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Middle-Late Permian (Murgabian-Djulfian) foraminifers of the northern Maku area (western Azerbaijan, Iran)

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ABSTRACT

The Maku section is located in western Azerbaijan (NW Iran), near Adaghan and Ali Abad villages, in the vicinity of Maku town, along the main road from Tabriz to Bazargan. The Permian Ruteh Formation of the Maku area is subdivided here into four biozones: (1) *Neoschwagerina simplex* Zone (samples P1-P21; early Murgabian); (2) an unzoned interval which corresponds probably to the rest of the Murgabian (samples P22-P29); (3) *Sumatrina annae*, *Dunbarula* aff. *pusilla* and *Chusenella* spp. Zone (samples P30-P41, P46?; Midian); (4) *Paraglobivalvulina mira*, *Paradagmarita*? sp., *Rectostipulina quadrata*, *Ichthyofrondina* spp., *Pseudotristix* sp. and *Colaniella* aff. *minuta* Zone (samples P47 to top unconformity; Djulfian = Wuchiapingian). The studied foraminiferal assemblages show relatively rare tuberitinids, palaeotextulariids, earlandiids, endothyrids and neoendothyrins. Conversely, the globivalvulinids are diversified, with the globivalvulinins *Globivalvulina*, *Labioglobivalvulina*, *Septoglobivalvulina*, *Retroseptellina*, *Charliella*? and *Paraglobivavulina*; rare dagmaritins represented by the same two species along all the series; and primitive paradagmaritins characteristic of the Djulfian. Fusulinida are dominated by staffelloids (*Sphaerulina*, *Nankinella*), whereas schubertelloids (*Schubertella*, *Grovesella*, *Grovesella*? and *Dunbarula*), schwagerinoids (*Chusenella*) and neoschwagerinoids (*Neoschwagerina* and *Sumatrina*) remain rare and scattered. Miliolates and Nodosariates are relatively diversified. Excellent specimens of *Pseudovermiporella* definitively evidenced the assignment of this taxon to the Miliolata. Other representatives of this class are *Hemigordius*, *Okimuraites*, *Hemigordiellina*, *Glomomidiella*, *Agathammina*, *Neodiscus* and *Crassiglomella*. The Middle Permian Nodosariata are represented by *Syzrania*, *Rectostipulina*, *Nodosinelloides*, *Protonodosaria*, *Langella*, *Pseudolangella*?, *Lingulina*, *Pseudotristix*, *Geinitzina*, *Pachyphloia* and rare *Robuloides*; whereas *Frondina* and *Ichythyofrondina* are numerous in the Djulfian. The new taxa are *Grovesella? ciryi* n. sp. and *Hemigordiellina*? *pulchrissima* n. sp.

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INTRODUCTION

The studied area forms a part of the Alborz-Azerbaijan unit (Figure 1), one of the 17 structural and sedimentological units defined by Nabavi (1976), in Iran. The Permian rocks are widespread in this unit, as well as in central Iran, Sanandaj-Sirjan Zone and Zagros (Figure 1).

Permian rocks of Azerbaijan are lithostratigraphically equivalent of the classical formations of the Alborz Mountains: Dorud, Ruteh and Nesen. The Ruteh Formation, defined in Alborz by Assereto (1963), displays a sequence relatively homogeneous of grey to dark limestone with intercalated marl. Lasemi (2001) characterized the sedimentary palaeoenvironments of the Ruteh Formation as equivalents of modern carbonate environments of the southern shelves of Persian Gulf with open sea, barrier, lagoon and tidal flat, respectively. The erosional lower boundary of the Ruteh Formation rests everywhere unconformably on the older lithological units (Aghanabati, 2006). The erosional surface with the Dorud Formation occasionally is underlined by a lateritic layer, which Stampfli (1978) interpreted as the unique record of the regional Artinskian-Kungurian gap. The upper sur-

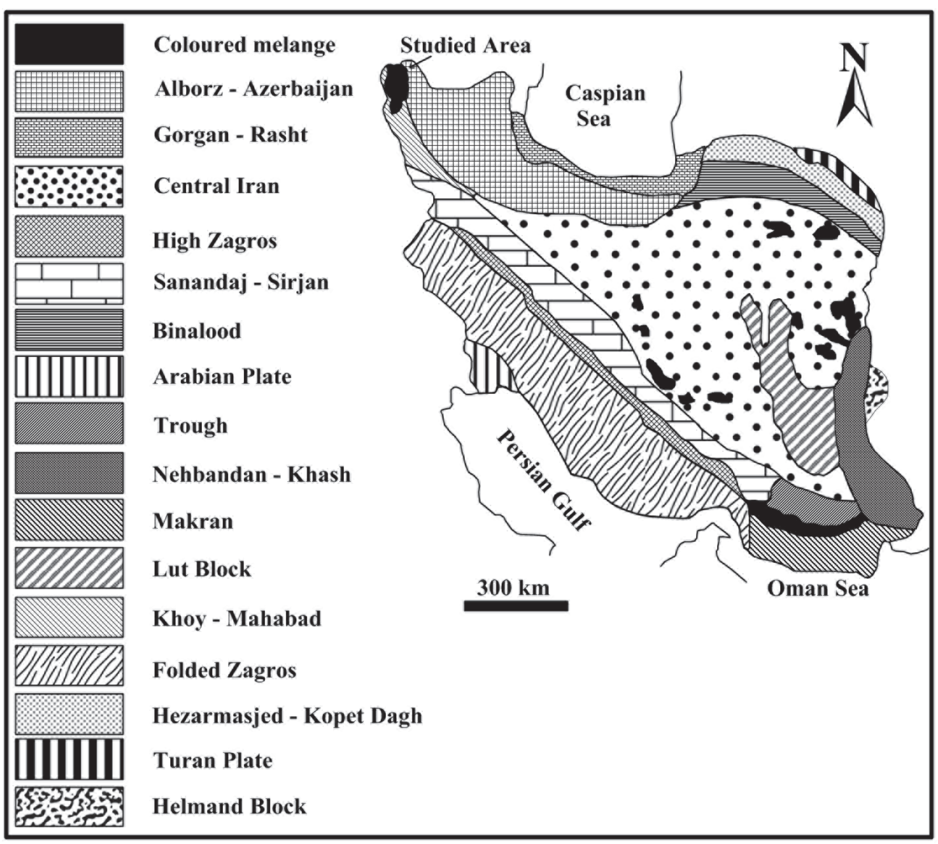

FIGURE 1. Structural and sedimentological units of Iran (Nabavi, 1976).

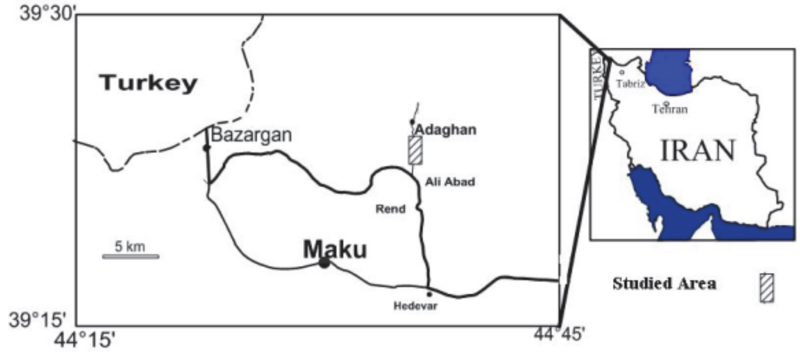

FIGURE 2. Location of studied area.

face of the Ruteh Formation is regionally marked by a karstic surface, locally filled by volcanic lavas and/or bauxite-laterite deposits (Shabani and Baghbani, 2008), while the Ruteh Formation is continuously overlain by the Elika Formation (Triassic) and/or Shemshak Formation (Triassic-Jurassic) in most areas of southern Alborz areas, or has a discontinuous contact with the latest Permian (Dorashamian = Changhsingian) Nesen limestone, in northern Alborz.

Late Permian rocks largely crop out in Azerbaijan especially in the classical area of Julfa (= Djulfa, Djoulfa or Dzhulfa, according to the translitterations), where the Djulfian stage has been defined, and where the Permian-Triassic boundary is well exposed. The first comprehensive study of the Julfa section was conducted by Stepanov et al. (1969) who subdivided the Permian and the Triassic strata into seven units: “A” to “G”. Another pioneer description of the Julfa area sections (especially of the Ali Bashi Mountains) was provided by Teichert et al. (1973). Biostratigraphic data (e.g., Kozur, 2004, 2005, 2007; Shen and Mei, 2010) and chemostratigraphic interpretations (Holser and Magaritz, 1987; Baud et al., 1989; Korte et al., 2004; Korte and Kozur, 2005; Kakuwa and Matsumoto, 2006; Richoz, 2006; Horacek et al., 2007; Richoz et al., 2010) were published for the Permian-Triassic sequences in the Ali Bashi sections. They provided a significant increase of the geological and palaeontological data and probably have allowed a nearly definitive geological schema of the region to be conceived. Nevertheless, in other areas of Azerbaijan, although the Ruteh Formation is extensively exposed (Aghanabati, 2006), its accurate biostratigraphy remained poorly known (e.g., Shabanian and Bagheri, 2008, with references therein), especially the Maku area.

Contrary to the Armenian and Turkish outcrops (Akopian, 1974; Altiner et al., 1980; Kotlyar et al., 1984, 1989; Pronina, 1988a; Altiner, 1984; Köyluoglu and Altiner, 1989) located in the other side of the Iranian border, the iconography of the foraminifers and algae remained very poor in NW Iran, so another goal was to publish an atlas more or less similar to the Bozorgnia’s atlas for the Alborz (Bozorgnia, 1973). This monography is therefore the first one dedicated to these very rich levels of Maku and tries to be the cornerstone for future micropalaeontogical research in this area. Hence, the aims of this work were: (1) the detailed biostratigraphical characterization of the Ruteh Formation in the Maku locality, (2) the description of its foraminifers, (3) the possible identification of lateral equivalents with the classical Julfa area and (4) the discussion of various palaeobiogeographical hypotheses concerning either the northern (i.e., Perigondwanan) border of the Neo-Tethys or the southern border of the Cimmerian continent.

GEOLOGICAL SETTING

The Maku section is located near Adaghan and Ali Abad villages, in the vicinity of Maku town, NW Iran (latitude 39° 32′ 20″-39° 22′ 05″N and longitude 44° 33′ 40″-44° 39′ 50″ E), along the main road from Tabriz to Bazargan (Figure 2).

The oldest Palaeozoic lithological units in the studied area are Silurian volcanic rocks (Figure 3). They are successively overlain by (a) the sediments of the Ilanqareh Formation (Late Devonian to earliest Mississippian) consisting of shale, quartzite, limestone, and phosphate layers (more or less 1300 m thick; according to Alavi Naini and Bolourchi, 1973), (b) the Middle Mississippian Limestone of the Mobarak Formation, and (c) the Permian Ruteh Limestone, especially studied here. North of Maku, this latter directly and disconformably rests on the Ilanqareh Formation (Figure 4). The Early Miocene Qom Formation (conglomerate, limestone, and marl), more or less 700 m thick, unconformably overlies the older formations (Alavi

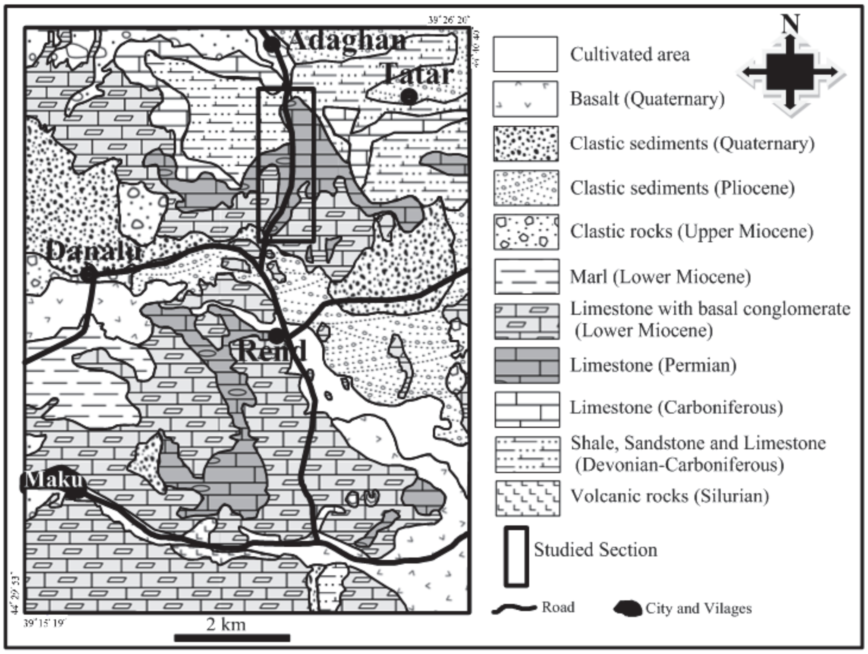

FIGURE 3. Geological map of studied area.

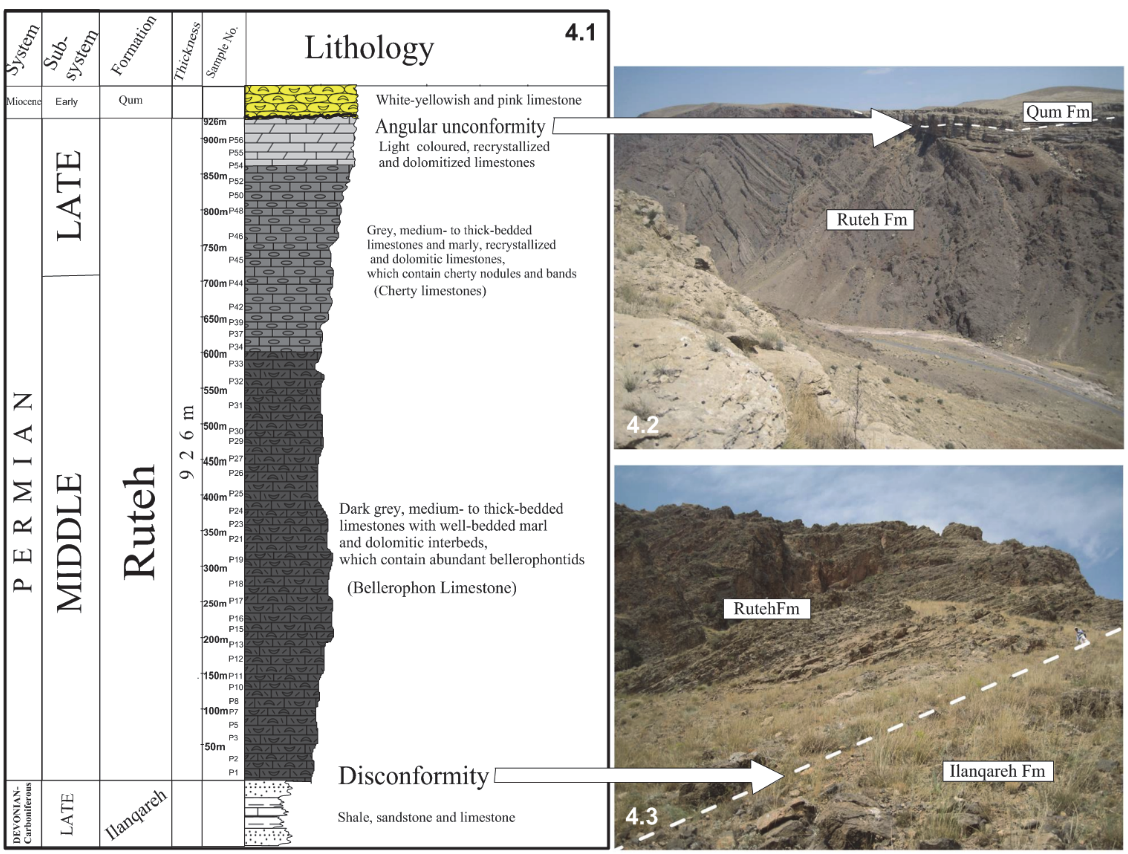

FIGURE 4. 4.1: The studied series with the thicknesses and sample locations. 4.2: Upper contact with the Cenozoic Qum Formation. 4.3: Lower conctat with the Devonian-Carboniferous Ilanqareh Formation.

SYSTEM	SERIES	INTERNATIONAL STAGES	TETHYAN STAGES	
PERMIAN	LATE	CHANGHSINGIAN	DORASHAMIAN	
		WUCHIAPINGIAN	DJULFIAN	
	MIDDLE	CAPITANIAN	MIDIAN	
		WORDIAN	l/m	MURGABIAN
		ROADIAN	e	
			KUBERGANDIAN	
	EARLY	KUNGURIAN	BOLORIAN	
		ARTINSKIAN	YAKHTASHIAN	
		SAKMARIAN	HERMAGORIAN	
		ASSELIAN	ASSELIAN	

FIGURE 5. Proposed correlation between the international and Tethyan scales of the Permian system (according to Leven, 1967, 1975, 1981, 1992, 1997; Henderson et al., 2012; Davydov et al., 2013; and D. Vachard (unpublished data)). Abbreviations: e = early l/m = late/middle.

Naini and Bolourchi, 1973). Quaternary basaltic flows constitute the youngest rocks in the area (Figure 3).

The Ruteh Formation is one of the most fossiliferous units in Alborz-Azerbaijan. The corals, brachiopods, algae and foraminifers of the Alborz Mountains have been accurately studied in the 20th century, and generally assigned to the Middle Permian (Murgabian-Midian). Lithostratigraphically, the Ruteh Formation in Azerbaidjan was correlated with the Jamal Formation in Central Iran and/or Gnishik layers in Julfa Mountains (Iran) and in Armenia. Furthermore, Bozorgnia (1973) suggested that the uppermost 25 metres of the Ruteh Formation, in some sections of Alborz, might be assigned to the Djulfian. Our study confirms the presence of the three stages, Murgabian, Midian and Djulfian within the formation in Maku.

There was only a lithostratigraphic study of the Ruteh Formation in Maku area (Alavi Naini and Bolourchi, 1973), where this formation was subdivided into two informal members (A and B). Our new data are summarized in the Figure 4.

The Ruteh Formation of Maku (Figure 4.1), 926 m thick, disconformably rests upon the Devonian-Carboniferous Ilanqareh Formation and is overlain by the Early Miocene Qum Formation with an angular unconformity (Figure 4.2-3). It is subdivided into three units: (1) the Bellerophon limestone, 604 m thick, composed of dark grey, medium- to thick-bedded limestone with marl and dolomitic limestone interbeds, with abundant bellerophontids, corals, crinoids, brachiopods, ostracods and algae; (2) the cherty limestone (261 m thick), composed of lighter coloured, grey, medium- to thick-bedded limestone and marly, crystallized, dolomitic limestone with nodules and bands of chert; (3) the last unit (61 m thick) is a light coloured, dolomitized limestone with brachiopods and ostracods.

BIOSTRATIGRAPHY

The stages and biozones of the Tethyan Realm were defined by Leven (1967, 1975, 1981, 1992, 1997). A correlation with the international scales of Henderson et al. (2012) is suggested below (Figure 5).

The foraminiferal composition and distribution of the Ruteh Formation of Maku is indicated in Figure 6. The discovered foraminifers permit to subdivide this formation into four biozones; namely, (1) *Neoschwagerina simplex* Zone (samples P1-P21; early Murgabian); (2) an unzoned interval which corresponds to the rest of the Murgabian Stage (samples P22-P29); (3) *Sumatrina annae*, *Dunbarula* aff. *pusilla* and *Chusenella* spp. Zone (samples P30-P41 P46?; Midian); (4) *Paradagmarita*? sp., *Paraglobivalvulina mira*, *Ichthyofrondina* spp., *Pseudotristix* sp., *Colaniella* aff. *minuta*, and *Rectostipulina quadrata* Zone (samples P47 to the top

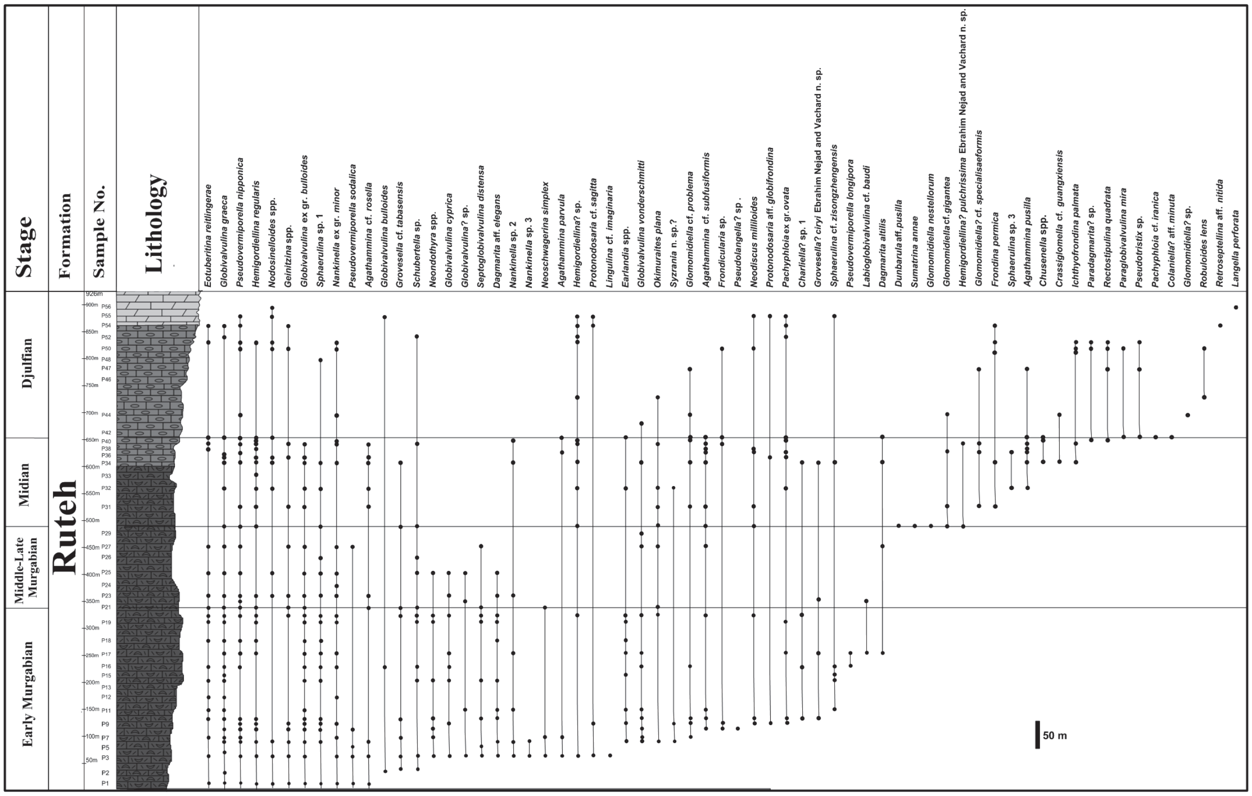

FIGURE 6. Foraminiferal distribution of the Ruteh Formation in Maku section (NW Iran).

of the series and the unconformity; Djulfian = Wuchiapingian), with the following remarks:

1. The FO (first occurrence) of *Neoschwagerina simplex* in P3 characterizes the base of the series P1-P21 as being early Murgabian in age.
2. The interval P22-P29 is devoid of characteristic fossils, and is either still early Murgabian or yet middle and/or late Murgabian in age. Consequently, the local middle and/or late Murgabian is very reduced in thickness or eventually absent.
3. The FO of *Sumatrina annae* and primitive *Dunbarula* aff. *pusilla* in P30 indicates the base of the Midian Stage. The LO (last occurrence) of *Chusenella* spp. in P41 is the upper limit of the Midian, based on the general disappearance of all the giant fusulinids like *Chusenella* at this limit. Consequently, the entire Midian might correspond to the interval containing the samples P30 to P46.
4. The concomitant FOs of *Paradagmarita*? sp., *Paraglobivalvulina mira*, *Ichthyofrondina* spp., *Pseudotristix* sp., *Colaniella* aff. *minuta*, and *Rectostipulina quadrata* in P47, indicate the Djulfian (= Wuchiapingian = early Late Permian; see Figure 5), because all these small taxa correspond to the classical Lilliput effect at the base of the Late Permian. No younger biomarkers, e.g., *Nanlingella*, *Paraglobivalvulinoides* and evolved *Colaniella* (known for example in the Alborz (e.g., Bozorgnia, 1973)) were found above; therefore, this interval (samples P47-P56) is dated as Djulfian (and probably early Djulfian).

