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BENTHIC FORAMINIFERAL FAUNA OF MALATYA OLIGO-MIOCENE BASIN, (EASTERN TAURIDS, EASTERN TURKEY)

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ABSTRACT

In this study, systematic description of 28 benthic foraminiferal taxa were carried out which had been detected in Oligo-Miocene aged Muratlı and Petekkaya formations cropping out over wide areas around Akçadağ town, west of Malatya province in Eastern Taurids. Miogypsina globulina which is a cosmopolite species located in Burdigalian aged shallow marine carbonates is described on wide geographical areas ranging from Central America to Indo-Pacific and Mediterranean Tethys. Miogypsina polymorpha on the other hand was reported only from Indo-Pacific in stratigraphical records until today. Considering the association of these species, the assumption of a probable marine connection mentioned between Indo-Pacific and Mediterranean Tethys in Burdigalian period in the region was strongly supported. Also considering the presence of marker planktonic foraminiferal species Globoquadrina dehiscens and Sphenolithus delphix from nannoplanktons which are described in marls between Chattian and Burdigalian units it was determined that these marls most probably indicated Aquitanian age.

1. Introduction

Malatya Oligo-Miocene basin is located in Eastern Anatolia Region around the town of Akçadağ at the junction point of Tauride-Anatolide platform (W Malatya) and is surrounded by towns of Doğanşehir in south, Hekimhan in north, Darende in northwest, Yazıhan in northeast and by Yeşilyurt in southeast (Figure 1). Marine sediments observed in and around the study area were deposited between Jurassic-Middle Miocene times (Figure 2). In this study, Oligocene and Lower Miocene units were investigated in detail; however Eocene-pre Eocene basement rocks and post Miocene young units were excluded from the scope of study (Figure 3). Middle Triassic-Cretaceous, Jurassic-Cretaceous and Upper Senonian neritic limestones, Mesozoic ophiolites, Late Cretaceous-Paleocene clastic and carbonate rocks, Early-Middle Eocene terrigenous clastic and sedimentary deposits consisting of Middle-Late Eocene neritic limestones, clastic and carbonate rocks form pre Oligo-Miocene basement geological units in the region. As for the younger sediments deposited which outcrop in the vicinity of the study area are composed of Late Miocene-Pliocene terrigenous clastic and pyroclastic rocks, Pliocene and Plio-Quaternary terrigenous sediments, alluvial fan, debris and young alluvial deposits. Detailed information about basement units and young deposits can be obtained from studies of Ayan (1961), Akkuş (1971), Yoldaş (1972), Kurtman (1978), Örçen (1986), Karaman et al. (1993) and Alkan (1997).

Muratlı and Petekkaya formations in which benthic foraminiferal fauna is rich among Oligo-Miocene units in the region were studied in detail and four stratigraphic sections were measured namely the Edilme (SW Akçadağ), Kuzkaya (W Akçadağ), Develi (W Akçadağ) and Karamağara (NE Akçadağ) measured stratigraphical sections (Gedik, 2010). In this study, systematic characteristics of benthic foraminiferal fauna were explained and all

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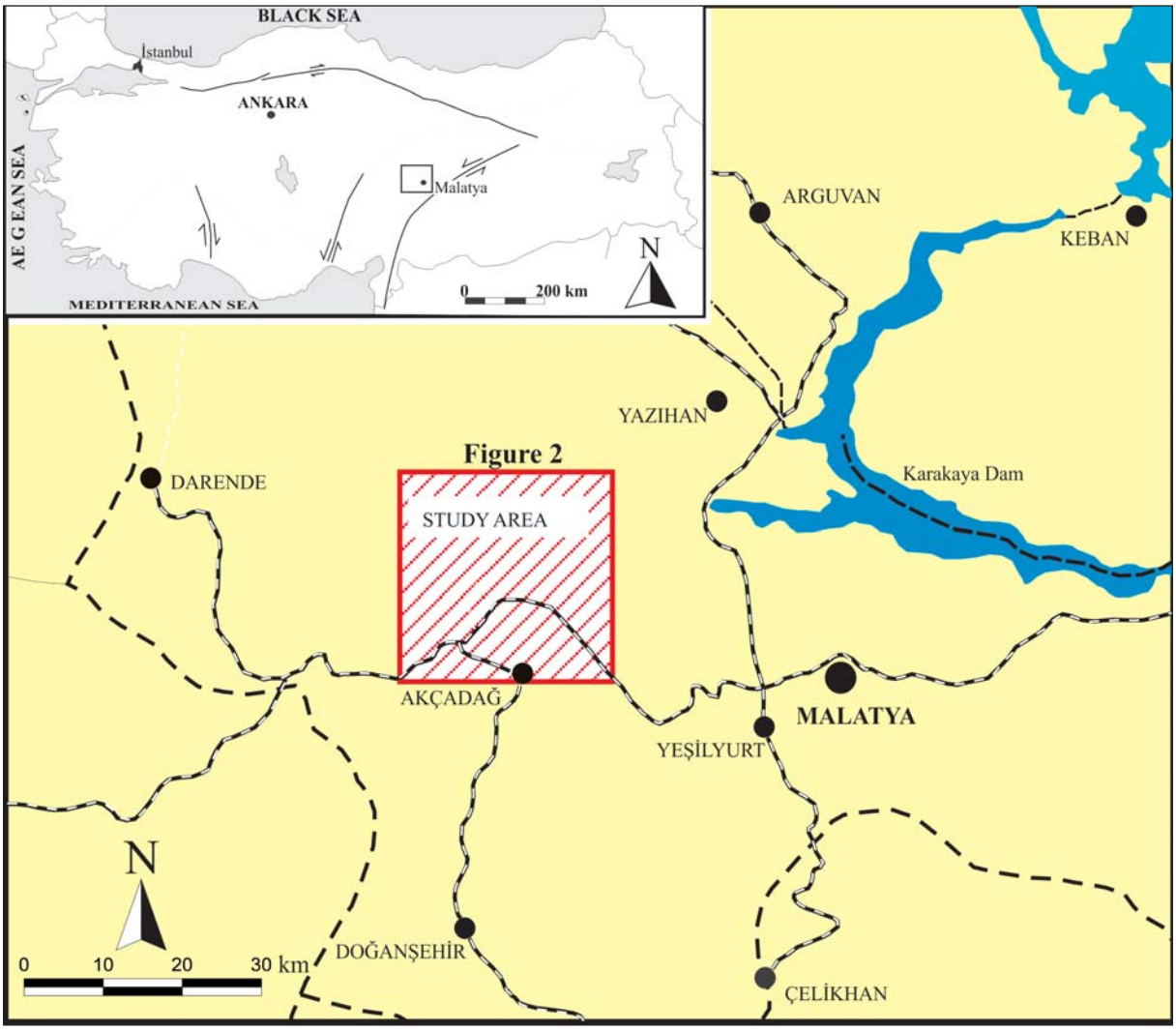

Figure 1- Location map of the study area.

stratigraphic sections were correlated by means of their stratigraphical ranges (Figure 4).

All thin sections of the foraminiferal species described and figured in this paper are deposited in the collection of General Directorate of Mineral Research and Exploration, Ankara, Turkey, under the numbers shown in Plates 1-13.

2. Systematic Paleontology

With this study, 28 taxa obtained from benthic foraminifers of Oligocene Muratlı and Lower Miocene Petekkaya formations were defined and their stratigraphic ranges were given. The author followed the systematic classification of Loeblich and Tappan (1987). Also, the systematic classification of the miogypsinid genera was based upon the taxonomy of Sirel and Gedik (2011).

Group: Protozoa Goldfuss, 1817

Sub Group: Sarcodina Schamarda, 1871

Class: Rhizopodea Von Siebold, 1845

Order: Foraminiferida Eichwald, 1830

Sub Order: Miliolina Delage and Herouard, 1896

Family: Soritidae Ehrenberg, 1839

Sub Family: Archaiasinae Cushman, 1927

Genus: *Archaias* de Montfort, 1808

Type Species: *Nautilus angulatus* Fichtel and Moll, 1798

Archaias kirkukensis Henson, 1950

(Plate 1, Figure 1-15)

1950 *Archaias kirkukensis* Henson, p. 43, plate 7, figures 3, 4, 9; plate 8, figures 1-5.

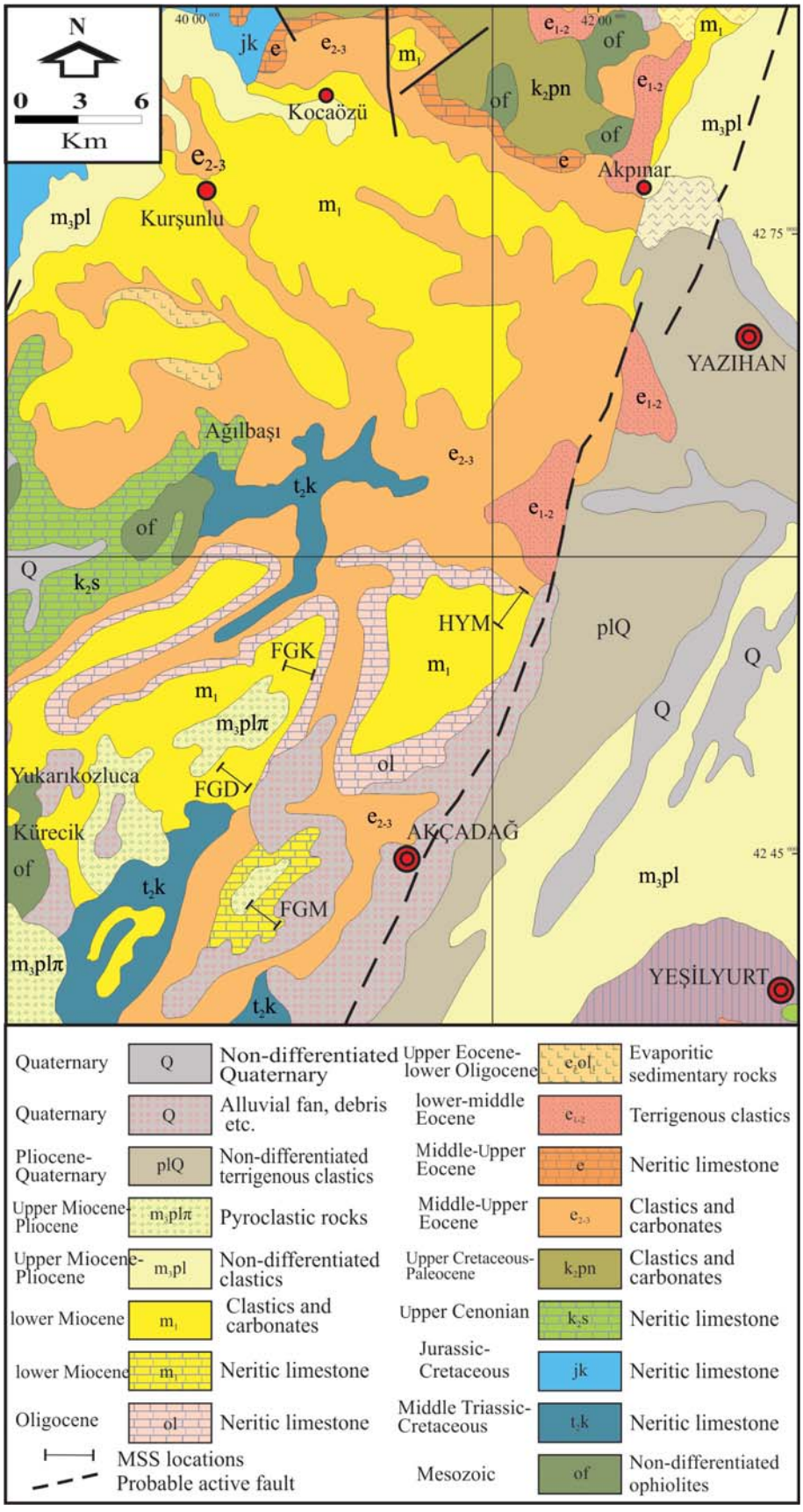

Figure 2- Geological map of the study area (MTA, 2002).

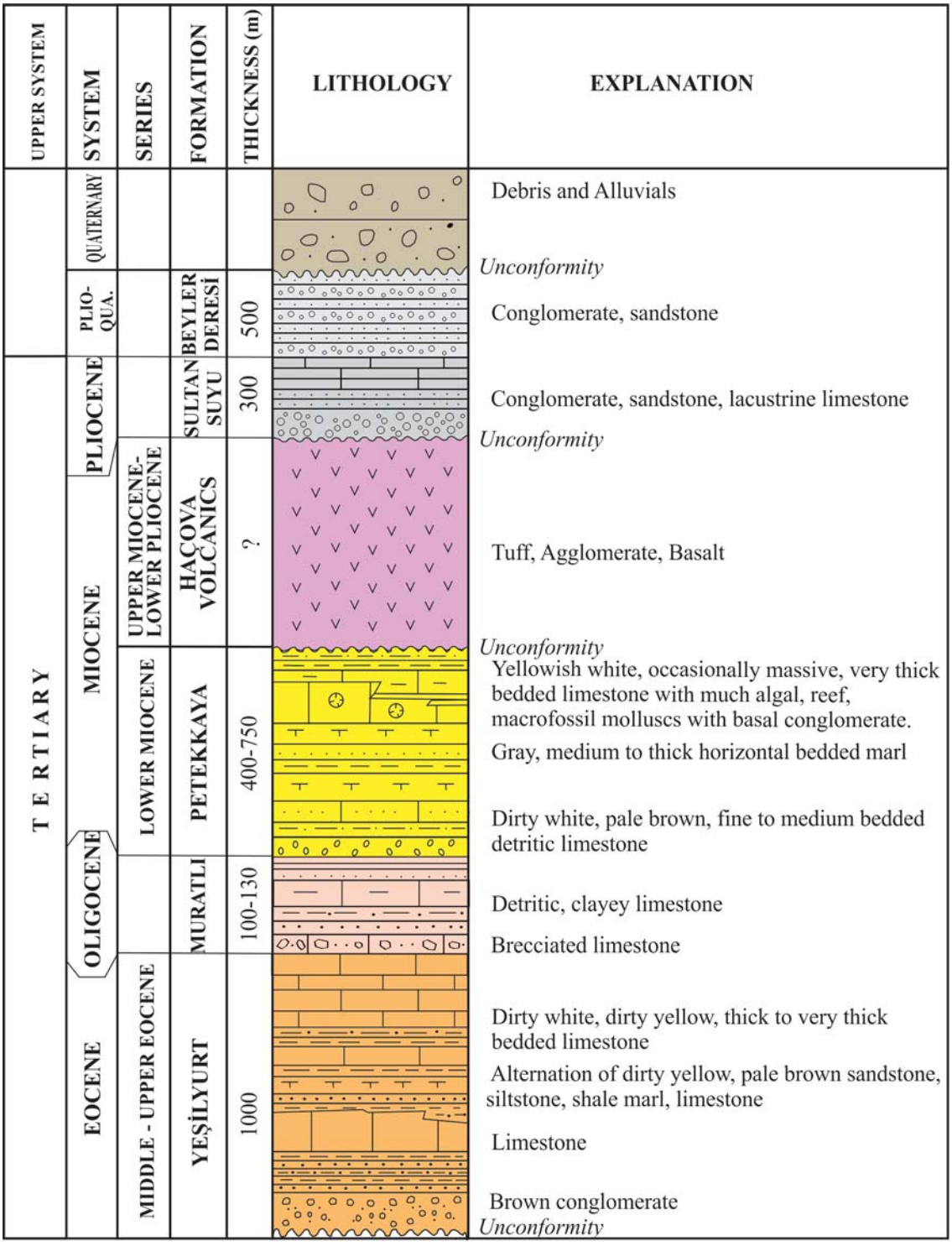

Figure 3- Generalized stratigraphical section of the study area (taken from Karaman et al., 1993).

