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# DISCOVERY OF THE LOWER MURGABIAN (MIDDLE PERMIAN) BASED ON NEOSCHWAGERINIDS AND VERBEEKINIDS IN THE TAURIDES, SOUTHERN TURKEY

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*Key words*: Fusulines, Early Murgabian, Taurides, Turkey.

*Abstract*. Lower Murgabian (Roadian) beds have been discovered for the first time in a thick carbonate sequence ranging from Devonian to Triassic in the Hadim area, central Taurides, southern Turkey. The Roadian limestone consists of black algal fusuline packstone and black bioclastic packstone, and contains *Presumatrina ciryi* n. sp., an evolved form of the genus, *Verbeekina erki* n. sp., an earliest species of *Verbeekina*, *Dunbarula protomathieui* n. sp., an ancestral form of *Dunbarula mathieui*, and several smaller foraminifera.

*Riassunto*. Sono stati individuati per la prima volta livelli fossiliferi di età Murgabiano inferiore (Roadiano) in una potente successione carbonatica che si estende dal Devoniano al Triassico nell'area di Hadim, Tauridi centrali, Turchia meridionale. I calcari di età Roadiana sono costituiti da packstone scuri con alghe e fusuline e da packstone bioclastici scuri. Essi contengono *Presumatrina ciryi* n. sp., una forma evoluta del genere; *Verbeekina erki* n. sp., una specie primitiva di *Verbeekina*, ed infine *Dunbarula protomathieui* n. sp., forma ancestrale di *Dunbarula mathieui*, oltre a numerosi piccoli foraminiferi.

## Introduction

More than 5.500 m thick carbonate rocks of the Aladag Unit ranging from the Devonian to Triassic are widely exposed in the Hadim-Taskent area, central Taurides, southern Turkey. In Altiner & Özgül (2001), the Carboniferous sequence measuring 910 m in thickness was divided into 14 foraminiferal zones within the interval from Visean to Moscovian and the Permian consisting of a 1.090 m thick succession was mostly assigned to the upper Middle Permian and Upper Permian (a questionable interval of Midian, Midian, Dzhulfian and Dorashamian). The Upper Carboniferous to Lower Permian interval had not been zoned in Altiner & Özgül (2001) and its biostratigraphy had been left for a further study. We recognized 11 fusuline zones in the Upper Carboniferous (Kasimovian and Gzhelian) and Lower Permian (Asselian to Artinskian?) of the Hadim area, and compared these fusuline faunas with contemporaneous ones of other West Tethyan, Southern Ural, and Russian Platform regions (Kobayashi & Altiner 2008a; 2008b).

On the other hand, the presence of upper Lower Permian to the middle part of Middle Permian (Artinskian to Wordian or Yakhtashian to Murgabian) is still uncertain in the Hadim area. In other Permian localities of the Tauride Block, the "Assemblage" characterized by four species of *Eopolydiexodina* (Altiner, 1984) and the *Eopolydiexodina* Zone (Köylüoglu & Altiner 1989) reported from the Hakkari area of southeast Turkey were thought to be Murgabian based on Leven (1981) who reported at that time that *Eopolydiexondina* is frequently present in the *Neoschwagerina craticulifera* and *Neoschwagerina margaritae* zones corresponding to the middle and upper Murgabian. In the absence of neoschwagerinids and verbeekinids in the Hakkari faunas it was not possible to assign a more detailed age to those levels. On the other hand, more prolific and variable fusulines of Murgabian or Midian age were reported from the blocks of the Karakaya Orogen in northern Turkey (Ciry 1938; Erk 1942; Skinner 1969; Leven & Okay 1996; Turhan et al. 2004; Altiner & Özkan-Altiner 2010).

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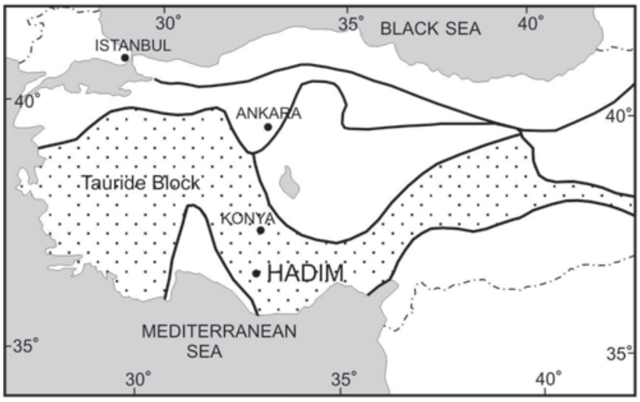
The difference between the Permian faunas of Turkey were analyzed in Altiner et al. (2000) who defined two biofacies belts in the Middle to Upper Permian. The Northern Biofacies Belt comprises the Permian exposures of the Karakaya Orogen and the outer platform or platform margin deposits of the Tauride Belt recognized in the Bolkar Dag Unit. The biostratigraphy in the Northern Biofacies Belt is based on a more diverse foraminiferal fauna and the Kubergandian and Murgabian stages are present. The Hakkari area with *Eopolydiexodina* belongs to the Southern Biofacies Belt very poor or absent in neoschwagerinids and verbeekinids. An advanced form of *Presumatrina* and a primitive form of *Verbeekina* reported in this paper are recognized in the Aladag Unit of the Hadim area. Throughout the Taurides, the Aladag Unit assignable to the Southern Biofacies Belt is tectonically overlain by the Bolkar Dag Unit belonging to the Northern Biofacies Belt. These two units were tectonically and paleogeographically separated until their amalgamation during the Late Cretaceous to Late Eocene (e.g., Sengör & Yilmaz 1981). The limestone beds with Murgabian and Midian neoschwagerinids reported from the Taskent area (Altiner & Özgül 2001) belong to the Bolkar Dagi Unit.

The purpose of this paper is to report the discovery of the lower Murgabian (Roadian) strata from the Aladag Unit of the Hadim area and to describe the Murgabian foraminiferal faunas including three new species of *Presumatrina ciryi*, *Verbeekina erki*, and *Dunbarula protomathieui*. Two limestone samples used in this paper were collected on the occasion of our field work of Carboniferous-Permian boundary sequences in the Hadim area in 2004. Limestone thin sections of the Hadim area used in this paper are stored in the collection of the Museum of Nature and Human Activities, Hyogo, Japan (Fumio Kobayashi Collection, MNHAH).

## Material

The Permian Çekiç Dagi Formation of the Hadim area is subdivided into four members in ascending order: Keltas, Çamalani, Kizilgeris, and Yellice. The Keltas Member is of Asselian to Sakmarian age (Kobayashi and Altiner 2008a). The Çamalani Member is unknown in age whereas the Kizilgeris Member is questionably assigned to the Midian. The thick carbonate succession of the Yellice Member belongs to the Midian to Dorashamian interval (Altiner & Özgül 2001).