SYSTEMATIC PALAEONTOLOGY

The following foraminiferal classification is based on those of Gaillot and Vachard (2007), Vachard et al. (2010) and Hance et al. (2011); taking into consideration those of Loeblich and Tappan (1987, 1992), Vdovenko et al. (1993), Rauzer-Chernousova et al. (1996) and Mikhalevich (1998, 2004) (Figure 7-19). Abbreviations: L = length, H = height, D = outer diameter, d = inner diameter, w = width, w/D = form ratio, p = proloculus diameter, n = number of whorls, h = height of last whorl or last chamber and s = wall thickness.

Phylum RHIZARIA Cavalier-Smith, 2002
Subphylum FORAMINIFERA d'Orbigny, 1826 nom.

PHYLUM	CLASSES	FAMILIES
FORAMINIFERA	NODOSARIATA	PACHYPHLOIIDAE
		NODOSARIIDAE
		COLANIELLIDAE
		FRONDINIDAE
		ROBULOIDIDAE
		GEINITZINIDAE
		PROTONODOSARIIDAE
		SYZRANIIDAE
	MILIOLATA	NEODISCIDAE
		HEMIGORDIIDAE
		CORNUSPIRIDAE
		CALCIVERTELLIDAE
	FUSULINATA	NEOSCHWAGERINIDAE
		CHUSENELLIDAE
		SCHUBERTELLIDAE
		STAFFELLIDAE
		GLOBIVALVULINIDAE
		PALAEOTEXTULARIIDAE
		ENDOTHYRIDAE
		EARLANDIIDAE
		TUBERITINIDAE

FIGURE 7. Classes and families of foraminifers described in this study (classification after Vachard et al., 2010 and Hance et al., 2011).

translat. Cavalier-Smith, 2003

Class FUSULINATA Möller, 1878 (non Fursenko, 1958) nom. translat. Gaillot and Vachard, 2007 nom. correct. Vachard, Krainer and Lucas, 2013

Subclass AFUSULINANA Vachard, Pille and Gaillot, 2010

Order ?PARATHURAMMINIDA Bykova in Bykova and Polenova, 1955 nom. translat. Mikhalevich, 1980

Family TUBERITINIDAE Miklukho-Maklay, 1958

Discussion. Despite their resemblances with some unilocular foraminifers with microgranular walls (Parathuramminida), the tuberitinids remain incertae sedis microfossils, because of some very peculiar characters, like the microstructures of their wall, their frequent mutual attachment, and the existence of a double life, free and attached (Conil and Lys in Conil et al., 1977). This latter character might indicate a relationship with the euglenophyta but this group is not calcified. No true foraminifers have a biological tolerance comparable to that of the tuberitinids. As indicated by Vachard (1994), some microstructural similarities might exist with the Calcitarcha Calcisphaeridae (e.g., *Tubesphaera* Vachard, 1994). Appeared in the Silurian, the group is present up to the Permian-Triassic Boundary (Vachard, 1994); it does not cross through this limit. The presence of tuberitinids in the Early Triassic, suggested by Song et al. (2011) result probably of the confusion of oblique sections through two chambers of foraminifers with the morphogenus *Diplosphaerina* Derville, 1952 (the free stage of *Eotuberitina*). This remark may appear anecdotal but it constitutes for us an evidence of the severeness of the PTB event; because the tuberitinids which resisted to all the previous Palaeozoic crises, finally disappeared at the PTB.

Occurrence. Silurian to latest Permian (Vdovenko et al., 1993); cosmopolite.

Genus EOTUBERITINA Miklukho-Maklay, 1958

Type species. *Eotuberitina reitlingerae* Miklukho-Maklay, 1958, p. 134 by original designation (nomen novum pro *Tuberitina maljavkini* sensu Reitlinger, 1950 non Mikhailov, 1939; see Loeblich and Tappan, 1987).

Eotuberitina reitlingerae Miklukho-Maklay, 1958
Figure 8.1-8.4

1958 *Eotuberitina reitlingerae* Miklukho-Maklay, p. 134 (see Reitlinger, 1950, p. 88, pl. 19, fig. 2).

Remarks. Very small Tuberitinidae with a flat to convex basal attachment disc and a thin microgranular wall. Groups of 2-3 specimens (rarely 4-5) can encrust themselves (see e.g., Zheng Hong, 1989, pl. 1, figs. 8-14, 26-27; Mamet, 1996, pl. 3, fig. 20; Nestell and Nestell, 2006, pl. 1, figs. 1-4, 7-8). The dimensions of our Permian material (D = 0.050-0.100 mm; H = 0.040-0.080 mm) are consistent with those of the type material, despite the Viséan age of this latter.

Occurrence. The presence of *Eotuberitina reitlingerae* up to Changhsingian times has been indicated by Lin et al., 1990; Vachard et al., 1993a; Berczi-Makk et al., 1995; Pronina-Nestell and Nestell, 2001; Zhang and Hong, 2004; Gaillot and Vachard, 2007; etc. Our specimens were observed in many samples of Maku (P1, P3, P7, P10, P11, P12, P14, P16, P17, P18, P19 (relatively common), P20, P21, P23, P25, P27, P38, P39, P41, P51 and P54).

Order EARLANDIIDA Cummings, 1955 nom. translat. Loeblich and Tappan, 1982

Family EARLANDIIDAE Cummings, 1955 emend.Vachard, 1994

Genus EARLANDIA Plummer, 1930

Type species. *Earlandia perparva* Plummer, 1930.

FIGURE 8. 1-4. *Eotuberitina reitlingerae* Miklukho-Maklay, 1958. 1. P18-5. Murgabian. 2. P17-34. Murgabian. 3. P10-33. Murgabian. 4. P23-17. Murgabian. 5-6, 11. *Deckerella* sp. 5. P41-17. Latest Midian. 6. Longitudinal section. P41-11. Latest Midian. 11. Initial stage similar to *Palaeotextularia*, with *Hemigordiellina regularis* (Lipina, 1949). P41-56. Latest Midian. 7-8. *Cribrogenerina* sp. 1. 7. Subaxial section with *Okimuraites plana* (Okimura and Ishii, 1981) (B; bottom left and top right). P21-50. Murgabian. 8. Oblique section with *Neodiscus milliloides* Miklukho-Maklay, 1953 (bottom, left). P20-30. Murgabian. 9, 12. *Cribrogenerina* sp. 2. 9. Subaxial section. P52-1. Djulfian. 12. Subaxial section. P50-33. Djulfian. 10, 13. *Climacammina* sp. 1. 10. Subtransverse section. P52-13. Djulfian. 13. Longitudinal section. P50-35. Djulfian. 14-15. *Climacammina* sp. 2. 14. Subaxial section. P34-36. Midian. 15. Oblique section. P34-17. Midian. 16. *Labioglobivalvulina* cf. *baudi* Gaillot and Vachard, 2007. Subaxial section. P3-40. Murgabian. 17, 19. *Globivalvulina bulloides* (Brady, 1876). 17. Axial section. P1-3. Murgabian. 19. Axial section (top left) with *G. graeca* (bottom). P2-2. Murgabian. 18, 20. *Globivalvulina* ex gr. *bulloides* (Brady, 1876). 18. Axial section. P1-20. Murgabian. 20. Transverse section. P1-27. Murgabian. 21-22. *Globivalvulina cyprica* Reichel, 1946. 21. Axial section. P17-31. Murgabian. 22. Transverse section. P17-16. Murgabian. 19, 23-26. *Globivalvulina graeca* Reichel, 1946. 19. Axial section (bottom) with *G. bulloides* (top left). P2-2. Murgabian. 23. Axial section. P17-11. Murgabian. 24. Transverse section. P22. Murgabian. 25. Transverse section. P17-29. Murgabian. 26. Transverse section. P6-38. Murgabian.

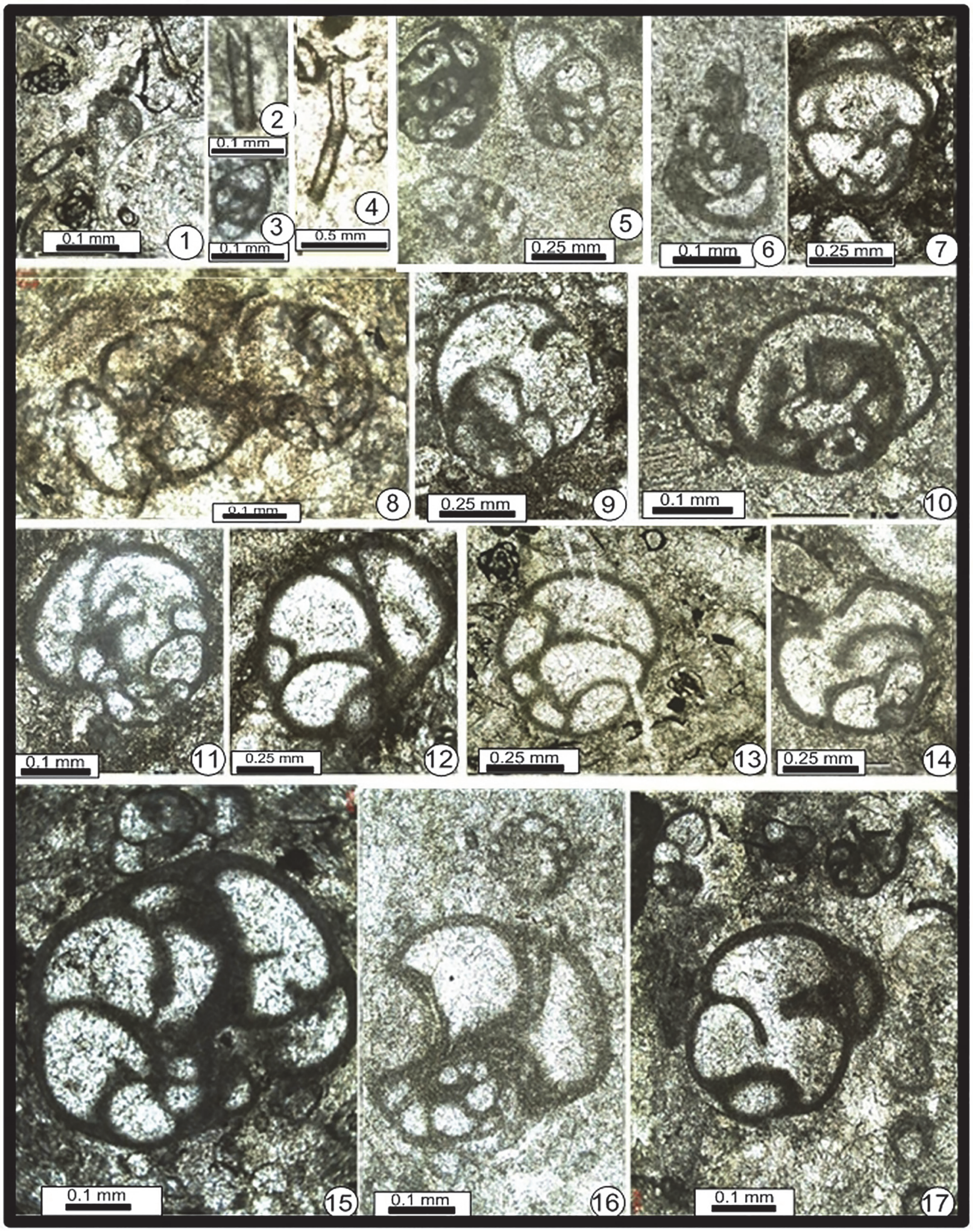

FIGURE 9. 1-2. *Earlandia* ex gr. *elegans* (Rauzer-Chernousova and Reitlinger in Rauzer-Chernousova and Fursenko, 1937). 1. Longitudinal section (top left) with *Geinitzina* sp. (top left) and *Hemigordiellina regularis* (Lipina, 1949) (bottom and top, left). P17-11. Murgabian. 2. Longitudinal section. P17-13. Murgabian. 1, 4. *Earlandia* ex gr. minor (Rauzer-Chernousova, 1948). 1. Oblique section (bottom left). P17-11. Murgabian. 4. Longitudinal section. P31-30. Murgabian. 3. *Endothyra*? sp. Axial section. P8-5. Murgabian. 5. *Endothyra* cf. *miassica* Malakhova, 1965. Transverse section (top, left) with *Globivalvulina graeca* Reichel, 1946 (top right) and *Nankinella* ex gr. minor Sheng, 1955 (bottom left). P10-64. Murgabian. 6. *Neoendothyra* sp.. Axial section. P25-1. Murgabian. 7, 11-14. *Globivalvulina graeca* Reichel, 1946. 7. Subaxial section. P1-18. Murgabian. 11. Subaxial section. P1-29. Murgabian. 12. Subtransverse section. P1-14. Murgabian. 13. Subaxial section with 3 specimens of *Hemigordiellina regularis* (Lipina, 1949). P6-6. Murgabian. 14. Axial section. P16-41. Murgabian. 8. *Septoglobivalvulina distensa* (Wang in Zhao et al., 1981). Two sections. P5-2. Murgabian. 9. *Globivalvulina* ex gr. *bulloides* (Brady, 1876). Axial section. P1-15. Murgabian. 10. *Paraglobivalvulina* cf. *mira* Reitlinger, 1965. Axial section. P25-24. Murgabian. 15-17. *Globivalvulina vonderschmitti* Reichel, 1946. 15. Transverse section with *Globivalvulina bulloides.* P34-35. Midian. 16. Transverse section with a *Nankinella*? sp. (top right). P11-8. Murgabian. 17. Subaxial section with *Globivalvulina* ex gr. *bulloides* (top left); transitional taxon to *Paradagmarita* (top, centre) and *Labioglobivalvulina* cf. *baudi* (top right). P22-9. Murgabian.

Earlandia spp.
Figure 9.1-9.2, 9.4

Remarks. Two groups of species seem to be relatively common in our samples P3, P6, P9, P10, P11, P15, P17, P18, P19, P20, P21, P32 and P40. The small taxon is *Earlandia* ex gr. *elegans* (Rauzer-Chernousova and Reitlinger in Rauzer-Chernousova and Fursenko, 1937) (Figure 9.1-9.2; D = 0.050-0.075 mm); the second one is the medium-sized *Earlandia* ex gr. *minor* (Rauzer-Chernousova, 1948) (Figure 9.1, 9.4; D = 0.120-0.200 mm). Gaillot and Vachard (2007) have given good arguments to assign the small tubular microgranular Permian tests to *Earlandia*. Nevertheless, some authors (e.g., Hughes, 2012) prefer to use *Aeolisaccus* Elliott, 1958. It was tried to justify two genera using the difference of wall microstructures (Vachard, 1980), but it seems evident now that all these tubes belong to *Earlandia*.
Occurrence. Late Silurian-Early Cretaceous, cosmopolite.

Subclass FUSULININA Möller, 1878 nom. translat. Vachard et al., 2010
Superfamily ENDOTHYROIDEA Brady, 1884 nom. translat. Glaessner, 1945
Family ENDOTHYRIDAE Brady, 1884 nom. translat. Rhumbler, 1895
Genus ENDOTHYRA Phillips, 1846 sensu Brady, 1876 emend. China, 1965

Type species. *Endothyra bowmani* Phillips, 1846 sensu Brady, 1876 emend. China, 1965.

Endothyra spp.
Figure 9.3?, 9.5

Remarks. Very rare specimens (in P8 and P10), either similar to *Endothyra miassica* Malakhova, 1965 (D = 0.500 mm; Figure 9.5) or *Endothyra*? sp. (D = 0.250 mm; Figure 9.3).

Genus NEOENDOTHYRA Reitlinger, 1965

Type species. *Neoendothyra reicheli* Reitlinger, 1965.

Neoendothyra sp.
Figure 9.3?, 9.6

Remarks. We found only nine specimens (P3, P7?, P8?, P10, P14?, P18, P19, P20 and P25) of this genus, which is generally more common in other areas of Iran and in Armenia where it was initially described. One typical *Neoendothyra* sp. is illustrated (Figure 9.6); another illustrated specimen (Figure 9.3) is transitional between *Endothyra* and *Neoendothyra* (see above) due to the periphery rounded and then, only carinate at the semi-last whorl. This latter specimen is relatively anachronistic, because this evolutionary trend appears earlier in the Carnic Alps and South China; i.e., in the Sakmarian/Artinskian (Lin, 1985; Vachard and Krainer, 2001).

Superfamily PALAEOTEXTULARIOIDEA Galloway, 1933 nom. translat. Habeeb, 1979
Family PALAEOTEXTULARIIDAE Galloway, 1933 nom. translat. Wedekind, 1937
Subfamily PALAEOTEXTULARIINAE Galloway, 1933
Figure 8.5-15

Remarks. The palaeotextulariins are relatively rare in our samples but represented by at least three genera. The species of these three genera are very abundant in the literature but all poorly characterized. Hence, we determined our taxa as: *Deckerella* sp. (Figure 8.1, 8.5-6, 8.11), *Climacammina* spp. (Figure 8.10-8.15), and *Cribrogenerina* spp. (Figure 8.7-9, 8.12).
Occurrence. *Deckerella* is latest Midian-Julfian (P41 and P55); *Climacammina* and *Cribrogenerina* are present in many samples (P3, P20, P21, P25, P34, P40, P41, P50, P52 and P55).

Superfamily GLOBIVALVULINOIDEA Reitlinger, 1950 nom. translat. Hance et al., 2011

Discussion. This group was previously denominated Biseriamminoidea but due to the poor definition and very rare re-findings of *Biserammina* Chernysheva, 1941, and to the establishment of phylogenetic lineages issued from *Pseudotaxis* Mamet, 1974b (Vachard et al., 2006; Hance et al., 2011), the superfamily Globivalvulinoidea was translated and re-described by Hance et al. (2011) according to the phylogenetic schemes of Gaillot and Vachard (2007).
Occurrence. ?Late Tournaisian; earliest Serpukhovian-late Changhsingian; cosmopolite or endemic.

Family GLOBIVALVULINIDAE Reitlinger, 1950 emend. Gaillot and Vachard, 2007

Description. Test biserial, entirely planispiral or initially trochospiral, or entirely uncoiled, or trochospiral becoming planispiral. Wall thin, dark, microgranular, eventually granular with inclusions of clearer carbonate particles, or differentiated into two, three or four layers. Endoskeletal folds or partitions lead to the formation of chamberlets. Oral tongue often present, occasionally passing to a siphon. Aperture terminal simple.
Included subfamilies. Four subfamilies: Globivalvulininae Reitlinger, 1950; Paraglobivalvulininae

Gaillot and Vachard, 2007; Dagmaritinae Bozorgnia, 1973 (= Louisettitinae); and Paradagmaritinae Gaillot and Vachard, 2007.

Occurrence. Mississippian-Permian (latest Tournaisian-latest Changhsingian). The Pennsylvanian genera are rather cosmopolite, whereas the Permian ones are restricted to the Neo-Tethys.

Subfamily GLOBIVALVULININAE Reitlinger, 1950

Description. Small, medium or large globivalvulinid test, entirely biseriate and planispiral (rarely slightly trochospiral). Subglobular with lobate periphery. Valvula projection generally well-developed. Wall dark, microgranular, homogeneous to differentiated. Aperture simple protected by the valvular projection.

Occurrence. Middle Mississippian-latest Permian/ earliest Triassic; first Palaeo-Tethyan, this genus becomes cosmopolite after the late Bashkirian times.

Genus GLOBIVALVULINA Schubert, 1921

Type species. *Valvulina bulloides* Brady, 1876.

Description. Globivalvulinin with a wall microgranular, dark, homogeneous to more or less differentiated, with e.g., (a) with a yellowish pseudofibrous inner layer (*G. mosquensis* Reitlinger, 1950), (b) as a finely perforated, *Omphalotis*-like, greyish wall (Vachard and Beckary, 1991), (c) granular with clearer calcareous agglutinated particules (*G. granulosa* Reitlinger, 1950), (d) with an intermediary clear layer ("diaphanotheca" of the authors): *G. bulloides* (Brady) of the authors. Nevertheless, this differentiation generally does not affect all the chambers and/or correspond to fossildiagenetic features. Hence, it is not yet admitted as a generic or subgeneric criterion among the *Globivalvulina* lineages.

Occurrence. Late Mississippian (earliest Serpukhovian-latest Permian (Changhsingian); first, this genus is Palaeo-Tethyan; then (after the late Bahkirian period), it becomes cosmopolite. Presence for confirming in the earliest Triassic (see *G. curiosa* Gaillot, Vachard, Galfetti and Martini, 2009; see also the double PTB event of Song et al., 2011, 2013). The Early Mississippian species, with a possible FAD in the late Tournaisian, are generally poorly known and need some revisions.

Globivalvulina bulloides (Brady, 1876)
Figures 8.17, 8.19 (top), 9.15

1876 *Valvulina bulloides* Brady, p. 89-90, pl. 4, figs. 12-15.

1998 *Globivalvulina* du groupe *G. bulloides* (Brady); Pinard and Mamet, p. 118-119, pl. 27, figs. 16-20, pl. 28, figs. 1-4, 5?, 6-11 (with synonymy).

2009 *Globivalvulina bulloides* (Brady); Song et al., fig. 7.29-35.

Description. *G. bulloides* is a subglobose species, medium-sized for the genus: D = 0.340-0.630 mm; w = 0.185-0.350 mm; w/D = 0.54-0.56; p = 0.060 mm; and s = 0.015-0.030 mm. The well-developed clear median layer in the wall ("diaphanotheca"), warmly advocated by Armstrong and Mamet (1977) or Pinard and Mamet (1998), is in reality very faintly developed (Groves, 1988; Brenckle, 2005) and/or unconspicuous (Vachard et al., 2006; this work). The synonymy with *G. moderata* Reitlinger, 1949, proposed by Groves (1988), is possible but this species is obviously smaller (D = 0.270-0.365 mm), and the *Biseriella parva* of this author (non sensu Chernysheva, 1948), with its diameter of 0.250-0.380 mm, is more closely related to *G. moderata*. All these possible misinterpretations and synonyms might demonstrate that the genera *Biseriella* and *Globivalvulina* are not morphologically distinct; therefore, only a hypothetical difference in their wall structure might confirm their separation.

Occurrence. ?Serpukhovian; Bashkirian to latest Permian, cosmopolite. Common in many samples of Maku (P2, P13, P16, and P55).

Globivalvulina ex gr. *bulloides* (Brady, 1876)
Figures 8.18, 8.20, 9.9, 9.17, 10.7, 10.12

Description. A small species with a thinner wall and a higher last chamber than the typical specimens of this species, with also a plane apertural face and a relatively strong valvula. D = 0.465-0.625 mm; w = 0.325-0.550 mm; w/D = 0.43- 0.83; p = 0.010 mm; n = 1.5; h = 0.115 mm; s = 0.007-0.020 mm. Our material resembles *G. bulloides* sensu Groves, 1992 (pl. 4, figs. 17?-18) and *G.* ex gr. *bulloides* sensu Pinard and Mamet (1998, pl. 27, figs. 17-20).

Occurrence. Murgabian-Midian of Maku (P1, P6, P8, P9, P10, P11, P14, P16, P17, P18, P19, P20, P21, P23, P25, P27, P31, P32, P34, P35 and P39).

Globivalvulina cyprica Reichel, 1946
Figures 8.21-8.22, 10.1?, 10.2, 10.3?, 10.4, 10.5?, 10.6, 10.15?, 10.18?

1946 *Globivalvulina cyprica* Reichel, p. 553-554, text-figs. 39 a-f.

non 2006b *Globivalvulina cyprica* Reichel; Kobayashi, p. 182-183, figs. 3.7, 3.11-3.15 (= *Retroseptellina*; and probably a new species of this genus).

