Geologia Croatica | 66/2 | 83–109 | 8 Figs. | | 11 Pls. | Zagreb 2013

Systematics and biostratigraphy of Oligocene (Rupelian-Early Chattian) foraminifera from lagoonal-very shallow water limestone in the eastern Sivas Basin (central Turkey)

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doi: 10.4154/gc.2013.07

Geologia Croatica

ABSTRACT

The aim of the present work is to describe the Oligocene (Rupelian-early Chattian) shallow water larger foraminifera from central Turkey (Sivas Basin). Among them is a new miliolid genus, *Sivasina* n. gen. SİREL & ÖZGEN-ERDEM (type species *Sivasina egribucakensis* n. gen. n. sp. SİREL & ÖZGEN-ERDEM), which occurs in the Eğribucak, Bakımlı, Tuzlagözü and Çaygören sections (E of Sivas). One new Rupelian-early Chattian lagoonal very shallow 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 very shallow 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, details on several already known Oligocene species are given (soritids: *Praearchaias diyarbakirensis* SİREL, *Praearchaias minimus* SİREL, *Archaias kirkukensis* HENSON, *Archaias asmaricus* SMOUT & EAMES; austrotrillinids: *Austrotrillina brunni* MARIE). In addition, the biostratigraphy of four studied sections is discussed.

Keywords: Oligocene, benthic foraminifera, systematics, 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 in 2009-2012 by the Department of Geological Engineering of Cumhuriyet (Sivas), at the universities of Ankara, Hacettepe (Ankara), Dumlupınar (Kütahya), Ege (İzmir) and Onsekizmart (Çanakkale) and at the Geological Mapping Department of MTA. The Oligocene (Rupelian-early Chattian) lagoonal-very shallow water larger foraminifera, including alveolinids, soritids, peneroplids, austrotrillinids and miliolids and their biostratigraphy were investigated as a part of this project.

According to our current knowledge marine sediments of Danian-Bartonian age are very widespread in the territory of Turkey. On the contrary, continental deposits are observed mostly after Bartonian stage at the Çankırı, Sivas and similar basins, as well as those of Oligocene age. Throughout the Mediterranean region, at the end of Bartonian or at the beginning of Priabonian, important paleogeographic, sedimentary and faunal (particularly in benthic foraminifera) changes occurred. These may be connected with tectonic movements

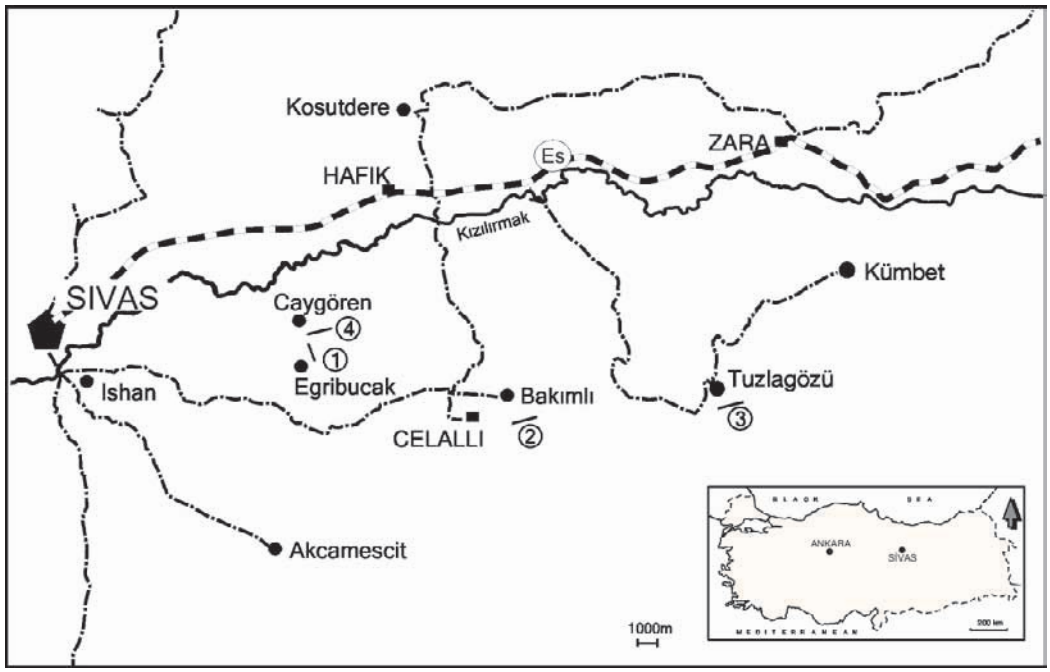


Figure 1: Location map of study area and stratigraphic sections. 1 – Eğribucak section, 2 – Bakımlı section, 3 – Tuzlagözü section, 4 – Çaygören section, ES – spot samples.

(particularly orogeny) causing major regressions. These changes are reflected in different ways in the study area, resulting in different facies developments benthic foraminiferal assemblages. The lagoonal, very shallow to 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.

Throughout the Mediterranean region, the very shallow water marine environments with porcellaneous foraminifera are virtually absent in the depositional sequences of Oligocene age. As yet, these depositional environments have been recorded from the Middle-East, Iran and Iraq by HENSON (1950), SMOUT & EAMES (1958), HOTTINGER (2007), AMIRSHAHKARAMI & TAHERI (2009), AMIRSHAHKARAMI et al. (2010), BENEDETTI (2010), SEYRAFIAN et al. (2011) and AMIRSHAHKARAMI (2013). In the Mediterranean area exceptions containing the very shallow water marine limestone with benthic foraminifera have previously been reported from the Forebetic of Moratalla, Spain (HOTTINGER, 1963), France (BIGNOT, 1972, p. 102, Pl. 1, fig. 4), Priabona, Italy (BARBIN & BIGNOT, 1986; BARBIN et al., 1997; BASSI et al., 2007), southern Apulia (ESU et al., 1994), Sicily (BENEDETTI, 2010) and the Ionian Islands, Western Greece (DI CARLO et al., 2010). In Turkey, interesting Early Oligocene very shallow water marine spot limestone samples with porcellaneous foraminifera (mainly soritids, miliolids, peneroplids and austrotrillinids species) have previously been reported from the Kırkbini village, SW Diyarbakır, southern Turkey by SİREL (1996) and Rupelian-early Chattian very shallow water marine limestone sequence with soritids, miliolids and austrotrillinids species from the Develi village, W of Malatya, E Turkey by SİREL (2003, Figs. 4, 14). In the studied area, interesting Rupelian-early Chattian lagoonal, four very shallow and shallow water lithologic successions were investigated with special reference 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 Central Turkey (Fig. 1) as follows.

The Eğribucak section, located near the Eğribucak village (E of Sivas) (Fig. 2), is the type locality of several new foraminiferal taxa, namely, the new miliolid genus *Sivasina* n. gen. (type species *S. egribucakensis* n. gen. n. sp.) and the new peneroplid species *Peneroplis flabelliformis* n. sp., *Coscinospira elongata* n. sp. and *C. sivasensis* n. sp. *S. egribucakensis* n. gen. n. sp. and *P. flabelliformis* n. sp. are recognized from the Rupelian-early Chattian (SBZ 21, 22) sequence of the Eğribucak section, whereas. *C. sivasensis* n. sp. and *C. elongata* n. sp. occur in the basal lagoonal clayey limestone of the Rupelian sequence of the section. The top shallow water algal limestone contains *Miogypsinella borodinensis* HANZAWA, *Miogypsinella* cf. *complanata* (SCHLUMBERGER), *Marasella* sp., *Postmiogypsinella* sp. and an undetermined miogypsinid species indicating a late Chattian age (SIREL & IŞIK, 2011; SIREL & GEDIK, 2011). Analogous Chattian assemblages have been reported from the Venetian Area (NE Italy) and from southern Apulia (Italy) by BASSI et al. (2007) and BENEDETTI & BRIGUGLIO (2012), respectively.

Another interesting succesion, here referred to as the Bakımlı section (Fig. 3) (samples Bak. 1 to 21) is situated southeast of the Bakımlı village, E of Sivas. The sandy limestone and limestone beds ranging from 15 to 21 are the type locality of *P. oligocenica* n. sp. and *P. minuta* n. sp. Two additional known Rupelian soritid species *P. diyarbakirensis* SİREL and *P. minimus* SİREL (SİREL, 1996, Pl. I and SİREL, 2003, Fig. 14) co-occur with the two new alveolinid species.

The Tuzlagözü section (Fig. 4) is an interesting succesion for the shallow/very shallow water Oligocene foraminifera, located SE of Tuzlagözü village, E of Sivas. The very shallow water limestone samples ranging from Tzg. 1 to Tzg. 5 yielded *S. egribucakensis*, *P. diyarbakirensis*, *P. minimus*, *P. flabelliformis* n. sp., *Peneroplis evolutus* HENSON and *A. kirkukensis* HENSON of Rupelian-early Chattian age. On the contrary, the top shallow water algal limestone beds ranging from sample Tzg. 6 to sample Tzg. 8 comprise *M.* cf. *complanata*, *Marasella* sp. (primitive type), an undetermined miolepidocyclinid species, *Planorbulina bronnimanni* BIGNOT & DECROUEZ, *Spiroclypeus* sp. and *Amphistegina* sp. of late Chattian age.

The last studied section is Çaygören (Fig. 5) ranging from sample Buc. 1 to sample Buc. 15 is situated SE of Çaygören village, E of Sivas. The lower part of the sequence, ranging from sample Buc. 1 to Buc. 12, is composed of limestone and sandy limestone with *S. egribucakensis* n. gen. n. sp. *P. flabelliformis* n. sp., *P. evolutus*, *Peneroplis* sp., *Archaias asmaricus* SMOUT & EAMES, and *Archaias* sp. of Rupelian-early Chattian age (SBZ 21, 22), thus indicating a very shallow water marine environment for the lower part of the Oligocene Çaygören sequence. Conversely, the top shallow water algal limestone of the Çaygören succession, ranging from sample Buc. 13 to sample Buc. 15, contains *M. borodinensis*, *M.* cf. *complanata*, *Marasella* sp., *Postmiogypsinella* sp. and undetermined miogypsinid species of late Chattian age (SBZ 23). The stratigraphic distributions in the studied sections of the here described Rupelian–early Chattian lagoonal-very shallow water foraminiferal species can be correlated with the shallow benthic zones of CAHUZAC & POIGNANT (1997) and be referred to lagoonal-very shallow water environments.

The description of the new foraminiferal taxa and the already known Oligocene species is by E. SİREL and N. ÖZGEN-ERDEM, as well as the interpretation of their structural elements, 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 the 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 labels shown in Pls. I-XI.

2. STUDIED SECTIONS

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

2.1. Eğribucak section

The well-exposed Oligocene sequence with new lagoonal-very shallow foraminiferal species *S. egribucakensis* n. gen. n. sp., *P. flabelliformis* n. sp, *C. sivasensis* n. sp and *C. elongata* n. sp. is located NE of Eğribucak village, E of Sivas (map reference İ38; coordinates 39°43’48.08’’N; 37°16’33.84’’E). Lithologically, the Eğribucak section (Fig. 2) commences with thick bedded sandstone (probably Eocene in age) and ranges to the shallow water algal limestone with *M. borodinensis*, *M.* cf. *complanata*, *Marasella* sp., *Postmiogypsinella* sp. and an undetermined miolepidocyclinid species of late Chattian age. As shown in Fig. 2, the lagoonal argillaceous limestone with miliolids and peneroplids species, that lies between gypsum beds, has a particularly interesting foraminiferal content.

The lithologic units and their foraminiferal content are given in Fig. 2.

2.1.1. Biostratigraphy

The following biostratigraphic benthic biozones are recognized 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. egribucakensis*.n. gen. n. sp. The first appearance of *M. borodinensis* and *M.* cf. *complanata* defines the upper boundary of the unit. The occurrence of the lagoonal peneroplid species *P. flabelliformis* n. sp, *C. sivasensis* n. sp., *C. elongata* n. sp. and known peneroplid species *P. evolutus* is 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. Bakımlı section

This is the most representative succession in the territory of Turkey as regards the Rupelian very shallow water limestone with the new alveolinid species *Praebullalveolina oligocenica* and *P. minuta*. The outcrop (Fig. 3) is situated 2 km SE of Bakımlı village, SE Hafik, NE Sivas (map reference İ38, coordinates 39°17’78’’N; 37°29’13.11’’E). The Eocene sequence ranging from Bak. 1 to Bak. 13 is composed of alternation of marl, sandstone and sandy limestone beds. The second lithostratigraphic unit ranging from Bak. 14 to Bak. 21 consists of very shallow water marine limestone with benthic foraminiferal species of Rupelian age (SBZ 21). The third lithostratigraphic unit, which is composed of sandstone and siltstone (Fig. 3), was likely deposited in a continental environment.

The lithologic units and their very shallow/shallow water benthic and planktonic (determined by Dr. Aynur HAKYEMEZ) foraminiferal species are given in Fig. 3.

