Frage der verwandtschaftlichen Beziehungen zwischen *Discocyclina* s.s und *Asterocyclina*. Eclog. geol. Helv. 38, 2, 579–615.

BRÖNNIMANN, P. 1946b: Zur Morphologie von *Aktinocyclina* Gümbel 1868. Eclog. geol. Helv. 38, 560–578.

BRÖNNIMANN, P. 1951: A model of the internal structure of *Discocyclina* s.s. J. Paleont. 25, 2, 208–211.

CİNER, A., DEYNOUX, M., RICOU, S. & KOŞUN, E. 1996: Cyclicity in the Middle Eocene Çayraz carbonate formation, Haymana basin, Central Anatolia, Turkey. Palaeogeo. Palaeoclim. Palaeoeco. 121, 313–329.

DİZER, A. 1964: Sur quelques *Alveolines* de l'Eocene de Turquie. Rev. de Micropaléont. 7, 265–279.

DİZER, A. 1968: Etude micropaleontologique du Nummulitique de Haymana (Turquie). Rev. de Micropaléont. 11, 13–21.

DOUVILLE, H. 1922: Révision des Orbitoides; Deuxième partie- Orbitoides du Danien et de l'Eocène. Bull. Soc. géol. France. Sér. 4, 22, 55–100.

FERRÁNDEZ-CAÑADELL, C. 1998a: Morphostructure and paleobiology of Mesogean orthophragminids (Discocyclinidae and Orbitoclypeidae, Foraminifera). Acta Geol. Hispánica. 27, 1–3, 183–187.

FERRÁNDEZ-CAÑADELL, C. 1998b: An Asterigerinacean origin for *Orbitoclypeus* and *Asterocyclina* (Orbitoclypeidae, Foraminifera). J. Foraminiferal Res. 28, 2, 135–140.

FERRÁNDEZ-CAÑADELL, C., LÓPEZ-CIVIT, C. & SERRA-KIEL, J. 1992: Estructura y ontogenia del genero *Discocyclina* Gümbel, 1870 (Macroforaminifero del Eoceno). Rev. Esp. Paleont. 7, 1, 13–23.

HOTTINGER, L. 1960: Über Paleocaene und Eocaene Alveolinen. Eclog. geol. Helv. 53, 1, 265–283.

KOÇYİĞİT, A. 1991: An example of an accretionary forearc basin from northern Central Anatolia and its implications for the history of Neo-Tethys in Turkey. Geol. Soc. America Bull. 103, 22–36.

LESS, G.Y. 1987: Paleontology and stratigraphy of the european orthophragminae. Geol. Hungarica 51, 1–373.

LESS, G.Y. 1998: The zonation of the Mediterranean Upper Paleocene and Eocene by orthophragminae. Dela-Opera Sazu. 34, 2, 21–43.

LESS, G.Y. 1999: The Late Paleogene larger foraminiferal assemblages of the Bükk Mountains (NW Hungary). Rev. Esp. Micropaleont. 31, 3, 347–356.

NEUMANN, M. 1955: Etude des orthophragmines continues dans les marnes à *Xanthopsis dufourii* (Lutétien Inferieur) de la Chalosse de Montfort (Landes). Bull. Soc. géol. France 5, 125–134.

NEUMANN, M. 1958: Révision des Orbitoididés du Crétacé et de l'Éocène en Aquitaine Occidentale. Mém. Soc. géol. France 37, 83, 1–174.

NEUMANN, M. 1972: Sur les Orbitoïdidés du Crétacé supérieur et du Tertiaire II: Structure et classification. Rev. de Micropaléont. 15, 163–189.

ÖZCAN, E., ÖZKAN-ALTINER, S. & ÇOLAKOĞLU, S. 2001: Biometric aspects of Orthophragminid foraminifera from Haymana-Polatli basin succession: calibration with pelagic organisms. Project No: TÜBİTAK-YDABÇAG 198Y046 (unpublished), p.1–117 (in Turkish with English abstract).