Two samples were collected from the 17-m-thick, thin bedded limestone succession intercalated within the quartz arenitic sandstone of the Kizilgeris Member (Figs 1, 2). They are located at about 12 km SW of the town of Hadim, southern Turkey (36°54'32″N, 32°23'08″E). Sample A is a black algal fusuline packstone poor in fossil diversity. In addition to a dominant fusuline fauna, algae referable to *Mizzia* and other algal bioclasts (mostly replaced by calcite) are packed within a lime mud matrix (Pl. 1, fig. 1). Sample B is different in microfacies from Sample A and is classified as black, bituminous, bioclastic packstone (Pl. 1, fig. 2). Foraminifers (Pl. 1, fig. 6) and a microproblematicum referable to *Pseudovermiporella sodalica* Elliott (Pl. 1, figs. 3-5) are the principal constituents in the sample. Fusulines, however, are completely absent in this bioclastic packstone except some rare staffellids (*Sphaerulina* and *Nankinella*).



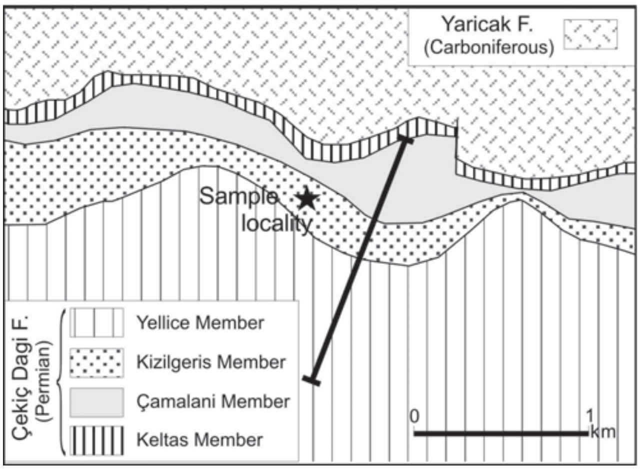




Fig. 1 - Upper: Map showing the distribution of the Tauride Block and the Hadim area, southern Turkey. Lower: Geologic map of Upper Paleozoic strata in the Hadim area, about 12 km SW of the town of Hadim and the limestone sample locality of Early Murgabian foraminifers. The bold line in right of the sample locality shows the location of the columnar section shown in Fig. 2 (modified from Altiner & Özgül 2001).

## Fauna and age

Foraminifers contained in Sample A are mostly composed of *Presumatrina ciryi* n. sp. and other species consisting of *Verbeekina erki* n. sp., *Dunbarula protomathieui* n. sp., *Dunbarula* sp., *Rauserella*? sp. Schubertellidae gen. and sp. indet. A, Schubertellidae gen. and sp. indet. B, *Nankinella* sp., *Endothyra* sp., *Climacammina* sp., *Palaeotextularia* sp., *Globivalvulina* sp., *Geinitzina*? sp., *Pachyphloia* spp., *Hemigordius discoides* Lin, Li & Sun, *Hemigordius* sp., *Multidiscus* sp., and *Neodiscus* spp. Fusulines referable to Schwagerinidae are absent in this fauna.

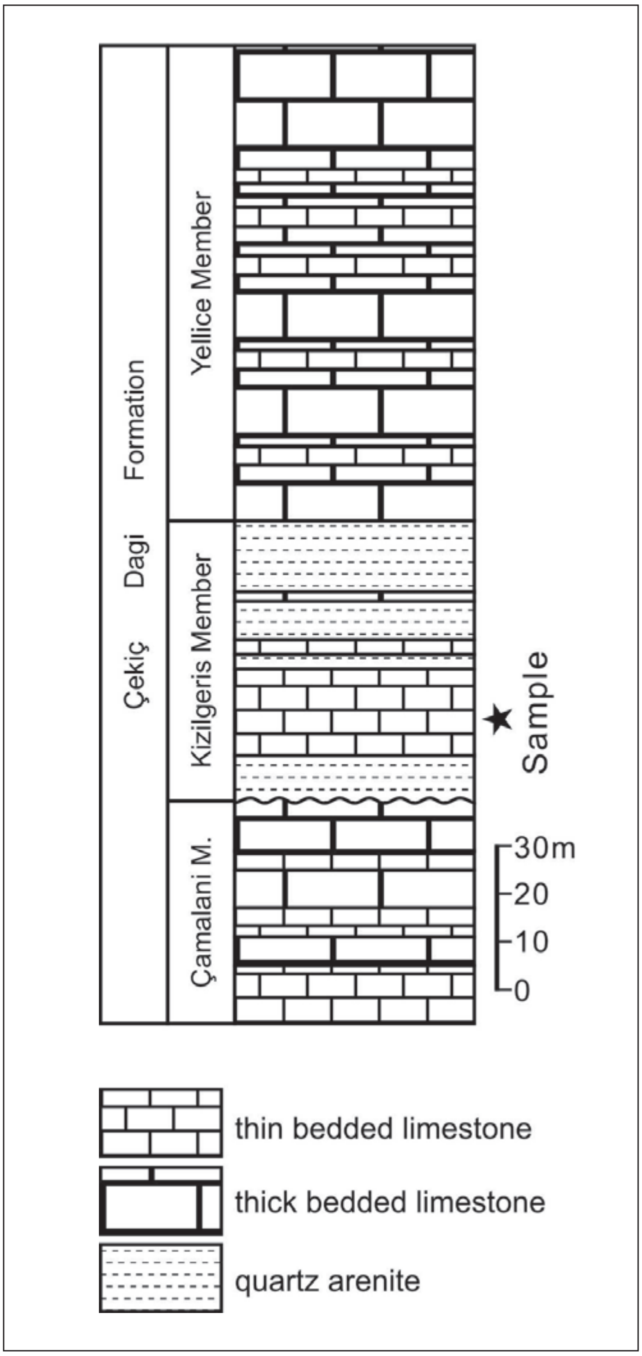



Fig. 2 - The columnar section of the Çekiç Daji Formation along the bold line shown in fig. 1. The stratigraphic level of the sample corresponds to the lower part of the Kizilgeris Member (modified from Altiner & Özgül 2001).

Faunal composition of Sample B is largely different from that of Sample A. Fusulines are very poor and confined to unidentified species of *Sphaerulina* and *Nankinella* in 39 slides of thin sections. Non-fusulinoidean foraminifers distinguished are *Neodiscus* spp., *Pachyphloia robusta* Miklukho-Maklay, *Pachyphloia* sp. *Geinitzina* spp., *Nodosinellodes* sp., and an indeterminate milioline species. Age-diagnostic species are not found in Sample B. The species composition in smaller foraminifers is highly different from that of the Sample A and coeval ones previously described. Palaeotextulariidae, Biseriamminidae, and Endothyridae are totally absent in Sample B.

