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A NEW LATE YPRESIAN SPECIES OF *ASTERIGERINA* AND THE FIRST RECORDS OF *ORNATOROTALIA* AND *GRANOROTALIA* FROM THE THANETIAN AND UPPER YPRESIAN OF TURKEY

ERCÜMENT SİREL & ALİ DEVECİLER

Department of Geological Engineering, Ankara University, 06830, Ankara, Turkey. E-mail: sirel@ankara.edu.tr; adeveci@eng.ankara.edu.tr

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Key words: Foraminiferida; larger foraminifera; Rotaliina; Paleocene; Eocene; *Asterigerina cayrazensis* n. sp.; Turkey.

Abstract. A new larger benthic foraminifer, *Asterigerina cayrazensis* n. sp., is described from the upper Ypresian (middle-upper Cuisian) of the Çayraz section, N of Haymana, S Ankara, central Turkey, from which also the rotaliine species *Ornatorotalia spinosa*, *O. granum* and *Granorotalia sublobata* are first recorded. In addition, *Ornatorotalia* sp. is recorded from the Thanetian limestone of the Harabekayış section, W Elazığ, eastern Turkey.

Introduction

The main purpose of this study is to describe the new benthic foraminiferal species *Asterigerina cayrazensis* n. sp. and three known rotaliine species established by Benedetti et al. (2011) from Italy, *Ornatorotalia spinosa*, *O. granum*, and *Granorotalia sublobata*, from the upper Ypresian (middle-upper Cuisian) limestone "key horizon" of the Çayraz section (Figs 1, 2). Furthermore, the first occurrence of *Ornatorotalia* from the Thanetian is reported from the Harabekayış section (Fig. 3).

Because of their abundance, variation and evolutionary rates, the rotaliine foraminifera play an important biostratigraphic and environmental role for age-dating and interpreting the shallow marine sediments of the Tethyan Paleogene (Hottinger 2014). Rotaliine foraminifera, along with other groups of benthic foraminifers, particularly alveolinids, nummulitids and orthophragminids, are especially useful for the assessment of shallow-water benthic foraminiferal biozones SBZ 1-20 of the Tethyan Paleocene and Eocene (Serra-Kiel et al. 1998) and biozones SB 21-26 of the European Oligo-Miocene (Cahuzac & Poignant 1997, 1998). In the upper Ypresian (middle-upper Cuisian) "key horizon" of the Çayraz section (Fig. 2), the smaller, strongly ornamented species of *Ornatorotalia* and *Granorotalia* are associated with *Alveolina cuspidata* Drobne, *A. schwageri* Checchia-Rispoli, *A.* cf. *cremae* Checchia-Rispoli, *A. minuta* Checchia-Rispoli, *A. oblonga* d'Orbigny, *A. decastroi* Scotto di Carlo, *A. boscii* (Defrance), *Glomalveolina minutula* (Reichel), *Lockhartia conditi* (Nuttall), *Linderina* sp., *Coskinolina liburnica* Stache, *Nummulites burdigalensis* de la Harpe, *N. fossulatus* de Cizancourt, *Assilina placentula* (Deshayes), and an undetermined cuvillierinid.

Finally, from the Thanetian limestone of the Harabekayış section (Fig. 3), we record here *Ornatorotalia* sp., showing partly the structural elements of the late Ypresian (Cuisian) species *O. spinosa*. In the Harabekayış section (Fig. 3), it is associated with *Valvulineria* cf. *patalaensis* Haque, *Bolkarina aksarayensis* Sirel, *Lockhartia diversa* Smout, *Elazigina harabekayisensis* Sirel, and *Discocyclina seunesi* Douvillé.

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Materials and methods

The samples investigated in the present work are either spot samples from Taş ocağı (Fig. 1) or come from two measured successions, the Jurassic-Bartonian section of Çayraz (Fig. 2) and the Thanetian section of Harabekayış (Fig. 3). The analysis is based on oriented thin sections of hard limestone from selected intervals of these two sections.

A well-exposed upper Jurassic-Bartonian succession, here referred to as the Çayraz section (Fig. 2), is located 6 km north of Haymana town, south of Ankara, central Turkey (map reference: Ankara J29-a1; beginning coordinate x: 71075, y: 58000, z: 1110, ending coordinate x: 72025, y: 58500, z:

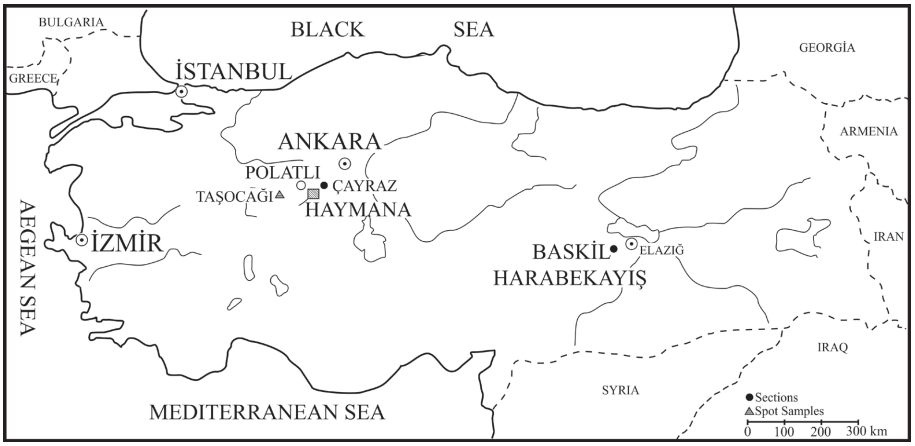

Fig. 1 - Location map.

1200). The lithostratigraphic units and the larger foraminiferal assemblages of the Çayraz section (Fig. 2) have been previously described by Sirel & Gündüz (1976, figs 1-3; pls 1-15). Thanetian-Chattian nummulitids from various successions of Turkey, including the Çayraz section, shall be discussed in a forthcoming monograph, in order to revise them. Therefore, the early-middle Eocene Nummulitidae of the Çayraz succession are not discussed here. In contrast, in the present work we focus on additional species of the assemblages from the limestone beds (Fig. 2).

In the Çayraz section, the studied limestone bed is 1 m-thick and extends laterally approximately 1 km from east to west, from shallow-water to very shallow-water marine environment. *A. canavarii* Checchia-Rispoli, *A. cayrazensis* Dizer, *A. bayburtensis* Sirel and *A.* spp. have been previously described and figured from the western part of the studied limestone bed by Sirel & Gündüz (1976, fig. 3, sample 9; pls. 19 and 15). The studied hard, gray limestone bed is distinguished easily from the other lithostratigraphic units of the Çayraz succession because it shows distinctive lithologic characteristics, foraminiferal content, continuity and accessibility; therefore, it has been chosen as a "key horizon" for the Haymana-Polatlı and Tuz Gölü basins. This allowed us to correlate the upper Ypresian (Cuisian) sediments of the Haymana-Polatlı and Tuz Gölü basins (Central Turkey).

The larger benthic foraminiferal species described here, such as *A. cayrazensis* n. sp. (Pl. 1, figs 1-16), *O. spinosa* (Pl. 2, figs 1-8; Pl. 3, fig. 1), *G. sublobata* (Pl. 3, figs 10-17) and their co-occurring species, namely, *A. cuspidata*, *A. schwageri*, *A.* cf. *cremae*, *A. oblonga*, *A. boscii*, *G. minutula*, *L. conditi,C. liburnica, N. burdigalensis, N. fossulatus, A. placentula* and an undetermined cuvillierinid, occur in the studied limestone. The inferred age of the studied limestone of the Çayraz section is largely based on the co-occurring alveolinid species listed above and figured in Pl. 4 (figs 1-9), that indicate SBZ 11-12 of Serra-Kiel et al. (1998). As seen in Fig. 2, the studied limestone bed and its foraminiferal assemblage underlies a bed with *N. laevigatus* (Bruguière), *N. lehneri* Schaub, and *A. spira* (de Roissy), an assemblage of early Lutetian age. It overlies the upper Ypresian (lower Cuisian) bed with *N. planulatus* (Lamarck) and *N. irregularis* Deshayes. The uppermost Ypresian (middle-upper Cuisian) stratigraphic position of the studied limestone is thus supported by the co-occurring species assemblage of the "key horizon".

