



Coscinospira prima n. sp., a new peneroplid foraminifer from the Paleocene of Iran and its bearing on the phylogeny of the Peneroplidae

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ABSTRACT - A new porcelaneous large-sized benthic foraminifera is described as *Coscinospira prima* n. sp. from the Paleocene shallow-water carbonates of different tectonic units of Iran. It has been observed in the Selandian-Thanelian Sachun Formation (Qorban Member) of SW Iran (Zagros Zone), in the Selandian carbonates of Central Iran (Yazd Block), and in the Selandian of the Palang Formation of Eastern Iran (Sistan Suture Zone). *Coscinospira* Ehrenberg was so far only known from the Miocene-Holocene (*C. hemprichii* Ehrenberg), and the early Oligocene (*C. elongata* Sirel and Özgen-Erdem, *C. sivasensis* Sirel and Özgen-Erdem). Being a rather simply structured taxon, differences of species are due to classical shape and size characters. The presence of *C. prima* n. sp. in the Selandian represents the earliest record of the genus and gives further information on the phylogeny and diversification of the Peneroplidae during the Early Paleogene.

Keywords: Foraminifera; Soritoidea; Paleogene; biostratigraphy; systematics.

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1. INTRODUCTION

Paleocene carbonates are known from different parts (or tectonic zones) of Iran: the Kopet-Dagh Basin, NE Iran (e.g., Rahaghi, 1983; Rivandi and Moosavizadeh, 2015; Salahi et al., 2018), the Sistan Suture Zone, E Iran (e.g., Rahaghi, 1983; Tirrul et al., 1983), Central Iran (e.g., Deloffre et al., 1977; Khosrow-Tehrani, 1987; Schlagintweit et al., 2019), and Zagros Zone, SW Iran (e.g., James and Wynd, 1965; Kalantari, 1976; Lasemi et al., 2007). Micropaleontological, taxonomic, and biostratigraphic studies of these rocks are rare and date back mostly to the 1970's and 1980's. Being rich in dasycladaleans and larger benthic foraminifera (LBF) much more attention has been given to the latter group (Kalantari, 1976; Rahaghi, 1983). Despite these works, several taxa remained unidentified. In a recent contribution new taxa of LBF have been described from a locality named Kuh-e-Chah Torsh (Kuh = mount in Persian), at the southwestern margin of the Yazd Block in Central Iran (Schlagintweit and Rashidi, 2019). In this contribution one taxon has been described in open nomenclature as *Coscinospira?* sp. because of incomplete knowledge on the early stage of growth. Due to new finds in other localities from different parts of Iran, all

morphological characteristics are available now for its systematic description as *Coscinospira prima* n. sp.

2. GEOLOGICAL SETTING

The samples containing the new foraminifera are from four localities in Iran: Kuh-e-Chah Torsh (Central Iran), Kuh-e-Patorgi (two sections: Bandan and Kuh-e-Patorgi sections; Eastern Iran), and the Qorban section (Zagros Zone) (Fig. 1, Tab. 1). So far only the Kuh-e-Chah Torsh section has been investigated in detail (Schlagintweit and Rashidi, 2019; Fig. 2). The specimen selected as holotype comes from the Bandan section, thereby becoming its type-locality.

2.1 KUH-E-PATORGI AREA (EASTERN IRAN): PATORGI AND BANDAN SECTIONS

From this area, the new species has been observed in two near-by sections, named the Patorgi and Bandan sections. The Patorgi section is located ~10 km SE of Bandan village, about 215 km from Zahedan, the central province city, and about 10 km from the Afghanistan-Iran border. The Bandan section is located ~10.3 km west-northwest of the Patorgi section, both accessible from the road Nehbandan to Zahedan. The geological setting

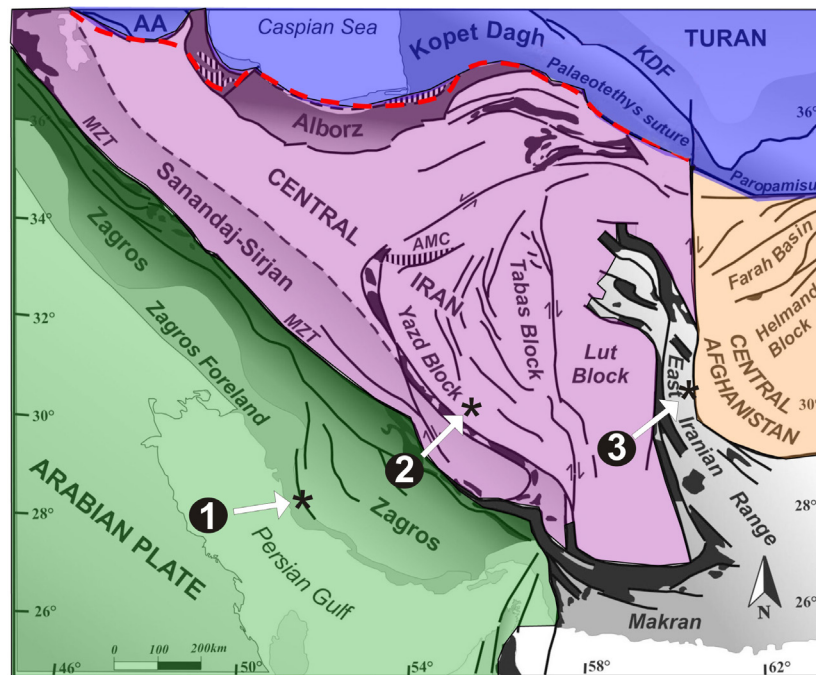


Fig. 1 - Tentative location of the sections with *Coscinospira prima* n. sp. (1-3, arrows) plotted on the tectonic map of Iran (modified from Zanchi et al., 2009). Abbreviations: AA = Anatolian-Armenian Block, AMC = Anarak Metamorphic Complex, KDF = Kopeh Dagh Foredeep, MZT = Main Zagros Trust.).

Tab. 1 - Summary data of the studied localities.