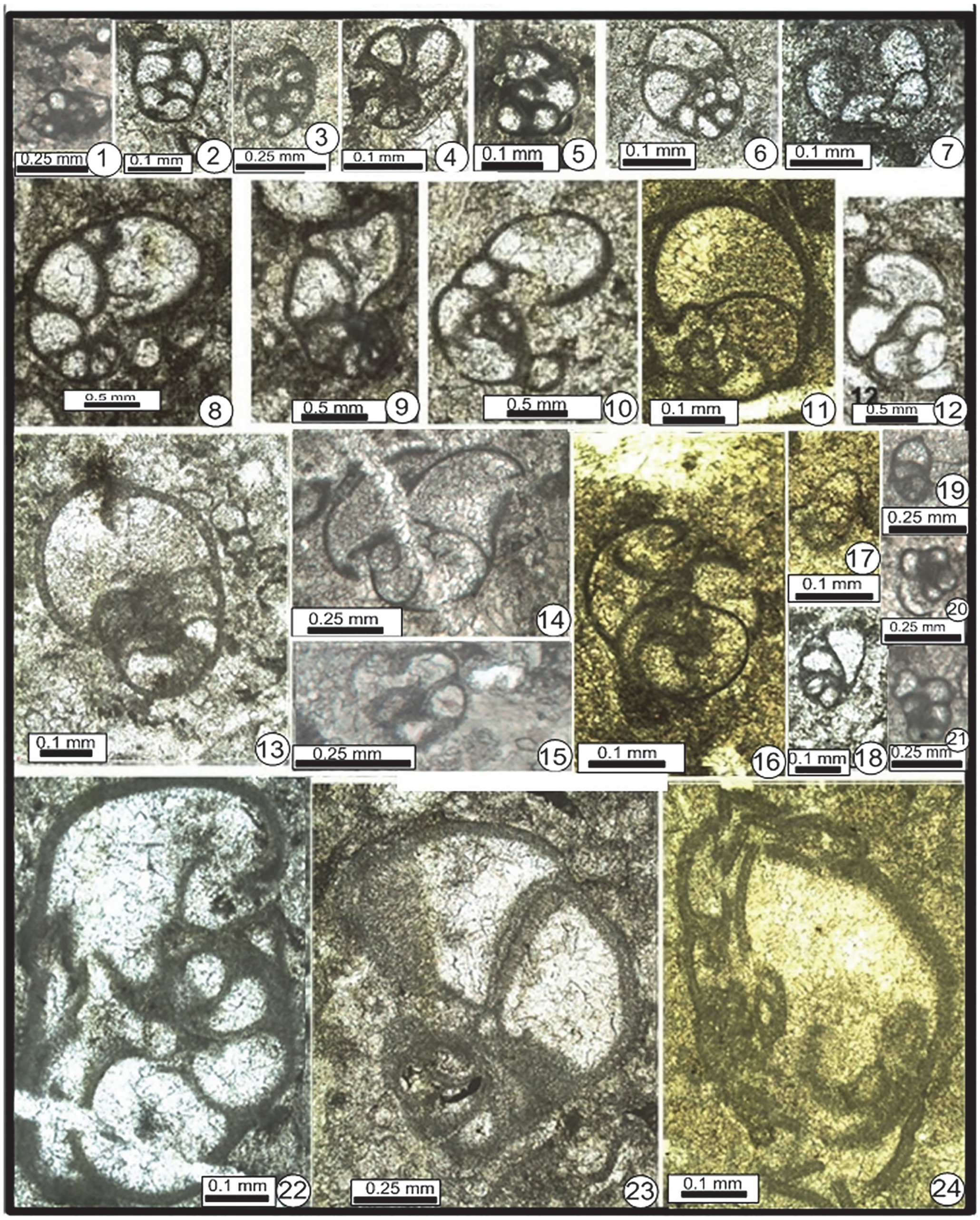

FIGURE 10. 1?, 2, 3?, 4, 5?, 6, 15, 18?. *Globivalvulina cyprica* Reichel, 1946. 1. Subtransverse section. P23. Murgabian. 2. Axial section. P22-34. Murgabian 3. Transverse section. P3-20. Murgabian. 4. Transverse section. P3-3. Murgabian. 5. Subtransverse section. P2-17. Murgabian. 6. Transverse section. P25-14. Murgabian. 15. Subtransverse section with *Hemigordiellina* sp. (top, right). P3. Murgabian. 18? Transverse section. P14-35. Murgabian. 7, 12. *Globivalvulina* ex gr. *bulloides* (Brady, 1876). 7. Axial section. P32-31. Midian. 12. Axial section. P1-7. Murgabian. 8-10. *Globivalvulina graeca* Reichel, 1946. 8. Transverse section. P16-23. Murgabian. 9. Transverse section. P16-34. Murgabian. 10. Axial section. P7-6. Murgabian. 11, 24. *Paraglobivalvulina mira* Reitlinger, 1965. 11. Axial section. Detail of a well preserved juvenarium surrounded by the fragments of the broken last chamber. P50-18. Djulfian. 24. Broken axial? section. P50-29. Djulfian. 13-14, 22. *Globivalvulina vonderschmitti* Reichel, 1946. 13. Axial section. P10-53. Murgabian. 14. Axial section. P20-31. Murgabian. 21. Transverse section. P34-19. Midian. 14. *Septoglobivalvulina distensa* (Wang in Zhao et al., 1981). Transverse section. P22. Murgabian. 16. *Rectoseptellina* aff. *nitida* (Lin, Li and Sun, 1990). Axial section. P54-18. Djulfian. 17. *Paradagmarita*? sp. Oblique subaxial section. P50-10. Djulfian. 19-21. *Globivalvulina*? sp. (Transitional from *Globivalvulina* to *Paradagmarita*). 19. Oblique section showing a last triangular chamber. P22. Murgabian. 20. Subaxial section. P22. Murgabian. 21. Subaxial section. P22. Murgabian. 23. *Charliella*? sp. 1. Subtransverse section. P16-40. Murgabian.

2009 *Globivalvulina cyprica* Reichel; Ueno and Tsutsumi, figs. 8.5, 9.23.

?2009 *Globivalvulina*? sp.; Nestell et al., pl. 2, figs. 18-19.

? 2010 *Globivalvulina cyprica* Reichel; Altiner and Özkan Altiner, text-fig. 3, pl. 3, figs. 35-38.

2010 *Globivalvulina cyprica* Reichel; Ueno et al., figs. 4.12, 5.30.

Description. Test ovoid, small-sized, with oblong chambers; wall typically bilayered with an inner pseudofibrous layer in the last chambers. D = 0.400-0.750 mm; w = 0.210-0.325 mm; w/D = 0.74-0.83; p = 0.020-0.030 mm; n = 1-1.5; h = 0.085-0.130 mm; s = 0.010- 0.020 (rarely 0.040) mm. The species generally attributed to *G. cyprica* in the Altiner's work (e.g., Altiner and Ozkan Altiner, 2010), is homeomorphous but its inner layer seems to be almost absent. Our specimens of Figure 8.1, 8.3, 8.5, 8.15, 8.18 might correspond to this latter taxon. The Iranian specimen of Jenny-Deshusses (1983, pl. 6, fig. 8) is also misinterpreted and more similar to *G. scaphoidea* Reitlinger, 1950. The specimens of Kobayashi (1988a, pl. 1, figs. 29-32, from Japan) and those of Lin et al. (1990, pl. 11, figs. 11-16, from South China) belong to the group *G. bulloides*. Our specimens have a typical test profile (especially, with the very high semi-last whorl). The wall is slightly and sporadically bilamellar. Subsequently to the description of Reichel (1946), this species has been rarely correctly identified in the literature (e.g., Nguyen Duc Tien, 1979, 1986a; Altiner and Ozkan Altiner, 2010).

Occurrence. Murgabian/Midian of Cyprus. Midian of Turkey, Italy, Iran, Cambodgia, Sumatra, Malaysia; type Wuchiapingian of South China (Isozaki and Vachard, unpublished data); Lopingian of Yunnan. Our specimens have been encountered in the Murgabian of Maku (P2, P3, P9, P14?, P16, P17, P20, P23 and P25).

Globivalvulina graeca Reichel, 1946
Figures 8.19 (bottom), 8.23-8.26, 9.5, 9.7, 9.11-9.14, 10.8-10.10, 11.3-11.4

1946 *Globivalvulina graeca* Reichel, p. 550-553, text-figs. 36, 38, pl. 19, figs. 15-17.

?1981 *Globivalvulina* sp.; Okimura and Ishii, pl. 2, fig. 17.

1990 *Globivalvulina graeca* Reichel; Lin et al., p. 163, pl. 11, figs. 17-21 (with synonymy).

v. 2005 *Globivalvulina graeca* Reichel; Vachard et al., p. 151, 153, pl. 3.1, 3.13? (with synonymy).

2010 *Globivalvulina graeca* Reichel; Angiolini et al., fig. 4.8-9.

Description. Test relatively large (diagnosis: D = 0.700-0.800 mm), subglobular, slightly depressed on the apertural face. Wall bilayered with an inner pseudofibrous layer present in the majority of chambers. As obvious in our specimens (e.g., in Figures 8.23, 8.26), the thickness and development of the inner layer is variable and seems exclude the creation of a subgenus for the *Globivalvulina* with an inconsistent inner layer, contrary to other foraminiferal genera as among the Palaeotextulariidae for example, where this inner layer is present in all chambers. The parameters of our specimens are: D = 0.625-0.800 mm; w = 0.550-0.640 mm; w/D = 0.71-0.91; p = 0.020-0.060 mm; n = 1.5; h = 0.200-0.250 mm; s = 0.010-0.045 mm.

Occurrence. Rare in late Early Permian (e.g., Artinskian of Slovenia (Kochansky-Devidé, 1970), Armenia (Akopian, 1974) and South China (Lin et al., 1990)). Common in Middle Permian and widespread in all the Palaeo-Tethys and Neo-Tethys: Greece, Italy, Austria, Tunisia, Hungary, Slovenia, Croatia, Montenegro, Turkey, Armenia, Iran (e.g., Kuh-e Jamal: Jenny-Deshusses, 1983b, pl. 6, fig. 1), Saudi Arabia, Afghanistan, Himalaya, Thailand, Malaysia, Cambodgia and South China. Rare in other Middle Permian ocean shelves, seamounts or insular microplates: New Zealand, Japan, and Greenland. Murgabian, Midian and Djulfian of Maku (P1, P2, P3, P4, P6, P7, P8 (relatively common), P10, P11, P12, P14, P15, P16, P17, P18, P19, P20, P21, P23, P25, P27, P30, P32, P34, P35(2), P36, P41, P52 and P54).

Globivalvulina vonderschmitti Reichel, 1946
Figures 9.15-17, 10.13-14, 10.22

1946 *Globivalvulina vonderschmitti* Reichel, p. 556, figs. 37a-e.

1997 *Globivalvulina vonderschmitti* Reichel; Kobayashi, pl. 4, figs. 1-5.

2004 *Globivalvulina vonderschmitti* Reichel; Kobayashi, fig. 6.51.

v. 2005 *Globivalvulina vonderschmitti* Reichel; Vachard et al., p. 153, 154, pl. 3.2 (with synonymy).

v. 2005 *Globivalvulina vonderschmitti* Reichel; Hughes, pl. 2, figs. 17-20.

2009 *Globivalvulina vonderschmitti* Reichel; Song et al., fig. 8.20-22.

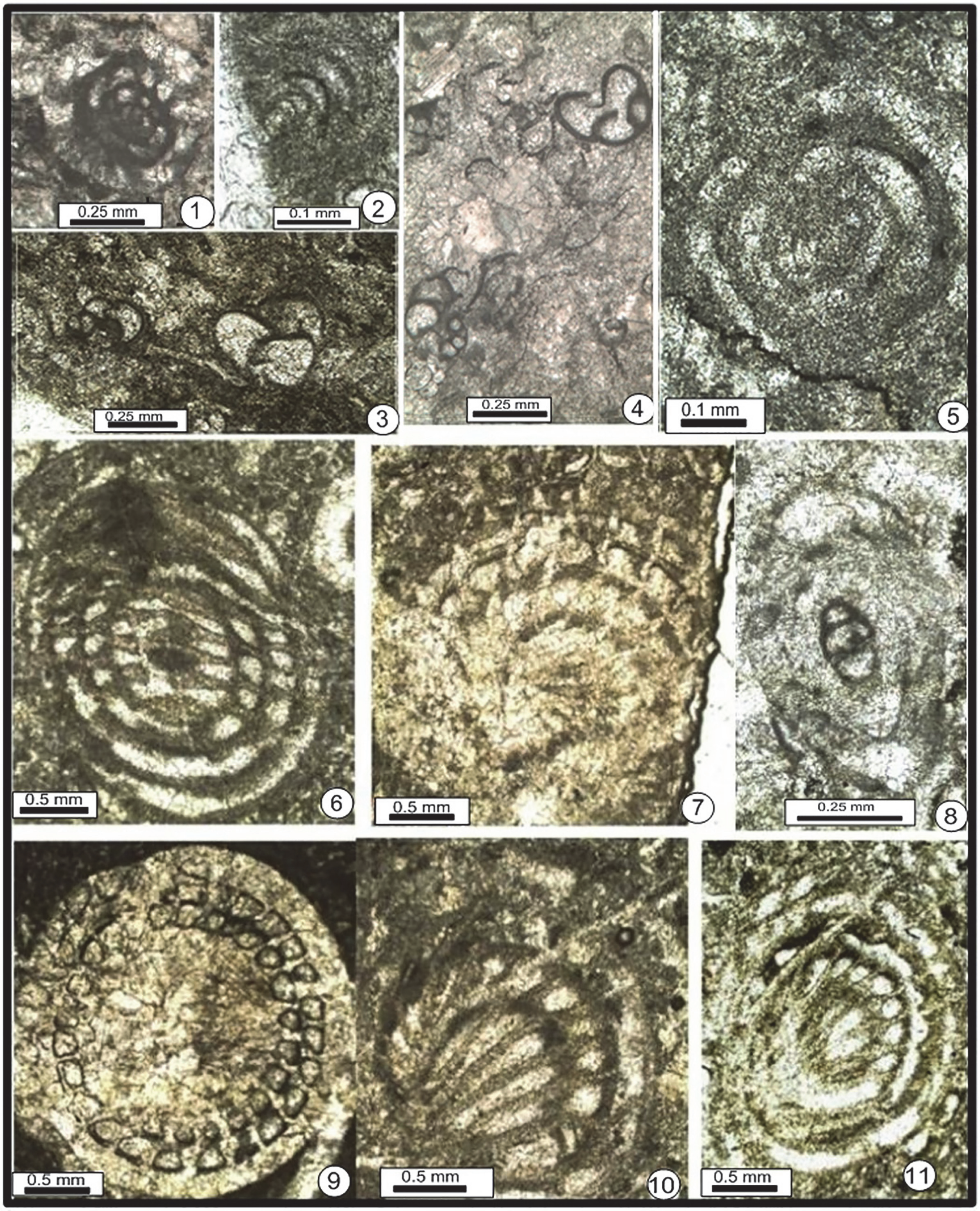

FIGURE 11. 1-2, 5. *Sphaerulina* sp. 1. 1. Subtransverse section. P2. Murgabian. 2. Axial section. P11-21. Murgabian 5. Axial section. P11-30. Murgabian. 3-4. *Globivalvulina graeca* Reichel, 1946. 3. Subaxial section (right) with *Globivalvulina bulloides* (left). P1-6. Murgabian. 4. Transverse section (bottom right) and subaxial section (top left). P22. Murgabian. 6-7, 10-11. *Sphaerulina* cf. *zisongzhengensis* Sheng, 1963. 6. Subaxial section. P11-21. Murgabian 7. Subtransverse section. P11-4. Murgabian. 10. Subtransverse section. P11-19. Murgabian 11. Subtransverse section. P1-25. Murgabian. 8. *Nankinella* sp. 2. Subaxial section with different stages of neosparitization. P6-61. Murgabian. 9. *Sphaerulina* sp. 3. Transverse section entirely microsparitized. P27-51. Murgabian.

2009 *Globivalvulina vonderschmitti* Reichel; Ueno and Tsutsumi, fig. 9.22.

2010 *Globivalvulina gigantea* Filimonova, p. 804, 806, pl. 15, figs. 21-22.

? 2010 *Globivalvulina vonderschmitti* Reichel; Ueno et al., fig. 5.25.

Description. Large species (D of type material = 0.930-1.040 mm), subglobular with chambers increasing very rapidly in size, and a thick, well developed, bilayered wall. Similarly, our material is smaller that the typical specimens. D = 0.850-0.950 mm; w = 0.680-0.800 mm; w/D = 0.76-0.80; p = 0.040-0.065 mm; h = 0.240-0.300 mm; s = 0.020-0.030 mm.

Remarks. As for *G. graeca* (see above), the thickness and development of the inner layer is variable and relatively inconsistent (e.g., in Figures 10.14n 10.22). Theoretically, the specimens of *G. gigantea* Filimonova, 2010 differ by "their greater size and wall structure," but the wall microstructure is identical, and the diameter of *G. vonderschmitti* measures 0.930-1.040 mm and that of *G. gigantea*, 0.900-1.550 mm. Consequently, we suggest that these species are synonymous. Moreover, a part of the type material of *G. gigantea* comes from Armenia where *G. vonderschmitti* has been already mentioned by Kotlyar et al. (1989, pl. 2, fig. 27). In North America, *G. guadalupensis* Nestell and Nestell, 2006 (= *G.* ex gr. *vonderschmitti* sensu Vachard et al., 1993c, pl. 8, figs. 2-3) might be a vicariant species.

Occurrence. Early Middle (Kubergandian)-Late Permian (Changhsinghian); widespread in all the Palaeo-Tethys and Neo-Tethys (Greece, Italy, Austria, Tunisia, Hungary, Slovenia, Croatia, Montenegro, Turkey, Saudi Arabia, Oman, Armenia, Iran (e.g., Bozorgnia, 1973, pl. 41, fig. 5; Lys et al., 1978, pl. 7, fig. 19; Partoazar, 1995, pl. 7, fig. 1), Afghanistan, Tajikistan, Himalaya, Pakistan, Sumatra, Thailand, Malaysia, Cambodgia and South China. Rare in Japan (Kobayashi, 1986, pl. 3, figs. 1-3; 1997, pl. 4, figs. 6-7). Rare specimens have been found in Murgabian- Djulfian of Maku (P6, P7, P8, P10?, P11, P16, P17, P20, P27, P29?, P34 and P43).

Globivalvulina? sp.
Figure 10.17-10.21

Description. Our material shows rare small, questionable *Globivalvulina* (D = 0.170-0.250 mm), which begin to present triangular chambers, especially conspicuous in cross sections. These specimens might be the distant ancestors of the genus *Paradagmarita* and, in this case, might confirm the phylogenies proposed by Gaillot and Vachard (2007). However, other filiations were suggested, passing from *Dagmarita* to *Paradagmarita* (see Altiner, 1997 and Altiner and Özkan Altiner, 2010). Therefore, the independence of both subfamilies: Dagmaritinae and Paradagmaritinae, although admitted by us, is a debatable subject (D. Altiner, pers. comm., october 2013).

Occurrence. Murgabian of Maku (P3?, P11?, P14, P22, and P25).

Genus CHARLIELLA Altiner and Özkan-Altiner, 2001

Type species. *Charliella rossae* Altiner and Özkan-Altiner, 2001.

Description. *Charliella* is another variation on the globivalvulinid theme, characterized by a four-layered wall and triangular chambers. It constitutes the most advanced genus of the globivalvulinins sensu stricto.

Occurrence. Midian of Palaeo-Tethys and Neo-Tethys. Guadalupian of northern Mexico and Texas (USA). Djulfian of Zagros and Fars (Iran) and Abu Dhabi (see Gaillot and Vachard, 2007). Wuchiapingian of Yunnan (Ueno et al., 2010). ?Changhsingian of southern Tibet (Wang et al., 2010). ?Lopingian of Japan (Kobayashi, 2013, fig. 7.17?-7.18)

Charliella? sp. 1
Figure 10.23

?p. 1995 *Paraglobivalvulina mira* Reitlinger; Partoazar, pl. 1(1), fig. 7 only (no fig. 6 = true *Paraglobivalvulina mira*).

Description. This atypical *Charliella*, globular, large-sized, with first chambers closely coiled, and a rapid increasing of the high of the semi-last whorl. First chambers triangular but the last ones appear similar to the last chambers of *Globivalvulina vonderschmitti*. Therefore, *Charliella*? sp. 1 appears perfectly transitional between *Globivalvulina vonderschmitti* and *Charliella rossae*. As an ancestral character, the chambers remain relatively globular and are not really triangular, and the differentiation of the wall is less complex. D = 0.720-0.895 mm; w = 0.500-0.700 mm; w/D = 0.70-0.88; number of whorls: 1.5; h = 0.250-0.270 mm; number of chambers: 7 pairs; s = 0.030-0.080 mm.

Comparison. Similar to *Globivalvulina vonderschmitti* by the very large size and the shape of last chambers but differing a lot by the wall structure. The new species is larger than *C. rossae* and *C. altineri* Gaillot and Vachard, 2007, the two known species of the genus.

Occurrence. Murgabian of Maku (P10, P16, P20 and P34).

Subfamily PARAGLOBIVALVULININAE Gaillot and Vachard, 2007

Remarks. We include in the subfamily the genera *Labioglobivalvulina*, *Septoglobivalvulina* and *Retroseptellina*, due to their trend to form spherical tests.

Genus LABIOGLOBIVALVULINA Gaillot and Vachard, 2007

Type species. *Labioglobivalvulina baudi* Gaillot and Vachard, 2007.
Description. *Labioglobivalvulina* is similar to *Septoglobivalvulina* but less globular and with a different aperture in elongate slit at the base of the chamber and not simple, more or less basal or areal in *Septoglobivalvulina* as in *Globivalvulina*.
Occurrence. Late Midian-Lopingian Palaeo-Tethys and Neo-Tethys. Discovered in the Murgabian of Maku.

Labioglobivalvulina cf. *baudi* Gaillot and Vachard, 2007
Figures 8.16, 9.17, 15.14

v. 2007 *Labioglobivalvulina baudi* Gaillot and Vachard, p. 54-55, pl. 4, figs. 2, 7?, 8-9, 11, pl. 12, figs. 8-10, pl. 28, figs. 4, 6, 11, pl. 29, fig. 20, pl. 31, fig. 8?, pl. 35, fig. 13 (with synonymy).

Description. Our specimens differ a little from typical *L. baudi*, by their relatively more globular shape. Moreover, they are Murgabian in age, although *L. baudi* was originally only encountered from latest Midian to Dorashamian and considered as especially characteristic of the Djulfian in Zagros and Fars regions in Iran (Gaillot and Vachard, 2007, p. 55). Consequently, (a) the importance of this taxon is lesser than that indicated by these authors; (b) *Labioglobivalvulina* might be also a junior synonym of *Septoglobivalvulina*.
Occurrence. Murgabian of Maku (P17 and P22).

Genus SEPTOGLOBIVALVULINA Lin, 1978 emend. Gaillot and Vachard, 2007

Type species. *Septoglobivalvulina guangxiensis* Lin, 1978.
Synonyms. *Globivalvulina* (part.); *Paraglobivalvulina* (part.).
Description. Globivalvulinin test with few whorls and few chambers with the last chamber increasing rapidly in height and width and often embracing partially or totally the preceeding chambers. Endoskeleton in the advanced species under the form of an incurved oral tongue. Wall microgranular unilayered. Aperture terminal simple.
Composition. *Septoglobivalvulina guangxiensis* Lin, 1978 (D = 0.820-0.920 mm); *S. similis* Lin, Li and Sun, 1990 (D = 0.740-0.870 mm); *Globivalvulina distensa* Wang in Zhao et al., 1981; *G. globosa* sensu Vachard et al., 2002 (probably a new species) non sensu Wang in Zhao et al., 1981 (= *Retroseptellina*).
Comparison. This genus differs (1) from *Globivalvulina* (see above) by the increasing in height and width of the last chamber becoming enveloping of the preceding coiled chambers; (2) from *Retroseptellina* (see below) by the shape of the septa plane and not curved backward, and the more marked increasing in height of the last chamber whereas the last chambers of *Retroseptellina* are wider; and (3) from *Paraglobivalvulina* Reitlinger, 1965 by the less spherical shape, the thin wall and the more rudimentary endoskeleton.
Occurrence. Early?-late Midian to Changhsingian: Oman, South China, ?Armenia, Turkey (Hazro), Iran (Zagros, Fars) and UAE (United Arabian Emirates).

Septoglobivalvulina distensa (Wang in Zhao et al., 1981)
Figures 9.8, 10.14

1981 *Globivalvulina distensa* Wang in Zhao et al., p. 48 (in Chinese), 75 (in English), pl. 2, figs. 1-3.

