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DESCRIPTIONS OF TWO NEW FAMILIES, THREE NEW SPECIES AND RE-DESCRIPTION OF FOUR KNOWN GENERA AND ONE SUBFAMILY FROM THE LARGER BENTHIC FORAMINIFERA OF PALEOCENE IN TURKEY

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ABSTRACT

Key words :
Foraminifera,
taxonomy,
Paleocene,
Turkey.

Two new foraminiferal families are introduced as follows: the Anatoliellidae (type genus *Anatoliella* Sirel) in the superfamily Ataxophragmiacea Schwager and the family Bolkarinidae (type genus *Bolkarina* Sirel) in the superfamily Orbitoidacea Schwager. Three new species of Paleocene are described and figured as follows: *Ranikothalia polatliensis*, *Nurdanella paleocenica*, *Periloculina yilmazi*. In addition, four known Paleocene genera such as *Bolkarina* Sirel, *Globoflarina* Rahaghi, *Nurdanella* Özgen and *Coskinon* Hottinger and Drobne and subfamily Globoflarininae are redescribed.

1. Introduction

1.1. The Aim of the Study

The description of Paleocene and partly early Eocene shallowest-shallow- water foraminiferal taxa have previously been reported from the various localities of Turkey (Figure 1) by Sirel (1981, 1988, 1992, 1994, 1996a, c, d, 1997a, b, 1998a, b and 1999). The aim of this study is to review the foregoing studies by the generic new data. On this occasion, two new benthic foraminiferal families were established as follows: the ataxophragmid genera such as Thanetian genus *Anatoliella* Sirel (1988) were transferred to the new families Anatoliellidae (type genus *Anatoliella*) by the differentiated structural elements of the endoskeleton and exoskeleton. On the other hand, Daniyen-early Thanetian so-called miscellanid genus *Bolkarina* 1981 has been placed in the new family Bolkarinidae by the numerous small chamberlets with annular and radial stolons and lateral chambers. Four known Paleocene foraminiferal genera, viz the Daniyen-early Thanetian genus *Bolkarina* (type species *B. aksarayensis* Sirel, 1981), Thanetian, Lutetian genus *Nurdanella* Özgen (type species *Nurdanella boluensis* Özgen, 2000)

and early Thanetian genus *Coskinon* Hottinger and Drobne (type species *Coskinolina* (*Coskinon*) *rajkae* Hottinger and Drobne, 1980) late Danian-early Selandian alveolinid genus *Globoflarina* Rahaghi, 1983 (type species *Cyclorbiculina ? sphaeroidea* Fleury, 1982) and subfamily *Globoflarininae* Sirel, 1998 are redescribed by the new generic features. In addition, three new foraminiferal species are described and figured as follows: *Ranikothalia polatliensis* n.sp. from the late Thanetian-early Ilerdian of the Polatli area, Central Turkey and *Nurdanella paleocenica* n.sp., *Periloculina yilmazi* n.sp. from the Thanetian of the Van region, Eastern Turkey (Figure 1).

All the random, oriented thin sections and free specimens of the foraminiferal species described and figured in this paper are deposited in the collection of General Directorate of Mineral Research and Exploration (MTA), Ankara, Turkey and Muséum d'Histoire Naturelle de Genève, under the numbers shown in Plates I-VII figure 1.

2. Systematic Paleontology

Two new families, Anatoliellidae and Bolkarinidae are introduced as follows:

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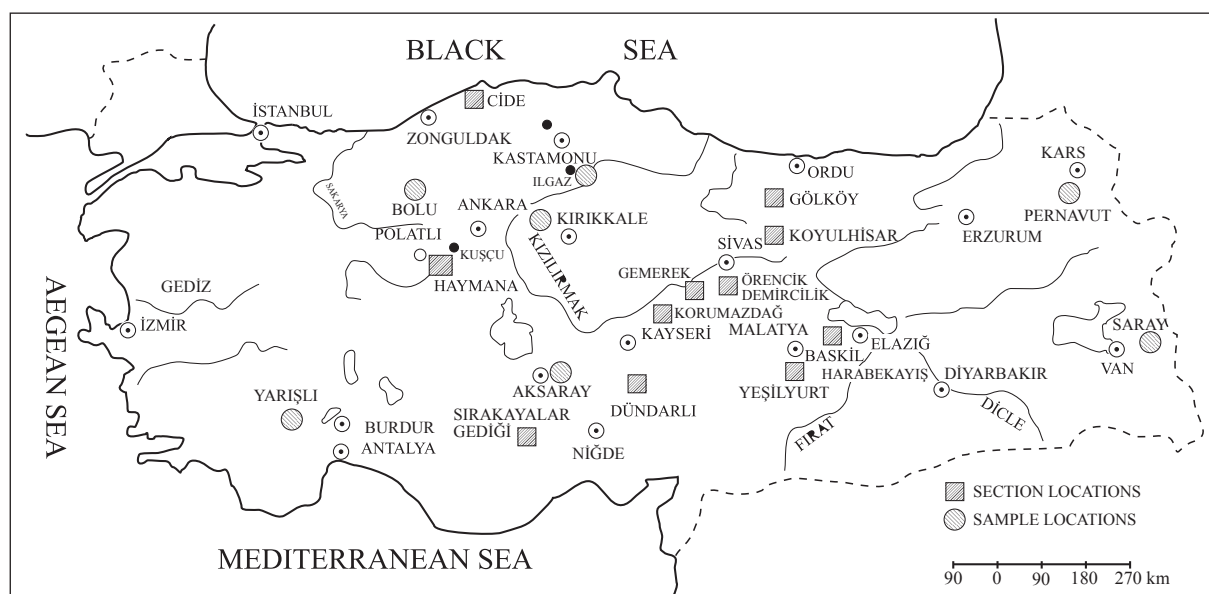


Figure 1- Location map, showing the localities of the measured sections and spot samples in Turkey.

Anatoliellidae n.fam.

Superfamily : Ataxophragmiacea Schwager, 1877

Family : Anatoliellidae n.fam.

Type genus : *Anatoliella* Sirel, 1988

Type species : *Anatoliella ozalpiensis* Sirel, 1988

Description : The description of the new family is based on Schroeder and Darmonoian (1977) and Sirel (1988). The genera of the new family have a conical test with agglutinated wall. The large subspherical-spherical protoconch is followed by a second chamber and few arcuate undivided chambers, arranged in a trochospiral pattern during the early ontogeny, but the divided inflated dome-like adult chambers are arranged in triserial-trochospiral mode in the late ontogeny. The marginal zone (exoskeleton) are divided by several generations of the vertical (beam) and horizontal rafters) partitions and they form numerous irregular alveolar compartments in each chamber. The intricate central part of the test (endoskeleton) has few thick irregular pillars recognized at the well oriented vertical sections, on the contrary, numerous basal foramina are recognized in the horizontal section. The dimorphism is distinct.

Age : Maastrichtian, Thanetian.

Remark.-The Maastrichtian genus *Gyroconulina* and the Thanetian genus *Anatoliella* have previously

been placed in the family Ataxophragmiidae Schwager by Schroeder and Darmonoian (1977) and Sirel (1988) respectively, although *Gyroconulina* and *Anatoliella* have a high conical, test with agglutinated wall, complex exoskeletal zone with three orders of vertical and horizontal partitions or both, resulting in a subepidermal alveolar compartments. On the other hand, in the latest foraminiferal classification of Loeblich and Tappan (1987, p. 153) the numerous genera together with *Gyroconulina* have been placed in the family Pfenderinidae Smout and Sugden, in spite of the fact that they have not dome-like triserial adult chambers with foregoing endoskeletal and exoskeletal structural elements, except *Gyroconulina*. So that, *Gyroconulina* and *Anatoliella* were transferred to the new family *Anatoliellidae*.

Anatoliella ozalpiensis Sirel, 1988

(Plate I, figures 1-12, Figure 2)

1988 *Anatoliella ozalpiensis* Sirel, page 478, plate I, figures 1-9, plate II, figures 1-11.

1990 *Anatoliella ozalpiensis* Sirel, Radoicic, page 92, plate 5, figure 5.

1991 *Anatoliella ozalpiensis* Sirel, Radoicic, page 58, plate 6, figure 1.

1995 *Anatoliella ozalpiensis* Sirel, İnan, page 109-118, plate II, figures 9,10.

1998b *Anatoliella ozalpiensis* Sirel, Sirel, page 46, plate 7, figures 6-11, plate 8, figures 9,10.

2008 *Anatoliella ozalpiensis* Sirel, Boudagher-Fadel, page 304, plate 6.2, figure 4.

Description : The type species of the Anatoliellidae n. fam. illustrated in Plate I, figures 1-12 have a high conical tests with complex endoskeletal and exoskeletal partitions in the both generations (Figure 2). The maximum cone height and horizontal diameter are 3.56 mm and 2 mm in the microspheric forms and 1 mm, 1.06 mm in the megalospheric forms respectively The megalospheric embryo consists of a large, subspheric protoconch (0.200-0.300 mm in diameter) with a semilunar second chamber followed by few, low trochospiral undivided early chambers (Plate I, figures 5,9, Figure 2 C). More inflated (dome-like) adult chambers of the late ontogeny are arranged in the triserial mode (Figures 2 D,E). All the endoskeletal and exoskeletal structural elements of the dome-like adult chambers are given in Figure 2.