*Presumatrina ciryi* n. sp. is thought to be one of the evolved species of the genus along with *Presumatrina ozawai* (Hanzawa) described from the lower Murgabian Akiyoshi Limestone of Japan (Hanzawa 1954), *Presumatrina grandis* Leven from the lower Murgabian of the Southeast Pamir (Leven 1967), and *Presumatrina uruzganensis* Leven from the lower Murgabian of Afghanistan (Leven 1997). These three species of *Presumatrina* have larger tests and more whorls than other described species of the genus. Secondary transverse septula first appear in the fourth whorl in this new species. They appear ontogenetically earlier than those of other species such as *Presumatrina schellwieni* (Deprat) and *P. neoschwagerinoides* (Deprat). Secondary transverse septula are less developed in outer whorls in comparison with those of *Afghanella*. *Presumatrina* is almost exclusively known from the early Murgabian (*Neoschwagerina simplex* Zone and its equivalents) in the Tethyan regions (e.g., Leven 1967, 1993, 1997, Ozawa 1970; Ozawa & Kobayashi 1990; Ueno 1992). Accordingly, Sample A is thought to be early Murgabian in age. On the other hand, the correlation of early Murgabian with the global Middle Permian time scale is a subject of dispute due to more or less different correlation schemes among authors based on zonations of fusulines, conodonts, and ammonoids. Its correlation to late Roadian (Early Guadalupian) is adopted by Menning et al. (2004) and to early Roadian by Wardlaw et al. (2004).

Early Murgabian age of Sample A suggests that *Verbeekina erki* n. sp. is the earliest among the known species of the genus. Because almost all species of *Verbeekina* are restricted to the middle and upper part of the Murgabian except for a few species ranging up to the Midian. Occurrence of *Dunbarula* and *Rauserella*?, rarely present in Sample A is not conflict with this age determination of the sample. Because both genera first appear in the *Cancellina nipponica* Zone (upper Kubergandian) in the Akasaka Limestone of Japan (Kobayashi's unpublished data) and in the *Parafusulina yabei* Zone (upper Kubergandian to lower Murgabian) in the Nabeyama Formation of Japan (Kobayashi 2006a; 2006b), and range up to the Midian (e.g., Kobayashi 2006c). Sample B is also thought to be coeval with Sample A because of their nearly the same stratigraphic level in spite of different faunal composition between them.

These lines of evidence lead to the conclusion that the questionable Midian age assigned to the Kizilgeris Member of the Çekiç Dagi Formation by Altiner & Özgül (2001) should be revised to early Murgabian. This revision suggests that the undoubted lower

Middle Permian is present in the Hadim area of southern Turkey.

### Systematic Paleontology

Suborder **Fusulinina** Wedekind, 1937
Superfamily Fusulinoidea von Möller, 1878
Family Schubertellidae Skinner, 1931
Subfamily Boultoniinae Skinner and Wilde, 1954
Genus *Dunbarula* Ciry, 1948

**Dunbarula protomathieui** n. sp.
Pl. 2, figs 40-43

**Origin of the name:** Ancestral form of *Dunbarula mathieui* Ciry.

**Type series:** Holotype D2-032813 (Pl. 2, fig. 40; tangential section). Paratypes D2-032784 (Pl. 2, fig. 41; tangential section), D2-032773 (Pl. 2, fig. 42; oblique section), D2-032780 (Pl. 2, fig. 43; parallel section).

**Material:** Two tangential, one oblique, and one parallel sections illustrated.

**Diagnosis:** Ellipsoidal to short fusiform *Dunbarula* having a minute proloculus, a few lenticular juvenile whorls succeeded by rapidly expanding fusiform whorls, closely spaced septa folded weakly in tunnel region and more intensely in axial and polar regions of outer whorls, and indistinct mural pores.

**Description.** Test ellipsoidal to short fusiform with broadly rounded periphery, slightly convex to straight lateral slopes, rounded to bluntly pointed poles, and straight axis of coiling. Mature test with five to six whorls, about 1.1 mm in length and 0.8 mm in width. Proloculus minute and inner few whorls discoidal to lenticular and tightly coiled. With a sharp change of axis of coiling, the following ellipsoidal to fusiform whorls rapidly increasing their length and width.

Wall consists of tectum and translucent layer with indistinct mural pores in outer fusiform whorls variably coated by secondary deposits. Septa closely spaced, partly very finely perforated, also coated by secondary deposits, and folded weakly in the tunnel region and more intensely in axial and polar regions. Chomata one-third to half as high as chambers in inner fusiform whorls, but indistinct in outer ones due to secondary deposits on chamber floor in tunnel region.

**Discussion.** In the absence of axial sections, morphologic variation of this new species is not totally clarified. However, this species is distinguished from the known species of *Dunbarula* in having diagnostic characters such as finely perforate wall and septa rather thick for the genus. In addition, smaller test and more weakly folded and smaller number of septa suggest that this new species represents the probable ancestral form of *Dunbarula mathieui*, originally described by Ciry (1948) and subsequently by Thompson (1954) and Skinner & Wilde (1967) from Tunisia (Fig. 3.1-3.4). Similarly, this new species has more primitive test characters than the specimens of *D. mathieui* recovered from the Midian Yellice Member in the Hadim area (Figs 3.5, 3.6) in the test size, and the number and folding of septa. Septal pores and mural pores are not prominent in this new species as in *D. mathieui*. Stratigraphic evidence in the Hadim area agrees with the phyletic relation from *Dunbarula protomathieui* to more advanced *Dunbarula mathieui*.

This new species differs from *Dunbarula nana* described by Kochansky-Devidé & Ramovš (1955) from the Murgabian to Midian of Slovenia in having larger and more rapidly expanding test with more rounded poles, and more intensely fluted septa. Primitive forms of *Dunbarula* are common in the Lower Murgabian limestone of Japan (e.g. Kobayashi 2006b). This new species is easily distinguished from these forms by its thicker wall and septa, larger test with more rounded poles, and more intensely fluted septa.