Locality (section base)	East Iran ~215 km N of Zahedan (31°22'59.10"N, 60°49'36.58"E)	East Iran ~218 km N of Zahedan (31°23'59.65"N, 60°43'11.26"E)	Central Iran ~70 km S of Yazd (31°14'37.28"N 54°33'43.27"E)	Southwestern Iran ~60 km SE of Shiraz (29°11'31.59"N; 52°52'40"E)
Section name	Kuh-e-Patorgi	Bandan	Kuh-e-Chatorsh	Qorban
Section thickness	~315 m	320 m	>150 m	~210 m
Formation	Palang Formation		Lithostratigraphically not defined	Sachun Formation, Qorban Member
Geotectonic setting	Sistan Suture Zone (or East Iran Flysch Zone)		Yazd Block, Central Iran Microcontinent	Zagros Zone, Arabian Plate
Palaeogeographic setting	Northern Neotethyan margin			Southern Neotethyan margin
Reference	Rahaghi (1983); Tirrul et al. (1983)		Deloffre et al., (1977); Khosrow-Tehrani (1987)	Rahaghi (1983); Bavi Oweydi et al. (2016)

is the same for both sections. Based on Bandan map 1:100000 (Eftekhari Nezhad et al., 1990), the oldest unit in these sections is represented by the Sefidabeh Formation that consists of volcanoclastic deposits. It is conformably overlain by the Paleogene Palang Formation, subdivided into two limestone members separated by coarse-grained clastics. The Paleocene sediments are unconformably overlain by Eocene rocks. Geotectonically, the study area is located between the Lut Block in the west and Helmand (or Afghan) Block to the east. It is known as Flysch or Sistan Suture Zone and mainly includes ophiolitic mélanges

and Upper Cretaceous to Paleogene sediments (Tirrul et al., 1983). Palaeogeographically it is part of the former Northern Neotethyan margin. Specimens of *Coscinospira prima* n. sp. have been observed in the second (upper) limestone member at the Patorgi section. The microfacies is a packstone with rotaliids, e.g., *Lockhartia* aff. *retiata* Sander, small miliolids, and dasycladalaen algae, e.g., *Acroporella? anceps* Segonzac, *Hamulusella sedalensis* Elliott, *Uteria* aff. *merienda* (Elliott), *Rostroporella oviformis* Segonzac, and *Cymopolia* ssp. Directly below, specimens of *Rotorbinnella* Smout [*R. detrecta* Hottinger,

R. hensoni (Smout)] have been observed indicating shallow benthic zones (SBZ) 2-3 (Serra-Kiel et al., 1998; Hottinger, 2014). *Lockhartia retiata* Sanders is known from SBZ 3-4 according to Hottinger (2014). For South Tibet, a biozonation with Lockhartiinae was established by Kahsnitz et al. (2016) with *L. retiata* restricted to the *Lockhartia* biozones 1 and 2 (= SBZ 2 and lower part of SBZ 3). This suggests that the *Coscinospira*-bearing levels can be assigned to the Selandian at Kuh-e-Patorgi. The coordinates of the Patorgi section base are 31°22'59.10"N, and 60°49'36.58"E, those from the Bandan section base are 31°23'59.65"N, 60°43'11.26"E.

2.2 KUH-E CHAH TORSH (CENTRAL IRAN)

The Mount Chah Torsh section is located about 55 km southeast of Mehriz, near Yazd city. In previous works this locality has been named Kuh-é-Tchahtorch (Deloffre et al., 1977), Tchah-Torch (Khosrow-Tehrani, 1987), Kamar-e-Chahtorsh (Nabavi, 1972), and Kuh-e-Chah Torsh (Majidifard and Vaziri, 2000). Geotectonically, the study site is part of the Central Iranian Microcontinent, namely the Yazd Block (e.g., Takin, 1972). Palaeogeographically it is part of the former Northern Neotethyan margin. It has been recently re-investigated with first new results already published (Schlagintweit et al., 2019; Schlagintweit and Rashidi, 2019). The exposed sedimentary sequence starts with Lower Cretaceous "*Orbitolina*" Limestone (= Taft Formation) assigned to the upper Aptian (Schlagintweit and Rashidi, 2019, for details). It is followed with erosional contact by clastic deposits, and finally upper Maastrichtian sandy limestones containing bryozoans, and LBF, e.g., *Orbitoides gensacicus* (Leymerie), *Canalispirina iapygia* Robles-Salcedo, Vicedo, Parente and Caus, and *Orbitoides gruenbachensis* Papp. Above the last sample with orbitoidids assigned to the upper Maastrichtian (Ah 73), an interval of sandy marls (0.8 m to 1.0 m) follows lacking any sample data (Fig. 2). Most likely it represents an emersion horizon at the K-Pg boundary interval. The lowermost sample of the following mixed carbonatic-siliciclastic marine bed (Ah 74), documents a new transgression, and contains textulariids and roaliids, among which is *Rotorbinella detrecta* Hottinger. This facies grades into nodular carbonates containing abundant rather thick-walled miliolids (*Ankarella*, *Haymanella*), the agglutinating taxon *Kolchidina paleocenica* (Cushman), and bryozoans, assigned to the Danian (e.g., Sirel, 2012). Especially the presence of green algae (*Ovulites moreletti* Elliott, *Terquemella* sp., *Cymopolia* cf. *barattoloi* Parente), lacking in the upper Maastrichtian samples, is worth mentioning. Upwards it is followed by alluvial fan conglomerates, unfossiliferous reddish sandstones, mudstones exhibiting fine cracks and black pebble formation (mud-flat deposits), subtidal grain-packstones with miliolids and algae (subtidal lagoon), and intercalated lensoidal dolomite bodies. The repetitive appearance of (sandy) mudstones and lagoonal grain/packstones indicates cyclic sedimentation due to oscillating sea-level (T-R cycles). In the lower part of the cycles a ca. 35-40 m

thick rhyolitic sill is intercalated. This unit is followed by a package of limestones that correspond from a microfacies point of view with the subtidal beds of the T-R cycles. These are followed upwards by thick-bedded to massive limestones reaching up to the summit of Mount Chah Torsh. The diversification of benthonic foraminifera and calcareous algae (see Fig. 2) starts in the middle to upper part increasing markedly in the last third of this unit. From this upper unit, *Coscinospira prima* n. sp. has been observed in some samples only. The typical microfacies is a packstone containing abundant miliolids, associated with dasycladalean and halimedacean algae. One of these algae has recently been described as a new species, *Dissocladella? chahtorshiana* (Schlagintweit et al., 2019).