2.2.1. Biostratigraphy

SBZ 21 (Rupelian): The middle part of the Bakımlı sequence (Fig. 3) ranging from Bak. 14 to Bak. 21, yields a significant very shallow water marine foraminiferal assem-

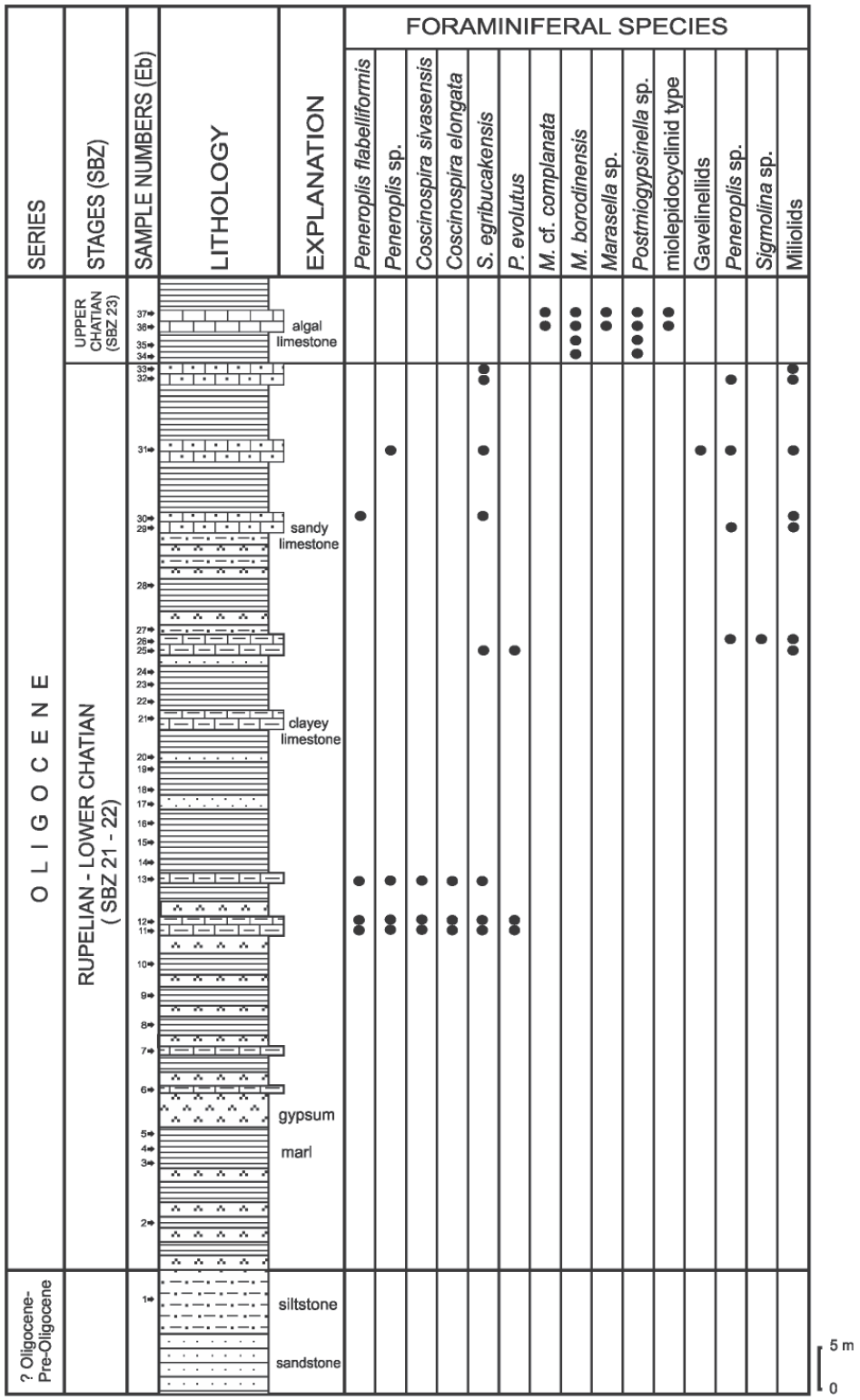


Figure 2: Stratigraphic distribution of the foraminiferal species in the Eğribucak section.

blage, that consists of *P. oligocenica* n. sp., *P. minuta* n. sp., *P. diyarbakirensis, P. minimus, A. kirkukensis, A. brunni, S. egribucakensis* n. gen. n. sp. and *Heterillina* sp. of Rupelian age. This foraminiferal association may be correlated with SBZ 21 of CAHUZAC & POIGNANT (1997) with *Borelis pygmaea* (HANZAWA), *Praerhapydionina delicata* HENSON, *Bullalveolina bulloides* REICHEL and austrotrillinid species of ADAMS (1967) and corresponds to the early Rupelian very shallow water limestone with *P. diyarbakirensis, P. minimus, P. delicata, A. brunni* and other species of Diyarbakır region, SE Turkey (SİREL, 1996, 2003, Fig. 14).

2.3. Tuzlagözü section

A further interesting Oligocene succession (Fig. 4) with peneroplids, soritids, miliolids and miogypsinids species is situ-

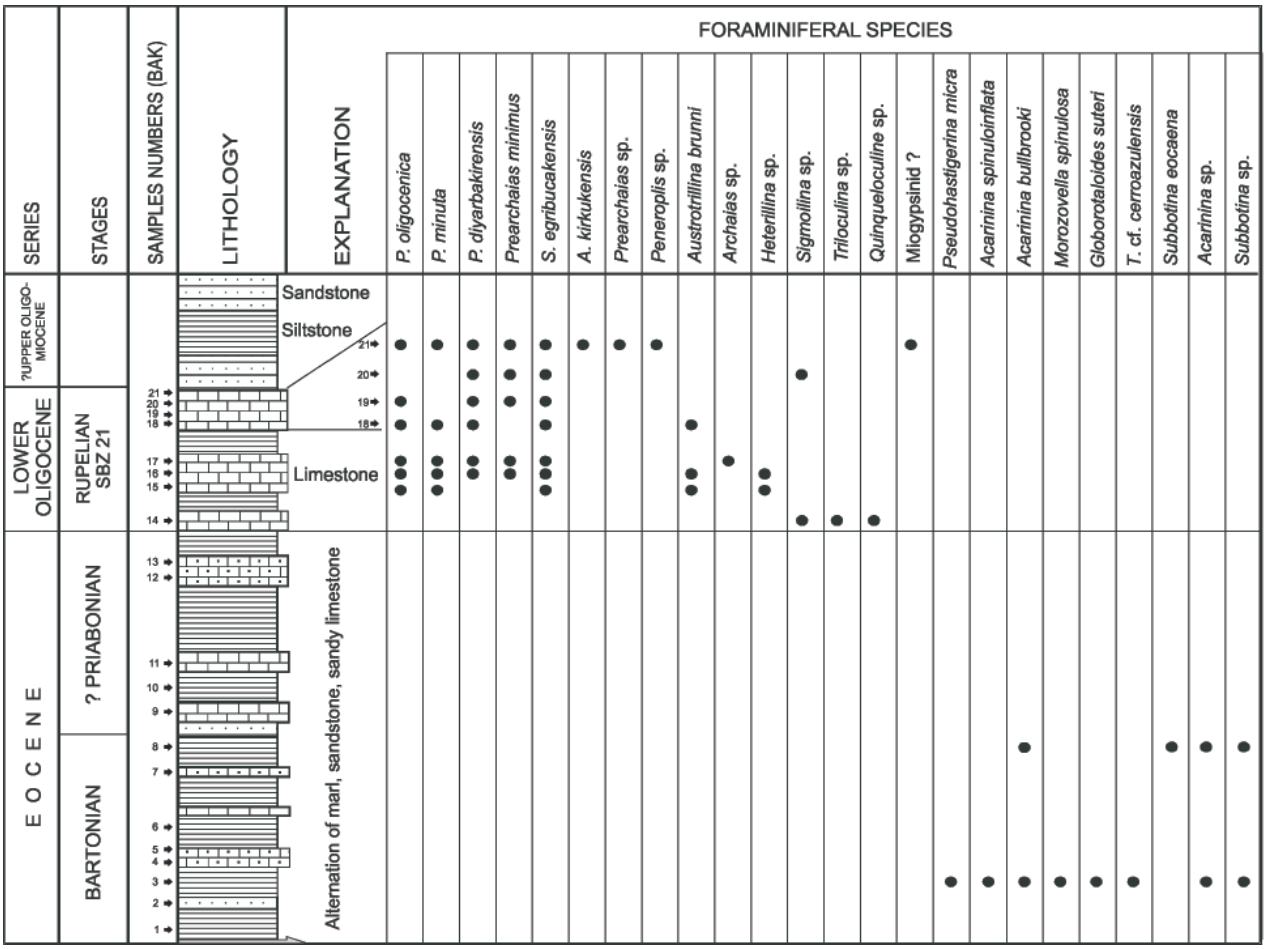


Figure 3: Stratigraphic distribution of the foraminiferal species in the Bakımlı section.

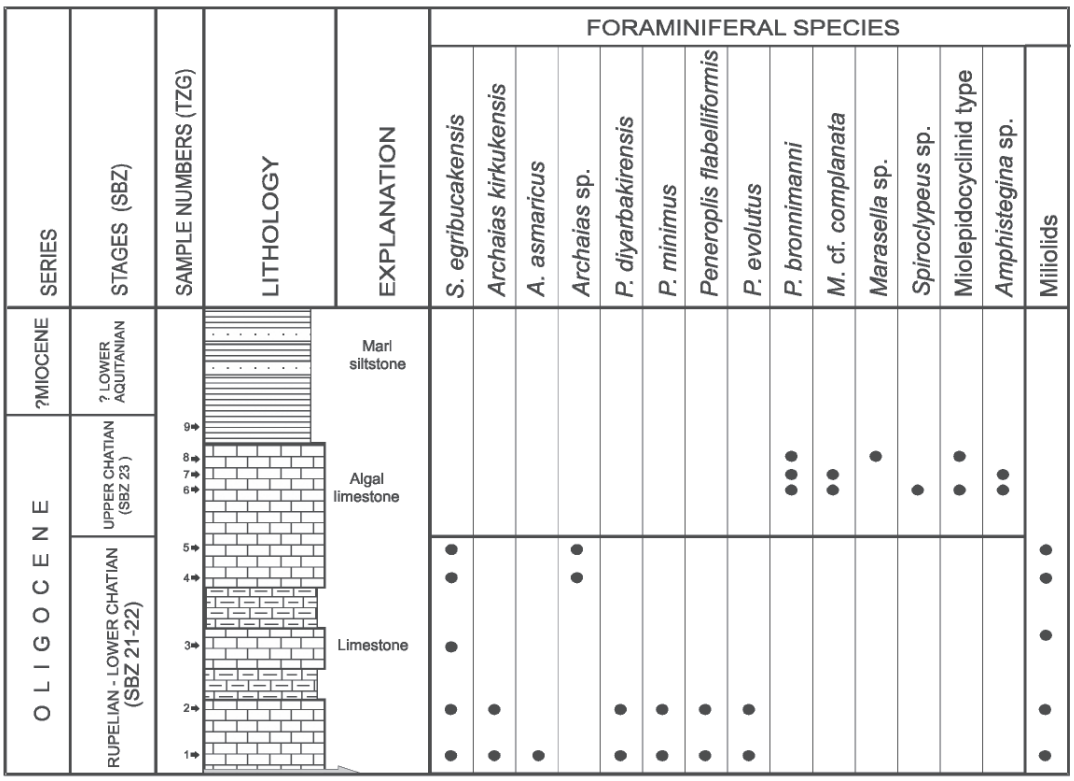


Figure 4: Stratigraphic distribution of the foraminiferal species in the Tuzlagözü section.

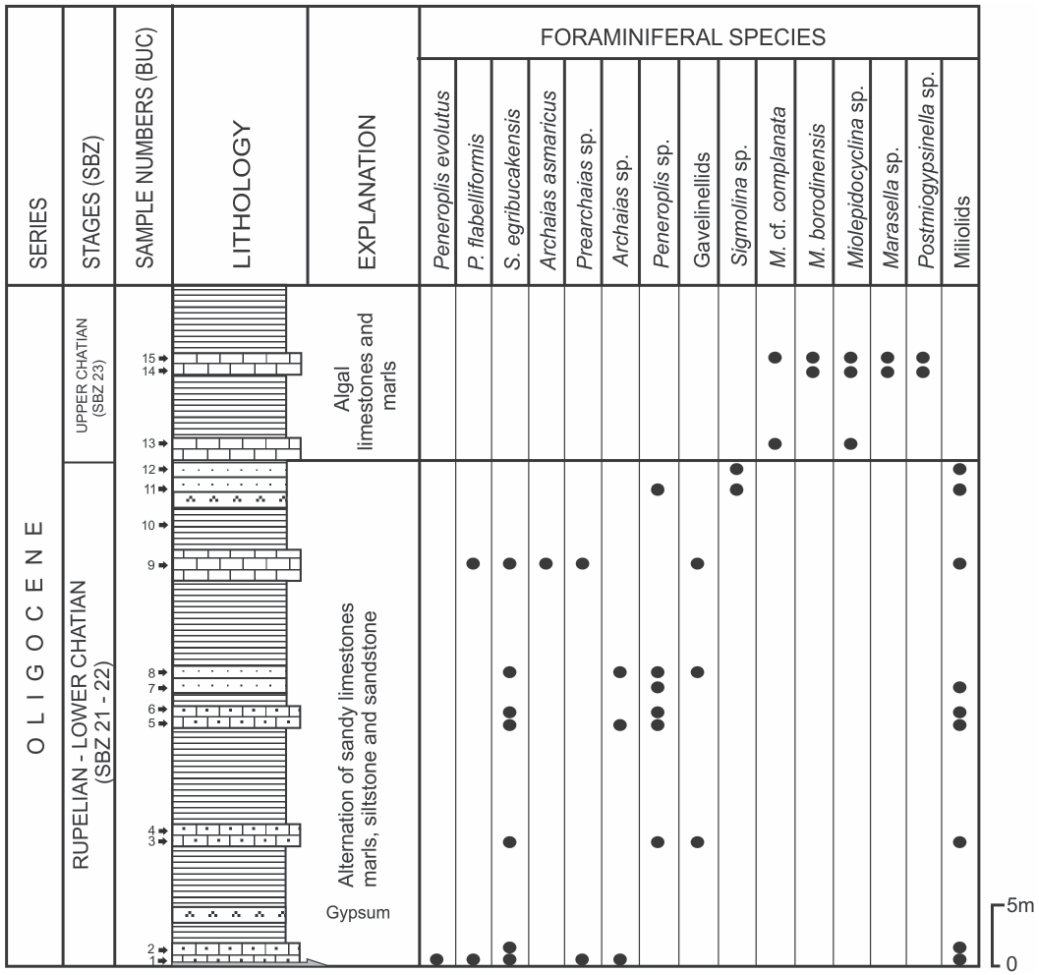


Figure 5: Stratigraphic distribution of the foraminiferal species in the Çaygören section.

ated near the Tuzlagözü village, S Zara town, E of Sivas (map references İ38; coordinate 39°42'45''N; 37°40' 41.23''E). The section commences with limestone and ends with marl beds of early Miocene age (Fig. 4). The lower part of the Tuzlagözü succession that ranges from sample Tzg. 1 to sample Tzg. 5 deposited in very shallow water marine environment with peneroplids, soritids and miliolids species of Rupelian-early Chattian age, as opposed to the upper part of the sequence, in which the algal limestone with miogypsinid species are developed in a deeper, shallow water environment.

