Foraminiferal description and biostratigraphy of the Oligocene (Rupelian-Early Chattian) lagoonal-shallowest-water limestones in the eastern Sivas Basin (central Turkey)

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ABSTRACT

Oligocene (Rupelian-early Chattian) new larger benthic foraminiferal taxons such as miliolid genus Sivasina n. gen., SİREL & ÖZGEN-ERDEM (type species Sivasina egribucakensis n. gen. n. sp. SİREL & ÖZGEN-ERDEM) occurs in the Eğribucak, Bakımlı, Tuzlagözü and Çaygören sections (E of Sivas). One new Rupelian-early Chattian lagoonal-shallowest-water peneroplid species Peneroplis flabelliformis n. sp., SİREL & ÖZGEN-ERDEM from the Eğribucak, Tuzlagözü and Çaygören sections and Rupelian lagoonal two new peneroplid species Coscinospira sivasensis n. sp. SİREL & ÖZGEN-ERDEM, Coscinospira elongata n. sp. SİREL & ÖZGEN-ERDEM from the Eğribucak section (E of Sivas), two new Rupelian shallowest-water alveolinid species Praebullalveolina oligocenica n. sp. SİREL & ÖZGEN-ERDEM and Praebullalveolina minuta n. sp. SİREL & ÖZGEN-ERDEM from the Bakımlı section are described and figured. Furthermore, the description of the known Oligocene soritid species Praearchaias diyarbakirensis SİREL, Praearchaias minimus SİREL, Archaias kirkukensis HENSON, Archaias asmaricus SMOUT & EAMES, peneroplid species P. cf. laevigatus d’ ORBIGNY and austrotillinid species Austrotrillina brunni MARIE are given shortly. In addition, the biostratigraphy of four studied sections are introduced.

Keywords: Oligocene, benthic foraminifera, systematic, biostratigraphy, Sivas basin, Central Turkey.
1. INTRODUCTION

The Scientific and Technological Research Council of Turkey (Tübitak) project on the Stratigraphy, Sedimentology and Basin Development in the Oligocene-Miocene of Sivas Basin was carried out during 2009-2012 in the Department of Geological Engineering of Cumhuriyet (Sivas), Ankara, Hacettepe (Ankara), Dumlupınar (Kütahya), Ege (İzmir) and Onsekizmart (Çanakkale) Universities and in the Geological Mapping Department of MTA. The Oligocene (Rupelian-early Chattian) lagoonal-shallowest-water marine larger benthic foraminifera including alveolinid, soritid, peneroplid, austrotrillinid and miliolid taxons and their biostratigraphy were investigated as a part of this project.

According to the current knowledge of us, the marine sediments of Paleocene-late middle Eocene (Bartonian) occur most wide-spread in the territory of Turkey. On the contrary, the terrestrial lithostratigraphic units are observed mostly after Bartonian stage at the Çankırı, Sivas and similar basins, as well as those of Oligocene age. All over the Mediterranean regions, at the end of Bartonian or at the beginning of Priabonian important paleogeographic, sedimentary and faunal (particularly benthic foraminifera) changes occurred. These may be connected with tectonic movements (particularly orogeny) causing great regression of the sea. These changes were reflected in different ways in the studied area, resulting different facies developments of sediments and different developments of benthic foraminifera. The lagoonal-shallowest and shallow-water limestones in the Eğribucak, Bakımlı, Tuzlagözü and Çaygören sections and few spot samples from the eastern Sivas basin yielded several new peneroplid, alveolinid, miliolid and known austrotrillinid and soritid species which are here described and figured.

All over the Mediterranean regions, the shallowest-water marine environments with porcellaneous, calcareous foraminifera are virtually absent in the depositional sequence of the Oligocene age. Besides occurrences in the Middle-east, Iran and Iraq HENSON (1950),
SMOUT & EAMES (1958) and HOTTINGER (2006); some Mediterranean exceptions containing the shallowest-water marine limestones with benthic foraminifera have previously been reported from Forebetic of Moratolla, Spain by (HOTTINGER, 1963) from France by (BIGNOT, 1972, p. 102, Pl. 1, fig. 4), from Priabona, Italy by (BARBIN & BIGNOT, 1986) and from Priabona, Italy by BARBIN et al. (1997). In Turkey, interesting early Oligocene shallowest-water marine spot limestone samples with porcellaneous foraminifera mainly soritid, miliolid, peneroplid and austrotrillinid species have previously been reported from the Kırkbini village, SW Diyarbakır, southern Turkey by (SİREL, 1996) and Rupelian-early Chattian shallowest-water marine limestones sequence with soritid, miliolid and austrotrillinid species from the Develi village, W of Malatya, E Turkey by (SİREL 2003, Figs. 4, 14). In the studied area, interesting Rupelia-early Chattian lagoonal-shallowest/shallow-water four lithologic successions were investigated with respect to the description of the porcellaneous foraminiferal species and their biostratigraphy. They were measured from different localities of the eastern Sivas basin, eastern part of the Central Turkey (Fig. 1) as follows:

![Figure 1. Location map of study area and stratigraphic sections. 1- Eğribucak section, 2- Bakımlı section, 3-Tuzlagözü section, 4- Çaygören section, ES- spot samples.](image-url)
The studied Eğribucak section (Fig. 2) that is the type locality of new foraminiferal taxons, namely, the new miliolid genus *Sivasina* (type species *S. egribucakensis*) and new peneroplid species *P. flabelliformis*, *C. elongata* and *C. sivasensis* is located at the Eğribucak village (E of Sivas). A new miliolid *S. egribucakensis* and new peneroplid *P. flabelliformis* are recognized from the Rupelian-early Chattian (SBZ 21, 22) lithologic succession of Eğribucak section. The other two new Rupelian peneroplid *C. sivasensis* and *C. elongata* occur in the basal lagoonal argillaceous limestone of the Oligocene sequence of the section. The top shallow-water algal limestones contain *Miogypsinella borodinensis* HANZAWA, *Miogypsinella cf. complanata* (SCHLUMBERGER), *Marasella* sp., *Postmiogypsinella* sp. and undetermined miogypsinid species indicated a late Chattian age.

Another interesting locality called as Bakımlı section (Fig. 3) ranging from Bak. 1 to 21 is situated at the SE of Bakımlı village, E of Sivas. The sandy limestones and limestone beds ranging from 15 to 21 are the type locality of *P. oligocenica* and *P. minuta*. The other known Rupelian soritid species *P. diyarbakirensis* and *P. minimus* SİREL (1996, Pl. I and 2003, Fig. 14) are found together with foregoing two new alveolinid species.

The studied Tuzlagözü section (Fig. 4) is an interesting locality for the shallow/shallowest-water foraminifera of Oligocene, located at the SE of Tuzlagözü village, E of Sivas. The shallowest-water limestone samples ranging from Tzg. 1 to Tzg. 5 yielded *S. egribucakensis*, *P. diyarbakirensis*, *P. minimus*, *P. flabelliformis*, *Peneroplis evolutus* HENSON and *A. kirkukensis* HENSON of Rupelian-early Chattian age. On the contrary, top shallow-water algal limestone beds ranging from Tzg. 6 to Tzg. 8 comprise *M. cf. complanata*, *Marasella* sp. (primitive type), undetermined miolepidocyclinid species, *Planorbulina brönnimanni* BIGNOT & DECROUEZ, *Spiroclypeus* sp. and *Amphistegina* sp. of late Chattian age.
The last studied section Çaygören (Fig. 5) ranging from Buc. 1 to Buc. 15 is situated at the SE of Çaygören village, E of Sivas. The lower part of sequence ranging from 1 to 12 is composed of limestones and sandy limestones with *S. egribucakensis*, *P. flabelliformis*, *P. evolutus*, *Peneroplis* sp., *Archaia smaricus* SMOUT & EAMES, *Archaia* sp. of Rupelian-early Chattian age (SBZ 21, 22) indicate a shallowest-water marine environment for the lower part of the Oligocene Çaygören sequence. Conversely, the top shallow-water algal limestones of the Çaygören succession, ranging from 13 to 15 contain *M. borodinensis*, *M. cf. complanata*, *Marasella* sp., *Postmiogypsinella* sp. and undetermined miogypsinid species of late Chattian age (SBZ 23). The stratigraphic distributions of here described Rupelian–early Chattian lagoonal-shallowest-water foraminiferal species in the studied sections are introduced in the shallow benthic zones of CAHUZAC & POIGNANT (1997, 1998) and in the lagoonal-shallowest-water environments.

Description of the new foraminiferal taxons and known Oligocene species were realized by E. SİREL and N. ÖZGEN-ERDEM and their structural elements are given in Fig. 6. The Eğribucak (Fig. 2), Bakımlı (Fig. 3), Tuzlagözü (Fig. 4) and Çaygören (Fig. 5) sections were measured by N. ÖZGEN-ERDEM and Ö. KANGAL. The Chattian and Miocene miogypsinid and other foraminiferal species are out of scope of present study.

All the random and oriented thin sections of the foraminiferal species described and figured in this paper are deposited in the collection of Cumhuriyet University (Sivas, Turkey), under the numbers shown in Pl. I-XI.

2. STRATIGRAPHY

In this chapter, the lithostratigraphic and biostratigraphic features of the studied sections (Figs. 2-5) are introduced. The benthic foraminiferal biozones in the foregoing lithologic successions are largely based on the SBZ of CAHUZAC & POIGNANT (1997, 1998). The
stratigraphic and environmental distributions of the Oligocene lagoonal-very shallow/shallow-water foraminiferal species are shown in Fig. 7 – 8, respectively.