**Occurrence.** Rare in sample A in association with *Presumatrina ciryi* n. sp., *Verbeekina erki* n. sp., and others.

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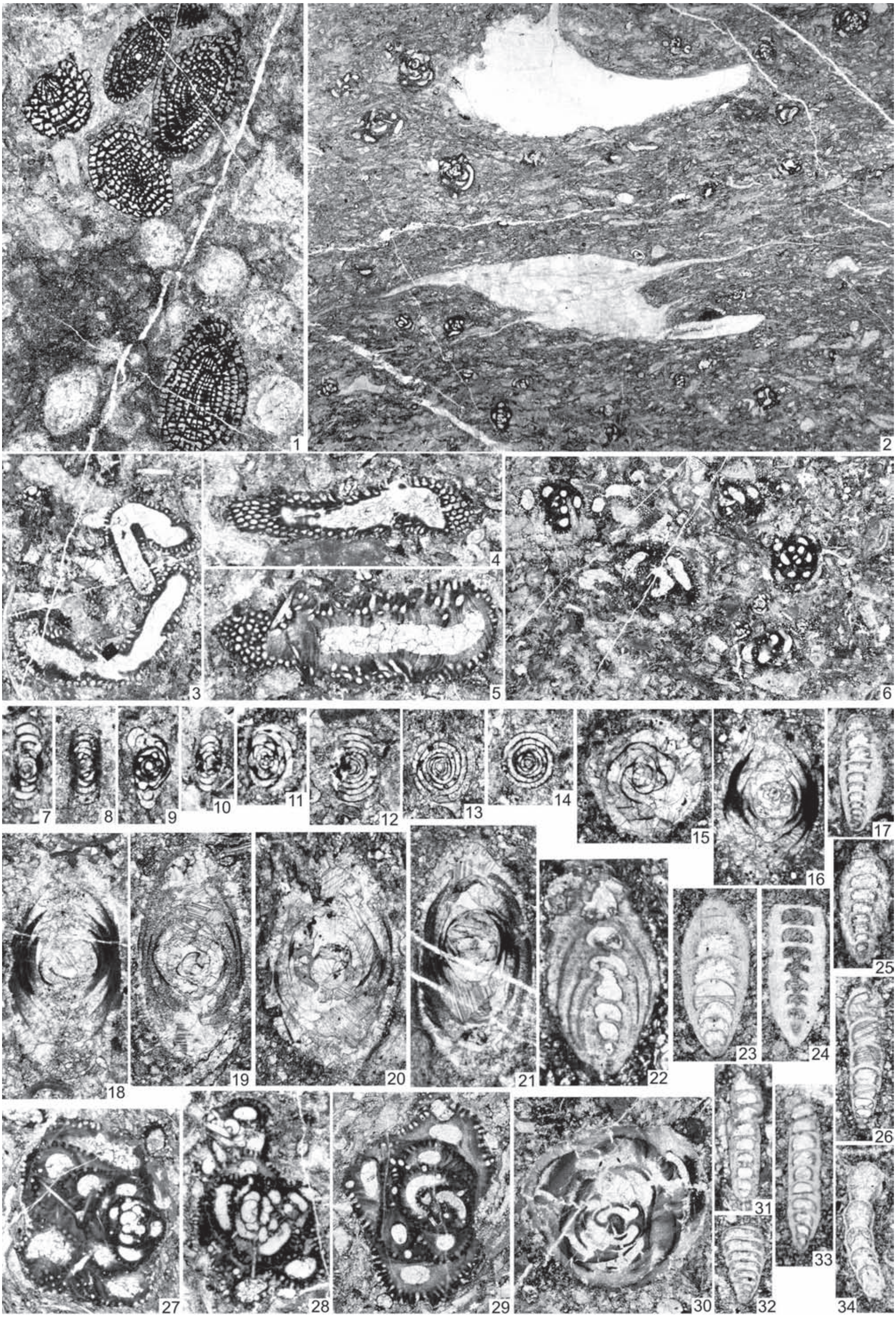
PLATE 1

Fig. 1 - Algal fusuline packstone, Sample A, × 8.5.
Fig. 2 - Bioclastic packstone containing many foraminifers and fossils of unknown affinity (light part in the upper and middle parts), Sample B, × 6.
Figs 3-5 - Microproblematica referable to *Pseudovermiporella sodalica,* Sample B, all × 30.
Fig. 6 - Indeterminate Miliolina and *Pseudovermiporella sodalica* contained in the bioclastic packstone, Sample B, × 15.
Figs. 7, 8, 9(?), 10-14 - *Hemigordius discoides* Lin, Li & Sun. 7: D2-032800; 8: D2-047880; 9: D2-047879; 10: D2-047876; 11: D2-032813; 12: D2-032816; 13: D2-032798; 14: D2-032797, all Sample A, 7 and 11: × 60; others: × 50.
Fig. 15 - *Hemigordius* sp. D2-032802, Sample A, × 40.
Figs. 16, 18-21 - *Multidiscus* sp. 16: D2-032792; 18: D2-032792; 19: D2-032805; 20: D2-047880; 21: D2-032805, all Sample A, × 40.
Fig. 22 - *Pachyphloia robusta* K. M. Miklukho-Maklay. D2-032765, Sample B, × 60.
Fig. 23 - *Langella* ? sp. D2-047875, Sample A × 50.
Fig. 24 - *Pachyphloia schwageri* Sellier de Civrieux & Dessauvagie, D2-032789, Sample A, × 50.
Fig. 25 - *Pachyphloia* sp. D2-032814, Sample A, × 40.
Figs. 26, 31, 33, 34 - *Nodosinelloides* sp. 26: D2-047880; 31: D2-047854; 33: D2-047878; 34: D2-032827, 31: Sample B; others: Sample A, all × 50.
Fig. 32 - *Geinitzina*? sp. D2-032800, Sample A, × 50.
Figs. 27-30 - Indeterminate *Miliolina* 27: D2-047844; 28: D2-032766; 29: D2-047862; 30: D2-047863, all Sample B, × 30.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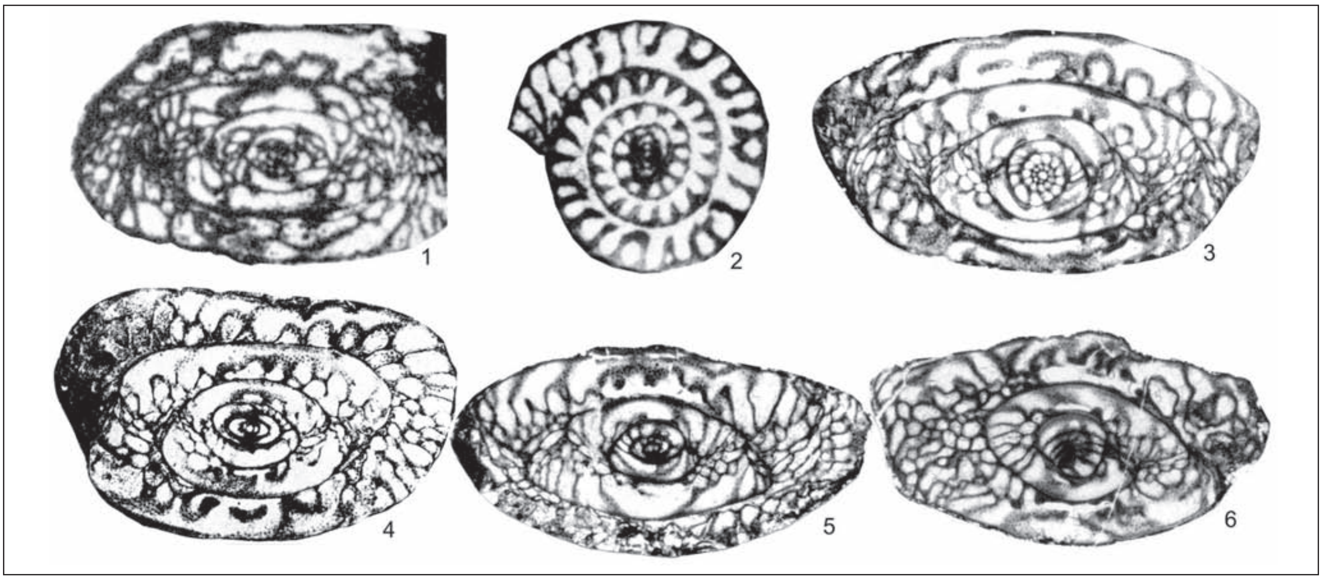



Fig. 3 - Six specimens of *Dunbarula mathieui* Ciry for comparison with *Dunbarula protomathieui* n. sp. 1, 2: Types from Tunisia (after Ciry 1948); 3: Topotype (after Skinner & Wilde 1967); 4: Topotype (after Thompson 1954); 5, 6: Specimens from the Yellice Member of the Çekiç Dagi Formation in the Hadim area. All × 30.