The lithologic units and their very shallow/shallow water foraminiferal species are given in Fig. 4.

2.3.1. Biostratigraphy

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

SBZ 21–22 (Rupelian-early Chattian): Defined by the biostratigraphic range of *S. egribucakensis* n. gen. n. sp. Foraminiferal species such as *A. kirkukensis, P. diyarbakirensis, P. flabelliformis* n. sp., *P. evolutus* and miliolids are recognized in this biostratigraphic unit. The upper boundary of the unit is defined by the first appearance of the late Chattian species *M.* cf. *complanata, Marasella* sp. and an undetermined miolepidocyclinids 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 occurrence of *M.* cf. *complanata, P. bronnimanni, Marasella* sp. and undetermined miolepidocyclinid species.

2.4. Çaygören section

The studied section (Fig. 5) is located 10 km SE of Çaygören village, E Sivas (map references İ 38, coordinates 39°44' 26.92''N; 37°16'07.94''E). The first lithostratigraphic unit, ranging from Buc. 1 to Buc. 12, consists of alternating sandstone, marl and sandy limestone with soritids, miliolids and peneroplids species of Rupelian-early Chattian age, which indicate a very shallow water marine environment for this unit. The shallow water marine algal limestone with miogypsinids of late Chattian age is found at the top of the Çaygören section.

The lithologic units and their very shallow/shallow foraminiferal species are given in Fig. 5.

2.4.1. Biostratigraphy

The following two biostratigraphic units are recognized in the Çaygören succession (Fig. 5).

SBZ 21–22 (Rupelian-early Chattian): The stratigraphic range of *S. egribucakensis* n. gen. n. sp. defines this unit.

Additional species, such as *P. evolutus*, *P. flabelliformis* n. sp., *A. asmaricus*, *Praearchaias* sp., *Archaia*s sp. and miliolids, are observed in this unit. The first occurrence of *M. borodinensis* marks the upper boundary 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 occurrence of *Postmiogypsinella* sp. and *Marasella* sp. in the unit is noteworthy, and thus this foraminiferal assemblage can be correlated with the late Chattian assemblages described by SİREL & IŞIK (2011) and SİREL & GEDİK (2011).

3. SYSTEMATIC PALEONTOLOGY

Family: Peneroplidae SCHULTZE, 1854
Genus: *Peneroplis* DE MONTFORT, 1808
Type species: *Nautilus planatus* FICHTEL & 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 (label, Eb. 11/36).

Paratypes: Illustrated in Pl. I, figs. 1–14; Pl. II, figs. 1,2; Fig. 6 A–C; labels indicated in Pl. I and II and Fig. 6.

Material: More than 120 specimens in equatorial, subequatorial and axial sections from the type locality.

Depository: Holotype and paratypes are deposited in the collection of Cumhuriyet University (Sivas, Central Turkey).

Type locality: Eğribucak section (Fig. 1), NE of Eğribucak village, E Sivas, Central Turkey, (Map reference İ38, coordinate 39°43'48.08''N; 37°16'33.84''E).

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 two planispiral-involute 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 to 0.08 mm. The connection between the early planispiral chambers is provided by single intercameral foramen (Fig. 6A), whereas the aperture is composed of two rows of foramina in the flabelliform chambers (Figs. 6A, C). The largest diameters of the planispiral and cyclical stages reach 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 *Peneroplis 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* n. sp. differs from the Oligocene specimens determined as *P.*cf. *damesini* HENSON by HOTTINGER (1963, p. 968, Pl. III, figs. 7, 8; text figs. q–r) in possessing a larger test, broader flabelliform chambers and cyclical chambers. The new species is distinguished from the late Eocene species indicated as *P.* cf. *damesini* HENSON by SİREL & ACAR (1982, Pl. 5, figs. 4, 7–9) in having a larger test, well-developed flabelliform and cyclical chambers.

Stratigraphic and geographic distribution: The new species occurs in the lagoonal-very shallow argillaceous limestone of the Eğribucak section (Fig. 2) and in the very shallow water marine limestone of the Tuzlagözü (Fig. 4) and Çaygören (Fig. 5) sections. The very shallow water limestones with new species underlie algal limestone beds with *M. borodinensis* and *M.*cf. *complanatus* of late Chattian age on the one hand, and it is associated in the very shallow water limestone 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 is interpreted as Rupelian-early Chattian (SBZ 21–22).

***Peneroplis* sp.**
(Pl. II, Figs. 3–11; Fig. 6F)

Synonymy:

2010. *Peneroplis* sp., AMIRSHAHKARAMI & TAHERI, Pl. 7, fig. 1.

Description: Compressed small test is 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 to 0.43 mm and the longitudinal diameter of the adult test from 0.68 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: The peneroplid specimens illustrated in Pl. II, figs. 3–11 resemble the Oligocene-Aquitanian specimens described as *Peneroplis* sp. by AMIRSHAHKARAMI & TAHERI (2010, pl. 7, fig. 1). The specimens described here are poorly sectioned, so the apertural face cannot be investigated in detail. Therefore we cannot decide whether they belong to *Peneroplis* de MONTFORT or *Laevipeneroplis* SULC. For the time being, they are referred to as *Peneroplis* sp.

Stratigraphic and geographic distribution: It is observed only in the lower level (SBZ 21–22) of the Eğribucak section (Fig. 2), in association with *P. flabelliformis* n. sp., *C. sivasensis* n. sp., *C. elongata* n. sp. and *S. egribucakensis* n. gen. n. sp. Considering its stratigraphic level, a Rupelian age for *Peneroplis* sp. appears more probable than a broader Rupelian-early Chattian age.

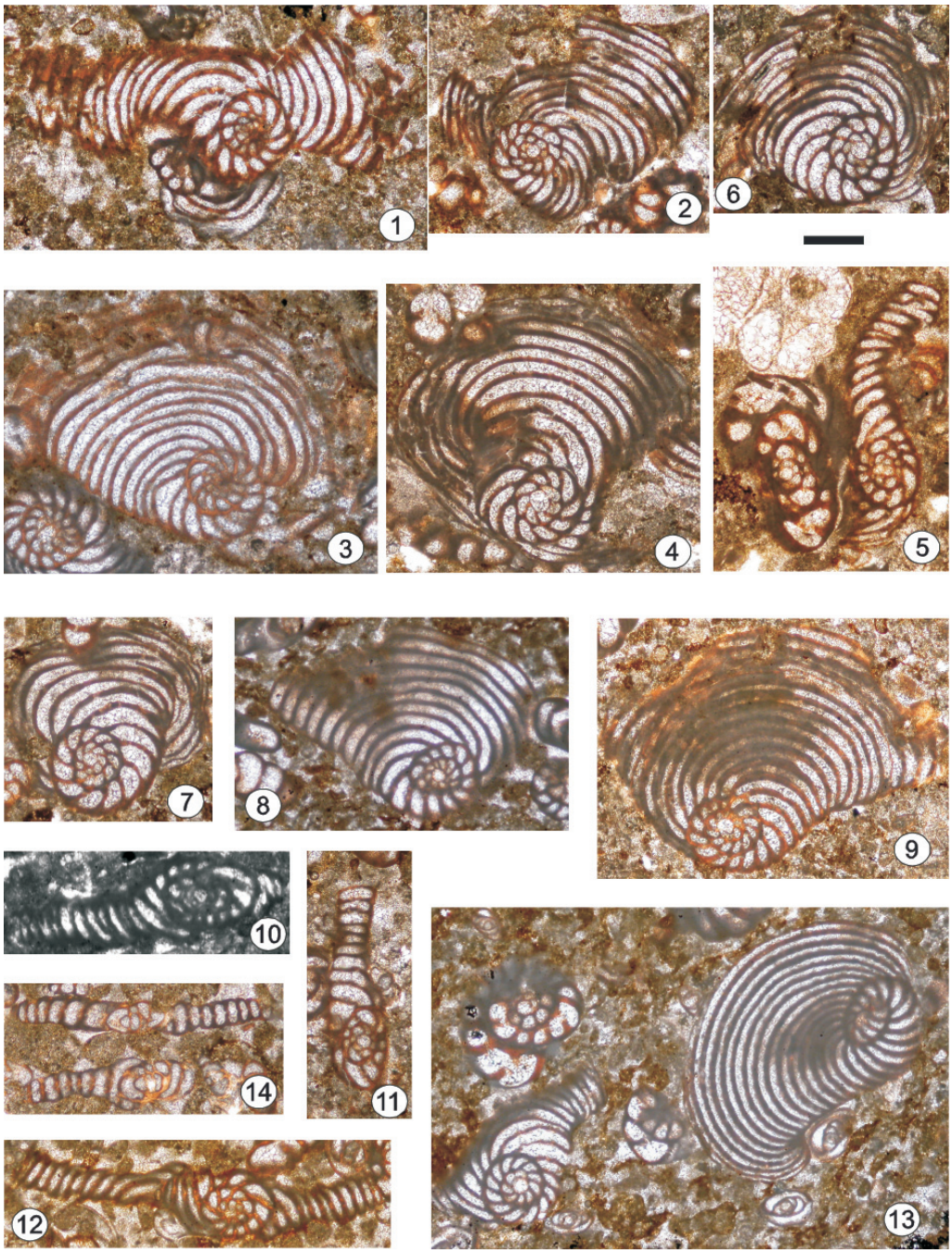


PLATE I
Peneroplis flabelliformis n. sp. SİREL & ÖZGEN-ERDEM
Rupelian-early Chattian, all figured specimens from Eğribucak section, X40
1 – incomplete equatorial section, showing planispiral early, flabelliform adult and cyclical senile chambers (holotype, label Eb.11/36).
2 – incomplete equatorial section (paratype, label Eb.11/64).
3 – equatorial section (paratype, label Eb.11/46).
4 – equatorial section (paratype, label Eb.11/107).
5 – axial section (paratype, label Eb.11/40).
6 – equatorial section (paratype, label Eb.11/40).
7 – equatorial section (paratype, label Eb.11/101).
8 – incomplete equatorial section (paratype, label Eb.11/21).
9 – equatorial section (paratype, label Eb.11/76).
10 – slightly oblique axial section (paratype, label Eb.13/19h).
11 – axial section (paratype, label Eb.11/65).
12 – axial sections of the cyclical form (paratype, label Eb.11/21).
13 – non centered equatorial section (paratype, label Eb.11/21).
14 – subaxial sections of cyclical forms (paratype, label Eb.13/1).
Scale bar: 0.25 mm

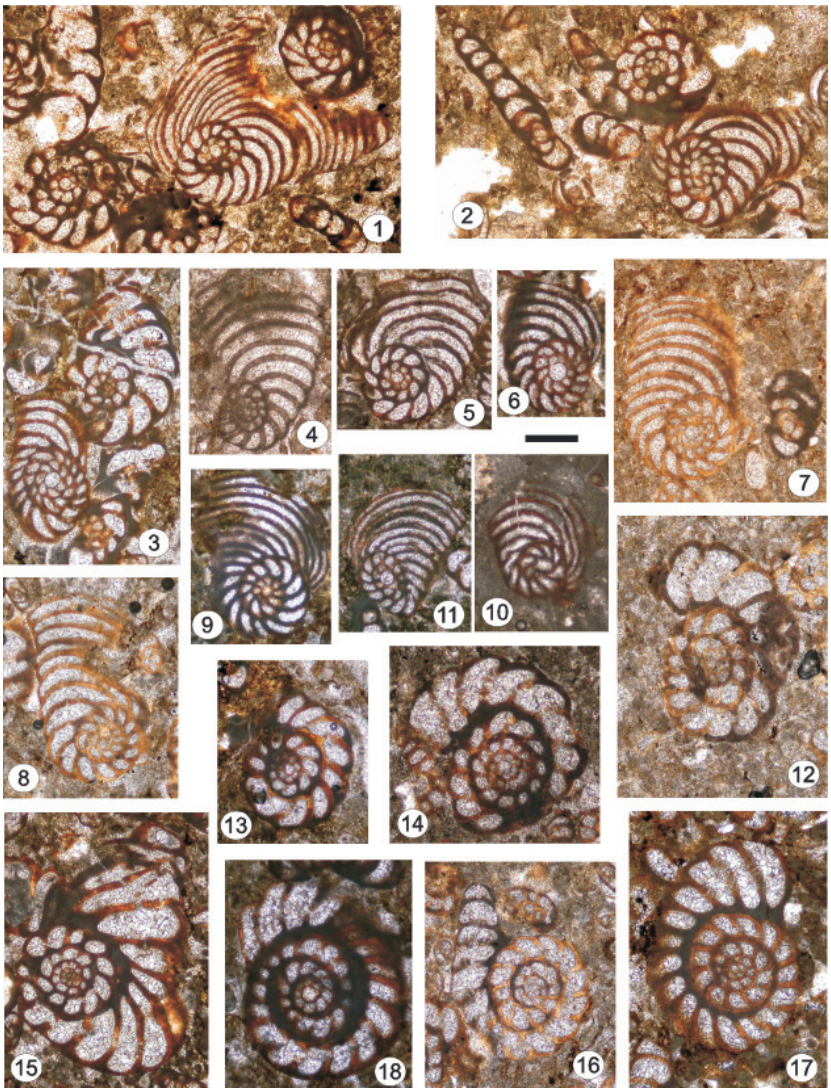


PLATE II

Peneroplis flabelliformis n. sp. SİREL & ÖZGEN-ERDEM
Rupelian-early Chattian, all figured specimens from Eğribucak section, X40
1 – incomplete equatorial section and equatorial sections of *Sivasina egribucakensis* n. gen. n. sp. (mid-bottom and upper right) (paratype, label Eb.11/71).
2 – incomplete equatorial sections (top), subaxial section (mid), equatorial sections of *S. egribucakensis* (bottom and upper left) (paratype, label Eb.11/63).