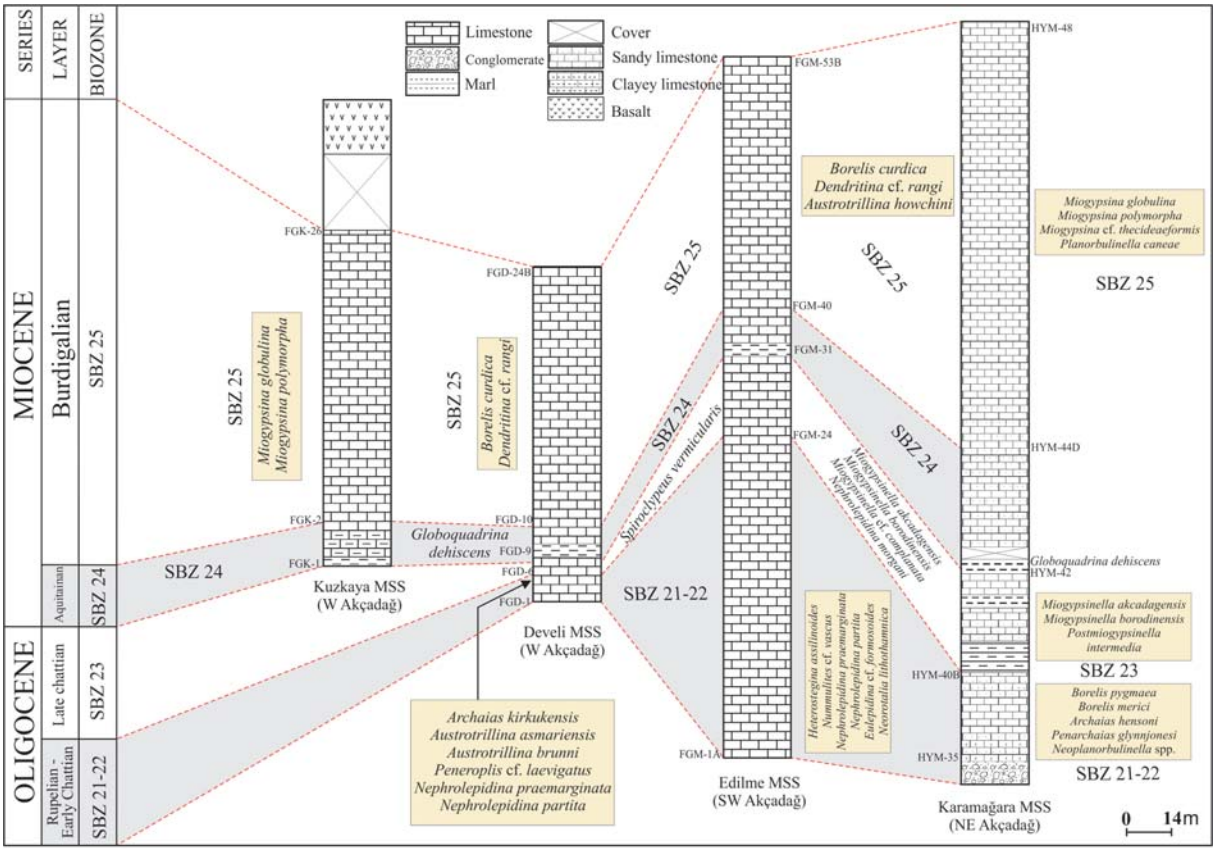

Figure 4-Lithological and biostratigraphical correlation tables of measured stratigraphical sections in the study area.

2013 *Archaias kirkukensis* Henson, Sirel et al., p. 103, plate 9, figures 1-8; plate 10, figures 14; plate 11, figures 1).

Description: The test is discoidal with slightly rounded periphery. The largest shell diameter reaches 3.9 mm in the megalospheric generations. Spheric megalosphere (its diameter 0.13-0.22 mm) followed by undivided planispiral-involute early chambers. The adult chambers are cyclical and evolute dividing by the interseptal pillars. The apertures of the early chambers are areal slits but in the cyclical chambers apertures consist of rows of openings.

Stratigraphic range: Rupelian-Early Chattian in Develi measured section.

Archaias hensoni Smout and Eames, 1958

(Plate 2, Figures 1-6)

1958 *Archaias hensoni* sp. nov., Smout and Eames, p. 219-220, plate 40, figures, 16-20; plate 41, figures 1-5, 21, 26, 28-29.

2007 *Archaias hensoni* Smout and Eames, Bassi et al., plate 2, figures 1-16.

Description: Only megalospheric form is observed. The specimens are characterized by their comparatively small size. The diameter of the test ranges from 1,05 to 3,05 mm and the central thickness 0,36 to 0,52 mm respectively. Spheric megalosphere (its diameter 0,16 - 0,22 mm) followed by undivided planispiral-involute early chambers. The adult chambers are cyclical and evolute dividing by the interseptal pillars. The apertures of the early chambers are areal slits but in the cyclical chambers apertures consist of rows of openings.

Stratigraphic range: Rupelian-Early Chattian in Karamağara measured stratigraphic section.

Genus: *Penarchaias* Hottinger, 2007

Type Species: *Peneroplis glynnjonesi* Henson, 1950

Penarchaias glynnjonesi (Henson, 1950)

(Plate 2, Figures 7-9)

1950 *Peneroplis glynnjonesi* Henson, p. 35, plate 9, figures 8-9.

2004 *Peneroplis* aff. *glynnjonesi* Henson, Sirel, p. 36, plate 35, figures 2, 3, 5, 10.

2007 *Penarchaias glynnjonesi* (Henson), Hottinger, p. 11-12, plate 1, figure 3; plate 6, figures 2, 10; plate 7, figures 7, 8; plate 8, figures 6, 10; plate 9, figures 6; plate 12, figures 2; plate 13, figures 3; plate 14, figures 13; plate 15, figures 1-5, 9.

Description: Only megalospheric form is observed. Test lenticular, its diameter 0,9 mm early stage, the diameter and the thickness of the test ranges from 1,31 to 1,36 mm and 0,47 to 0,52 mm respectively. Spheric megalosphere followed by planispiral early chambers and later chambers becoming uniserial (plate 2, figures 7, 9). Interior skeletal apertures are observed on the septum (Hottinger 2007; plate 7, figures 7, 9). Apertures which are one of the most important characteristics of the genus are observed in plate 2 and figures 7, 9.

Stratigraphic range: Rupelian-Early Chattian in Karamağara measured section.

Family: Peneroplidae Schultze, 1854

Genus: *Dendritina* d'Orbigny, 1826

Type Species *Dendritina arbuscula* d'Orbigny, 1826

Dendritina cf. *rangi* d'Orbigny, 1904 in Fornasini

(Plate 9, Figures 6-8)

1904 *Dendritina* cf. *rangi* d'Orbigny, in Fornasini, plate 1, figures 13, 13a.

1950 *Dendritina* cf. *rangi* d'Orbigny, Henson, p. 31, plate 5, figure 2; plate 6, figures 2-3, plate 10, figure 3.

1963 *Dendritina* cf. *rangi* d'Orbigny, Hottinger, p. 970, plate 4, figures 1, 2.

1976 *Dendritina* cf. *rangi* d'Orbigny, Bignot and Guernet, p. 17, plate 1, figures 2-4.

Description: Test is planispiral and involute, its diameter 1.4 mm and the thickness 0.45 mm in megalospheric form. Chambers are simple and not subdivided. The diameter of the large megalosphere is 0.065 mm. It is characterized by dendritic type aperture.

Stratigraphic range: Burdigalian in Develi measured section.

Genus: *Peneroplis* de Montfort, 1808

Type Species *Nautilus planatus* Fichtel and Moll, 1798

Peneroplis cf. *laevigatus* d'Orbigny in Fornasini, 1904

(Plate 3, Figures 2, 3)

1904 *Peneroplis* cf. *laevigatus* d'Orbigny in Fornasini, plate 1, figures 15, 15a.

1963 *Peneroplis* cf. *laevigatus* d'Orbigny in Fornasini, Hottinger, p. 968, plate 3, figures 9-10.

Description: Test is flabelliform, its diameter 1.4-1.5 mm. The protoconch is followed by $1^{1/2}$ planispiral-involute whorls, later chambers flaring and arranged in peneropline and flabelliform (plate 3, figure 3). The connection between the chambers is provided by numerous foramen (plate 3, figure 2).

Stratigraphic range: Rupelian-Early Chattian in Develi measured section.

Family: Austrotrillinidae Loeblich and Tappan, 1986

Genus *Austrotrillina* Parr, 1942

Type Species: *Trillina howchini* Schlumberger, 1893

Austrotrillina asmariensis Adams, 1968

(Plate 3, Figure 25; Plate 4, Figures 1-13)

1947 *Trillina howchini* Schlumberger, Bursch, p. 12, plate 1, figures 1, 2, 9, 13, 14.

1962 *Austrotrillina howchini* (Schlumberger), Dizer, plate 3, figure 7.

1968 *Austrotrillina asmariensis* Adams, p. 82, plate 1, figures 1-12.

1996 *Austrotrillina howchini* (Schlumberger), Sirel, p. 171, figures 11, 13-15.

2003 *Austrotrillina asmariensis* Adams, Sirel, p. 294, plate 9, figures 1-15.

Description: Megalospheric form: Test is porcelain calcareous. Large test is triangular with bluntly rounded margin in transverse and ovate in the longitudinal sections. The lenght of the test ranges from 1,2 to 1,8 mm and the width from 0,9 to 1,1 mm. Very large, spherical proloculus (its diameter varies between 0,1and 0,2 mm; plate 4, figures 3, 6, 8, 10, 12) is followed by the early chambers arranged in triloculine. Outer wall of the chambers consisting simple, thick subepidermal partitions arranged closely.

Microspheric form: This form has a large elongated ovate test in transverse sections (plate 4,

figure1). The lenght of the test ranges from 1,6 to 2,5 mm and the width from 1,1 to 1,3 mm. Very small (diameter could not be measured), spherical microsphere is followed by the early chambers arranged in quinqueloculine mode, later chambers arranged in triloculine pattern (plate 4, figure 1). Outer wall of the chambers consist of two order of thick subepidermal partitions forming alveolar subepidermal network (plate 4, figures 2, 4, 9, 12).

Stratigraphical range: Rupelian-Early Chattian in Develi measured section, Late Chattian in Edilme measured section.

Austrotrillina brunni Marie, 1955

(Plate 3, Figures 5, 12-16, 18-22)

1955 *Austrotrillina brunni* Marie, p. 203, plate 9, figures 4-8.

1968 *Austrotrillina brunni* Marie, Adams, p. 85, plate 6, figures 6, 8.

2003 *Austrotrillina brunni* Marie, Sirel, p. 294, plate 10, figures 10-16.

Description: Megalospheric form: The test is small and the peripheral margin is rounded in transverse sections (plate 3, figure 21). The lenght of the test ranges from 0,62 to 0,75 mm and the width from 0,39 to 0,49 mm. The spheric megalosphere (0,11-0,19 mm in diameter) is followed by small individed chambers arranged in triloculine mode. Later adult chambers with fine subepidermal partitions are also lined up in triloculine pattern. Two types of subepidermal partitions form small alveolar compartments.

Microspheric form: The small test is triangular with rounded margin in transverse sections. The lenght of this species unknown, the width of the test 0,8 mm. Very small, spherical microsphere is followed by the early chambers arranged in quinqueloculine mode, later chambers arranged in triloculine pattern (plate 3, figure 15).

Stratigraphical range: Rupelian-Early Chattian in Develi and Karamağara measured sections and Late Chattian in Edilme measured section.

Austrotrillina howchini (Schlumberger, 1893)
(Plate 3, Figures 17, 23, 24)

1893 *Trillina howchini* Schlumberger, p. 119-120, plate 3, figure 6.

1968 *Austrotrillina howchini* (Schlumberger), Adams, plate 2, figures 1-7; plate 6, figures 1-5, 7.

Description: Only megalospheric form is observed. Test has a diameter of 0.82 mm and a width of 0.52 mm in longitudinal section; however it has a diameter of 0.65 mm and a width of 0.55 mm in transverse section. The diameter of the spherical microsphere which cannot be well observed could not be measured. Spherical microsphere is followed by the early chambers arranged in triloculine mode. Subepidermal partitions show thick and complex structure.

Stratigraphical range: Burdigalian in Edilme measured section.

Family: Alveolinidae Ehrenberg, 1839

Genus: *Borelis* de Montfort, 1808

Type Species: *Nautilus melo* Fichtel and Moll, 1798

Borelis curdica (Reichel, 1937)

(Plate 5, Figures 1-28)

1937 *Neoalveolina melo curdica* n. ssp., Reichel, p. 108, plate 10, figures 4-7.

1966 *Borelis melo curdica* (Reichel), Reiss and Gvirtzman, plate 1, figure 8; plate 2, figure 1.

1976 *Borelis curdica* (Reichel), Bignot and Guernet, p. 19, plate 2, figures 1-10.

Description: Test is spheric to subspheric and is mainly nautiloid in shape. The diameter and width of test in which megalosphericand microspheric forms cannot be well differentiated vary between 0.29-0.85 mm and 0.32-0.82 mm, respectively. Elongation index (the ratio of axial diameter to equatorial diameter) ranges between 0.79-1.14. Diameter of the proloculus could not be measured in any of the forms. Preseptal canal in equatorial sections (plate 5, figure 1), uniserial aperture in subaxial sections (plate 5, figure 5) and fully ordered spine knob chambers in tangential sections are definite (plate 5, figures 10, 13).

Stratigraphical range: Burdigalian in Develi, Edilme and Kuzkaya measured section.

Borelis pygmaea (Hanzawa, 1930)

(Plate 3, Figure 11)

1930 *Borelis* (*Fasciolites*) *pygmaea* Hanzawa, p. 94, plate 26, figures 14, 15.

1932 *Neoalveolina pygmaea* (Hanzawa), Bakx, p. 237, plate 3, figures 18, 19.

1947 *Neoalveolina pygmaea* (Hanzawa), Bursch, p. 28, plate 1, figures 11, 15, 19.

1965 *Neoalveolina pygmaea* (Hanzawa), Adams, p. 25 a-c.

2003 *Borelis pygmaea* (Hanzawa), Sirel, p. 298, plate 11, figures 1-7.

Description: The specimens of the megalospheric form have a medium size, fusiform with axial diameter of 2.10 mm and equatorial diameter of 0.68mm at the 6^{th} whorls. Index of elongation is 3.05 mm. The small spherical megalosphere (its diameter is 0.65 mm; (plate 3, figure 11) is followed by tightly coiled four or five oval shape and it's both axial and equatorial thickenings are rigorous. However, the chambers in adult stage were arranged in fusiform. Chambers are much rigorous in equatorial region but loose in axial region. Therefore, the axial thickening is abundant in adult stage such that it reaches 4-5 times more than the size of chambers. Nevertheless, this thickening decreases during last two rounds compared to previous whorls. Lobes are closely arranged and mainly spheroidal. Lobes in last three whorls exhibit an oval shaped structure towards upper parts.

Stratigraphic range: Rupelian-Early Chattian in Karamağara measured section.

Borelis merici Sirel and Gündüz, 1981

(Plate 3, Figures 8-10)

1981 *Borelis merici* Sirel and Gündüz, p. 73-74, plate 1, figures 9-13.

2003 *Borelis merici* Sirel and Gündüz, Sirel, p. 299, plate 11, figures 8, 9.