2.1. Eğribucak section

A well exposed Oligocene sequence with new lagoonal-shallowest foraminiferal species *S. egribucakensis, P. flabelliformis, C. sivasensis* and *C. elongata* is located at the NE of Eğribucak village, E of Sivas (map reference İ38; coordinates 351 686 - 4 400 450). The lithologic units in the Eğribucak section (Fig. 2) commence with thick bedded sandstone (probably in Eocene age) and range to the shallow-water algal limestone with *M. borodinensis, M. cf. complanata, Marasella sp. Postmiogypsinella* sp. and undetermined miolepidocyclinid species of late Chattian age. As seen in Fig. 2, the lagoonal argillaceous limestone with miliolid and peneroplid species, that lie between gypsum beds, were worthy of notice.

The lithologic units and their foraminiferal contents recognized, are from bottom to top (sample numbers are shown as Eb. 1- Eb. 37):

Eb. 1- Siltstones without fossil.

Eb. 2-10- Marls without fossil.

Eb. 11-13- Argillaceous limestone with abundant lagoonal foraminiferal species, namely, *P. flabelliformis, P.cf. laevigatus, P. evolutus, S. egribucakensis, C. sivasensis* and *C. elongata* of Rupelian-early Chattian age (probably Rupelian).

Eb. 14-24- Alternation of marls, sandstone and clayey limestone without fossil.

Eb. 25-26- Argillaceous limestones with *P. evolutus, S. egribucakensis* and miliolid species.

Eb. 27-28- Marl and gypsum.

Eb. 29- Sandy limestone with *Peneroplis* sp. and miliolid species.

Eb. 30- Sandy limestone with *P. flabelliformis, S. egribucakensis* and miliolid species.
Figure 2. Stratigraphic distribution of the foraminiferal species in the Eğribucak section.
Eb. 31-32- Sandy limestones with *S. egribukakensis, Peneroplis cf. laevigatus, Peneroplis* sp. and miliolids species.

Eb. 33- Sandy limestone with *S. egribukakensis, Peneroplis* sp. and miliolids species

Eb. 34-35- Marl beds with *M. borodinensis* and *Postmiogypsinella* sp.

Eb. 36-37- Algal limestones with *M. borodinensis, M. cf. complanata, Marasella* sp.

*Postmiogypsinella* sp. and miolepidocyclinid type of late Chattian age.

2.1.1. Biostratigraphy

The following biostratigraphic benthic biozones are fixed in the Eğribucak succession.

**SBZ 21-22** (Rupelian-early Chattian): The first biostratigraphic unit ranging from Eb. 11 to Eb. 33 is defined by the first and the last occurrences of *S. egribukakensis*. The first appearance of *M. borodinensis* and *M. cf. complanata* define the upper boundary of the unit. The existence of the lagoonal peneroplid species *P. flabelliformis, C. sivasensis, C. elongata* and known peneroplid species *P. cf. laevigatus* and *P. evolutus* recognized in the basal level of this zone (Fig. 2).

**SBZ 23** (late Chattian): The unit ranging from Eb. 34 to Eb. 37 is characterized by the presence of *M. borodinensis* and *M. cf. complanata.*

2.2. Bakımhl section

It is the best locality for all the Turkish territory in terms of the existence of Rupelian shallowest-water limestones with new alveolinid species *P. oligocenica* and *P. minuta*. The section (Fig. 3) is situated at the 2 km SE of Bakımhl village, SE Hafik, NE Sivas (map reference İ38, coordinates 394 290 - 4 372 931). The Eocene sequence ranging from Bak. 1 to
Bak. 13 is composed of alternation of marls, sandstones and sandy limestone beds. The second lithostratigraphic unit ranging from Bak. 14 to Bak. 21 consists of the shallowest-water marine limestones with benthic foraminiferal species of Rupelian age (SBZ 21). The third lithostratigraphic unit, which is composed of sandstones and siltstones (Fig. 3), is likely deposited in a terrestrial environment.

The lithologic units and their foraminiferal species are recognized from bottom to top as follows (sample numbers are shown as Bak. 1-21):

Bak. 1- Marls
Bak. 2- Sandstone without fossils
Bak. 3- Marl with planktonic foraminifera
Bak. 4- Sandy limestone with pelecypod shell fragments
Bak. 5,7- Sandy limestone with few small benthic foraminifera
Bak. 6, 8, 10- Marl with planktonic foraminifera
Bak. 9- Limestone with pelecypod shell fragments
Bak. 11- Sandy limestone with very rare small benthic foraminifera
Bak. 12-13- Sandy limestone with pelecypod shell fragments
Bak. 14- Limestone containing Milolidae such as Sigmoilina sp., Triloculina sp., Quinqueloculina sp., alveolinid form and Rotalidae.
Bak. 15- Limestone with P. oligocenica, P. minuta, S. egribucakensis, Austrotrillina brunni MARIE, Heterillina sp. and undetermined miogypsinid form.
Bak. 16- Limestones with P. oligocenica, P. minuta, P. diyarbakirensis, P. minimus, S. egribucakensis, A. brunni, Heterillina sp. and undetermined miogypsinid form.
Bak. 17- Limestone with P. oligocenica, P. minuta, P. diyarbakirensis, P. minimus, S. egribucakensis and Archaias sp.
Bak. 18- Limestone with *P. oligocenica*, *P. minuta*, *P. diyarbakirensis*, *S. egribuckakensis* and *A. brunni*.

Bak. 19- Limestone with *P. oligocenica*, *P. diyarbakirensis*, *P. minimus*, *S. egribuckakensis* and miliolid species.

Bak. 20- Limestone with *P. diyarbakirensis*, *P. minimus*, *S. egribuckakensis*, *Sigmoilina* sp and miliolid species.

Figure 3. Stratigraphic distribution of the foraminiferal species in the Bakımlı section.
Bak. 21- Limestone containing of *P. oligocenica*, *P. minuta*, *P. diyarbakirensis*, *P. minimus*, *S. egribucakensis*, *A. kirkukensis*, *Prearchaias* sp., *Peneroplis* sp., miogysninid species that is the transition beds between Rupelian and Chattian.

The upper part of the Bakımlı sequence is represented by terrestrial sandstones and siltstones (probably of late Chattian-Miocene age).

### 2.2.1. Biostratigraphy

**SBZ 21 (Rupelian):** Middle part of the Bakımlı sequence (Fig. 3) ranging from Bak. 14 to Bak. 21 has an important outcrop for shallowest-water marine foraminiferal association that consists of *P. oligocenica*, *P. minuta*, *P. diyarbakirensis*, *P. minimus*, *A. kirkukensis*, *A. brunni*, *S. egribucakensis* and *Heterillina* sp. of Rupelian age. This foraminiferal association could be correlated with the SBZ 21 of CAHUZAC & POIGNANT (1998, p. 766) with *Borelis pygmaea* (HANZAWA), *Praerhapydionina delicata* HENSON, *Bullalveolina bulloides* REICHEL and austrotrillinid species of ADAMS (1967) or it corresponds to early Rupelian shallowest-water limestone with *P. diyarbakirensis*, *P. minumus*, *P. delicata*, *A. brunni* and the other species of Diyarbakır region, SE Turkey (SİREL, 1996, 2003, Fig. 14).

### 2.3. Tuzlagözü section

One of the interesting Oligocene succession (Fig. 4) with peneroplid, soritid, miliolid and miogysninid species is situated near the Tuzlagözü village, S Zara town, E of Sivas (map references İ38; coordinate 386 637-4 397 104). The section commences with limestones and ranges to the marl beds of early Miocene (Fig. 4). The lower part of the Tuzlagözü succession that ranges from Tzg. 1 to Tzg. 5 is deposited in the shallowest-water marine environment with peneroplid, soritid and miliolid species of Rupelian-early Chattian age, as opposed to the
upper part of the sequence, in which the algal limestones with miogypsinid species are
developed in a shallow-water environment.

The lithologic units and their foraminiferal species recognized, from bottom to top are
(sample number are shown as Tzg. 1-9):

Tzg. 1- Limestone with *S. egribucakensis*, *P. diyarbakirensis*, *P. minimus*, *A. kirkukensis*, *A. asmaricus*, *P. flabelliformis*, *P. evolutus* and miliolid species

Tzg. 2- Limestone with *S. egribucakensis*, *P. diyarbakirensis*, *P. minimus*, *A. kirkukensis*, *P. flabelliformis*, *P. evolutus* and miliolid species

Tzg. 3- Limestone with *S. egribucakensis* and miliolid species

Tzg. 4- Limestone with *S. egribucakensis*, *Archaia* sp. and miliolid species

Tzg. 5- Limestone with *S. egribucakensis*, *Archaia* sp. and miliolid species

Tzg. 6- Algal limestone with *M. cf. complanata*, *P. brønnimanni*, *Spiroclypeus* sp., *Amphistegina* sp. and undetermined miolepidocyclinid species of late Chattian age

Tzg. 7- Algal limestone with *P. brønnimanni*, *M. cf. complanata* and *Amphistegina* sp.

Tzg. 8- Algal limestone with *P. brønnimanni*, *Marasella* sp. and miolepidocyclinid species of late Chattian age

Tzg. 9- Marls with planktonic foraminifera

2.3.1. Biostratigraphy

The following benthic biozones are fixed in the lithologic succession of the Tuzlagözü
section.

**SBZ 21-22 (Rupelian-early Chattian):** Defined by the biostratigraphic range of *S. egribucakensis*. Foraminiferal species such as *A. kirkukensis*, *P. diyarbakirensis*, *P. flabelliformis*, *P. evolutus* and miliolid species are recognized in this biostratigraphic unit. On
the other hand, the upper boundary of the unit is defined by the first appearance of the late Chattian species *M*. cf. *complanata*, *Marasella* sp. and undetermined miolepidocyclinid species similar to that of SİREL & GEDİK (2011, Pl. III, figs. 4-6).