Peneroplis sp.
Rupelian-early Chattian, all specimens from Eğribucak section, X40
3 – equatorial section (bottom left and almost equatorial section of Coscinospira (upper) (label Eb.11/25).
4 – equatorial section showing planispiral early and fan like adult chambers (label Eb.13/19g).
5 – equatorial section (label Eb. 11).
6 – equatorial section (label Eb.11/98).
7 – equatorial section (left) and Sivasina sp. (right), (label Eb.11/11).
8 – equatorial section, note, numerous openings on the flabelliform chamber, (label Eb.11/73).
9 – equatorial section showing numerous openings on the flabelliform chambers (label Eb.11/123).
10 – equatorial section of young form, (label Eb.31/1g).
11 – equatorial section showing numerous openings on the flabelliform chambers (label Eb.11/123).

Coscinospira sivasensis n. sp. SİREL & ÖZGEN-ERDEM
Rupelian-early Chattian, all specimens from Eğribucak section, X40
12 – slightly oblique equatorial section, showing single foramen in the planispiral and cribrate aperture in the uncoiled chambers (paratype, label Eb.11/03).
13 – equatorial section (paratype, label Eb.11/18).
14 – equatorial section showing cribrate aperture in the last planispiral and uncoiled chambers (paratype, label Eb.11/30).
15 – equatorial section showing cribrate aperture in the uncoiled, single foramen in the planispiral chambers (paratype, label Eb.11/21).
16 – equatorial section of C. elongata n. sp. (paratype, label Eb.11/10).
17 – equatorial section (paratype, label Eb.11/57).
18 – equatorial section (paratype, label Eb.11/45).
Scale bar: 0.25 mm

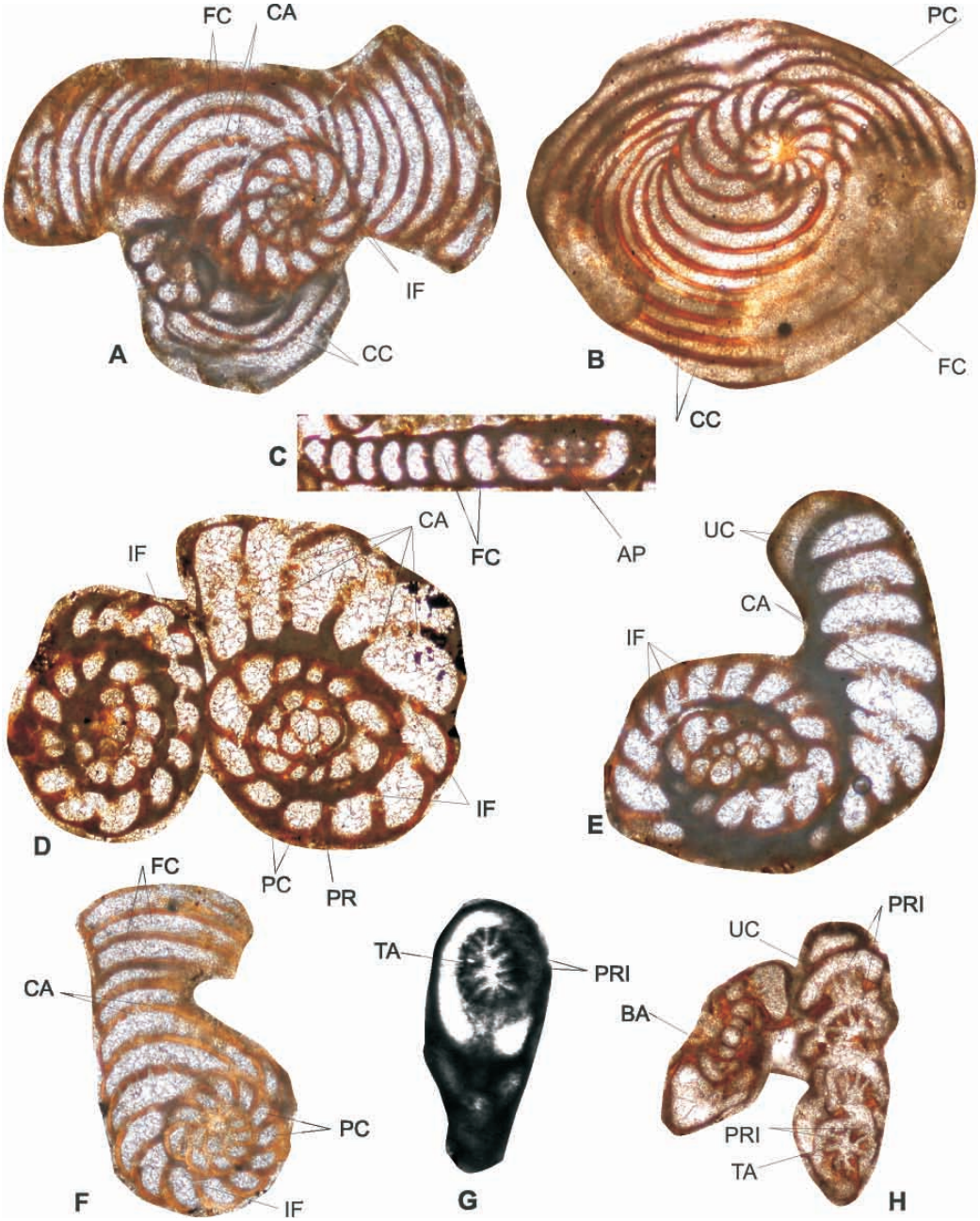


Figure 6: Structural elements of the following Oligocene lagoonal restricted marine and very shallow water marine benthic foraminiferal species. A–C – Peneroplis flabelliformis n. sp. SİREL & ÖZGEN-ERDEM, A – equatorial section (holotype, label Eb. 11/36), B – equatorial section (paratype, label Eb. 11/35), C – tangential section (paratype, label Eb. 11/25), D – Coscinospira sivasensis n. sp. SİREL & ÖZGEN-ERDEM equatorial section (holotype, label Eb. 11/269, E – Coscinospira elongata n. sp. SİREL & ÖZGEN-ERDEM, equatorial section (paratype, label Eb. 11/14), F – Peneroplis sp. equatorial section), G, H – Sivasina egribucakensis n. gen. n. sp. SİREL & ÖZGEN-ERDEM, G – tangential section (paratypes, label Eb. 33/1e-145), H – axial and tangential sections (paratypes, Eb. 33/1e-08) 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, (PRI) peristomal ribs, (BA) axial section of biumbilicate test.

Genus: *Coscinospira* EHRENBERG, 1839

Type species: *Coscinospira hemprichii* EHRENBERG, 1839

Diagnosis: The test is large, operculiniform (in *C. sivasensis* n. sp; Pl. II, figs. 14,17) or crosier-shaped (in *C. elongata* n. sp; Pl. III, figs. 6, 7, 11, 13) with imperforate, calcareous, porcellaneous wall. The early arcuate chambers are arranged planispirally for two or 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 between 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 crosier-shaped peneroplid foraminifer *Coscinospira* EHRENBERG (type species *Coscinospira hemprichii* EHRENBERG) was described from the Holocene of the 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* n. sp. and *C. elongata* n. sp (Pl. II, figs. 12–18; Pl. III, figs. 1–13). Therefore the specimens illustrated in Pls. II, III are here referred to the genus *Coscinospira* EHRENBERG. On the other hand, some crosier-shaped peneroplid specimens 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* n. sp.) has its crosier test shape, planispiral early and rectilinear adult chambers in common with the Eocene-Holocene genus *Spirolina* LAMARCK (type species *Spirolina cylindracea* LAMARCK), but the former has a cribrate aperture in the last planispiral chambers of the early stage and rectilinear chambers of the adult stage. In contrast, in *Spirolina*, the aperture is a 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: From Sivas, a city in the eastern part of the Central Turkey, the type locality of the new species.

Holotype: Illustrated in Pl. III, fig. 2 (bottom; label-Eb. 11/26.

Paratypes: Illustrated in Pl. II, figs. 12–15; Pl. III, figs. 1,3–5 and Fig. 6D; labels are given in Pl. II,III and Fig. 6D.

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

Depository: Holotype and paratypes are deposited in the collection of Cumhuriyet University (Sivas, Central Turkey).

Type locality: Eğribucak section (Fig. 1), NE of Eğribucak village, E Sivas, Central Turkey, (Map reference İ 38, coordinate 39°43'48.08''N; 37°16'33.84''E).

Type level: Rupelian (SBZ 21).

Description: Both generations have a large, operculiniform (Pl. II, figs. 12, 14, 17) or short crosier-shaped test with imperforate, calcareous, porcellaneous wall. The diameter of the planispiral early stage ranges from 0.83 to 1.16 mm in megalospheric forms, and from 0.8 to 1.1 mm in microspheric forms. The relatively large, spheric megalosphere (0.083–0.100 mm in diameter) is followed by planispiral arcuate early chambers increasing suddenly in size 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. Microspheric forms are rather rare in respect to the megalospheric forms. The small, spheric microsphere (about 0.030 mm in diameter) is followed by arcuate early chambers, planispirally arranged. There are 34 and 37 planispiral early chambers in an equatorial section measured 0.76 mm (Pl. II, fig. 15) and 1 mm in diameter (Pl. II, fig. 17), respectively. Later chambers tend to uncoil (Pl. II, figs. 12, 14–18) with cribrate aperture.

Stratigraphic and geographic distribution: The new species *C. sivasensis* n. sp. and *C. elongata* n. sp. are frequent in the clayey lagoonal limestone of the Eğribucak (Fig. 2) in association with *P. flabelliformis* n. sp., *Peneroplis* sp. and *S. egribucakensis* n. gen. n. sp. This lagoonal limestone with *C. sivasensis* n. sp. and *C. elongata* n. sp. lies in the lower level of SBZ 21–22, therefore the stratigraphic range of these 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*.

Holotype: Centered longitudinal section, illustrated in Fig. 6E (label Eb. 11/14).

Paratypes: Illustrated in Pl. III, figs. 7–9, 11–13; labels are given in the Pl. III.

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

Depository: Holotype and paratypes are deposited in the collection of Cumhuriyet University (Sivas, Central Turkey).

Type locality: Eğribucak section (Fig. 2), NE of Eğribucak village, E Sivas, Central Turkey, (map reference İ 38, coordinate 39°43'48.08''N; 37°16'33.84''E).

Type level: Rupelian (SBZ 21).

Description: The new species has an elongated, crosier-shaped test with imperforate, calcareous, porcellaneous wall. The small, spheric megalosphere (0.050–0.075 mm in diameter) is followed by arcuate planispiral chambers with an intercameral 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 measuring 0.63 mm in diameter (Pl. III, fig. 7). There are 16–17 dome-like uniserial chambers in the uncoiled stage measuring 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).

Remarks: It is distinguished from the type species of the genus, *C. hemprichii*, in its larger test and longer biserial stage. The new species differs from *C. sivasensis* n. sp. in possessing smaller early planispiral and longer uniserial stages.

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

Origin of name: After Sivas, a city in the eastern part of Central Turkey; gender: feminine.

Diagnosis of genus: The new miliolid genus has a biumbilicate, inflated lenticular test with rounded-pointed periphery and trematophorate cribrate terminal aperture supported

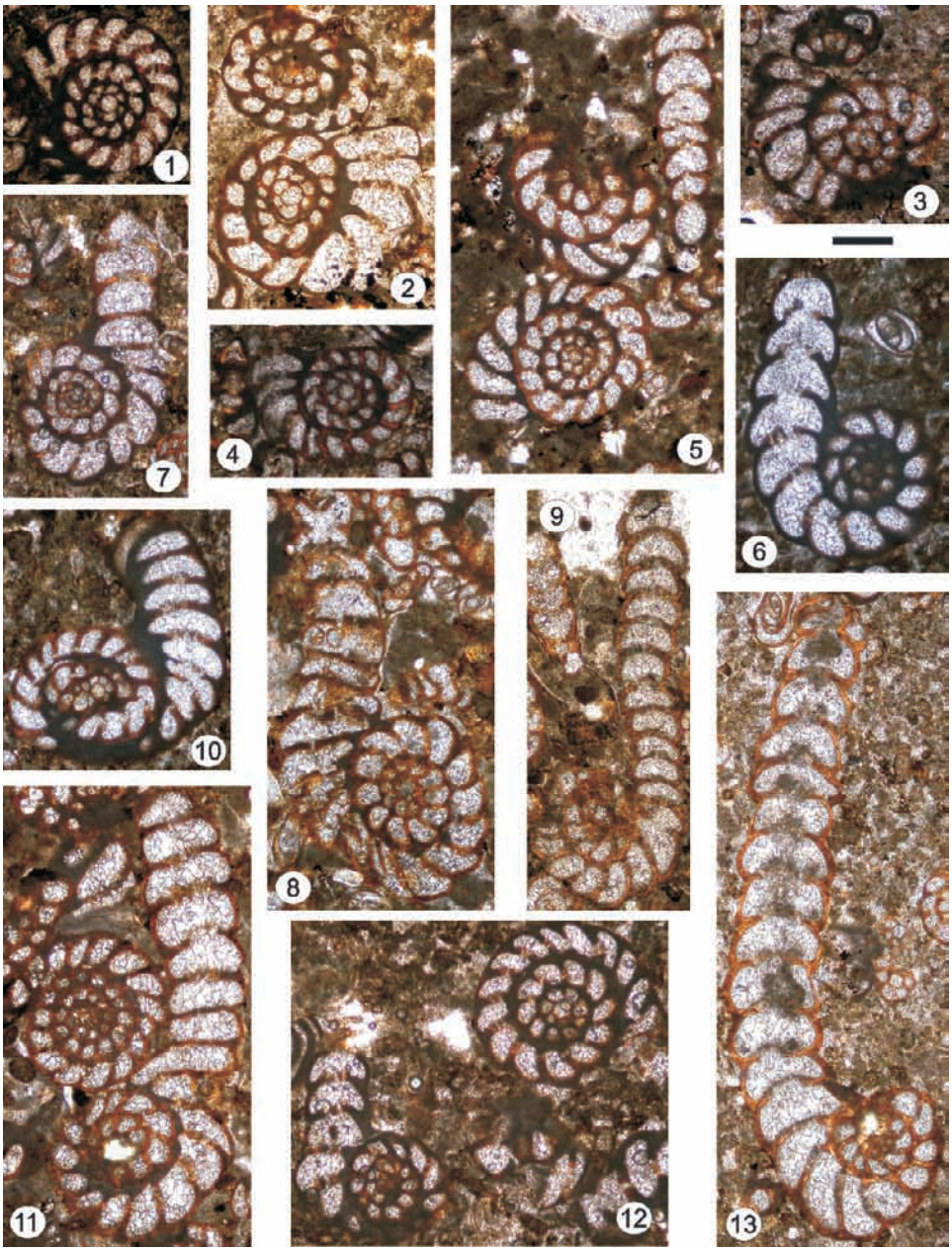


PLATE III

Coscinospira sivasensis n. sp. SİREL & ÖZGEN-ERDEM

Rupelian-early Chattian, all figured specimens from Eğribucak section, X40

1 – equatorial sections (upper), axial and oblique sections of *S. egribucakensis* n. gen. n. sp. (bottom) (paratype, label Eb.11/124a).