SAMUEL, O., BORZA, K., & KÖHLER, E. (1972)- Microfauna and lithostratigraphy of the Paleogene and adjacent Cretaceous of the middle Vah valley (west Carpathian). Geologický Ústav Dionijca, Bratislava. p. 1– 246.

SCHLUMBERGER, C. 1903: Troisième note sur les *Orbitoides*. Bull. Soc. géol. France 4, 3, 273–289.

SCHLUMBERGER, C. 1904: Quatrième note sur les *Orbitoides*. Bull. Soc. géol. France 4, 4, 119–135.

SEN GUPTA, B. 1963: A restudy of two common species of *Discocyclina* from India. Micropaleontology 9, 1, 39–49.

SERRA-KIEL, J., HOTTINGER, L., CAUS, E., DROBNE, K., FERRÀNDEZ, C., JAUHRI, AK., LESS, G. Y., PAVLOVEC, R., PIGNATTI, J., SAMSÓ, J. M., SCHAUB, H., SİREL, E., STROUGO, A., TAMBAREAU, Y., TOSQUELLA, J. & ZAKREVSKAYA, E. 1998: Larger foraminiferal biostratigraphy of the Tethyan Paleocene and Eocene. Bull. Soc. géol. France. 169, 2, 281–299.

SİREL, E. 1976: Systematic study of the some species of the genera *Alveolina*, *Nummulites*, *Ranikothalia* and *Assilina* in the south of Polatli. Bull. Geol. Soc. Turkey. 19, 89–102 (in Turkish with English abstract).

SİREL, E. 1992: Field Trip. In: Introduction to the early Paleogene of the Haymana-Polatli Basin, IGCP 286 'Early Paleogene Benthos', Third Meeting, Ankara (Turkey), General Directorate of Mineral Research and Exploration. 1–10.

SİREL, E. 1998: Foraminiferal description and biostratigraphy of the Paleocene- Lower Eocene shallow-water limestones and discussion on the Cretaceous- Tertiary boundary in Turkey. General Directorate of Mineral Research and Exploration, Monograph Ser. 2, p. 1–117.

SİREL, E. 1999: Four new genera (*Haymanella*, *Kayseriella*, *Elazigella* and *Orduella*) and one new species of *Hottingerina* from the Paleocene of Turkey. Micropaleontology 45, 2, 113–137.

SİREL, E., & GÜNDÜZ, H. 1976: Description and stratigraphic distribution of some species of the genera *Nummulites*, *Assilina* and *Alveolina* from the Ilerdian, Cuisian and Lutetian of Haymana region. Bull. Geol. Soc. Turkey 19, 31–44 (in Turkish with English abstract).

SİREL, E., DAĞER, Z. & SÖZERİ, B. 1986: Some biostratigraphic and paleogeographic observations on the Cretaceous-Tertiary boundary in the Haymana Polatli region (Central Turkey). In: O. Walliser (Ed.) Global Bio-Events. Lecture Notes in Earth Sciences. 8, 385–396.

SIROTTI, A. 1978: Discocyclinidae from the Priabonian type-section (Lessini Mountains, Vicensza, Northern Italy). Boll. Soc. Paleont. Italiana 17, 1, 49–67.

TOKER, V. 1980: Nannoplankton biostratigraphy of the Haymana region (SW Ankara). Bull. Geol. Soc. Turkey. 23, 165–178 (in Turkish with English abstract).

TOUMARKINE, M. 1967: Une nouvelle espece d'Orthophragmine de l'Eocene Marin du Mont-Cayla (Aude): *Discocyclina neumannae*. Rev. Micropaléont. 10, 3, 209–214.

ÜNALAN, G., YÜNALAN, G., YÜKSEL, V., TEKELİ, T., GÖNNENÇ, O., SEYİRT, Z., & HÜSEYİN, S. 1976: The stratigraphy and paleogeographical evolution of the Upper Cretaceous- Lower Tertiary sediments in the Haymana- Polatli region (SW Ankara). Bull. Geol. Soc. Turkey 19, 159–176 (in Turkish with English abstract).

YÜKSEL, S. 1970: Etude Géologique de la Region d'Haymana (Turquie Centrale), (Ph.D. Thesis), Thèse Fac. Sci. Univ. de Nancy, p.1–179.