1985 *Globivalvulina* sp. of *G. vonderschmitti* group; Okimura et al., pl. 1, fig. 10.

1988a *Paraglobivalvulina*? sp.; Pronina, pl. 2, figs. 8-9.

1990 *Globivalvulina laxa* Lin, Li and Sun, p. 163-164, pl. 11, fig. 36 only (non figs. 35, 37-38 = globivalvulinid indet.).

2005 *Paraglobivalvulina globulosa* (sic, probably: *globosa* Wang); Hughes, pl. 2, figs. 22-23 (non fig. 21 = ?*S. guangxiensis*).

v. 2006 *Septoglobivalvulina distensa* (Wang in Zhao et al.); Gaillot, p.71, pl. I.4, fig. 5, pl. I.5, fig. 15, pl. I.7, fig. 12, pl. I.17, fig. 12, pl. I.37, fig. 9, pl. I.43, fig. 15, pl. II.8, figs. 1, 5, pl. II.9, fig. 1, pl. II.31, fig. 4, pl. III.6, fig. 5, pl. III.15, fig. 14?, pl. III.16, fig. 5, pl. VI. 4, figs. 10-11, 16, pl. VI.5, fig. 18, pl. VI.6, fig. 21, pl. VII.2, figs. 2.

v. 2007 *Septoglobivalvulina distensa* (Wang in Zhao et al.); Gaillot and Vachard, p.

59-60, pl. 1, fig. 5, pl. 3, fig. 12, pl. 4, fig. 15, pl. 5, pl. 14?, pl. 7, fig. 5, pl. 12, fig. 18, pl. 15, fig. 12, pl. 17, fig. 5, pl. 27, fig. 4, pl. 28, fig. 15, pl. 29, figs. 10-11, 16, pl. 31, fig. 9, pl. 36, fig. 1, pl. 37, fig. 2, pl. 40, figs. 1, 5.

2011 *Paraglobivalvulina*; Song et al., fig. 6.29.

Description. Diameter = 0.500-1.000 mm; width = 0.960 mm; w/D = 0.96; number of volution: 1; number of chambers: 3-4; proloculus diameter = 0.060-0.160 mm; height of last chamber = 0.235-0.600 mm (i.e., more than the half total diameter, generally 53%); wall thickness = 0.015-0.030 mm.

Comparison. Typical *S. distensa* are a little smaller (D = 0.500-0.700 mm) and the last chamber occupies only one-third of the total diameter, but these variations are probably intraspecific. The specimens of Pronina (1988a, pl. 2, figs. 8-9) might be immature *S. distensa.*

Occurrence. Early?-late Midian to Changhsingian: Oman, South China, Turkey (Hazro), Iran (Zagros) (Gaillot, 2006). Late Changhsingian of South China and ?Armenia. Murgabian of Maku (P3, P5, P8, P10, P11, P14, P19, P20, P21, P22, and P27).

Genus RETROSEPTELLINA Gaillot and Vachard, 2007

Type species. *Globivalvulina decrouezae* Köylüoglu and Altiner, 1989.

Synonyms. *Globivalvulina* (part.); *Septoglobivalvulina*? sensu Vachard et al., 2005; *Septoglobivalvulina* (part.); *Paraglobivalvulina* (part.).

Description. Coiling similar to *Globivalvulina*, but with a more globular test and more depressed chambers, few whorls and few chambers per whorl, and a tendency of the increasing of the width of the chambers during the growth whereas their height is relatively constant. Septa strongly curved backward. Wall unilayered, thin and microgranular.

Composition. *Globivalvulina globosa* Wang in Zhao et al., 1981; *G. decrouzae* Köylüoglu and Altiner, 1989; *Paraglobivalvulina nitida* Lin, Li and Sun, 1990.

Discussion. The strong curvature of the septa backward generates a space announcing probably the additional chamberlets of *Paraglobivalvulina* Reitlinger, 1965 and *Paraglobivalvulinoides* Zaninetti and Jenny-Deshusses, 1985. By this character, *Retroseptellina* is transitional between the Globivalvulininae and the Paraglobivalvulininae.

Occurrence. Questionable in "early Murgabian" of Thailand (Ueno and Sakagami, 1993; in our opinion, these levels are Midian in age). Murgabian, Djulfian, Dorashamian of southern Turkey (e.g., Canuti et al., 1970 updated by Gaillot, 2006; Koylüoglu and Altiner, 1989; Unal et al., 2003); Thailand and Malaysia (Yanagida et al., 1988; Fontaine et al., 1993, 1994). Midian of Oman (Vachard et al., 2002). Latest Midian-earliest Djulfian of Armenia (Kotlyar et al., 1989). Midian of New Zealand (Vachard and Ferrière, 1991). Midian of central Japan (Kobayashi, 2006b). Dorashamian of Greece (Altiner and Özkan-Altiner, 1998; Baud et al., 1991; Grant et al., 1991). Wuchiapingian-Changhsingian of South China (Lin et al., 1990; Zhang and Hong, 2004). Wuchiapingian of northern Italy and Iran (Mohtat-Aghai and Vachard, 2005) Wuchiapingian of Yunnan (Ueno et al., 2010). Duhaysan Member (late Djulfian) of Saudi Arabia (Vachard et al., 2005). Changhsingian of NW Caucasus (Pronina-Nestell and Nestell, 2001). Changhsingian of Hungary (Théry et al., 2007) and southern Tibet (Wang et al., 2010). Lopingian of Japan (Kobayashi, 2013). Maku (P17, P27 and P54).

Retroseptellina aff. *nitida* (Lin, Li and Sun, 1990)
Figure 10.16

1983b *Globivalvulina vonderschmitti* Reichel; Jenny-Deshusses, pl. 22, fig. 1.

?1990 *Paraglobivalvulina nitida* Lin, Li and Sun, p. 166, pl. 12, figs. 20-21.

1995 *Paraglobivalvulina* aff. *mira* Reitlinger; Partoazar, pl.1(3), fig. 6.

p. 2004 *Globivalvulina globosa* Wang; Zhang and Hong, p. 21, pl. 1, figs. 25-26 (only, no fig. 4 = true *Retroseptellina globosa*).

?p. 2010 *Retroseptellina nitida* (Lin, Li and Sun); Wang et al., fig. 4. 25-26.

Description. Test medium sized, globular with semi-evolute last whorl. Proloculus not observed. The first whorl is similar to that of *R. nitida*, but the last one is deviated. The two last pairs of chambers are relatively equal and give a typical quadripartite aspect to the axial section. The valvular projection is high and curved. The septa are strongly curved backward. The wall is simple, thin, dark, microgranular. The aperture is an elongate slit at the base of the last chamber. H = 0. 500-0.620 mm; w = 0.240-0.255 mm; n: 1.5 whorl; h = 0.100-0.260 mm; s = 0.005-0.010 mm.

Comparison. Typical *R. nitida* is larger for the same number of whorls and its profile is more globular. "*Paraglobivalvulina*" *globosa* sensu Pronina-

Nestell and Nestell, 2001 (pl. 5, figs. 2-3) is probably synonym of these typical *Rectoseptellina nitida*.
Òccurrence. Djulfian of Maku (Northwest Iran). The specimen illustrated by Jenny-Deshusses (1983) comes from the sample Nesen 42 from Alborz (northern Iran); the sample of Partoazar (1995) comes also from the Nesen Fm of central Alborz. Changhsingian of Fujian (South China).

Genus PARAGLOBIVALVULINA Reitlinger, 1965

Type species. *Paraglobivalvulina mira* Reitlinger, 1965.
Description. Medium-sized paraglobivalvulinins whose last whorls embraces completely the preceeding whorls. Additional interseptal stolons are present. Wall microgranular relatively thick but undifferentiated.
Remarks. Many "*Paraglobivalvulina*" of the literature (see for example, Kobayashi, 1997, pl. 4, figs. 1-5; Song et al., 2009, fig. 9.8-10) belong in reality to *Paraglobivalvulinoides*, a genus typical of the late Changhsingian.
Occurrence. Midian-Lopingian of Armenia, Turkey, Zagros, Fars, Alborz (Iran), NW Caucasus, Carnic Alps, Hungary, South China, Phillipines, ?Cyprus, Salt Range, Japan, and Thailand (Gaillot and Vachard, 2007).

Paraglobivalvulina mira Reitlinger, 1965
Figures 9.10, 10.11, 10.24

1965 *Paraglobivalvulina mira* Reitlinger, p. 65, pl. 1, figs. 13-14.

p. 1995 *Paraglobivalvulina mira* Reitlinger; Partoazar, pl. 1(1), fig. 6 (non fig. 7 = ?*Charliella*? sp. 1), pl. 2(3), fig. 2.

1995 *Paraglobivalvulina* sp.; Partoazar, pl. 1(1), fig. 11.

2004 *Paraglobivalvulina mira* Reitlinger; Jenny et al., pl. 8, fig. 5.

v. 2006 *Paraglobivalvulina mira* Reitlinger; Insalaco et al., pl. 2, fig. 6.

v. 2007 *Paraglobivalvulina mira* Reitlinger; Gaillot and Vachard, p. 60-61, pl. 1, fig. 4, pl. 8, fig. 6, pl. 17, figs. 18-19, pl. 18, fig. 2, pl. 32, figs. 3-5, 18-20, pl. 34, figs. 8, 11-12, pl. 36, figs. 7-10, pl. 39, figs. 4-8 (with synonymy).

2010 *Paraglobivalvulina* sp.; Wang et al., fig. 4.18.

2010 *Paraglobivalvulina* aff. *mira* Reitlinger; Angiolini et al., fig. 4.10.

?2010 *Urushtenella* sp.; Wang et al., fig. 3.22.

Remark. All our specimens are broken; therefore, their measurements are a little smaller than those of the type material: D = 0.690-0.750 mm; w = 0.550-0.625 mm; w/D = 0.75-0.85; s = 0.025-0.040 mm. Some are questionably assigned to the species (P25, P50; Figure 10.24). Others have an initial part occasionally well-preserved (Figure 10.11).
Occurrence. Midian-Lopingian of Palaeo-Tethys and Neo-Tethys. Sporadic but common in samples P41 and P50 of Maku (Iran).

Subfamily DAGMARITINAE Bozorgnia, 1973 nom. translat. and emend. Gaillot and Vachard, 2007

Synonyms. Biseriamminidae Chernysheva, 1941 (pars); Globivalvulinidae Reitlinger, 1950 (pars); Louisettitinae Loeblich and Tappan, 1984; Louisettitidae nom. translat. Rauzer-Chernousova et al., 1996; dagmaritin-type biseriamminids sensu Altiner (1997, text-fig. 1 p. 3).
Description. Globivalvulinidae uncoiled biseriate (or exceptionally biserially coiled). Undivided or divided chambers, often with horn-like lateral expansions. Aperture basal simple with a valvula.
Composition. *Dagmarita* Reitlinger, 1965; *Sengoerina* Altiner, 1999; *Crescentia* Ciarapica, Cirilli, Martini and Zaninetti, 1986; *Labiodagmarita* Gaillot and Vachard, 2007; *Bidagmarita* Gaillot et al., 2009; *Louisettita* Altiner and Brönnimann, 1980; *Danielita* Altiner and Özkan Altiner, 2010.
Remarks. This subfamily corresponds to the lineage of *Dagmarita*, from the ancestor (Murgabian) *Sengoerina* to the last avatar (Changhsingian) *Louisettita*. This evolution is remarkably homogeneous from the loss of the coiling to the emergence of an endoskeleton; hence, the addition of taxa like Louisettitinae or Louisettitidae, as suggested by Loeblich and Tappan (1984, 1987), does not make sense. *Sengoerina* is transitional between *Globivalvulina cyprica* and *Dagmarita* according to the phylogeny reconstructed by Altiner (1997). *Crescentia* may be considered as a return to planispiral coilings. The group of *Paradagmarita* constitutes a second derivation from *G. cyprica*; that of the Paradagmaritinae.
Occurrence. Murgabian to latest Changhsingian; Palaeo-Tethyan and Neo-Tethyan.

Genus DAGMARITA Reitlinger, 1965

Type species. *Dagmarita chanakchiensis* Reitlinger, 1965.
Description. Test entirely biseriate (excepted maybe the three initial chambers more or less globivalvulinid in shape). Spines ("horny-like expansions") developed on the upper outer lateral side of the chambers. Oral tongue located at the distal

extremity of septum. Wall single microgranular mono-, double- or trilayered. Aperture terminal basal.

Occurrence. Early Murgabian (Vachard, 1980) and/or early Maokouan (Lin et al., 1990) to latest Changhsingian (Zhao et al., 1981; Lin et al., 1990) of Palaeo-Tethys and Neo-Tethys: Italy, Montenegro, the Carnic Alps, Hungary, western Turkey, eastern Taurus, Hazro, Armenia, central Alborz (Bozorgnia, 1973; Jenny-Deshusses, 1983); central Iran (Mohtat-Aghai and Vachard, 2003); Lopingian of Zagros and Fars (Gaillot, 2006); central Afghanistan, Salt Range (Pakistan), Ladakh (Himalaya), South China, West Thailand, northwestern Thailand, Malaysia, Philippines, Cambodgia, Primorye and Japan.

Dagmarita aff. *elegans* Sosnina in Sosnina and Nikitina, 1977
Figure 12.1-6

1977 *Dagmarita elegans* Sosnina in Sosnina and Nikitina, p. 50, pl. 2, fig. 8.

Remarks. As in Afghanistan, these *Dagmarita* correspond probably to the oldest representatives of this genus whose FAD can be definitively emplaced in the early Murgabian. Their wall is monolayered, dark and microgranular.

Occurrence. Rare small specimens have been observed in the Murgabian of Maku (P3, P6, P10, P11, P14, P18, P19, P20, P23, and P25).

Dagmarita altilis Wang in Zhao et al., 1981
Figure 12.9

1981 *Dagmarita altilis* Wang in Zhao et al., p. 47, 74, pl. 1, fig. 21.

1988a *Dagmarita altilis* Wang in Zhao et al.; Pronina, pl. 2, figs. 10-11.

1989 *Dagmarita altilis* Wang in Zhao et al.; Pronina in Kotlyar et al., pl. 1, figs. 10-11.

1990 *Dagmarita altilis* Wang in Zhao et al.; Lin et al., p. 122, pl. 2, fig. 20-22.

v. 2006 *Dagmarita altilis* Wang in Zhao et al.; Insalaco et al., p. 122, pl. 2, fig. 2.

v. 2007 *Dagmarita altilis* Wang in Zhao et al.; Gaillot and Vachard, p. 65-66, pl. 1, figs. 10-11, pl. 5, figs. 3, 8, 17, pl. 15, fig. 15, pl. 17, figs. 1, 8, pl. 27, figs. 5, 9, pl. 34, fig. 10, pl. 37, fig. 19, pl. 38, fig. 14?, pl. 45, fig. 1, pl. 47, figs. 12-13 (with synonymy).

Description. There are only four specimens perfectly typical of this Chinese species re-analyzed in Gaillot and Vachard (2007), the wall of which is also microgranular.

Occurrence. Murgabian-Lopingian of South China. Lopingian of Zagros, Fars, Turkey and Abu Dhabi. Changhsingian of Armenia. Murgabian-Midian of Maku (P17, P27, P34 and P41).

Dagmarita? *shahrezaensis* Mohtat-Aghai and Vachard, 2003
Figure 12.7-12.8

v. 2003 *Dagmarita shahrezaensis* Mohtat-Aghai and Vachard, p. 38-40, pl. 1, figs. 1-13, 14? (with synonymy).

v. 2005 *Dagmarita shahrezaensis* Mohtat-Aghai and Vachard; Mohtat-Aghai and Vachard, pl. 2, figs. 21-22, pl. 3, fig. 5.

v. 2007 *Dagmarita*? *shahrezaensis* Mohtat-Aghai and Vachard; Gaillot and Vachard, p. 66, pl. 12, figs. 1, 19, pl. 31, fig. 16, pl. 35, fig. 9, pl. 37, fig. 18? (with synonymy).

Description. This atypical *Dagmarita* is devoid of horny protuberances. It might represent another ancestor candidate of *Paradagmarita*.

Occurrence. Late Midian-Changhsingian of Zagros and Taurus. Late Wuchiapingian-?Changhsingian of central Iran, Himalaya, Armenia, South China and Malaysia. Questionable in early Changsinghian of Saudi Arabia and late Changhsingian of Primorye. Murgabian-Midian of Maku (P25, P40 and P41).

Subfamily PARADAGMARITINAE Gaillot and Vachard, 2007

Description. A subfamily of Globivalvulinidae (i.e., with a biserially coiled growth and a microgranular wall, occasionally differentiated) characterized by an uncoiling more or less developed after an initial coiling generally slightly trochospiral.

Composition. *Paradagmarita* Lys in Lys and Marcoux, 1978; *Paradagmaritopsis* Gaillot and Vachard, 2007; *Paradagmaritella* Gaillot and Vachard, 2007; *Paradagmacrusta* Vachard and Gaillot, 2007; *Paremiratella* Gaillot and Vachard, 2007.

Discussion. According to Altiner and Özcan-Altiner (2010), the genera *Paradagmaritopsis*; *Paradagmaritella*; *Paremiratella* are not phylogenetically related to *Paradagmarita* and its ancestors. Nevertheless, we do not find, during our study, any new data in order to modify the assignments of Gaillot and Vachard (2007). Paradagmaritinae differ from Globivalvulininae by the terminal uncoiled part of the test; they differ from

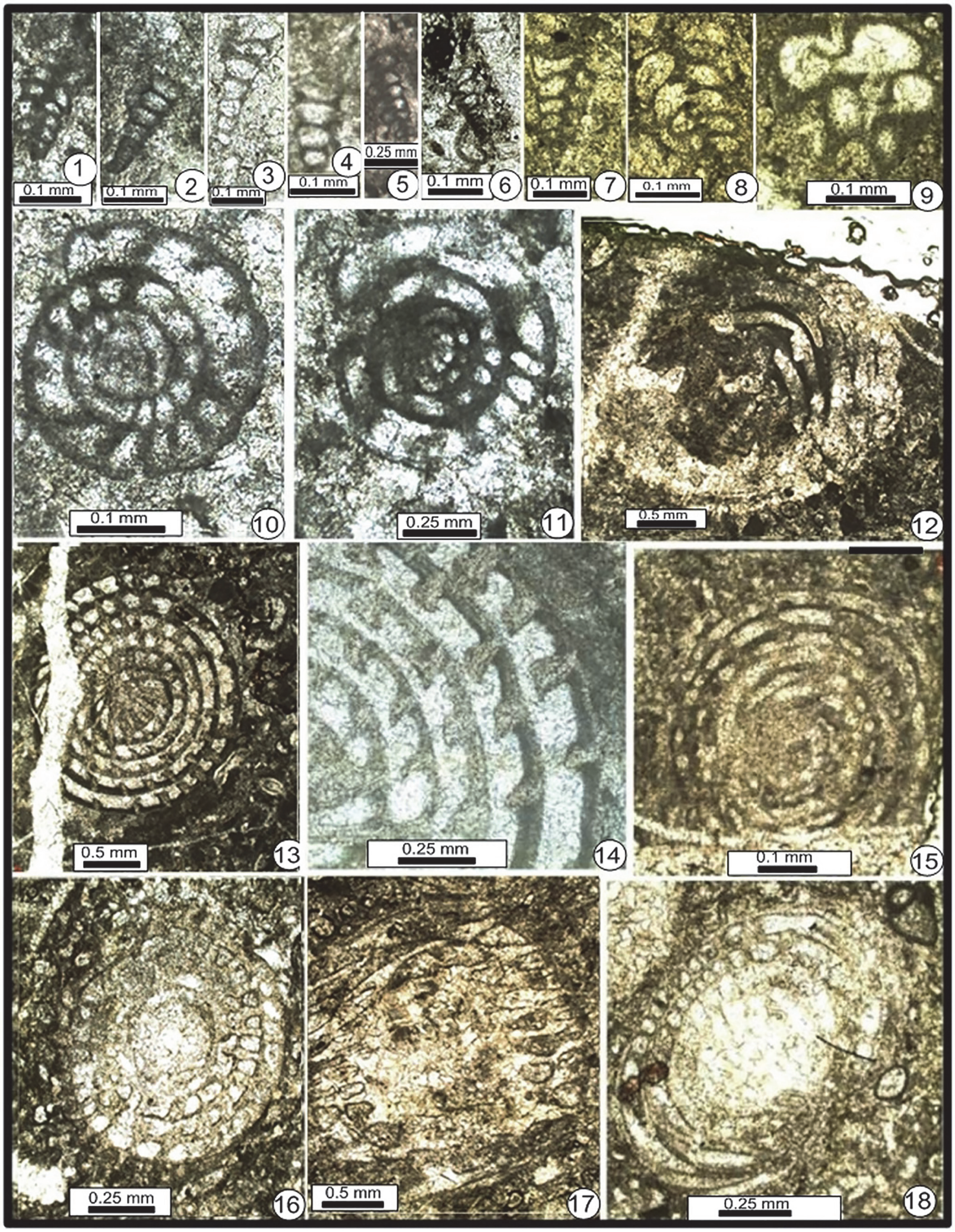

FIGURE 12. 1-6. *Dagmarita* aff. *elegans* Sosnina in Sosnina and Nikitina, 1977. 1. Axial section. P14-37. Murgabian. 2. Oblique section. P18-6. Murgabian. 3. Oblique section. P25-7. Murgabian. 4. Oblique section. P10-61. Murgabian. 5. Axial section. P2. Murgabian. 6. Subaxial section. P6-60. Murgabian. 7-8. *Dagmarita*? *sharezaensis* Mohtat-Aghai and Vachard, 2003. 7. Subaxial section. P40-56. Midian. 8. Axial section. P40-28. Late Midian. 9. *Dagmarita altilis* Wang in Zhao et al., 1981. Axial section. P41-78. Latest Midian. 10-11, 12?. *Sphaerulina* sp. 1. 10. Transverse section. P18-20. Murgabian. 11. Subtransverse section. P14-54. Murgabian. 12. Subaxial section with developed chomata. P14-3. Murgabian. 13-15. *Sphaerulina* cf. *zisongzhengensis* Sheng, 1963. 13. Subtransverse section. P32-1. Midian. 14. Detail of a transverse section showing the typical recrystallization of the wall. P32-20. Midian 15. Subaxial section. P11-8. Murgabian. 16-17, 18? *Sphaerulina* sp. 3. 16. Subtransverse section. P1-26. Murgabian. 17. Subaxial section. P6-47. Midian. 18? Oblique section. P16-52. Murgabian.

Dagmaritininae (= Louisettitinae) by the initial coiled part. No evidence of the phylogenic filiation between *Dagmarita* and *Paradagmarita* (as proposed by Altiner, 1997) has been observed in our material. A filiation from *Globivalvulina* seems to be more likely (see the specimens illustrated by Okimura et al., 1985, pl. 1, fig. 16, and Berczki-Makk et al., 1995, pl. 6, fig. 4), and eventually, those discovered in this study (Figure 10.19-10.20; see discussion above).

Occurrence. Lopingian, probably limited to the western Neo-Tethys (although questionably quoted from southern Italy to Thailand).

Genus PARADAGMARITA Lys in Lys and Marcoux, 1978 emend. Gaillot and Vachard, 2007

Type species. *Paradagmarita monodi* Lys in Lys and Marcoux, 1978.

Description. Small to medium-sized globivalvulinid paradagmaritin characterized by an early stage enrolled, biserial, involute, slightly trochospiral, and a later uncoiled, biserial stage, relatively long. Wall dark, microgranular, relatively thin, uni- or multilayered. Chambers inflated. Aperture simple, terminal, interio-marginal with a valvula.

Occurrence. Late Djulfian-Dorashamian. Palaeo-Tethyan and Neo-Tethyan, principally known in Turkey (Taurus), Iran (Zagros), Saudi Arabia (Vachard et al., 2005) and Armenia (Pronina-Nestell and Nestell, 2001), but mentioned (probably erroneously) from Italy to Japan (e.g., Jenny and Stampfli, 2000, p. 32). The *Paradagmarita* from Afghanistan described by Vachard (1980) are the westernmost representatives of this genus. Despite it seems likely that true *Paradagmarita* are present also in South China (Gaillot et al., 2009). The “*Paradagmarita*” from Thailand and Pakistan are very different and probably are derived from *Charliella*. The “*Paradagmarita*” from Japan (Kobayashi, 1997b, 2004) belong to *Paradagmaritopsis*, a genus also present in South China (Gaillot et al., 2009).