SBZ 23 (Late Chattian): The biostratigraphic zone ranges from Tzg. 6 to Tzg. 8. As mentioned above, this unit is characterized by the existence of *M*. cf. *complanata*, *P. brönnimanni*, *Marasella* sp. and undetermined miolepidocyclinid species.

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Figure 4. Stratigraphic distribution of the foraminiferal species in the Tuzlagözü section.

2.4. Çaygören section

The studied section (Fig. 5) is located at the 10 km SE of Çaygören village, E Sivas (map references İ 38, coordinates 394 427-4 371 608). The first lithostratigraphic unit ranging from Buc. 1 to Buc. 12 contains alternation of sandstone, marl and sandy limestone with soritid,
miliolid and peneroplid species of Rupelian-early Chattian age, indicate a very shallow-water marine environment for this unit. The shallow-water marine algal limestone with miogypsinid species of late Chattian age are found at the top of the Çaygören section.

The lithologic units and their shallowest/shallow foraminiferal species recognized, are from bottom to top (sample numbers are shown as Buc. 1-15):

Buc. 1- Sandy limestone with *P. evolutus*, *P. flabelliformis*, *S. egribucakensis*, *Archaias* sp., *Prearchaias* sp. and miliolid species.

Buc. 2- Sandy limestone with *S. egribucakensis*, miliolid and abundant pelecypod shell fragments.

Buc. 3- Sandy limestone with *S. egribucakensis*, *Peneroplis* sp., gavelinellinid types, and miliolid species.

Buc. 4- Sandy limestone without fossil.

Buc. 5- Sandy limestone with *S. egribucakensis*, *Peneroplis* sp., *Archaias* sp., miliolid.

Buc. 6- Sandy limestone with *S. egribucakensis*, *Peneroplis* sp. and miliolid species.

Buc. 7- Sandstones with *Peneroplis* sp. and miliolid species.

Buc. 8- Sandstones with *S. egribucakensis*, *Peneroplis* sp., *Archaias* sp. and gavelinellinid.

Buc. 9- Limestone with *A. asmaricus*, *P. flabelliformis*, *S. egribucakensis* and *Prearchaias* sp.

Buc. 10- Marl with pelecypod fragments

Buc. 11- Sandstone with *Sigmoidolina* sp., *Peneroplis* sp. and miliolid species.

Buc. 12- Sandstone with coral, *Sigmoidolina* sp. and miliolid species.

Buc. 13- Algal limestone, *M. cf. complanata* and *Miolepidocyclina* sp.

Buc. 14- Limestone with *M. borodinensis*, *Miolepidocyclina* sp., *Marasella* sp. and *Postmiogypsinella* sp.

Buc. 15- Algal limestone with *M. borodinensis*, *M. cf. complanata*, *Miolepidocyclina* sp., *Marasella* sp., *Postmiogypsinella* sp.
2.4.1. Biostratigraphy

Following two biostratigraphic units are recognized in the Çaygören succession (Fig. 5):

**SBZ 21-22 (Rupelian-early Chattian):** The stratigraphic range of *S. egribucakensis* defines this unit. The other species such as *P. evolutus, P. flabelliformis, A. asmaricus, Praearchaias*...
sp., *Archaias* sp. and Miliolidae are observed in this unit. The first occurrence of *M. borodinensis* draws the upper boundaries of the unit.

**SBZ 23 (Late Chattian):** The first and the last occurrence of *M. borodinensis* define the lower and upper boundaries of this zone, respectively. The existence of *Postmiogypsinella* sp. and *Marasella* sp. in the unit were noticed, so that this foraminiferal association could be correlated with the late Chattian associations of SİREL & IŞIK (2011) and SİREL & GEDİK (2011).

### 3. SYSTEMATIC PALEONTOLOGY

**Family:** Peneroplidae SCHULTZE, 1854  
**Genus:** *Peneroplis* DE MONTFORT, 1808  
**Type species:** *Nautilus planatus* FICHTEL AND MOLL, 1798

*Peneroplis flabelliformis* n. sp., SİREL & ÖZGEN-ERDEM  
(Pl. I, Figs. 1-14; Pl. II, Figs. 1-2; Fig. 6A-C)

**Origin of name:** The test of the new species resembles a fan.

**Holotype:** Almost centered equatorial section, illustrated in Fig. 6B.

**Material:** More than 100 specimens in equatorial, subequatorial and axial sections from the type locality.
**Type locality:** Eğribucak section (Fig. 1), NE of Eğribucak village, E Sivas, Central Turkey, (Map reference İ38, coordinate 351 686-4 400 450).

**Type level:** Rupelian-early Chattian (SBZ 21-22).

**Description:** The porcellaneous, calcareous test of the new species is composed of three growth stages, namely, small and arcuate early chambers are lined up in a planispiral-involute two whorls, later low and broad chambers flaring and arranged in peneropline and flabelliform mode, senile chambers become cyclical (Pl. I, fig. 12; Figs. 6A, B). Diameter of the spheric protoconch ranges from 0.05 mm to 0.08 mm. The connection of the early planispiral chambers provide by single inter cameral foramina (Fig. 6A), whereas the aperture is composed of two rows of foramina in the flabelliform chambers (Figs. 6A, C). The largest diameter of the planispiral and cyclical stages up to 0.47 mm and 1.8 mm (measured from Pl. I, figs. 7 and 12), respectively. The early planispiral-involute stage forms a swollen central boss on both sides of the test (Pl. I, figs. 10-12).

**Remarks:** A flabelliform-cyclical form was first described and figured as *Penerolis damesini* HENSON from the late Eocene of Iraq by HENSON (1950, p.34-35, Pl. 4, figs. 2,3,6; Pl. 5, fig. 1). Unfortunately, the embryonic and nepionic stages (planispiral-involute chambers) have not been described adequately in the original definition of *P. damesini*. However, the new species differs from *P. damesini* in its smaller test and developed broad flabelliform chambers. *P. flabelliformis* differs from the Oligocene species *P.cf. damesini* HENSON of HOTTINGER (1963, p. 968, Pl. III, figs. 7, 8; text figs. q-r) in possessing larger test, broader flabelliform chambers and cyclical chambers. The new species is distinguished
from the late Eocene species of *P. cf. damesini* HENSON of (SİREL & ACAR 1982, Pl. 5, figs. 4,7-9) in having larger test, well developed flabelliform and cyclical chambers.

**Stratigraphic and geographic distribution:** The new species is created in the lagoonal-shallowest argillaceous limestones of the Eğribucak section (Fig. 2) and in the shallowest-water marine limestones of the Tuzlagözü (Fig. 4) and Çaygören (Fig. 5) sections. The shallowest-water limestones with new species underlie algal limestone beds with *M. borodinensis* and *M. cf. complanatus* of late Chattian age on the one hand, it is associated in the shallowest-water limestones of the Tuzlagözü section (Fig. 4) with *P. diyarbakirensis, P. cf. minimus* of Rupelian age (SİREL, 1996) on the other hand. Therefore, the stratigraphic range of the new species was accepted as Rupelian-early Chattian (SBZ 21-22).

*Peneroplis* cf. *laevigatus* D'ORBIGNY, 1839

(Pl. II, Figs. 3-11; Fig. 6F)

**Synonymy:**


**Description:** The compressed small test composed of two stages. The early stage is enrolled planispirally and involute with numerous low arched chambers, later adult chambers are uncoiled and arranged in flaring peneropliform pattern (Pl. II, figs. 5, 10, 11). The diameter of the planispiral early stage ranges from 0.25 mm to 0.43 mm and longitudinal diameter of the adult test from 0.68 mm to 1 mm. The interior of the chamber is undivided. The connection of the planispiral early chambers is provided by a single intercameral
foramen, whereas the connection between the adult chambers is provided by the numerous openings (Fig. 6F).

**Remarks:** This peneroplid specimens illustrated in Pl. II, figs. 3-11 are compared with the Oligocene specimens *P. cf. laevigatus* of HOTTINGER (1963, Pl. III, figs. 9,10; text Fig. s-v). Here described specimens are badly sectioned, so, the apertural face cannot be safely described. Therefore we do not decide whether they belong to *Peneroplis de MONTFORT* or *Laevipeneroplis SULE*. For the time being, they were described as *P. cf. laevigatus*.

**Stratigraphic and geographic distribution:** It is observed only in the lower level (SBZ 21-22) of Eğribucak section (Fig. 2), in association with *P. flabelliformis, C. sivasensis, C. elongata* and *S. egribucakensis*. Considering its stratigraphic level, Rupelian age for *P. cf. laevigatus* would be more proper than Rupelian-early Chattian age.

**Genus: Coscinospira EHRENBERG, 1839**

Type species: *Coscinospira hemprichii* EHRENBERG, 1839

**Diagnosis:** Test is large, operculiniform (in *C. sivasensis* Pl. II, figs. 14,17) or crosier shape (in *C. elongata* Pl. III, figs. 6, 7, 11, 13) with imperforate, calcareous, porcellaneous wall. The early arcuate chambers are arranged in a planispiral mode for two and two and half whorls (Pl. II, figs. 12-18; Pl. III, figs. 5-8), later chambers are partly or entirely uncoiled and become rectilinear (Pl. II, figs. 15, 16; Pl. III, figs. 5-13). The connection of the adjacent early planispiral chambers is provided by the intercameral foramen (Pl. III, figs. 2, 3, 10-13; Figs. 6D-E). The aperture becomes cribrate in the last planispiral chambers (Pl. II, fig. 14; Pl. III,
figs. 1, 12) and in the rectilinear chambers (Pl. III, figs. 6, 10-13; Figs. 6D-E). The size of the test and protoconch suggest the existence of both generations.