The larger benthic foraminifer *Sistanites iranicus* Rahaghi is among the most common taxa in the upper part of the section (Fig. 2). Its first occurrence is (in accordance with literature data from other regions, e.g., Pignatti et al., 2008; Sirel, 1998, 2012,) tentatively used as the separation of SBZ 1 and SBZ 2 sensu Serra-Kiel et al. (1998). There is no biostratigraphic evidence that the Paleogene carbonates exposed at Mount Chah Torsh reach into the Thanetian. Based on this evidence, the interval containing *Coscinospira prima* n. sp. can be assigned to the Selandian. The coordinates of the section base are 31°14'37.28"N, and 54°33'43.27"E.

2.3 QORBAN SECTION (ZAGROS ZONE, SW IRAN)

The section name refers to the Qorban (or Ghorban) Member of the Paleocene-lower Eocene Sachun Formation (e.g., James and Wynd, 1965; Bavi Oweydi et al., 2016). It is located about 70 km southeast of the city of Shiraz and consists of thick-bedded gray limestone, yellowish sandy, dolomitic limestone and dolomite. The Qorban member is a carbonatic unit within the Sachun Formation widespread in the area south and south-east of Shiraz. The thickness of the studied succession is about 210 m. The study site is located within the Mozaffari anticline structure, located 4 km near the road Shiraz-Jahrom. Palaeogeographically it belongs to the Zagros Zone, SW Iran, part of the former southern Neotethyan margin. The Ghorban (or Qorban) Member contains a diverse association of dasycladalean algae and benthic foraminifera, among which are many LBF of biostratigraphic importance. In the part of the section with *Coscinospira prima* n. sp. the following taxa have been identified (in alphabetical order): *Anatoliella ozalpiensis* Sirel, *Cincoriola ovoidea* (Haque), *Dictyokathina simplex* Smout, *Dictyoconus? turriculus* Hottinger and Drobne, *Elazigina* aff. *lenticula* (Hottinger), *Fallotella alavensis* Mangin, *Hottingerina lucasi* Drobne, *Lockhartia retiata* Sander, *Mardinella daviesi* (Henson), *Miscellanea miscella* (d'Archiac and Haime), *Miscellanites* cf. *globularis* (Rahaghi), *Rotospirella* cf. *conica* (Smout), and *Slovenites pembaphis* Hottinger (Fig. 3). This assemblage allows an attribution to SBZ 3-4 (late Selandian-Thanetian) (Serra-Kiel et al., 1998, 2016b; Pignatti et al., 2008; Hottinger, 2009, 2014; Sirel, 2012). The coordinates of the section base are 29°11'40.58"N, 52°52'36.40"E.

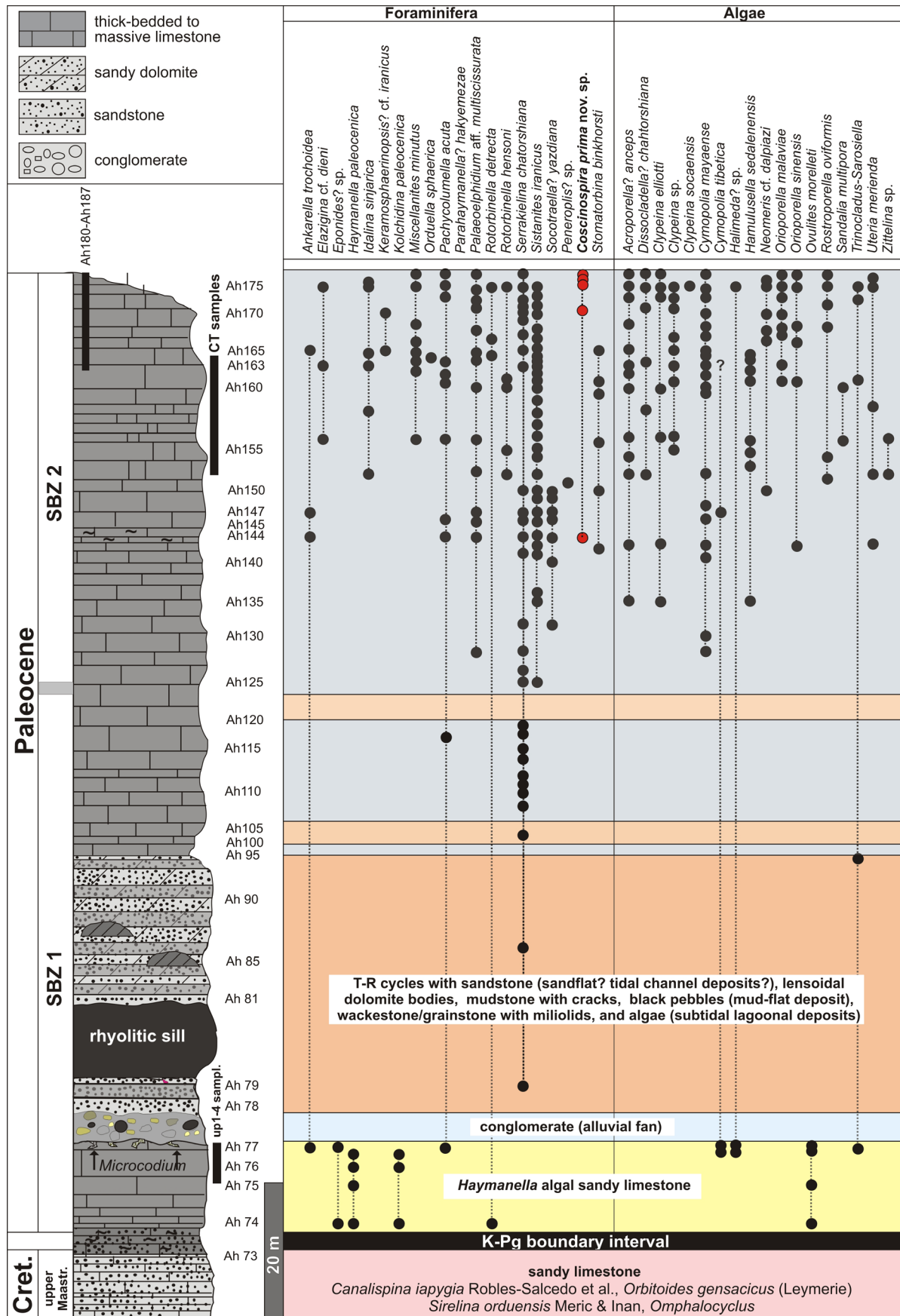


Fig. 2 - Simplified lithostratigraphic column of the Kuh-e-Chah Torsh section with position of samples and distribution of benthic foraminifera including *Coscinospira prima* n. sp. and calcareous algae (modified from Schlagintweit and Rashidi, 2019). Inferred SBZ zones after Serra-Kiel et al. (1998), Sirel (1998, 2012), and Hottinger (2014).