The species *O. spinosa*, illustrated in Pl. 3 (figs 1-5), occurs in a spot limestone sample from the upper Ypresian (middle-upper Cuisian) of Taş ocağı (Fig. 1), 10 km south of Polatlı town, SW Ankara, central Turkey (map reference: Ankara İ28-d3; coordinates: x: 76525 y: 28625 z: 840). The foraminiferal assemblage of this locality is similar to that of the coeval samples of the Çayraz section.

The Thanetian succession here referred to as the Harabekayış section (Fig. 3) is situated 18 km SW of Baskil town, west of Elazığ, eastern Turkey (map reference: Malatya L41-a2, beginning coordinate x: 78200 y: 58700 z: 1050, ending coordinate x: 77980 y: 58900 z: 1090). Selected Thanetian larger foraminiferal specimens are figured in Pl. 5. Some of the rotaliine specimens of the Harabekayış section have been previously described and figured as unidentified "rotaliinid Genus 5" or "miscellanid genus 5" by Sirel (1998,

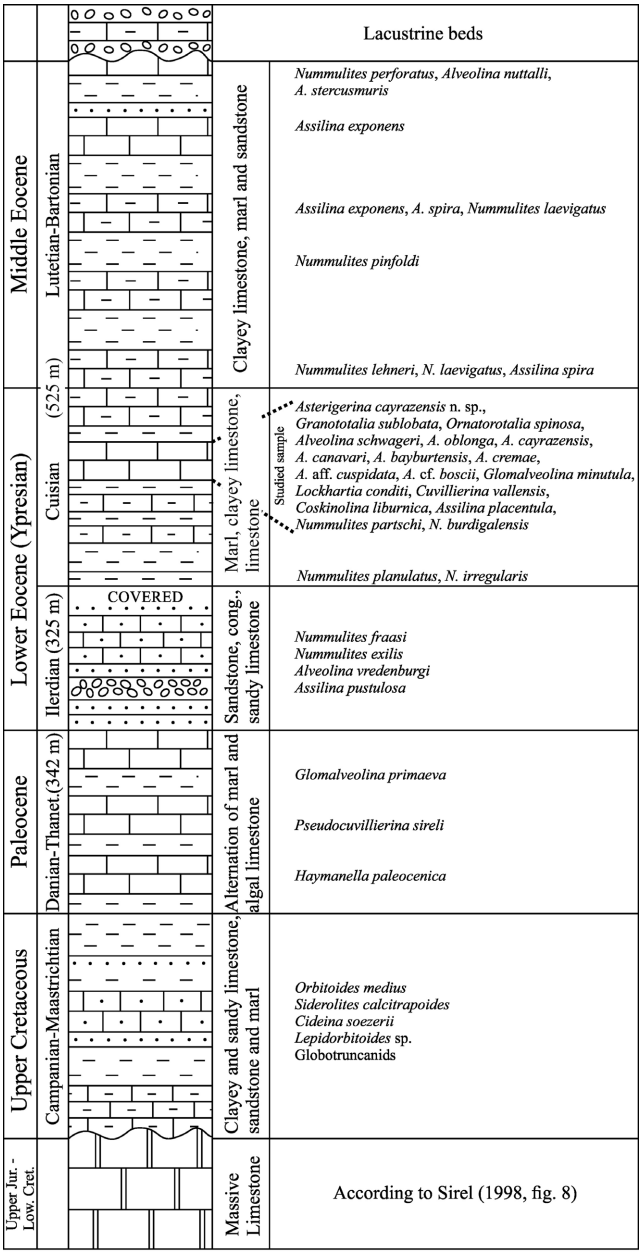

Fig. 2 - Çayraz section, showing the stratigraphic position of *Asterigerina cayrazensis* n. sp., *O. spinosa*, *O. granum*, *G. sublobata* and some co-occurring foraminiferal species, based on Sirel & Gündüz (1976: figs 2, 3) and Deveciler (2010: fig. 2) (not to scale).

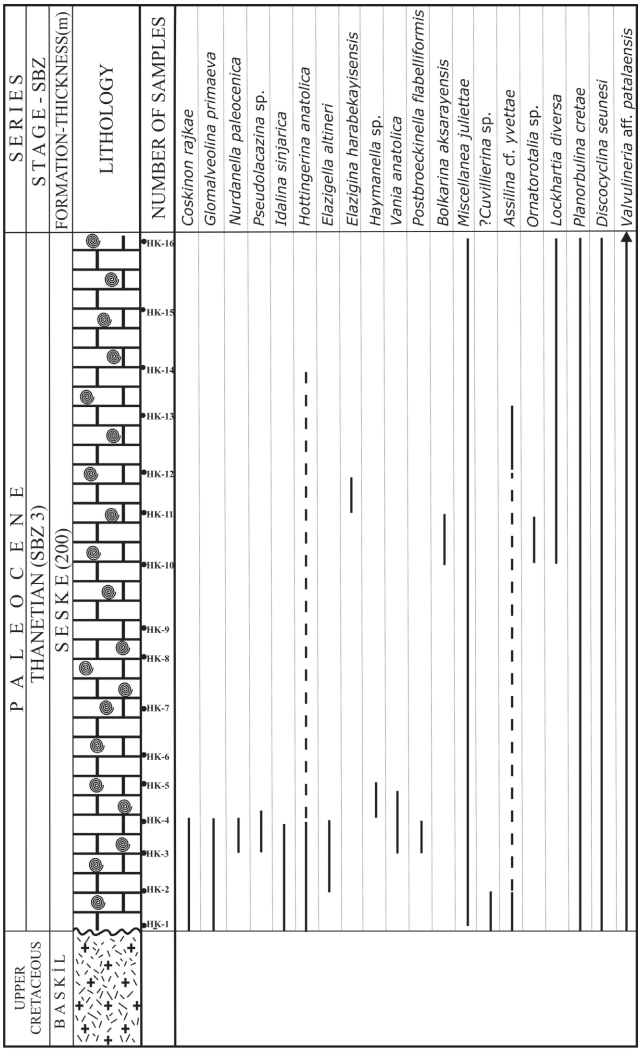

Fig. 3 - Stratigraphic distribution of the species of *Ornatorotalia* and the other foraminiferal species in the Thanetian limestone of the Harabekayış section, S of Baskil, W of Elazığ, eastern Turkey (partly modified after Sirel 2012) (not to scale).

2009 and 2012). The rotaliine specimens figured in Sirel (1998, pls 61, 68) are here redescribed, along with additional specimens: they are here assigned to the genus *Ornatorotalia*, and referred to as *Ornatorotalia* sp. (Pl. 3, figs 6-9), because of the structural elements similar to the upper Ypresian (Cuisian) forms (Fig. 5A-C; Pl. 3, figs 6-8).

All thin sections of the foraminiferal species described and figured in this paper are deposited in the collection of Ankara University, Faculty of Engineering, Department of Geological Engineering.

Systematic paleontology

The suprageneric classification follows Loeblich & Tappan (1987) and Benedetti (2015). The description of morphological features applies the terms employed by Müller-Merz (1980), Loeblich & Tappan (1987), and Hottinger (2006).