**Differential Diagnosis:** The peneroplid foraminifera with crosier shape test *Coscinospira* EHRENBERG (type species *Coscinospira hemprichii* EHRENBERG) is described from the Holocene of Red Sea by EHRENBERG (1839). It has planispiral early chambers and uncoiled adult chambers with cribrate aperture in common with here described species *C. sivasensis* and *C. elongata* (Pl. II, figs. 12-18; Pl. III, figs. 1-13). Therefore the figured specimens in Pls. II, III have been described as the species of *Coscinospira* EHRENBERG. On the other hand, some peneroplid specimens with crosier-shaped were described and figured as *C. hemprichii* from the Holocene of Red Sea by HOTTINGER et al. (1993, p. 69, Pl. 76, figs. 1-12; Pl. 77, figs. 1-8), in spite of the fact that they have numerous fissures on the uncoiled chambers (Pl. 76, fig. 7; Pl. 77, figs. 4, 5). The genus *Coscinospira* (particularly in *C. elongata*) has its crosier test shape, planispiral early and rectilinear adult chambers in common with Eocene-Holocene genus *Spirolina* LAMARCK (type species *Spirolina cylindracea* LAMARCK), but former has cribrate aperture in the last planispiral chambers of the early stage and rectilinear chambers of the adult stage. Whereas in *Spirolina*, the aperture is single opening.

**Coscinospira sivasensis** n. sp., SİREL & ÖZGEN-ERDEM

(Pl. II, Figs. 12-15, 17, 18; Pl. III, Figs. 1-5; Fig. 6D)

**Origin of name:** Sivas is a city in the eastern part of the Central Turkey.

**Co-types:** Pl. II, figs. 12-15; Pl. III, figs. 1-5.
Material: Fifty five specimens in random sections from the Eğribucak section (Fig. 2).

Type locality: Eğribucak section (Fig. 1), NE of Eğribucak village, E Sivas, Central Turkey, (Map reference İ 38, coordinate 351 686- 4 400 450).

Type level: Rupelian (SBZ 21).

Description: Both generation have a large, operculiform (Pl. II, figs. 12, 14, 17) or short crosier in shape with imperforate, calcareous, porcellaneous wall. The diameter of the planispiral early stage ranges from 0.83 mm to 1.16 mm in megalospheric forms and from 0.8 mm to 1.1 mm in microspheric forms. Relatively large, spheric megalosphere (0.083-0.100 mm in diameter) is followed by planispiral arcuate early chambers increase suddenly in the last whorl (Pl. II, figs. 12, 14, 15, 17). There are 39 planispiral chambers in an equatorial section of 1.16 mm in diameter that are arranged in the three whorls (Pl. II, fig. 18). Later few adult chambers start to uncoil. The microspheric forms are rather rare in accordance with the megalospheric forms. The small, spheric microsphere (about 0.030 mm in diameter) is followed by the arcuate early chambers lined up in the planispiral mode. There are 34 and 37 planispiral early chambers in an equatorial section measured 0.76 mm (Pl. II, fig. 15) and 1 mm in diameters (Pl. II, fig. 17) respectively. Later chambers tend to uncoiled (Pl. II, figs. 12, 14-18) with cribrate aperture.

Stratigraphic and geographic distribution: The new species C. sivasensis and C. elongata abound in the clayey lagoonal limestones of the Eğribucak (Fig. 2) with P. flabelliformis, P. cf. laevigatus and S. egribucakensis. This lagoonal limestone with C.
*sivasensis* and *C. elongata* lie at the lower level of (SBZ 21-22), therefore the stratigraphic range of two species of *Coscinospira* is considered as Rupelian.

**Coscinospira elongata** n. sp., SİREL & ÖZGEN-ERDEM

(Pl. II, Fig. 16; Pl. III, Figs. 6-13; Fig. 6E)

**Origin of name:** The uncoiled stage of the test is elongated as opposed to *C. sivasensis*.

**Co-types:** Pl. III, figs. 6-13.

**Material:** Fifty five specimens in random sections from the Eğribucak section (Fig. 2).

**Type locality:** Eğribucak section (Fig. 2), NE of Eğribucak village, E Sivas, Central Turkey, (map reference İ 38, coordinate 354 686-4 400 450).

**Type level:** Rupelian (SBZ 21).

**Description:** The new species has a elongated crosier shape test with imperforate, calcareous, porcellaneous wall. The small, spheric megalosphere (0.050-0.075 mm in diameter) is followed by arcuate planispiral chambers with intercамeral foramen (fig. 6E), later numerous adult chambers with cribrate aperture are uncoiled and lined up in a long series (Pl. III, figs. 9-13). There are 28 arcuate planispiral chambers in an equatorial section measured 0.63 mm in diameter (Pl. III, fig. 7). There are 16-17 dome like uniserial chambers in the uncoiled stage measured 2 mm in length (Pl. III, fig. 13). The size of the uniserial chambers becomes constant during the late ontogeny (Pl. III, figs. 6, 7, 9, 11, 13).
Figure 6. Structural elements of the following Oligocene lagoonal restricted marine and shallowest-water marine benthic foraminiferal species. A-C- Peneroplis flabelliformis n. sp., SİREL & ÖZGEN-ERDEM, A, B- equatorial sections, C- tangential section, D- Coscinospora sivasensis n. sp., SİREL & ÖZGEN-ERDEM equatorial section, E- Coscinospora elongata n. sp., SİREL & ÖZGEN-ERDEM, equatorial section, F- Peneroplis cf. laevigatus d'ORBIGNY (equatorial section), G, H- Sivasina egribucakensis n. gen. n. sp., SİREL & ÖZGEN-ERDEM, G- tangential section, H- axial and tangential sections, all figs. X60. Abbreviations: (FC) flabelliform chambers, (AP) apertural pores, (IF) intercameral foramen, (CC) cyclical chambers, (PC) planispiral chambers, (PR) protochonch, (UC) uncoiled chambers, (CA) cribrate aperture, (TA) terminal aperture, (RI) ribs, (BA) axial section of biumbilicate test.
Remarks: It is distinguished from the type species *C. hemprichii* in its larger test and longer biserial stage. The new species differs from *C. sivasensis* in possessing smaller early planispiral and longer uniserial stages.

Super family: Miliolicea EHRENBERG, 1839
Family: Hauerrinidae, SCHWAGER 1876
**Genus: Sivasina n. gen., SİREL & ÖZGEN-ERDEM**
Type species: *Sivasina egribucakensis* n. gen. n. sp. SİREL & ÖZGEN-ERDEM

**Origin of name:** Sivas is a city in the eastern part of Central Turkey.

**Diagnosis of genus:** The new miliolid genus has a biumbilicate, inflated lenticular test with rounded-pointed periphery and trematophorid cribrate terminal aperture supported by thin ribs (Pl. IV, figs. 1, 4, 13; Pl. V, figs. 7, 8; Pl. VI, figs. 4, 5), particularly in the last chambers of the planispiral stage (Pl. V, fig. 2; Pl. VI, fig. 6), embryonic chambers of probably quinqueloculine arrangement in microspheric specimens (Pl. IV, figs. 5, 11), but biloculine arrangement in megalospheric specimens (Pl. IV, figs. 7, 8, 13). Later planispiral-evolute (Pl. IV, figs. 1, 7, 8, 13) undivided chambers increasing in breadth and height from the protoconch to the last chamber. The chambers of the final stage are uncoiled and become rectilinear (Pl. IV, fig. 6; Pl. VI, fig. 5). The wall of the test is imperforate, calcareous and porcellaneous. The connection of the adjacent planispiral chambers is provided by single intercameral foramen (Pl. IV, figs. 9, 10), but the aperture becomes terminal cribrate, reflecting as thin ribs that line the upper part of the chamber interior in the vicinity of the aperture and project into the openings (Pl. IV, fig. 4; Pl. V, figs. 7, 8; Pl. VI, figs. 5, 6). The
test size and shape suggest the existence of two generations, when compared with figures in
(Pl. IV, figs. 6, 13; Pl. V, figs. 1, 3, 6; Pl. VI, figs. 1, 5).

**Differential diagnosis:** The new genus has biumbilicate test, planispiral-evolute adult
chambers in common with Lutetian-Holocene genus *Dendritina* d'ORBIGNY (type species
*Dendritina arbusculla* d'ORBIGNY), but the former has a trematophorid cribrate terminal
aperture with thin ribs (Pl. IV, figs. 1, 4, 13; Pl. V, figs. 7, 8; Pl. VI, figs. 5, 6), whereas latter
has an areal dentritic aperture (in LEOBLICH & TAPPAN, 1987, p. 370, Pl. 391, fig. 3).
Some Miocene biumbilicate forms with planispiral-evolute whorls were described and figured
as *Peneroplis farcensis* HENSON (1950, p. 33, Pl. 5, figs. 3-6) from the Miocene of Iraq,
Syria and Qatar. These Middle East forms absolutely differ from the species of *Peneroplis de
MONTFORT* in having planispiral-evolute whorls and trematophorid aperture. According to
the authors, this species could belong to the new genus by the structural elements of the
aperture. Also Oligocene species *Dendritina cf. rangi* d'ORBIGNY, illustrated in (HENSON
1950, p. 31, Pl. 5, fig. 2) show close similarity with *S. egribucakensis* by the biumbilicate test
with planispiral-evolute whorls and trematophorid aperture. Furthermore, the following
Oligocene specimens with biumbilicate test were described and figured as *Peneroplis cf.
elegans* d'ORBIGNY, *Peneroplis cf. farsensis* HENSON, *Dendritina cf. rangi* d'ORBIGNY
and *Peneroplis aff. honestus* TODD & POST by HOTTINGER (1963, Pl.V, figs. 1-9) that are
identical with the species of *Sivasina* by planispiral-evolute whorls and structure of the
aperture.