2 – equatorial section showing cribrate aperture in the uncoiled chambers (bottom) and subequatorial section (upper) (holotype, label Eb.11/26).

3 – equatorial section (bottom) and oblique section of *S. egribucakensis* n. gen. n. sp. (upper) (Eb.11/75).

4 – equatorial section (paratype, label Eb.11/103).

5 – equatorial section (bottom) and uncoiled chambers of *C. elongata* n. sp. (paratype, label Eb.11/50).

Coscinospira elongata n. sp. SİREL & ÖZGEN-ERDEM

6 – centered longitudinal section showing cribrate aperture in the uncoiled chambers (paratype, label Eb.11/21).

7 – centered longitudinal section (paratype, label Eb.11/128).

8 – centered longitudinal section of the large specimen, tending to *C. sivasensis* n. sp. (paratype, label Eb.11/49).

9 – centered longitudinal section (paratype, label Eb.11/58).

10 – longitudinal section showing reproduction of the embryo (holotype, label Eb.11/14).

11 – uncentered longitudinal section showing cribrate aperture in the rectilinear chambers, equatorial section of *C. sivasensis* n. sp. (mid-left) (paratype, label 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* n. sp. showing single foramen in the early planispiral chamber an cribrate aperture at the last chamber (upper right) (paratype, label Eb.11/27).

13 – uncentered longitudinal section showing uncoiled chambers lined up in a long serie (paratype, label Eb. 11/30).

Scale bar: 0.25 mm

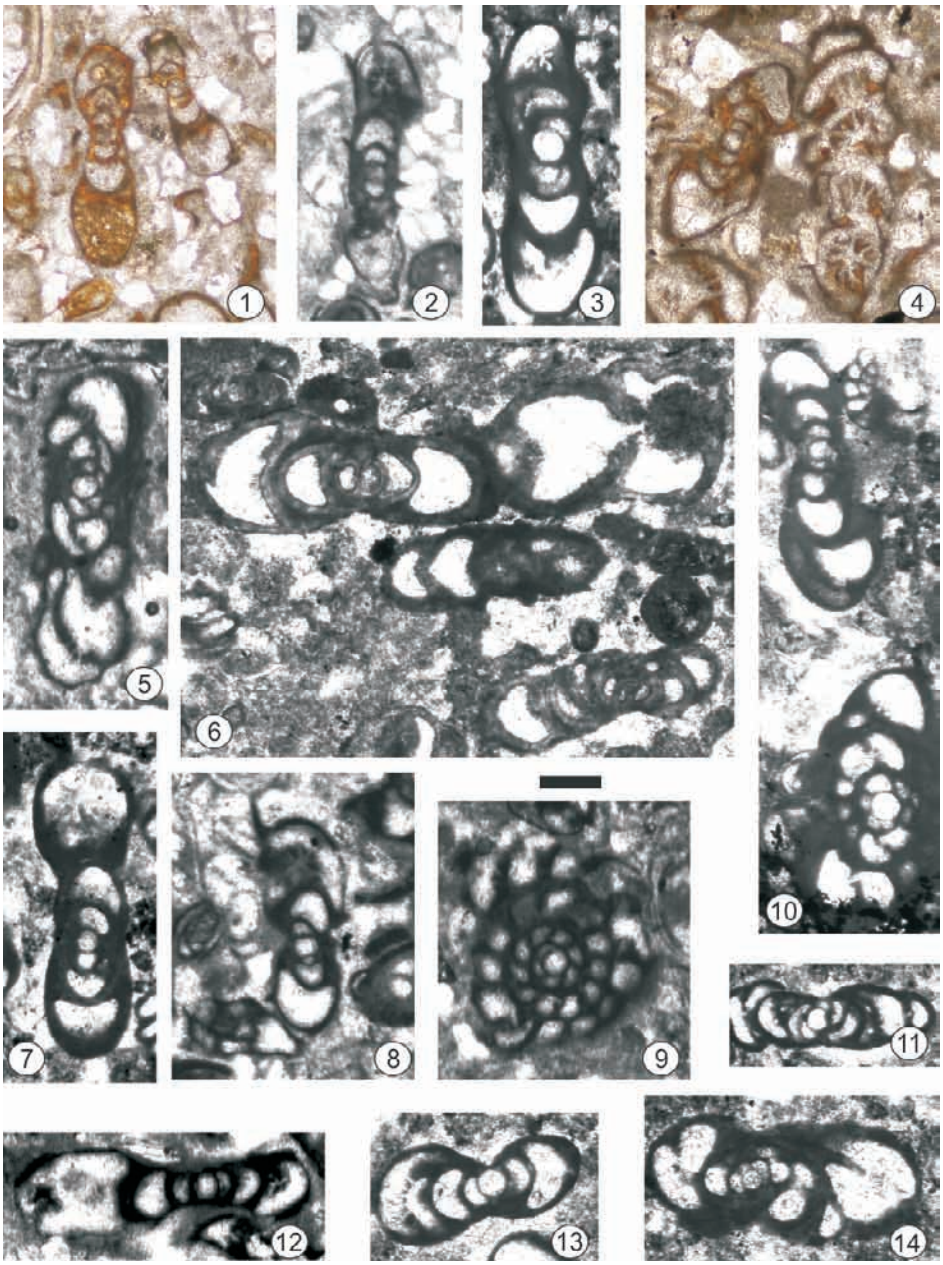


PLATE IV

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

Rupelian-early Chattian, all figured specimens from Eğribucak section, X60

1 – axial section showing cribrate aperture lower ultimate chamber (paratype, label Eb.33/1e).
2 – axial section (paratype, label Eb.33/1e).
3 – axial section, A form (paratype, label 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 (paratype, label Eb.33/1e-08).
5 – oblique section (paratype, label Eb.33/1e).
6 – axial section with uncoiled chamber, B form (top) and oblique sections (bottom) (paratype, label Eb.11/08).
7 – axial section (paratype, label Eb.11/34).
8 – axial section (paratype, label Eb.33/1e).
9 – equatorial section tending to uncoil (paratype, label Eb.33/1e).
10 – axial section (top) and subequatorial section (bottom) (paratype, label Eb.11/2).
11 – slightly oblique axial section (paratype, label Eb.33/1e).
12 – axial section (paratype, label Eb.33/1e).
13 – axial section, A form showing cribrate aperture at the upper penultimate chamber (paratype, label Eb.33/1e).
14 – oblique section, B form (paratype, label Eb.33/1e).

Scale bar: 0.166 mm

by thin ribs (Pl. IV, figs. 1, 4, 13; Pl. V, figs. 7, 8; Pl. VI, figs. 4, 5), also known as= peristomal ribs (Hottinger, 2006, p. 52), particularly in the last chambers of the planispiral stage (Pl. V, fig. 2; Pl. VI, fig. 6), and juvenile chambers of probably quinqueloculine arrangement in microspheric specimens (Pl. IV, figs. 5, 11), and 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 between adjacent planispiral chambers is provided by a single intercameral foramen (Pl. IV, figs. 9, 10). The incompletely known apertural system of *Sivasina* n. gen. (type species *Sivasina egribucakensis* n. gen. n. sp.) is rather complicated. The aperture of the new genus is cribrate or with a sieve plate (Pl. IV, fig. 1), possesses teeth or pillars (Pl. V, fig. 6, Pl. VI, fig. 4) and peristomal rim (HOTTINGER, 2006) (as illustrated in text-fig. 6G, Pl. IV, fig. 4, Pl. V, fig. 7, pl. VI, fig. 5) lining the upper part of the chamber interior in the vicinity of the aperture and projecting into the openings (Pl. IV, fig. 4; Pl. V, figs. 7, 8; Pl. VI, figs. 5, 6). Differences in test size and shape suggest the existence of two generations, as indicated by the illustrated specimens (Pl. IV, figs. 6, 13; Pl. V, figs. 1, 3, 6; Pl. VI, figs. 1, 5).

Differential diagnosis: The new genus has biumblicate test, planispiral-evolute adult chambers in common with middle Eocene-Holocene genus *Dendritina* d'ORBIGNY (type species *Dendritina arbuscula* d'ORBIGNY), but the former has a cribrate aperture, teeth/pillar and with peristomal thin ribs (HOTTINGER, 2006, p. 52, Fig. 12) (see Pl. IV, figs. 1, 4, 13; Pl. V, figs. 7, 8; Pl. VI, figs. 5, 6), whereas the latter has an areal dendritic aperture (LOEBLICH & TAPPAN, 1987, p. 370, Pl. 391, fig. 3). Some Miocene biumbilicate forms with planispiral-evolute whorls were described and figured as *Peneroplis farsensis* HENSON (1950, p. 33, Pl. 5, figs. 3–6) from the Miocene of Iraq, Syria and Qatar. These Middle East forms differ notably from the species of *Peneroplis* de MONTFORT in having planispiral-evolute whorls and trematophorate aperture. According to the authors, this species could be accommodated in the new genus because of the structural elements of the aperture. Also the Oligocene specimens indicated as *Dendritina* cf. *rangi* d'ORBIGNY by HENSON (1950, p. 31, Pl. 5, fig. 2) closely resemble *S. egribucakensis* n. gen. n. sp. because of their biumbilicate test with planispiral-evolute whorls and trematophorid-like aperture. Furthermore, Oligocene specimens with biumbilicate test 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) can be referred to *Sivasina* because of their planispiral-evolute whorls and structure of the aperture.

The specimen recorded as *Dendritina rangi* d'ORBIGNY from the Oligocene-lower Miocene of the Asmari Formation (SW Iran) by AMIRSHAHKARAMI et al. (2010, p. 81, pl. 2, fig. 2) is identical with the specimen figured in the present work in Pl. VI, fig. 3.

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, b.
1963. *Dendritina* cf. *rangi* d'ORBIGNY, HOTTINGER, p. 970, Pl. V, fig. 8, Fig. 2 e–g.
1963. *Peneroplis* aff. *honestus* TODD & POST, HOTTINGER, p. 969, Pl. V, fig. 9.
2010. *Dendritina rangi* D'ORBIGNY, AMIRSAHKARAMI et al., p. 81, pl. 2, fig. 2.

Origin of name: From the type locality Egribucak, a village in the Sivas basin, Central Turkey.

Holotype: Axial section, B form?, illustrated in Pl. VI, fig. 4 (label Bak. 16/16).

Paratypes: Illustrated in Pl. IV, figs. 1–14; Pl. V, figs. 1–10; Pl. VI, figs. 1–6; labels are given in Pl. IV, V and VI.

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

Depository: Holotype and paratypes are deposited in the collection of Cumhuriyet University (Sivas, Central Turkey).

Type locality: Eğribucak section (Fig. 1), NE of Eğribucak village, E Sivas, Central Turkey, (Map reference İ 38, coordinate 39°43'48.08''N; 37°16'33.84''E).

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

Description: Both generations have an inflated, biumbilicate lenticular test with trematophorid aperture. Diameter of the test ranges from 0.66 to 0.9 mm in the megalospheric form and from 1to 2 mm in the microspheric form.

The 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 in size 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).