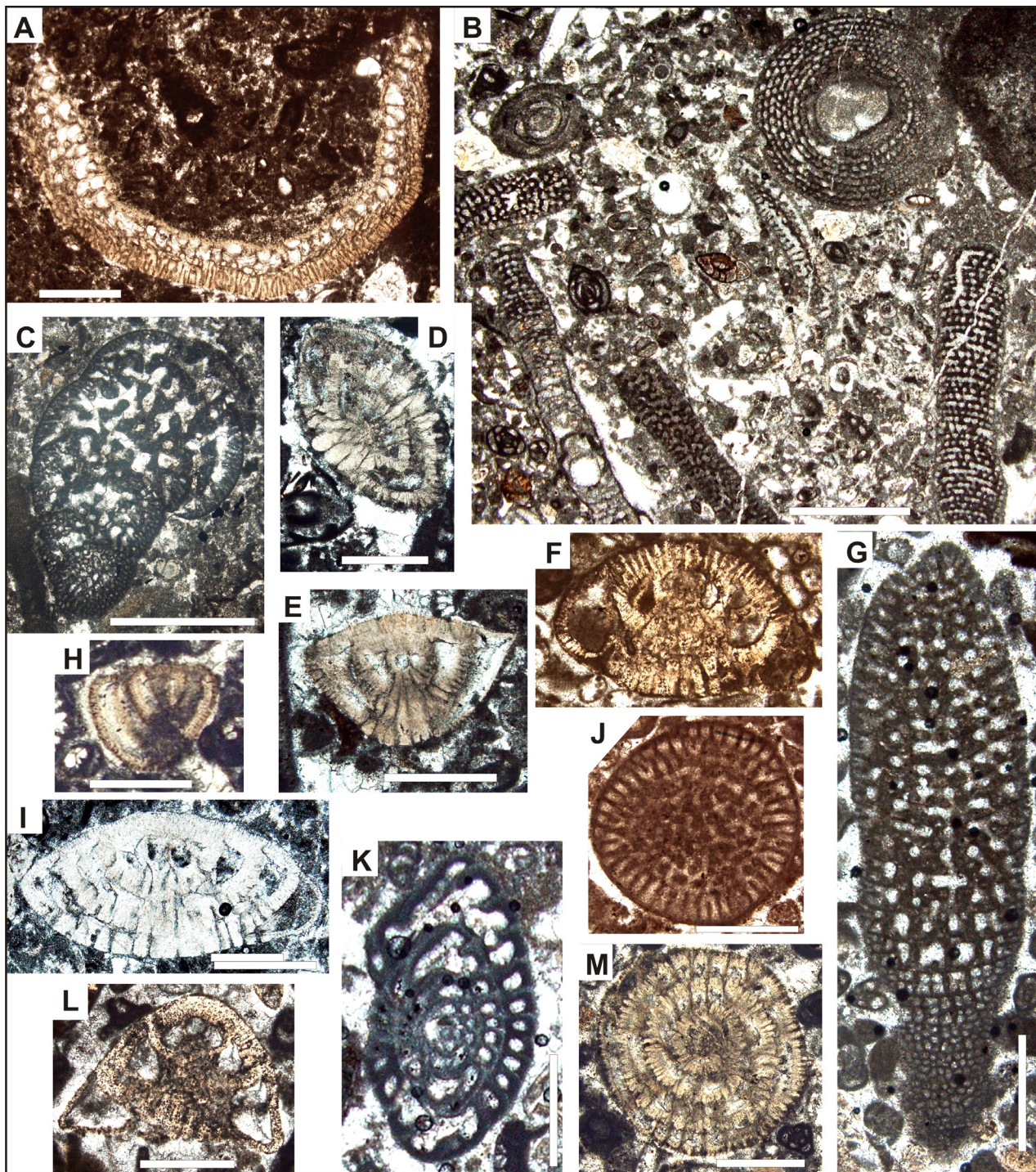


Fig. 3 - Assemblage of Larger Benthic Foraminifera (SBZ 3) from the Qorban section, Zagros Zone: *Dictyokathina simplex* Smout (A), microfacies with several specimens of *Mardinella daviesi* (Henson) (B), *Anatoliella ozalpiensis* Sirel (C), *Miscellanea miscella* (d'Archiac and Haime) (D), *Elazigina* aff. *lenticula* (Hottinger) (E), *Lockhartia retiata* Sander (F), *Dictyoconus? turriculus* Hottinger and Drobne (G), *Cincoriola ovoidea* (Haque) (H), *Slovenites pembaphis* Hottinger (I), *Fallotella alavensis* Mangin (J), *Hottingerina lucasi* Drobne (K), *Rotospirella* cf. *conica* (Smout) (L), *Miscellanites* cf. *globularis* (Rahaghi) (M). A. Qs 66. B. Q 16-1. C. Q 24. D. Q 19. E. Q 17-1. F. Qs 74. G, K. Q 17. H, M. Q 17-2. I. Q 16. J. Qs 84. L. Qs 33. Scale bars: 1.0 mm (A-C), 0.5 mm (D-M).

3. MATERIAL AND METHODS

This study of Paleocene limestones is based exclusively on thin-sections. All thin-sections with the specimens illustrated in the present paper, 14 in number, are

deposited in the Geosciences Museum of Mashhad (in the Geological Survey of North-Iran East territory). The specimens coming from the Kuh-e-Chah Torsh section have been stored in the framework of the study by Schlagintweit and Rashidi (2019) (see Tab. 2). In the

present paper the original sample numbers as designated in the field are used. The Larger Benthic Foraminifera have been determined based on Hottinger and Drobne (1980), Sirel (1998), and Hottinger (2014).