*Sivasina egribucakensis* n. gen. n. sp., SİREL & ÖZGEN-ERDEM
(Pl. IV, Figs. 1-14; Pl. V, Figs. 1-10; Pl. VI, Figs. 1-6; Figs 6G, H)

**Synonymy:**
1950  *Peneroplis farsensis* HENSON, p. 33, Pl. 5, figs.3-6.

1963  *Peneroplis* cf. *elegans* d'ORBIGNY, HOTTINGER, p. 969, Pl. V, figs. 3-5.

1963  *Peneroplis* cf. *farsensis* HENSON, HOTTINGER, p. 969, Pl. V, figs. 6,7; Fig. 2 a-d.

1963  *Dendritina* cf. *rangi* d'ORBIGNY, HOTTINGER, p. 970, Pl. V, fig. 8, Fig. 2 e-g.


**Origin of name:** Egribucak is a village in the Sivas basin, Central Turkey.

**Co-types:** Pl. IV, figs. 1, 4, 6, 7, 13; Pl. V, figs. 1-8 and Pl. VI, figs. 1-6.

**Material:** 140 specimens in random sections from the Eğribucak section (Fig. 2)

**Type locality:** Eğribucak section (Fig. 1), NE of Eğribucak village, E Sivas, Central Turkey, (Map reference İ 38, coordinate 351 686-4 400 450).

**Type level:** Rupelian-early Chattian (SBZ 21-22).

**Description:** Both generations have an inflated, biumbilicate lenticular test with tremataphorid aperture. Diameter of the test ranges from 0, 66 mm to 0.9 mm in megalospheric form and from 1 mm to 2 mm in microspheric form.

Megalospheric test is small, biumbilicate with rounded periphery (Pl. IV, figs. 3, 7, 8, 13; Pl. V, figs. 1, 3, 6). The relatively large, spherical megalosphere (0. 066- 0.100 mm in diameter) is followed by probably bilocular early chambers (Pl. IV, figs. 8, 13; Pl. V, figs. 1, 3, 6), later dome-like adult chambers are arranged in an oscillating, planispiral-evolute pattern (Pl. IV, figs. 7, 10, 13). The chambers increase gradually from the megalosphere to the last
chamber. Some equatorial and axial sections clearly show that the last three chambers tend to uncoil (Pl. IV, figs. 3, 7, 8; Pl. V, fig. 6).

Microspheric test is medium sized, biumbilicate lenticular with rounded to pointed periphery (Pl. IV, fig. 6; Pl. VI, figs. 2, 4, 5). The small, spheric microsphere (about 0.050 mm in diameter) is followed by early chambers that are arranged in a probably quinqueloculine chambers for one whorl (Pl. IV, fig. 14; Pl. V, fig. 10), later dome-like adult chambers are lined up in a planispiral-evolute mode, the last chambers with trematophorid aperture are uncoiled (Pl. IV, fig. 6; Pl. VI, figs. 1, 3, 5).

**Remarks:** Similarities and differences between *S. egribucakensis* and other species are given in the differential diagnosis chapter of new genus.

**Stratigraphic and geographic distribution:** This new miliolid species is occurred in the lagoonal restricted marine limestones-shallowest-water marine limestones of all studied sections (Figs 2-5).

The interesting Oligocene (Rupelian-early Chattian) lagoonal-shallowest-water marine succession crops out in the vicinity of Eğribucak village (E Sivas). As seen in Eğribucak section (Fig. 2), the Oligocene (Rupelian-early Chattian) sequence composed of various lithologic units. The basal lagoonal argillaceous limestones with *S. egribucakensis*, *P. flabelliformis*, *P. cf. laevigatus*, *C. sivasensis* and *C. elongata* that lie between gypsum beds were noticed. On the other hand, *S. egribucakensis* was observed in the upper part of the Rupelian-early Chattian sequence that was found together with peneroplid and miliolid species (see Fig. 2).

It is found in the very shallow-water marine limestones of the Bakımli section (Fig. 3) with soritid species *P. diyarbakirensis*, *P. minimus* and new alveolinid species *P. oligocenica*
and *P. minuta* of Rupelian age. The other very shallow-water foraminiferal species *A. kirkukensis, A. brunni* and miliolid species were described in this biostratigraphic unit SBZ 21 (Rupelian).

It is associated in the shallowest-water marine limestones of the Tuzlagözü section with *P. diyarbakirensis, P. minimus, A. kirkukensis, P. flabelliformis, P. evolutus, Archaias* sp. and miliolid species of Rupelian-early Chattian age (Fig. 4).

It abounds in the Rupelian-early Chattian shallowest-water marine limestones of the Çaygören section (Fig. 5) with *P. flabelliformis, P. evolutus, A. asmaricus, Praearchaias* sp. and gavelinellinid species.

Superfamily: Alveolinacea EHRENBERG, 1839

Family: Alveolinidae EHRENBERG, 1839

**Genus: Praebullalveolina** SİREL & ACAR, 1982

Type species: *Praebullalveolina afyonica* SİREL & ACAR, 1982

**Re-description of genus:** The alveolinid genus has slightly ovoid, subspherical/spherical to nautiloid test with alternating septula and chamberlets. The apertural face has one row of main aperture and secondary aperture of smaller diameter (Pl. VI, fig. 7; Pl. VII, figs. 1, 2; Pl. VIII, figs. 1, 4). The postseptal passage is absent. On the contrary the preseptal passage is well developed and large. One row of alveols is communicating through secondary aperture in the previous septum with the preceding preseptal passage (Pl. VI, fig. 7; Pl. VII, figs. 1-2; Pl. VIII, figs. 1, 4, 9). The juvenile stage of microspheric form is composed of a small microsphere, two rows of quinqueloculine and one row of triloculine cycles (Pl. VII, fig. 1; Pl. VIII, figs. 1, 6, 9). But the early undivided chambers of the megalospheric generation are probably arranged in triloculine mode (Pl. VII, fig. 3); the large planispiral chambers are
divided by septula into numerous chamberlets; the ramifying septula generate small triangular space at the roof of the chambers, in which the small supplemantary chamberlets are formed (Pl. VIII, figs. 3,7); dimorphism faint, late Eocene-early Oligocene.

**Note:** A perfect equatorial section with distinct structural elements, illustrated in (SİREL & ACAR, 1982, Pl. 5, fig. 1) was chosen as a lecto-type of *P. afyonica* instead of holotype in (SİREL & ACAR, 1982, Pl. 1, fig. 1).

**Remark:** In the original definition of *Praebullalveolina*, two rows of alveols connected with two rows of secondary apertures have previously been reported as a diagnostic characteristic of the genus by SİREL & ACAR (1982, p. 823-824). This late Eocene-early Oligocene alveolinid genus has absolutely one row of main and secondary apertures. The undivided early stage consists of two cycles of quinqueloculine and later one cycle of triloculine chambers, that are recognized well in the microspheric form. In addition, the supplementary chamberlets are present in the adult planispiral chambers.

*Praebullalveolina oligocenica* n. sp., SİREL & ÖZGEN-ERDEM

(Pl. VI, Figs. 7,8; Pl. VII, Figs. 1-9; Pl. VIII, Figs. 1,2)

**Origin of name:** It is found in the early Oligocene limestones.

**Holotype:** Equatorial section, illustrated in Pl. VII, fig. 1.

**Material:** 65 specimens in random sections from the Bakımlı section, (Fig. 3).
**Type Locality:** Bakımlı section (Fig. 3), E of Sivas, eastern part of Central Turkey, (Map reference İ 38, coordinates 394 290-4 372 931).

**Type Level:** Early Rupelian, (SBZ 21).

**Description:** The specimens with coarser structure have a slightly nautiloid test (Pl. VII, figs. 3,4). The axial and equatorial diameters range from 0.6 mm to 0.83 mm and from 0.83 mm to 1.05 mm, respectively. The new species has characteristically larger divided chambers when compared with the type species *P. afyonica* and new species *P. minuta*. In well preserved microspheric specimens, very small protoconch is followed by two may be more cycles of quinqueloculine undivided early chambers (Pl. VII, fig. 1; Pl. VIII, fig. 1). Later undivided chambers are lined up in triloculine pattern (Pl. VII, fig. 1; Pl. VIII, fig. 1) and the adult divided planispiral chambers that are characteristically broad and inflated arranged in the planispiral whorls. Height of the planispiral chambers increases gradually from the undivided triloculine chambers towards the last whorl (Pl. VII, fig. 1; Pl. VIII, fig. 1), but they increase suddenly in height and length in the last whorl. There are eight divided chambers in the last whorl of the equatorial section, measured 1 mm in diameter (Pl. VII, fig. 1).

**Remarks:** The new species differs from the type species *P. afyonica* in its coarser test with larger divided planispiral chambers (Pl. VII, figs. 1-2; Pl. VIII, figs. 1-2). There are eight divided chambers in the last whorl measuring in an equatorial diameter of 1 mm (in holotype; Pl. VII, fig. 1); whereas, in *P. afyonica*, there are 15 divided lower and smaller chambers in the last whorl measured in an equatorial diameter of 0.92 mm (SİREL & ACAR 1982, Pl. I, figs. 1,5). In addition, the chamberlets of *P. oligocenica* are larger than the chamberlets of the type species of *P. afyonica*. The new species *P. minuta* is distinguished from *P. oligocenica* in
possessing smaller test with lower and narrower numerous divided adult chambers with smaller chamberlets (Pl. VIII, figs. 4, 8).