Description: Test is slightly elongated oval with an axial diameter of 1.01-1.41 mm and equatorial diameter of 0.45-0.78 mm. Index of elongation is 1.79-2.71 mm. There is not any axial thickening along 5 whorls after the proloculus. Therefore, the shape of the test at this stage is ovoid. Axial thickening slightly increases in last 4 whorls. Therefore, test is elongated and oval in adult stage. Diamorphism is indefinite.

Stratigraphical range: Rupelian-early Chattian in Karamağara measured section.

Suborder: Rotaliina Delage and Herouard, 1896

Family: Planorbulinidae Schwager, 1877

Genus: *Planorbulina* d'Orbigny, 1826

Type Species: *Planorbulina mediterranensis* d'Orbigny, 1826

Planorbulina brönnimanni Bignot and Decrouez, 1982

(Plate 2, Figures 10-22)

1982 *Planorbulina brönnimanni* Bignot and Decrouez, p. 144, plate 1, figures 1-9; plate 2, figures 1-5; plate 3, figures 1-3; plate 4, figures 1-6, plate 5, figures 1-9; plate 6, figures 1-8.

1993 *Planorbulina brönnimanni* Bignot and Decrouez, Sirel and Acar, p. 181, 183, plate 2, figure 21.

Description: Test discoidal with calcareous wall and its diameter varies in between 0.55-1.89 mm. It is diamorphic and there are chambers in megalospheric forms with trochospiral whorls after the proloculus (plate 2, figures 10, 12, 13, 16, 20). The following chambers are irregularly arranged in different sizes. As it was clearly seen in well oriented sections, the connection between chambers is provided by base stolons (plate 2, figures 10, 12, 13, 14, 15, 21).

Stratigraphical range: Early-Late Chattian in Develi measured section and Rupelian-Early Chattian in Karamağara and Edilme measured section.

Genus: *Neoplanorbulinella* Matsumaru, 1976

Type Species: *Neoplanorbulinella saipanensis* Matsumaru, 1976

Neoplanorbulinella spp.

(Plate 2, Figures 23-30)

Description: The diamorphism is observed in these forms as test size and embryonic chambers are different. Test form ranges from low conical to very high conical; the spiral side is strongly convex however the umbilical side is concave. The base diameter and height of the cone range between 0.5-1.1 mm and 0.4-0.8 mm, respectively. Spiral angle shows variation between 90°-140°. The first and second chambers are located at top of the cone and are spherical. Diameters of the first and second chambers vary between 0.07-0.09 mm and 0.03-0.07 mm, respectively. Equatorial chambers which follow embryonic chambers are regularly arranged on margin of the cone in external skeletal, and their

diameters are in the form of arch gradually growing towards the bottom of cone. The diameter of umbilical pore ranges between 0.2-0.8 mm, and this pore is filled by numerous lateral chambers.

Stratigraphical range: Rupelian-Early Chattian in Karamağara measured section.

Genus: *Planorbulinella* Cushman, 1927

Type Species: *Planorbulina vulgaris* d'Orbigny var. *larvata* Parker and Jones, 1865

Planorbulinella caneae Freudenthal, 1969

(Plate 9, Figure 9)

Description: Description was based into one equatorial section. Test is small discoidal and has a diameter of 1.2 mm. Chambers are trochospirally coiled in early stage. Later chambers developed in the form of circular series, and the connection between chambers is provided by stolons.

Stratigraphical range: Burdigalian in Karamağara measured section.

Family: Lepidocyclinidae Scheffen, 1932

Genus: *Nephrolepidina* Douvillé, 1911

Type Species *Nummulites marginata* Michelotti, 1841

Nephrolepidina praemarginata Douvillé, 1908

(Plate 6, Figures 1-14)

1908 *Lepidocyclina praemarginata* Douvillé**,** p. 91 - 92, figures 1, 2, 4a.

2003 *Nephrolepidina praemarginata* (Douvillé), Sirel, p. 302, plate 4, figures 1 - 13.

Description: The small test is inflated lenticular with central umbo, so that the shell is getting thicker towards the center (plate 6, figures 7, 10, 12). The diameter of the test ranges from 1.6 to 3.2 mm and the thickness from 0.7-1.3 mm. The large, central umbo consists of numerous small pustules. This feature is well observed neither in external side nor in axial-transversal sections (plate 6, figures 5, 7, 9, 11). Lateral chambers are numerous at the surface of test and are rosette shaped, and this feature forms comb view at the surface (plate 6, figures 11, 12). The embryo consists of hemisphere small protoconch (its diameter is 0.06-0.3 mm) and reniform deuteroconch (its diameter is 0.1-0.4 mm). Secondary chambers are very small and their sizes are almost equal to each other. The equatorial chambers are subrectangular or rhombic in outline. There are 6-7 orders of lateral chambers in the center of the test.

Stratigraphical range: Rupelian-Early Chattian in Develi and Edilme measured section.

Nephrolepidina partita Douvillé, 1924

(Plate 7, Figure 1-9)

1924 *Nephrolepidina partita* Douvillé, p. 76, plate 6, figures 1- 4.

2003 *Nephrolepidina partita* Douvillé, Sirel, p. 302, plate 5, figures 1-10.

Description: The description was based on axial sections and on one equatorial section which belong to limited megalospheric forms. The small test is lenticular with central umbo with large pustules, so that the shell of this species is getting thicker toward the center (plate 7, figure 1-4, 5-8). The diameter of the test ranges from 1.1 to 2.4 mm and the thickness from 0.7 to 1.2 mm. The embryo consists of small protoconch (its diameter is 0.1 mm) and large reniform deuteroconch (its diameter is 0.2 mm). The equatorial chambers are rectangular in outline.

Stratigraphic range: Rupelian-Early Chattian in Develi and Edilme measured section.

Nephrolepidina morgani (Lemoine and Douvillé, 1904)

(Plate 7, Figures 12, 13)

1904 *Lepidocyclina morgani* Lemoine and Douvillé**,** p. 5-41, plate 1, figures 12, 15, 17; plate 2, figures 4, 12; plate 3, figure 2.

1924 *Nephrolepidina morgani* (Lemoine and Douvillé), Douvillé**,** p. 80.

1929 *Nephrolepidina morgani* (Lemoine and Douvillé), Gomez Llueca, p. 1-400, plate 33, figures 29, 32.

1991 *Lepidocyclina* (*Nephrolepidina*) *morgani* (Lemoine and Douvillé), Less, p. 445-446, plate 7, figures 1-6; plate 8, figures 1-6; plate 9, figures 1-2.

2003 *Nephrolepidina morgani* (Lemoine and Douvillé), Sirel, p. 303, plate 5, figures 11-16; plate 6, figures 1-7.

Description: The test is inflated lenticular with numerous central pustules, so that the shell of this species is getting thicker towards the center. The diameter of the shell ranges from 1.08 to 2.94 mm and

the thickness from 0.35 to 1.05 mm. The embryo consists of small spherical protoconch (its diameter is 0.2 mm) and large semilunar deuteroconch (its diameter is 0.3 mm; plate 7, figure 13). The equatorial chambers are rhomboidal in shape.

Stratigraphical range: Late Chattian in Edilme measured section.

Eulepidina cf. *formosoides* Douvillé, 1924

(Plate 7, Figures 10, 11)

1924 *Eulepidina formosoides* Douvillé, p. 71, plate 3, figures 2- 4.

1967 *Eulepidina formosoides* Douvillé, Poignant, p. 208, plate 5, figures 9, 11; plate 6, figures 1, 6.

1975 *Eulepidina favosa* Cushman, Sirel et al., p. 179, plate 4, figures 2, 3.

1975 *Eulepidina dilatata* Michelotti, Sirel et al., p. 179, plate 4, figures 1.

2003 *Eulepidina formosoides* Douvillé, Sirel, p. 272, figure 2.

Description: The test is lenticular with large umbo, so that the shell is getting thicker towards the center. The diameter of the test ranges from 4.6 to 5.2 mm. Embryonic apparatus consists of small protoconch (its diameter is 0.4-1.08 mm) and large sub spheric deuteroconch (its diameter is 0.8-1.7 mm). The equatorial chambers are polygonal in shape.

Stratigraphical range: Rupelian-Early Chattian in Develi and Edilme measured section.

Family: Miogypsinidae Vaughan, 1928

Genus: *Miogypsinella* Hanzawa, 1940

Type Species: *Miogypsinella borodinensis* Hanzawa, 1940

Miogypsinella akcadagensis (Gedik and Sirel), 2009

(Plate 8, Figures 1-3)

2009 *Miogypsinoides akcadagensis* n. sp., Gedik and Sirel, p. 35-43, plate 1, figures 1-7.

2011 *Miogypsinella akcadagensis* (Gedik and Sirel), Sirel and Gedik, p. 591-603, plate 2, figures 1-5.

Description: The equatorial (plate 8, figures 1, 2) and axial sections (plate 8, figure 3) clearly show that the general shape of the test is fan-like with rather thickened apical portion. The test of this species is formed in two periods: the early stage is typical rotaliid manner coiled trochospirally, adult period chambers arranged in miogypsinid pattern. The diameter of the test measured along the apical-frontal line (Amato and Drooger, 1969) ranges from 0.5 to 1.3 mm. The diameter and height in rotallid period are 0.6-1.08 mm and 0.5-0.7 mm, respectively. The embryonic apparatus positioned at the apex of the fan, consisting of spheric protoconch (0,1 mm - 0,2 mm in diameter) and hemispherical deutroconch (0,20 mm - 0,28 mm in diameter), that are followed by 8-10 spiral chambers of the early stage (plate 8, figures 1, 2). The miogypsinid chambers in the adult stage are smaller in comparison with the spiral chambers.

Stratigraphical range: Late Chattian in Edilme and Karamağara measured section.

Miogypsinella borodinensis Tan, 1936

(Plate 8, Figures 4, 5)

1936 *Miogypsinoides* (*Miogypsinoides*) *complanata* (Schlumberger) forma *bantamensis* Tan Sin Hok, plate 1, figure 13.

1940 *Miogypsinoides borodinensis* Hanzawa, p.755-802, plate 39, figures1-9; s.767, figures 2.

1940 *Miogypsinoides bantamensis* Tan, Hanzawa, plate 39, figures 15-19.

1951 *Miogypsinoides bermudezi* Drooger, p. 357-365, figures 4-6; p.358, figures 1a-c, 2a-c, 3a-b.

2007 *Miogypsinoides bantamensis* Tan, Bassi et al., plate 2, figures 18, 19.

2011 *Miogypsinella borodinensis* Hanzawa, Sirel and Gedik, p. 591-603, plate 2, figures 6-8.

Description: The equatorial (plate 8, figure 5) and axial sections (plate 8, figure 4) show that the general shape of the test is fan-like with rather thickened apical portion. The early stage is typical rotaliid manner coiled trochospirally, adult period chambers arranged in miogypsinid pattern. The diameter of the test is ranges from 1,06 mm to 1,63 mm. The diameter and height of the rotaliid stage are 0,6 - 0,8 mm and 0,6 - 0,9 mm respectively. The embryonic apparatus positioned at the apex of the fan, consisting of spheric protoconch (0,1 mm-0,2 mm in diameter) and hemispherical deutroconch (0,15 mm-0,18 mm in diameter), that are followed by 12-14

spiral chambers of the early stage (plate 8, figure 5). The miogypsinid chambers in the adult stage are smaller in comparison with the spiral chambers.

Stratigraphical range: Late Chattian in Edilme and Karamağara measured section.

Miogypsinella cf. *complanata* (Schlumberger, 1900)

(Plate 9, Figures 4, 5)

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

1937 *Miogypsina* (*Miogypsinoides*) *complanata* (Schlumberger), Barker and Grimsdale, p. 161-178, plate 5, figures 6; plate 6, figures 1-6; plate 7, figures 1; plate 8, figures 6.

1957 *Miogypsinoides complanatus* (Schlumberger), Cole, p. 318, 319, plate 25, figures 1, 2.

2003 *Miogypsinoides complanatus* (Schlumberger), Sirel, p. 301, plate15, figures 1-16.

2011 *Miogypsinella* cf. *complanata* (Schlumberger), Sirel and Gedik, p. 591-603, plate 3, figures 1-3.

Description: Though several samples were prepared, no equatorial sections were obtained therefore; the description was made based only on axial sections. Chambers were arranged in typical rotaliid order in early stage and in miogypsinid model in adult stage. The diameter and thickness were measured as between 1.60-2.01 mm and as 0.59 mm, respectively. The diameter and height in rotaliid stage are 0.63-0.83 mm and 0.45-0.61 mm, respectively. The diameter of the spherical shaped first chamber varies between 0.15-0.21 mm. Embryonic chambers in early stage are followed by minimum 16 spiral chambers. However, this feature was not figured out in this study as it did not have any equatorial section. It was seen that miogypsinid chambers in adult stage were bigger and closer to each other when compared with spiral chambers.

Stratigraphical range: Late Chattian in Edilme measured section.

Genus: *Postmiogypsinella* Sirel and Gedik, 2011

Type Species: *Postmiogypsinella intermedia* Sirel and Gedik, 2011

Postmiogypsinella intermedia Sirel and Gedik, 2011

(Plate 8, Figures 6-10)

2011 *Postmiogypsinella intermedia* n.gen., n. sp., Sirel and Gedik, p. 591-603, plate 1, figures 1-12.

Description: Test is fan-like, small sized and hyaline calcareous. The diameter of the test measured along the apical-frontal line (Amato and Drooger, 1969) and ranges from 0.7 to 1.18 mm. Diameter and height in rotaliid stage range between 0.4-0.5 mm and 0.3-0.5 mm, respectively. The first chamber is spherical and surrounded by a thick wall. Its diameter was measured as 0.06-0.1 mm. The second chamber is hemispherical and has a diameter of 0.1 mm. There are around 10-11 spiral chambers of rotaliid period after the first chamber. Later chambers are ordered in the form of miogypsinid model, and are in arch shaped. Approximately, pent serial of chambers arranged in miogypsinid order is observed.

Stratigraphical range: Late Chattian in Karamağara measured section.

Genus: *Miogypsina* Sacco, 1893

Type Species: *Nummulites globulina* Michelotti, 1841

Miogypsina globulina (Michelotti, 1841)

(Plate 10, Figures 1-7)

1841 *Nummulites globulina* Michelotti, p. 297, plate 3, figure 6.

1952 *Miogypsina irregularis* (Michelotti) in Drooger, p. 54, plate 2, figures 25-29.

1959 *Miogypsina globulina* (Michelotti) in Drooger and Socin, plate 1, figure 5.

1974 *Miogypsina* (*Miogypsina*) *globulina* (Michelotti) in Raju, p. 82-83, plate 2, figures 1-4; plate 5, figures 6, 7; plate 6, figure 1.

2009 *Miogypsina globulina* (Michelotti), Özcan and Less, p. 33, plate 1, figures 24-25; plate 2, figure 6.

Description: Test is in the form of enlarging fan and there are radiating pillars on either side. Traces of these pillars are observed as granules at the upper surface. Granules are clearly observed in equatorial and axial sections (plate 10, figures 1, 3, 5, 6, 7). The diameter of the test measured along apical-frontal line and ranges from 0.35 to 2 mm (Amato and Drooger, 1969), and the width is around 0.3-0.6 mm. Chambers were arranged in short spiral order in early stage and as miogypsinid model in adult stage. Embryonic

chambers are located at top of the test, and are made up of spherical first chamber and hemispherical second chamber. Diameters of the first and second chambers were measured as 0.06-0.33 mm and 0.1-0.26 mm, respectively. Chambers in miogypsinid pattern in equatorial sections were observed in spatula shape.

Stratigraphical range: Burdigalian in Karamağara and Kuzkaya measured section.

Miogypsina polymorpha (Rutten, 1912)

(Plate 11, Figures 1-4)

1912 *Miogypsina polymorpha* Rutten, p. 201-217, plate 12, figures 6-9.