Family Verbeekinidae Staff & Wedekind, 1910

Genus *Verbeekina* Staff, 1909

**Verbeekina erki** n. sp.

Pl. 3, figs 23-28

**Origin of the name:** In honor of the fusuline paleontologist who established the genus *Reichelina* based on materials from Bursa, northwestern Turkey.

**Type series:** Holotype D2-032775 (Pl. 3, fig. 23; axial section). Paratypes D2-032799 (Pl. 3, fig. 24; tangential section), D2-032774 (Pl. 3, fig. 25; axial section), D2-032775 (Pl. 3, fig. 26; tangential section), D2-032825 (Pl. 3, fig. 27; parallel section), D2-032812 (Pl. 3, fig. 28; oblique section).

**Material:** Two axial, two tangential, and one parallel and one oblique sections illustrated.

**Diagnosis:** A primitive form of *Verbeekina* having a small test and less number of juvenile whorls for the genus, and low and well-developed parachomata in outer whorls.

**Description.** Test nearly spherical with shallow umbilical depressions and straight axis of coiling. Mature test with 12 to 13 whorls, about 4.7 to 5.1 mm in length, about 4.6 to 4.7 mm in width, and about 0.97 to 1.0 in form ratio.

Proloculus spherical, minute, 0.03 to 0.04 mm in diameter, and 0.036 mm in the holotype. Inner two whorls lenticular and very tightly coiled. The next one to one and half whorls become thick lenticular to subspherical with slight change of axis of coiling. Beyond fourth whorl, they become nearly spherical with shallowly umbilicated poles. Length from the 1st to 12th whorls 0.04, 0.10, 0.17, 0.44, 0.83, 1.24, 1.75, 2.46, 2.94, 3.50, 4.07, and 4.61? mm; width from the 1st to 12th

PLATE 2

Figs 1-3 - *Endothyra* sp. 1: D2-032810, × 40; 2: D2-032785, × 40; 3: D2-032778, × 50; all Sample A.

Figs 4, 5 - *Palaeotextularia* sp. 4: D2-047869, × 40; 5: D2-032788, × 30; both Sample A.

Figs 6-10 - *Climacammina* sp. 6: D2-032804; 7: D2-032787; 8: D2-047879; 9: D2-032793; 10: D2-047875, all Sample A, × 20.

Figs 11-17 - *Globivalvulina* sp. 11: D2-047874; 12: D2-047874; 13: D2-032770; 14: 47880; 15: D2-032798, × 50; 16: D2-047868, × 50; 17: D2-032783, all sample A, 13 and 17: × 40, others: × 50.

Figs 18-20, 23-26 - *Sphaerulina* sp. A 18: D2-047858; 19: D2-047866; 20: D2-032763; 23: D2-047863; 24: D2-047862; 25: D2-047859; 26: D2-047863, all Sample B, 20: × 60, others: × 40.

Fig. 21 - *Nankinella* sp. B D2-032825, Sample A, × 40.

Fig. 22 - *Nankinella* sp. A D2-032764, Sample B, × 15.

Figs. 27, 28 - *Sphaerulina* sp. B 27: D2-047863, × 40; 28: D2-032769, × 30; both Sample B.

Figs. 29-31 - Schubertellidae gen. & sp. indet. A 29: D2-032778, × 40; 30: D2-032781, × 50; 31: D2-032779, × 40; all Sample A.

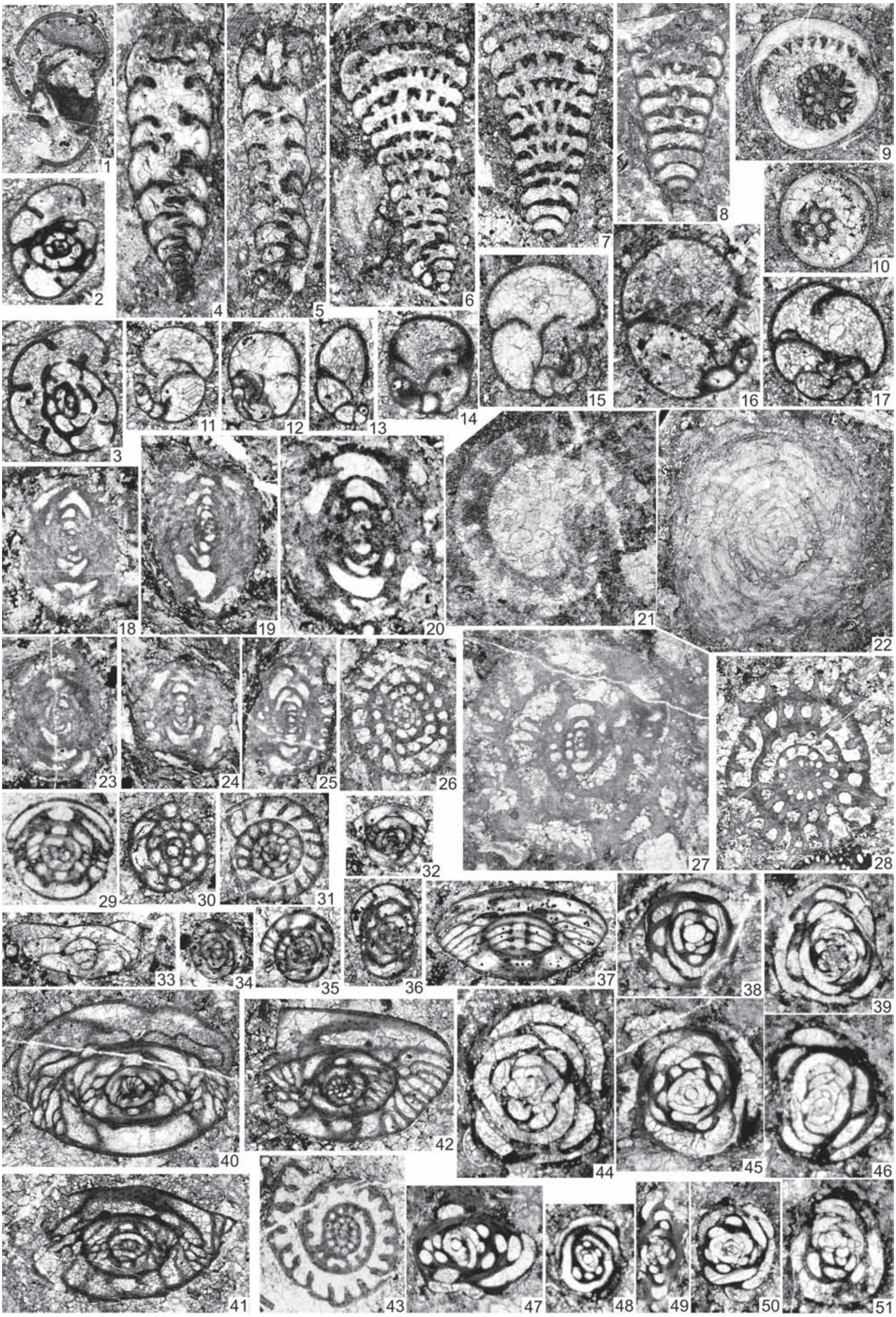
Figs. 32, 34-36 - Schubertellidae gen. & sp. indet. B 32: D2-032800, × 40; 34: D2-047876, × 50; 35: D2-032796, × 40; 36: D2-032788, × 50; all Sample A.