**Stratigraphic and geographic distribution:** Until 1998, the alveolinid genus *Praebullalveolina* (type species *P. afyonica*) was introduced as a marker species of the Priabonian shallowest environment in the Mediterranean region by SİREL & ACAR (1982) and SERRA-KIEL et al. (1998). The first occurrence of *Praebullalveolina* at the Priabonian/Oligocene boundary was reported from the Priabona region (Italy) by BARBIN et al. (1998). This biostratigraphic age concerning *Praebullalveolina* was confirmed by the presence of the associated early Rupelian foraminiferal species *P. delicata* and *Austrotrillina paucialveolata* GRIMSDALE by BARBIN et al. (1998, p. 143). An interesting very shallow-water marine limestone sequence (Fig. 3) located at the Bakımlı village (E Sivas), in which two new species of *Praebullalveolina* appeared together with *P. diyarbakirensis, P. minimus* and others (see Fig. 3) of Rupelian age (SİREL, 1996).

*Praebullalveolina minuta* n. sp., SİREL & ÖZGEN-ERDEM

(Pl. VIII, Figs. 3-8)

**Origin of name:** The test of the new species is smaller than the other species of *Praebullalveolina*.

**Holotype:** Equatorial section, illustrated in Pl. VIII, fig. 4.

**Material:** 60 specimens in oriented and random sections from the Bakımlı section.
**Type locality:** Bakımlı section (Fig. 1), E of Sivas, eastern part of Central Turkey; (map reference İ 38, coordinates 394 290-4 372 931).

**Type level:** Early Rupelian, (SBZ 21).

**Description:** The specimens have a subspheric small test with imperforate, calcareous, porcellaneous wall. The axial and equatorial diameters range from 0.61 mm to 0.66 mm and from 0.70 mm to 0.78 mm, respectively. The test of the new species is composed of characteristically numerous narrow and low planispiral adult chambers with small chamberlets when compared with *P. afyonica* and *P. oligocenica*. In some sections, very small protoconch is followed by two cycles of undivided quinqueloculine early chambers (Pl. VIII, fig. 6), later undivided chambers arranged in triloculine pattern as in *P. oligocenica* (Pl. VIII, figs. 6, 8). The adult chambers are lined up in planispiral mode and divided into numerous chamberlets by septula. The height of the planispiral whorls increases gradually towards the last whorl. There are 14 divided planispiral chambers in the last whorl (holotype, Pl. VIII, fig. 4) measuring 0.78 mm in diameter.

**Remarks:** *P. minuta* differs from *P. afyonica* and *P. oligocenica* in having smaller test, lower and narrower chambers with small chamberlets.

**Stratigraphic and geographic distributions:** Its stratigraphic range and geographic distribution of *P. minuta* are given in the chapter of *P. oligocenica*.

Superfamily: Soritacea EHRENBERG, 1839

Family: Soritidae EHRENBERG, 1839
Genus: *Archaias* De MONTFORD, 1808

Type species: *Archaias spirans* de MONTFORT, 1808 = *Nautilus angulatus* FICHTEL & MOLL, 1798

*Archaias kirkukensis* HENSON, 1950

(Pl. IX, Figs. 1-8; Pl. X, Fig. 14; Pl. XI, Fig. 1)

**Synonymy:**

1950 *Archaias kirkukensis* HENSON, p. 43, Pl. 7, figs. 3,4,9; Pl. 8, figs. 1-5.

1950 *Archaias cf. aduncus* (FICHTEL & MOLL), HENSON, p. 44, Pl. 8, figs. 6,7.

1958 *Archaias kirkukensis* HENSON, SMOUT & EAMES, p.218, Pl.40, figs.1-8; Pl. 41, figs.12-19.

2003 *Archaias kirkukensis* HENSON, SİREL, Pl. XIII, figs. 1-18.

**Description:** The species has a discoidal test with swollen central boss. The diameter of the test ranges from 2.56 mm to 3.06 mm. Very small microsphere is followed by small undivided, arcuate chambers lined up in a planispiral pattern for one and half whorls, later divided chambers with interseptal partitions arranged in a cyclical mode (Pl. IX, figs. 1, 3-8).

**Stratigraphic and geographic distribution:** According to the following authors, the species was reported from late Oligocene of the type locality, Kerkük, Iraq by HENSON (1950, p. 43). It has been found in Oligocene of Sivas, Central Turkey, by TURNOVSKY (1955) and VAN BELLEN (1956). The existence of *A. kirkukensis* in the Rupelian-early Chattian (SBZ 21, 22) shallowest-water limestones was introduced from the neighbouring locality (Akçadağ, Malatya, Eastern Turkey) by SİREL (2003, p. 295, fig. 4), in that it overlies beds with *Nummulites* group *fabiani, N. cf. incrassatus* de la HARPE, *Rhabdorites*
cf. malatyaensis (SİREL), Asterigerina rotula (KAUFMANN) and orthophragminid species of Priabonian age and it underlies beds with *M. complanata* and *M. borodinensis* of late Chattian age (SİREL, 2003, p. 273, fig. 4).

**Archaias asmaricus** SMOUT & EAMES, 1958

(Pl. IX, Figs. 9-16)

**Synonymy:**

1958 *Archaias hensoni* SMOUT & EAMES, p. 220, Pl. 40, figs. 20-24; Pl. 41, figs. 7,10,20.

**Description:** The definition of this species is based on the holotype of *A. asmaricus* (SMOUT & EAMES 1958, Pl. 41, fig. 7). The species has an inflated lenticular test with rounded periphery. The thickness of the swollen central part decreases toward the periphery (Pl. IX, figs. 10-16). The diameter of the test ranges from 1.66 mm to 2.33 mm, the central thickness from 0.73 mm to 0.83 mm and the peripheral thickness 0.33 mm to 0.43 mm. Very small protoconch is followed by few undivided, arcuate small chambers (Pl. IX, figs. 10, 11), later divided chambers are arranged in planispiral-involute mode (Pl. IX, fig. 9) and the following cyclical adult chambers are divided thin interseptal partitions into numerous small chamberlets.

**Stratigraphic and geographic distribution:** This species is found in the shallowest-water marine limestone of the Tuzlagözü section (Fig. 4) with soritid species *A. kirkukensis* of Rupelian-early Chattian age (SBZ 21,22).

Family: Soritidae EHRENBERG, 1839

Genus: *Praearchaias* SİREL, 1996
Type species: *Praearchaias diyarbakirensis* SİREL, 1996

*Praearchaias diyarbakirensis* SİREL, 1996

(Pl. X, Figs. 1-8)

**Synonym:**


2004 *Praearchaias diyarbakirensis* SİREL, SİREL, p. 52, Pl. 48, figs. 1-7, 13-17, 9.

2007 *Archiaas operculiniformis* HENSON, HOTTINGER, p. 12, Pl. 8, figs. 4,6,7; Pl. 10, fig. 8.

2007 *Archaias diyarbakirensis* (SİREL), HOTTINGER, p. 13, Pl. 7, figs. 2,4,7; Pl. 13, fig. 10; Pl. 15, fig. 7.

**Description:** The megalospheric soritid species has an inflated lenticular test with imperforate, calcareous porcellaneous wall. The diameter of the test ranges from 1.6 mm to 2.6 mm and the thickness from 0.48 mm to 0.8 mm. The large, spherical megalosphere (about 0.160 mm in diameter) is followed by semilunar second chamber (Pl. X, fig. 4), later few undivided arcuate chambers and the last divided chambers of the adult stage are arranged in a planispiral-involute mode throughout ontogeny (Pl. X, figs. 3, 4). The chambers are divided by complete/incomplete interseptal pillars (Pl. X, figs. 4, 7).

**Remarks:** The genus *Praearchaias* (type species *P. diyarbakirensis*) was first described and figured from the Oligocene of Kırkbini village, SW of Diyarbakır, SE Turkey by SİREL (1996, p. 168-169, Pl. 1, figs. 1-7, 13-17). *Praearchaias* absolutely differs from *Archaias* de MONTFORT in that it is devoid of the cyclical adult chambers in the *Archaias*. In addition,
*Praearchaias* has a cribrate areal aperture (*SİREL* 1996, Pl. I, figs. 1, 13,14; 2003, Pl. XIII, figs. 8,14,18) instead of numerous pores on the peripheral band (*SİREL* 2003, Pl. XIII, figs. 7,8).

**Stratigraphic and geographic distribution:** This early Oligocene (Rupelian) species is found in the shallowest-water marine limestone of the Bakımlı section (Fig. 3) with two new species, *P. oligocenica* and *P. minuta*. It is found in the lower part of the (SBZ 21, 22) Tuzlagözü section with the other foraminiferal species (see Fig.4).

*Praearchaias minimus* **SİREL, 2004**

(Pl. X, Figs. 8-13)

**Synonymy:**

1996 *Praearchaias* sp. *SİREL*, p. 169, Pl. 1, figs. 8-12,18.

2003 *Praearchaias* sp. *SİREL*, *SİREL*, p. 296, Pl. X, figs. 8-12,18.

2004 *Praearchaias minimus* *SİREL*, p. 52, Pl. 48, figs. 8-12, 17, 18.

**Description:** It has small, inflated lenticular test with imperforate, calcareous, porcellaneous wall. The diameter of the test ranges from 0.8 mm to 1.3 mm and the thickness from 0.36 mm to 0.75 mm. The small, spheric megalosphere (0.08-0.13 mm in diameter) is followed by semilunar second chamber (Pl. X, figs. 8, 10, 13) and few undivided arcuate small chambers (Pl. X, fig. 9), later subrectangular adult chambers by interseptal pillars (Pl. X, fig. 9) are lined up in planispiral-involute whorls throughout ontogeny.