Description: Test is typical with its variable shapes. The upper part is generally thick in axial sections and thins out towards frontal region. The test with this structure exhibits an appearance of resembling to frog larva. The diameter of the test measured along apical-frontal line (Amato and Drooger, 1969). Diameter and thickness range between 1.3-4.3 mm and 0.4-1 mm, respectively. The first chamber is spherical and located at a point close to the top part of test. Its diameter is 0.1-0.2 mm. Pre-embryonic chambers which follow the first chamber are variable in size and different shapes, though spherical in general (plate 11, figures 1, 3, 4). Equatorial chambers are typical and polygonal (Rutten 1912, plate 11, figure 4). Granules are observed on both sides of test though not very clear.

Stratigraphical range: Burdigalian in Karamağara and Kuzkaya measured section.

Miogypsina cf. *thecideaeformis* (Rutten, 1912)

(Plate 9, Figures 1, 2)

1912 *Miogypsina thecideaeformis* Rutten, p. 201-217, plate 12, figures 1, 4-5.

Description: The test is inflated lenticular. Embryonic chambers are generally located at top of the symmetrical test, and equatorial chamber divides the test into two equal parts. The first chamber is spherical and has a diameter of 0.16 mm. The second chamber is hemispherical and is almost as big as the first chamber. Equatorial chambers are arranged as decreasing in size starting from one pole of the test to the other pole. Lateral chambers which are observed on both sides of test are in different shapes, though rectangular in general. Lateral chamber series were separated by pillars.

Stratigraphical range: Burdigalian in Karamağara measured section.

Family: Rotaliidae Ehrenberg, 1839

Genus: *Neorotalia* Bermudez, 1952

Type Species: *Rotalia mexicana* Nuttall, 1928

Neorotalia lithothamnica Uhlig, 1886

(Plate 12, Figures 1-8)

1886 *Rotalia lithothamnica* Uhlig, Bd. 36, p. 195.

1991 *Pararotalia lithothamnica* (Uhlig), Cahuzac and Poignant, p. 69-78, plate 2, figures 1-6, 9, 10.

1998 *a, b Neorotalia lithothamnica* (Uhlig), Cahuzac and Poignant, p. 155-169.

2003 *Neorotalia lithothamnica* Uhlig, Sirel, p. 304, plate 8, figures 1-5.

Description: The test is small, plano-convex to biconvex; occasionally the ventral side is more convex than dorsal side. The diameter of the test ranges from 1.16 to 2.06 mm and the thickness from 0.5 to1.3 mm. The edge of test is sharp and last 4-5 chambers have short spines (plate 12, figures 1, 4, 6). The sutures are radiate but depressed on the ventral side. The ornamentation is distinct on the umbilical edge side when compared the spiral side (plate 12, figures 2, 3). The large solid umbilical plug is observed at the center of the ventral side.

Stratigraphical range: Rupelian-Early Chattian in Develi and Edilme measured section.

Family: Nummulitidae de Blainville, 1827

Genus: *Spiroclypeus* Douvillé, 1905

Type Species: *Spiroclypeus orbitoideus* Douvillé, 1905

Spiroclypeus vermicularis Tan, 1937

(Plate 13, Figures 1, 2, 5)

1937 *Spiroclypeus vermicularis* Tan, p. 187, plate 1, figures 7, 8; plate 4, figures 15, 16.

Description: Description was based on megalospheric forms. The central part of the test is inflated lenticular structure which thins out towards sides. Thickness is 1 mm at the center and 0.4 mm on edges. The diameter of the test ranges from 2.4 to 3.06 mm. The first chamber is spherical and has a diameter of 0.33 mm. Semicircular chambers starting

from the first chamber towards last whorl almost fill out spiral interval which gradually thickens. These chambers are divided into several chamberlets in rectangle/rectangle like shapes. There are few pillars which spread out from first chamber.

Stratigraphical range: Late Chattian in Develi measured section.

Spiroclypeus sp.

(Plate 13, Figures 3, 4, 6, 7)

Description: Description was made on equatorial section belonging to only one megalospheric form. The test is lenticular and has a diameter of 1.9 mm. The first chamber is large and spherical (its diameter is 0.2 mm). Semicircular chambers starting from the first chamber towards last whorl almost fill out spir interval which gradually thickens. These chambers were divided into several chamberlets in rectangle/rectangle like shapes. Chamberlets in early stage are small rectangular but in adult stage they become rectangles of which its height is larger than width.

Stratigraphical range: Late Chattian in Develi measured section.

Genus: *Heterostegina* d'Orbigny, 1826

Type Species: *Heterostegina depressa* d'Orbigny, 1826

Heterostegina assilinoides Blanckenhorn, 1890 emend. Henson, 1937

(Plate 13, Figures 8-10, 12-15)

1890 *Heterostegina assilinoides* n. sp., Blanckenhorn, p. 342, plate 17, figure 5.

1937 *Heterostegina assilinoides* Blanckenhorn emend. Henson, p. 48. plate 4, figures 1 - 5; plate 6, figure 2.

1966 *Grzybowskia assilinoides* (Blanckenhorn), Butt, p. 93 - 94, plate 8, figures 24 - 26.

1977 *Heterostegina assilinoides* Blanckenhorn emend. Henson, Hottinger, figure 47 A-B.

1991 *Heterostegina assilinoides* Blanckenhorn emend. Henson, Less, p. 443, plate 4, figures 4 - 5; plate 5, figures 1 - 2.

Description: The description was made based on megalospheric generations. Test is thin and small. The diameter of the test ranges from 2.5 to 3.6 mm. The test surface is shaped with dense granulation (plate 13, figures 10, 14, 15). Mesh network is not observed at the surface. Equatorial section of the megalospheric form possesses first and second chambers which are medium sized, semi isolepidin in shape (plate 13, figure 12). Septa are dense, high and curved. Secondary septa are mainly observed after 2-4 operculine chambers and reaches until chamber wall. Equatorial section belonging to microspherical form was not observed.

Stratigraphical range: Rupelian-Early Chattian in Edilme measured section.

Genus: *Nummulites* Lamarck, 1851

Type Species: *Camerina laevigata* Bruguiere, 1792

Nummulites cf. *vascus* (Joly and Leymerie, 1848)

(Plate 13, Figures 16-19)

1848 *Nummulites vasca* Joly and Leymerie, p. 38, 67; plate 1, figures 15-17; plate 2, figure 7.

1883 *Nummulites boucheri* de la Harpe, p. 137-156; plate 1, figures 2a, 5a, 6a, 8-10.

1937 *Nummulites boucheri* de la Harpe, Silvestri, p. 45- 264, plate 5, figures 1- 6; plate 2, figures 1, 2; plate 12, figures 1, 5; plate 15, figures 5, 6.

1952 *Nummulites vascus* Joly and Leymerie, Grimsdale, p. 224, plate3.

1961 *Nummulites vascus* Joly and Leymerie, Montanari, p. 570- 579, plate 1, figures 1, 2a-2c.

1962 *Nummulites vascus* Joly and Leymerie, Eames et al., plate 1, figures A.

1975 *Nummulites vascus* Joly and Leymerie, Sirel et al., plate 2, figures 1-3, 5-8.

1981 *Nummulites vascus* Joly and Leymerie, Schaub, p. 123, plate 53, figures 1-6.

2003 *Nummulites vascus* Joly and Leymerie, Sirel, p. 292, plate 2, figures 4, 5.

2008 *Nummulites vascus* Joly and Leymerie, Gedik, p. 36, plate 1, figures 17; plate 2, figures 1-5.

Description: Description was made on axial sections of only megalospheric forms. Test is inflated lenticular with a diameter of 1.5-2.2 mm and a thickness of 0.6-0.7 mm. The first chamber is small,

spherical; however its diameters could not be measured. Spir is rather thick and septa are slightly curved and arranged in order (plate 13, figure 17).

Stratigraphical Range: Rupelian-Early Chattian in Edilme measured section.

3. Results

In the study area, measurements of four stratigraphic sections were made which cover Oligo-Miocene successions, and systematically 182 hard rock samples were taken in these sections. As a result of paleontological studies, 28 taxa belonging to families of Soritidae, Planorbulinidae, Peneroplidae, Austrotrillinidae, Alveolinidae, Lepidocyclinidae, Miogypsinidae and Nummulitidae were described.

Oligo-Miocene transition in the region was observed based on biostratigraphical locations of benthic foraminiferal taxa which were described in Develi, Edilme, Kuzkaya and Karamağara measured stratigraphical sections. Marine units ranging from Oligocene to Miocene which were correlated lithostratigraphically and biostratigraphically exhibit a characteristic of continuous succession in these sections. Paleontological findings do also support this observation.

Stratigraphically; the marls between Chattian and Burdigalian units in the region constitute rich planktik foraminifera and nannoplankton assemblages. The indicative planktonic foraminiferal species *G. dehiscens* which were described in Develi and Karamağara measured sections occurs with *S. delphix*. Besides, marls stratigraphically occur in Late Chattian-Burdigalian shallow marine carbonates which were described in the succession. All these facts point out that the age of these marls with different lithology is most probably Aquitanian.

Cosmopolite species *M. globulina* is observed in Burdigalian shallow marine carbonates in Kuzkaya and Karamağara measured sections, and is described over large geographic regions ranging from Central America to Indo-Pacific and West (Mediterranean) Tethys. The co-occurrence of this species with *M. polymorpha* which is seen in stratigraphical records (only from Indo-Pacific) highly support the assumption of a probable marine connection between Indo-Pacific and Mediterranean Tethys in Burdigalian time in the region (Harzhauser et al., 2002; Reuter et al., 2009, Qom formation, Iran).

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PLATES

PLATE - 1

Figures 1-15: *Archaias kirkukensis* Henson

Rupelian-Early Chattian, Develi measured stratigraphical section, W Malatya, Eastern Turkey, (figure 1 not included) X20.

1: Views of *Archaias kirkukensis* Henson in different plans and Miliolidae, (FGD-2A/5/1).

2: Subaxial section and Miliolidae, (FGD-2A/9/1).

3: Equatorial section, A form, (FGD-2A/11/1).

4: Axial section, A form, (FGD-2B/12/7).

5: Section crossing margin chord (aperture surface), (FGD-2A/10/4).

6: Equatorial section, A form, (FGD-2A/7/2).

7: Equatorial section, A form, (FGD-2A/11/4).

8: Section passing through margin chord (aperture surface), (FGD-2A/3/10).

9: Axial section, A form, (FGD-2A/11/2).

10: Axial section, A form, subaxial section and Miliolidae (FGD-2A/9/9).

11: Subaxial section, (FGD-2A/3/2).

12: Slightly oblique equatorial section, (FGD-2A/11/3).

13: Equatorial section, A form, (FGD-2B/5/2).

14: Axial section, A form, (FGD-2A/4/5).

15: Axial section (left), subaxial section (right), A form, (FGD-2A/3/3).

PLATE- 1

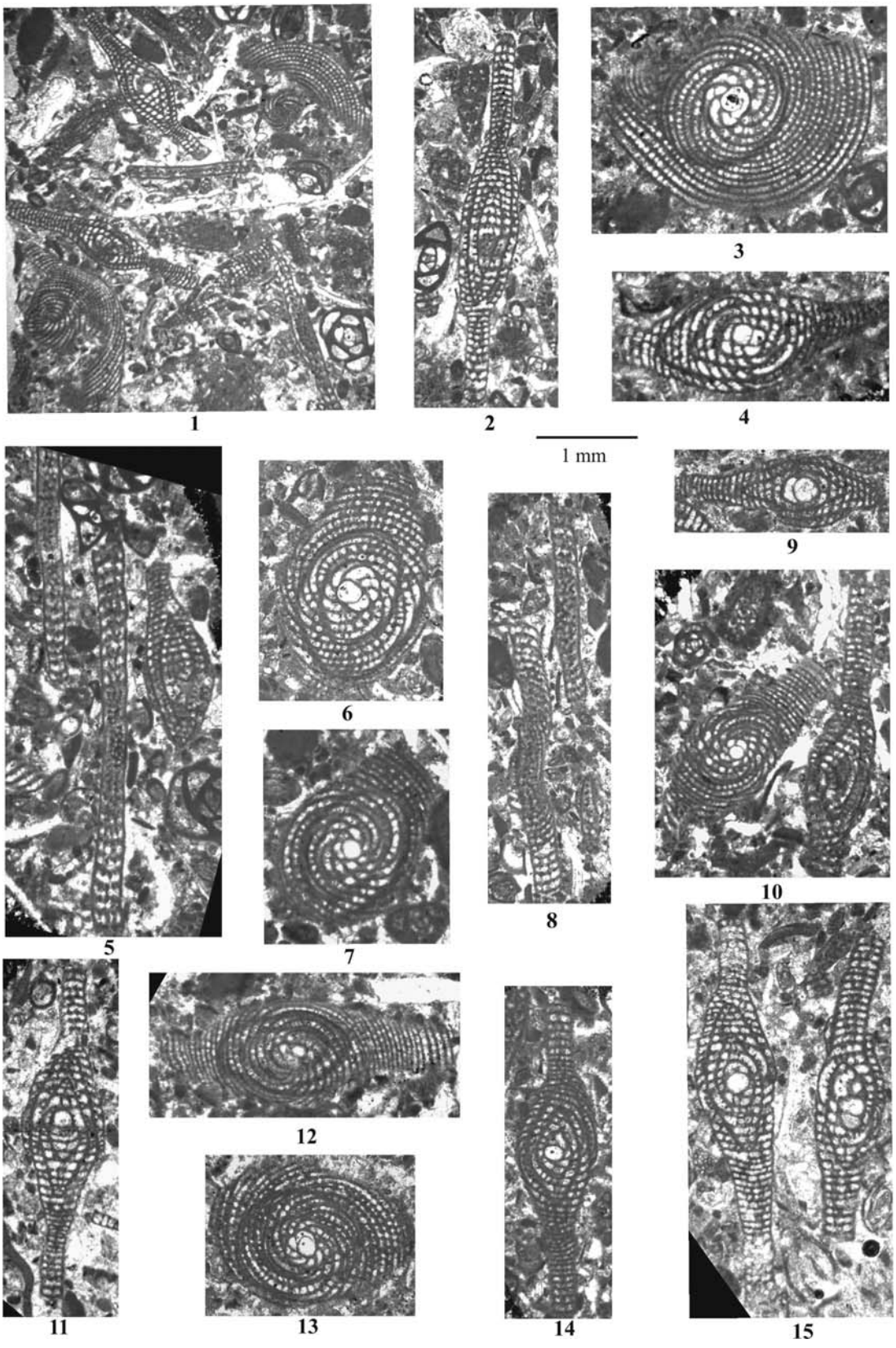

PLATE - 2

Figure 1-6: *Archaias hensoni* Smout and Eames

Rupelian-Early Chattian, Karamağara measured stratigraphical section, NE Akçadağ, W Malatya, Eastern Turkey, X 20.

1, 6: Axial section, A form, (HYM-38/1, HYM-38/2).

2, 3: Subaxial section, (HYM-36A/3/3, HYM-36A/4).

4, 5: Equatorial section, A form, (HYM-36B/8/1, HYM-38/2/1).

Figure 7-9: *Penarchaias glynnjonesi* (Henson)

Rupelian-Early Chattian, Karamağara measured stratigraphical section, NE Akçadağ, W Malatya, Eastern Turkey, X40.

7, 9: Axial section, A form, planispiral chambers following the first chamber and chambers of the uniserial stage are observed, (HYM-36A/3, HYM-36A).

8: Axial section, A form, following the first chamber planispiral chambers are observed, (HYM-36A).

Figures 10-22: *Planorbulina brönnimanni* Bignot and Decrouez.

Oligocene, Develi, Karamağara and Edilme measured stratigraphical sections, W Malatya, Eastern Turkey, X35.