Paradagmarita? sp.
Figure 10.17-10.19

? 1985 *Paradagmarita* sp. of *P. monodi* group; Okimura et al., pl. 1, fig. 16 (the magnification indicated seems to be erroneous).

?p. 1988 *Globivalvulina* sp. 1; Pronina, pl. 2, fig. 6 (no fig. 5 = *Labioglobivalvulina baudi*).

? 1988 *Globivalvulina* sp. 2; Pronina, pl. 2, fig. 7.

Description. Test small, planispiral to trochospiral but the uncoiling of the test is not yet clearly marked. However, the aperture simple, terminal, interio-marginal with a valvula (V-shaped) is clearly recognisable. Wall dark, microgranular, trilayered with a clear intermediary layer. Chambers inflated. They differ from an ancestral globivalvuline by more triangular to quadrate chambers in transverse section and more angular chambers in axial section.

Dimensions. Height = 0.200-0.400 mm; width = 0.220-0.240 mm; ratio = 0.73; number of uncoiled chambers: 3-4 pairs; height of last chamber = 0.100-0.160 mm; wall thickness = 0.010-0.020 mm.

Occurrence. ?Changhsingian of Armenia. Lopingian of Zagros and Fars (southern Iran; Gaillot, 2006). Wuchiapingian of Hazro (Turkey). Djulfian of Maku (P40?, P50, and P51).

Subclass FUSULINANA Fursenko, 1958 nom. translat. Vachard et al., 2010
Order FUSULINIDA Wedekind, 1937
Superfamily STAFFELLOIDEA Miklukho-Maklay, 1949 nom. translat. Solovieva, 1978
Family STAFFELLIDAE Miklukho-Maklay, 1949
Genus SPHAERULINA Lee, 1933

Type species. *Sphaerulina crassispira* Lee, 1933.

Description. Test large, subspherical, planispiral, early whorls about the subspherical proloculus have short axis and lenticular test (like in *Nankinella*), later whorls with somewhat lengthened axis and spherical test or with slightly depressed umbilici (like in *Staffella*). Septa plane. Wall thick, probably originally aragonitic, microgranular, dark and finely perforate, often recrystallized in whitish granular microsparite. Single tunnel, chomata low and asymmetrical, sloping gently toward the poles.

Remarks. Although our specimens are abundant, we have observed few well-oriented sections. Moreover, the species described in the literature are very abundant and generally poorly discriminated. Consequently, we remain our specimens in open nomenclaure. Nevertheless, three groups of sections may be characterized, *Sphaerulina* sp. 1, *S*. cf. *zisongzhengensis* Sheng, 1963, and *S*. sp. 3, respectively.

Occurrence. Late Permian (Lopingian); South China; Yunnan; Japan; Uzbekistan (SE Pamir); NW Iran, Armenia, Turkey, Croatia, Carnic Alps and Italy.

Sphaerulina sp. 1
Figures 11.1-11.2, 11.5, 11.12?, 12.10-12.11, 12.12?

Description. Test relatively small for the genus, planispirally coiled, involute nautiloid, with a rounded periphery. Chomata usually faint to absent. The principal character of this staffellid is constituted by the wall microstructure, well-preserved, microgranular and dark. This taxon is possibly identical to *Sphaerulina iranensis* Kobayashi and Ishii, 2003 (see also Leven and Gorgij, 2011), or related to *S. croatica* (Kochansky-Devidé, 1965). An atypical specimen exhibits well-developed chomata (Figure 12.12). It corresponds eventually to another taxon.
Occurrence. Early Murgabian-Djulfian of Maku (P1, P6, P8, P9, P14, P16, P17, P18, P19, P20, P23, P25, P26, P30, P32, P34 and P48).

Sphaerulina cf. *zisongzhengensis* Sheng, 1963

Figures 11.6-11.7, 11.10-11.11, 12.13-12.15

1963 *Sphaerulina zisongzhengensis* Sheng, p. 153-154, pl. 2, figs. 6-7.

1967 *Staffella zisongzhengensis* (Sheng); Leven, p. 125-126, pl. 1, figs. 6-8.

2004 *Staffella zisongzhengensis* (Sheng); Jenny et al., pl. 7, fig. 5.

2012 *Sphaerulina zisongzhengensis* Sheng; Chang et al., pl. 2, fig. 1.

Description. Test relatively similar to *Staffella* but larger and almost spherical. The diameter is moderate to large. No chomata. The principal character of this species (well illustrated by Leven, 1967) is constituted by the wall microstructure: the original dark wall remains well-preserved, while the septa become microsparitized and, by constrast, appear whitish (see especially Figure 12.14).
Occurrence. Middle-Late Permian of South China, SE Pamir, Oman, Greece, Turkey and Murgabian-Djulfian of Maku (P11, P14, P15, P16, P34 and P55).

Sphaerulina sp. 3
Figures 11.9, 12.16-17, 12.18?

Description. Test spherical to ovoid. The diameter is moderate. The chomata are faint to absent. The wall is generally microsparitized but the microsparitization is generally not complete and do not affect the last whorls. *S. ogbinensis* Rozovskaya, 1965 is relatively similar to this taxon (see also *Staffella* sp. sensu Partoazar, 1995, pl. 3(1), fig. 9, and *Sphaerulina* cf. *ogbinensis* sensu Leven, 1997, p. 58, pl. 1, fig. 8). *S. ogbinensis* was described in the Midian of Armenia and is also known in the Midian of Oman and southern Afghanistan.
Occurrence. *S.* sp. 3 was rarely found in our Midian samples of Maku (?P32 and P37).

Genus NANKINELLA Lee, 1933

Type species. *Staffella discoides* Lee, 1933.
Description. Schwagerinidae lenticular, discoidal or rhomboidal up to 6 mm in diameter, poles rounded to umbilicate, early stage with angular to rounded periphery, later more angular, up to 14 whorls in the adult. Septa and walls typical of the family (see *Staffella*), median crescentic tunnel and distinct chomata. Wall probably originally aragonitic, microgranular, dark and finely perforate, often recrystallized in whitish granular microsparite.
Occurrence. Early Bashkirian to latest Permian (late Changhsingian); China; Japan; Russia (North Urals, Caucasus); Ukraine (Crimea); Armenia; Croatia; Turkey; Greece; Vietnam; North America.

Nankinella ex gr. *minor* Sheng, 1955
Figures 11.8, 13.1-4

1955 *Nankinella minor* Sheng, p. 291, pl. 1, fig. 7.

v. 2005 *Nankinella minor* Sheng; Mohtat-Aghai and Vachard, pl. 2, figs. 8-9.

2009 *Nankinella minor* Sheng; Song et al., fig. 9.6-7.

Description. Test relatively small for the genus, planispirally coiled, involute nautiloid, with rounded periphery. Chomata faint to absent. Wall generally well preserved, microgranular and dark.
Occurrence. Murgabian to Djulfian of Maku (P1, P3, P7, P9, P10, P12, P16, P17, P19 P20, P23, P24, P25, P27, P34, P39, P40, P44, P50 and P51).

Nankinella sp. 2
Figure 13.5?-13.6, 13.8

Description. Test moderate in size, weakly (Figure 13.8) to strongly recrystallized (Figure 11.6); occasionally slightly biumbilicate (Figure 13.6, 13.8). Our specimens resemble those illustrated by Zhang et al. (2010, p. 961-962, 965, 966, fig. 5-3-5; and 2012, p. 145, 146, fig. 4K-O) but relatively different of the type material of Sheng (1963, p. 32, 156-157, pl. 3, figs. 7-15).
Occurrence. Murgabian-Midian of Maku (P3, P6, P11, P17, P23, P34 and P40).

Nankinella sp. 3
Figure 13.7

Description. Test moderate to large. Strongly recrystallized, except or the central part of the test. Number of whorls relatively high: 8-9.5. The carina

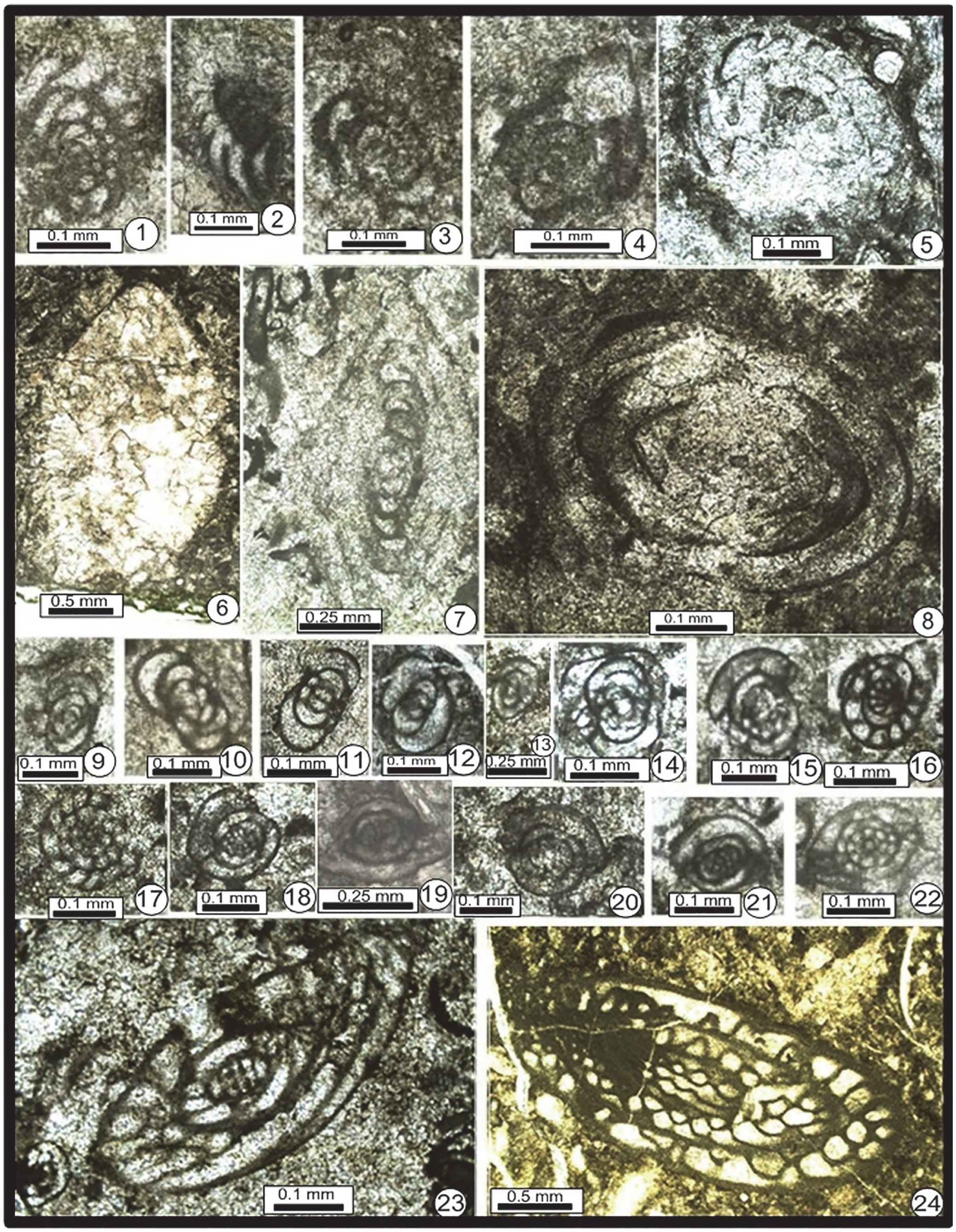

FIGURE 13. 1-4. *Nankinella* ex gr. *minor* Sheng, 1955.1. Subtransverse section. P10-6. Murgabian. 2. Oblique tranverse. P19-13. Murgabian. 3. Subaxial section. P17-34. Murgabian. 4. Subaxial section. P17-29. Murgabian. 5?-6, 8. *Nankinella* sp. 2. 5. Transverse oblique recrystallized section. P23-17. Murgabian. 6. Completely microsparitized section. P34-1. Midian. 8. Partially recrystallized axial section. P17-6. Murgabian. 7. *Nankinella* sp. 3. Axial section. P6-1. Murgabian. 9-12. *Grovesella*? *ciryi* Ebrahim Nejad and Vachard n. sp. 9. Paratype. Subaxial section. P17-30. Murgabian. 10. Holotype. Axial section. P10-8. Murgabian. 11. Paratype. Subaxial section. P22-11. Murgabian. 12. Paratype. Subaxial section with very enveloping last whorl. P34-16. Midian. 13-16. *Grovesella* sp. 13. Small axial section. P1-21. Murgabian. 14. Axial section. P14-24. Murgabian. 15. Subaxial section. P14-8. Murgabian. 16. Transverse section. P6-24. Murgabian. 7-22. *Schubertella* sp. 17. Transverse section. P22-19. Murgabian. 18. Axial section. P14-14. Murgabian. 19. Axial section. P2. Murgabian. 20. Axial section. P14-41. Murgabian. 21. Axial section. P2-21. Murgabian. 22. Axial section. P3-29. Murgabian. 23. *Dunbarula* aff. *pusilla* Skinner, 1969. Subaxial section. P30-12. Earliest Midian. 24. *Chusenella* sp. Subaxial section showing the septal folding. P41-54. Latest Midian.

is well developed, and, by this character, our material resembles *Nankinella acuta* Rui, 1979 (p. 283, pl. 1, figs. 9-10), but the other parameters are too different to permit an assignment to this latter species.

Occurrence. Murgabian of Maku (P3 and P6).

Superfamily SCHUBERTELLOIDEA Skinner, 1931 nom. translat. Vachard in Vachard et al., 1993a

Remark. This superfamily encompasses the shortly fusiform fusulinids displaying a wall composed of a tectum and a protheca, and their ancestors with microgranular walls.

Family SCHUBERTELLIDAE Skinner, 1931 nom. translat Miklukho-Maklay et al., 1958
Subfamily SCHUBERTELLINAE Skinner, 1931
Genus SCHUBERTELLA Staff and Wedekind, 1910 emend. Sheng, 1963

Type species. *Schubertella transitoria* Staff and Wedekind, 1910.

Description. See Shen (1963, p. 158).

Remarks. As *Schubertella* given rise to many lineages, many subgenera and/or genera might be created with the schubertellid ancestors, generally included in *Schubertella* sensu lato (a taxon which currently could include approximately 200 registered species). Apparently, the genera *Grovesella* Davydov and Arefifard, 2007 and *Praedunbarula* Vachard in Kolodka et al., 2012, both matched an attempt to individualize different trends in the genus *Schubertella*. However, Davydov and Arefifard (2013, p. 19) have written: “The morphology of the new genus *Praedunbarula*, in our opinion, is perfectly consistent with long-ranging *Schubertella*, indicating that the proposed age of the *Praedunbarula* Biozone is therefore questionable.” Consequently, we deduced that our “dialectic” interpretation of *Grovesella* was erroneous. Furthermore, in our opinion, the phylogenies of Leven (2010) and Davydov (2011) established principally in using *Grovesella* and *Zarodella* Sosnina, 1981, and only based on the test morphologies (often convergent among the primitive fusulinids), are totally opposed to the wall microstructure analyses. For instance, the Bashikirian taxa have a microgranular dark wall, other representatives of the proposed lineage have a schubertelloid wall (i.e., tectum plus protheca), whereas *Zarodella* has a recrystallized wall (characteristic of the staffelloids), and, finally, all are given as ancestors of *Pamirina* Leven, 1970, which is a primitive Neoschwagerinoidea (i.e., a taxon with a fine keriothecal wall). Therefore, in the phylogeny proposed by Leven (2010), are closely linked in the same lineage, all the microstructures of walls of the order Fusulinida, considered by us as suprafamiliar characters (and even as order characters by some Russiuan authors: see Rauzer-Chernousova et al., 1996). In conclusion, a revision of the taxa included in *Schubertella* sensu lato remains necessary, but it starts pretty bad.

Occurrence. Typical *Schubertella* are distributed globally in all the palaeotropical areas, from Moscovian to Wordian (Rauzer-Chernousova et al., 1951; Skinner and Wilde, 1966; Leven, 1998a, b). Bashkirian-early Moscovian forms, because of their dark microgranular wall, belong more probably to the genus *Schubertina* Marshall, 1969 emend. Davydov, 2011 (= *Eoschubertella* Thompson, 1937 of the authors, non Thompson, 1937), whereas typical representatives are distributed from late Moscovian to latest Permian.

Schubertella sp.
Figure 13.17-13.22

Description. Test small, up to about 1.500 mm in length, early stage discoidal, later stage with sharply changed axis of coiling and becoming fusiform with acute poles, septa numerous, unfluted, or with slight fluting at the poles of the outer whorls; wall composed of tectum and protheca, chomata low, asymmetrical and bordering a broad low tunnel.

Occurrence. Murgabian, Midian, and Djulfian of Maku (P2, P3, P14, P16, P19, P20, P21, P25, P26, P30, P39 and P52).

Genus GROVESELLA Davydov and Arefifard, 2007

Type species. *Grovesella tabasensis* Davydov and Arefifard, 2007.

Diagnosis of Davydov and Arefifard (2007, p. 6)**.** Test very small to moderate in size for this group of schubertellids discoidal to nautiloid or nearly globular, with broadly rounded periphery and weakly to mildly umbilicate flanks. Coiling skewed in initial one or two volutions or can be nearly straight. Length of the test is equal or less than width and consequently the means of form ratio is equal or less than one. Wall thin, poorly visible, most probably two layered with darker and thin tectum and slightly lighter, structureless primatheca. Chomata not observed in type species, but present in the Pennsylvanian representatives of the genus.

Composition (of Davydov and Arefifard (2007, p. 6))**.** *Grovesella mosquensis* (Rauzer-Chernousova in Rauzer-Chernousova et al., 1951); *Grovesella compressa* (Rauzer-Chernousova in Rauzer-Chernousova et al., 1951); *Grovesella miranda* (Leontovich in Rauzer-Chernousova et al., 1951); *Grovesella globulosa* (Safonova in Rauzer-Chernousova et al., 1951); *Grovesella pseudoglobulosa* (Safonova in Rauzer-Chernousova et al., 1951); *Grovesella borealis* (Rauzer-Chernousova in Rauzer-Chernousova et al., 1951).

Remarks. In reality, it is clear that the original diagnosis includes all the small, nautiloid to nearly globular schubertellids with a form ratio equal to, or less than 1.0. The primatheca mentioned in this diagnosis is probably a synonym of protheca used in our descriptions. Therefore, *Grovesella* has typically a schubertelloid wall, but it is not the case of the group initially named *Schubertella mosquensis*. All the authors admitted that this latter form is transitional between the Ozawainelloidea Profusulinellidae (with the dark microgranular wall of this group) and the Schubertellidae (with their typical shape, coiling, deviated juvenarium, septal folding, etc.). It is relevant, in this case, that *Grovesella* contains various lineages of small, globular schubertellins and encompasses several genera or subgenera; a Pennsylvanian part of them having a microgranular wall and being derived from *Schubertina/Eoschubertella* (see above), the second part, Permian in age, having a typical schubertellid wall with a primatheca (or protheca) and probably derived from typical *Schubertella*.

Occurrence. Bashkirian(?)-Artinskian of Urals-Arctic, Carnic Alps-Chios, Darvaz, Afghanistan, and Central Iran (Davydov and Arefifard, 2007; Leven and Gorgij, 2011). Murgabian-Midian of Maku (this work).

Grovesella cf. *tabasensis* Davydov and Arefifard, 2007
Figure 13.13-16

2007 *Grovesella tabasensis* Davydov and Arefifard, p. 6, fig. 4.12-16.

Description. Small, nautiloid tests, slightly umbilicate, without chomata.

Remarks. One of the reviewer of our manuscript suggested that this taxon is identical to *G. tabasensis*, but this assignment is questionable, because, if our material is poor (20 specimens), the type material of *G. tabasensis* is even poorer. Indeed, *G. tabasensis* was described with a material of 5 specimens of the Early Permian of central Iran and 20 specimens of the Early Permian of Nevada (U.SA). However, some years later, Davydov (2011) created, with all the material of Nevada, the species *G. nevadaensis* Davydov, 2011. Consequently, the type material of *G. tabasensis* was reduced to five specimens. Therefore, (1) an accurate comparison is difficult, and (2) it is surprising that a genus of fusulinids was founded, in the 21th century, with a type species represented by only five specimens.

Occurrence. Murgabian-Midian of Maku (P2, P3, P7, P10, P20, P21, P30 and P34).

Genus GROVESELLA?

Comparison. *Grovesella*? differs from *Grovesella* by the smaller size, the discoidal test, the coiling more endothyroid than schubertelloid (in particular, the obvious absence of tight and deviated first whorls). It differs from *Endothyra* and *Planoendothyra* by the type of wall, which is typically schubertellid. It differs from all other schubertelloids by its character very primitive, and it is probably homeomorphous of the Bashkirian forms transitional from the pseudostaffelloids and the schubertelloids. Similarly, *Grovesella*? might constitute a parallel homeomorphous lineage with the *Grovesella* and *Schubertella* forms found in our material (see below).

Occurrence. As for *Grovesella*? *ciryi* n. sp.; i.e., Murgabian-early Midian of Maku

Grovesella? *ciryi* Ebrahim Nejad and Vachard n. sp.
Figure 13.9-12

zoobank.org/74752719-6E0E-4893-A8F1-BD1CC94258F3

Etymology. To the great specialist of fusulinids Raymond Ciry who created notably the genus *Dunbarula*.

Holotype. Figure 13.10 (P10).

Type locality. Maku (Northwest Iran).

Type level. Murgabian.

Diagnosis. An atypical *Grovesella* characterized by its “endothyrid” shape and type of coiling.

Description. Test subdiscoidal, compressed, with rounded periphery. Proloculus small, spherical. No juvenarium. Septa plane; only weakly curved at the poles. Deviation of axis permanent but slight (i.e., endothyroid in coiling). Chomata absent or very weak (Figure 11.9). Aperture basal in arch. Diameter = 0.150-0.220 (rarely 0.500 mm) mm; width = 0.090-0.100 mm (rarely 0.300 mm); w/D = 0.46-0.60; proloculus diameter = 0.020-0.035 mm; number of whorls: 3-4; number of chambers: 8-11; height of last chamber: 0.030-0.050 mm (rarely 0.075 mm); wall thickness at the last whorl: 0.005-0.010 mm (rarely 0.015 mm).

Material. 15 sections.

Repository of the material. University of Lille1, number USTL 100-3.

Comparison. In addition to the characters which differ from the typical genus, *G.? cyrii* n. sp. differs from the other Iranian species *G. tabasensis* by

form ratio (w/D) of 0.46-0.60, when the typical *G. tabasensis* have a w/D parameter of 0.60-0.85.
Occurrence. Murgabian-early Midian of Maku (P10, P17, P22 and P34).