Stratigraphic and geographic distribution : This conical, triserial foraminiferal species with complex structure has been found together with *Pseudodictyokathina vanica* (Sirel), *Karsella hottingeri* Sirel, *Miscellanea juliettae* Leppig, *Soriella bitlisica* Sirel, *Dictyoconus baskilensis* Sirel, *Sistanites* sp. and Miliolidae in the Thanetian limestone blocks within the ophiolitic melange near the village of Saray, NE of Van, Eastern Turkey, (type locality, Figure 1). It occurs in the Paleocene algal limestone of Iraq and Bosnia, where it is associated with algal species described by Radoicic (1990, p. 92 and 1991, p. 58) respectively. It is associated in the Thanetian limestone of Koyulhisar area, N of Sivas, Eastern part of the Central Turkey, with *B. aksarayensis* and algae (İnan, 1995).

Bolkarinidae n.fam.

Superfamily : Orbitoidacea Schwager, 1876

Family : Bolkarinidae n. fam.

Type genus : *Bolkarina* Sirel, 1981

Type species : *Bolkarina aksarayi* Sirel, 1981

Description : The microspheric and megalospheric generations of the type genus *Bolkarina* have a large, thin and undulating lenticular test. The spheric microsphere and megalosphere are followed by

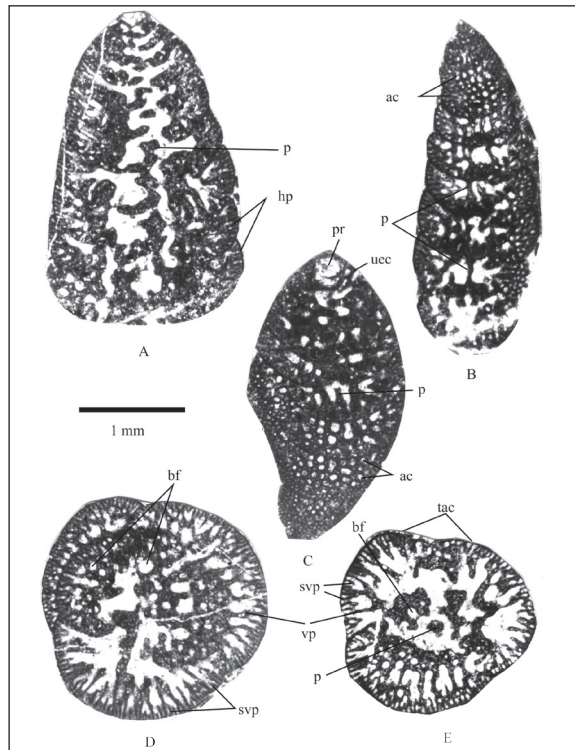


Figure 2- Structural elements of *Anatoliella* Sirel (type genus of Anatoliellidae n.fam.), all figures from Sirel (1988), scale bar 1 mm. A: Vertical section, B form, B: Oblique vertical section, B form C: Centered, oblique vertical section A form, , D: Slightly oblique horizontal section, B form, E: Horizontal section, B form, pr: protoconch. uec: undivided early chambers. p: pillars. hp: horizontal partitions (rafters). vp: vertical partitions (beams). svp: shorter vertical partitions. tac: triserial adult chambers. bf: basal foramina.

numerous small arcuate chambers arranged in a planispiral-involute pattern. The thin septa have characteristically bifurcate intraseptal canals. later adult chambers with subrectangular-polygonal chamberlets are arranged in an annular mode; the connections of between adjacent chamberlets are provided by annular and radial stolons. The broad lateral chambers appear at the both sides of the test of the two generations. Also, the pillars and radial canals (funnels) are developed at the both sides of early stage of two generations. Selandian-early Thanetian.

Remark : In the original description, the type genus *Bolkarina* has been placed in the family Miscellaneidae Sigal in its planispiral-involute early chambers with pillars by Sirel (1981). In late

classification of the foraminiferal genera, the family Miscellaneidae has been suppressed by Loeblich and Tappan (1987, p. 681) and the genera *Miscellanea* and *Bolkarina* have been placed in Pellatispiridae Hanzawa. Last of all, *B. aksarayensis* has been shown in the new family Miscellanitinae within the family Miscellaneidae by Hottinger (2009, p. 2,7). According current knowledge of us, *Bolkarina* (type species *B. aksarayensis*) shows close similarities with the known taxa of Orbitoidacea Schwager by the lateral chambers on the both sides and annular chambers with subrectangular-hexagonal chamberlets with annular and radial passages (stolons). Besides, the genera of Miscellaneidae and Pellatispiridae definitely differ from *Bolkarina* in having the canal system (marginal sutural and spiral canals), septal and umbilical flaps. Otherwise, the genera of the foregoing two families are devoid of the annular chambers, subrectangular-hexagonal chamberlets with radial and annular stolons and lateral chambers of *Bolkarina*. Therefore, the genus *Bolkarina* was transferred to the new family Bolkarinidae within the superfamily Orbitoidacea Schwager.

2.1 Redescription of Four Foraminiferal Genera and One Subfamily

In this chapter, the known four Paleocene genera such as *Bolkarina* Sirel, *Nurdanella* Özgen, *Coskinon* Hottinger and Drobne, *Globoflarina* Rahaghi and its subfamily Globoflarininae were re-described in the light of the current generic knowledge.

Bolkarina Sirel, 1981

Redescription : The redescription of the type genus *Bolkarina* is entirely based on the Selandian specimens which are collected from the various locality of Turkey, figure 3 (see the chapter of the stratigraphic and geographic distribution of *B. aksarayensis*). All the previously known and new diagnostic structural elements of *Bolkarina* are given in the chapter of Bolkarinidae n. fam.

Remark : The dimorphic *B. aksarayensis* has characteristically planispiral arcuate early chambers with bifurcate intraseptal canal, the annular adult chambers with stoloniferous subrectangular-polygonal chamberlets and lateral chambers. It occurs abundantly in the Selandian algal limestones of the various localities of Turkey (Figure 1). Also it occurs rarely in the algal limestones of the lowermost Thanetian. On the other hand, the appearance of *Bolkarina* in Danian was reported by Drobne et al.

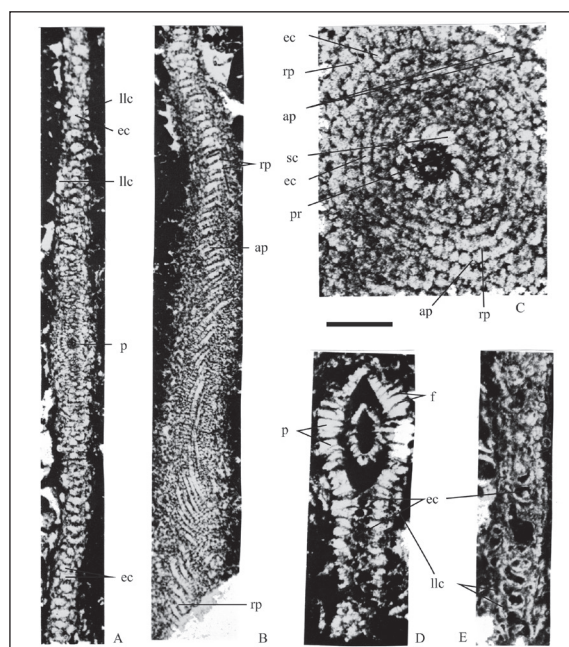


Figure 3- Structural elements of *Bolkarina* Sirel (type genus of Bolkarinidae n.fam.); all figures from Sirel (1981), scale bar in Figure. A: Axial section of B form, scale bar= 1.26 mm, B: Tangential section of B form, scale bar= 1.54 mm, C: Central portion of equatorial section, enlarged from Plate II, figure 1, B form, scale bar= 0.35 mm; D: Incomplete subaxial section of A form, scale bar= 0.4 mm, E: Incomplete subaxial section of B form, scale bar= 0.83 mm. pr: proloculus, sc: spiral chamber, ec: annular equatorial chamberlets, llc: lengthened lateral chambers, ap: annular passages (stolons), rp: radial passages (stolons), p: pillars, f: funnels.

(1988), that is an important phylogenetic data for the evolution between late Cretaceous and Thanetian benthic foraminifera with stolon systems and lateral chambers. According to the current knowledge, all the representatives of foraminiferal Orbitoididae Schwager and Lepidorbitoididae Vaughan disappeared at the end of Cretaceous or at the beginning of Tertiary by the C/T crisis (mass extinction). On the contrary, the orthophragminid genera appear in Thanetian. Because of the existence of the foregoing diagnostic structural elements of *Bolkarina* (particularly stolon system and lateral chambers), the Danian-early Thanetian genus *Bolkarina* has been considered as a transition form between the late Cretaceous orbitoidids, lepidorbitoidids and Thanetian orthophragminids with stolons and lateral chambers.