10, 12, 14: Tangential section, (MA-91, MA-89, MA-92, FGM-4A/1).

11: Subaxial section, (MA-90).

13, 15, 19-21: Transverse section, (MA-90, MA-69, FGM-4G/1, FGM-4A/3, FGM-16/2).

16: Equatorial section, only planispiral chambers following the first chamber were observed, (HYM-36A/6/1).

17, 18, 22: Subaxial section, (FGM-2/1, FGM-4G/3, FGM-12D/1).

Figures 23-30: *Neoplanorbulinella* spp.

Rupelian-Early Chattian, Karamağara measured stratigraphical section, NE Akçadağ, W Malatya, Eastern Turkey, X72.

23: Axial section, A form, (HYM-36A/11/1).

24: Axial section, A form, following the first chamber equatorial chambers and lateral chambers in umbilical pores are observed, (HYM-36A/3/2).

25: Axial section, B form, (HYM-36A/4/1).

26: Axial section, A form, equatorial chambers and lateral chambers in umbilical pores following the small, spheroidal first chamber are observed, (HYM-36A/8/1).

27: Axial section, (HYM-36A).

28: Axial section, A form, following the first chamber equatorial chambers and lateral chambers in umbilical pores are observed, (HYM-36A/5/2).

29: Axial section, (HYM-36A/10/4).

30: Axial section, B form, (HYM-36A/2/1).

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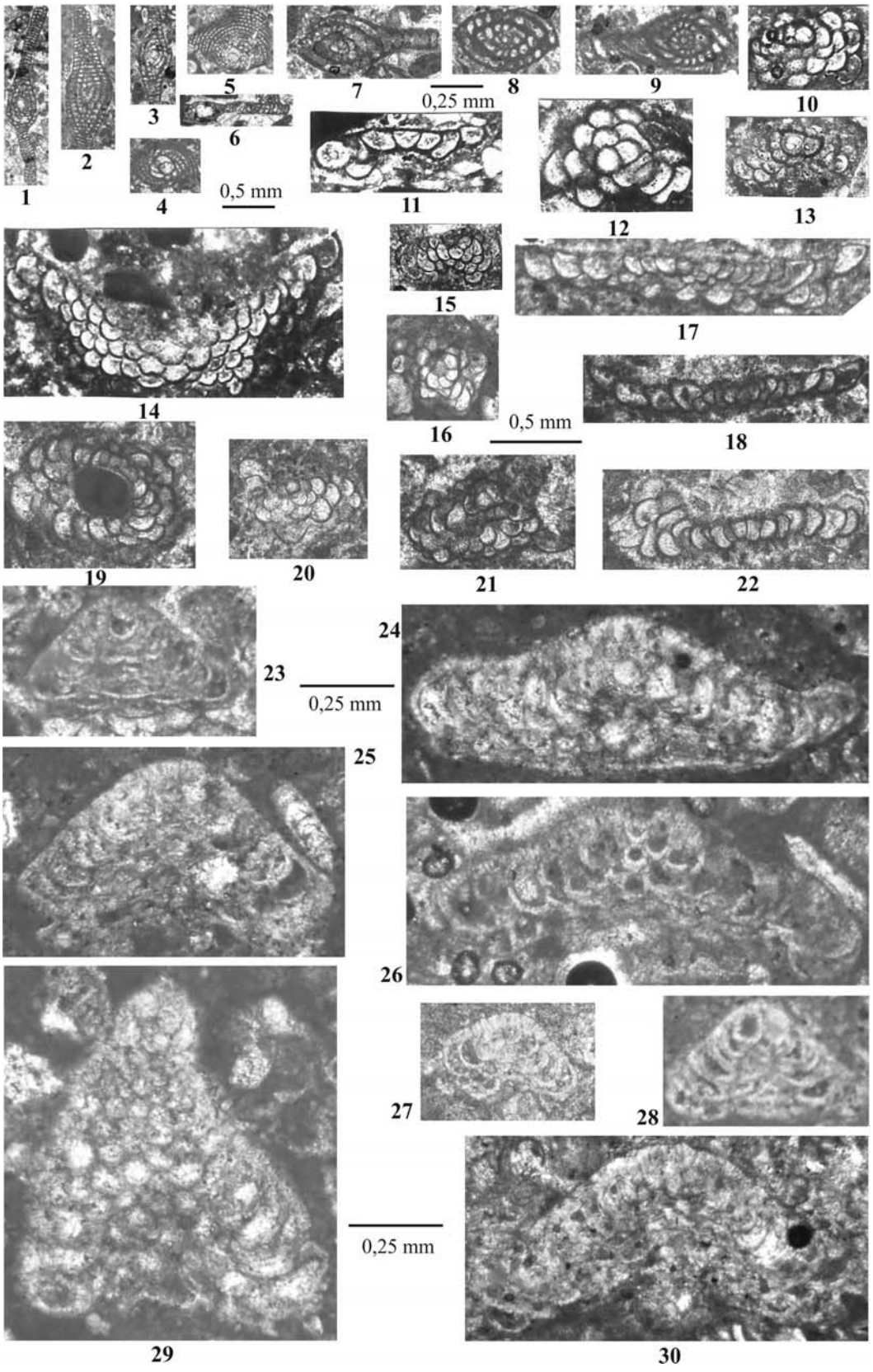
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PLATE - 3

Figures 2, 3: *Peneroplis* cf. *laevigatus* d'Orbigny

Rupelian-Early Chattian, Develi measured stratigraphical section, W Malatya, Eastern Turkey, X20.

Equatorial section, (FGD-2A, FGD-2B).

Figure 1: *Archaias kirkukensis* (A), *Peneroplis* sp. (P), *Nephrolepidina* sp., limestones with (N), X26, (FGD-2A).

Figure 4: *Peneroplis* sp.

Equatorial section, X 20, (FGD-2B).

Figures 5, 12-16, 18-22: *Austrotrillina brunni* Marie

Rupelian-Early Chattian, Develi and Karamağara measured stratigraphical sections, W Malatya, Eastern Turkey, X36.

Figures 5, 22: Late Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X36.

5: Equatorial section, (FGM-29/7/2).

22: Off centered equatorial section, (FGM-29/6/1).

12: Tangential section, (FGM-3/2/1).

13, 14, 15,19, 20: Equatorial section, (FGD-2A/9/7, FGD-2B/7/1, FGD-2B/13/3, HYM-35/1/1, FGD-2B/12/1).

16, 18: Sub equatorial section, (HYM-36A/10/1, HYM-36A/3/1).

21: Equatorial section, A form, (HYM-36A/1).

Figures 6, 7: Agglutinated Miliolid forms, X30, (FGD-6, FGD-7).

Figures 8-10: *Borelis merici* Sirel.

Rupelian-Early Chattian, Karamağara measured stratigraphical section, W Malatya, Eastern Turkey, X60.

8: Axial section, young specimen, (HYM-36B/2).

9: Noncentered equatorial section, only the chamber front of the *Borelis* genus indicates the presence of canal system (HYM-36A/2/2).

10: Off centered axial section, (HYM-36A/5/4).

Figure 11: *Borelis pygmaea* Hanzawa

Rupelian- Early Chattian, Karamağara measured stratigraphical section, W Malatya, Eastern Turkey, X60.

Axial section, A form, (HYM-36A/1/1).

Figures 17, 23, 24: *Austrotrillina howchini* (Schlumberger)

Burdigalian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X36.

17: Tangential section showing subepidermal thick alveolarine structure, (FGM-52/1).

23: Tangential section, (FGM-52/2).

24: Noncentered equatorial section, (FGM-52/2).

Figure 25: *Austrotrillina asmariensis* Adams

Late Chattian, Edilme measured stratigraphical section, W Malatya, eastern Turkey, X36.

Equatorial section, (FGM-29/1/6).

PLATE - 3

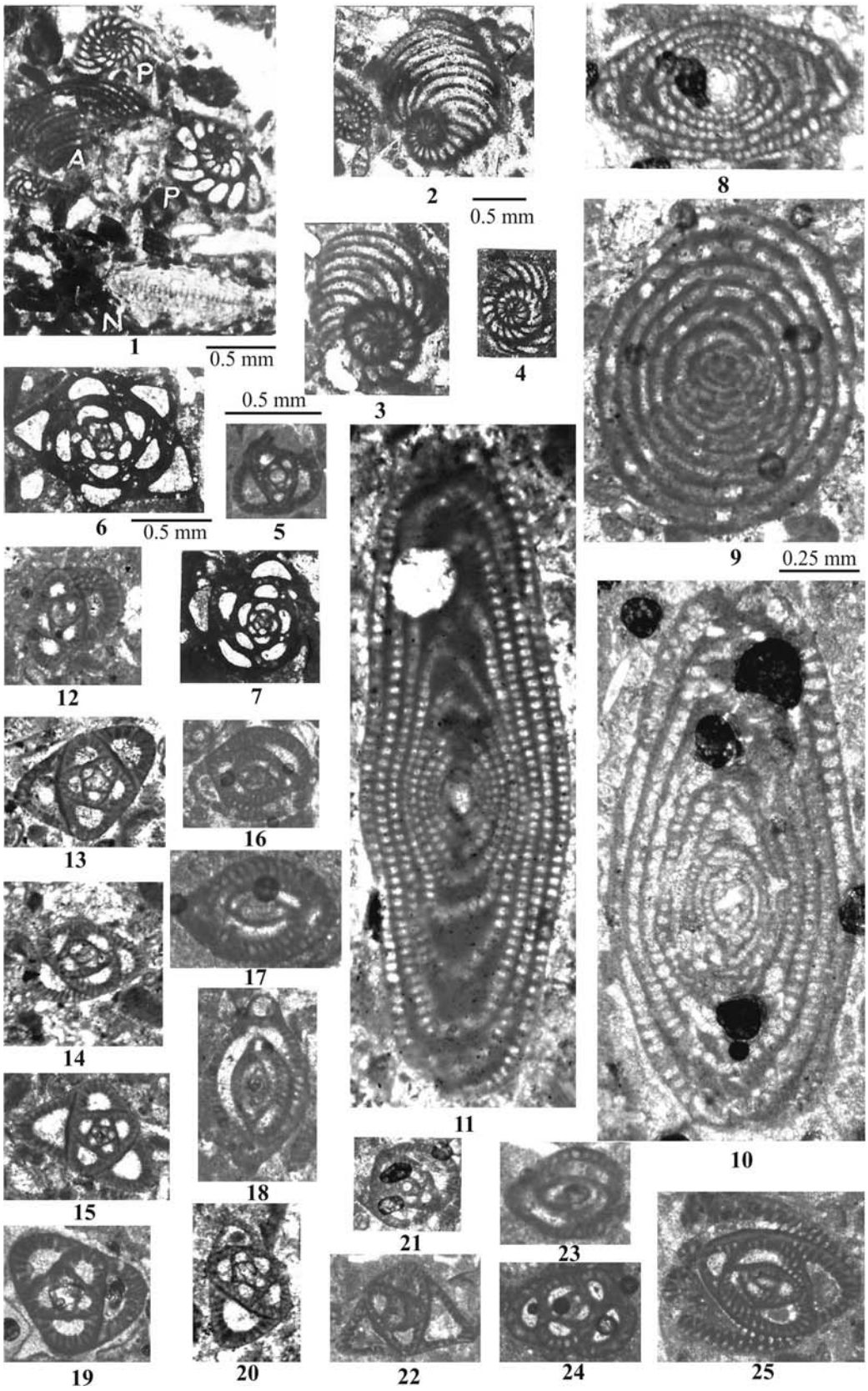
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PLATE - 4

Figures 1-13: *Austrotrillina asmariensis* Adams

Rupelian-Early Chattian, Develi measured stratigraphical section, W Malatya, Eastern Turkey, X36.

1: Equatorial section, B form (FGD-2A/7/1).

2: Tangential section, (FGD-2A/10/6).

3: Equatorial section, A form, (FGD-2B/1/1).

4: Slightly transversal equatorial section, A form, (FGD-2A/1/1).

5: Subequatorial section, A form, (FGD-2A/7/6).

6: Equatorial section, A form, (FGD-2A/11/5).

7: Slightly transversal equatorial section, (FGD-2A/3/13).

8: Equatorial section, A form,(FGD-2A/6/6).

9: Tangential sections, (FGD-2B/5/4).

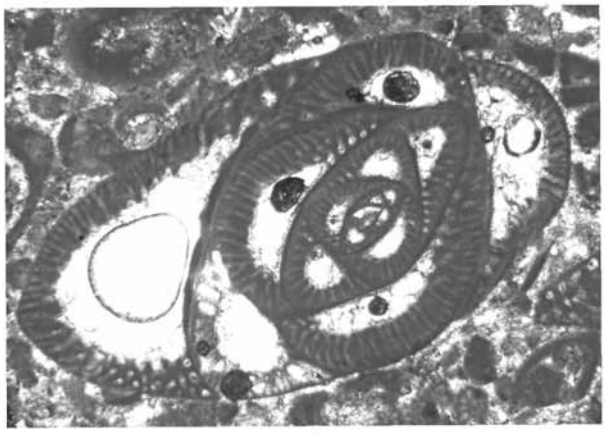
10: Equatorial section, A form, (FGD-2A/3/12).

11: Subequatorial section, (FGD-2A/7/7).

12: Equatorial section, A form, (FGD-2A/3/8).

13: Slightly transversal equatorial section, (FGD-2B/8/2).

PLATE - 4



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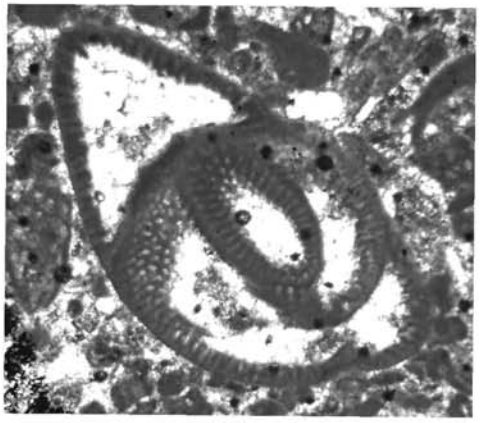

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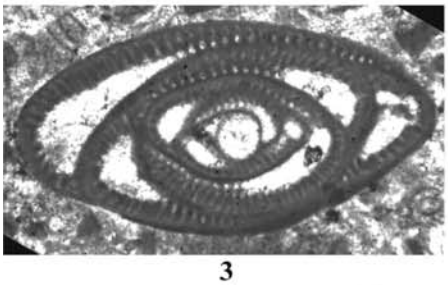

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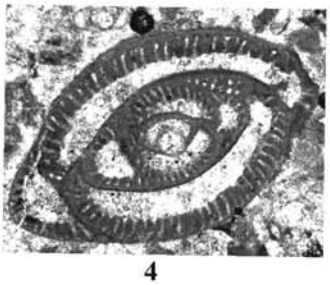

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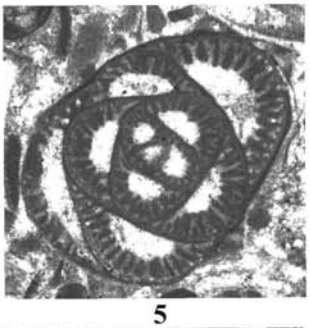

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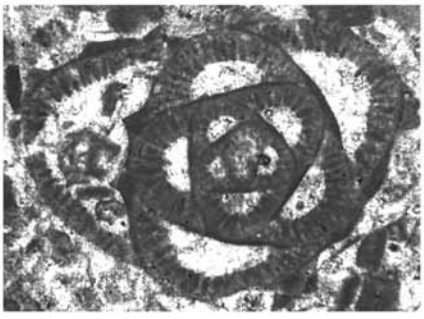

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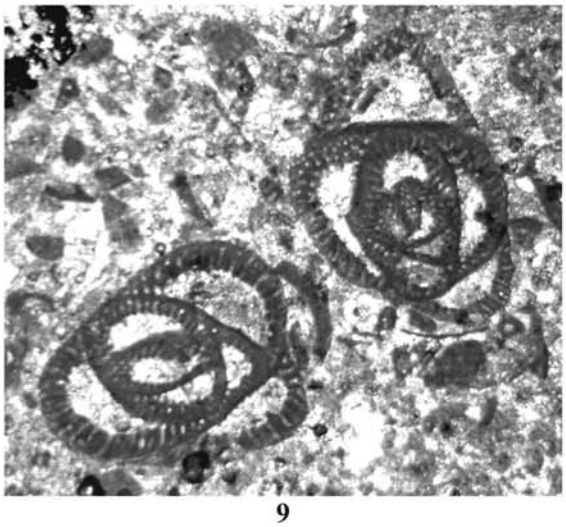

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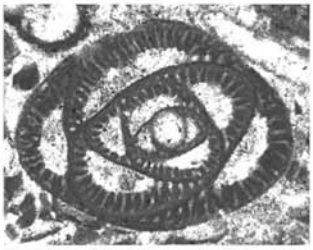

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PLATE - 5

Figures 1-28: *Borelis curdica* (Reichel)

Burdigalian, Develi and Edilme measured stratigraphical sections, W Malatya, Eastern Turkey, X 40.