Manuscript received May 3, 2001
Revision accepted October 23, 2001

PLATE 1

1–2, 4–7– *Nemkovella strophiolata* (Gümbel, 1868) *fermonti* Less, 1987. **1–2, 5–7–** equatorial section: **1–2,** sample YEŞ.91-108. **5–6,** sample YEŞ.91–18. **7,** sample ÇAY.9-1. **4–** vertical section, sample YEŞ.91–103.
3– *Nemkovella evae* Less, 1987. equatorial section: sample YEŞ.80–47.
8–10– *Discocyclina trabayensis trabayensis* Neumann, 1955. equatorial section: **8–9,** sample YEŞ.87–31. **10,** sample YEŞ.91–46.
11–12 (?)– *Discocyclina augustae* van der Weijden, 1940 *sourbetensis* Less, 1987. **11–** equatorial section: sample YEŞ.91–10. **12–** vertical section: sample ÇAY.7–16.
1, 4–5, 7–8, x26; 2, 3, 6, 9–11, x70; 12, x18.

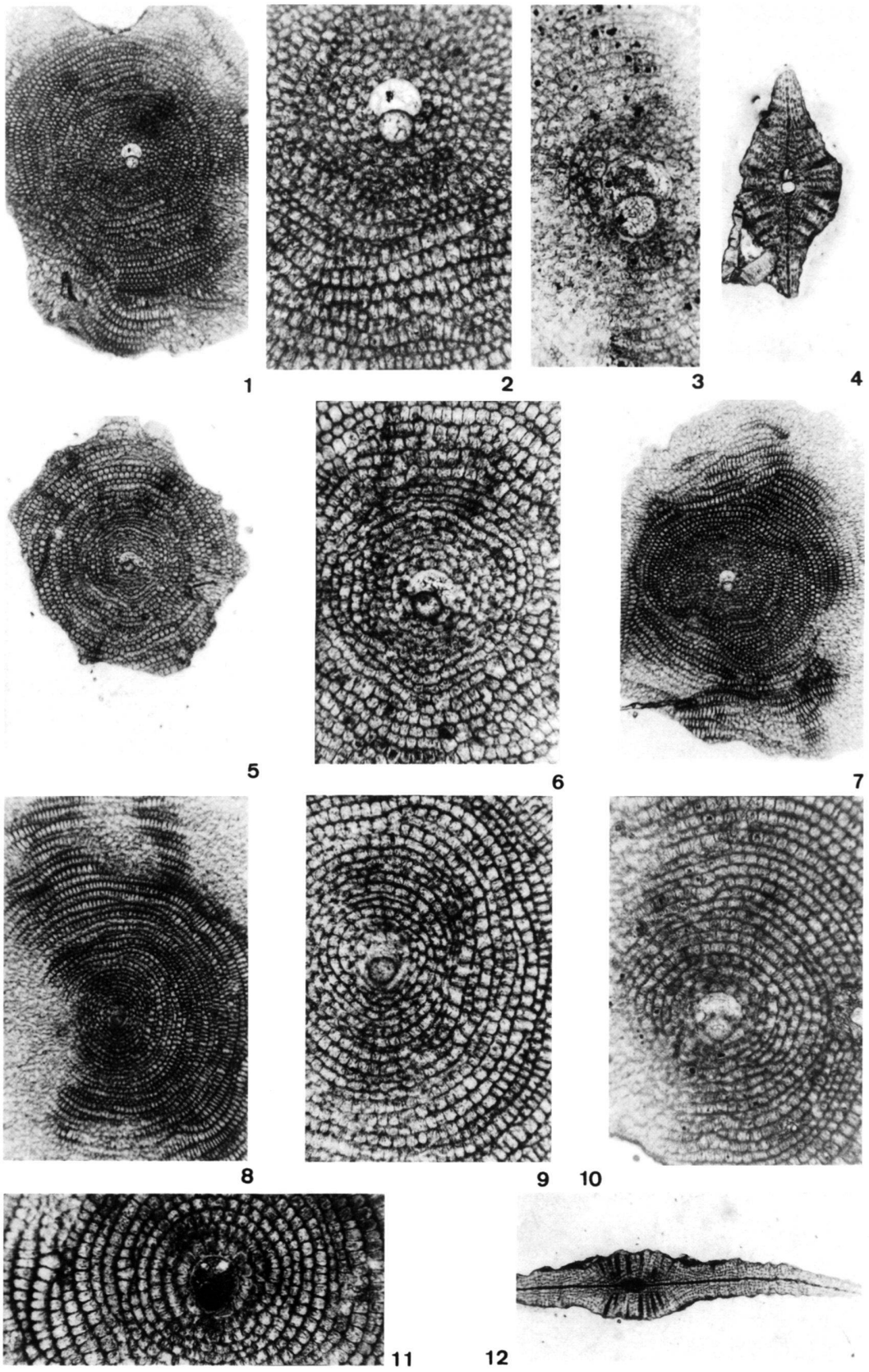

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 2

1–3– *Discocyclina augustae* van der Weijden, 1940 *sourbetensis* Less, 1987. equatorial section: **1–2,** sample YEŞ.87–1. **3,** sample ÇAY.5–27.
4–6– *Discocyclina 'dispansa'* (Sowerby, 1840) *taurica* Less, 1987. equatorial section: **4–5,** sample YEŞ.87–4. **6,** sample ÇAY.7–3.
7–9– *Orbitoclypeus schopeni* (Checcihia-Rispoli, 1908) *suvlukayensis* Less, 1987. equatorial section: **7–8,** sample YEŞ.80–46. **9,** sample YEŞ.80–2.
10–12– *Orbitoclypeus douvillei douvillei* (Schlumberger, 1903). **10–11–** equatorial section: sample ÇAY.7–12. **12–** vertical section: sample ÇAY.7.15.
2, 4, 8, 12, x26; 1, 3, 5–7, 9–10, x70; 11, x18.