Superfamily: Rotaliacea EHRENBERG, 1839

Family: Austrotrillinidae LOEBLICH & TAPPAN, 1986
Genus: *Austrotrillina* PARR, 1942

Type species: *Trillina howchini* SCHLUMBERGER, 1893

*Austrotrillina brunni* MARIE, 1955

(Pl. XI, Figs. 2-17)

**Synonymy:**

1955 *Austrotrillina brunni* MARIE, p.203, Pl.9, figs.4-8.

1968 *Austrotrillina brunni* MARIE, ADAMS, p.85, Pl.6, figs. 6, 8.

2003 *Austrotrillina brunni* MARIE, SİREL, p.294, Pl. X, figs. 10-16.

**Description:** Test is small and has rounded peripheral margin. The transverse diameter of the test ranges from 0.88 mm to 1.19 mm, the longitudinal diameter from 1 mm to 1.27 mm. The spheric megalosphere (0.100-0.138 mm in diameter) is followed by small undivided chambers arranged in probably triloculine mode (Pl. XI, figs. 2-6, 9, 11, 12, 14). Later adult chambers with fine subepidermal partitions are also lined up in triloculine pattern (Pl. XI, figs. 3, 12). Two kinds of subepidermal partitions form small alveolar compartments (Pl. XI, figs. 16, 20).

**Stratigraphic and geographic distribution:** This species is found in the Rupelian shallowest-water marine limestones of the Bakımlı section (Fig. 3) with *P. oligocenica*, *P. minuta*, *P. diyarbakirensis* and *S. egribucakensis*. 
Figure 7. Stratigraphic distribution of the Oligocene lagoonal-very shallow-water foraminiferal species in the benthic bio-zone of CAHUZAC & POIGNANT (1997, 1998).

4. CONCLUSION AND DISCUSSION

All over the Turkish territory, the lagoonal-shallowest-water marine limestones with porcellaneous calcareous foraminifera such as alveolinid, soritid, peneroplid, austrotrillinid and miliolid species are virtually absent in the depositional successions in the Oligocene age. Exceptions, interesting early Rupelian shallowest-water marine spot limestone samples with
soritid, peneroplid, austrotrillinid and miliolid species have previously been reported from the Kırkbini village, SW of Diyarbakır, southern Turkey by SİREL (1996) and Rupelian-early Chattian shallowest-water marine limestone sequence with mainly soritid and austrotrillinid species from the Develi village, W of Malatya, eastern Turkey by SİREL (2003, Fig. 4,14). The studied lagoonal/shallowest-water marine Oligocene successions in the Sivas Basin with the miliolid, alveolinid, peneroplid and soritid species were noticed. The described miliolid new genus Sivasina (type species S. egribucakensis n.gen.n.sp) is a unique foraminifer among all here described foraminiferal taxon of the Sivas basin, because it is occurred in all studied sections (Figs. 2-5). The lagoonal-shallowest-water new miliolid species with trematophorid aperture is appeared in the Bakımlı section (Fig. 3) with early Rupelian species P. diyarbakirensis, P. minimus SİREL (1996) on the one hand and it appears below the late Chattian shallow-water algal limestone of Eğribucak section (Fig. 2) with M. borodinensis and M. cf. complanata on the other hand. Therefore, its biostratigraphic range has been introduced as Rupelian-early Chattian (SBZ 21, 22). The lagoonal argillaceous limestone observed between the gypsum beds in the Eğribucak section (Fig. 2), yielded abundant miliolid and peneroplid species such as S. egribucakensis, P. flabelliformis, P. cf. laevigatus, C. sivasensis and C. elongata. Two new peneroplid species C. sivasensis, C. elongata and known species P. cf. laevigatus are only observed in the basal level of the Oligocene sequence in the Eğribucak section (Fig. 2). Considering the biostratigraphic range of S. egribucakensis in Bakımlı section, Rupelian age has been accepted for these two new peneroplid species and P. cf. laevigatus. The other species P. flabelliformis is found together with S. egribucakensis of Rupelian-early Chattian age in the Eğribucak section (Fig. 2). Two new alveolinid species P. oligocenica and P. minuta have only been found in the very shallow-water marine limestones of the Bakımlı section (Fig. 3) with P. diyarbakirensis and P. minimus of early Rupelian age. According to SİREL (1996, 2003, Fig. 14, 2004, s. 52), foregoing two soritid
species and their foraminiferal companions *P. delicata, Austrotrillina striata* TODD & POST indicate early Rupelian age. In addition, the existence of *Praebullalveolina* in the early Rupelian shallowest-water limestone of the Priabona region, Vicentin, Italy BARBIN et al. (1997), supported an early Rupelian age for two *Praebullalveolina*’s species.

<table>
<thead>
<tr>
<th>STAGES &amp; BIO-ZONES</th>
<th>ENVIRONMENTS</th>
<th>LAGOONAL</th>
<th>VERY SHALLOW WATER</th>
<th>SHALLOW WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARLY MIO. SBZ 24</td>
<td></td>
<td></td>
<td>Miogypsinid species and others</td>
<td></td>
</tr>
</tbody>
</table>
| LATE CHATTIAN SBZ 23 |              |          | *M. borodinensis*  
|                    |              |          | *M. cf. complanata*  
|                    |              |          | *Marasella sp.*  
|                    |              |          | *Postmiogypsinella sp.*  
|                    |              |          | *Miolepidoyclina sp.* |
| RUPELIAN-EARLY CHATTIAN SBZ 21-22 | S. egribucakensis  
|                                 | *A. asmaricus*  
|                                 | *P. flabelliformis*  
|                                 | *A. kirkukensis*  
|                                 | *P. flabelliformis*  
|                                 | *P. diyarbakirensis*  
|                                 | *P. minutus*  
|                                 | *S. egribucakensis*  
|                                 | *Prae. oligocenica*  
|                                 | *Prae. minuta*  
|                                 | *A. brunni* |
| LEOCENE SBZ 19-20 |              |          |                    |                |

Figure 8. Showing the distribution of the larger benthic foraminiferal species in the lagoonal-very shallow–shallow marine environments.
ACKNOWLEDGMENTS
This study was carried out as part of project ÇAYDAG- 109Y041, supported by the Scientific and Technological Research Council of Turkey (TÜBITAK).

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Plate I

*Peneroplis flabelliformis* n. sp., SİREL & ÖZGEN-ERDEM

Rupelian-early Chattian, all figs from Eğribucak section, X40

1- incomplete equatorial section, showing planispiral early, flabelliform adult and cyclical senile chambers (Eb.11/36),

2- incomplete equatorial section (Eb.11/64),

3- equatorial section (Eb.11/46),

4- equatorial section (Eb.11/107),

5- axial section (Eb.11/40),

6- equatorial section (Eb.11/40),

7- equatorial section (Eb.11/101),

8- incomplete equatorial section (Eb.11/21),

9- equatorial section (Eb.11/76),

10- slightly oblique axial section (Eb.13/19h),

11- axial section (Eb.11/65),

12- axial sections of the cyclical form (Eb.11/21),

13- non centered equatorial section (Eb.11/21),

14- subaxial sections of cyclical forms (Eb.13/19),
Plate II

*Peneroplis flabelliformis* n. sp., SİREL & ÖZGEN-ERDEM

Rupelian-early Chattian, all figs from Eğribucak section, X40

1- incomplete equatorial section and equatorial sections of *Sivasina egribucakensis* n. gen. n. sp. (mid-bottom and upper right) (Eb.11/71),

2- incomplete equatorial sections (top), subaxial section (mid), equatorial sections of *S. egribucakensis* (bottom and upper left) (Eb.11/63),

*Peneroplis cf. laevigatus* d'ORBIGNY, 1839

Rupelian-early Chattian, all figs from Eğribucak section, X40

3- equatorial section (bottom left and almost equatorial section of *Coscinospira* (upper) (Eb.11/25),

4- equatorial section showing planispiral early and fan like adult chambers (Eb.13/19g),

5- equatorial section (Eb. 11),

6- equatorial section (Eb.11/98),

7- equatorial section (left) and *Sivasina* sp. (right) (Eb.11/11),

8- equatorial section, note, numerous openings on the flabelliform chamber (Eb.11/73),

9- equatorial section showing numerous openings on the flabelliform chambers (Eb.11/123),

10- equatorial section of young form (Eb.31/1g),

11- equatorial section showing numerous openings on the flabelliform chambers (Eb.11/123),

*Coscinospira sivasensis* n. sp.

Rupelian-early Chattian, all figs from Eğribucak section, X40
12- slightly oblique equatorial section, showing single foramina in the planispiral and cribrate aperture in the uncoiled chambers (Eb.11/03),

13- equatorial section (Eb.11/18),

14- equatorial section showing cribrate aperture in the last planispiral and uncoiled chambers (Eb.11/30),

15- equatorial section showing cribrate aperture in the uncoiled, single foramina in the planispiral chambers (Eb.11/21),

16- equatorial section of *C. elongata* (Eb.11/10),

17- equatorial section (Eb.11/57),

18- equatorial section (Eb.11/45).
Plate III

Coscinospira sivasensis n. sp., SİREL & ÖZGEN-ERDEM

Rupelian-early Chattian, all figs from Eğribucak section, X40,

1- equatorial sections (upper), axial and oblique sections of S. egribucakensis n. gen. n. sp. (bottom) (Eb.11/124a),
2- equatorial section showing cribrate aperture in the uncoiled chambers (bottom) and subequatorial section (upper) (Eb.11/26),
3- equatorial section (bottom) and oblique section of S. egribucakensis (upper) (Eb.11/75),
4- equatorial section (Eb.11/103),
5- equatorial section (bottom) and uncoiled chambers of C. elongata n. sp. (Eb.11/50).