Fig. 33 - *Rauserella*? sp. D2-032814, Sample A, × 40.

Fig. 37 - *Dunbarula* sp. D2-032806, Sample A, × 40.

Figs. 38, 39, 44-51 - *Neodiscus* spp. 38: D2-047859; 39: D2-032794; 44: D2-032777; 45: D2-047863; 46: D2-032776; 47: D2-047851; 48: D2-032774; 49: D2-047843; 50: D2-047851; 51: D2-032780; 38, 39, 45, 47, 49, 50: Sample B; 44, 46, 48, 51: Sample A; 38, 39, 45, 47, 50: × 50; 44, 46, 48, 51: × 60; 49: × 40.

Figs. 40-43 - *Dunbarula protomathieui* n. sp. 40: tangential section of the holotype, 41: tangential section of the paratype, 42: oblique section of the paratype, 43: parallel section of the paratype. all Sample A, × 40. Registered numbers are shown in the description part.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whorls 0.08, 0.15, 0.17, 0.40, 0.65, 1.10, 1.63, 2.19, 2.78, 3.36, 3.96, and 4.42? mm; form ratio from the 1st to 12th whorls 0.50, 0.67, 1.00, 1.10, 1.28, 1.13, 1.07, 1.12, 1.06, 1.04, 1.03, and 1.04?, respectively, in the holotype.

Septa gently inclined anteriorly, long, and partly in contact with parachomata. Wall structureless in inner three whorls, consisting of tectum and protheca in the 4th and 5th, and of tectum and very finely alveolar keriotheca beyond the 6th. Thickness of wall from the 1st to 12th whorls 5, 8, 8, 16, 18, 17, 20, 22, 33, 37, 43, and 45 microns in the holotype.

Parachomata low, well developed in the 3rd or 3rd to 5th whorls, rudimentary or absent in the succeeding ones, and well developed in further outer whorls.

**Discussion.** Test characters such as the size and expansion of the test, and the development of parachomata suggest that the new species is close to a transitional form between *Armenina* and *Verbeekina*. It is better assignable to *Verbeekina* than to *Armenina* in its thinner wall and lesser developed parachomata.

Among described species, *Verbeekina erki* n. sp. is most similar to *V. furnishi* Skinner & Wilde originally described from the upper Murgabian of Sicily (Skinner & Wilde 1966), subsequently reported from the Murgabian to Midian of the central Afghanistan (Leven 1997) and from the middle to upper Murgabian of the Abadeh Formation of Iran (Kobayashi & Ishii 2003). However, this new species has a smaller test, fewer juvenile whorls and more developed parachomata. *Verbeekina grabaui* Thompson & Foster described from the middle Murgabian of Sichuan in South China (Thompson & Foster 1937) resembles this new species, but the former has more whorls, a thinner wall, and lesser developed parachomata.

**Occurrence.** Rare in sample A and found in association with *Presumatrina ciryi* n. sp. and others.

Family Neoschwagerinidae Dunbar & Condra, 1927
Subfamily Sumatrininae Silvestri, 1933
Genus *Presumatrina* Tumanskaya, 1950

### **Presumatrina ciryi** n. sp.

Pl. 3, figs 1-22

**Origin of the name:** In honor of the fusuline paleontologist who established the genus *Dunbarula*.

**Type series:** Holotype D2-032818 (Pl. 3, fig. 2; axial section). Paratypes D2-032785 (Pl. 3, fig. 1; axial section), D2-032797 (Pl. 3, fig. 3; axial section), D2-032815 (Pl. 3, fig. 4; axial section), D2-032781 (Pl. 3, fig. 5; axial section), D2-032800 (Pl. 3, fig. 6; axial section), D2-032783 (Pl. 3, fig. 7; axial section of the microspheric form), D2-032796 (Pl. 3, fig. 8; axial section), D2-032793 (Pl. 3, fig. 9; axial section), D2-032802 (Pl. 3, fig. 10; axial section), D2-032814 (Pl. 3, fig. 11; axial section), D2-032794 (Pl. 3, fig. 12; axial section), D2-032784 (Pl. 3, fig. 13; axial section), D2-032777 (Pl. 3, fig. 14; sagittal section), D2-032801 (Pl. 3, fig. 15; axial section), D2-032810 (Pl. 3, fig. 16; axial section), D2-032776 (Pl. 3, fig. 17; axial section), D2-032808 (Pl. 3, fig. 18; sagittal section), D2-032778 (Pl. 3, fig. 19; sagittal section), D2-032820 (Pl. 3, fig. 20; sagittal section), D2-032795 (Pl. 3, fig. 21; sagittal section), D2-032791 (Pl. 3, fig. 22; sagittal section).

**Material:** Fifteen axial and six sagittal sections of megalospheric forms and one axial section of microspheric form illustrated.

**Diagnosis:** A large-sized species of *Presumatrina* with broadly rounded poles and large proloculus in megalospheric forms, well developed secondary transverse septula that first appear in the fourth whorl, thin wall and septa, and low and massive parachomata.

**Description.** Test ellipsoidal, with broadly rounded poles and straight axis of coiling. Mature specimens with 8 to 9.5 whorls, about 3.5 to 4.4 mm in length, about 2.1 to 2.8 mm in width, and about 1.5 to 1.9 in form ratio in megalospheric form; with 12 whorls, about 5.5 mm in length, about 2.7 mm, and about 2.0 in form ratio in the microspheric form (Tab. 1).