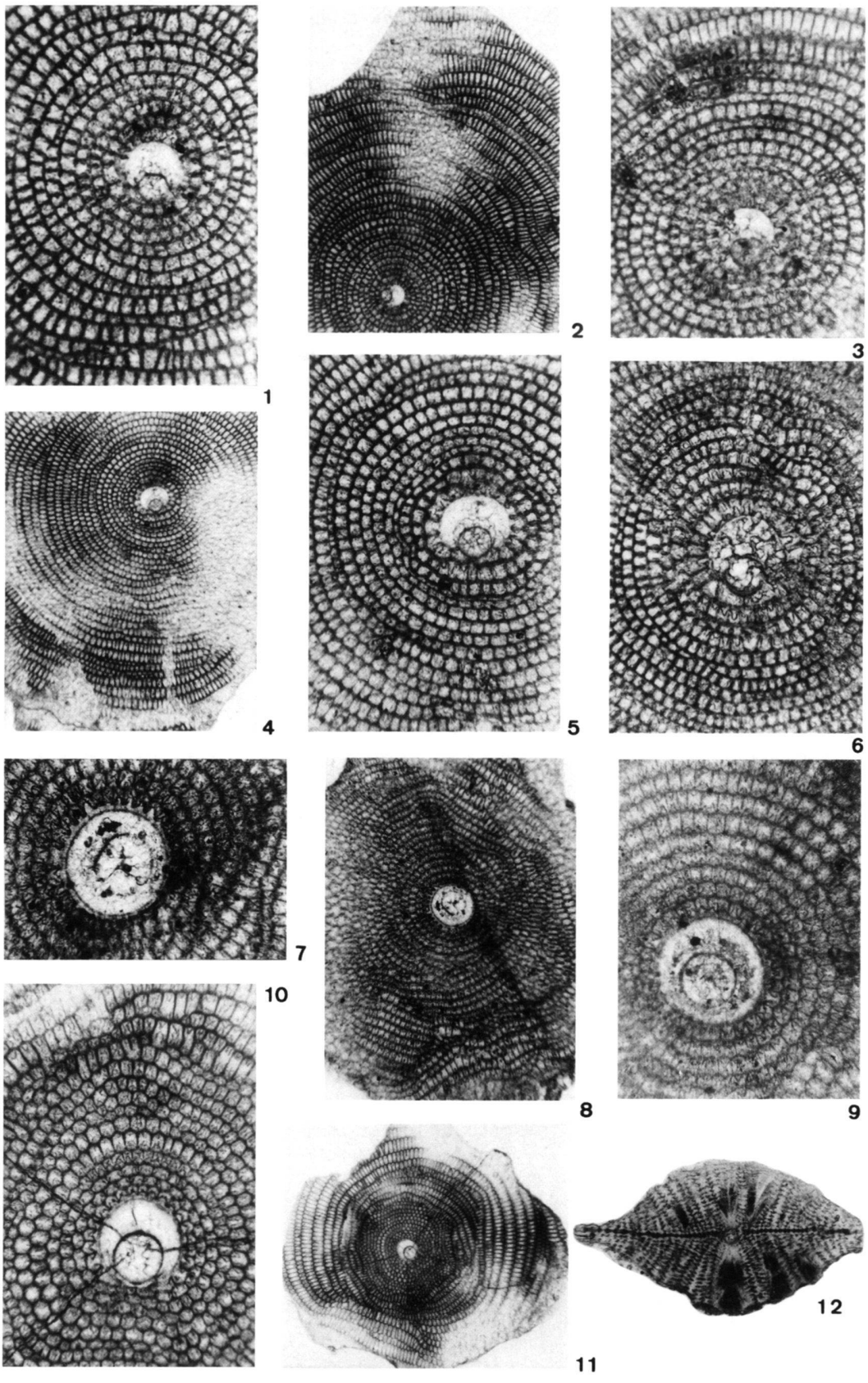


PLATE 3

1, 8–10– *Orbitoclypeus varians* (Kaufmann, 1867) *portnayae* Less, 1987. equatorial section: **1,** sample YEŞ.91–107. **8,** sample YEŞ.87–2. **9,** sample ÇAY.7–25. **10,** sample YEŞ.91–61.
2–5, 7, 13– *Orbitoclypeus douvillei* (Schlumberger, 1903) *yesilyurtensis* n. ssp. **2–4:** equatorial section: **2,** sample ÇAY.17–36. **3, 4,** sample ÇAY.17–2. **7–** vertical section: sample ÇAY.17–23. **5–** Pillar- lateral chamberlet network after slight abrasion of the test: sample ÇAY.17–32. **13–** external view: sample ÇAY.17.
6– *Orbitoclypeus douvillei douvillei* (Schlumberger, 1903). equatorial section: sample ÇAY.5–12.
11, 12– *Orbitoclypeus munieri munieri* (Schlumberger, 1904). equatorial section: sample ÇAY.5–22.
1–3, 6, 8–10, 12, x70; 4, 7, 11, x18, 5, x26, 13, x11.