Bolkarina aksarayensis Sirel, 1981

(Plate. II, figures 1-7, Figures 3 A-E),

- 1981 *Bolkarina aksarayi* Sirel, page 79-82, plate 1, figures 1-3, plate 2, figures 1-4, plate 3, figures 1-6.
- 1987 *Bolkarina aksarayi* Sirel, Loeblich and Tappan, page 681, plate 801, figures 1-5.
- 1998b *Bolkarina aksarayensis* Sirel, Sirel, page 92-93, plate 53, figures 1-4.
- 2004 *Bolkarina aksarayensis* Sirel, Sirel, page 53-57, plate 49, figures 1-3, plate 50, figures 1-4, plate 51, figures 1-6.
- 2009 *Bolkarina aksarayensis* Sirel, Hottinger, page 10-12, Figure 3, plate 21, figures 1-6, plate 22, figures 1-9, plate 23, figures 1-5, plate 24, figures. 1-9, plate 25, figures 1-5.

Description : The description of the megalospheric form is based on the incomplete centered subequatorial section (Plate II, figure 2). According to this specimen, its radius reaches 1.62 mm and the external surface of it is covered by granules. The small spheric megalosphere (0.80 mm in diameter) is followed by 22 arcuate early chambers arranged in planispiral-involute two whorls, measured from the incomplete specimens (Plate II, figure 2). The later stage consists of annular chambers with numerous chamberlets as in the microspheric generation.

The microspheric form has a large, undulating thin discoidal test with an equatorial diameter up to 21 mm and thickness of 1 mm. The microsphere is relatively small, subspherical and its diameter is 0.65 mm. It is followed by arcuate spiral chambers of the early stage, arranged in planispiral-involute 3-3.5 whorls (Plate II, figures 3,6). The adult stage has 64 annular chambers including numerous subrectangular-polygonal chamberlets with radial and annular stolons.

Stratigraphic and geographic distribution : *B.aksarayensis* occurs abundantly in the following localities:

It abounds in the hard, brown-coloured Selandian algal limestone of the type locality, Tilkitepe and Kocaağildere, approximately 2 km SW of Karandere village, NW of Aksaray, Central Turkey (Figure 1), It is associated there with *Pseudolacazina oeztemueri*

(Sirel), *Pseudolacazina donatae* (Drobne), *Akbarina primitiva* (Rahaghi) , *Idalina sinjarica* Grimsdale, *Hottingerina* sp. and Miliolidae.

It occurs in brown-coloured Selandian algal limestone of Mahmutlar village, NW of Kırıkkale, Central Turkey (Figure 1), with *P. oeztemueri*, *P. donatae*, *A. primitiva*, Peneroplidae and Miliolidae.

It is found in the white-coloured Selandian algal limestone of the Yarışlı area, NW of Burdur, Southern Turkey (Figure 1), with *G. sphaeroidea*, *Sistanites iranica* Rahaghi, *I. sinjarica*, *A. primitiva*, undetermined micellanid genus and Miliolidae.

It occurs in the light brown-coloured Selandian limestone of Sırakayalar gediği, approximately 25 km N of Bolkar mountains (Sirel, 1998b, Figure 16), with *P. oeztemueri*, *P. donatae*, *I. sinjarica*, *A. primitiva* and Miliolidae.

It was observed in the Selandian algal limestones, of the Örencik and Demircilik villages, W of Gürlevik mountains, S of Sivas, Central Turkey (Sirel, 1998b, Figure. 18), with *P. oeztemueri*, *P. donatae*, undetermined keramospherid genus and Miliolidae.

This species abounds in the Selandian limestones of the Çaldağ, (Sirel, 2009, Figure 2) and Babayakup sections, W of Ankara (Sirel, 1998b, Figure 11) with numerous foraminiferal species.

It occurs in the Selandian-lowermost early Thanetian limestones of the Bahçecik section with numerous species, S Ankara (Sirel, 2009, Figure 5).

B. aksarayensis occurs rarely in the early Thanetian limestone of the Harabekayış section, W Elazığ (Sirel, 2009, Figure 10) associated with *M. juliettae*, *Lockhartia diversa* Smout, *Elazigina harabekayisensis* Sirel, *Planorbulina cretae* (Marsson), *Kathina? selveri* Smout and Miliolidae.

Globoflarininae Sirel, 1998

Superfamily : Alveolinacea Schwager, 1876

Family : Alveolinidae Ehrenberg, 1839

Subfamily : Globoflarininae Sirel, 1998

Genus : *Globoflarina* Rahaghi, 1983

Type species : *Cyclorbiculina ? sphaeroidea* Fleury 1982

Redescription : The subfamily Globoflarinae was first described by Sirel (1998b, p. 68). It was reorganized by the following new additional generic structural elements of the type genus Globoflarina Rahaghi (Figure 4). Test free, nautiloid to subspheric, the arrangement of the early chambers are triloculine in megalospheric and quinqueloculine in microspheric generations, later planispiral chambers subdivided by aligned septula into numerous chamberlets. One row of alveols are connected with the preseptal passage of preceding chamber by intercalary (secondary) apertures (as keyhole-shaped), main apertures (intercameral foramen) located just above the septum.

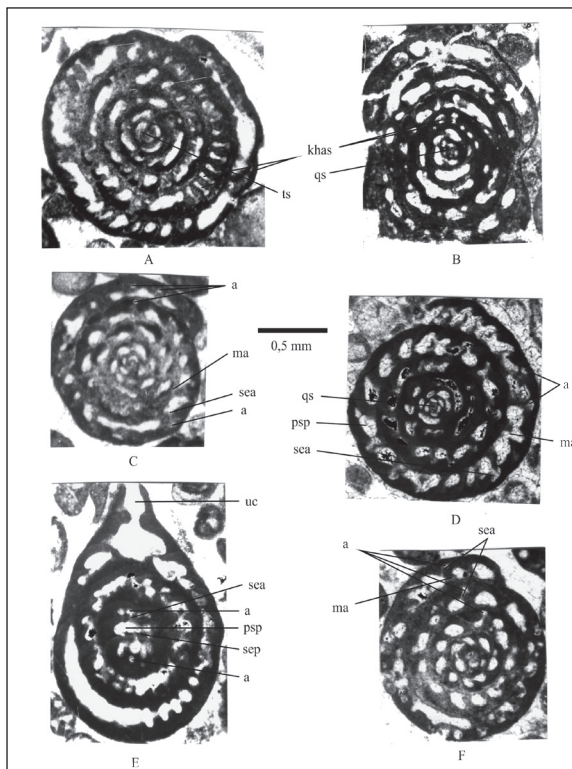


Figure 4- Structural elements of *Globoflarina* Rahaghi (type genus of Globoflarinae Sirel), all figures from Sirel (1998b, plate 32,33,34). Scale bar in figure. A: Slightly oblique equatorial section of A form, B: Slightly oblique axial section of B form, C: Equatorial section, probably young B form, D: Equatorial section of B form, scale bar= 0.4 mm, E: Tangential section; F: Non centered equatorial section; ts: triloculine stage, qs: quinqueloculine stage, ma: main aperture, sea: secondary aperture, a: alveols, khas: key-holes apertural system (alveols and secondary apertures together), sep: septula, psp: preseptal passage, uc: uncoiled chambers.

The gerontic uncoiled chambers have incomplete subepidermal partitions and multiple apertural openings (cribrate).

Remark : The type genus of the new subfamily differs from the known genera of Alveolinidae in having uncoiled chambers with subepidermal partitions and cribrate aperture.

Globoflarina Rahaghi, 1983

New description : The redescription of *Globoflarina* Rahaghi (1983) is based on the Anatolian specimens illustrated in (Plate III, figures 1-10, Plate IV, figures 1-6 and Figures 4 A-F). The dimorphic, alveolinid genus has large, nautiloid to subspheric test with imperforate, percellaneous calcareous wall. The spheric, large megalosphere and the small microsphere are followed by one cycles of triloculine chambers in the megalospheric and two cycles of quinqueloculine undivided early chambers in the microspheric forms. The following planispiral adult chambers are subdivided by aligned septula into numerous small chamberlets. The planispiral whorls increase rapidly in height as added, so that the adult test uncoil and become flabelliform in the microspheric generation. The chambers in the flabelliform stage are subdivided by numerous incomplete subepidermal partitions. The main aperture (intercameral foramina) located at the middle part of the septa recognized best in the equatorial sections. The planispiral chambers has one row of alveols which are connected with preseptal passage of preceding chamber by intercalary foramina (as keyholes-shaped) in the septum. The connection between the flabelliform adult chambers provide by the numerous openings (cribrate). Occasionally, the uncoiled chambers develop at the both sides of the test

Remark : The globular specimens was first described and figured as *Cyclorbiculina ? sphaeroidea* from the Paleocene of Greece by Fleury (1982), despite the fact that it has typical alveolinid characters: namely, milioline juvenile chambers, planispiral adult chambers with chamberlets preseptal passage, main and secondary aperture. Later on, the same foraminiferal taxon was introduced as a new genus *Globoflarina* from the upper Paleocene of Iran by Rahaghi (1983). But, the diagnosis of the genus was devoid of the adequately generic features in Rahaghi (1983), therefore, *Globoflarina* was here redescription by the materials of Sirel (1998b), Fleury (1982) and Rahaghi (1983).