Order **Foraminiferida** Eichwald, 1830
Suborder **Rotaliina** Delage & Hérouard, 1896
Superfamily Asterigerinoidea d'Orbigny, 1839
Family Asterigerinidae d'Orbigny, 1839

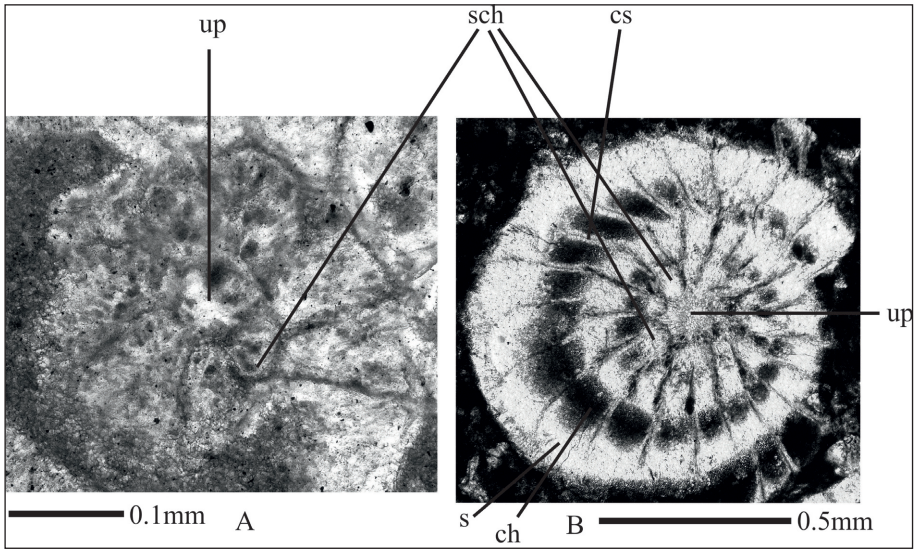

Fig. 4 - Structural elements of *Asterigerina cayrazensis* n. sp.
A: Enlarged central portion of specimen figured in Pl. 1, fig. 3 (B.5.2-5), B: Equatorial section, holotype (Ç. 8.5), up: umbilical plug. ch: chambers. cs: curved septa. s: septum. sch: supplementary chamberlets.

Genus *Asterigerina* d'Orbigny, 1839
Type species: *Asterigerina carinata* d'Orbigny, 1839

Asterigerina cayrazensis n. sp.
Pl. 1, figs 1-16

Derivatio nominis: From Çayraz, a village in the Haymana region, S Ankara, central Turkey.

Holotype: Specimen in thin section illustrated in Fig. 4B, label Ç. 8-5.

Paratypes: Specimens in thin section illustrated in Pl. 1 figs 3-9, 11, 14, 15 (labels are given in Pl. 1).

Material: 16 oriented sections and 25 random sections from thin sections.

Type locality: Çayraz section, 7 km north of Haymana, Ankara, central Turkey.

Type level: upper Ypresian (middle-upper Cuisian; SBZ 11-12).

Specific diagnosis: Small-sized (0.7 to 1.3 mm) species of *Asterigerina* characterized by conspicuous lamination of the wall, a large umbilical plug occupying one third of the ventral area, and small supplementary chamberlets arranged around the umbilical boss.

Description. The test is rather small, inequally biconvex, being more elevated ventrally (Pl. 1, figs 1, 5, 9, 12, 14). The diameter of the test ranges from 0.7 to 1.3 mm, and its axial thickness from 0.53-0.75 mm. The periphery is acute with a limbate keel (Pl. 1, figs 6, 8, 9). The lamination is conspicuous, especially on the central portion of the spiral sides and in the huge umbilical plug (Pl. 1, figs 1, 3, 5, 6, 11, 14, 16). The solid, reversed conical umbilical plug occupies one third of the ventral area (Pl. 1, figs 1, 5, 11, 14). The small supplementary chamberlets are arranged around the umbilical boss (Fig. 4A, B; Pl. 1, figs 4, 15).

Remarks. *Asterigerina* d'Orbigny has a stellate series of chamberlets around the umbilicus, a large umbonal plug, carinate periphery and bilamellar wall structure, a toothplate (foramenal plate) in the chamber lumen and an apertural system (as interiomarginal slit) in common with *Amphistegina* d'Orbigny 1826, but the former differs from the latter by its slightly inequally biconvex test with a huge umbonal plug and a different coiling plane (Loeblich & Tappan 1987; Hottinger et al. 1993). The structural elements, such as test shape with a huge umbilical plug, coiling plane and stellate supplementary chamberlets around the umbilical plug of the well-known middle-late Eocene species *Asterigerina rotula* (Kaufmann), as described and figured in Grimsdale (1952, 238; pl. 23, figs 10, 11; pl. 24, figs 1, 2), Drobne et al. (1979, 170; pl. 4, fig. 5), and Sirel (2000, pl. 3, figs 8, 9), have been taken into consideration in the description of the new species.

The new species differs from the Eocene species *Amphistegina cubensis* Palmer, 1934 by its smaller inequally biconvex test. The lower Eocene species *Asterigerina indica* Jacob & Sastri, 1950, *Asterigerina cuneiformis* Haque, 1956, *Asterigerina brencei* Haque, 1960, and *Asterigeina sorri* Haque, 1960 have a conical test with a peripheral keel and supplementary chamberlets on the ventral side in common with *Asterigerina cayrazensis* n. sp., but the new species differs by possessing a different test shape and a huge ventral plug (Fig. 4A, B; Pl. 1, figs 5, 11).

Stratigraphic distribution. The new species was found together with *O. spinosa*, *O. granum*, *G. sublobata* (Pl. 2, 3), co-occurring with the alveolinid species *A. cuspidata*, *A. schwageri*, *A.* cf. *cremae*, *A. minuta*, *A. oblonga*, *A. decastroi*, *A. boscii*, *G. minutula* (Pl. 4), and other larger foraminiferal species such as *L. conditi*, *Linderina* sp., *C. liburnica*, *N. burdigalensis*, *N.*