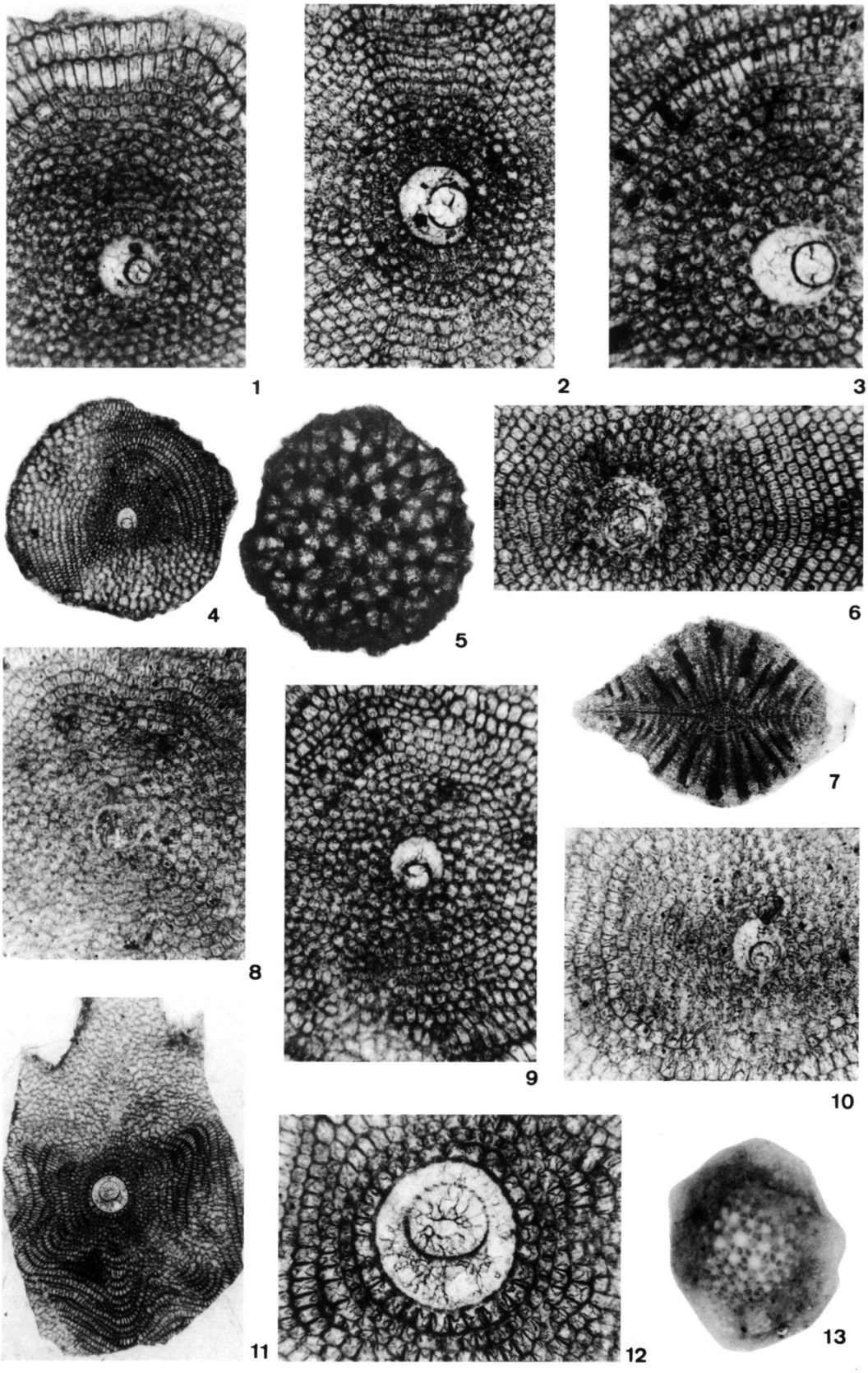