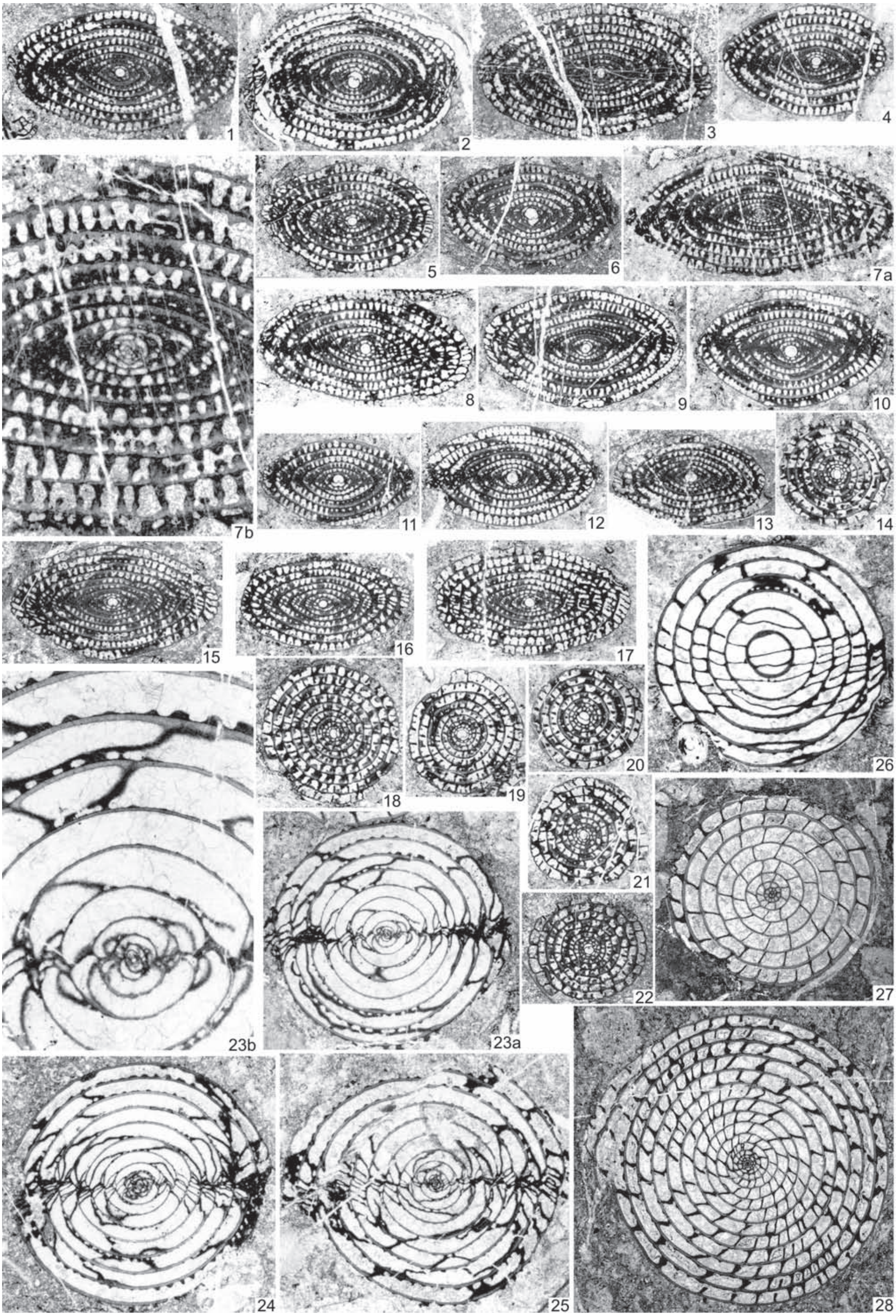
Proloculus spherical to subspherical and 0.18 to 0.27 mm in megalospheric form, and 0.02 mm in microspheric form. The first whorl subspherical to short fusiform, then becoming short fusiform to ellipsoidal. Test expands gradually decreasing their form ratio and increasing roundness of poles outwards. Length from the first to 9th whorls 0.32 to 0.45, 0.64 to 0.86, 1.12 to 1.42, 1.60 to 2.03, 2.04 to 2.61, 2.57 to 3.13, 3.02 to 3.70, 3.51 to 4.14?, and 3.98 or 4.1? mm in illustrated 13 specimens of megalospheric form. Length from the first to 12th whorls 0.03, 0.11, 0.25, 0.44, 0.80, 1.29, 1.94, 2.75, 3.36, 4.12, 4.87, and 5.5 mm in microspheric form. Width from the first to 9th whorls 0.25 to 0.37, 0.34 to 0.55, 0.51 to 0.74, 0.70 to 1.02, 0.93 to 1.35, 1.20 to 1.71, 1.49 to 2.07, 1.80 to 2.25, and 2.18 to 2.62 mm in illustrated 19 specimens. Width of the first to 12th whorls 0.06, 0.12, 0.20, 0.26, 0.37, 0.54, 0.78, 1.07, 1.42, 1.83, 2.24, and 2.7? mm in microspheric form.

Wall thin for the test size and less than 0.05 mm in the thickest part of outer whorls, mostly structureless in the first and second whorl, and consists of tec-

PLATE 3

Figs. 1-22 - *Presumatrina ciryi* n. sp. 2: axial section of the holotype; 1, 3-13, 15-17: axial sections of paratypes; 14, 19-22: sagittal sections of paratypes. 7: microspheric form; others: megalospheric forms, all Sample A, 7b: × 30; others: × 10. Registered numbers are shown in the description part.

Figs. 23-28 - *Verbeekina erki* n. sp. 23: axial section of the holotype; 24, 26: tangential sections of paratypes; 25: axial section of the paratype; 27: parallel section of the paratype; 28: oblique section of the paratype, all Sample A, 23b: × 30; others: × 10. Registered numbers are shown in the description part.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tum and very finely alveolar keriotheca from the third whorl. Septa thin and closely spaced. Septal counts from the first to 9th whorls 5 to 7, 11 to 13, 14 to 16, 15 to 17, 17 to 21, 20 to 23, 23 or 24, 24 to 27, and 29 in six megalospheric sagittal sections illustrated.

Primary transverse septula long, slender, and well developed and present in all whorls. Secondary transverse septula short and slender, and first appear in the fourth whorl in most specimens. One secondary transverse septulum, rarely two secondary transverse septula, inserted between adjacent primary transverse septula. Axial septula absent in inner few whorls, poorly developed in the succeeding one or two whorls, and relatively well developed, but short for the width of outer whorls. One or two axial septula present between adjacent septa in outer whorls.

Parachomata, partly in contact with septa in middle and outer whorls, low, massive, node-like, and well developed from the second whorl and also present on the proloculus in some specimens.

**Discussion.** This new species is easily distinguished from the previously described species of *Presumatrina* in its shape and size of the test, proloculus size, and development of secondary transverse septula and parachomata. It is different from *Presumatrina schellwieni* (Deprat) and *P. neoschwagerinoides* (Deprat) in having a larger test with much more rounded poles, a larger proloculus, and better developed secondary transverse septula. *Presumatrina grandis* Leven described from the lower Murgabian of the Southeast Pamir (Leven 1967) seems to be the closest taxon to *Presumatrina ciryi* n. sp. among the described species. However, the former has more whorls and lesser developed secondary transverse septula than the latter. Further comparison is impossible since the morphologic variation of *P. grandis* is uncertain from two specimens illustrated by Leven (1967). *Presumatrina uruzganensis* Leven described from the lower Murgabian of the Bamian Zone of northern Afghanistan (Leven 1997) has a smaller test and proloculus, more whorls, smaller proloculus, better developed secondary transverse septula, and higher and more massive parachomata.

With respect to lesser developed secondary transverse septula and axial septula, this new species is distinguished from *Presumatrina ozawai*, originally described by Hanzawa (1954) from the Akiyoshi Limestone and the index species of the upper part of the *Parafusulina kaerimizensis* Zone (lower Murgabian) of the Akiyoshi Terrane (Kobayashi 1988; Ozawa & Kobayashi 1990; Ueno 1992).