Coscinospira elongata n. sp.

6- centered longitudinal section showing cribrate aperture in the uncoiled chambers (Eb.11/21),
7- centered longitudinal section (Eb.11/128),
8- centered longitudinal section of the large specimen, tending to C. sivasensis (Eb.11/49),
9- centered longitudinal section (Eb.11/58),
10- longitudinal section showing reproduction of the embryo (Eb.11/14),
11- non centered longitudinal section showing cribrate aperture in the rectilinear chambers, equatorial section of C. sivasensis (mid-left) (Eb.11/88),
12- almost longitudinal section showing single foramina in the planispiral and cribrate aperture in the uncoiled stages (left) and equatorial section of C. sivasensis showing single foramen in the early planispiral chamber an cribrate aperture at the last chamber (upper right) (Eb.11/27),
13- non centered longitudinal section showing uncoiled chambers lined up in a long serie.
Plate IV

*Sivasina egribucakensis* n. gen. n. sp., SİREL & ÖZGEN-ERDEM

Rupelian-early Chattian, all figs from Eğribucak section, X60

1- axial section showing cribrate aperture lower ultimate chamber (Eb.33/1e),

2- axial section (Eb.33/1e),

3- axial section, A form (Eb.11/17),

4- axial section of the biumbilicate specimens (mid-left) and tangential section passing from the rectilinear chambers showing apertural face with ribs (bottom) and cribrate aperture in the rectilinear chamber (Eb.33/1e-08),

5- oblique section (Eb.33/1e),

6- axial section with uncoiled chamber, B form (top) and oblique sections (bottom) (Eb.11/08),

7- axial section (Eb.11/34),

8- axial section (Eb.33/1e),

9- equatorial section tending to uncoil (Eb.33/1e),

10- axial section (top) and subequatorial section (bottom) (Eb.11/2),

11- slightly oblique axial section (Eb.33/1e),

12- axial section (Eb.33/1e),

13- axial section, A form showing cribrate aperture at the upper penultimate chamber (Eb.33/1e),

14- oblique section, B form (Eb.33/1e).
Plate V

*Sivasina egribucakensis* n. gen. n. sp., SİREL & ÖZGEN-ERDEM

Rupelian-early Chattian, all figs from Eğribucak section, X60

1- axial and oblique sections (Eb.11/66),

2- equatorial section (Eb.33/1e),

3- axial section showing aperture at the upper penultimate chamber (Eb.33/1e),

4- slightly oblique equatorial and axial sections (Eb.11/78),

5- equatorial section with deformed last three chambers (Eb.33/1e),

6- axial sections (Eb.33/1e-147),

7- tangential section showing terminal aperture with thin ribs (Eb.33/1e-142),

8- axial section showing apertural face with ribs at the upper ultimate chamber (Eb.33/1e-145),

9- deformed subaxial section showing aperture with ribs at the upper ultimate chamber (Eb.33/1e),

10- oblique sections (Eb.11/92).
Plate VI

*Sivasina egribucakensis* n. gen. n. sp., SİREL & ÖZGEN-ERDEM

Early Rupelian, all figs from Bakımlı section, except Fig. 6 from Eğribucak section, X60

1- subaxial section (bottom), subaxial section of *Praearchaias minimus* SİREL (mid) and tangential section of *Praebullalveolina* sp. (Bak.16/5),

2- axial section (Bak.16/2),

3- slightly oblique equatorial section showing cribrate aperture in the uncoiled chambers (Bak.17/4),

4- axial section (Bak.16/6),

5- axial section showing apertural face with ribs at the left penultimate chamber (Bak.17/4),

6- equatorial section showing cribrate aperture in the last chamber (Eb.33/1e-95).

*Praebullalveolina oligocenica* n. sp.

7- almost equatorial section (Bak.16/13),

8- equatorial section of the small B form (Bak.16/13).
Plate VII

_Praebullalveolina oligocenica_ n. sp., SİREL & ÖZGEN-ERDEM

Early Rupelian, all figs from the Bakımlı section, X 60

1- centered equatorial section, holotype, B form, showing two rows of quinqueloculine and one row of triloculine undivided chambers and planispiral adult chambers with main and secondary aperture (Bak.16/7),

2- equatorial section (Bak.16/2),

3- slightly oblique axial section, B form (Bak.16/5),

4- subaxial section (Bak.16/1),

5- slightly oblique subaxial section (Bak.16/6),

6- slightly oblique non centered equatorial section (Bak.16/9),

7- oblique section (Bak.16/5),

8- non centered equatorial section (Bak.16/5),

9- tangential section showing one row of alveols in the upper penultimate whorl (Bak.16/1).
Plate VIII

_Praebullalveolina oligocenica_ n. sp., SİREL & ÖZGEN-ERDEM

Early Rupelian, all figs from Bakımlı section, X60

1- equatorial section, B form, showing two rows of quinqueloculine undivided early chambers, one and half row of triloculine undivided chambers and planispiral adult chambers with main, secondary aperture (Bak.16/7),

2- slightly oblique subequatoial section (Bak.16/7),

_Praebullalveolina minuta_ n. sp.:

3- non centered equatorial section (Bak.16/5),

4- almost equatorial section, B form, holotype, showing main and secondary apertures (Bak.16/8),

5- oblique section (Bak.16/8),

6- centered oblique section, showing two rows of quinqueloculine, undivided early chambers, one or more triloculine undivided chambers (Bak.16/5),

7- oblique subaxial section (Bak.16/9),

8- almost axial section showing small chamberlets (Bak.16/5),

_Praebullalveolina_ sp.

9- almost equatorial section showing two may be more rows of quinqueloculine, undivided early chambers and planispiral, divided adult chambers with main and secondary aperture (Bak.16/1).
Plate IX

*Archaia* kirkukensis* HENSON

Rupelian-early Chattian, Figs. 1, 2 from spot samples collected on the Hafik-Sivas road (ES), Figs. 3-8 from Tuzlagözü section, all figs. X30

1- non centered incomplete equatorial section, B form (ES. 1-L48),
2- equatorial section of young B form (ES.1m-L 46),
3- subaxial section (Tzg. 1/8-6),
4- tangential section showing interseptal pillars (Tzg. 2/1),
5- incomplete subaxial section (Tzg. 1/2-2),
6- centered axial section (Tzg.1/2-1),
7- subaxial section (Tzg.1/6-6),
8- axial section (Tzg.1/2).

*Archaia* asmaricus* SMOUT & EAMES*

Rupelian-early Chattian, Figs. 9, 11-13, 15, 16 are spot samples collected on the Hafik-Sivas road (ES), Figs. 10, 14 from Tuzlagözü section, X30

9- subaxial section (ES.1f-K 521),
10- centered incomplete equatorial section (Tzg.1/7),
11- subequatorial section (ES.1f-K 517),
12- sub axial section (ES.1L-L51),
13- oblique equatorial section (ES.1K-K 523),
14- oblique equatorial section (Tzg.1/1b),
15- oblique section (ES.1f- K516),
16- subaxial section (ES.1L-L50).
**Plate X**

*Praearchaias diyarbakirensis* SİREL

Early Rupelian, all figs. from Bakımlı section (Fig. 3), X30

1- subaxial sections (Bak. 16/14),

2- Oblique axial section (Bak.16/4),

3- axial section (Bak.16/8),

4- incomplete axial section (Bak.16/9),

5- tangential section, showing cribrate aperture (mid) (Bak.16/9),

6- tangential section (Bak.16/9),

7- axial section with large megalosphere (Bak.16/8);

*Praearchaias minimus* SİREL,

early Rupelian, Figs. 8-10,12,13 from Tuzlagölü section; Fig. 11 from Bakımlı section, all figs. X 30.

8- axial section with small protochonch (Tzg. 2),

9- equatorial section (Tzg. 2),

10- axial section (Tzg. 1/6),

11- axial section (Bak.17/1),

12- axial section (Tzg. 2/1),

13- axial section of broken specimen (Tzg. 2/1),

14- *A. kirkukensis*, subaxial section of broken specimen (bottom), horizontal section of *Haymanella* (top left) and *Peneroplis* sp. (mid-top) (Tzg. 2/1).
Plate XI

Early Rupelian, all figs from Bakımlı section, all figs. X36, except Fig. 1, X30

*Archaia kirkukensis* HENSON

1- incomplete equatorial section (Es.1k-K525).

*Austrotrillina brunni* Marie

2- transverse section (Bak.15a),

3- transverse section (Bak.15c),

4- transverse section (Bak.18a),

5- transverse section (Bak.15b),

6- transverse section (Bak.175g),

7- longitudinal section (Bak.15d),

8- longitudinal section (Bak.15a),

9- subtransverse section (Bak.15c),

10- longitudinal section (Bak.15b),

11- subtransverse section (Bak.15a),

12- transverse section (Bak.15g),

13- longitudinal section (Bak. 15c),

14- transverse section (Bak.15f),

15- sublongitudinal section (Bak.15c),

16- tangential section showing subepidermal partitions (Bak.15a),

17- transverse section (Bak.15d),

*Austrotrillina* sp1.,
18- longitudinal section (Bak.15e),

19- transverse section (Bak.18a),

20- tangential section showing subepidermal partitions on the external part of the chamber (Bak.15g),

Austrotrillina sp2.,

21- transverse section (Bak.15g),

22- subtransverse section (Bak.15c).