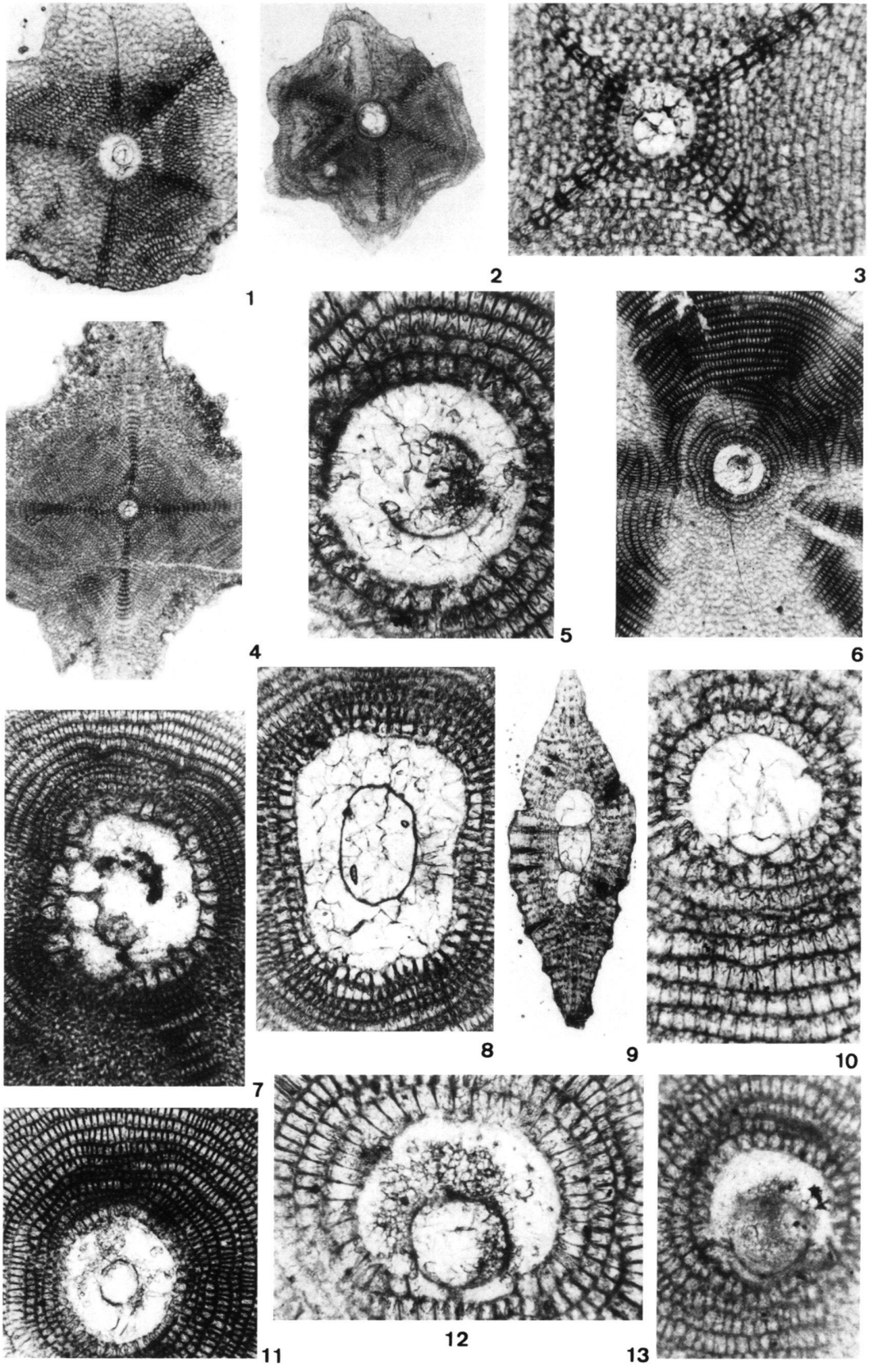