The 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 0.05 mm in diameter) is followed by early chambers that are arranged probably in a quinqueloculine mode for one whorl (Pl. IV, fig. 14; Pl. V, fig. 10), later dome-like adult chambers

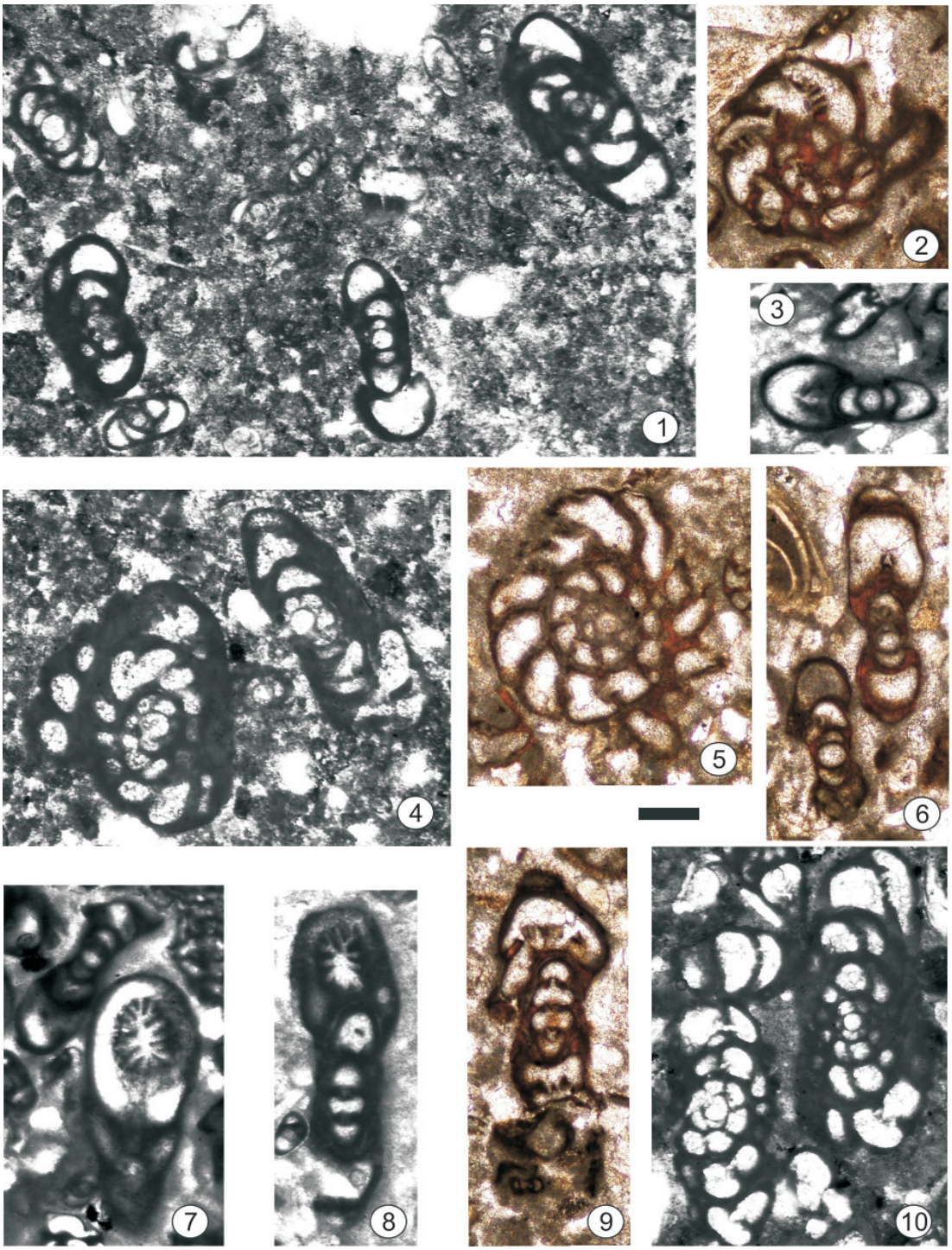


PLATE V
Sivasina egribucakensis n. gen. n. sp. SİREL & ÖZGEN-ERDEM
Rupelian-early Chattian, all specimens from Eğribucak section, X60
1 – axial and oblique sections (paratype, label Eb.11/66).
2 – equatorial section (paratype, label Eb.33/1e).
3 – axial section showing aperture at the upper penultimate chamber (paratype, label Eb.33/1e).
4 – slightly oblique equatorial and axial sections (paratype, label Eb.11/78).
5 – equatorial section with deformed last three chambers (paratype, label Eb.33/1e).
6 – axial sections (paratype, label Eb.33/1e-147).
7 – tangential section showing terminal aperture with thin ribs (paratype, label Eb.33/1e-142).
8 – axial section showing apertural face with ribs at the upper ultimate chamber (paratype, label Eb.33/1e-145).
9 – deformed subaxial section showing aperture with ribs at the upper ultimate chamber (paratype, label Eb.33/1e).
10 – oblique sections (paratype, label Eb.11/92).
Scale bar: 0.166 mm

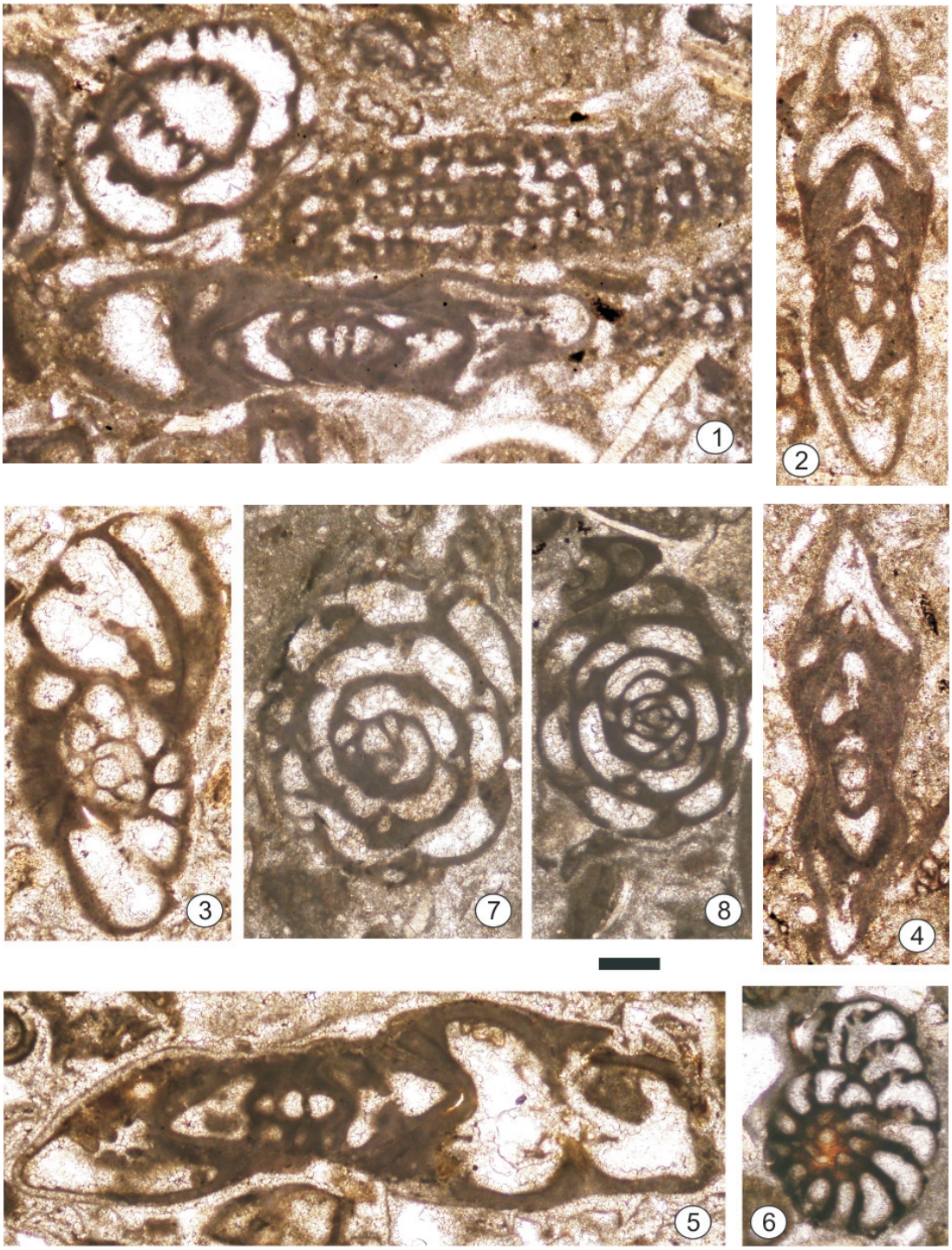


Plate VI

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

Early Rupelian, all figured specimens 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. (paratype, label Bak.16/5).

2 – axial section (paratype, label Bak.16/2).

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

4 – axial section, showing teeth/pillars in the ultimate chamber (holotype, label Bak.16/6).

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

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

Praebullalveolina oligocenica n. sp.

7 – subequatorial section, showing main and secondary apertural foramina in the penultimate whorl (paratype, label Bak.16/13).

8 – equatorial section of the small B form (paratype, label Bak.16/13).

Scale bar: 0.166 mm

are arranged in a planispiral-evolute mode. The last chambers have like trematophorate aperture with peristomal ribs and are uncoiled (Pl. IV, fig. 6; Pl. VI, figs. 1, 3, 5).

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

Stratigraphic and geographic distribution: This new miliolid species occurs in the lagoonal restricted marine limestone-very shallow water marine limestone of all studied sections (Figs 2–5).

The interesting Oligocene (Rupelian-early Chattian) lagoonal-very shallow 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 is composed of various lithologic units. The basal lagoonal argillaceous limestone with *S. egribucakensis* n. gen. n. sp *P. flabelliformis* n. sp., *Peneroplis* sp., *C. sivasensis* n. sp and *C. elongata* n. sp that lies between gypsum beds is noteworthy. On the other hand, *S. egribucakensis* n. gen. n. sp. was observed in the upper part of the Rupelian-early Chattian sequence along with peneroplids and miliolids species (see Fig. 2).

This species occurs also in the very shallow water marine limestone of the Bakımlı section (Fig. 3), associated with the soritid species *P. diyarbakirensis, P. minimus* and the new alveolinid species *P. oligocenica* n. sp. and *P. minuta* n. sp. of Rupelian age. Additional very shallow water foraminiferal species, *A. kirkukensis, A. brunni* and miliolids, occur in this biostratigraphic unit SBZ 21 (Rupelian).

In addition, it occurs in the very shallow water marine limestone of the Tuzlagözü section, associated with *P. diyarbakirensis, P. minimus, A. kirkukensis, P. flabelliformis* n. sp., *P. evolutus, Archaias* sp. and miliolids of Rupelian-early Chattian age (Fig. 4).

Finally, it abounds in the Rupelian-early Chattian very shallow water marine limestone of the Çaygören section (Fig. 5), along with *P. flabelliformis* n. sp., *P. evolutus, A. asmaricus, Praearchaias* sp. and gavelinellinids.

Superfamily Alveolinacea EHRENBERG, 1839
Family Alveolinidae EHRENBERG, 1839
Genus *Praebullalveolina* SİREL & ACAR, 1982
Type species *Praebullalveolina afyonica* SİREL & ACAR, 1982

Re-description of genus: This alveolinid genus has slightly ovoid, subspherical/spherical to nautiloid test with alternating septula and chamberlets. The apertural face has one row of main apertures and secondary apertures of smaller diameter (Pl. VI, fig. 7; Pl. VII, figs. 1, 2; Pl. VIII, figs. 1, 4). The postseptal passage is absent; in contrast, the preseptal passage is well developed and large. One row of alveoli communicate through secondary apertures 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 the 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). Moreover the early undivided chambers of the megalospheric generation are probably arranged in triloculine mode (Pl. VII, fig. 3); the large planispiral chambers are diveded by septula into numerous chamberlets; the ramifying septula generate small triangular spaces at the roof of the chambers, in which the small supplementary chamberlets are formed (Pl. VIII, figs. 3,7). Dimorphism faint; Late Eocene-Early Oligocene.

Remark: In the original definition of *Praebullalveolina*, two rows of alveoli 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 definitely 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 well recognizable 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 limestone.

Holotype: Equatorial section, illustrated in Pl. VII, fig. 1 (label Bak. 16/7).

Paratypes: Illustrated in Pl. VI. Figs. 1, 7, 8; Pl. VII, figs. 1–9; Pl. VIII, figs. 1, 2; labels are given in Pls. VI–VIII.

Material: 65 specimens in random sections from the Bakımlı section, (Fig. 3).

Depository: Holotype and paratypes are deposited in the collection of Cumhuriyet University (Sivas, Central Turkey).

Type Locality: Bakımlı section (Fig. 3), E of Sivas, eastern part of Central Turkey, (Map reference İ 38, coordinates 39°17’78’’N; 37°29’13.11’’E).

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 to 0.83 mm and from 0.83 to 1.05 mm, respectively. The new species has characteristically larger divided chambers when compared with the type species *P. afyonica* and the new species *P. minuta* n. sp. In well-preserved microspheric specimens, the very small protoconch is followed by two or possibly 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. The height of the planispiral chambers increases first gradually from the undivided triloculine chambers towards the last whorl (Pl. VII, fig. 1; Pl. VIII, fig. 1), then suddenly in height and length in the last whorl. There are eight divided chambers in the last whorl of the equatorial section, measuring 1 mm in diameter (Pl. VII, fig. 1)