Globoflarina sphaeroidea (Fleury, 1982)

(Plate III, figures 1-10, Plate IV, figures 1-6; Figures 4 A-F)

- 1982 *Cyclorbiculina ? sphaeroidea* Fleury, page 160, plate 1, figures 1-9, plate 2, figures 1-11.
- 1983 *Globoflarina sphaeroidea* (Fleury), Rahaghi, page 43, plate 15, figures 1-8, plate 16, figures 1-12, plate 17, figures 1-12.
- 1998b *Globoflarina sphaeroidea* (Fleury), Sirel, page 68-71, plate 32, figures 1-8, plate 33, figures 1-9, plate 34, figures 1-11.
- 2009 *Globoflarina sphaeroidea* (Fleury), Sirel, plate IV, figures 1-4.

Description : The test is large, nautiloid to subspheric, slightly depressed at the direction of the coiling axis (Plate III, figures 3,4, Plate IV, figures 2,3,6). The index of elongation reaches 1.75 in the microspheric form, at least 1.5 in the megalospheric specimens. The equatorial diameter ranges from 1,6 mm to 1.75 mm and from 1.3 mm to 1.6 mm in the microspheric and megalospheric generations respectively. The largest length of the uncoiled stage reach 6.5 mm. The spherical megalosphere (0.150-0.160 mm in diameter) is followed by one cycles of undivided triloculine chambers reaching 0.370 mm diameter. Later planispiral whorls are divided by thick septa into numerous chambers with chamberlets in both generations. The microspheric test is composed of two rows of quinqueloculine early, planispiral adult and uncoiled senile chambers.

Stratigraphic and geographic distribution : It occurs in the Selandian limestones of the Yarışlı area, W of Burdur, Southern Turkey (Figure 1). It is associated there with *B. aksarayensis*, *Laffitteina erki* (Sirel), *A. primitiva*, undetermined miscellanid genus, *I. sinjarica* and *Miliolidae*.

It is found in the late Danian-early Selandian limestones of Bolu area, Western Turkey (Figure 1), with *Laffitteina mengaudi* (Astre), minimiscellanid type and abundant *Miliolidae*.

Nurdanella Özgen, 2000

Superfamily : Miliolacea Ehrenberg, 1839

Family : Hauerinidae Schwager, 1876

Genus : *Nurdanella* Özgen, 2000

Type species : *Nurdanella boluensis* Özgen, 2000

Redescription : The redescription of the genus is based on Özgen (2000) and here described *Nurdanella paleocenica* n. sp. (Plate IV, figures 7-12). Two generations have subspheric to ovoid test with imperforate, porcellaneous calcareous wall (Özgen, 2000, plate I, figure 4) and (Plate IV, figure 7). Very small microsphere is followed by two rows of quinqueloculine chambers (Özgen, 2000, plate I, figures 3,7,12,14) and (Plate IV, figure 13). Later undivided adult chambers are arranged in a planispiral pattern (Özgen, 2000, plate I, figure 1, Figure A) and (Plate IV, figures 9,11). The connection of the long and low planispiral chambers provide by the crenated/notched aperture (Özgen, 2000, plate I, figure 4) and (Plate IV, figure 7).

The megalospheric form has a small, subspheric test with imperforate porcellaneous calcareous wall (Özgen, 2000, plate I, figures 10,11). Almost spheric and large megalosphere is followed by 1-1.5 rows of triloculine early chambers (Özgen, 2000, plate I figures 10, 11). Later undivided adult chambers are coiled in a planispiral mode (Plate IV, figure 13). Dimorphism distinct, Thanetian, Lutetian.

Coskinon Hottinger and Drobne, 1980

Ataxophragmiidae : Ehrenberg, 1839

Family : Coskinolinidae Moullade, 1965

Genus : *Coskinon* Hottinger and Drobne, 1980

Type species : *Coskinolina (Coskinon) rajkae* Hottinger and Drobne, 1980

Redescription : It is largely based on Hottinger and Drobne (1980) and partly here described species in (Plate V, figures 1-5). Two generations have large and high conical test with keriothecal wall. The subspheric proloculus is followed by more than five rows of biserial (like-textularine) early chambers, later adult chambers become uniserial (Hottinger and Drobne, 1980, plate 2, figures 2,4, plate 12, figures 18, 19, 22, 23). The marginal zone (exoskeleton) is devoid of the vertical and horizontal partitions. The weakly developed endoskeletal pillars appear as from the last biserial textularine chambers Hottinger and Drobne (1980, plate 12, figures 1, 18-21). The basal foramina are scattered in central part of the cone (Hottinger and Drobne, 1980, plate 12, figures 9,16).

Remark : The Ataxophragmid genus was first described and figured as a subgenus of *Coskinolina* Stache (type species *Coskinolina (Coskinon) rajkae* Hottinger and Drobne) from the early Thanetian of Yugoslavia by (Hottinger and Drobne, 1980, page 231). Later on, this benthic subgenus was introduced as the new genus *Coskinon* (type species *Coskinolina (Coskinon) rajkae* Hottinger and Drobne) by Loeblich and Tappan (1987, page 155). Unfortunately, the generic features of *Coskinon*, particularly in the early chambers have not been adequately described by the foregoing authors. Whereas, the vertical sections of Hottinger and Drobne clearly show that the early chamber arrangement is biserial (textularine) (Hottinger and Drobne, 1980, plate 12, figures 18,19, 21-23); and endoskeletal pillars begin as from the last biserial chambers (Hottinger and Drobne, 1980, plate 2, figure 4, plate 12, figures 18,19,21). The genus *Coskinon* differs from *Coskinolina* Stache in possessing five rows of the biserial textularine chambers in the early ontogeny, whereas the early chambers of *Coskinolina* are arranged in trochospiral pattern in Hottinger and Drobne (1980).

Coskinon rajkae Hottinger and Drobne, 1980

(Plate V, figures 1-5)

1980 *Coskinolina (Coskinon) rajkae* Hottinger and Drobne, page 231, plate 2, figures 2,3,4, plate 12, figures 1-28, Figure 2.

1987 *Coskinon rajkae* Hottinger and Drobne, Loeblich and Tappan, page 155, plate 166, figures 2-6.

1998b *Coskinolina (Coskinon) rajkae* Hottinger and Drobne, Sirel, page 47, plate 9, figures 6-10.

Description : Only megalospheric form has been observed in the early Thanetian limestone of the Harabekayış section (Sirel, 1998b, plate 9, figures 6-10 and 2009, Figure 10). The test has medium sized, high conical with convex base. The maximum cone height and basal cone diameter are 1.76 mm and 1.75 mm respectively. The ratio basal cone diameter to vertical cone height is 0.67-1.17. The megalosphere (0.100-0.140 mm in diameter) is followed by few biserial textularine early chambers (Plate V, figures 1,2). The exoskeletal elements (vertical and the horizontal partitions) are absent in the marginal zone.

Stratigraphic and geographic distribution : This species occurs in the early Thanetian limestones of

the Harabekayış section (Sirel 2009, Figure 10), S of Baskil town, W of Elazığ, Eastern Turkey. It is associated there with *Glomalveolina primaeva* (Reichel), *Vania anatolica* Sirel and Gündüz, *Hottingerina anatolica* Sirel, *Haymanella paleocenica* Sirel, *I. sinjarica*, *Pseudobroeckinella flabelliformis* Sirel, *Kathina* sp. and Miliolidae.

2.2 Description of Three Species

In this chapter, the description of three new foraminiferal species are introduced as follows:

Superfamily : Nummulitacea De Blainville, 1827

Family : Nummulitidae De Blainville, 1827

Genus : *Ranikothalia* CaudriI, 1944

Type species : *Ranikothalia nuttalli* Davies, 1927

Ranikothalia polatliensis n.sp.

(Plate V, figures 6-9, Plate VI, figures 1-13)

1998b *Ranikothalia sindensis* (Davies), Sirel, page 105, plate 64, figures 1-13, plate 65, figures 1-7.

Derivation of name : Polatlı is a town in the Ankara region, Central Turkey.

Holotype : Subaxial section, illustrated in Plate VI, figure 1.

Type locality : In the Kuşcu village, 15 km SE of Polatlı, SW of Ankara, Central Turkey (Figure 1).

Type level : Late Thanetian?-early Ilerdian.

Diagnosis : The microspheric generations have a flattened and large lenticular test with rounded periphery (Plate V, figures 7,9, Plate VI, figure 13), on the contrary, the test becomes inflated lenticular in the megalospheric form (Plate VI, figures 3, 9-11). The diameter of the microspheric test ranges from 3.7 mm to 6.5 mm and the thickness from 0.7 mm to 1.1 mm. The large, subrectangular chambers are arranged in a planispiral-involute whorls and the interval of the spirals increases suddenly toward the last whorl (Plate VI, figure 1). The marginal cord is strongly thickened and developed, in which numerous marginal sutural canals form thick layer of network (Plate V, figures 6,9, Plate VI, figures 7,13).

The inflated lenticular megalospheric test with rounded periphery is middle size. The diameter of the test ranges from 2 mm to 3.1 mm and the thickness from 1 mm to 1,2 mm. The ovoid megalosphere (0.350 X 0,450 mm in diameter) is followed by semilunar second chamber (Plate VI, figures 6,8) and subrectangular numerous chambers. The interval of the whorls increases gradually from the first to the last whorl. The bifurcate intraseptal canals are probably connected with the marginal canals (Plate VI, figure 8) There are 26 chambers in the last whorl measuring 2.9 mm in diameter (Plate VI, figure 8).