1
2
3
4
5
6
7
8
9
10
11
12
13

PLATE 4

1, 2– *Orbitoclypeus munieri munieri* (Schlumberger, 1904). equatorial section: **1,** sample YEŞ.91–11. **2,** sample ÇAY.5–42.
3, 4– *Orbitoclypeus* cf. *munieri munieri* (Schlumberger, 1904). equatorial section: sample ÇAY.5–41.
5, 6, 11– *Discocyclina fortisi fortisi* (d'Archiac, 1850). equatorial section: **5– 6,** sample ÇAY.5-10. **11,** sample YEŞ.91.1.
7– *Discocyclina 'stratiemanuelis'* Brönnimann, 1942. equatorial section: sample YEŞ.91–20.
8, 9– *Discocyclina fortisi* (d'Archiac, 1850) *cairazensis* n ssp. **8–** equatorial section: sample ÇAY.21–18. **9–** vertical section: sample ÇAY.14–14.
12– *Discocyclina archiaci archiaci* (Schlumberger, 1903). equatorial section: sample YEŞ.91–77.
10, 13– *Discocyclina* sp.1, equatorial section: **10,** sample ÇAY.5–33. **13,** sample YEŞ.80–22.
1, 8 x26; 2, 4, 6, 9 x18; 3, 5, 10, 12–13, x70; 7, 11 x38.


1
2
3
4
5
6
7
8
9
10
11
12
13