Genus DUNBARULA Ciry, 1948

Type species. *Dunbarula matthieui* Ciry, 1948.
Description. Schubertelloid (i.e., having a wall with tectum and protheca) with a moderately sized, inflated fusiform test. First two to five volutions forming a juvenarium perpendicular to the two to three adult wide whorls, up to 3 mm in length, planispirally coiled throughout, about six or seven whorls, septa strongly folded at the poles, moderately to strongly fluted in the median portion of chambers; chomata low to high, narrow, and asymmetrical, aperture terminal central and septal pores.
Occurrence. Midian of Tunisia, Croatia, Slovenia, Italy (Istria, Monte Facito, Sicily), Greece (Chios), Cambodgia, Sumatra, Thailand, Malaysia, South China, North China, Tibet, Japan, New Zealand, Koryak Terrane, Pamir, Afghanistan, Oman, Armenia, Crimea, Northern Caucasus, Turkey, Iran (Abadeh and Kuh-e Shotor: Kahler and Kahler, 1979; central Alborz: Partoazar, pl. 1(3), fig. 13 (as *Codonofusiella* sp.); Djulfa area: Shabanian et al., 2007; Zagros: Insalaco et al., 2006). Questionable in North America: Washington, Oregon, Texas (USA), British Columbia (Canada).
Remarks. We agree with Leven (e.g., Leven, 1998) for considering that the FAD of the genera *Sumatrina*, *Dunbarula* and *Kahlerina* is located at the the base of the Midian stage. This conclusion is discussed because for example Altiner and Özkan-Altiner (2010; text-fig. 1) indicate that *Dunbarula* and *Kahlerina* exist before the FAD of *Yabeina*, theoretical unique unquestionable marker of the Midian. Kobayashi and Altiner (2011) have recently described a *Dunbarula protomatthieui*. This species is supposed early Murgabian in age, because it is associated with *Praesumatrina*. Nevertheless, this *Dunbarula* is yet an advanced form of the genus (especially if compared with the taxon described hereafter), very similar to *Dunbarula tumida* Skinner, 1969 (also described in Turkey), and is associated with *Aulacophloia* Gaillot and Vachard, 2007 (Pl. 1, fig. 22) and *Glomomidiella* Vachard, Rettori, Angiolini and Checconi, 2004 (Pl. 2, figs. 44-51), which are both Midian-Lopingian in age. Therefore, it is probable that this assemblage and this species of *Dunbarula* are Midian in age. Furthermore, the type material of the type species *D. matthieui*, from Jebel Tebaga (Tunisia) was probably defined in early Djulfian beds of this locality (study in progress with W. Ghizzay and S. Razgallah). Concerning the specimens of *Praesumatrina* associated with *Dunbarula*, there are at least three solutions: (a) a Lazarus effect in this single locality; (b) more likely, we have observed in a thin section from Afghanistan of the collection D. Vachard (University Lille 1), that an atypical *Sumatrina* specimen is devoid of transverse septula of second order; (c) moreover, in the same collection, it is conspicuous that the septula of the genera *Afghanella* and *Sumatrina*, are often rudimentary or even absent, and do not permit to assign many specimens to one or another genus. This problem might also exist in Turkey and is most probably ontogenetic than biostratigraphic.

Dunbarula aff. *pusilla* Skinner, 1969
Figure 13.23

1969 *Dunbarula pusilla* Skinner, p. 7-9, pl. 11, figs. 4-9, pl. 12, figs. 1-4.

?1983b ?*Dunbarula* sp.; Jenny-Deshusses, pl. 9, fig. 8.

Description. This species is very primitive and seems exactly transitional with *Neofusulinella* Deprat, 1912 (e.g., with *N.* aff. *kobrigensis* sensu Davydov et al., 1996), but it belongs yet to *Dunbarula* by the septal folding relatively intense at the poles and the deviation of juvenarium. Our material is relatively similar to *D. pusilla*, from the Midian of Turkey, but this one shows a stronger septal folding. True *D. pusilla* seem exist in Iran (Abadeh) under the name *D.* cf. *matthieui* sensu Kobayashi and Ishii (2003, p. 313, pl. 1, figs. 27-28).
Remark. The *Dunbarula*? of Jenny Deshusses (1983b) belongs eventually to this taxon or more probably are congeneric with the Alborz *Neofusulinella* illustrated by Bozorgnia (1973).
Occurrence. Early Midian of Maku (P30).

Superfamily SCHWAGERINOIDEA Dunbar and Henbest, 1930 nom. translat. Solovieva, 1978
Family CHUSENELLIDAE Kahler and Kahler, 1966
Genus CHUSENELLA Hsu, 1942

Type species. *Chusenella ishanensis* Hsu, 1942.
Description. Test ovate, robust fusiform to elongate fusiform with sharp apices, up to 13.5 mm in length, small to medium-sized proloculus, early whorls tightly coiled, up to eight or nine volutions in the adult, later ones more loosely expanded, early septa without fluting, later septa highly and tightly fluted throughout length; wall thin, with tectum and weakly fibrous keriotheca increasing slowly in thickness, rudimentary chomata in the juvenile stage of some species, or chomata may be com-

pletely lacking throughout, axial filling prominent, but tunnel present in the equatorial region.

Occurrence. Middle Permian: China, Laos, Croatia, Turkey, Iran, Tunisia, Pamir, Caucasus, Japan, and USA (California, Texas, Washington).

Chusenella spp.
Figures 13.24, 14.1-14.2, 14.6, 14.8

Description. Our specimens are relatively rare, and always cut in section subaxial to tangential sections. The most identifiable specimen (Figure 14. 1) seems to be relatively similar to *Chusenella conicocylindrica* Chen, 1956; especially, to the specimens attributed to this species by Leven (1998, pl. 6, figs. 11, 15, 19); Kobayashi and Ishii (2003, pl. 9, figs. 1-2); and Kobayashi (2011a, figs. 2.7-8). It seems also rather identical to *Schwagerina* sp. of Partoazar (1995, pl. 1(1), fig. 4). This test, relatively large, is inflated in the centre and conical at the poles; its keriotheca is well developed and resembles a stalactotheca; and its axial filling is heavy in the central areas.

Occurrence. Late Kubergandian-early Murgabian of Armenia. Midian of South China, Turkey, Japan, Greece (Hydra), Uzbekistan (Darvaz), and Iran (Abadeh). Midian of Maku (P34, P40 and P41).

Superfamily NEOSCHWAGERINOIDEA Dunbar and Condra, 1927 orth. mut. Minato and Honjo, 1966
Family NEOSCHWAGERINIDAE Dunbar and Condra, 1927
Subfamily NEOSCHWAGERININAE Dunbar and Condra, 1927
Genus NEOSCHWAGERINA Yabe, 1903

Type species. *Schwagerina craticulifera* Schwager, 1883.

Description. The genus *Neoschwagerina* has a medium to large and fusiform shell, with bluntly pointed to narrowly rounded poles. The spirotheca is composed of a tectum and a fine keriotheca. The septulum occurs in two directions, i.e., in the direction of the axis of coiling (axial septula) and in the direction of coiling (transverse or spiral septula). Primary transverse septula are contact with the parachomata only adjacent to the septa in primitive forms, but extend to the top of the parachomata in advanced forms. Secondary transverse septula are generally absent. Parachomata are broad and short in the primitive species and become relatively narrower and higher in the more-evolved species. There are foramina throughout the shell.

Occurrence. The range-zone is Murgabian-Midian in age; i.e., middle-late Middle Permian; the genus is relatively common in Palaeo-Tethys, Neo-Tethys and Panthalassa, but very rare in the USA.

Neoschwagerina simplex Ozawa, 1927 emend. Sheng, 1963
Figure 14.3, 14.5, 14.7, 14.9

1927 *Neoschwagerina simplex* Ozawa, p. 153-154, pl. 34, figs. 7-11, 22-23, pl. 37, figs. 3, 6a.

1963 *Neoschwagerina simplex* Ozawa; Sheng, p. 234-235, pl. 34, figs. 14-15.

1967 *Neoschwagerina simplex* Ozawa; Leven, p. 189-190, pl. 32, figs. 8-10.

1983b *Neoschwagerina schuberti* Kochansky-Devidé; Jenny-Deshusses, pl. 15, figs. 1, 5.

1988 *Neoschwagerina simplex* Ozawa; Kobayashi, p. 11, pl. 6, figs. 11-17, pl. 13, figs. 6-7.

1993 *Neoschwagerina* ex gr. *simplex* Ozawa; Baghbani, pl. 2, figs. 10-14.

v. 2000 *Neoschwagerina simplex* Ozawa; Hauser et al., fig. 4.5.

2011b *Neoschwagerina simplex* Ozawa; Kobayashi, p. 524, 526, pl. 32, figs. 1-20, pl. 37, figs. 1-3 (with synonymy).

Description. Most primitive species of the genus (see the emended diagnosis of Sheng, 1963) showing moderately large, ellipsoidal to inflated fusiform tests with broadly rounded poles.

Occurrence. Early Murgabian of Palaeo- and Neo-Tethys (Japan, Crimea, South China, North-Pamir, SE Pamir, Vietnam, Thailand, Central Mountains of Afghanistan, Iran (Kuh-e Jamal), Sumatra, Malaysia, NW Turkey, Oman). Early Murgabian of Maku (P3, P7 and P21).

Genus SUMATRINA Volz, 1904

Type species. *Sumatrina annae* Volz, 1904.

Description. Test of medium size, elongate fusiform to subcylindrical, large proloculus and few loosely coiled whorls, septa long, thin, and widely spaced, thin and short primary transverse septula, 2-4 thin secondary transverse septula between adjacent primary transverse septula, their lower part thickened and clavate, may have up to seven axial septula between adjacent septa; wall very thin, of tectum and extremely thin keriotheca, parachomata massive and high, attaching to the lower ends of the primary transverse septula, axial fillings present in all but part of the last whorl; numerous foramina occur throughout the length of the test.

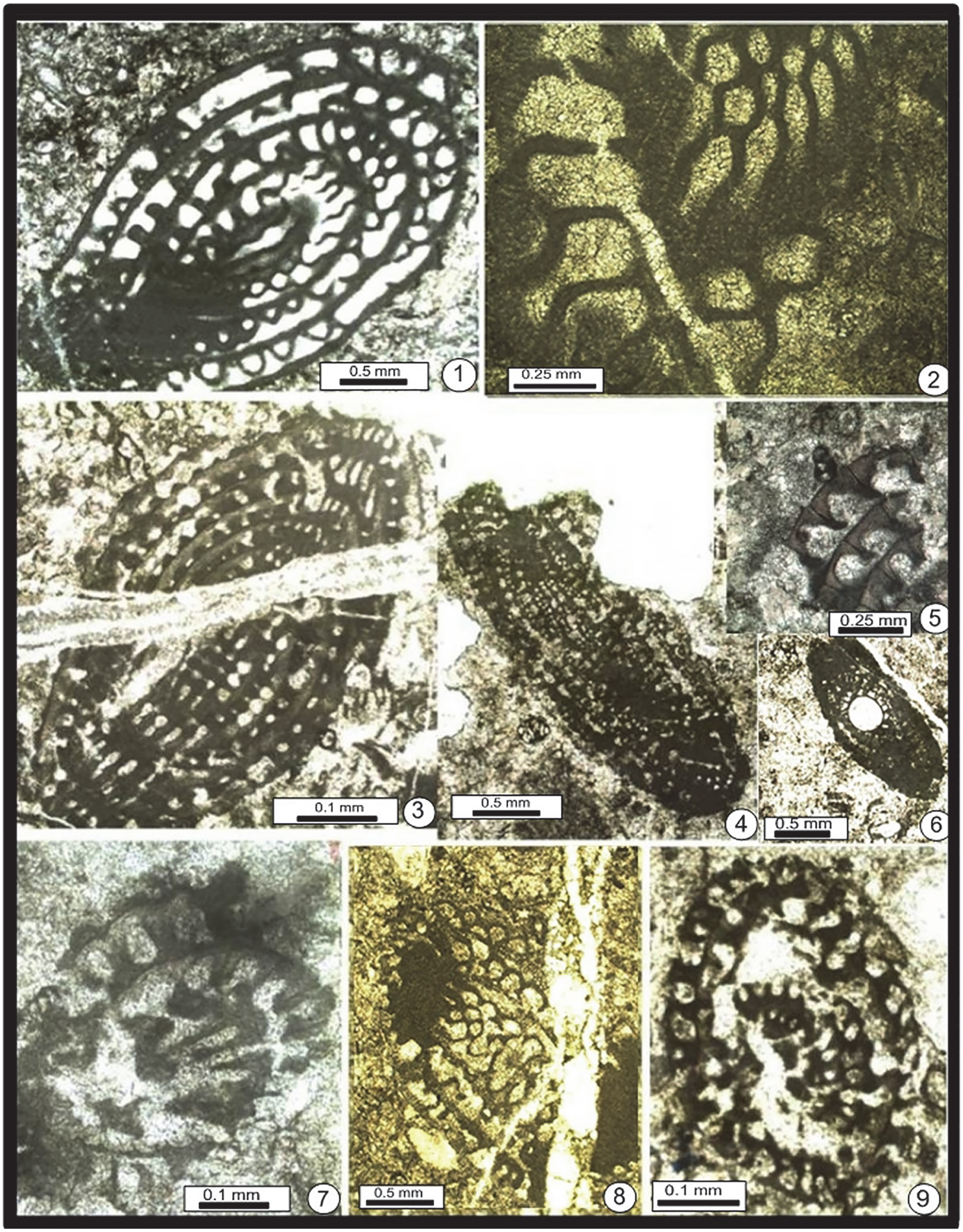

FIGURE 14. 1-2, 6, 8. *Chusenella* spp. 1. Subaxial section. P34-22. Midian. 2. Detail of the keriotheca. P41-25. Latest Midian. 6. Oblique section with the axial filling. P40-1. Latest Midian. 8. Oblique section with septal folding and axial filling. P40-60. Latest Midian. 3, 5, 7, 9. *Neoschwagerina simplex* Ozawa, 1927 emend. Sheng, 1963. 3. Subaxial section showing the parachomata and the transverse septula of first order. P21-51. Murgabian. 5. Fragment of transverse section showing the wall microstructure and the absence or rarity of axial septula. P3. Murgabian. 7. Oblique section. P3-13. Murgabian. 9. Oblique transverse section. P3-35. Murgabian. 4, 6. *Sumatrina annae* Volz, 1904. 4. Subaxial section. P30-56. Earliest Midian. 6. Axial section of a young specimen. P30-54. Earliest Midian.

Occurrence. Late Middle Permian (Midian); Sumatra, South China (Yunnan, Kueichow, Kwangsi), ?Tibet, Primorye, Laos, Cambodgia, Vietnam, Thailand, Malaysia, S.E. Pamir, Afghanistan, Japan, Iran (Espahan, Abadeh), Armenia, Turkey, Crimea, Greece, Croatia, Tunisia.

Sumatrina annae Volz, 1904
Figure 12.4-12.5

1904 *Sumatrina annae* Volz, p. 98-100, text figs. 27-31.

1963 *Sumatrina annae* Volz; Sheng, p. 245-246, pl. 36, figs. 1-11.

1967 *Sumatrina annae annae* Volz; Leven, p. 200, pl. 37, figs. 6-7, 9.

1967 *Sumatrina annae brevis* Volz; Leven, p. 201, pl. 37, figs. 4-5.

? 1998 *Sumatrina vediensis* Leven, p. 325, pl. 9, figs. 18-20.

2003a *Sumatrina annae* Volz; Kobayashi and Ishii, fig. 5.7-8.

2003b *Sumatrina annae* Volz; Kobayashi and Ishii, p. 328, pl. 11, figs. 7-14.

2011 *Sumatrina annae* Volz; Leven and Gorgij, pl. 28, fig. 16.

Description. Test of medium size for the genus, elongate fusiform, with 9-10 whorls and a length of 5.600-6.500 mm. Two to three transverse septula of second order are located between each transverse septulum of first order.

Remarks. The specific differences of *S. annae*, *S. brevis* and *S. vediensis* are not very easy to characterize, a synonymy is possible.

Occurrence. Midian of Sumatra, South China (Yunnan, Kueichow, Kwangsi), Tibet?, Laos, Viet nam, Thailand, Malaysia, S.E. Pamir, Afghanistan, Primorye, Japan, Turkey, Crimea, Italy, Croatia, Tunisia, Armenia and Iran (Espahan, Abadeh). Maku (P30).

Class MILIOLATA Lankester, 1885
Order MILIOLIDA Delage and Hérouard, 1896
Superfamily NUBECULARIOIDEA Jones in Griffith and Henfrey, 1875 nom. translat. Mikhalevich, 1988
Family CALCIVERTELLIDAE Loeblich and Tappan, 1964 nom. translat. Reitlinger in Vdovenko et al., 1993 emend. Gaillot and Vachard, 2007
Genus PSEUDOVERMIPORELLA Elliott, 1958 emend. Henbest, 1963

Type species. *Pseudovermiporella sodalica* Elliott, 1958.

Remarks. Although the work of Henbest (1963) had definitively demonstrated that *Pseudovermiporella* is a miliolid foraminifer, this genus has been still recently considered as an alga (Granier and Deloffre, 1994; Gaetani et al., 2009; Angiolini et al., 2010; Schlagintweit, 2011) or a microproblematicum (Flügel, 2004). The type of development and the amber-coloured, well- preserved test are characteristic of a porcelaneous foraminifer. That is only after a microsparitic recrystallisation and an inner abrasion of the tube, that this porcelaneous can be confused with a dasyclad. Unlike *Palaeonubecularia*/“*Tolypammina*”, from Moscovian (Delvolvé et al., 1987, pl. 1, fig. 11) to Triassic time (Wendt, 1969), microreefs with *Pseudovermiporella* are lacking in the Earth history, probably due to the biological function of the pits, which cannot be covered. Our new material definitively confirms the existence of proloculi and juvenaria.

Although some questionable species, like *Pseudovermiporella*? *graiferi* (Baryshnikov in Baryshnikov et al., 1982 emend. Vachard and Krainer, 2001), appear in the latest Sakmarian, the FAD of true *Pseudovermiporella* is probably early Artinskian in age (Vachard, Krainer and Lucas, unpublished data). The main Middle-Late Permian species are *P. nipponica* (with its numerous synonyms), probably cosmopolite; *P. sodalica*, apparently limited to western Neo-Tethys; and *P. elliotti*, only known in Turkey and Oman (Vachard et al., 2001). The numerous other species described in the literature are probably all junior synonyms of these three ones.

Occurrence. Late Early Permian (Artinskian)-Late Permian (Changhsingian), cosmopolite. Common in Lopingian of southern Turkey (Hazro) and Zagros.

Pseudovermiporella nipponica (Endo in Endo and Kanuma, 1954)
Figure 15.3-15.4, 15.6, 15.8-15.10, 15.13-15.14

1954 *Vermiporella* (?) *nipponica* Endo in Endo and Kanuma, p. 191, pl. 13, figs. 2-5.

1963 *Vermiporella nipponica* Endo; Praturlon, p. 124-126, pl. 1, figs. 1-10 (with synonymy).

v. 1981 *Pseudovermiporella* ex gr. *nipponica* (Endo); Vachard in Vachard and Montenat, p. 72-73, pl. 2, fig. 8, pl. 13, fig. 12, pl. 14, figs. 1-3.

1983b *Pseudovermiporella* ex gr. *nipponica* (Endo); Jenny-Deshusses, p. 155, pl.

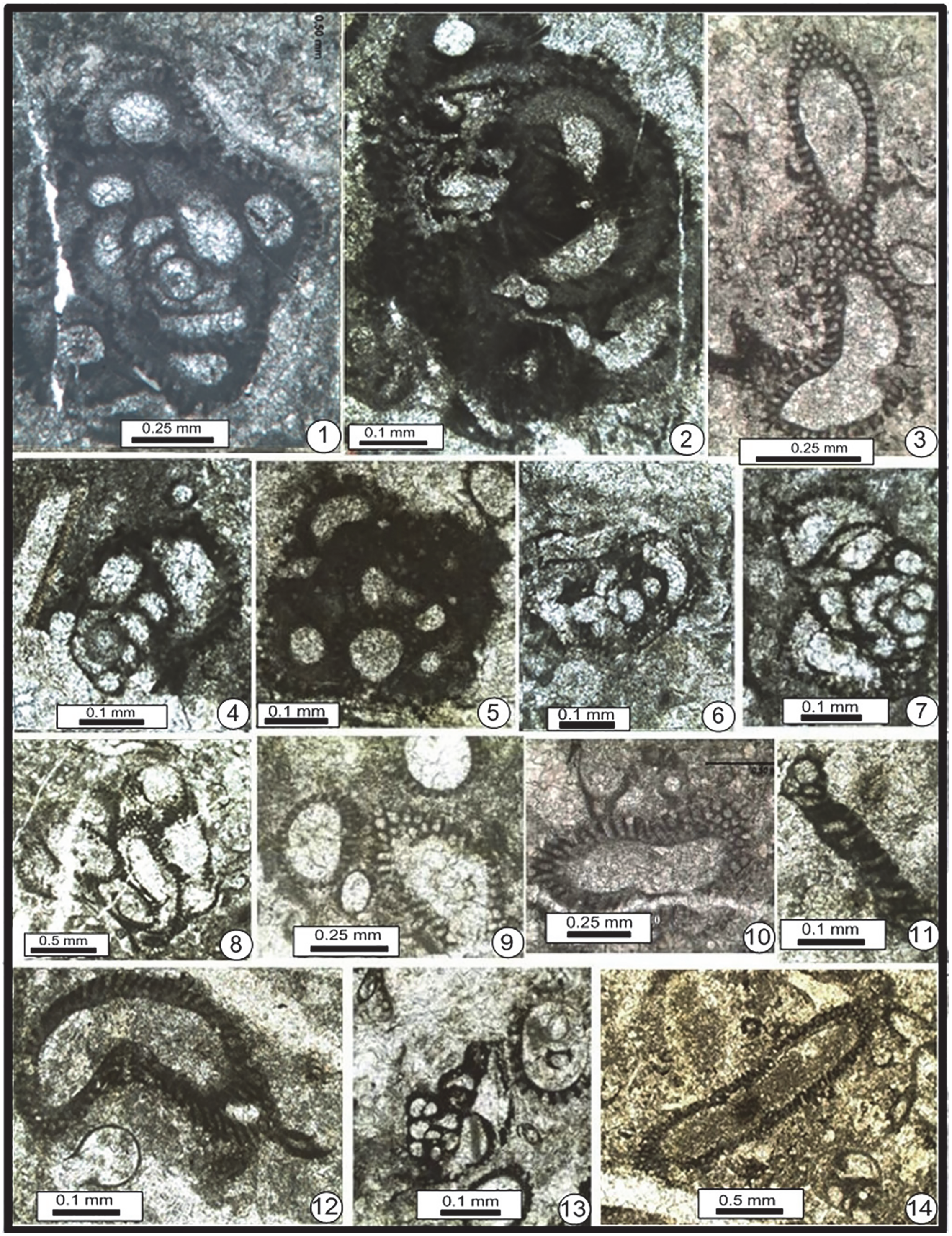

FIGURE 15. 1-2, 5, 7? *Pseudovermiporella sodalica* Elliott, 1958. 1. Typical specimen. P22. Murgabian. 2. Typical thick wall. P8-42. Murgabian. 7? Thick-walled specimen with the proloculus (centre, right). P27-7. Murgabian. 3-4, 6, 8-10, 13-14. *Pseudovermiporella nipponica* (Endo in Endo and Kanuma, 1954). 3. Longitudinal to tangential section. P22. Murgabian. 4. Juvenarium with the proloculus. P27-42. Murgabian. 8. Group of tubules. P27-37. Murgabian. 9. Two transverse sections. P16-42. Murgabian. 10. Longitudinal section. P22. Murgabian. 13. A juvenarium (centre) and various adult sections. P6. Early Murghabian. 14. Longitudinal section (centre) with *Labioglobivalvulina* cf. *baudi* (bottom right). P17-28. Murgabian. 11-12. *Pseudovermiporella longipora* (Praturlon, 1963). 11. Detail of the wall. P17-30. Murgabian. 12. Longitudinal section with *Eotuberitina reitlingerae* (Figure 8.2). P17-14. Murgabian.

16, figs. 2, 5?, pl. 20, fig. 4 (with synonymy).

v. 1993a *Pseudovermiporella* ex gr. *nipponica* (Endo); Vachard et al., pl. 6, fig. 9, pl. 7, fig. 1.

1995 *Vermiporella nipponica* Endo; Partoazar, pl. 1(3), fig. 9, pl. 2(3), fig. 5, pl. 3(2), fig. 12, pl. 6(4), fig. 4, pl. 8(5), figs. 4, 6, 10.

v. 2001 *Pseudovermiporella nipponica* (Endo); Vachard and Krainer, p. 191, pl. 4, fig. 26 (with synonymy).

v. 2007 *Pseudovermiporella nipponica* (Endo); Gaillot and Vachard, p. 82-83, pl. 58, fig. 16, pl. 59, figs. 4, 19 (with synonymy).

v. 2009 *Pseudovermiporella* ex gr. *nipponica* (Endo); Mohtat-Aghai et al., pl. 1, fig. 12.

2010 *Mizzia velebitana* Pia; Angiolini et al., fig. 4.33.

v. 2013 *Pseudovermiporella nipponica* (Endo); Parvizi et al., fig. 9h.

Description. Dimensions: L = 1.250-2.500 mm; D = 0.325-0.960 mm; d = 0.170-0.440 mm; s = up to 0.260 mm; width of pits = 0.015-0.036 mm. Excellent examples of spherical or even reniform proloculi have been discovered in our material (Figure 15.4, 15.6).