4. SYSTEMATIC PALAEOLOGY

The high-rank classification follows Pawlowski et al. (2013). For the low-rank classification Loeblich and Tappan (1988) is used.

Phylum Foraminifera d'Orbigny, 1826
 Class Tubothalamea Pawlowski, Holzmann and Tyszka, 2013
 Order Miliolida Delage and Hérouard, 1896
 Superfamily Soritoidea Ehrenberg, 1839
 Family Peneroplidae Schultze, 1854
 Gen. *Coscinospira* Ehrenberg, 1839
 Synonym *Cribrospiroolina* Haman, 1972
 Type species: *Coscinospira hemprichii* Ehrenberg, 1839

Remarks: The main characteristics of the genus are: (i) elongate (crosier-shaped) test with a planispirally coiled juvenile part, and an uncoiled, uniserial adult part. (ii) chamber interior simple, without exo- or endoskeleton. (iii) cribrate aperture composed by numerous intercameral foramina occupying the central part of the septum (Ehrenberg, 1839; Loeblich and Tappan, 1988a; Hottinger et al., 1993; Sirel et al., 2013). Fine surface ornamentation (ribs perpendicular to the septum) as typical in some species of the genus *Peneroplis* (e.g., Hofker, 1950; Loeblich and Tappan, 1988a) is also present in *Coscinospira* (e.g., Hottinger et al., 1993). It is noteworthy that this observation, chamber subdivision and external ribs excluding each others, is the normal

case in the Soritoidea with only few exceptions (Fleury, 1997). Referring to *Coscinospira*, Hottinger et al. (1993, p. 69) noted that "The apertures are often bi- or trilobate and rimmed by strong, everted peristomes. Apertures transformed into an irregularly multiple intercameral foramen lose parts of their peristomal rims by resorption while the caliber of the foramina is enlarged". The apertural features are usually not accessible in random thin-sections, and the existence of peristomal rims around the foramina have not been observed neither in our material nor in the Oligocene species described by Sirel et al. (2013). Also, the possibility to observe fine surface ornamentation requires special sections, e.g., oblique shallow tangential. In our material only two sections provided this information (Fig. 5G, 5J), whereas none of the sections of the two new Oligocene species by Sirel et al. (2013) does. Last but not least, populations of the type-species *Coscinospira hemprichii* Ehrenberg studied by Hottinger et al. (1993) from the Gulf of Aqaba, Egypt, showed both specimens with peneropliform and spiroliniform morphologies.

Coscinospira prima n. sp.

Figs. 4A-K; Fig. 5A-J.

1983 *Rhapydionina* sp. or *Spirolina* sp. - Rahaghi, Pl. 10, Figs. 10-12, 14, non 13 (= ? *Serrakielina chatorshiana* Schlagintweit and Rashidi).

2017 *Cribrogoesella* sp. - Al-Dulaimi and Al-Dulaimi, Pl. 8, Fig 5.

2019 *Coscinospira?* sp. - Schlagintweit and Rashidi, Pl. 8, Figs. 7-10.

Etymology: *prima* (latin = the first), referring to the first (= oldest) known record of the genus.

Type material: Holotype: BN N2a, complete adult

Tab. 2 - Numbers of thin-sections (original field samples) with *Coscinospira prima* n. sp., and official depository numbers (DN) of the Geosciences Museum of Mashhad (in the Geological Survey of North-Iran East territory).

number	Original sample number	Depository number	Localites - sections
1	Ah 177-1	Gmm13950F65	Kuh-e-Chah Torsh
2	Ah 185	Gmm13950F70	Kuh-e-Chah Torsh
3	Ah 187	Gmm13950F71	Kuh-e-Chah Torsh
4	BN N2a	Gmm1395072	Bandan section
5	BN N2b	Gmm1395073	Bandan section
6	BN P2c	Gmm1395074	Bandan section
7	2pz 28	Gmm1395075	Patorgi section
8	2pz 49	Gmm1395076	Patorgi section
9	Q 12	Gmm1395077	Qorban section
11	Q 18	Gmm1395078	Qorban section
12	Qs 44	Gmm1395079	Qorban section
13	Qs 77	Gmm1395080	Qorban section
14	Qs 97	Gmm1395081	Qorban section