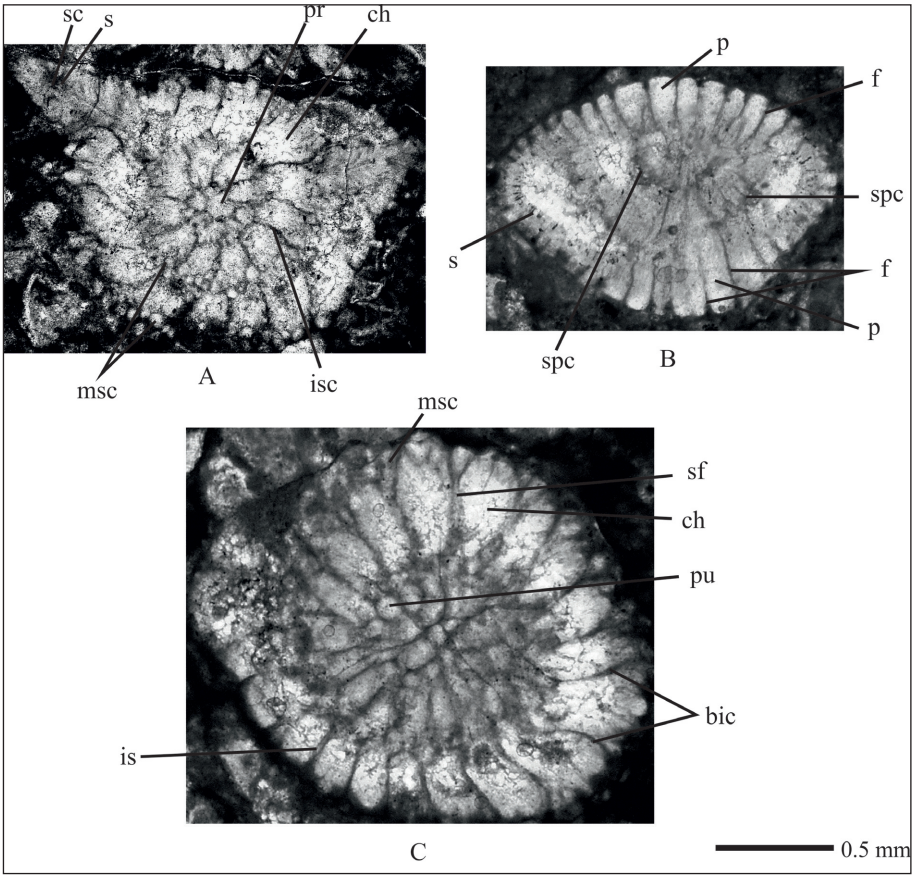

Fig. 5 - Structural elements of *O. spinosa* Benedetti, Di Carlo & Pignatti, 2011.
A: Equatorial section (Ç. 11-8), B: Axial section (1d-5), C: Subequatorial section (Ç. 5-2); pr: proloculus; s: spine; sc: spinal canal; msc: marginal sutural canals.; bic: bifurcate intraseptal canal; spc: spiral canal; is: intraseptal canal; f: funnel (vertical canal); p: pillar; pu: pustules; sf: septal flap; ch: chamber.

fossulatus, *A. placentula* and an undetermined cuvillierinid (Pl. 4, figs 10-19) in the hard, gray-light brown coloured upper Ypresian (middle-upper Cuisian) limestone, i.e., the so-called "key horizon" (Fig. 2).

Superfamily Rotalioidea Ehrenberg, 1839
Family Ornatorotaliidae Benedetti, 2015
Genus *Ornatorotalia* Benedetti, Di Carlo & Pignatti, 2011

Type species: *Ornatorotalia spinosa* Benedetti, Di Carlo & Pignatti, 2011

Diagnosis of the genus: The test is small, inequally biconvex, with more elevated ventral side (Pl. 2, figs 3, 14). The chambers are almost evolute dorsally; in contrast, they become involute on the ventral side (Pl. 2, figs 1, 8). The inflational pillars (Smout 1954: 18, 19) form numerous coarse pustules on the center of the ventral and dorsal surface of the test (Fig. 5C, Pl. 2, figs 2, 8). On the periphery, the chambers may bear spines (Fig. 5A, C; Pl. 2, figs 4, 5, 6; Pl. 3, figs 1, 6, 8). The wall is calcareous, fibrous and thick, perforate. The slightly curved septa have a septal flap and bifurcate intraseptal canals (Fig. 5C; Pl. 3, fig. 6). *Ornatorotalia* is characterized in addition by canal systems, marginal sutural canals recognized best in tangential section (Fig. 5C; Pl. 3, fig. 6), and umbilical and dorsal radial canals (funnels) developed between the pillars (Fig. 5B; Pl. 2, figs 1-4). The spiral canal is visible in centered axial and equatorial sections (Fig. 5B; Pl. 3, fig. 6); spinal canals are also present (Fig. 5A; Pl. 2, figs 4, 5). The connection between the adjacent chambers is through intercameral foramina (Pl. 3, fig. 6).

Remarks. The rotaliine genera *Ornatorotalia* and *Granorotalia* were firstly described and figured from the upper Ypresian (Cuisian) of central and southern Italy by Benedetti et al. (2011). These genera occur abundantly in the middle-upper Cuisian of the Haymana-Polatlı basin and the Thanetian of Elaziğ region.

It is likely that L. Hottinger was unaware of Benedetti et al. (2011), when he left his almost finished manuscript on the rotaliids, published posthumously (Hottinger 2014). Thus, specimens of *Ornatorotalia* and *Granorotalia* were ascribed to different rotaliid genera by Hottinger (2014: pls. 7.4, 8.1, and 8.2), although they have numerous funnels between the inflational pillars on the both sides of the test.

Ornatorotalia spinosa Benedetti, Di Carlo & Pignatti, 2011

Pl. 2, figs 1-14; Pl. 3, figs 1-5; Pl. 5, figs 1-3

2011 *Ornatorotalia spinosa* Benedetti, Di Carlo & Pignatti, p. 705, figs 4a-h, 5a-i, 7a-j, 10e-f.
2015 *Ornatorotalia spinosa* - Benedetti: figs 1, 2.

Description. The test is slightly convex dorsally and strongly convex ventrally (Pl. 2, figs 1, 14). The diameter of the adult test ranges from 1.4 to 2 mm and

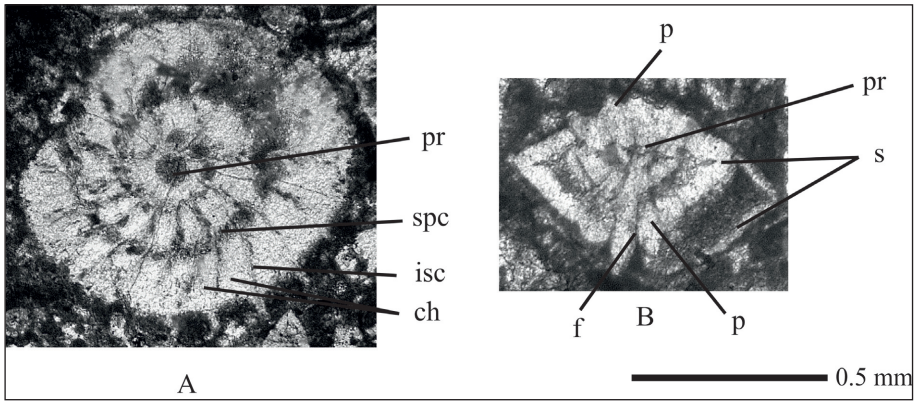

Fig. 6 - Structural elements of *Granorotalia sublobata* Benedetti, Di Carlo & Pignatti, 2011. A: Equatorial section (B. 5.6-4); B: Axial section (B. 6-3); pr: protoconch; p: inflational pillar; ch: chamber; spc: spiral canal; is: intraseptal canal; s: septum.

its thickness from 0.98 to 1.2 mm. The large, globular megalosphere (0.10-0.15 mm in diameter) is followed by tooth-like chambers, increasing gradually from the center to the periphery. The other features of the species are given in the diagnosis of the genus.

Ornatorotalia granum Benedetti, Di Carlo & Pignatti, 2011

Pl. 2, figs 9-14

2011 *Ornatorotalia granum* Benedetti, Di Carlo & Pignatti, p. 710, figs 8a-g, 9a-f, 10a-d.

Description. The test is trochoid and inequally biconvex (Pl. 2, figs 3, 14). The diameter of the test ranges from 0.8 to 1 mm and the thickness from 0.5 to 0.75 mm. The structural elements of the species are given in the diagnosis of the genus.

Remarks. The type species *O. spinosa* differs from *O. granum* Benedetti et al. (2011, pl. 2, figs 9-14) by possessing a larger test, spines with their own spinal canals, greater and numerous pustules and a larger proloculus (Benedetti et al. 2011).

Ornatorotalia sp.

Pl. 3, figs 6-9

1998 Unidentified rotaliinid genus 5 Sirel, p. 99, pl. 61, figs 1-5, pl. 68, figs 21-23.

Description. Trochospirally coiled biconvex lenticular test with 13 chambers in the last whorl measured at 1.5 mm in diameter (Pl. 3, fig. 6). The diameter of the test ranges from 1.35 to 1.50 mm and the thickness from 0.85 to 0.98 mm. The globular large proloculus is followed by tooth-like chambers in the early whorls of the equatorial section; in the last four chambers of the last whorl they become of semicircular shape (Pl. 3, fig. 6). The canal system, the intraseptal, spiral, and marginal sutural canals, the septal flap and the retral bend are recognized best in the oriented equatorial section (Pl. 3, fig. 6). An underdeveloped spine has been observed in tangential section (Pl. 3, fig. 8).