1: Equatorial section, (FGD-11/7/1).

2: Axial section, young individual, (FGD-11/5/2).

3: Highly transversal axial section, young specimen, (FGD-11/6/4).

4: Axial section, (FGD-11/6/1).

5: Axial section showing especially the mouth opening in the last whorl, adult individual, (FGD-13B/1/1).

6: Transversal axial section, young individual, (FGD-11/4/3).

7: Transversal axial section, young individual, (FGD-11/6/2).

8: Axial section, young individual, (FGD-11/5/8).

9: Transversal axial section, young specimen, (FGD-11/5/5).

10: Tangential section of which chambers are observed in central part, (FGD-11/5/7).

11: Partly tangential, partly equatorial section, (FGD-11/4/1).

12: Axial section, (FGD-11/5/4).

13: Tangential section, (FGD-11/7/2).

14: Equatorial section, (FGD-11/5/3).

15: Badly fossilized equatorial section, (FGD-13B/5/1).

16: Partly tangential partly axial section showing uniserial mouth aperture, (FGD-11/4/2).

17: Tilted axial section, (FGD-11/6/6).

18: Transversal equatorial section, (FGD-11/6/5).

19: Axial section, (FGD-19B/2/1).

20: Partly tangential partly axial section, young individual, (FGD-11/6/3).

21: Axial section, (FGD-13B/3/1).

22: Tangential section, young specimen, (FGD-11/5/6).

23: 26-28. Axial section, (FGM-40/2; FGM-53A/1; FGM-40A/1; FGM-43B/1).

24: Equatorial section, (FGM-40/3).

25: Transversal axial section, (FGM-50/1).

PLATE - 5

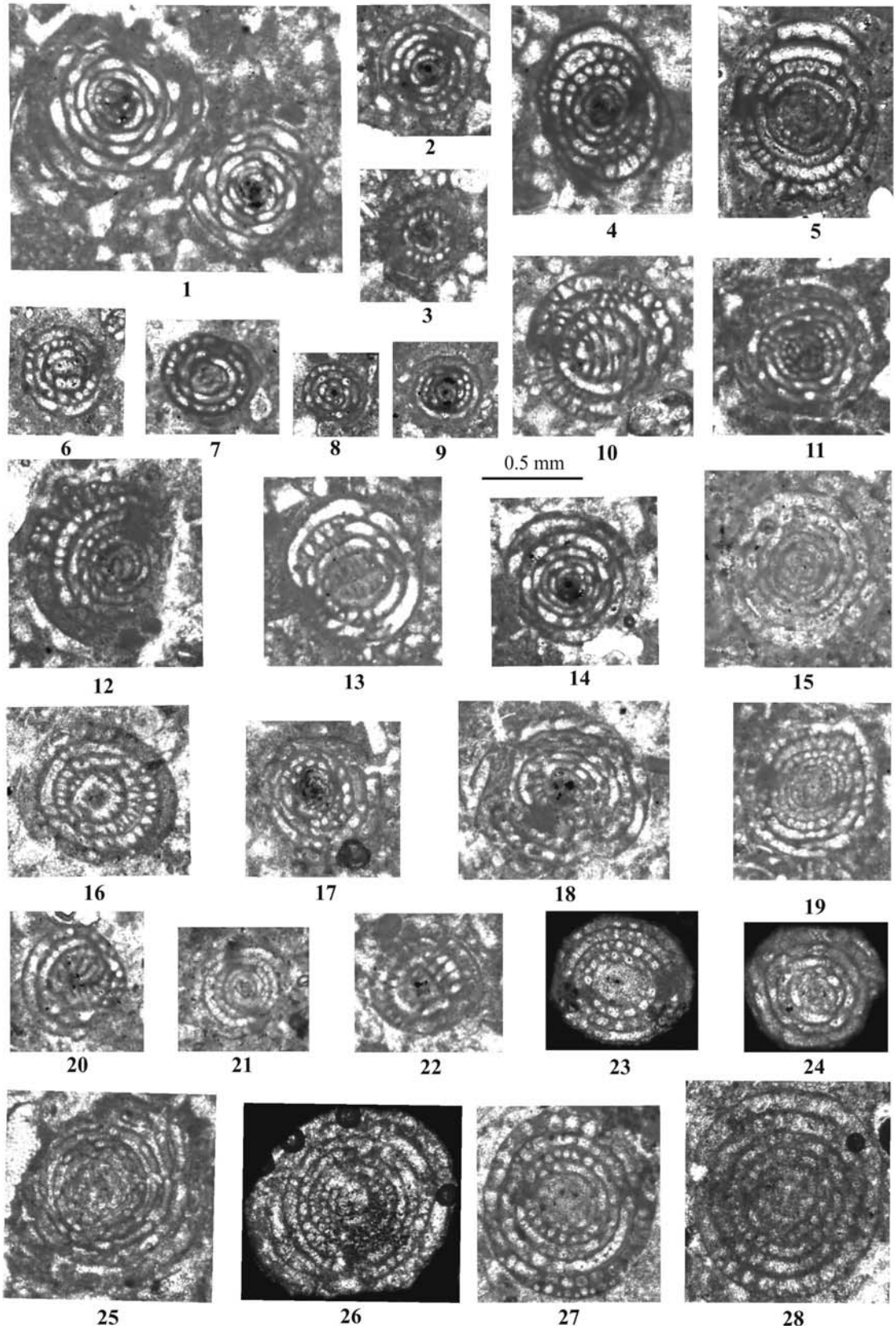
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PLATE - 6

Figures 1-7, 9, 10, 12-14: *Nephrolepidina praemarginata* Douvillé

Rupelian-Early Chattian, Edilme and Develi measured stratigraphical section, W Malatya, Eastern Turkey, all figures (figures 4, 10, 14 not included) X30, Figures 4, 10, X15, Figure 14 not scaled.

1: Equatorial section, (FGM-19/3).

2: Transversal equatorial section, (FGM-19/4/1).

3: Transversal equatorial section, (FGM-19/9).

4: Transversal equatorial section, (FGD-2B).

5: Equatorial section, (FGD-2B).

6, 7, 9, 10, 12: Axial section, (FGM-19/3/3, FGM-19/13/1, FGM-19/4/2, MA-88).

13: Transversal axial section, they are also observed from granular surface, (FGM-19/13/1).

14: *N. praemarginata*, *Neorotalia lithothamnica* and much algal limestones, (FGM-19).

Figures 8, 11: *Nephrolepidina* sp.

8: Transversal equatorial section, (FGM-19/13/4), 11. Transversal axial section, (FGM-19/3/2).

PLATE - 6

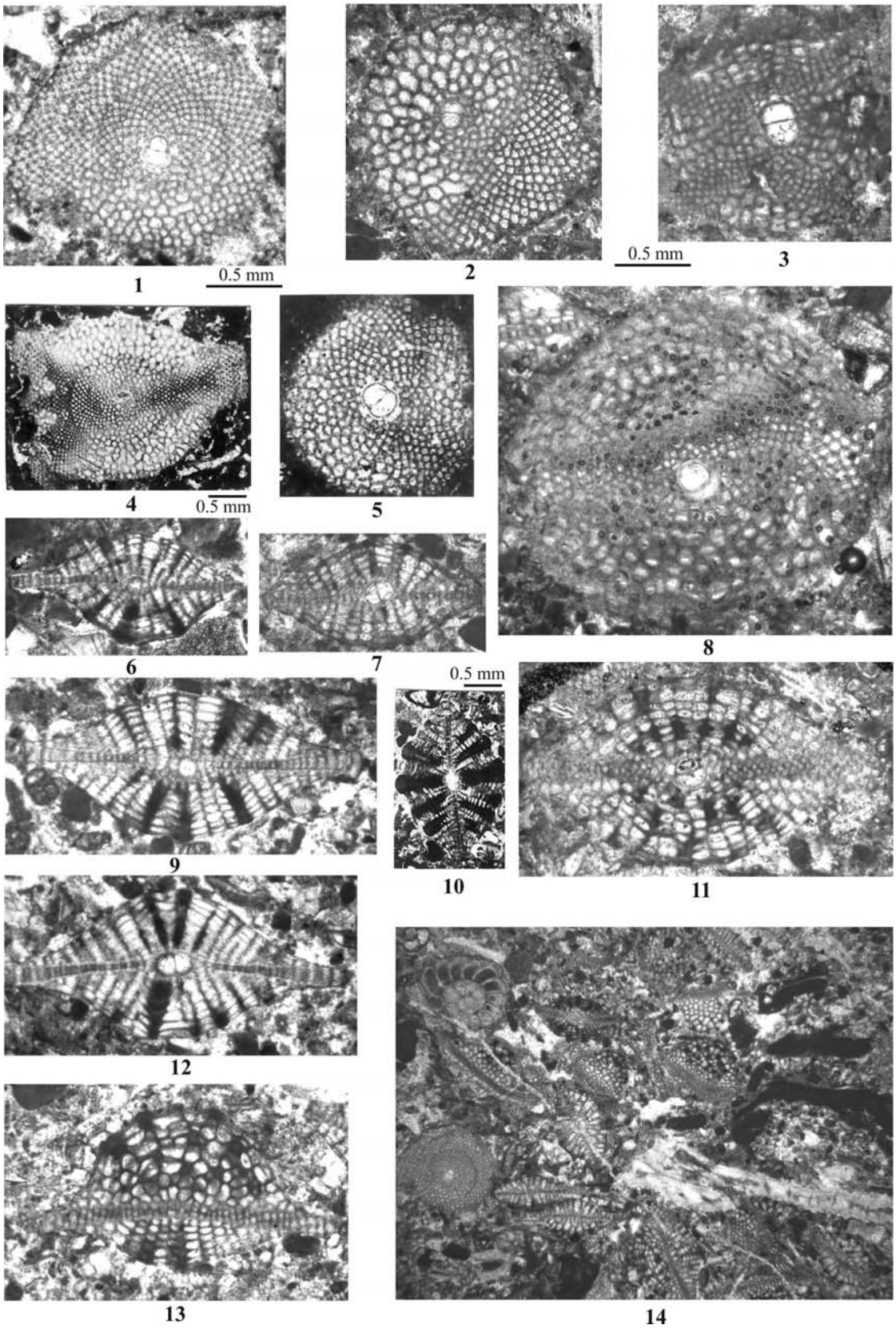


PLATE - 7

Figures 1-9: *Nephrolepidina partita* Douvillé

Rupelian-Early Chattian, Edilme and Develi measured stratigraphical sections, W Malatya, Eastern Turkey, X 30.

1-8: Axial section, large umbo at the center of shell is clearly observed, (FGD-3/1/1, FGM-5E/6/1, FGM-5E/2/2, FGM-19/24/4, FGM-19/15/2, FGM-19/14/2, FGM-13C/1, FGM-4G/2).

9: Equatorial section, small sphericalfirst chamber and semilunar shaped second chamber are observed, (FGM-19/27/4).

Figure 10: *Eulepidina* cf. *formosoides* Douvillé

Equatorial section, (FGM-19/11/1).

Figure 11: *Eulepidina* sp.

Axial section, (FGM-19/11/3).

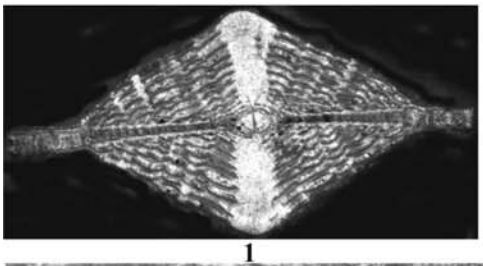
Figures 12, 13: *Nephrolepidina morgani* (Lemoine and Douvillé)

Late Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 30.

12: Axial section, (FGM-29/1/4).

13: Equatorial section, (FGM-29/7/5).

PLATE - 7



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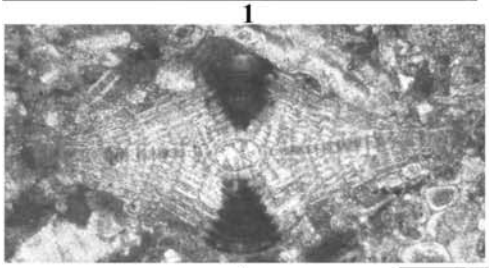

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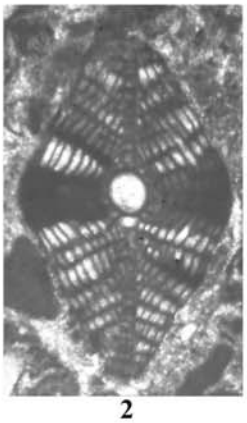

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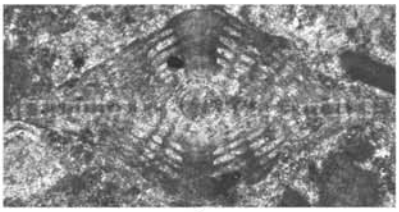

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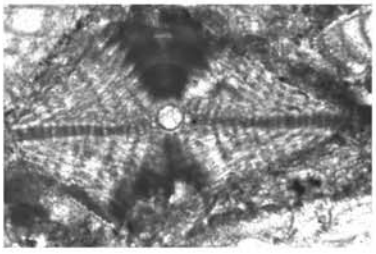

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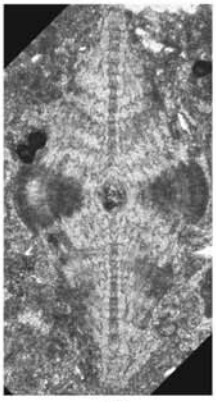

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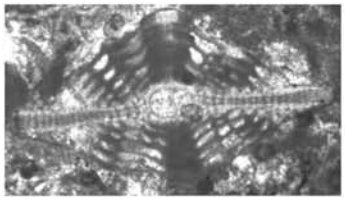

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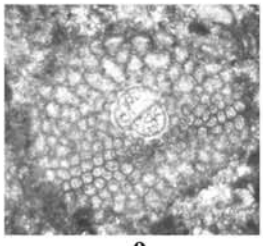

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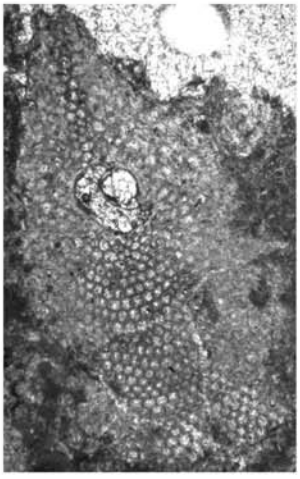

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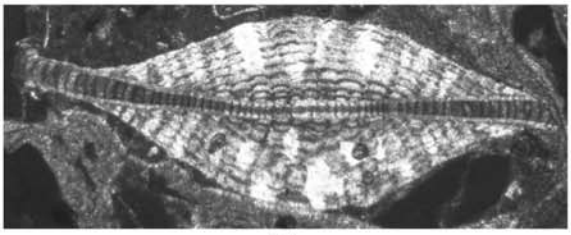

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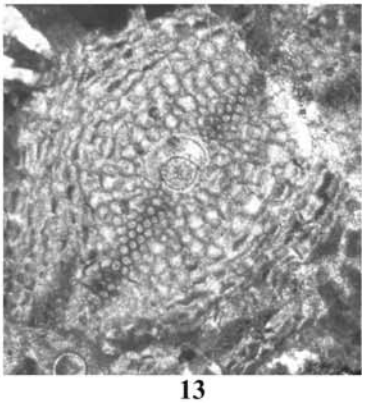

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PLATE - 8

Late Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 60.