Occurrence. As for the genus. Very common in all the series of Maku (P1, P3, P6, P7, P8, P9, P10, P14, P16, P17, P18, P20, P21, P22, P23, P25, P27, P30, P31, P34, P37, P39, P41, P44, P50, P51, P54 and P55).

Pseudovermiporella sodalica Elliott, 1958
Figure 15.1-15.2, 15.5, 15.7

1958 *Pseudovermiporella sodalica* Elliott, p. 419-422, pl. 1, figs. 1-6, pl. 2, figs. 2-6, pl. 3, figs. 1-4, 7.

v. 2006 *Pseudovermiporella sodalica* Elliott; Insalaco et al., pl. 1, fig.12.

v. 2007 *Pseudovermiporella sodalica* Elliott; Gaillot and Vachard, p. 83, pl. 34, fig. 18, pl. 57, figs. 2-6 (with synonymy).

v. 2013 *Pseudovermiporella sodalica* Elliott; Parvizi et al., fig. 9a-b.

Dimensions. L = 0.400-0.700 mm, D = 0.400-0.600 mm, d = 0.500-0.600 mm, s = up to 0.600 mm, width of pits = 0.020-0.040 mm. Unquestionable proloculi and foraminiferal coiled first whorls have been observed (Figure 15.1, 15.7). The proloculi are also spherical or reniform.

Remarks. This species differs from *P. nipponica* by thicker walls, larger tubes and wider pits.

Occurrence. More endemic than *P. nipponica*. Common in Late Midian-Lopingian of Zagros, Iraq, Fars and Abu Dhabi. Murgabian in Maku (P1, P3, P5, P8 and P27).

Pseudovermiporella longipora (Praturlon, 1963)
Figure 15.11-15.12

1963 *Vermiporella nipponica* var. *longipora* Praturlon, p. 126, pl. 2, figs. 1-7.

v. 2001 *Pseudovermiporella longipora* (Praturlon) n. comb.; Vachard et al., p. 396, fig. 21.15-21.16.

v. 2003 *Pseudovermiporella* ex gr. *nipponica* (Endo); Vachard et al., pl. 4, fig. 3.

v. 2013 *Pseudovermiporella longipora* (Praturlon); Parvizi et al., fig. 9i.

Remarks. This species differs from *P. nipponica* by deeper and more curved pits.

Occurrence. Murgabian of Maku (P16 and P17).

Superfamily CORNUSPIROIDEA Schultze, 1854
nom. translat. Mikhalevich, 1988
Family CORNUSPIRIDAE Schultze, 1854
Subfamily CORNUSPIRINAE Schulze, 1854
Genus HEMIGORDIELLINA Marie in Deleau and Marie, 1961 emend. Vachard in Vachard and Beckary, 1991

Type species. *Glomospira diversa* Cushman and Waters, 1930.

Synonyms. *Glomospira* (of the Russian authors; from Lipina, 1949 to Filimonova, 2010).

Remarks. Small glomospiroid porcelaneous tests are here assigned to *Hemigordiellina*, because "*Glomospira*" is truly agglutinated and *Pseudoglomospira* (of the authors) microgranular. Many micropalaeontologists do not admit this interpretation, and therefore, a new name might be introduced in the nomenclature. Among the Cornuspiridae, the most primitive, late Mississippian, streptospiral genus, *Hemigordiellina*, give rise, in the Pennsylvanian, to *Hemigordius* (the terminal stage of which is planispiral). Then, *Hemigordius* give rise to a Early Permian genus with an oscillating-sygmoidal terminal coiling, also called *Hemigordius* or *Midiella* in the literature. Both names are incorrect; the first one because of the different coiling, the second one because the typical *Midiella* appear very later in the Late Permian, coming from another lineage.

Occurrence. Pennsylvanian-Permian; cosmopolite.

Hemigordiellina regularis (Lipina, 1949)
Figures 8.11, 9.1, 9.13, 16.2, 16.7-13, 19.28

1949 *Glomospira regularis* Lipina, p. 205, pl. 2, fig. 6.

p. 1981 *Glomospira* spp.; Okimura and Ishii, pl. 2, figs. 2?, 4 (neither fig. 3, 5 = *Hemigordiellina*? spp.; nor figs. 6-7 = *Glomomidiella nestellorum*).

v. 2005 *Hemigordiellina regularis* (Lipina); Vachard et al., p. 157, pl. 2.6, 2.8 (with synonymy).

v. 2006 *Hemigordiellina regularis* (Lipina); Insalaco et al., pl. 1, fig. 8.

v. 2007 *Hemigordiellina regularis* (Lipina); Gaillot and Vachard, p. 85, pl. 2, figs. 5-6, 7?, 8, 14, pl. 4, figs. 21-22, pl. 14, figs. 6, 8, pl. 63, figs. 4-8 (with synonymy).

2010 *Hemigordiellina regularis* (Lipina); Angiolini et al., fig. 4.14.

Dimensions. Our measurements are similar to those of the type material. D = 0.250-0.500 mm; p = 0.025-0.060 mm; h = 0.050-0.075 mm; s = 0.007-0.015 mm.

Occurrence. From Early Permian (Lipina, 1949; Lin et al., 1990) to latest Triassic (Salaj et al., 1983). Typical specimens of *H. regularis* are mostly present in the late Capitanian and abundant in the Djulfian of Persian Gulf. Very common and widespread in Maku (P1, P3, P6, P8, P9, P10, P16, P17, P18, P19, P20, P21, P23, P30, P31, P32, P33, P34, P35, P38, P39, P40, P41, P45 and P51).

Hemigordiellina? *pulchrissima* Ebrahim Nejad and Vachard n. sp.
Figures 17.2-17.3, 17.21, 18.1

zoobank.org/20D6170D-D454-4FD2-9701-C355FB0A1FDF

p. 1981 *Glomospira* spp.; Okimura and Ishii, pl. 2, fig. 3 (neither figs. 2, 4-5 = *Hemigordiellina* (sensu lato); nor figs. 6-7 = *Glomomidiella nestellorum*).

p. 1995 *Kamurana jolfiensis* Partoazar, pl. 2(1), fig. 13 (nomen nudum: no description, no holotype designation) (non fig. 21 = *Glomomidiella* cf. *nestellorum*).

?1997 *Glomospira tenuifistula* Ho; Kobayashi, pl. 3, figs. 19-20.

2007 *Kamurana* cf. *Bronnimanni* (sic); Shabanian et al., pl. 1, fig. 9.

Etymology. Latin, pulcher, pulchra, pulchrissima; i.e., a very nice small form.
Holotype. Figure 17.21 (P39).
Type locality. Maku (Northwest Iran).
Type level. Late Midian.
Diagnosis. An atypical *Hemigordiellina* due to the thin whorls, low tube and numerous whorls.
Description. Small ovoid test with numerous whorls. D = 0.200-0.275 mm; w = 0.160-0.250 mm. The central glomus is relatively large with numerous glomospiroid whorls, followed by oscillant whorls semi-evolute to evolute. The proloculus is small but larger than the first whorls; it measures 0.025-0.030 mm. Up to seven initial, streptospiral whorls and two to three terminal whorls tending to be aligned. The porcelaneous wall is proportionally thin (s = 0.005-0.010 mm). Aperture terminal, simple.
Material. 20 sections (P30 and P39).
Repository of the material. University of Lille 1, number USTL 100-04.
Comparison. No typical *Hemigordiellina* can be compared with this new species; some coiling similarities exist with the Triassic genus *Pilammina* Pantic, 1965.
Occurrence. Iran: early Djufian of Djulfa; late Midian of Maku.

Hemigordiellina? sp. 2
Figure 16.14-17

p 1981 *Glomospira* spp.; Okimura and Ishii, pl. 2, fig. 5 (neither figs. 2-4 = *Hemigordiellina* (sensu lato); nor figs. 6-7 = *Glomomidiella nestellorum*).

Remarks. The material seems relatively typical of this long-ranged species or group of species (Artinskian-Dorashamian).
Occurrence. As for the genus. Murgabian-Djulfian in Maku (P3, P20, P30, P32, P34, P39, P40, P45, P51, P52, P54 and P55).

Hemigordiellina? sp. 3
Figure 15.1

1981 *Glomospirella*? sp.; Okimura and Ishii, pl. 2, fig. 23.

Remark. Our material is poor; the initial coiling is unconspicuous; the terminal whorls seem evolute; some pseudosepta seem present; and the wall is very thin for the genus. This taxon is also relatively similar to *Pseudoagathammina* Lin, Li and Sun, 1990, non sensu Filimonova, 2010.
Occurrence. Murgabian-Midian of Maku (P 10, P31, P39?).

Subfamily AGATHAMMININAE Ciarapica, Cirilli and Zaninetti in Ciarapica et al., 1987

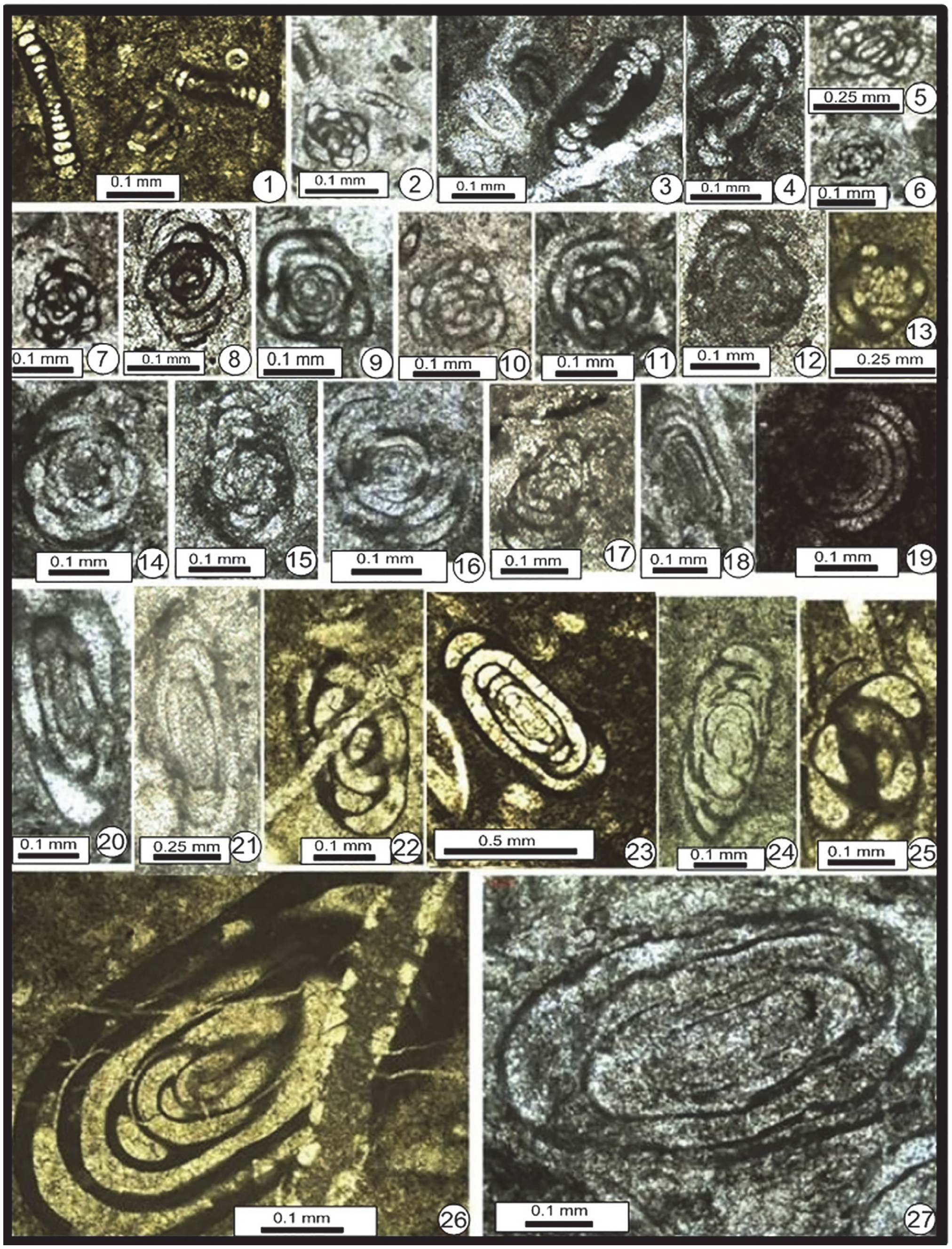

FIGURE 16. 1-2, 3?, 4?, 5?, 6?, 19? *Okimuraites plana* (Okimura and Ishii, 1981). 1 Two typical specimens (left and right) with *Hemigordiellina*? sp. (centre). P39-50. Midian. 2. Two axial sections (top) with *Hemigordiellina regularis* (bottom). P31-12. Murgabian. 3? Subaxial section (right) with *Syzrania* n. sp.? (left). P32-7. Midian. 4? Subaxial section. P32-22. Midian. 5? Subaxial section. P30-4. Midian. 6? Axial section. P18-13. Murgabian. 19? Transverse section. P27-18. Murgabian. 7-13. *Hemigordiellina regularis* (Lipina, 1949). Seven random sections. 7. P6-23. Murgabian. 8. P6-11. Murgabian. 9. P8-44. Murgabian. 10. P10-3. Murgabian. 11. P21-35. Murgabian. 12. P22-7. Murgabian. 13. P41-26. Midian. 14-17. *Hemigordiellina*? sp. 2. 14. Oblique section. P34-7. Midian. 15. Axial section. P32-33. Midian. 16. Oblique section. P32-33. Midian. 17. Subaxial section. P10-31. Murgabian. 18. *Agathammina parvula* (Lin, 1978). Three longitudinal sections. 18. P21-36. Murgabian. 20-21. *Agathammina* cf. *rosella* Pronina, 1988b. 20. P8-47. Murgabian. 21. P27-3. Murgabian. 22-25. *Agathammina* cf. *subfusiformis* Okimura and Ishii, 1981. Four subaxial sections. 22. P41-74. Latest Midian. 23. P41-8. Latest Midian. 24. P38-7. Midian. 25. P39-36. Midian. 26-27. *Agathammina pusilla* (Geinitz in Geinitz and Gutbier, 1848) emend. Wolanska, 1959. Two axial sections. 26. P41-47. Midian. 27. P34-33. Midian.

Genus AGATHAMMINA Neumayr, 1887 emend. Wolanska, 1959

Type species. *Serpula pusilla* Geinitz in Geinitz and Gutbier, 1848.

Description. Test elongate. Chamber undivided, tubular with a quinqueloculine coiling. Wall porcelaneous. Aperture terminal, simple.

Remark. This genus constitutes the link between the Palaeozoic primitive Miliolata and the true Milolata. It is very easy to identify in thin sections; not only in axial sections but also in transverse sections.

Occurrence. FAD poorly known probably Artinskian (= Yakhtashian) of Darvas (Tajikistan), with *A. darvasica* Filimonova, 2010. The LAD occurs during the latest Permian; hence, the Triassic "*Agathammina*" belong to another genus. Essentially Palaeo- and Neo-Tethyan, the genus *Agathammina* is nevertheless present in the USA (New Mexico; Nestell and Nestell, 2006).

Agathammina parvula (Lin, 1978)
Figure 14.18

1978 *Hemigordius parvulus* Lin, p. 39, pl. 5, figs. 18-19.

v. 2007 *Agathammina ovata* Wang; Gaillot and Vachard, p. 88, pl. 22, fig. 7, pl. 55, fig. 6, pl. 67, fig. 6.

2010 *Agathammina* ex gr. *multa* Pronina; Filimonova, pl. 2, fig. 17.

Remarks. This species is identical to *A. pusilla* but smaller for the same number of whorls. It differs from *A. ovata* Wang, 1976 by a smaller size; moreover, *A. ovata* is possibly a juvenarium of *A. pusilla*.

Occurrence. Middle Permian of South China and NW Caucasus. Late Midian-Changhsingian of Zagros. Kungurian (= Bolorian) of Armenia. Murgabian-Midian of Maku (P3, P7, P37 and P41).

Agathammina cf. *rosella* Pronina, 1988b
Figure 16.20-21

1988b *Agathammina rosella* Pronina, p. 61-62, fig. 3.11.

v 2007 *Agathammina* cf. *rosella* Pronina; Gaillot and Vachard, p. 88, pl. 67, fig. 1.

Description. Test ovoid elongate, medium-sized for the genus, thin-walled.

Occurrence. Murgabian-Midian of Maku (P1, P3, P6, P21, P23, P31, P32, P34 and P39).

Agathammina cf. *subfusiformis* Okimura and Ishii, 1981
Figures 16.22-25, 17.5

1981 *Agathammina subfusiformis* Okimura and Ishii, p. 16, pl. 1, figs. 7-8.

1995 *Agathammina subfusiformis* Okimura and Ishii; Partoazar, pl. 2(1), fig. 6, pl. 3(1), fig. 2 pl. 2(2), fig. 1.

Description. Test ellipsoidal, medium-sized and thick-walled.

Occurrence. Murgabian-Midian of Maku (P8, P10, P11, P20, P27, P30, P31, P34, P37, P38, P39 and P41).

Agathammina pusilla (Geinitz in Geinitz and Gutbier, 1848) emend. Wolanska, 1959
Figure 16.26-27

1848 *Agathammina pusilla* Geinitz in Geinitz and Gutbier, p. 6, pl. 3, figs. 3-6.

1959 *Agathammina pusilla* Geinitz; Wolanska, p. 47-48 (in Polish), 57 (in English), text-fig. 1-2 (p. 37), 3 (p. 41), 4 (p. 42), pl. 1, figs. 1a-3d, pl. 2, figs. A-C, 1-23, pl. 3, figs. 24-55 (with synonymy).

1988a *Agathammina pusilla* (Geinitz); Pronina, pl. 1, figs. 25-26.

1995 *gathammina pusilla* (Geinitz); Partoazar, pl. 2, fig. 15.

2006 *Agathammina pusilla* (Geinitz); Nestell and Nestell, p. 10, pl. 3, figs. 1-5 (with synonymy).

v. 2007 *Agathammina pusilla* (Geinitz); Gaillot and Vachard, p. 87-88, pl. 2, fig. 18, pl. 53, fig. 11, pl. 66, fig. 14.

2010 *Agathammina* aff. *pusilla* (Geinitz); Angiolini et al., fig. 4.13.

? 2011 "*Agathammina*"; Song et al., fig. 6.52.

Remarks. This species is large and elongate. Contrary to its name (pusillus means very small in Latin), *A. pusilla* is a large species. Other large or very large species have been described in the literature: *A. magna* sensu Ueno, 1992; *A. psebaensis* Pronina-Nestell and Nestell, 2001; *A. gigantea* Kobayashi, 2012. All are probably synonymous of *A. pusilla*. D = up to 0.900 mm; w = up to 0.350 mm; n: up to 11-12.

Occurrence. See the distribution indicated by Nestell and Nestell (2006) and add: Midian of Turkey; Changhsingian of South China and Primorye; Wuchiapingian of Iranian Djulfa; late Wuchiapingian to Changhsingian of Zagros. Form com-

FIGURE 17. 1. *Hemigordiellina*? sp. 3. Axial section. P31-17. Midian. 2-3, 21. *Hemigordiellina*? *pulchrissima* Ebrahim Nejad and Vachard n. sp. Three axial sections. Midian. 2. Paratype. P39-23. 3. Paratype. P39-57. 21. Holotype. P39-45. 4, 6?, 7-11, 20? *Glomomidiella nestellorum* Vachard, Rettori, Angiolini and Checconi, 2008. 4. Axial section transitional to *Neodiscus*. P30-19. Midian. 6. Transverse section showing the pseudosepta. P30-20. Earliest Midian. 7-11. Various sections (7. P30-11; 8. P30-3; 9. P30-13; 10. P30-3; 11. P30-5). 20. P30-10. Midian. 16-17. *Glomomidiella* cf. *gigantea* (Lin, 1984). 16. P37-25. Murgabian. 17. P31-14. Midian. 5. *Agathammina* cf. *subfusiformis* Okimura and Ishii, 1981. Longitudinal section. P39-53. Midian. 12-13, 19. *Neodiscus milliloides* Miklukho-Maklay, 1953. Four axial sections. 12. P38-24. Midian. 13. P37-13. Midian. 19. P21-9. Murgabian. 14-15, 18. *Glomomidiella*? cf. *specialisaeformis* (Lin, Li and Sun, 1990). 14. P39-38. Midian. 15. P47-24. Djulfian.18. P47. Djulfian. 22. P47-12. Djulfian. 22-24. *Glomomidiella* cf. *problema* (Lin, 1978). 22. Two specimens. P47-24. 23. P40-13. Late Midian. 24. P44-20. Djulfian.

mon in Maku (P32, P34, P37, P38, P39, P41 and P47).

Family HEMIGORDIIDAE Reitlinger in Vdovenko et al., 1993

Subfamily HEMIGORDIINAE Reitlinger in Vdovenko et al., 1993

Genus OKIMURAITES Reitlinger in Vdovenko et al., 1993 emend. herein

Type species. *Discospirella plana* Okimura and Ishii, 1981.

Synonym. *Discospirella* Okimura and Ishii, 1981 (preoccupied); *Brunsispirella* Gaillot and Vachard, 2007.

Emended diagnosis. Hemigordiinae small, discoid and with numerous planispirally coiled whorls, involute to semi-evolute and evolute.

Remarks. We consider here *Okimuraites* as a genus, and not as a subgenus of *Hemigordius*, because its more numerous for a smaller size, its more compressed and discoidal test, its stratigraphic range limited to the Midian and Late Permian, and its geographic distribution restricted to the Tethys. Our typical section of Figure 16.1-2 (left) can be compared with the associated, typical *Hemigordius* sp. (Figure 16.2 (right), 16.3-6) because of its more numerous whorls for a smaller size.

With the proposed emended diagnosis, *Brunsispirella* becomes a junior synonym of *Okimuraites*.

Occurrence. Midian-Lopingian of Palaeo-Tethys and Neo-Tethys.

Okimuraites plana (Okimura and Ishii, 1981)
Figures 8.7, 16.1-16.2 (top right and top left), 16.3?-16.6, 16.19?, 18.1

1981 *Discospirella plana* Okimura and Ishii, p. 13, pl. 1, figs.1-2.

1993 *Hemigordius* (*Okimuraites*) *plana* (Okimura and Ishii); Reitlinger in Vdovenko et al., p. 89, pl. 14, figs. 18-19.

v. 2005 *Glomospirella*? *linae* Vachard and Gaillot in Vachard et al., p. 157, 159, pl. 4.3-4.17.

v. 2007 *Brunsispirella linae* (Vachard and Gaillot in Vachard et al.); Gaillot and Vachard, p. 98-99, pl. 2, figs. 28, 29?, 30-31, pl. 56, figs. 1-2, 4-7, 12, pl. 60, fig. 1, pl. 68, figs. 6, 9-10, 13, 15-17, 20 (with synonymy).

2009 *Hemigordius longus* Grozdilova; Song et al., fig. 7.3-6.

2009 *Hemigordius discoides* Lin, Li and Sun; Ueno and Tsutsumi, fig. 9.17.

v. 2009 *Brunsispirella* aff. *linae* (Vachard and Gaillot in Vachard et al.); Mohtat-Aghai et al., pl. 2, fig. 3.

Description. This Miliolata (i.e., with a porcelaneous wall) is a homeomorph of *Brunsia spirillinoides* (Grozdilova and Glebovskaya, 1948). It summarizes all the nomenclatural problems of Miliolata Cornuspiroidea and Fusulinata Pseudoammodiscoidea; and how two primitive taxa can appear similar, although they belong to two different classes. Like for *Brunsia*, in the abundant populations, some oblique, juvenile and transverse sections (Figure 16.3-6, 16.19) can be confused with other primitive undivided, bilocular genera.

Occurrence. Murgabian-Dorashamian of Palaeo-Tethys and Neo-Tethys. Murgabian-Midian (P6, P20, P21, P27, P30, P31, P32, P39 and P45).