Remarks. The specimens collected from the Thanetian of Harabekayış section (Fig. 3) have previously been described as rotaliinid genus 5 in Sirel (1998, pl. 61, figs 1-5; pl. 68, figs 21-23). The hint of Benedetti et al. (2011, 715), with reference to the occurrence of *Ornatorotalia* in the Thanetian of Harabekayış section basing on Sirel (1998), encouraged us to investigate this topic.

Because of the similarities of large test, septal flaps, marginal sutural canals (Pl. 3, fig. 6), and indistinct spines (Pl. 3, fig. 8), the species is placed in *Ornatorotalia*.

Genus *Granorotalia* Benedetti, Di Carlo & Pignatti, 2011

Type species: *Granorotalia sublobata* Benedetti, Di Carlo & Pignatti, 2011

Granorotalia sublobata Benedetti, Di Carlo & Pignatti, 2011

Pl. 2, fig. 15; Pl. 3, figs 10-17

2011 *Granorotalia sublobata* Benedetti, Di Carlo & Pignatti: 715, figs 11a-e, 12 a,b, 13 a-f, 14 a-h.

Description. The small test is almost biconvex with keeled periphery. The ventral side is more convex than dorsal side (Pl. 3, figs 12, 13, 17). The subrectangular chambes are arranged in 3 whorls. The diameter of the test ranges from 0.65 to 0.85 mm and the thickness from 0.43 to 0.58 mm. The small, globular proloculus (about 0.125 mm in diameter) is followed by subrectangular chambers with a thin imperforate hyaline wall, arranged in a low trochospiral mode (Pl. 3, figs 10-13, 16-17). The umbilical and dorsal regions

are filled with inflational pillars (Pl. 3, figs 10-13, 16-17). The canal system is well developed, in accordance with *Ornatorotalia*. It has only intraseptal, spiral and radial canals (funnels) (Fig. 6).

Conclusions

The asterigerinid form here described as *Asterigerina cayrazensis* n. sp. is characterized by its trochospiral test with a peripheral keel (Pl. 1, fig. 8), a huge umbilical plug (Pl. 1, figs 5, 11, 15) and supplementary chamberlets at the center of the ventral area (Fig. 4). In the upper Ypresian (middle-upper Cuisian) limestone ("key horizon") of the Çayraz section (Fig. 2), it is associated to the rotaliine species, here determined as *O. spinosa*, *O. granum*, and *G. sublobata*, that were first described and figured from central and southern Italy by Benedetti et al. (2011) and later assigned to the new family Ornatorotaliidae by Benedetti (2015). The co-occurring alveolinid species are *A. cuspidata*, *A. schwageri*, *A.* cf. *cremae*, *A. minuta*, *A. oblonga*, *A. decastroi*, *A. boscii*, *G. minutula* (Pl. 4) and other larger foraminifera, such as *L. conditi*, *Linderina* sp., *C. liburnica*, *N. burdigalensis*, *N. fossulatus*, *A. placentula* and an undetermined cuvillierinid. The biostratigraphic range of the co-occuring alveolinid species indicates a middle-late Cuisian age (SBZ 11-12) for the new asterigerinid and the rotaliine species here described. Also the other foraminiferal species listed above support a late Ypresian (Cuisian) age. The occurrence of *A. cayrazensis* n. sp., *G. spinosa*, and *G. sublobata* in the upper Ypresian (middle-upper Cuisian) limestone ("key horizon") of Çayraz section provides further biostratigraphic and environmental data towards the correlation between the studied area and neighboring regions with complex geologic structure, especially the Tuz Gölü region.

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PLATE 1

Asterigerina cayrazensis n. sp.; all illustrated specimens are from the upper Ypresian (middle-upper Cuisian), Çayraz section, 7 km N of Haymana, S Ankara, central Turkey, except fig. 12 from Taş ocağı, 10 km S of Polatlı, SW Ankara, central Turkey.

Fig. 1 - Centered axial section (B.6X-1).
Fig. 2 - Equatorial section, showing strongly curved septa and stellate chamberlets at the central part of the ventral region (B.5.2-1).
Fig. 3 - Axial section (B.5.2-5).
Fig. 4 - Equatorial section, showing supplementary chamberlets arround the umbilical boss (B.6-4X).
Fig. 5 - Axial section, showing large umbilical plug with laminated wall structure (B.5.61).
Fig. 6 - Axial section with peripheral keel (left) (B.5.2-3).
Fig. 7 - Equatorial section, A form (B.5.6-2).
Fig. 8 - Axial section, showing peripheral keel (right) (*A*.2-1).
Fig. 9 - Axial section (B.5-1).
Fig. 10 - Axial section (B.3.2-3).
Fig. 11 - Axial section, showing umbilical plug with laminated wall structure (*A*.3.2-3).
Fig. 12 - Axial section (1B-5).
Fig. 13 - Axial section, (B.3.4-1).
Fig. 14 - Axial section (B.5.2-3).
Fig. 15 - Equatorial section, showing supplementary chamberlets at the center of the test (C. 11-7).
Fig. 16 - Axial section (B. 5-2).

PLATE 2

Ornatorotalia and *Granorotalia* from the upper Ypresian (middle-late upper Cuisian), Çayraz section, 7 km N of Haymana, S Ankara, central Turkey.

Figs 1-8 - *Ornatorotalia spinosa* Benedetti et al., 2011. 1) Centered axial section (Ç.15/5). 2) Centered axial section, showing ventral and dorsal inflational pillars and funnels (Ç.12/4). 3) Centered axial section (Ç.14/3). 4) Tangential section with spine, inclined to the equatorial plane (Ç.15/3). 5) Tangential section with spine, inclined to the equatorial plane (Ç.1/4). 6) Oblique equatorial section and axial section of *O. granum* Benedetti et al. (top left) (Ç.1/4). 7) Almost axial section with spine (right) (Ç.13/3). 8) Centered axial section (Ç.4/1).

Figs 9-14 - *O. granum* Benedetti et al., 2011. 9) Almost axial section (Ç.5/5). 10) Centered axial section (Ç.10/3). 11) Almost equatorial section (Ç.13/2). 12) Centered axial section (Ç.2/3). 13) Subequatorial section (Ç.2/4).

Fig. 14 - Centered axial section (Ç.10/2).

Fig. 15 - *Granorotalia sublobata* Benedetti et al., 2011, axial sections of four specimens (B.3.4-5).

PLATE 3

Additional records of *Ornatorotalia* and *Granorotalia* from central and eastern Turkey.

Figs 1-5 - *Ornatorotalia spinosa* Benedetti et al., 2011, upper Ypresian (middle-upper Cuisian) of the Taş ocağı area, S Polatlı, SW Ankara, central Turkey. 1) tangential section inclined to the equatorial plane, showing marginal sutural canals and spines (Ç.2-6). 2) almost equatorial section, (1d/1). 3) axial section (Ç.10/1). 4) axial section of juvenile specimen (1f/7a). 5) oblique subequatorial section (Ç.13/1).

Figs 6-9 - *Ornatorotalia* sp. from the Thanetian of Harabekayış section, W Elazığ, eastern Turkey. 6) equatorial section, showing septal flap, marginal sutural and spiral canals and intercameral foramina (HK.10d/2), also figured in Sirel (1998, pl. 68, fig. 21). 7) axial section, showing ventral and dorsal inflational pillars, funnels and partly imperforate chamber wall (HK.10/A/2a), from Sirel (1998, pl. 68, fig. 22). 8) tangential section, showing underdeveloped spine(?) (bottom left) (HK.11c/5). 9) axial section, showing perforate chambers wall and possibly ventral and dorsal inflational pillars (HK.10a/3/2).