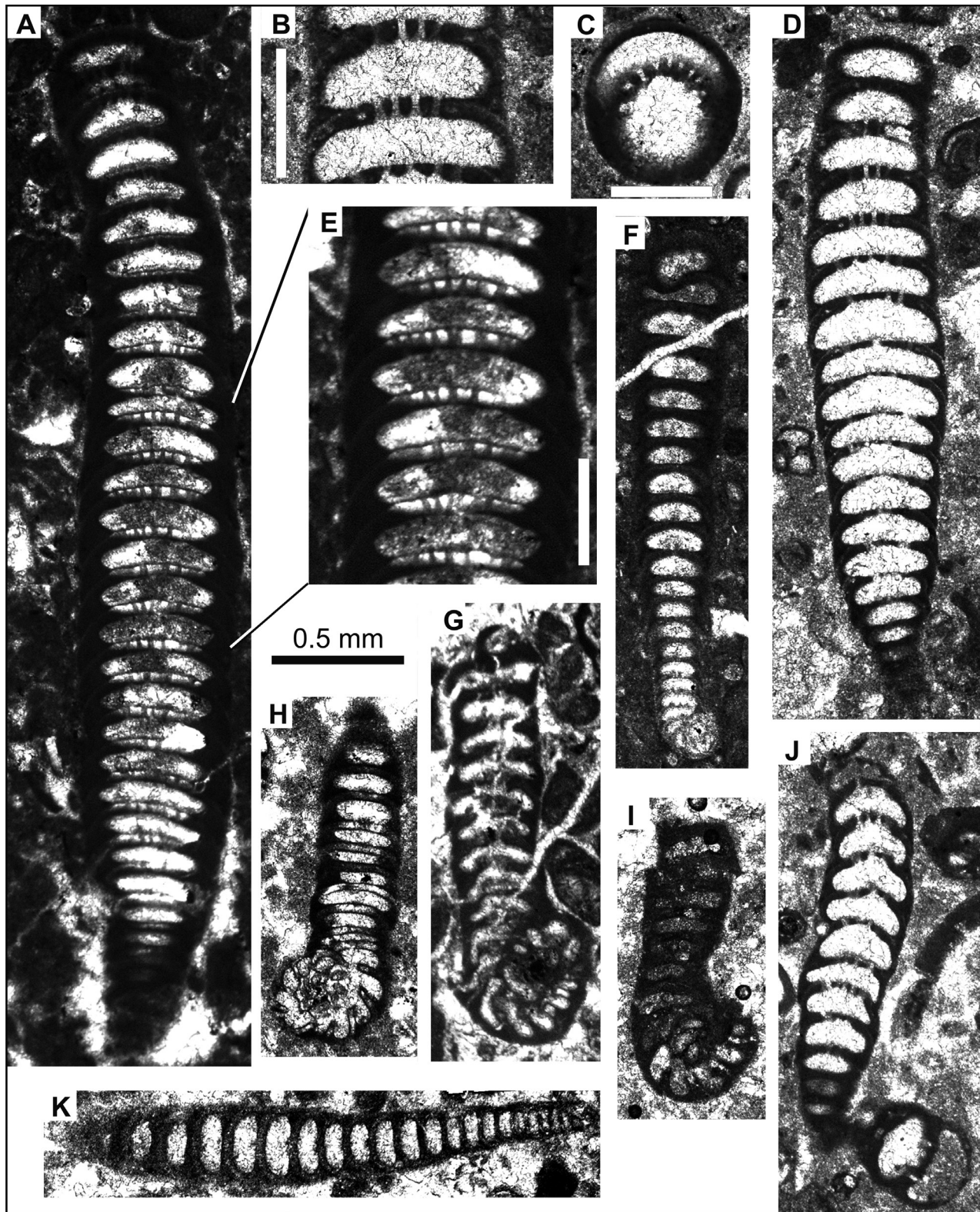


Fig. 4 - *Coscinospira prima* n. sp. (F, holotype) from the Selandian-Thanetian of Iran (Qorban section: A, E, G-I; Mount Chah Torsh section: B-D, J; Bandan section: F, K): longitudinal section of the uniserial adult part (A, D, J-K) with details showing multiple foramina (B, E), oblique transverse section showing multiple foramina (C), equatorial sections of juvenile coiled and uncoiled adult parts (F-I). A, E. Qs 78-2. B, D, J. Ah 177-1. C. Ah 187. F. BN N2a. G. Qs 44. H-I. Q 18. K. BN P2c.

specimen (length 2.0 mm) with small initial spire (?microspheric specimen) (Fig. 4F), depository number Gmm1395072 (Tab. 1).

Type locality: Bandan section, Eastern Iran.

Type horizon: upper part of the Paleocene carbonate succession (upper Danian-Selandian), lithostratigraphically