Figures 1-3. *Miogypsinella akcadagensis* (Gedik and Sirel)

1: Equatorial section, (FGM-30A/12/1), embryonic chambers, spiral chambers in early stage and miogypsinid chambers are observed.

2: Equatorial section, (FGM-30A/3/1), embryonic chambers, spiral chambers in early stage and miogypsinid chambers are observed.

3: Centered axial section, (FGM-30A/5/2), chambers in rotaliid period and miogypsinid order are observed.

Figures 4, 5: *Miogypsinella borodinensis* Hanzawa

4: Axial section, (FGM-30A/11/1), chambers in rotallid order with coarse plug and miogypsinid order are observed.

5: Equatorial section, (FGM-30A/6/3), spherical shaped first chamber and semilunar shaped second chamber, 13 spiral and equatorial chambers are seen.

Figures 6-10: *Postmiogypsinella intermedia* Sirel and Gedik

Late Chattian, Karamağara and Edilme measured stratigraphical sections, W Malatya, Eastern Turkey, X 60.

Figure 6: Axial section, A form, (FGM-30A/9/3).

Figure 7: Subaxial section, A form, (FGM-30A/2/3).

Figure 8: Equatorial section, A form, spiral chambers in rotaliid period and the development of equatorial chamber in miogypsinid order are seen. (HYM-42/2/2).

Figure 9: Equatorial section, A form, (HYM-42/7/4).

Figure 10: Subaxial (right) and axial section (left), A form belonging to young specimens, (HYM-42/7/4).

PLATE - 8

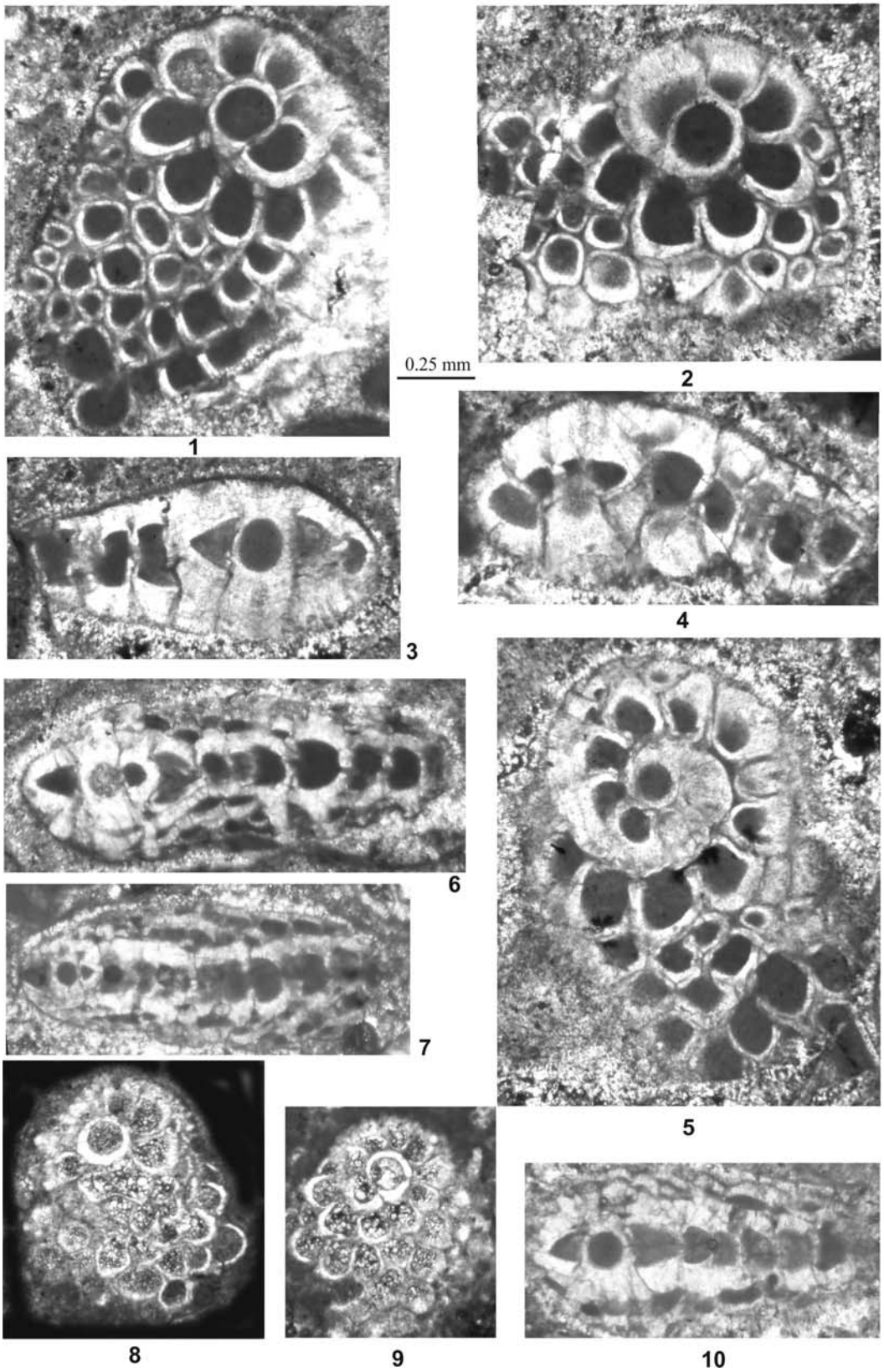


PLATE - 9

Burdigalian, Karamağara and Kuzkaya measured stratigraphical section, W Malatya, Eastern Turkey, X60.

Figures 1, 2: *Miogypsina* cf. *thecideaeformis* (Rutten)

Axial sections, (HYM-45B, HYM-47B), inflated lenticular shell, spherical first chamber located on top of shell and semi spherical second chamber, equatorial chambers following embryonic chambers degrading in size, rectangular lateral chambers on both sides of shell and internal pillars are observed.

Figure 3: Nephrolepidinid form, axial section, (HYM-45A/8/3).

Figures 4-5: *Miogypsinella* cf. *complanata* (Schlumberger)

Late Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 60.

Axial section, (FGM-30A/12/3, FGM-30B/2/2), equatorial chambers in rotaliid order where spherical first chamber takes place and miogypsinid orders are seen.

Figures 6-8: *Dendritina* cf. *rangi* d'Orbigny

Burdigalian, Develi and Edilme measured stratigraphical sections, W Malatya, Eastern Turkey, X 40.

6: Axial section, (FGM-40A).

7, 8: Equatorial section, A form, (FGD-11/6/7, FGD-11/5/1).

Figure 9: *Planorbulinella caneae* Freudenthal

Equatorial section, (HYM-46).

Figure 10: *Nephrolepidina* sp.

Axial section, (HYM-45A/6/2), lenticular shell, nephrolepidin type first and second chambers and following equatorial chambers, lateral chambers on both sides of the shell and granules which are the traces of pillars between lateral chambers.

PLATE - 9

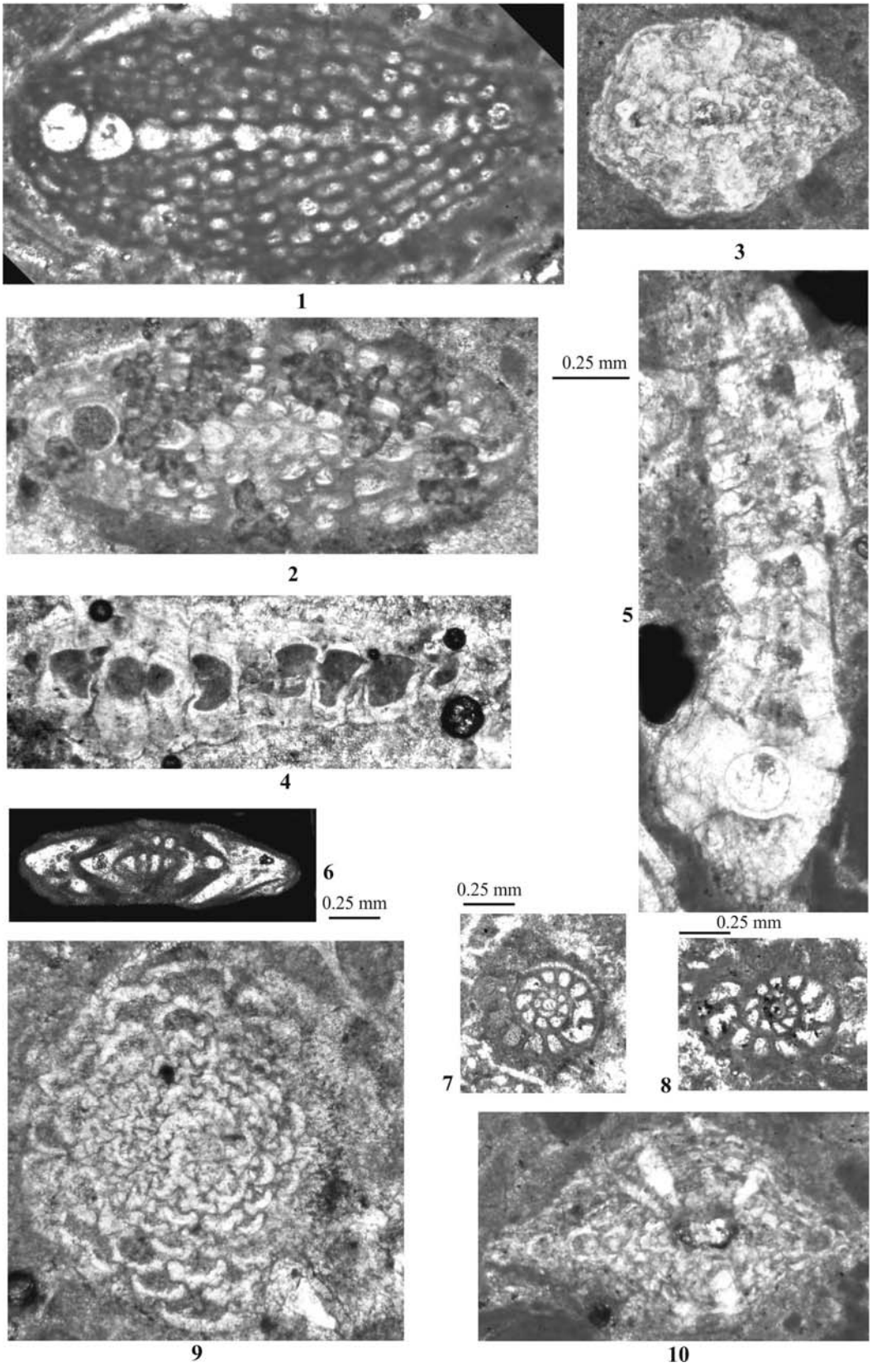


PLATE - 10

Burdigalian, Karamağara measured stratigraphical section, W Malatya, Eastern Turkey, X 60.

Figures 1-7: *Miogypsina globulina* (Michelotti)

1: Equatorial section, (HYM-45A), embryonic chambers formed by first and second chambers and pillars observed in granules on the surface of shell are clearly seen.

2-7: Axial sections, (HYM-45A, HYM-45A, HYM-45A, HYM-45A/3/6, HYM-45A/3/7, HYM-45A, HYM-45A), embryonic chambers and granules are seen.

PLATE - 10

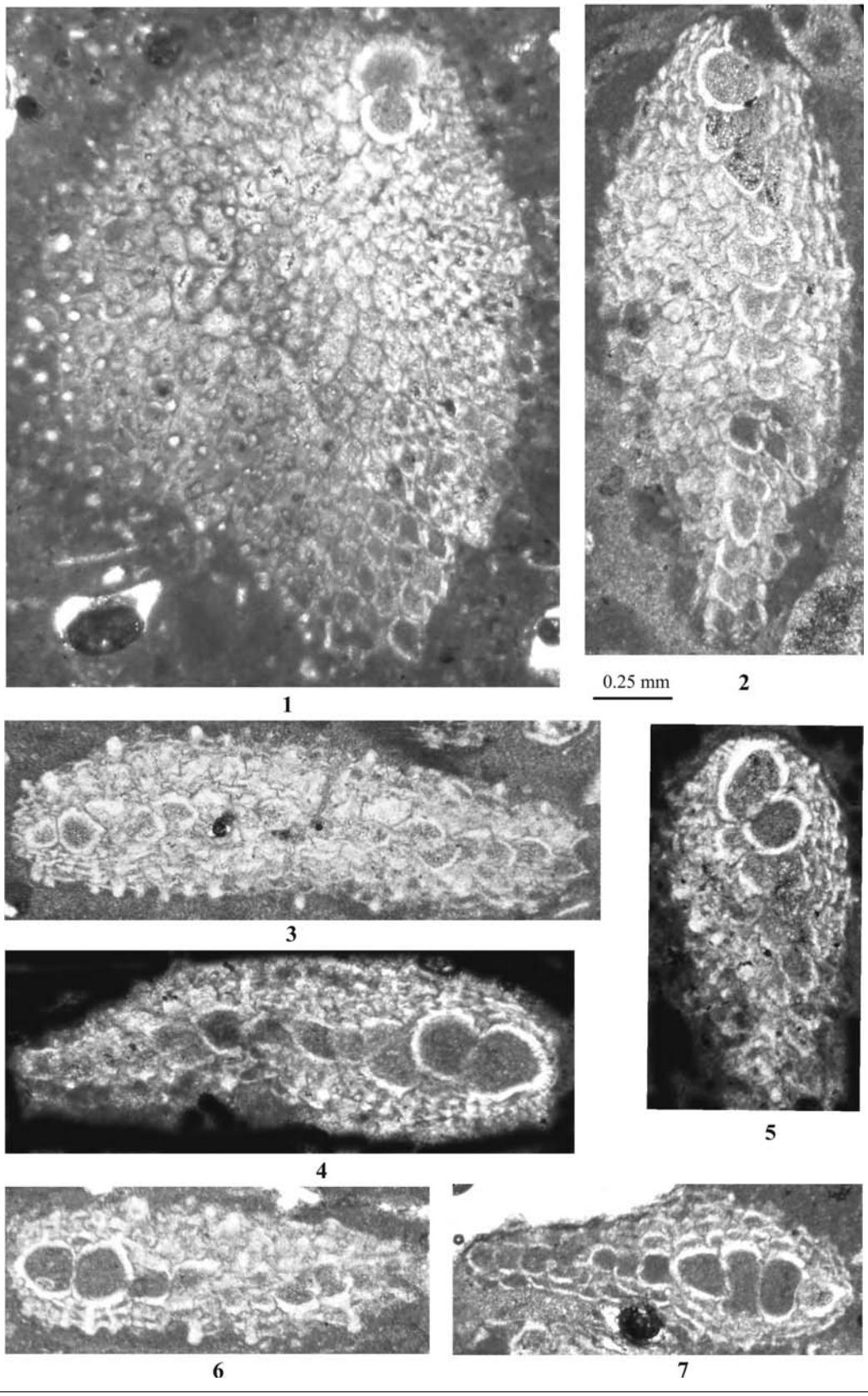


PLATE - 11

Burdigalian, Karamağara measured stratigraphical section, W Malatya, Eastern Turkey, X 60.