**Occurrence.** Common in sample A and found in association with *Verbeekina erki* n. sp. and others.

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| Fig. in Pl. | No. whorl | Length | Width | Form ratio | Proloculus | Length of whorl | | | | | | | | | | | | Width of whorl | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Pl. 1, fig. 1 | 9 | - | 2.48 | - | 0.22 | 0.41 | 0.79 | 1.21 | 1.82 | - | - | - | - | - | - | - | - | 0.32 | 0.47 | 0.63 | 0.86 | 1.15 | 1.46 | 1.80 | 2.16 | 2.51 | - | - | - |
| Pl. 1, fig. 2 | 9.5 | 4.35? | 2.82 | 1.54? | 0.24 | 0.44 | 0.86 | 1.27 | 1.65 | 2.04 | 2.57 | 3.02 | 3.51 | 3.98 | - | - | - | 0.37 | 0.55 | 0.74 | 0.95 | 1.20 | 1.51 | 1.86 | 2.20 | 2.62 | - | - | - |
| Pl. 1, fig. 4 | 8 | - | 2.12 | - | 0.19 | 0.37 | 0.65 | 1.17 | 1.74 | - | - | - | - | - | - | - | - | 0.27 | 0.39 | 0.57 | 0.81 | 1.10 | 1.35 | 1.76 | 2.12 | - | - | - | - |
| Pl. 1, fig. 5 | 8 | 3.5? | 2.25? | 1.6? | 0.19 | 0.32 | 0.66 | 1.25 | 1.76 | 2.20 | 2.72 | 3.06 | 3.5? | - | - | - | - | 0.27 | 0.44 | 0.66 | 0.92 | 1.23 | 1.56 | 1.93 | 2.25? | - | - | - | - |
| Pl. 1, fig. 6 | 8 | 3.5? | 2.2? | 1.6? | 0.27 | 0.45 | 0.79 | 1.30 | 1.87 | 2.24 | 2.73 | 3.13 | 3.5? | - | - | - | - | 0.35 | 0.54 | 0.70 | 0.95 | 1.22 | 1.51 | 1.86 | 2.2? | - | - | - | - |
| Pl. 1, fig. 7 | 12 | 5.5? | 2.7? | 2.0? | 0.02 | 0.03 | 0.11 | 0.25 | 0.44 | 0.80 | 1.29 | 1.94 | 2.75 | 3.36 | 4.12 | 4.87 | 5.5? | 0.06 | 0.12 | 0.20 | 0.26 | 0.37 | 0.54 | 0.78 | 1.07 | 1.42 | 1.83 | 2.24 | 2.7? |
| Pl. 1, fig. 8 | 8 | 4.14? | 2.24? | 1.85? | 0.21 | 0.40 | 0.84 | 1.42 | 2.03 | 2.61 | 3.13 | 3.70 | 4.14? | - | - | - | - | 0.34 | 0.47 | 0.66 | 0.91 | 1.20 | 1,55 | 1.92 | 2.24? | - | - | - | - |
| Pl. 1, fig. 9 | 8 | 3.8? | 2.24 | 1.7? | 0.20 | 0.36 | 0.78 | 1.26 | - | - | - | - | - | - | - | - | - | 0.29 | 0.41 | 0.60 | 0.85 | 1.14 | 1.50 | 1.88 | 2.24 | - | - | - | - |
| Pl. 1, fig. 10 | 8 | 3.75? | 2.25 | 1.67? | 0.25 | 0.42 | 0.81 | 1.23 | 1.76 | 2.19 | 2.77 | 3.28 | 3.75? | - | - | - | - | 0.36 | 0.50 | 0.69 | 0.94 | 1.21 | 1.52 | 1.87 | 2.25 | - | - | - | - |
| Pl. 1, fig. 11 | 6.5 | - | - | - | 0.21 | 0.45 | 0.83 | 1.36 | 1.86 | - | - | - | - | - | - | - | - | 0.30 | 0.44 | 0.64 | 0.89 | 1.16 | 1.48 | - | - | - | - | - | - |
| Pl. 1, fig. 12 | 7.5 | 3.42 | 1.92 | 1.78 | 0.23 | 0.34 | 0.71 | 1.12 | 1.60 | 2.11 | 2.68 | 3.21 | - | - | - | - | - | 0.28 | 0.41 | 0.58 | 0.80 | 1.10 | 1.39 | 1.74 | - | - | - | - | - |
| Pl. 1, fig. 15 | 9 | 4.1? | 2.18 | 1.9? | 0.21 | 0.36 | 0.64 | 1.18 | 1.68 | 2.15 | 2.69 | 3.21 | 3.68 | 4.1? | - | - | - | 0.25 | 0.37 | 0.51 | 0.70 | 0.93 | 1.20 | 1.49 | 1.80 | 2.18 | - | - | - |
| Pl. 1, fig. 16 | 7.5 | 3.4? | 1.9? | 1.8? | 0.18 | 0.43 | 0.82 | 1.28 | 1.77 | 2.37 | 2.84 | 3.23 | - | - | - | - | - | 0.28 | 0.44 | 0.63 | 0.87 | 1.13 | 1.42 | 1.75 | - | - | - | - | - |
| Pl. 1, fig. 17 | 8.5 | 3.85? | 2.10 | 1.83? | 0.20 | 0.35 | 0.73 | 1.21 | 1.72 | 2.29 | 2.74 | 3.22 | 3.66 | - | - | - | - | 0.25 | 0.34 | 0.52 | 0.73 | 0.98 | 1.25 | 1.57 | 1.93 | - | - | - | - |
| | | | | | | Number of septa | | | | | | | | | | | | Width of whorl | | | | | | | | | | | |
| Pl. 1, fig. 14 | 8.4 | - | 2.15 | - | 0.18 | 6 | 12 | 15 | 16 | 20 | 23 | 23 | 25 | - | - | - | - | 0.29 | 0.45 | 0.61 | 0.86 | 1.11 | 1.38 | 1.75 | 2.03 | - | - | - | - |
| Pl. 1, fig. 18 | 9.0 | - | 2.82 | - | 0.19 | 7 | 12 | 14 | 17 | 21 | 22 | 23 | 26 | 29 | - | - | - | 0.31 | 0.50 | 0.73 | 1.02 | 1.35 | 1.71 | 2.07 | 2.20 | 2.82 | - | - | - |
| Pl. 1, fig. 19 | 8.6 | - | 2.32 | - | 0.20 | 5 | 12 | 14 | 15 | 18 | 20 | 24 | 25 | - | - | - | - | 0.28 | 0.44 | 0.60 | 0.81 | 1.07 | 1.40 | 1.79 | 2.11 | - | - | - | - |
| Pl. 1, fig. 20 | 7.7 | - | 2.11 | - | 0.21 | 6 | 13 | 14 | 15 | 18 | 21 | 24 | - | - | - | - | - | 0.37 | 0.54 | 0.72 | 0.95 | 1.30 | 1.59 | 1.91 | - | - | - | - | - |
| Pl. 1, fig. 21 | 8.2 | - | 2.24 | - | 0.18 | 6 | 11 | 15 | 15 | 18 | 22 | 23 | 27 | - | - | - | - | 0.30 | 0.44 | 0.65 | 0.88 | 1.17 | 1.46 | 1.85 | 2.18 | - | - | - | - |
| Pl. 1, fig. 22 | 8.6 | - | 2.25 | - | 0.18 | 5 | 11 | 16 | 16 | 17 | 20 | 23 | 24 | - | - | - | - | 0.28 | 0.44 | 0.60 | 0.85 | 1.16 | 1.41 | 1.75 | 2.03 | - | - | - | - |

Tab. 1 - Measurement of *Presumatrina ciryi*, n. sp. Pl. 1, fig. 7: microspheric form; others: megalospheric forms.

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