Remark : The microspheric form of *R. polatliensis* differs from *R. sindensis* in its loosely coiled whorls with large chambers and rather thickened marginal cord with developed marginal sutural canals (Plate V, figures 6,9, Plate VI. figures 7,8,13). It is distinguished from the type species *Ranikothalia nuttalli* (Davies) in possessing smaller test, thickened marginal cord with developed marginal sutural canals.

Stratigraphic and geographic distribution : All the material concerning this study are collected from the Kuşçu village, SE of Polatlı, SW of Ankara (Figure 1). It occurs abundantly in the sandy limestone without foraminiferal species, so that its age could not be safely fixed. However the sandy limestone with new species conformably overlies the sediments of the Paleocene Kartal formation in the type locality. Considering the stratigraphic position of the sandy limestone with *R. polatliensis*, the age of the new species has been thought as early Ilerdian than late Thanetian.

Nurdanella paleocenica n.sp.

(Plate IV, figures 7-13)

1998b Unidentified miliolid genus, Sirel, page 51-51, plate 19, figures 1-3, 5,6.

Derivation of name : It occurs in Paleocene.

Holotype : Axial section, figured in Plate IV, figure 7.

Type locality : Exotic limestone block within the ophiolitic melange, near the Saray village, northeast of Van, Eastern Turkey (Figure 1).

Type level : Thanetian (SBZ 3-4).

Diagnosis : The generic characters of the genus are given in the chapter of the re-description of *Nurdanella* Özgen. The microspheric form of the dimorphic miliolid with notched /crenated aperture has a ovoid test with imperforate porcellaneous calcareous test. The largest axial and equatorial diameters reach 1.87 mm and 1,62 mm respectively. The early chambers are arranged in a quinqueloculine pattern (Plate IV, figure. 13). Later adult chambers are coiled in a planispiral mode (Plate IV, figures 9-11). There are 5-6 long and low planispiral chambers in an equatorial sections (Plate IV, figures 8,9).

The specific features of the macrospheric generation are based on only one almost centered equatorial section (Plate IV, figure 11), its diameter is 0.82 mm. The megalosphere (about 0.100 mm in diameter) is followed by probably triloculine early chambers. Later adult chambers are arranged in a planispiral pattern. There are three long and low planispiral chambers in the last whorl of the equatorial section.

Remark : The new species *N. paleocenica* differs from the type species *Nurdanella boluensis* Özgen in its smaller test with low chambers; in addition, the new species has 5-6 chambers in the last whorl of microspheric form (Plate IV, figure 9), whereas There are two chambers in the last whorl of the holotype of *N. boluensis* Özgen (2000, plate 1, figure 1).

Stratigraphic and geographic distribution.- The new species is found in the Thanetian exotic limestone blocks within the ophiolitic melange, located near the Saray village, NE of Van (Figure 1), with abundant foraminiferal species, such as *P. vanica*, *D. baskilensis*, *P. flabelliformis*, *A. ozalpiensis*, *I. sinjarica* and Miliolidae.

Periloculina Munier-Chalmas and Schlumberger, 1885

Description : The diagnostic characters of *Periloculina* is based on here described *Periloculina yilmazi* n.sp., Drobne (1974 and 1984), Loeblich and Tappan (1987) and Hottinger et al. (1989).

The dimorphic fabularid genus has a ovoid test with central annular trematophore. The trematophoric system is located alternatively crowning the upper or lower, flattened surface of the test with numerous openings supported by pillars (Plate VII, figures 1,11,13); the wall is imperforate, porcellaneous calcareous. Microspheric ovoid test has two cycles of

undivided pleuroloculine (probably quinqueloculine) chambers of the juvenile stage (Plate VII, figures 2,4), (Drobne, 1974, plate 11, figures 2,3,6; 1984, plate 2, figure d, plate 5, figures 1,5,7). Later few cycles of divided chambers become biloculine and finally 4-7 cycles of monoloculine (Plates VII, figures 1,4,11,12). The biloculine and monoloculine chambers of the adult stage are subdivided by continuous, longitudinal septula or ribs into numerous chamberlets (Plate VII, figures 3,4,12), (Drobne, 1984, plate 5, figures 5-7) and (Hottinger et al., 1989, plate 23, figure 9).

Megalospheric generation has a slightly elongated ovoid to subspheric test. The large megalosphere with bottle-neck (Plate VII, figure 9), (Drobne, 1984, plate 4, figures 13,15) is followed by one and half cycles of the undivided triloculine chambers (Plate VII, figures 5,8,10), (Drobne, 1984, plate 2, Figures h-k), later biloculine chambers (Plate VII, figures 7,9), (Drobne, 1984, plate 2, figures h-k) are subdivided by septula into numerous chamberlets. The trematophoric aperture supported by pillars, recognized in the well oriented equatorial sections (Plate VIII, figures 9,13) and (Drobne, 1984, plate 4, figure 2).

Periloculina yilmazi n.sp.

(Plate VII, figures 1-13)

1988 *Periloculina slovenica* Drobne, Sirel, page 482, plate VI, figures 1-13.

Derivation of name : This species is dedicated to Yücel Yılmaz who has done a lot of contributions on the geology of Turkey.

Holotype : Axial section of the microspheric form, illustrated in Plate VII, figure 4.

Type locality: Exotic limestone blocks within the ophiolitic melange, near the Saray village, northeast of Van, Eastern Turkey (Figure 1).

Type level : Thanetian (SBZ 3,4).

Diagnosis : The megalospheric generations have a elongated ovoid test with small size. The axial diameter ranges from 1.2 mm to 1.9 mm and equatorial diameter from 2.3 mm to 2.5 mm. The subspheric deformed megalosphere (0.150-0.350

mm in diameter) with bottle-neck is followed by the pleuroloculine early chambers, probably "triloculine" (Plate VII, figures 6, 8,10), later divided chambers arranged in a biloculine mode (Plate VII, figures 7,9,13). The trematophoric aperture is developed at the pole of the ovoid test, supported by thick pillars (Plate VII, figures 9,13).

The microspheric test is large, ovoid and elongated in the direction of the apertural axis (Plate VII, figures 1,2,11). The axial diameter ranges from 4 mm to 4.5 mm and the equatorial diameter from 2.75 mm to 3.25 mm. The early stage composed of three cycles of undivided pleuroloculine chambers. The adult stage comprises 3-4 cycles of biloculine and finally 7-8 cycles of the monoloculine chambers. The tightly coiled biloculine and monoloculine chambers are divided by continuous septula into numerous chamberlets (Plate VII, figures 3,4).

Remark : The fabularid genus *Periloculina* (type species *P. zitteli*) was first described and figured from the Senonian of France by Munier – Chalmas and Schlumberger (1885). Later on, the Senonian species *P. zitteli* was described detailed from the late Coniacian and Santonian of southern France and Spain by Hottinger et al. (1989). The generic characters of the the Thanetian new species *P. yilmazi* apparently similar to that of *P. zitteli* of Loeblich and Tappan (1987, p. 357) and Hottinger et al. (1989). But, the new species differs from *P. zitteli* in its smaller test of the both generations and tightly coiled adult biloculine and monoloculine chambers. It differs from the contemporaneous species *Periloculina slovenica* Drobne (1974 and 1984) in having larger test and tightly coiled adult chambers.

Stratigraphic and geographic distribution : Numerous exotic limestone blocks of Thanetian age were observed within the ophiolitic melange near the village of Saray (Figure 1), yielded abundant foraminiferal species such as *K. hottingeri*, *D. baskilensis*, *I. sinjarica*, *S. bitlisica*, *M. juliettae* and Miliolidae.

3. Conclusions

The known Maastrichtian genus *Gyroconulina* Schroeder and Darmoian and the Thanetian genus *Anatoliella* Sirel were placed in the new foraminiferal family Anatoliellidae (type genus *Anatoliella* Sirel) within the superfamily Ataxophragmicea Schwager

by the complex structure of the endoskeletal and exoskeletal elements (Figures 2 A-E)). The Danian-early Thanetian genus *Bolkarina* Sirel was placed in the new family Bolkarinidae (type genus *Bolkarina*) within the superfamily Orbitoidacea Schwager by the presence of the chamberlets with annular and radial stolons and lateral chambers. Furthermore, subfamily Globoflarininae Sirel 1998b was redescribed by the new generic features. Known four Paleocene genera, namely, *Bolkarina* Sirel (type species *B. aksarayensis*), *Globoflarina* (type species *C. ? sphaeroidea*), *Coskinon* Hottinger and Drobne (type species *C. (Coskinon) rajkae*), and *Nurdanella* Özgen (type species *N. boluensis*) which have previously been described inadequately by the foregoing authors, so that they are here redescribed by the new generic data. Furthermore, previously determined three foraminiferal species of Paleocene in Sirel (1998b) which were renamed as follows: the nummulitid species *R. sindensis* as *Ranikothalia polatliensis* n.sp., the unidentified miliolid new genus 6 redescribed as *Nurdanella paleocenica* n.sp., the fabularid species *P. slovenica* as *Periloculina yilmazi* n.sp. The stratigraphic and environmental distributions of here described Paleocene foraminiferal species and other Paleocene species have previously been given in (Sirel, 2012, Figures 11,12) respectively.