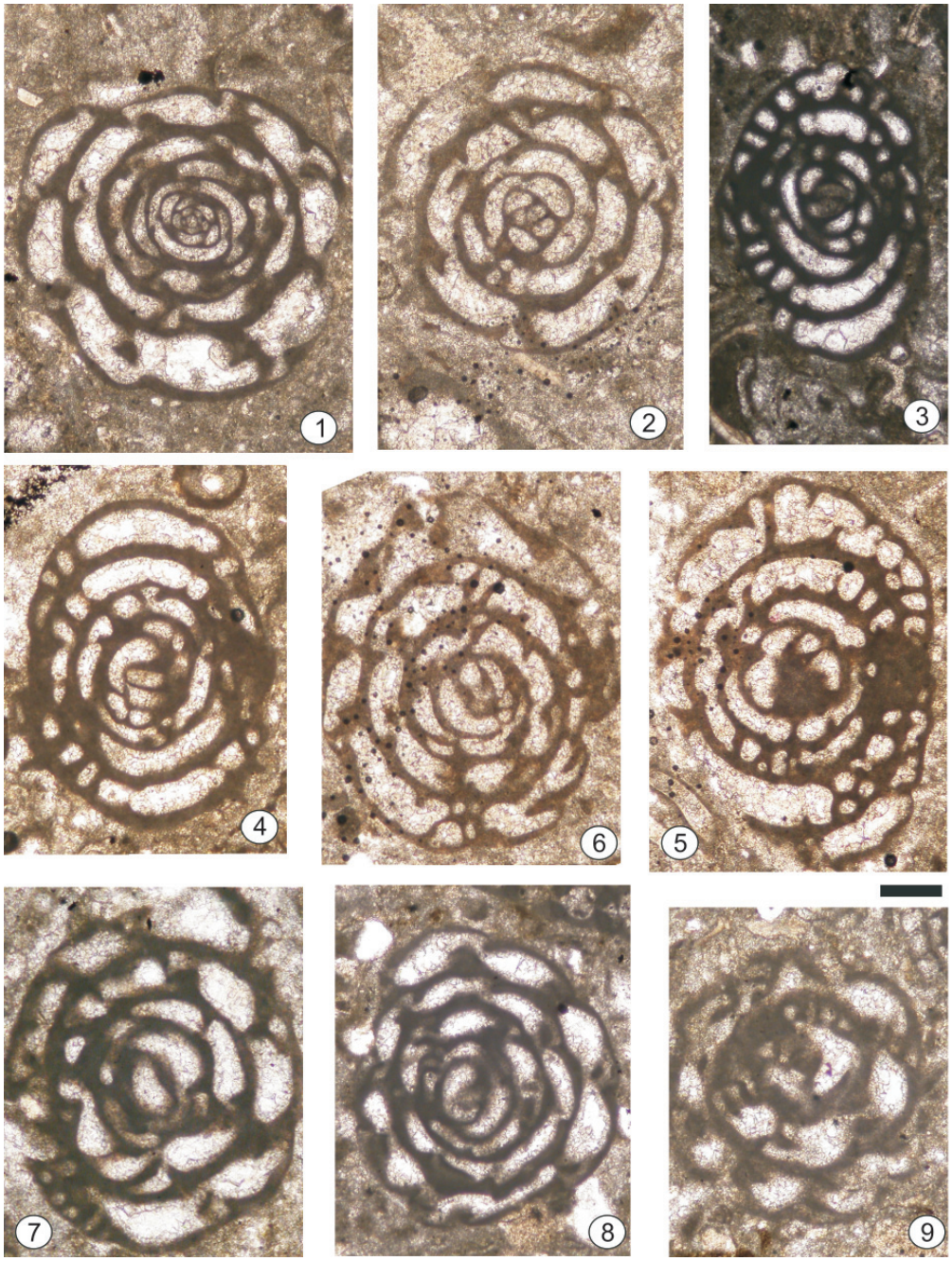


PLATE VII
Praebullalveolina oligocenica n. sp. SİREL & ÖZGEN-ERDEM
Early Rupelian, all figured specimens from the Bakımlı section, X 60
1 – centered equatorial section, B form, showing two whorl of quinqueloculine and one whorl of triloculine undivided chambers and planispiral adult chambers with main and secondary aperture (holotype, label Bak.16/7).
2 – equatorial section (paratype, label Bak.16/2).
3 – slightly oblique axial section, B form (paratype, label Bak.16/5).
4 – subaxial section (paratype, label Bak.16/1).
5 – slightly oblique subaxial section (paratype, label Bak.16/6).
6 – slightly oblique non centered equatorial section (paratype, label Bak.16/9).
7 – oblique section (paratype, label Bak.16/5).
8 – non centered equatorial section (paratype, label Bak.16/5).
9 – tangential section showing one row of alveols in the upper penultimate whorl (paratype, label Bak.16/1).
Scale bar: 0.166 mm

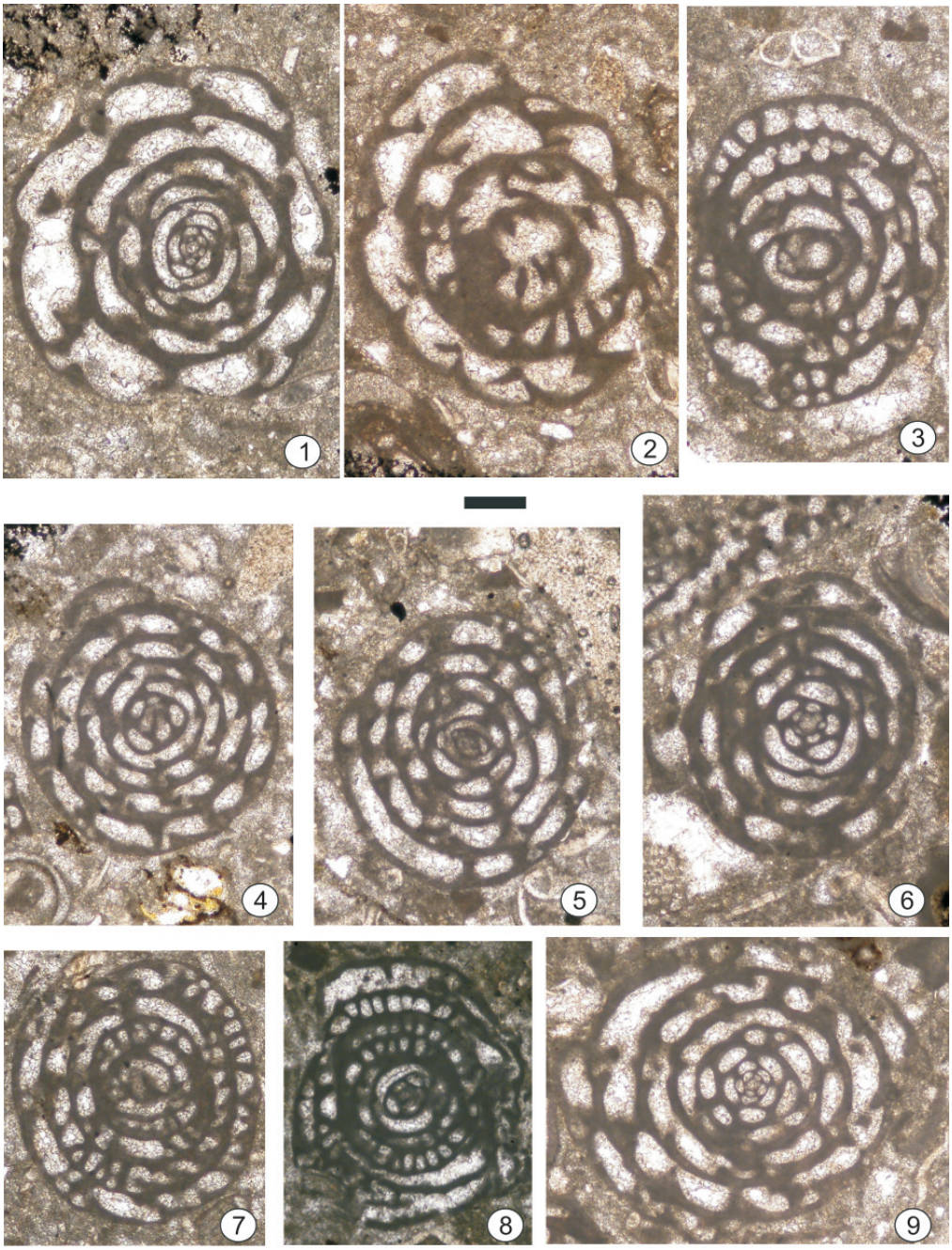


PLATE VIII

Praebullalveolina oligocenica n. sp. SİREL & ÖZGEN-ERDEM
Early Rupelian, all figured specimens from Bakımlı section, X60

1 – equatorial section, B form, showing two whorl of quinqueloculine undivided early chambers, one and half whorl of triloculine undivided chambers and planispiral adult chambers with main and secondary aperture (paratype, label Bak.16/7).
2 – slightly oblique subequatoial section (paratype, label Bak.16/7).

Praebullalveolina minuta n. sp. SİREL & ÖZGEN-ERDEM
3 – uncentered equatorial section (paratype, label Bak.16/5).
4 – subequatorial section, B form, showing main and secondary apertures (holotype, label Bak.16/8).
5 – oblique section (paratype, label Bak.16/8).
6 – centered oblique section, showing two rows of quinqueloculine, undivided early chambers, and one or more triloculine undivided chambers (paratype, label Bak.16/5).
7 – oblique subaxial section (paratype, label Bak.16/9).
8 – subaxial section showing small chamberlets (paratype, label Bak.16/5).

Praebullalveolina sp.
9 – subequatorial section showing two may be more rows of quinqueloculine, undivided early chambers and planispiral, divided adult chambers with main and secondary aperture (label Bak.16/1).
Scale bar: 0.166 mm

BENTHIC BIOZONES / FORAMINIFERAL SPECIES		EO.	OLIGOCENE			MIO.
		SBZ 20	SBZ 21	SBZ 22	SBZ 23	SBZ 24
Peneroplidae	*Peneroplis flabelliformis*					
	Peneroplis sp.					
	Coscinospira sivasensis					
	Coscinospira elongata					
Mi.	*Sivasina egribucakensis*					
Alve.	*Praebullalveolina oligocenica*					
	Praebullalveolina minuta					
Soritidae	*Archaias kirkukensis*					
	Archaias asmaricus					
	Praearchaias diyarbakirensis					
	Praearchaias minutus					
	Austrotrillina brunni					
Mio.	*Miogypsinella borodinensis*					
	Miogypsinella cf.c *omplanata*					

Figure 7: Stratigraphic distribution of the Oligocene lagoonal-very shallow and shallow water foraminiferal species of the studied sections in the benthic biozonation of CAHUZAC & POIGNANT (1997).

STAGES	BIO-ZONES	ENVIRONMENTS		
		LAGOONAL	VERY SHALLOW WATER	SHALLOW WATER
EARLY MIO.	SBZ 24			Miogypsinid species and others
LATE CHATTIAN	SBZ 23			*M. borodinensis* *M. cfomplanata* *Marasella* sp. *Postmiogypsinella* sp. *Miolepidocyclina* sp.
RUPELIAN-EARLY CHATTIAN	SBZ 21-22	*S. egribucakensis* *P. flabelliformis* *Peneroplis* sp. *C. sivasensis* *C. elongata*	*S. egribucakensis* *A. asmaricus* *P. flabelliformis* *A. kirkukensis* *P. flabelliformis* *P. diyarbakirensis* *P. minutus* *S. egribucakensis* *Prae. oligocenica* *Prae. minuta* *A. brunni*	
L.EOCENE	SBZ 19-20			

Figure 8: Distribution of the larger benthic foraminiferal species in the lagoonal-very shallow–shallow marine environments of studied sections.

Remarks: The new species differs from the type species of the genus *P. afyonica* in its larger test with larger divided planispiral chambers (Pl. VII, figs. 1–2; Pl. VIII, figs. 1–2).

In the holotype of *P. oligocenica* n. sp. there are eight divided chambers in the last whorl at an equatorial diameter of 1 mm (Pl. VII, fig. 1), whereas in *P. afyonica* there are 15 divided lower and smaller chambers in the last whorl at an equatorial diameter of 0.92 mm (SİREL & ACAR 1982, Pl. I, figs. 1,5). In addition, the chamberlets of *P. oligocenica* n. sp. are larger than the chamberlets of *P. afyonica*. The new species *P. minuta* n. sp. differs from *P. oligocenica* n. sp. 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 considered as a marker species of the Priabonian very shallow 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 constrained by the presence of the associated early Rupelian foraminiferal species *P. delicata* and *Austrotrillina paucialveolata* GRIMSDALE by BARBIN et al. (1998, p. 143).

Thus, the very shallow water marine limestone sequence (Fig. 3) located near Bakımlı village (E Sivas) is particularly interesting, because here the two new species of *Praebullalveolina* appear together with *P. diyarbakirensis, P. minimus* and other taxa (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 that of the other known species of *Praebullalveolina*.

Holotype: Equatorial section, illustrated in Pl. VIII, fig. 4 (label Bak. 16/8).

Paratypes: Illustrated in Pl. VIII, figs. 3–8; labels are given in Pl. VIII.

Material: 60 specimens in oriented and random sections from the Bakımlı section.

Depository: Holotype and paratypes are deposited in the collection of Cumhuriyet University (Sivas, Central Turkey).

Type locality: Bakımlı section (Fig. 1), E of Sivas, eastern part of Central Turkey; (map reference İ 38, coordinates 39°17’78’’N; 37°29’13.11’’E).

Type level: Early Rupelian (SBZ 21).

Description: The investigated specimens have a subspheric small test with imperforate, calcareous, porcellaneous wall. The axial and equatorial diameters range from 0.61 to 0.66 mm and from 0.70 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. oligo-*

cenica n. sp. In some sections, the very small protoconch is followed by two cycles of undivided quinqueloculine early chambers (Pl. VIII, fig. 6), and later undivided chambers arranged in triloculine pattern as in *P. oligocenica* n. sp. (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* n. sp. differs from *P. afyonica* and *P. oligocenica* n. sp. in having smaller test, lower and narrower chambers with small chamberlets.

Stratigraphic and geographic distributions: Its stratigraphic range and geographic distribution of *P. minuta* n. sp. coincide with those of *P. oligocenica* n. sp.

Superfamily Soritacea EHRENBERG, 1839
Family Soritidae EHRENBERG, 1839
Genus *Archaias* de MONTFORT, 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 to 3.06 mm. The 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: The species was reported from the late Oligocene of the type locality, Kerkük, Iraq by HENSON (1950, p. 43). It has been found in the Oligocene of Sivas, Central Turkey, by TURNOVSKY (1955) and VAN BELLEN (1956). The occurrence of *A. kirkukensis* in the Rupelian-early Chattian (SBZ 21, 22) very shallow water limestone was recognized in the neighbouring locality of Akçadağ (Malatya, Eastern Turkey) by SİREL (2003, p. 295, fig. 4), where it overlies beds with *Nummulites* gr. *fabianii, 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 to 2.33 mm, the central thickness from 0.73 to 0.83 mm and the peripheral thickness 0.33 to 0.43 mm. The protoconch is very small, 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 by thin interseptal partitions into numerous small chamberlets.

Stratigraphic and geographic distribution: This species is found in the very shallow 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)

Synonymy:

1996. *Praearchaias diyarbakirensis* SİREL, p. 168–169, Pl. 1,figs. 1–7, 13–17.

2003. *Praearchaias diyarbakirensis* SİREL, SİREL, p. 296, Pl. X, figs. 17–19.

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

2007. *Archaias 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.

2010. *Praearchaias* sp., BENEDETTI, p. 202, pl. I, fig. 8.