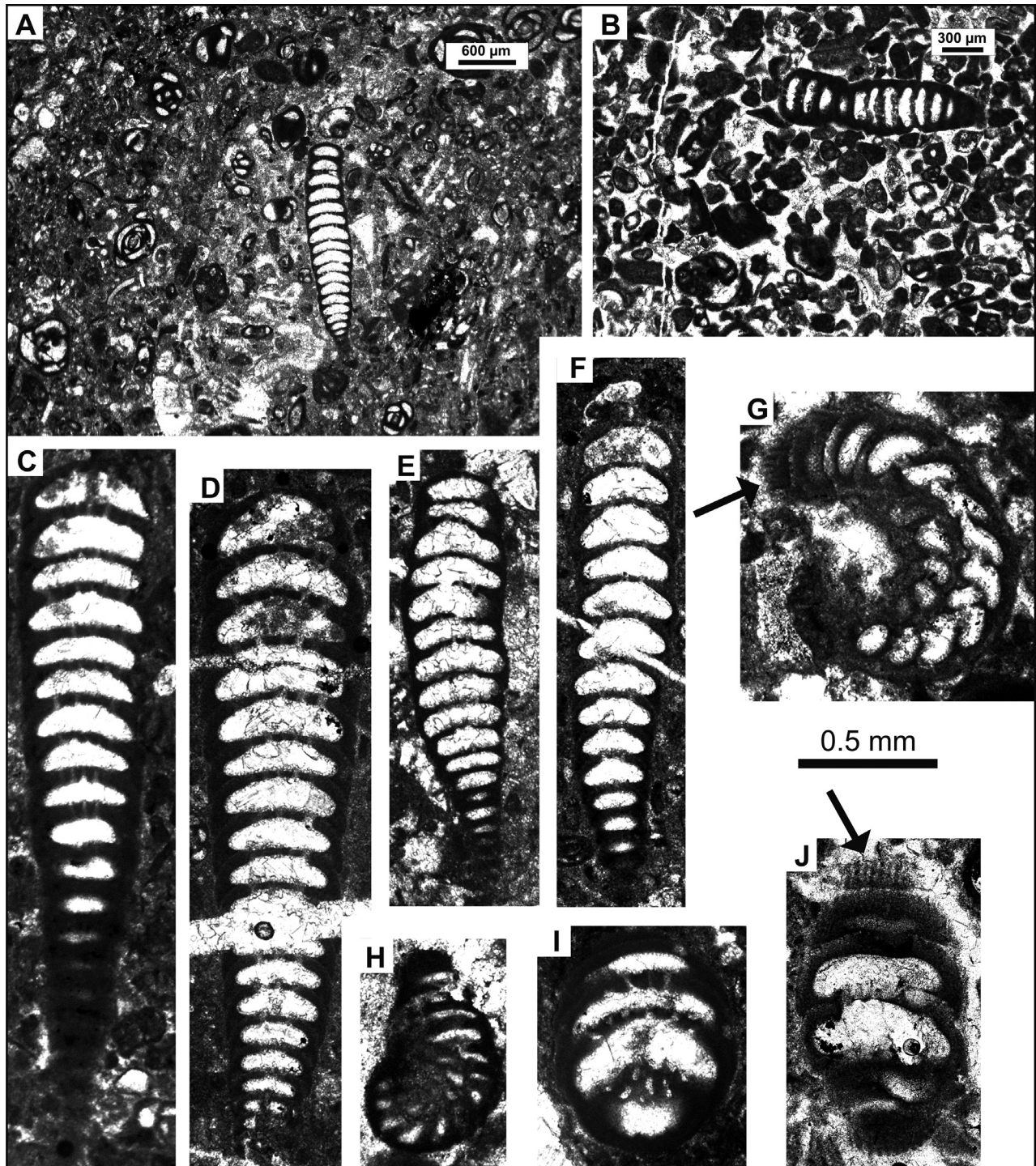


Fig. 5 - *Coscinospira prima* n. sp. from the Selandian-Thanetian of Iran (Mount Chah Torsh section: A, I; Bandan section: C, D, F; Patorgi section: B, E; Qorban section: G-H, J): packstone with miliolids and *Coscinospira prima* n. sp. (detail shown in Fig. 4D) (A), grainstone with *Coscinospira prima* n. sp. (B), longitudinal section of the uniserial adult part (C-F), oblique equatorial section showing fine surface striae (G, arrow), equatorial section of juvenile specimen (H) oblique section cutting four chambers showing multiple foramina (I) and fine surface striae (J), A. Ah 177-1. B. 2pz 49. C-D. BN N2a. E. 2pz 28. F. BN N2-b. G, J. Qs 77. H. Qs 97. I. Ah 185.

not defined.

Material: About 100 specimens in random thin-sections.

Diagnosis: Comparably large-sized representative of *Coscinospira*, displaying wide infraspecific variability with respect to size (length, diameter, initial spire). The

coiled part consists of up to two and a half whorls with numerous chambers. The uniserial adult part consists of up to 30 chambers. Details on the foramina (number, disposition) in the coiled stage are unclear. In the uniserial adult part, the multiple foramina are concentrated in the central part of the septa, and appear as if they are

concentrically arranged.

Description: Test elongate (crosier-shaped) displaying a juvenile planispiral stage and an uniserial adult stage of up to 4 mm in length. The coiled part consists of up to two and a half whorls with numerous chambers (Figs. 4H-I, 5G). The preservation and section planes do not permit to assess the exact number of chambers in a whorl. The proloculus has not been observed. The diameter of the coiled part (in equatorial sections) ranges from 0.25 mm (Fig. 4F) up to 0.85 mm (Fig. 5G). The different size of the coiled part may possibly be linked to test dimorphism (e.g., Fig. 4F against 4G). One specimen (holotype) shows a reduced initial spire of a single whorl only. This might possibly belong to a microspheric generation, thus indicating dimorphism. Depending on the size (= length) of the enrolled part, the greatest test diameter may be within the spiral part (e.g., Fig. 4G). In very rare sections, a fine surface striation can be observed in the uncoiled part (Fig. 5 G,J). In specimens with numerous uncoiled chambers the greatest width lies within the uniserial part (e.g., Fig. 4F). The uniserial enrolled adult part, up to 0.6 mm in diameter and displaying round transverse sections (Fig. 4C), may be straight (Fig. 4F), or slightly bending (Fig. 4A). It consists of up to 30 chambers, almost constant in height, and a width increasing slightly but continuously (Figs. 4F, 5C). There are six to eight chambers for the last mm in adult specimens. The uniserial chambers are convex towards the apertural face separated by septa exhibiting equal thickness as the wall (~0.04 mm to 0.06 mm). Often, the septa display a preservation differing from the wall, with a bright colorless upper part clearly contrasting the typical dark porcelaneous aspect (Fig. 4 A,H). The sutures are only slightly depressed. Details on the foramina (number, disposition) in the coiled stage are unclear. In the uniserial adult part, the multiple foramina (diameter ~0.02 mm to 0.04 mm) are concentrated in the central part of the septa (Fig. 4E), and appear as if they are concentrically arranged (Fig. 4C).

Remarks: The often observed preservation of the septa with a bright colorless upper part is reported also from other porcelaneous (larger) taxa. Such a “thin vitreous layer” was, for instance, described by Consorti et al. (2015) from the Cenomanian *Praetaberna*. Based on an observable chaotic orientation of calcite crystals, Consorti et al. (2015, p. 382) concluded a secondary origin, “a diagenetic modification of the original wall microstructure”.

Differences: The comparably high intraspecific variability of the few characters of the simply structured genus *Coscinospira* generally raises some problems for clear discrimination of species. Differences between species simply refer to shape and size. Comparing the type-species with the fossil representatives is hampered also by the fact that the latter are only known from random thin-sections. Some characters, e.g., details of surface ornamentation (striae, pits, orientation, numbers), are not easily accessible in thin-section material. However, the reported species are well separated stratigraphically

from each others (Fig. 6): *C. hemprichii* (Miocene-Holocene; Haman, 1972; Hottinger et al., 1993; Chan et al., 2017), *C. elongata* and *C. sivasensis* (early Oligocene; Sirel et al., 2013; Serra-Kiel et al., 2016a), and *C. prima* (Selandian-Thanelian). Nonetheless, there are specific differences that can be related to size and shape.

The type-species *Coscinospira hemprichii* (synonym *Cribrospiroolina distinctiva* Haman, see Loeblich and Tappan, 1988a), has barrel-shaped uniserial chamber, less compressed vertically than *C. prima*. The maximum test size reported by Haman (1972, for *Cribrospiroolina distinctiva* = a junior synonym of *Coscinospira hemprichii*, see Loeblich and Tappan, 1988b) is 2.2 mm, more or less the same as for the largest specimen illustrated by Hottinger et al. (1993, pl. 76, Fig. 10). There may be up to 11 chambers in the enrolled uniserial part (Hottinger et al., 1993, pl. 76, Fig. 10), contrasting up to 30 in *C. prima*. There are four to five chambers in the last mm in *C. hemprichii* (measured from Haman, 1972, holotype specimen, and Hottinger et al., 1993, pl. 76, Fig. 10) compared to six to eight in *C. prima*. In *C. hemprichii*, the aperture is irregularly radially arranged bearing elevated peristomes, whereas the intercameral foramina are irregularly multiple and elongated (Hottinger et al., 1993; see also Hottinger 2006, Fig. 4d). In *C. prima* the foramina appear concentrically arranged and this may represent a specific difference. The two species *C. elongata* and *C. sivasensis* have been described by Sirel and Özgen-Erdem in Sirel et al. (2013) from the lower Oligocene (Rupelian) of Turkey. The former is distinguished from the latter by its more developed uniserial stage (see also Serra-Kiel et al., 2016a). Due to this, only *C. elongata* is compared here with *C. prima*. According to Serra-Kiel et al. (2016a), there are four uniserial chambers per 1.2 mm, resulting in a lower number compared with *C. prima*. The uniserial part of *C. elongata* is made up of 16-17 dome-like chambers measuring up to 2 mm in length.