Figs 10-17 - *Granorotalia sublobata* Benedetti et al., 2011, upper Ypresian (Cuisian), Çayraz section, N of Haymana, S Ankara, central Turkey. 10) axial section (*A*.3/1/4). 11) oblique axial section, inclined to the equatorial plane (B.5/6/3). 12) axial section (B.6/3). 13) axial section (B.5/4). 14) equatorial section (B.2/3). 15) equatorial section (B.3/1). 16) axial section (B.5/3/2). 17) axial section (B.2/2).

PLATE 4

Larger foraminiferal assemblage from the upper Ypresian (middle-upper) Cuisian of the Çayraz section, N of Haymana, S Ankara, central Turkey.

Fig. 1 - *Alveolina cuspidata* Drobne, axial section (Ç.4/6).
Fig. 2 - *Alveolina schwageri* Checchia-Rispoli, axial section (B.3/2/2).
Fig. 3 - *Alveolina* cf. *cremae* Checchia-Rispoli, axial section (B.6/4).
Fig. 4 - *Alveolina minuta* Checchia-Rispoli, axial section (Ç.8/2).
Fig. 5 - *Alveolina oblonga* d'Orbigny, axial section (Ç.2/7).
Fig. 6 - *Alveolina decastroi* Scotto di Carlo, axial section of juvenile specimen (B.3/4/3).
Figs 7, 8 - *Alveolina boscii* (Defrance), 7) axial section (B.1/5); 8) axial section (*A*. 3/2/5).
Fig. 9 - *Glomalveolina minutula* (Reichel), subaxial section (B. 4/1/1).
Figs. 10-12 - Undetermined cuvillierinid, 10) axial section (Ç.8/3); 11) oblique equatorial section (Ç. 9/3); 12) subequatorial section (Ç.3/4).
Figs 13-15 - *Lockhartia conditi* (Nuttall). 13) axial section of juvenile specimen (*A*.4/1); 14) axial section (*A*.4/3); 15) axial section of juvenile specimen (left) and *Nummulites burdigalensis* de la Harpe (right) (*A*.3/1/1).
Figs 16, 17 - *Linderina* sp., 16) detail of central portion of equatorial section, showing embryonic and adauxiliary chambers (B.5/6/2b); 17) axial section (*A*.3/2/6).
Figs. 18, 19 - *Coskinolina liburnica* Stache, 18) subvertical section (B.4/1); 19) nearly vertical section (B.2/4).

PLATE 5

Larger foraminifera from the Thanetian of the Harabekayış section, S Baskil town, W Elazığ, eastern Turkey (figs 1-13), and the upper Ypresian of the Taş ocağı area, S Polatlı, SW Ankara, central Turkey (figs 14, 15).

Figs 1-4 - *Ornatorotalia* sp., 1) axial section (HK.10h/3); 2) axial section (HK.10b/1); 3) axial section, (HK.11d/5); 4) axial section (HK.10a/2).
Fig. 5 - *Lockhartia diversa* Smout, axial section (HK.10b/4).
Figs 6, 7 - *Elazigina harabekayisensis* Sirel, 6) axial section (HK. 10e/1); 7) equatorial section (HK.11b/3).
Figs 8-11 - *Valvulineria* aff. *pataloensis* Haque, 8) almost equatorial section (HK.11a/3); 9) subaxial section (HK. 11 d/1/2); 10) equatorial section (HK.11e/3): 11) equatorial section (HK.11h/4).
Fig. 12 - *Bolkarina aksarayensis* Sirel, subaxial section (HK.10a/4).
Fig. 13 - *Discocyclina seunesi* Douvillé, equatorial section (HK.11a/2).
Fig. 14 - *Assilina placentula* (Deshayes), axial section (1e/6).
Fig. 15 - *Nummulites fossulatus* de Cizancourt, subaxial section (1f/6).