Description: The megalospheric test has an inflated lenticular shape with imperforate, calcareous porcellaneous wall. The diameter of the test ranges from 1.6 to 2.6 mm and the thickness from 0.48 to 0.8 mm. The large, spherical megalosphere (about 0.160 mm in diameter) is followed by a semilunar second chamber (Pl. X, fig. 4), later by 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 or 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

PLATE IX

Archaias kirkukensis HENSON

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

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

Archaias asmaricus SMOUT & EAMES

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

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

Scale bar: 0.33 mm

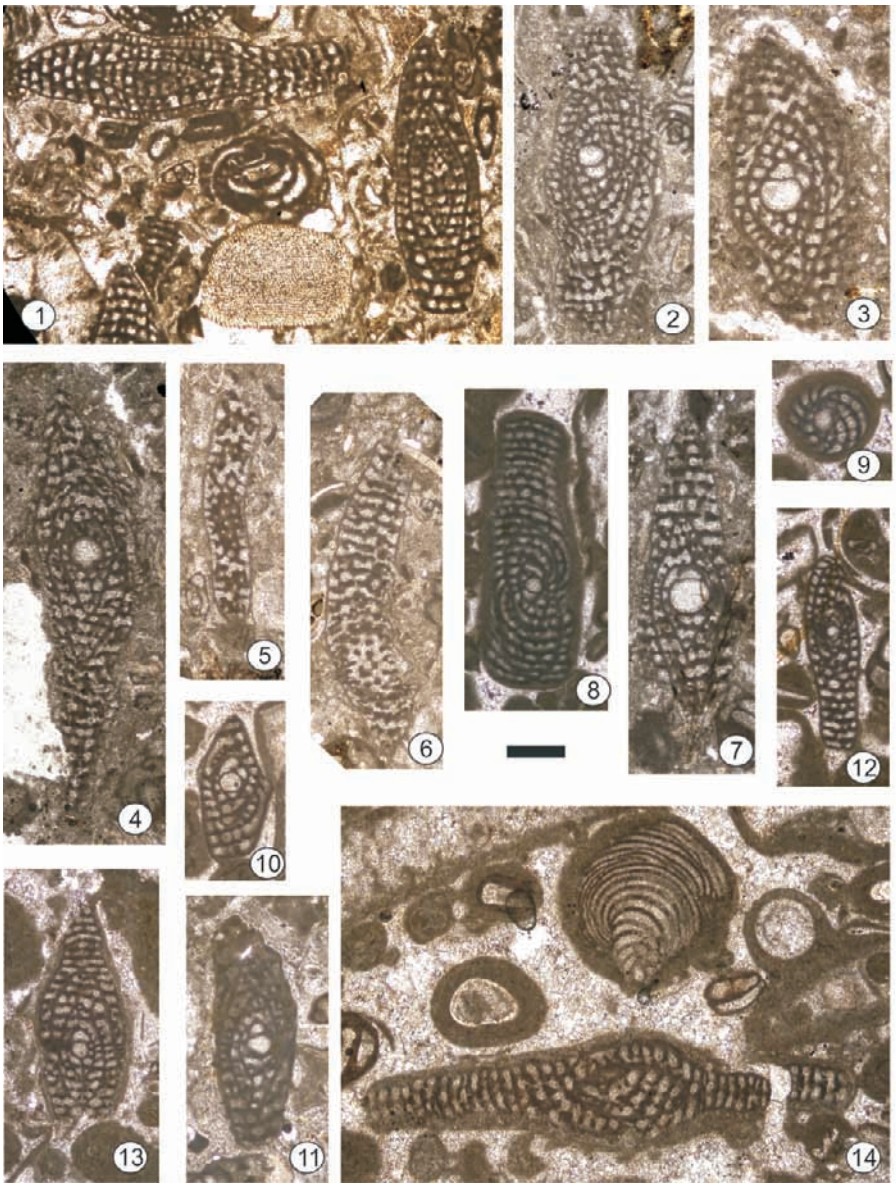


PLATE X

Praearchaias diyarbakirensis SİREL

Early Rupelian, all figured specimens from Bakımlı section, X30

1 – subaxial sections (label Bak. 16/14).
2 – oblique axial section (label Bak.16/4).
3 – axial section (label Bak.16/8).
4 – incomplete axial section (label Bak.16/9).
5 – tangential section, showing cribrate aperture (mid) (label Bak.16/9).
6 – tangential section (label Bak.16/9).
7 – axial section with large megalosphere (Bak.16/8).

Praearchaias minimus SİREL

Early Rupelian, specimens figured in Figs. 8–10, 12, 13 from Tuzlagölü section, Fig. 11 from Bakımlı section, all figs. X 30.

8 – axial section with small protochonch (label Tzg. 2).
9 – equatorial section (label Tzg. 2).
10 – axial section (label Tzg. 1/6).
11 – axial section (label Bak.17/1).
12 – axial section (label Tzg. 2/1).
13 – axial section of broken specimen (label Tzg. 2/1).
14 – A. kirkukensis, subaxial section of broken specimen (bottom), horizontal section of Haymanella (top left) and Peneroplis sp. (mid-top) (label Tzg. 2/1).
Scale bar: 0.33 mm

SİREL (1996, p. 168–169, Pl. 1, figs. 1–7, 13–17). *Praearchaias* differs strongly from *Archaias* de MONTFORT in that it is devoid of the cyclical adult chambers which are present in *Archaias*. In addition, *Praearchaias* has a cribrate areal aperture (SİREL 1996, Pl. I, figs. 1, 13,14; SİREL, 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 very shallow water marine limestone of the Bakımlı section (Fig. 3) with the two new species, *P. oligocenica* n. sp. and *P. minuta* n. sp. It is found in the lower part of SBZ 21–22 in the Tuzlagözü section with additional 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: Small, inflated lenticular test with imperforate, calcareous, porcellaneous wall. The diameter of the test ranges from 0.8 to 1.3 mm and the thickness from 0.36 to 0.75 mm. The small, spheric megalosphere (0.08–0.13 mm in diameter) is followed by a 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 Miliolacea 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.

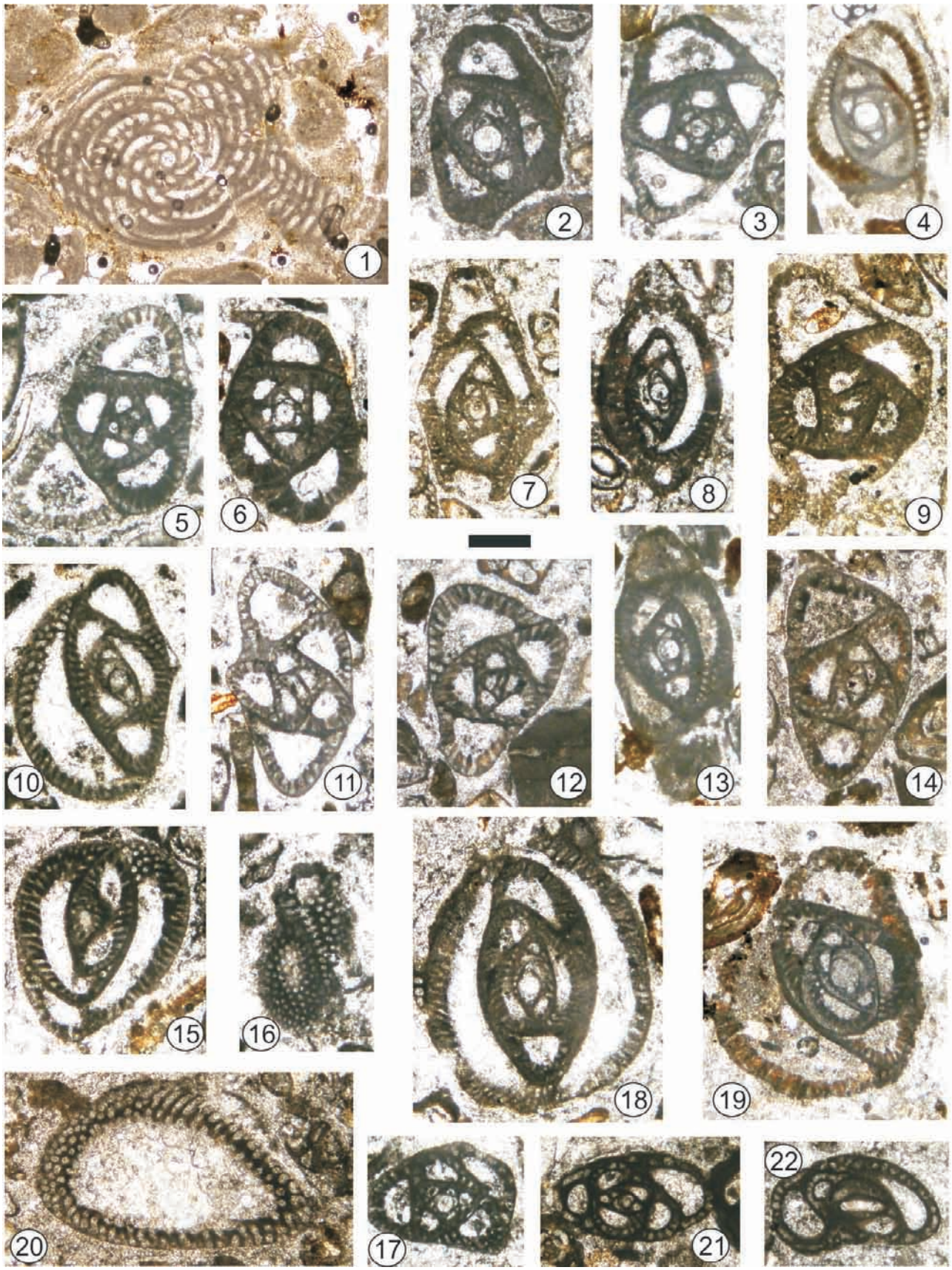
1968. *Austrotrillina brunni* MARIE, ADAMS, p.85, Pl.6, figs. 6, 8.

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

Description: The test is small and the peripheral margin is rounded. The transverse diameter of the test ranges from 0.88 to 1.19 mm, the longitudinal diameter from 1 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 types of subepidermal partitions form small alveolar compartments (Pl. XI, figs. 16, 20).

PLATE XI

Early Rupelian, all figured specimens from Bakımlı section, all figs. X36, except Fig. 1, X30
Archaias kirkukensis HENSON
1 – incomplete equatorial section (label Es.1k-K525).
Austrotrillina brunni Marie
2 – transverse section (label Bak.15a).
3 – transverse section (Bak.15c).
4 – transverse section (label Bak.18a).
5 – transverse section (label Bak.15b).
6 – transverse section (label Bak.17g).
7 – longitudinal section (label Bak.15d).
8 – longitudinal section (label Bak.15a).
9 – subtransverse section (label Bak.15c).
10 – longitudinal section (label Bak.15b).
11 – subtransverse section (label Bak.15a).
12 – transverse section (label Bak.15g).
13 – longitudinal section (label Bak. 15c).
14 – transverse section (label Bak.15f).
15 – sublongitudinal section (label Bak.15c).
16 – tangential section showing subepidermal partitions (label Bak.15a).
17 – transverse section (label Bak.15d).
Austrotrillina sp1.
18 – longitudinal section (label Bak.15e).
19 – transverse section (label Bak.18a).
20 – tangential section showing subepidermal partitions on the external part of the chamber (label Bak.15g).
Austrotrillina sp2.
21 – transverse section (label Bak.15g).
22 – subtransverse section (label Bak.15c).
Scale bar: 0.277, except fig. 1 (0.33 mm)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Stratigraphic and geographic distribution: This species is found in the Rupelian very shallow water marine limestone of the Bakımlı section (Fig. 3) with *P. oligocenica* n. sp., *P. minuta* n. sp, *P. diyarbakirensis* and *S. egribucakensis* n. gen. n. sp.

4. CONCLUSION AND DISCUSSION

Throughout Turkey, lagoonal-very shallow water marine limestone with porcellaneous calcareous foraminifera such as alveolinids, soritids, peneroplids, austrotrillinids and miliolids are virtually absent in the Oligocene depositional successions. Interesting exceptions are, early Rupelian very shallow water marine spot limestone samples with soritids, peneroplids, austrotrillinids and miliolids which have previously been reported from the Kırkbini village, SW of Diyarbakır, southern Turkey by SİREL (1996) and the Rupelian-early Chattian very shallow water marine limestone sequence with mainly soritids and austrotrillinids species from the Develi village, W of Malatya, eastern Turkey by SİREL (2003, Figs. 4, 14). The lagoonal-very shallow water marine Oligocene successions recorsed here from the Sivas Basin with miliolids, alveolinids, peneroplids and soritids species are thus particularly noteworthy. The new miliolid genus *Sivasina* n. gen. (type species *S. egribucakensis* n. gen. n. sp.) is unique among all foraminiferal taxa described here from the Sivas basin, because it occurs in all studied sections (Figs. 2–5).

The lagoonal-very shallow water new miliolid species with trematophorate aperture occurs 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 interpreted 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* n. gen. n. sp., *P. flabelliformis* n. sp., *Peneroplis* sp., *C. sivasensis* n. sp. and *C. elongata* n. sp. Two new peneroplid species *C. sivasensis* n. sp. and *C. elongata* n. sp. and *Peneroplis* sp. are only observed in the basal level of the Oligocene sequence in the Eğribucak section (Fig. 2). Considering the biostratigraphic range of *S. egribucakensis* n. gen. n. sp. in Bakımlı section, a Rupelian age has been inferred for these two new peneroplid species and *Peneroplis* sp. The other species *P. flabelliformis* n. sp. is found together with *S. egribucakensis* n. gen. n. sp. of Rupelian-early Chattian age in the Eğribucak section (Fig. 2). The two new alveolinid species *P. oligocenica* n. sp. and *P. minuta* n. sp. have only been found in the very shallow water marine limestone 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), the two soritid species above and their accompanying taxa *P. delicata* and *Austrotrillina striata* TODD & POST indicate an early Rupelian age. In addition, the existence of *Praebullalveolina* in the early Rupelian very shallow water limestone of the Priabona region,Vicentin, Italy (BARBIN et al., 1997), supports an early Rupelian age for the two *Praebullalveolina* species.

ACKNOWLEDGEMENT

This study was carried out as part of project ÇAYDAG-109Y041, supported by the Scientific and Technological Research Council of Turkey (TÜBITAK). Many thanks are due to Prof. Johannes PIGNATTI ("La Sapienza" University of Rome, Italy) for linguistic improvements of text. We thank to two anonymous reviewers for the helpful comments.

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Manuscript received October 02, 2012
Revised manuscript accepted April 30, 2013
Available online June 19, 2013