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PLATES

PLATE- I

Anatoliella ozalpiensis SİREL

(Thanetian, all figures from the Saray village, NE of Van, eastern Turkey, Figure 1, figures 1-6, 10-12 microspheric forms, figures 7-9 megalospheric forms, scale bar in Plate)

Figure 1- Vertical section, holotype in (Sirel, 1988, plate I, figure 2), showing structural elements of endoskeletal and exoskeletal, (MHNG, GEPI, no 88-170).

Figure 2- Almost vertical section, parallel to the coiling axis, (MHNG, GEPI, no 88-174).

Figure 3- Oblique vertical section, (MHNG, GEPI, no 88-187).

Figure 4- Tangential section, showing several orders of beams and rafters and numerous alveolar compartments (top), (MNGH, GEPI, no 88-171).

Figure 5- Centered oblique section, showing large megalosphere with second chamber and trochospiral early chambers at the apex of the cone and alveolar compartments at the bottom. (MHNG, GEPI, no 88-169).

Figure 6- Horizontal section, indicating triserial arrangement of the inflated adult chambers and showing several order of the exoskeletal vertical partitions, basal foramina and pillars in the central area, (MHNG, GEPI, no 88-179).

Figure 7- Centered vertical section of the young A form, (MHNG, GEPI, no 175).

Figure 8- Centered vertical section of the young A form, (MHNG, GEPI, no 88- 175).

Figure 9- Vertical section of the A form, (MHNG, GEPI, no 88-171).

Figure 10- Slightly oblique horizontal section, (MHNG, GEPI, no 88- 176).

Figure 11- Slightly oblique horizontal section, (MHNG, GEPI, no 88-175).

Figure 12- Slightly oblique horizontal section, (MHNG, GEPI, no 88-181).

All samples are deposited in the collection of Muséum d'Histoire Naturelle de Genève, under the numbers shown in PLATE I.

PLATE I

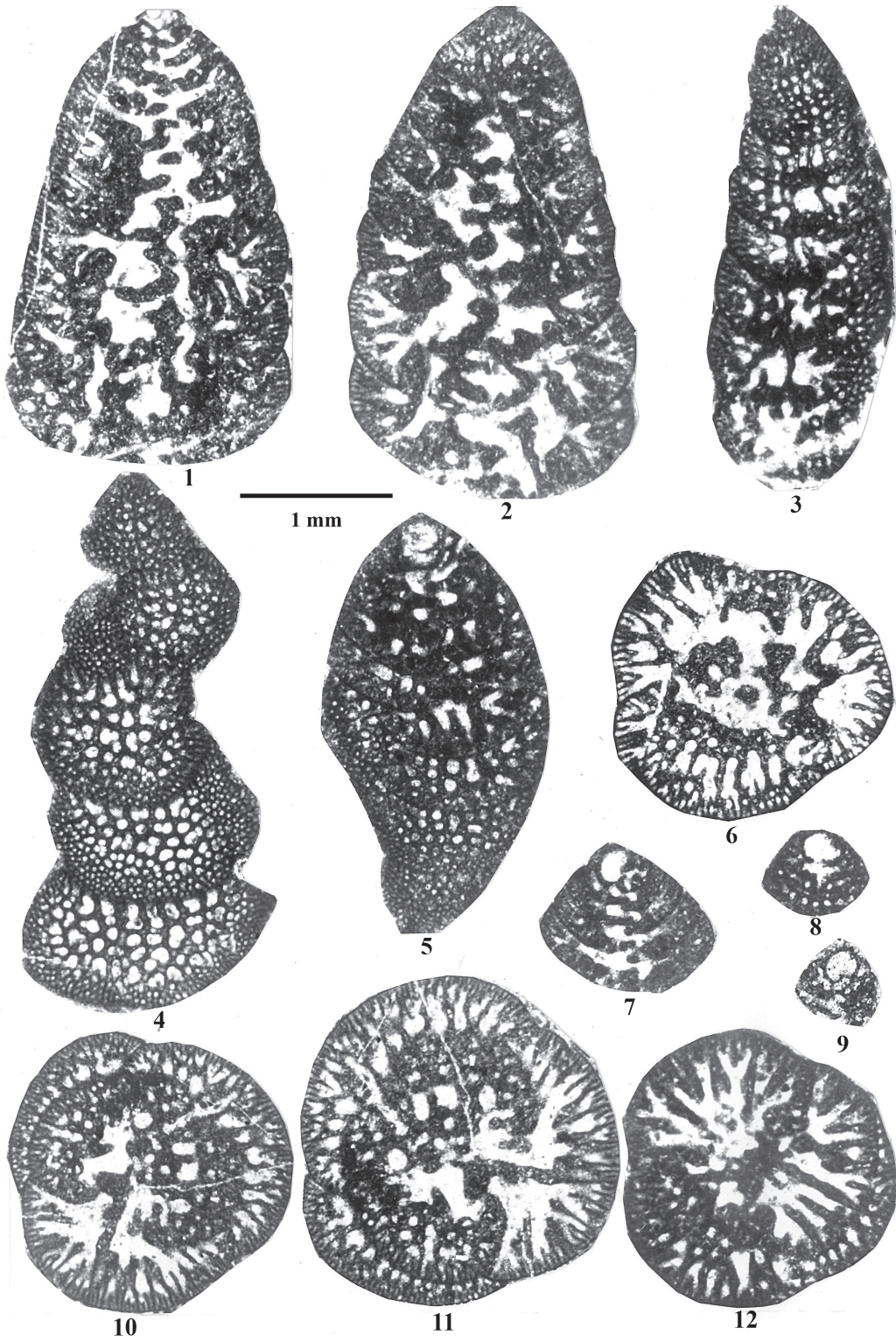


PLATE – II

Bolkarina aksarayensis Sirel

(Selandian-early Thanetian figures 1,3,4,5,6,7 from the Karandere, NW of Aksaray; from the Mahmutlar village, NW of Kırıkkale, Central Turkey; figure 2 from the Bolkar area, Southern Turkey, Figure 1, all figures from Sirel, 1981, scale bar top left of figure 1),

Figure 1- Incomplete equatorial section, B form, holotype, Sirel (1981, plate I, figure1), (Ak-1), scale bar= 2 mm.

Figure 2- Oblique equatorial section, A form, (Bol. 1), scale bar= 0.75 mm.

Figure 3- Incomplete equatorial section of B form, (Ak-20), scale bar=0.75 mm.

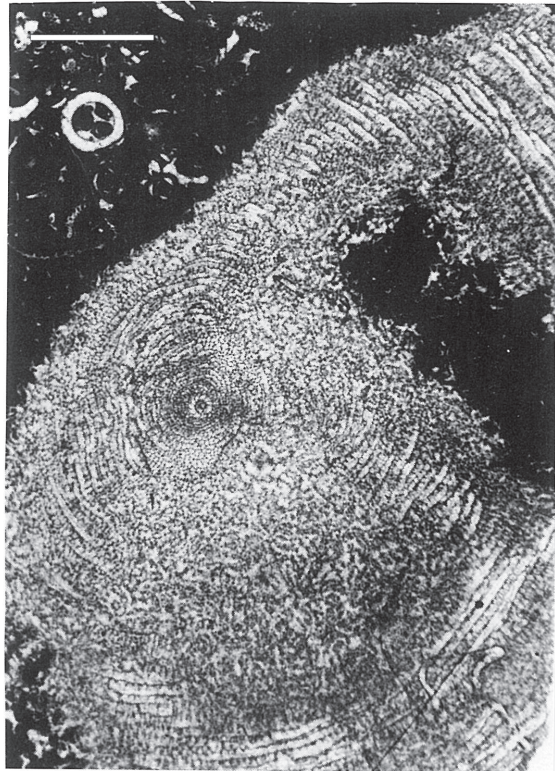
Figure 4- Equatorial section of the early spiral chambers, B form, (Ak-2), scale bar= 0.6 mm.

Figure 5- Subaxial section, (Kır. 1), scale bar= 1.8 mm.

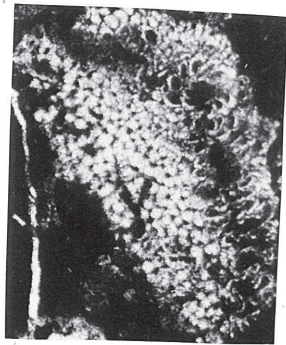
Figure 6- Axial section, showing spiral chambers of the early stage, (Ak-6), scale bar= 1.75 mm.

Figure 7- Subaxial section of A form, showing lateral chambers (bottom), (Ak-40), scale bar= 0.57 mm.