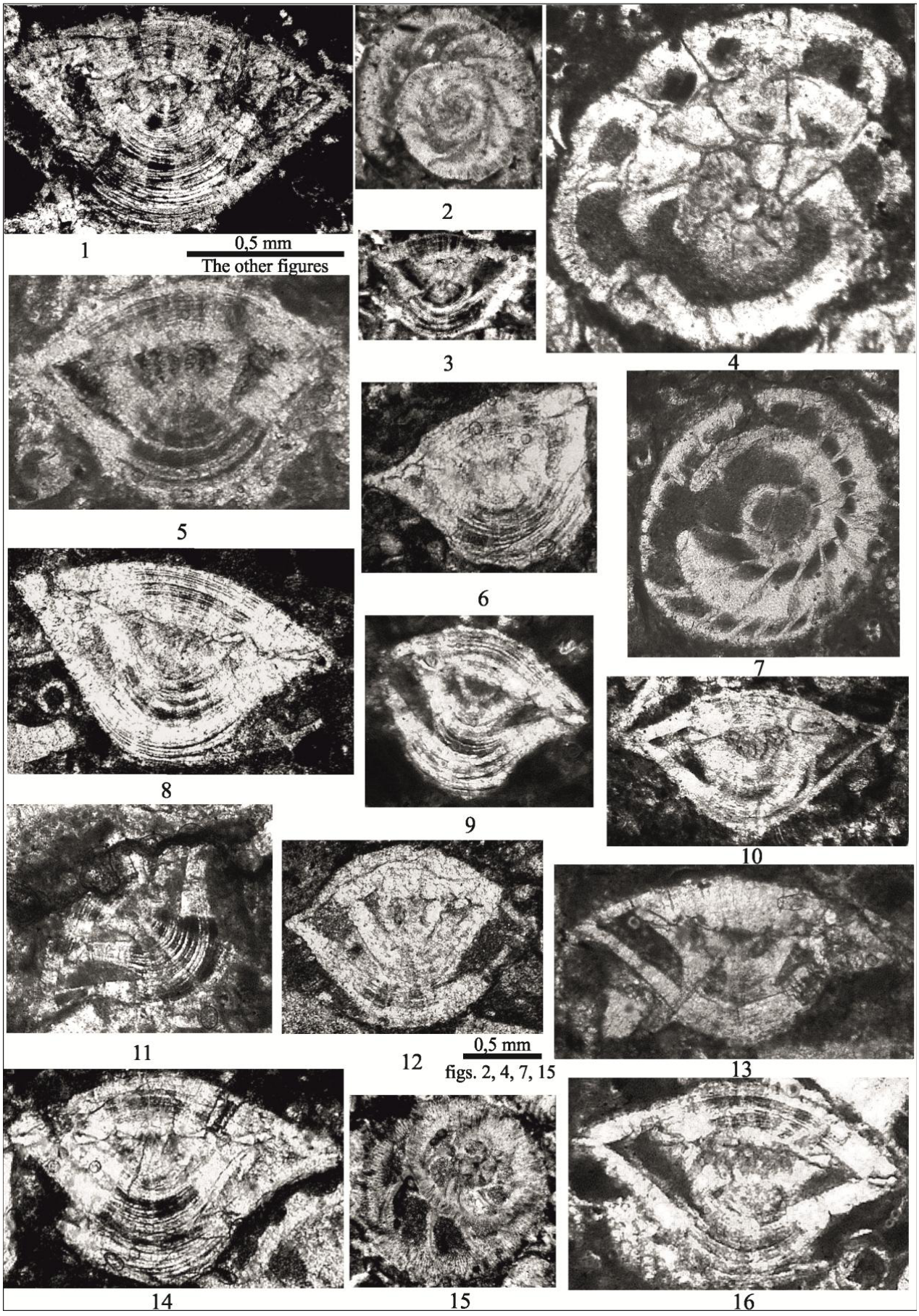
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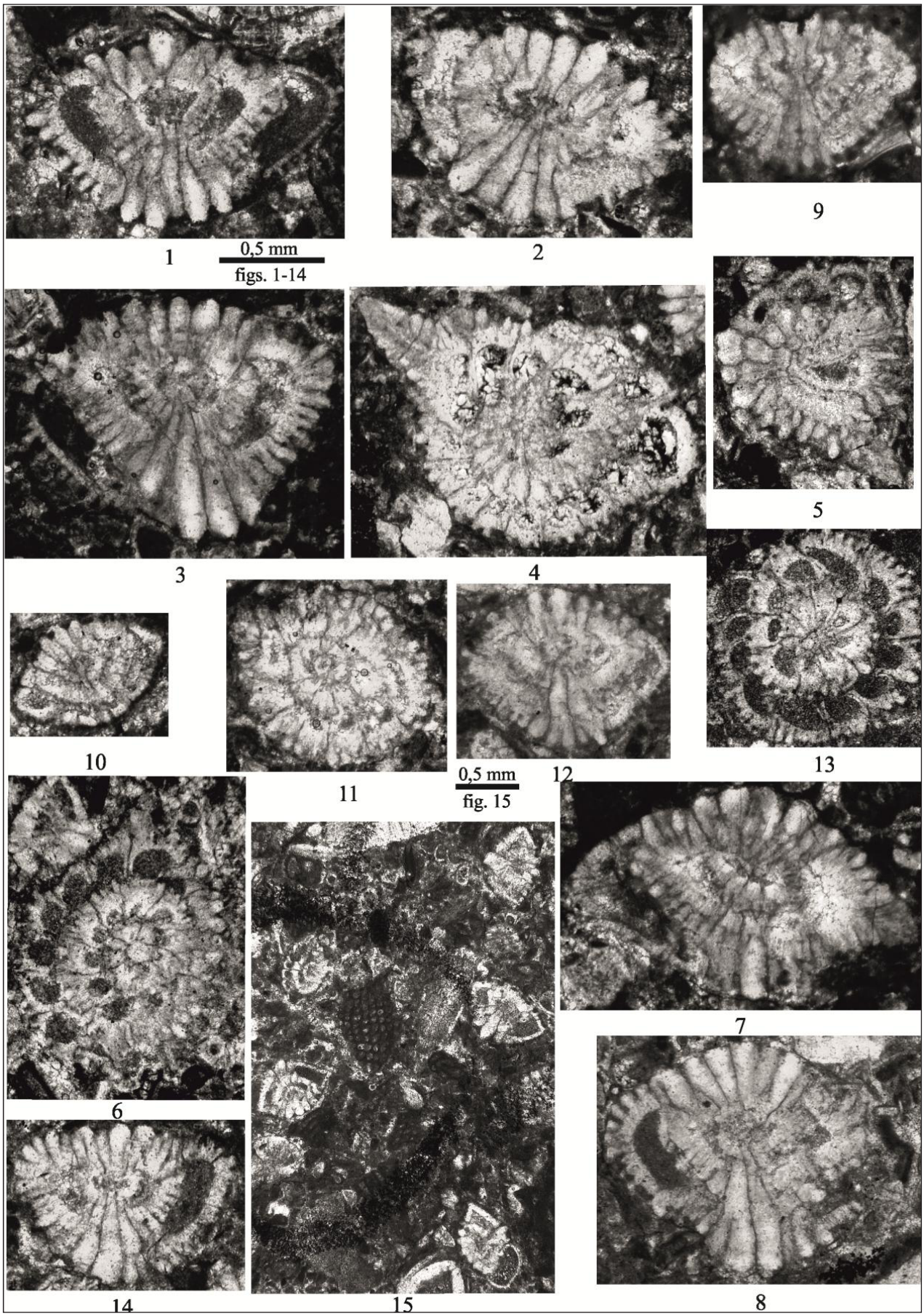
PLATE 1



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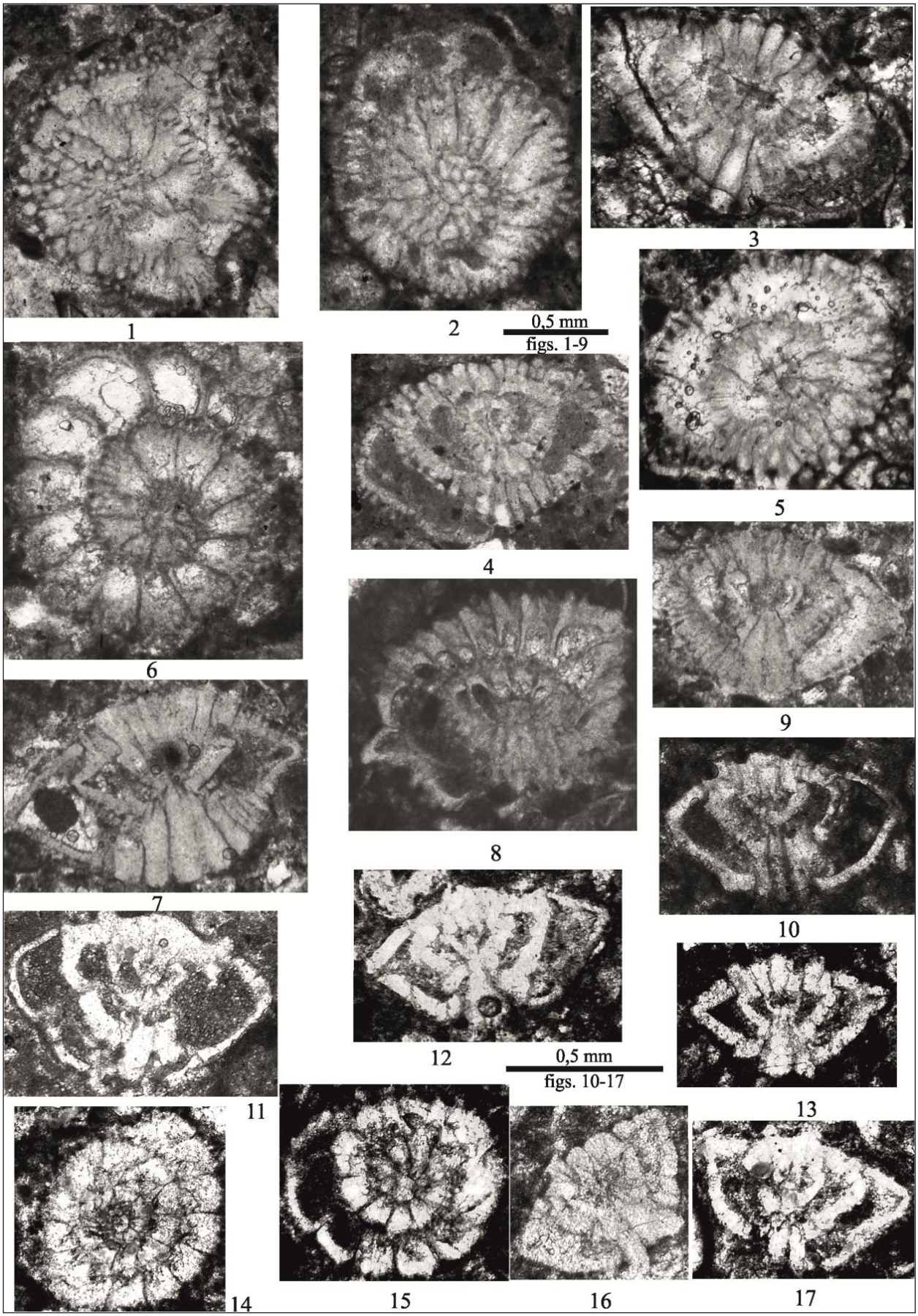