Stratigraphy: In the studied sections, the levels with *Coscinospira prima* can be assigned to the Selandian-Thanelian. It has not been recorded in the Danian (see column of Mount Chah-Torsh section, Fig. 2). Mention should be made that forms conspecific to *Coscinospira prima* from the Sinjar Formation of Iraq were assigned to the arenaceous genus *Cribrogoesella* Cushman by Al-Dulaimi and Al-Dulaimi (2017). Together with other benthic foraminifera, “*Cribrogoesella*” sp. was taken an index taxon for an assemblage zone (“Foraminifera Biozone F4”) indicative of an interval within the (lower) Selandian.

5. REMARKS ON PHYLOGENY

The first diversification of the Peneroplidae took place in the late Albian-early Cenomanian (De Castro, 1965; Cherchi and Schroeder, 1982; Chiocchini, 2008). For a short and general overview on other Upper Cretaceous representatives of the Soritoidea see De Castro (1965). Like several other groups of Larger Benthic Foraminifera,

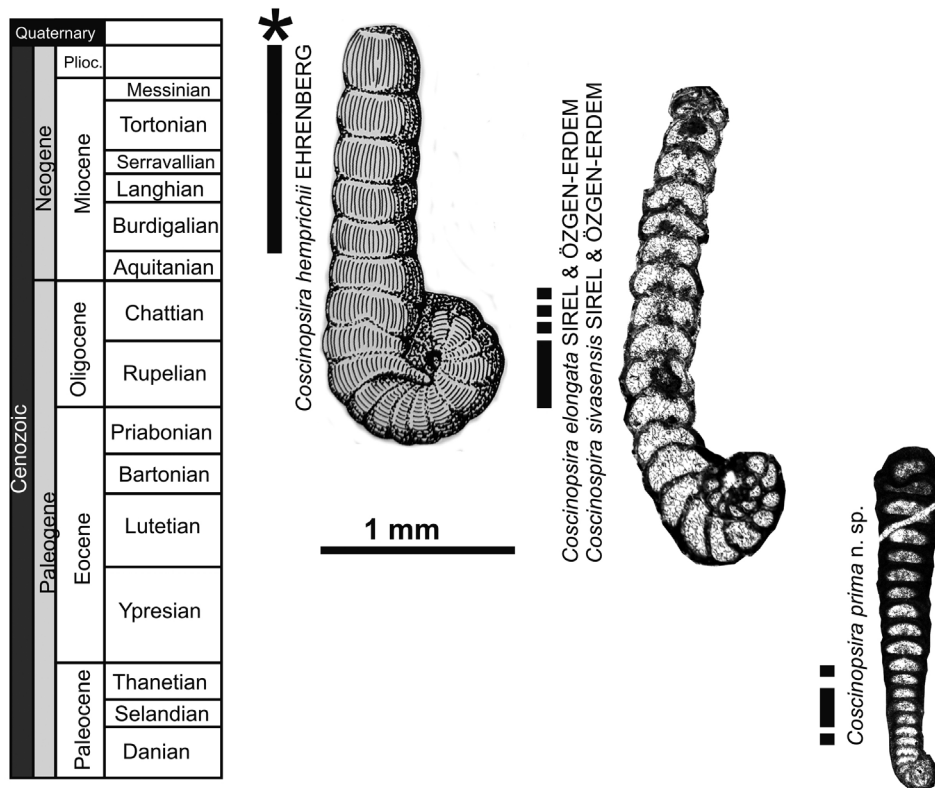


Fig. 6 - Different species of *Coscinospira* Ehrenberg and their stratigraphic distribution [*C. hemprichii* Ehrenberg from Haman, 1972, text-Fig. 1a (= holotype of *Cribrospiroolina distinctiva*; *C. elongata* from Sirel et al., 2013, pl. 3, Fig. 13)]. Further details in the text.

also many representatives of the Soritoidea became extinct at the Maastrichtian-Paleogene (K-Pg) boundary (Loeblich and Tappan, 1988b), marking the end of the so-called Upper Cretaceous global community maturation cycle (see Hottinger, 2001, for details). The occurrence of *Coscinospira prima* in the Selandian of Iran shows that the post K-Pg diversification of the Peneroplidae already started in the Early Paleogene. For further details the reader is referred to Henson (1955), Colom (1971), and Hottinger (2007). With *C. hemprichii* (Burdigalian-Holocene), *C. elongata* [Oligocene-lowermost Burdigalian, = *Dendritina rangi* (d'Orbigny) in Roozpeykar and Mogghadam, 2013], and *C. prima* (Selandian-Thanetian), the genus *Coscinospira* displays a discontinuous stratigraphic record (Fig. 6). According to our knowledge there are no records of *Coscinospira* in the literature from Eocene strata, at least under its generic name. It is assumed that this lack is just a matter of wrong identifications in the literature (see e.g., Roozpeykar and Mogghadam, 2013) and that *Coscinospira* is well present in this interval. For instance, Azzaroli (1952, pl. 11, Fig. 10) illustrated *Cribrogenerina?* sp. from the Eocene of Somalia. Also the widespread occurrence of "*Spirolina*" in the Eocene ("*Spirolina* facies") might be a good candidate (e.g., Sartoni and Crescenti, 1962; Radoičić, 1995; Barattolo et al., 2000; Vecchio et al., 2007). For example, a longitudinal section shown by Travé et al. (1996, Fig. 12b) as *Spirolina* sp. from the Eocene (Priabonian) of Spain

might well belong to *Coscinospira*, because the differing apertural/foraminal features are not clearly displayed.

6. CONCLUSIVE REMARKS

The new finds add further knowledge and new data on the stratigraphic distribution of the genus *Coscinospira*, so far only known from the Oligocene to Recent interval. The genus obviously appeared in the recovery phase of many shallow-water taxa that became extinct during the KPg boundary event(s). There are several records of *Peneroplis* from Cretaceous strata, but so far none of *Coscinospira*. The appearance in the Selandian offers new insights in the evolution of the Peneroplidae in the Early Paleogene for future research.

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