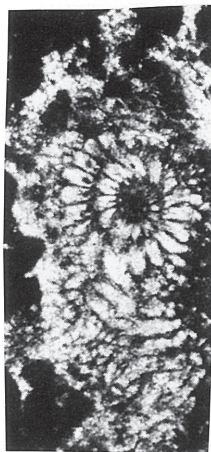
PLATE II



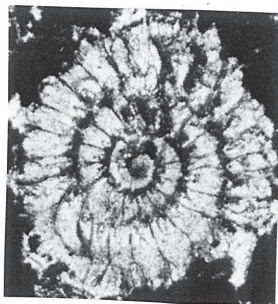
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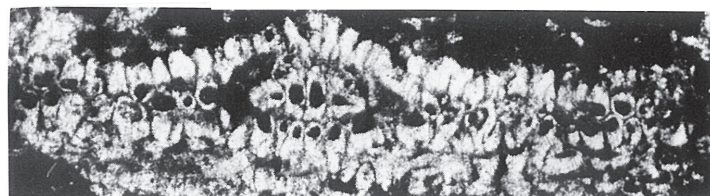
2



3



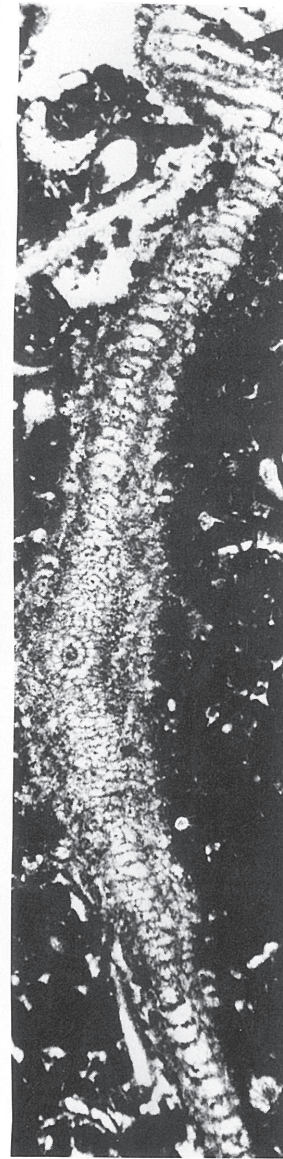
6



7



4



5

PLATE - III

Globoflarina sphaeroidea (FLEURY)

(Late Danian-early Selandian, all figures from Bolu area, western Turkey, Figure 1, scale bar= 0.45 mm for figures 1,5,10 and scale bar top left of figure 3)

Figure 1- Oblique section, showing two kind of aperture in the upper penultimate whorl (top), (211/4/2), scale bar= 0.45 mm.

Figure 2- Subaxial section with uncoiled stage, (211/18/1), scale bar 1 mm.

Figure 3- Oblique section, inclined to the axial plane, tending uncoil, (211/18/1), scale bar = 1 mm.

Figure 4- Almost axial section (211/20/1), scale bar= 1 mm.

Figure 5- Tangential section, intersecting last two whorls, showing two kind of aperture in the ultimate whorl (at top), (211/15/4), scale bar= 0.45 mm.

Figure 6- Tangential section, showing aligned septula (mid) and secondary aperture with keyhole-shape (mid-top), (211/35/1), scale bar= 1 mm.

Figure 7- Axial section of the megalospheric form, (211/1), scale bar= 1 mm.

Figure 8- Tangential section with uncoiled stage at the both sides, (211/1/1), scale bar= 1 mm.

Figure 9- Subaxial section, (211/5/3), scale bar= 1 mm.

Figure 10-Equatorial section, (211/4/5)., scale bar= 0.45 mm.

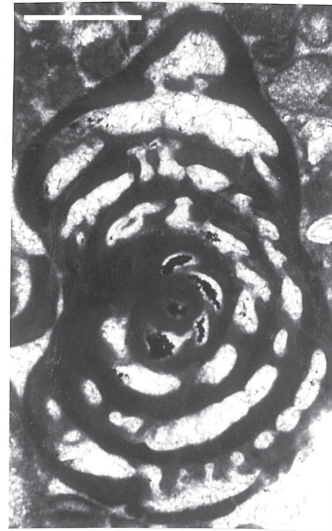
PLATE III



1



2



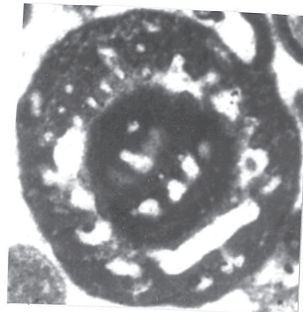
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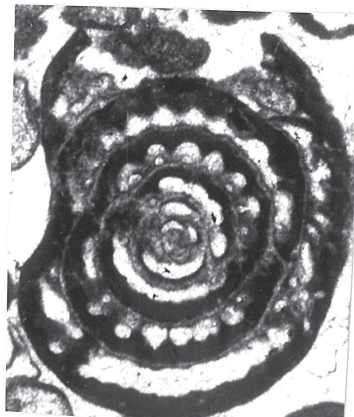
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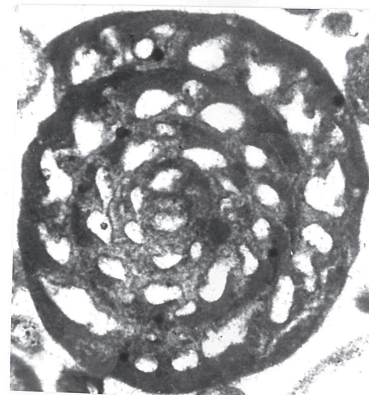
7



8



9



10

PLATE - IV

Globoflarina sphaeroidea (FLEURY)

(Late Danian-early Selandian, all figures from the Bolu area, western Turkey, Figure 1, figures 5,7 megalospheric form, the others microspheric form, scale bar top right of figure 1)

Figure 1- Non centered axial section, tending uncoil, (211/1), scale bar= 0.45 mm.

Figure 2- Non centered axial section, (211/16/2), scale bar= 0.45 mm.

Figure 3- Axial section with uncoiled stage, (211/1/1), scale bar= 1 mm.

Figure 4- Oblique section with uncoiled stage is devoid of the chambers, (211/19/2), scale bar= 1 mm.

Figure 5- Equatorial section, note young gamonts in the last whorl, (211/1), scale bar= 0.45 mm.

Figure 6- Axial section of the young specimen, (211/32/2), scale bar= 0.45 mm.

Nurdanella paleocenica n.sp

(Thanetian, all figures from the Saray village, NE of Van, eastern Turkey, Figure 1, scale bar among figures)

Figure 7- Axial section, probably microspheric form, holotype, showing crenated/ notched aperture in the upper antepenultimate chamber (left) and in the early chamber (right) (112/1),

Figure 8- Subequatorial section, B form, (105/1).

Figure 9- Almost equatorial section, B form, (88/211).

Figure 10- Subequatorial section, (Y.19d/3/3).

Figure 11- Equatorial section, A form, (88/208).

Figure 12- Subequatorial section, probably young A form, (105/1).

Figure 13- Axial section of young B form, showing quinqueloculine early chambers and notched/crenated aperture in the lower ultimate chamber, (105/1).