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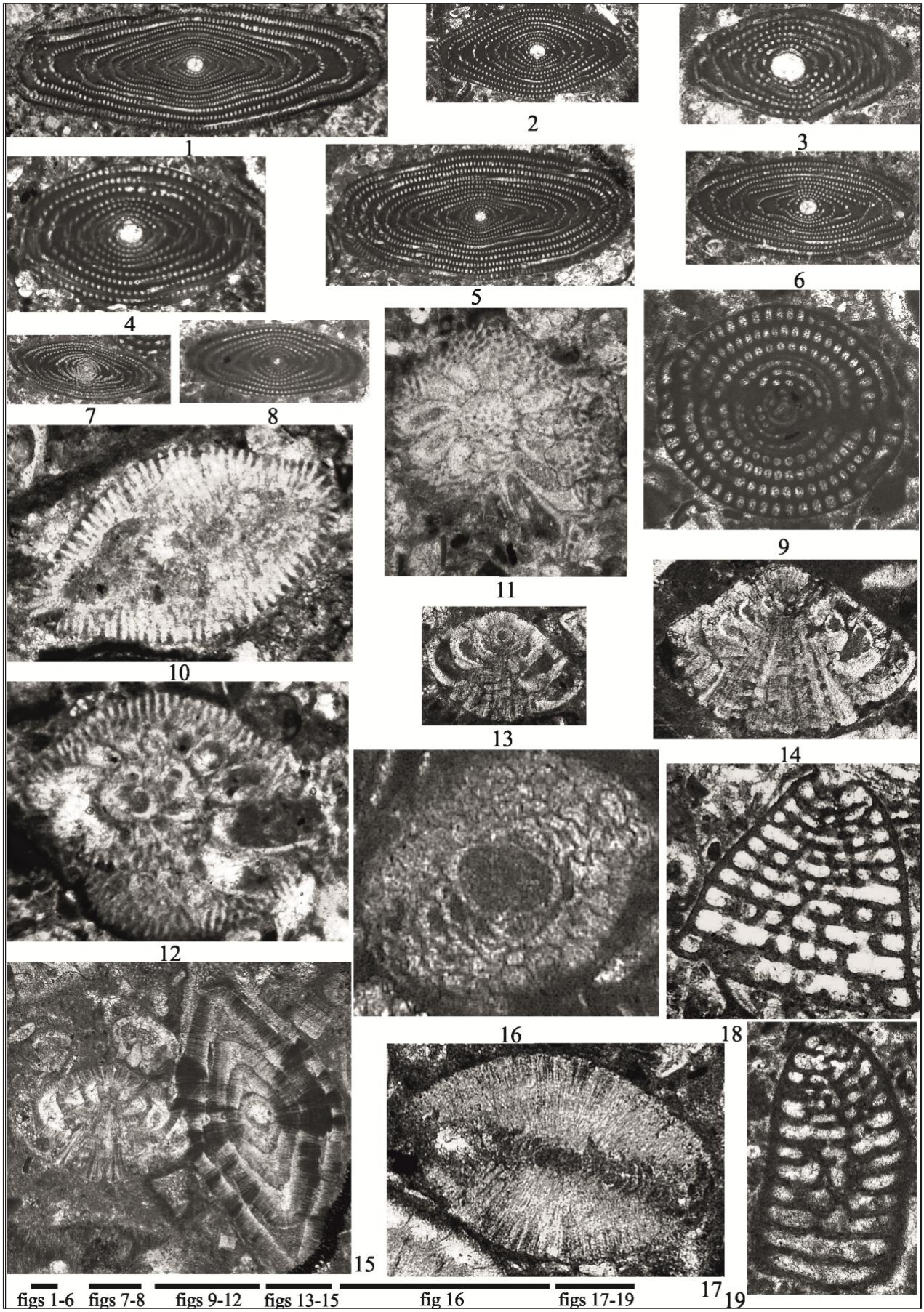
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PLATE 4

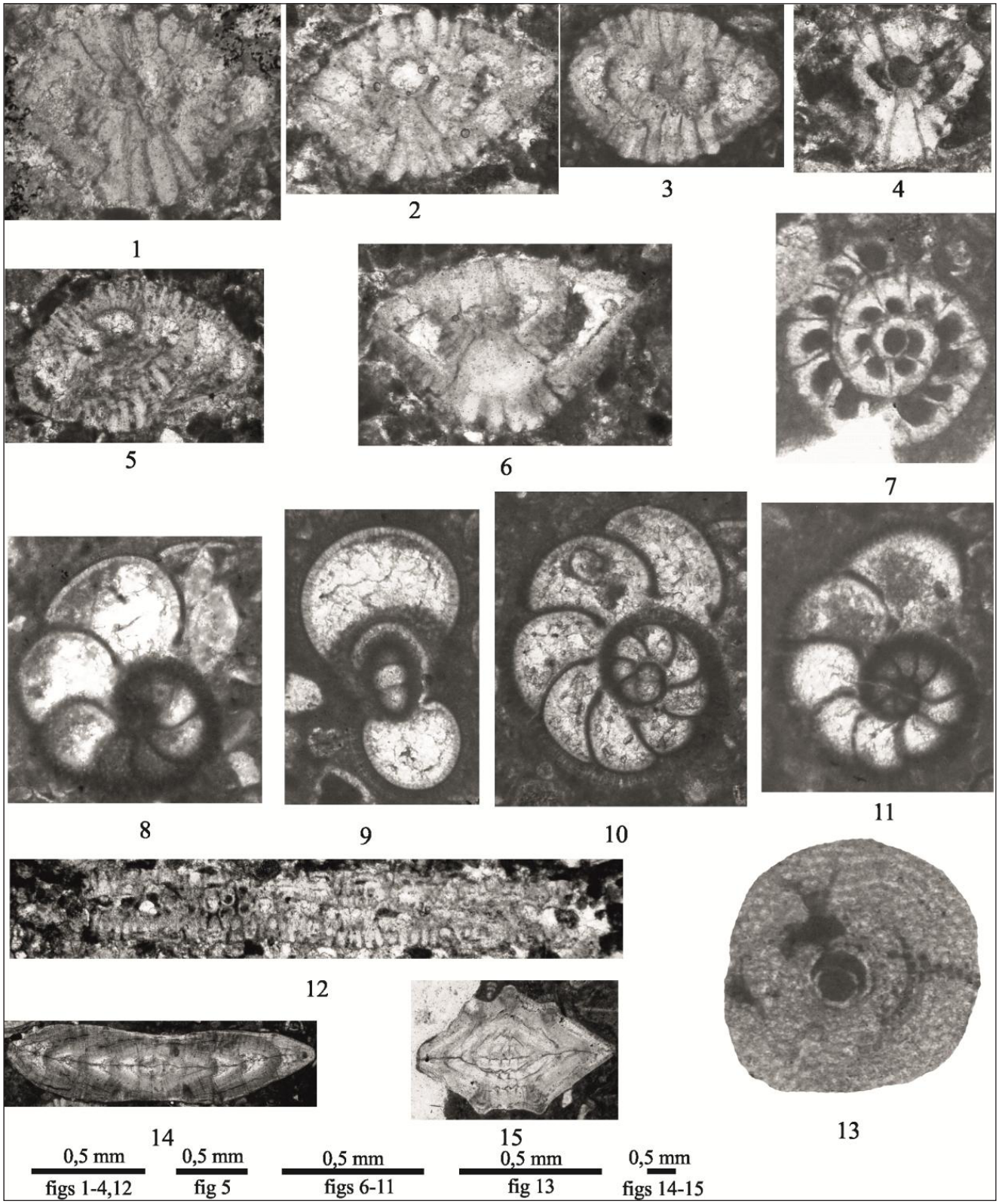
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PLATE 5