Figures 1-4: *Miogypsina polymorpha* (Rutten)

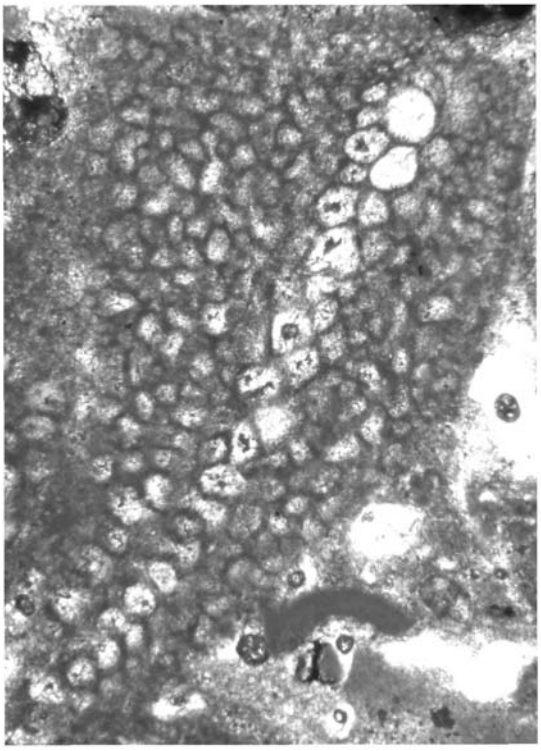
1: Centered transversal section, (HYM-45B/4/1),

2: Equatorial section, (HYM-45B/2/2),

3: Almost equatorial section, (HYM-48/1/1),

4: Transversal section tending to equatorial plane, (HYM-45B/5/1).

PLATE - 11



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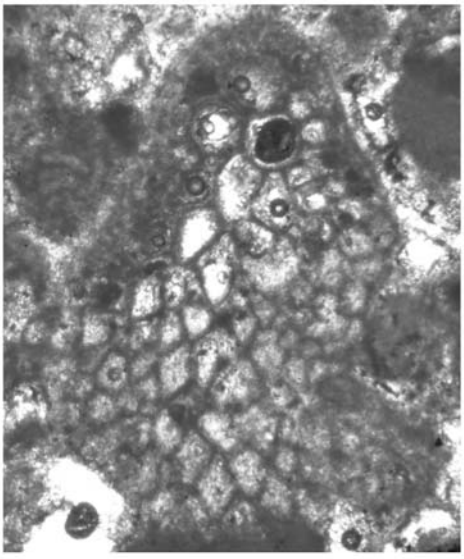

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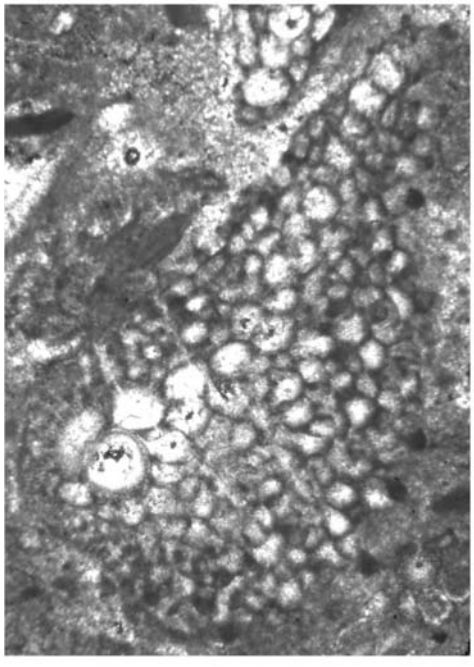

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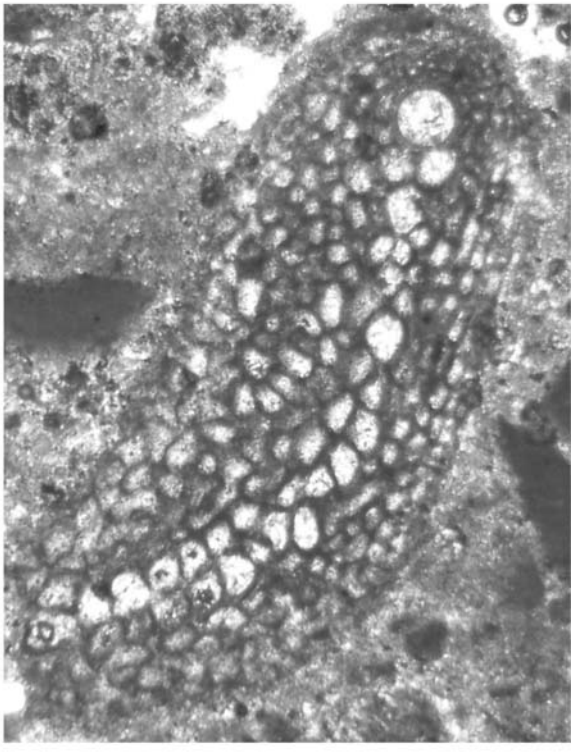

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PLATE - 12

Rupelian-Early Chattian, Edilme and Develi measured stratigraphical sections, W Malatya, Eastern Turkey, X 50.

Figures 1-8: *Neorotalia lithothamnica* Uhlig, 1886

1: Transversal equatorial section, (FGM-19/29/2).

2: Equatorial section, (FGD-2B/13/2).

3: Transversal section, (FGM-19/22/1), dense ornaments in umbilical side are very clearly seen.

4: Noncentered equatorial section, (FGM-19/24/2), ornaments in umbilical side and short spines in last chambers are seen.

5: Almost equatorial section, (FGM-19/3/1).

6: Equatorial section, (FGM-19/3/1).

7: Axial section, (FGM-19/25/1).

8: Axial section, (FGM-19/28/1).

PLATE - 12

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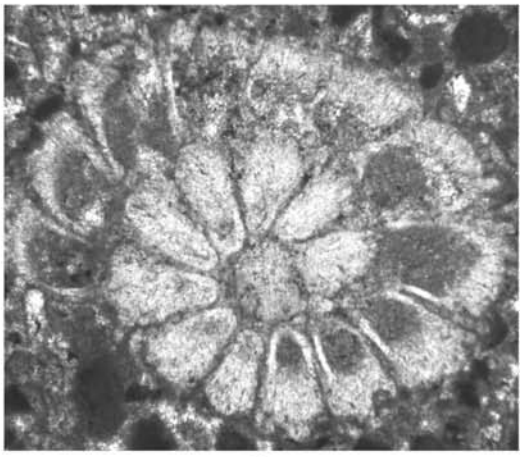

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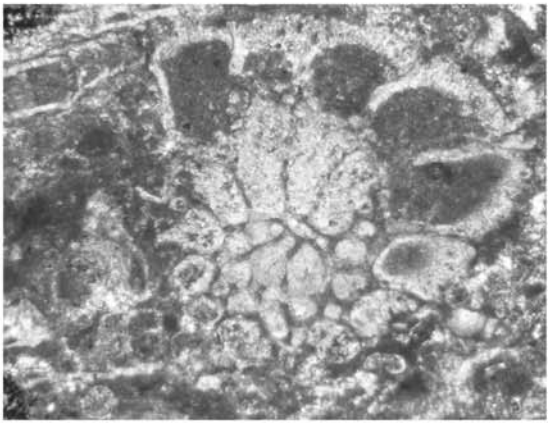

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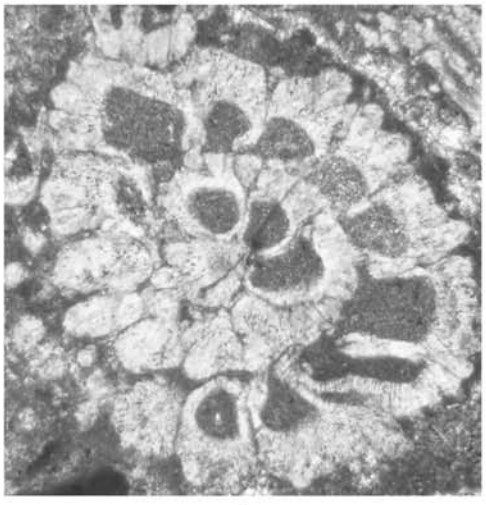

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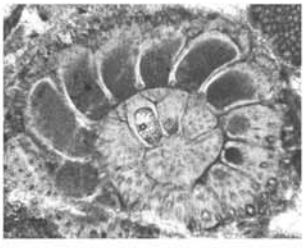

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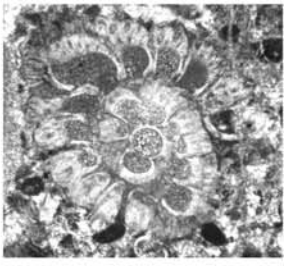

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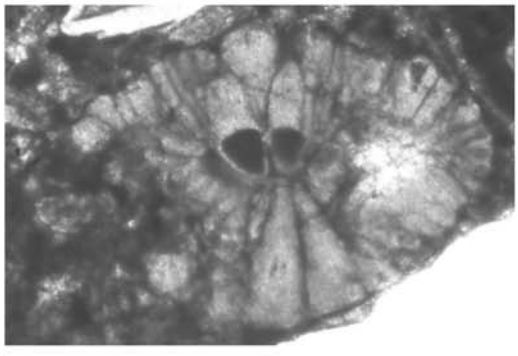

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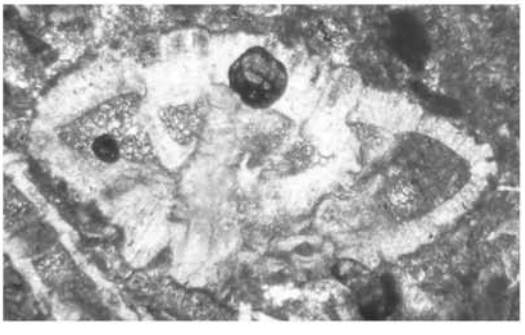

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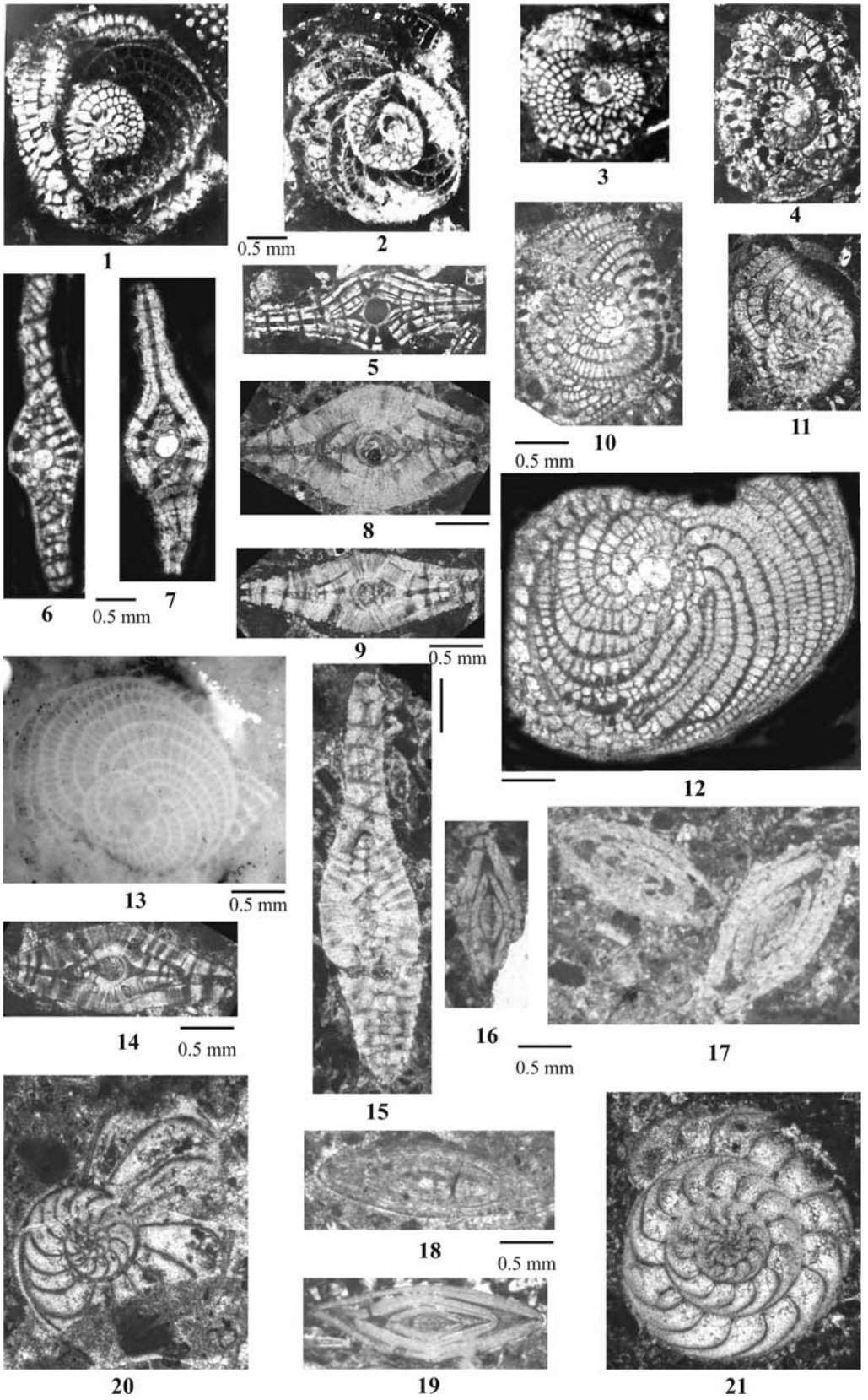
PLATE - 13

Figures 1, 2, 5: *Spiroclypeus vermicularis* Tan, 1937
Late Chattian, Develi measured stratigraphical section, W Malatya, Eastern Turkey, X 15.
1, 2: Equatorial section, A form, (FGD-7).
5: Axial section, A form, (FGD-7).
Figures 3, 4, 6, 7: *Spiroclypeus* sp.
Oligocene, Develi and Edilme measured stratigraphical sections, W Malatya, Eastern Turkey, X 15.
Equatorial section, (FGD-6, FGM-18, FGM-14).
Figures 8-10, 12-15: *Heterostegina assilinoides* Blanckenhorn, 1890 emend. Henson, 1937
Rupelian-Early Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 20.
8, 9, 14, 15: Axial section, A form, (FGM-12B, FGM-5B, FGM-19, FGM-4A).
10: Uncompleted equatorial section, A form, (FGM-19/8).
12, 13: Equatorial section, A form, (FGM-19/1, FGM-19/2).
Figure 11: Nummulitidae (*Spiroclypeus* ?/ *Heterostegina* ? sp.)
Transversal equatorial section, (FGM-5B).
Figures 16-19: *Nummulites* cf. *vascus* Joly and Leymerie
Rupelian-Early Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 20.
Axial sections, (FGM-5E/2/3, FGM-5E/3/1, FGM-5E/1/1, FGM-5E/5/5).
Figure 20: *Operculina* sp.
Equatorial section, (FGM-9B).
Figure 21: *Amphistegina* sp.
Equatorial section, (FGM-7A).

PLATE - 13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