PLATE IV

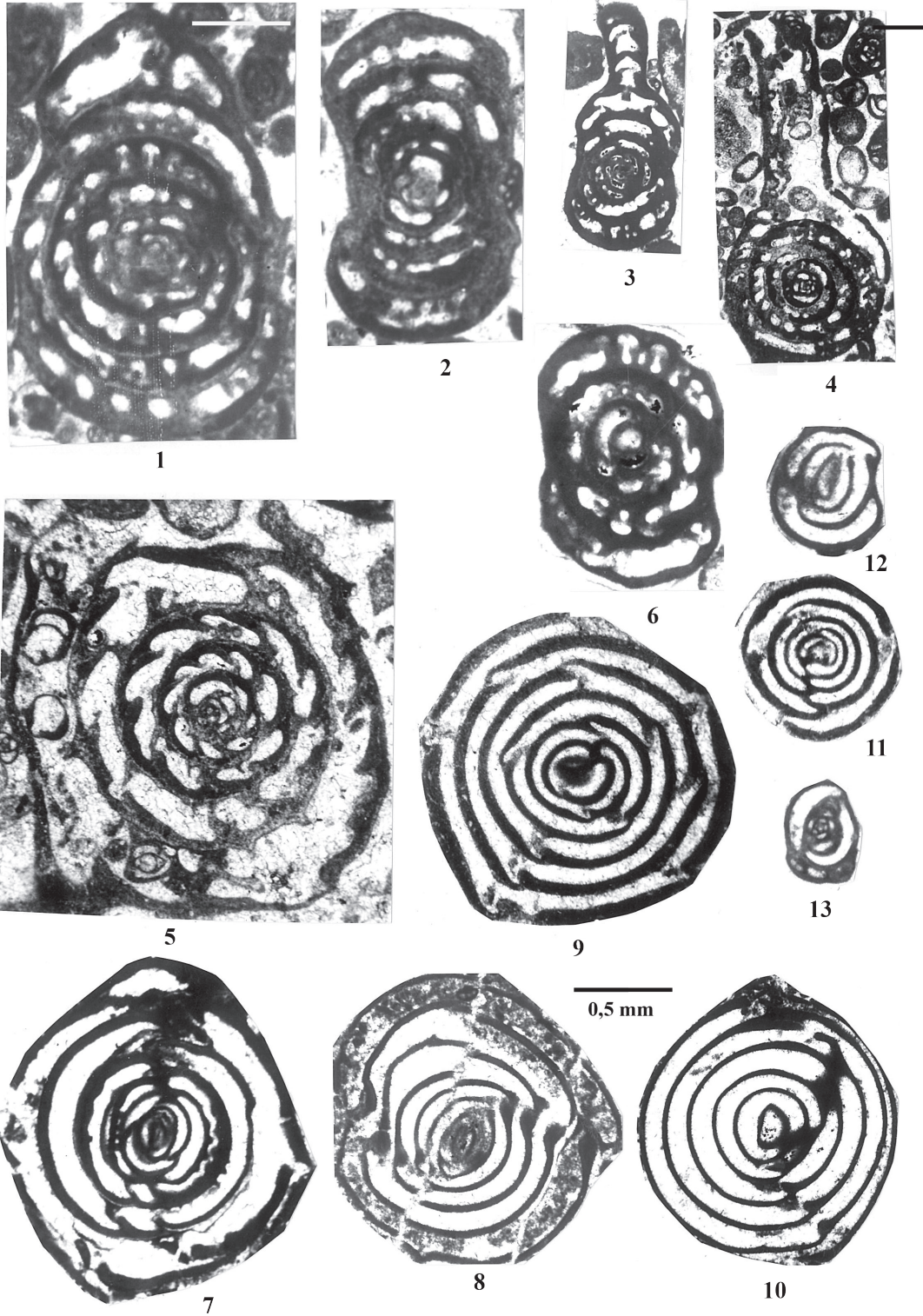


PLATE – V

Coskinon rajkae HOTTINGER and DROBNE

(Early Thanetian, all figures from the Harabekayış section (Sirel, 2009, Figure 10) Elazığ area, Eastern Turkey, all figures megalospheric forms, scale bar top right of figure 1)

Figure 1-Vertical section (top), showing biserial early chambers at the apex of the cone and undivided uniserial chambers at the marginal zone, subaxial section of *H. anatolica* (mid) and incomplete axial sections of *G. primaeva* (bottom), (HK. 4/7/3).

Figure 2-Almost vertical section, (HK. 4/2/3).

Figure 3-Almost vertical section, showing biserial early chambers and endoskeletal pillars, (HK. 4/1/3).

Figure 4-Almost vertical section, (HK. 4/12/1).

Figure 5-Almost vertical section, (HK. 4/7/1).

Ranikothalia polatliensis n.sp.

(Late Thanetian?-early Ilerdian, all figures from the Kuşçu village, SE of Polatlı, SW of Ankara, Central Turkey, Figure 1, all figures microspheric form, except figure 8, scale bar on figure 9),

Figure 6- Tangential section of the last two incomplete whorls, showing network of marginal canals, (30/5/5).

Figure 7- Almost axial section, (30/7/2).

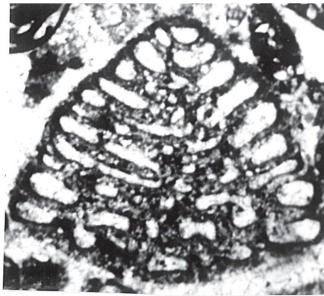
Figure 8- Incomplete equatorial section, (30/7/2).

Figure 9- Subaxial section, showing marginal canals at the both pole of the whorls, (30/12/3).

PLATE V



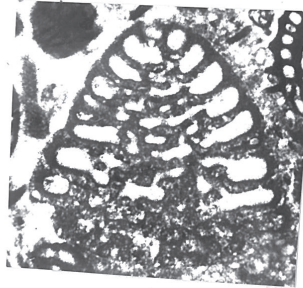
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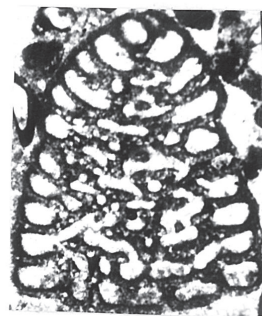
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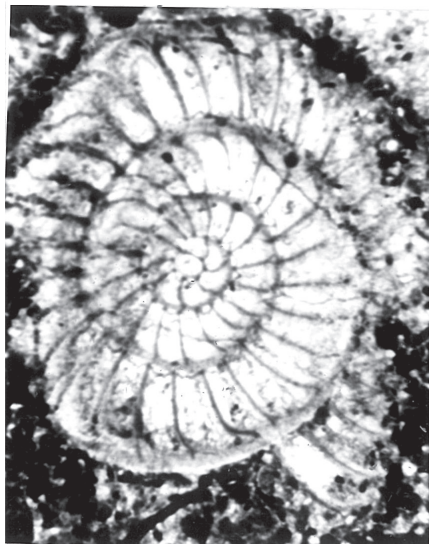
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6

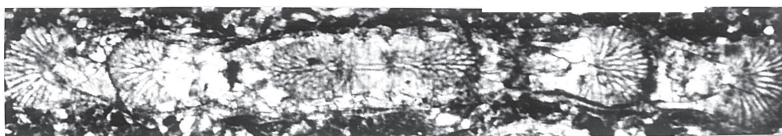


7



8

1 mm



9

PLATE - VI

Ranikothalia polatliensis n.sp.

(Late Thanetian?-early Ilerdian, all figures from the Kuşçu village, S of Polatlı, SW of Ankara, Central Turkey
Figure 1, figures 1,13 microspheric and figures 2-12 megalospheric forms, scale bar in Plate)

Figure 1- Almost equatorial section, holotype, (30/5/1).

Figure 2- Equatorial section, (30/5/2).

Figure 3- Axial section, (30/5/3).

Figure 4- Equatorial section, (30/5/4).

Figure 5- Axial section, (30/5/4).

Figure 6- Equatorial section, (30/5/5).

Figure 7- Tangential section, showing network of marginal canal at the peripheral margin (30/5/7).

Figure 8- Equatorial section, showing marginal cord with marginal stural canals between the ultimate and penultimate whorls, (30/5/8).

Figure 9- Axial section, (30/5/9).

Figure 10- Axial section, (30/5/10).

Figure 11- Axial section, (30/5/11).

Figure 12- Equatorial section, (30/5/12).

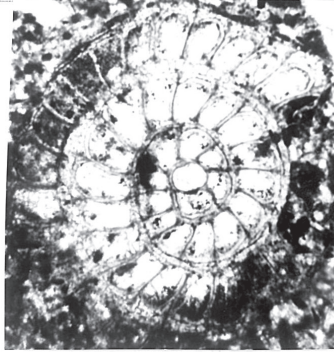
Figure 13- Subaxial section, showing marginal canals at the either poles of the whorls, (30/5/13)

PLATE VI



1

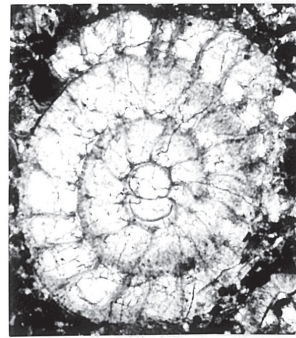
1 mm



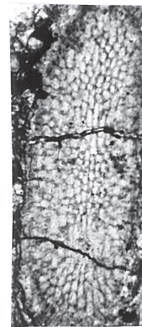
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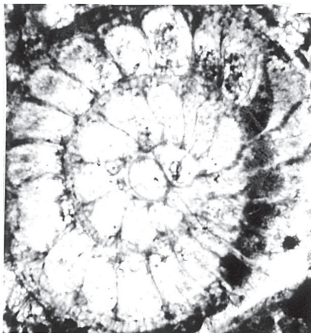
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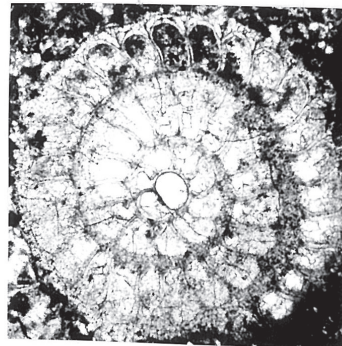
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4



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8



13



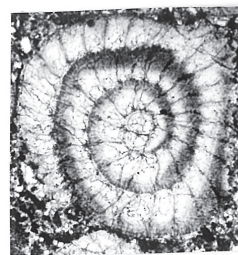
9



10



11



12

PLATE – VII

Periloculina yilmazi n.sp.

(Thanetian, all figures from the Saray village, NE of Van, Eastern Turkey Figure 1; figures 1- 3,4,11,12 microspheric, figures 5-10, 13 megalospheric forms, scale bar in Plate)

Figure 1-Oblique section, inclined to the axial plane, showing trematophorean pillars at the upper part of the test, (P.1).

Figure 2-Slightly oblique axial section, (P. 2).

Figure 3-Tangential section showing continuous septula, (P. 3).

Figure 4-Centered axial section, perpendicular to the apertural axis, (P.4).

Figure 5-Centered axial section, perpendicular to the apertural axis, (P. 5).

Figure 6-Centered axial section section, showing two cycles of triloculine chambers, (P.6).

Figure 7-Slightly oblique centered axial section, (P. 7).

Figure 8-Centered axial section, (P. 8).

Figure 9-Equatorial section, showing proloculus with bottle-neck and trematophorean pillars at the both poles, (P. 9).

Figure 10-Centered axial section of the adult specimen, (P. 10).

Figure 11-Oblique axial section, (P. 11).

Figure 12-Axial section, perpendicular to apertural axis, (P. 12).

Figure 13-Slightly oblique equatorial section, showing trematophorean pillars at the upper pole, (P. 13)

PLATE VII