Family NEODISCIDAE Lin, 1984 nom. translat. emend. Gaillot and Vachard, 2007

Description. Large Miliolata test composed of a spherical proloculus followed by an undivided tubular chamber, diversely coiled: entirely glomospiral (*Crassiglomella* Gaillot and Vachard, 2007), entirely glomospiral with pseudo-septa (*Glomomidiella* Vachard, Rettori, Angiolini and Checconi, 2008), initially glomospiral and then planispiral (or aligned) involute (*Neodiscus* Miklukho-Maklay, 1953), glomospiral becoming planispiral evolute or semi-involute (*Graecodiscus* Vachard in Vachard et al., 1993), planispirally involute compressed (*Uralogordius* Gaillot and Vachard, 2007 = *Arenovidalina* Baryshnikov, Zolotova and Kosheleva, 1982 non Ho, 1959; including *Hemigordius magnus* Rauzer-Chernousova in Akopian, 1974 and *Neodiscus mirabilis* Ueno, 1992) or inflated (*Multidiscus* Miklukho-Maklay, 1953), if slightly deviated at the beginning: *Neohemigordius* Wang and Sun, 1973), agathamminoid, i.e., pseudo-quinqueloculine (*Septagathammina* Lin, 1984). The chamber is semicircular in section (some flosculinisations are observable in advanced forms of *Neodiscopsis* Gaillot and Vachard, 2007), the thick wall is still re-inforced by buttresses at the contact with the preceding whorl. Aperture terminal simple.

Occurrence. ?Sakmarian, ?Artinskian, Lopingian with a late Changhsingian acme. Palaeo-Tethys from Greece to South China; Neo-Tethys: Taurides (Turkey), Zagros (southern Iran), Oman (Batain Plain).

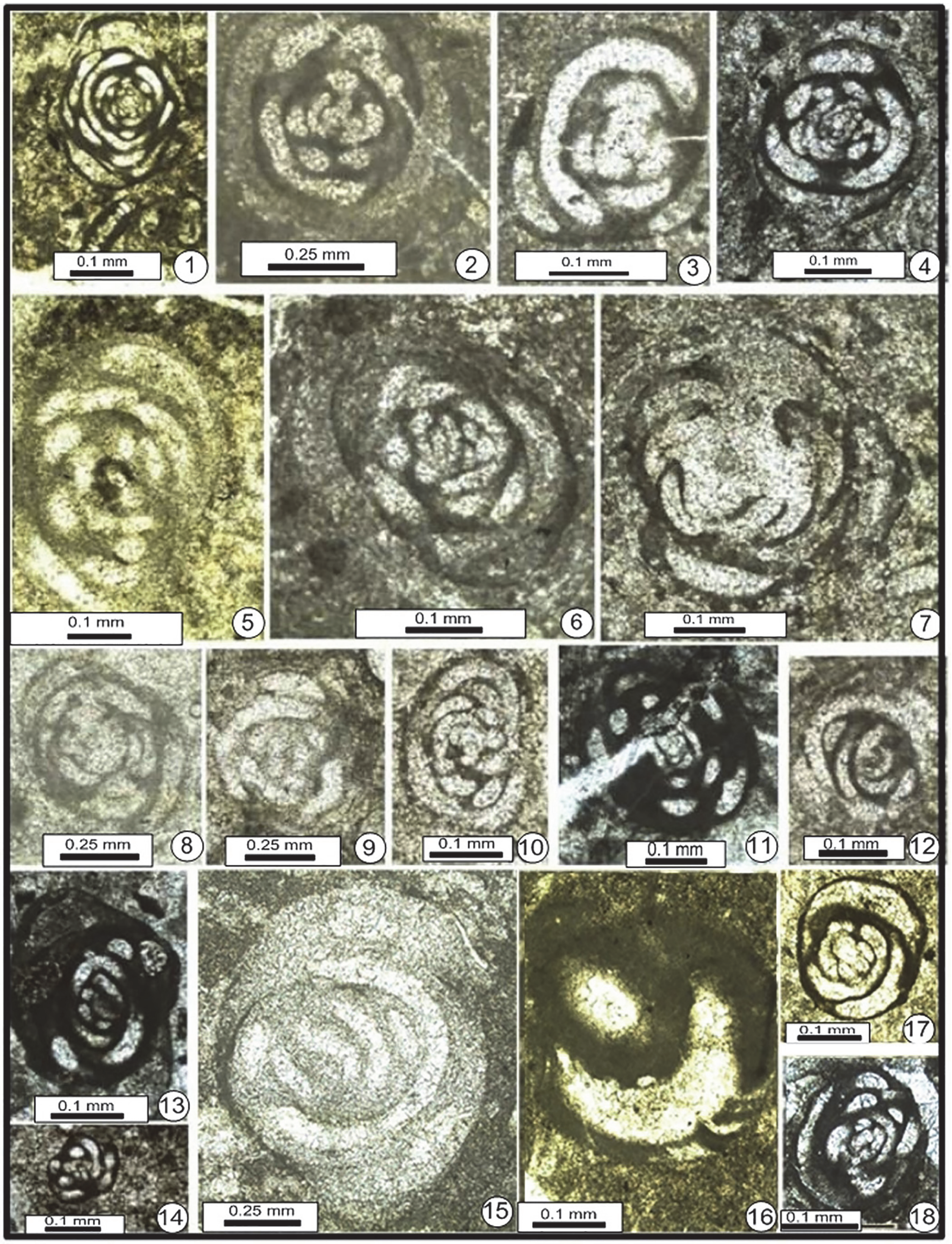

FIGURE 18. 1. *Hemigordiellina*? *pulchrissima* Ebrahim Nejad and Vachard n. sp. Paratype (top) with *Okimuraites plana* (Okimura and Ishii, 1981) (bottom). P39-71. Midian. 2-4. *Glomomidiella* cf. *problema* (Lin, 1978). 2. P9-50. Murgabian. 3. with *Hemigordiellina*? sp. (bottom) P9-38. Murgabian. 4. P34 32. Midian. 5. *Glomomidiella*? sp. 5. P44-26. Djulfian. 6. *Neodiscus milliloides* Miklukho-Maklay, 1953. P9-18. Murgabian. 7, 15-16. *Crassiglomella* cf. *guangxiensis* (Lin, 1978) emend. Gaillot and Vachard, 2007. 7. P10-1. Murgabian. 15. P16- 44. Murgabian. 16. P41-45. Latest Midian. 8-10, 12. *Glomomidiella* cf. *problema* (Lin, 1978). 8. P7-22. Murgabian. 9. P16 39. Murgabian. 10. P10-15. Murgabian. 12. P10-24. Murgabian. 11, 13-14, 17-18. *Glomomidiella* cf. *gigantea* (Lin, 1984). 11. P37-22. Midian. 13. P31-3. Midian. 14. P30-10. Earliest Midian. 17. P44-24. Djulfian. 18. P37-23. Midian.

Genus GLOMOMIDIELLA Vachard, Rettori, Angiolini and Checconi, 2008

Type species. *Glomomidiella nestellorum* Vachard, Rettori, Angiolini and Checconi, 2008.
Description. Test spherical, rarely ovoid, involute, with rounded periphery and without umbilicus. Streptospirally coiled with the last few volutions rarely aligned. Spherical proloculus followed by an enrolled pseudoseptate second chamber gradually and proportionally increasing in size. Periphery margin broadly rounded. Two groups of specimens considered as megalospheric and microspheric generations. Wall calcareous porcelaneous, well-preserved. The pseudoseptation produces a rugose inner periphery. Aperture simple at end of the tubular chamber.
Occurrence. Capitanian to Changhsingian. Palaeo-Tethys and Neo-Tethys: Tunisia, Croatia, Serbia, Hungary, Greece, Italy, Turkey, Iran, Himalaya, South China, Sumatra, and Malaysia.

Glomomidiella nestellorum Vachard, Rettori, Angiolini and Checconi, 2008
Figure 17.6-11

p. 1981 *Glomospira* spp.; Okimura and Ishii, pl. 2, figs. 6-7 (non figs. 2-5 = *Hemigordiellina* (sensu lato)).

1983b ?*Kamurana*; Jenny-Deshusses, pl. 20, figs. 3, 5.

? 1995 *Kamurana bronnimanni* Altiner and Zaninetti; Partoazar, pl. 1(1), fig. 4, 12-16.

v. 2008 *Glomomidiella nestellorum* Vachard, Rettori, Angiolini and Checconi, p. 354-356, pl. 1, figs. 1-19, pl. 2, figs. 1-20 (with synonymy).

2004 *Hemigordius* ssp. (sic for spp.); Jenny et al., pl. 7, fig. 6.

2009 *Glomomidiella nestellorum* Vachard, Rettori, Angiolini and Checconi; Song et al., fig. 8.33-34.

Description. Our specimens are consistent with the measurements of the type material.
Occurrence. As for the genus. Only abundant in one level of Maku (P30).

Glomomidiella cf. *gigantea* (Lin, 1984)
Figures 17.16-17, 18.11, 18.13-14, 18.17-18

?1981 *Baisalina pulchra* Reitlinger; Okimura and Ishii, p. 14-15, pl. 1, fig. 18.

1984 *Baisalina giganta* (sic) Lin, p. 127, pl. 3, figs. 22-23.

1995 *Baisalina pulchra* Reitlinger; Partoazar, pl. 2(1), figs. 1-5, pl. 4(1), fig. 1?, pl. 1(2), figs. 3-10, pl. 3(2), figs. 9-11.

?1995 *Baisalina pulchra* Reitlinger; Berczi-Makk, pl. 13, figs. 3-4, 6-7, pl. 14, figs. 4-5, pl. 15, fig. 6?.

1997 *Neodiscus grandis* (Lin, Li and Sun); Kobayashi, pl. 4, figs. 11-12.

2006b *Baisalina* sp.; Kobayashi, fig. 3.17-19.

v. 2008 *Glomomidiella gigantea* (Lin); Vachard et al., p. 354 (n. comb. orth. mut.; no illustration).

2011 *Glomomidiella*; Song et al., fig. 6.46.

Description. Although smaller than the species of Lin (1984), our material exhibits similar pseudo-septa, irregular in length and location. The taxon described here is probably the direct ancestor of typical *Baisalina pulchra* Reitlinger, 1965. Besides, many false *Baisalina pulchra* from the literature are similar to *Glomomidiella* ex gr. *gigantea* (e.g., Lys in Montenat et al., 1976, pl. 17, fig. 4; Whittaker et al., 1979, pl. 1, figs. 1-7; Lys et al., 1980, pl. 2, figs. 2-4; Zaninetti et al., 1981, pl. 4, figs. 19-2; Okimura et al., 1985, pl. 1, fig. 9; Partoazar, 1995 and Berczki-Makk et al., 1995 (for these two latter, see the synonymy list)).
Occurrence. Midian Lopingian of Palaeo- and Neo-Tethys. Midian-Djulfian of Maku (P30, P31, P37 and P44).

Glomomidiella cf. *problema* (Lin, 1978)
Figures 17.22-17.24, 18.2-18.4, 18.8-18.10, 18.12

1978 *Glomospira problema* Lin, p. 11, pl. 1, figs. 6-7.

?1982 *Neodiscus lianxanensis* Hao and Lin, p. 27, pl. 3, figs. 25-26.

?1995 Foram. indet. sp.; Berczi-Makk et al., pl. 13, figs. 3-4, 6-7, pl. 14, figs. 4-5, pl. 15, fig. 6?.

?v. 1992 *Baisalina* (?) sp.; Fontaine et al., pl. 5, fig. 7, pl. 20, fig. 4, pl. 35, figs. 4, 7-9, pl. 36, figs. 1, 6-7, pl. 47, fig. 10.

?v. 2007 *Neodiscus lianxanensis* Hao and Lin; Gaillot and Vachard, p. 95, pl. 56, figs. 15-16 (with synonymy).

v. 2008 *Glomomidiella problema* (Lin); Vachard et al., p. 354 (n. comb. orth. mut.; no illustration).

v. 2009 *Glomomidiella* sp.; Mohtat-Aghai et al., pl. 1, fig. 16.

Description. Our specimens have a coiling which differs from that of *G.* cf *gigantea* being tighter in the beginning and with a thinner wall. This species is probably the transitional form between *Glomomidiella* and *Crassiglomella*.

Occurrence. Murgabian-earliest Djulfian of Maku (P7, P9, P10, P16, P31, P34, P40, P41, P44 and P47).

Glomomidiella? cf. *specialisaeformis* (Lin, Li and Sun, 1990) n. comb.
Figure 17.14-15, 17.18

1990 *Hemigordius specialisaeformis* Lin, Li and Sun, p. 216-217, pl. 26, figs. 1-3.

1995 *Baisalina pulchra magna* Lys; Partoazar, pl. 3(1), figs. 3-7.

Remark. This species seems to be the ancestor of *Glomomidiellopsis* Gaillot and Vachard, 2007, a characteristic genus of the Lopingian. It can be also transitional to *Crassiglomella*.

Occurrence. Midian-Djulfian of Maku (P31, P37, P39 and P47).

Glomomidiella? sp. 5
Figure 18.5

Description. A unique specimen, the last whorls of which are aligned and give a compressed outline to the test, atypical for the genus.

Occurrence. Maku (P44).

Genus NEODISCUS Miklukho-Maklay, 1953 emend. Gaillot and Vachard, 2007

Type species. *Neodiscus milliloides* Miklukho-Maklay, 1953.

Synonyms. *Glomospira* Rzehak, 1885 (pars), *Archaediscus* Brady, 1873 (pars).

Description. Neodiscidae initially glomospiral and finally planispiral involute to semi-involute. Buttresses well developed. All volutions exhibit a high lumen.

Composition. *Neodiscus milliloides* Miklukho-Maklay, 1953; *N. eximius* Lin, Li and Sun, 1990; *N. grandis* Lin, Li and Sun, 1990; *Neodiscus lianxianensis* Hao and Lin, 1982; *N. orbicus* Lin, 1984; *N. ovatus* sensu Lin, Li and Sun, 1990 or sensu Ueno, 1992 non Grozdilova, 1956; *N. plectogyraeformis* Lin, Li and Sun, 1990; *N. scitus* Lin, 1984; *Agathammina* sp. B sensu Kobayashi, 1988, pl. 2, figs. 15, 22 (probably transitional to *Crassiglomella* n. gen.); *Hemigordius reicheli globulus* nom. nud. Altiner, 1981, pl. 44, figs. 11-13; *Kamurana* or *Neodiscus* sp. sensu Altiner and Özkan-Altiner, 1998, pl. 4, fig. 19; *Neohemigordius maopingensis* Wang and Sun, 1973 (part.).

Occurrence. Changhsingian of NW Caucasus (Miklukho-Maklay, 1953: indicated also as present in the Early Triassic). Midian of Oman (Vachard et al., 2002), Tunisia and central Japan, Changhsingian of Greece (Vachard et al., 1993a, b). Turkey (discovered in Hazro; present in Himmetli: D.V. unpublished data), and South China.

Neodiscus milliloides Miklukho-Maklay, 1953
Figures 8.8?, 17.12-13, 17.19, 18.6

1953 *Neodiscus milliloides* Miklukho-Maklay, p. 129, pl. 6, fig. 6.

?1981 *Hemigordius abadehensis* Okimura and Ishii, p. 16-17, pl. 1, figs.19-20.

?1988 *Kamurana broennimanni* Altiner and Zaninetti; Pronina, pl. 1, figs. 13-14.

2006a *Neodiscus padangensis* (Lange); Kobayashi, fig. 4.1-13, 4.21.

v. 2007 *Neodiscus milliloides* Miklukho-Maklay; Gaillot and Vachard, p. 95, pl. 21, fig. 3?, pl. 27, figs. 14-15, pl. 53, figs. 1, 7, pl. 54, fig. 2?, pl. 71, figs. 7?, 8?

? 2011 *Multidiscus*; Song et al., fig. 6.48.

Description. *Neodiscus* ovoid, slightly asymmetrical, last whorls aligned, involute to semi-evolute. D = (0.640)-1.100-1.550 mm (type material: 2.000-2.500 mm), w = 0.730-0.910 mm (type material = 1.000-1.600 mm), w/D = 0.66-0.69, p = (0.060) 0.090 mm, n = 6-7, h = 0.100-0.145 mm, s = 0.050-0.060 mm.

Occurrence. ?Murgabian-?Midian of Armenia. Late Midian of Sumatra and central Japan. ?Kalabagh Member of Salt Range (Pakistan). Late Changhsingian of NW Caucasus, South China and Zagros. Murgabian-Djulfian in Maku (P9, P10?, P20, P21, P30, P31, P37, P38, P50 and P55).

Genus CRASSIGLOMELLA Gaillot and Vachard, 2007

Type species. *Glomospira guangxiensis* Lin, 1978.

Synonym. *Glomospira* Rzehak, 1885 (part.).

Description. Neodiscidae entirely glomospiral, showing well developed buttresses and a high lumen of the whorls.

Composition. *Glomospira guangxiensis* Lin, 1978; *Agathammina pusilla* sensu Berczi-Makk, 1978, pl. 1, fig. 1; *A. pusulla* (sic) sensu Nguyen Duc Tien, 1986a, pl. 5, fig. 5; *A.* sp. A sensu Kobayashi, 1988, pl. 2, figs. 7-12; Foram. Indet. sp. sensu Berczi-Makk et al., 1995, pl. 15, figs. 1-3; ?*Baisalina pulchra* sensu Berczi-Makk et al., 1995, pl. 13, figs. 3-4, 6-7, pl. 14, figs. 4-5, pl. 15, fig. 6?

Comparison. It differs from the other Neodiscidae by the entirely glomospiral coiling, and from the *Glomospira* auctorum (= *Hemigordiellina* Marie in Deleau and Marie, 1961 sensu Vachard in Vachard and Beckary, 1991) by the large size and the buttresses.

Occurrence. Midian of Oman (Vachard et al., 2002) and central Japan (Kobayashi, 1988, reinterpreted). Lopingian of Cambodgia (Nguyen Duc Tien, 1986a). Changhsingian of Greece (Vachard et al., 1993a, b). Turkey (discovered in Hazro; also present in Himmetli, Vachard unpublished data). South China. Zagros and Fars (Iran) (Gaillot, 2006). Murgabian to Djulfian of Maku (P6, P7, P9, P10, P16?, P20, P21, P31, P44 and P54).

Crassiglomella cf. *guangxiensis* (Lin, 1978)
emend. Gaillot and Vachard, 2007
Figures 17.24, 18.7, 18.15-18.16

1965 *Glomospira* sp.; Kochansky-Devidé, pl. 13, figs. 7-8.

? 1973 *Hemigordius* sp.; Bozorgnia, pl. 41, figs. 1, 3.

1978 *Glomospira guangxiensis* Lin, p. 11, pl. 1, figs. 2-3.

?1981 *Hemigordius reicheli* Lys; Altiner, pl. 44, figs. 9-10 (see below).

?1990 *Neodiscus maopingensis* (Wang and Sun); Lin et al., p. 202, pl. 22, figs. 7-8.

1990 *Glomospira guangxiensis* Lin; Lin et al., p. 86 (no illustration).

1991 *Hemigordius*; Baud et al., pl. 1, fig. 1, pl. 2, fig. 1?

v. 1993a *Multidiscus* ex gr. *padangensis* (Lange); Vachard et al., pl .6, figs. 1, 3.

v. 1993a *Neodiscus milliloides* Milklukho-Maclay (sic); Vachard et al., pl. 6, figs. 4-7.

v. 1993a *Kamurana*? sp.; Vachard et al., pl. 6, fig. 6.

v. 1993b *Glomospira* [(?) ou *Kamurana* (?)] *guangxiensis* Lin; Vachard et al., pl. 8, fig. 3.

2001 *Kamurana*? sp.; Ueno, pl. 2, fig. 10.

non 2002 *Glomospira guangxiensis* Lin; Gu et al., p. 165, pl. 1, fig. 23 (a *Hemigordiellina*).

v. 2002 "*Glomospira*" ex gr. *guangxiensis* Lin; Vachard et al., pl. 6, fig. 1.

v. 2006 *Crassiglomella guangxiensis* (Lin); Gaillot, p. 111-112, pl. II.26, figs. 14, 16, pl. IV.4, fig. 12, pl. VI. 7, figs. 14, 17?

v. 2007 *Crassiglomella guangxiensis* (Lin); Gaillot and Vachard, p. 96, pl. 22, figs. 14, 17?, pl. 54, figs. 14, 16.

v. 2009 *Crassiglomella* sp.; Mohtat-Aghai et al., pl. 1, fig. 13-15, pl. 2, fig. 1.

Description. Buttresses very developed. Last whorl partially involute. Large diameter but remaining always inframillimetric for 5-6 whorls. Diameter (D) = 0.500-0.900 mm; width (w) = 0.400-0.600 mm; w/D ratio = 0.70-0.90; number of volutions: 5-6; height of last volution = 0.100-0.200 mm; wall thickness = 0.020-0.050 mm.

Remarks. The type of sections and/or growths of the individuals are very diverse. Hence, some sections can be interpreted as *Neodiscus* or *Multidiscus* (see Bozorgnia, 1973; Altiner, 1981; Vachard et al., 1993a or Lin et al, 1990). An unpublished material from Hazro (Turkey) showed us that the taxa *Glomospira guangxiensis*, *Multidiscus arpaensis* and *Neodiscus* cf. *milliloides* in the sense of Vachard et al. (1993a) correspond in reality to the unique species *Crassiglomella guangxiensis*.

Occurrence. Midian of Oman, Midian of Yunnan (Ueno, 2001, updated by Gaillot and Vachard, 2007). Lopingian of Croatia and Hungary. Wuchiapingian of South China. Changhsingian of Greece, Turkey, and South China. Late Changhsingian of Abu Dhabi. Latest Changhsingian of Offshore Fars (Iran). Midian of Maku (P34, P38 and P 44).

Class NODOSARIATA Mikhalevich, 1993
Superfamily ROBULOIDOIDEA Reiss, 1963 nom. translat. Loeblich and Tappan, 1984 emend. Gaillot and Vachard, 2007
Family SYZRANIIDAE Vachard in Vachard and Montenat, 1981

Remarks. The original definition is confirmed here: tubular Nodosarioidea without septation or with faint pseudosepta.

Composition. *Syzrania* Reitlinger, 1950; *Syzranella* Mamet and Pinard, 1992; *Amphoratheca* Mamet and Pinard, 1992; *Tezaquina* Vachard in Vachard and Montenat, 1981 non Vachard, 1980; ?*Vervilleina* Groves in Groves and Boardman, 1999 (this latter possesses more complete septa, and might be alternatively assigned to the Protonodosariidae).

Occurrence. Late early Moscovian to late Changhsingian, cosmopolite during the Pennsylvanian and Cisuralian, posteriorly limited to Neo-Tethyan and Palaeo-Tethyan.

Genus SYZRANIA Reitlinger, 1950

Type species. *Syzrania bella* Reitlinger, 1950.

Decription. Test cylindical, bilocular, undivided, with a proloculus followed by a chamber. Wall bilayered with an outer hyaline fibrous layer and an inner, microgranular wall. Aperture terminal simple.
Remark. This genus is the most primitive taxon with a hyaline wall, and consequently, it is the ancestor of all the hyaline foraminifers (Rotaliata sensu lato) currently dominant among the group.
Occurrence. Moscovian-Changhsingian, cosmopolite from Moscovian to Artinskian; then, only Tethyan.

Syzrania n. sp.?
Figures 16.3, 18.1-3

1988a *Syzrania* sp.; Pronina, pl. 2, fig. 1.

v. 2007 *Syzrania*? sp.; Gaillot and Vachard, pl. 85, figs. 10, 12.

Description. Test similar to a large *Syzrania*; i.e., with thick outer hyaline wall, thin inner microgranular layer, cylindrical, no septation. Proloculus not observed. Length = 0.780-0.950 mm; outer diameter (D) = 0.250-0.280 mm; inner diameter (d) = 0.170-0.200 mm; d/D ratio = 0.30-0.41; wall thickness = 0.035-0.050 mm.
Occurrence. Dorashamian of Armenia. Lopingian of Zagros and Guadalupian (Murgabian to Midian) of Maku (P6, P9 and P32).

Genus RECTOSTIPULINA Jenny-Deshusses, 1985 emend. Gaillot and Vachard, 2007

Type species. *Rectostipulina quadrata* Jenny-Deshusses, 1985.
Synonym. *Stipulina* Lys in Lys and Marcoux, 1978 (nomen nudum: no type species designated and/or described).
Description. Test tubular, small, undivided (or very rarely faintly divided), generally quadrate in transverse section. Wall hyaline yellowish. Proloculus are very rarely observed but present.
Discussion. Although criticized by Altiner and Savini (1997) and Groves (2000), the assignment of *Rectostipulina* to the Syzraniidae (Vachard and Montenat, 1981) or the Nodosariidae (Fontaine and Nguyen Duc Tien, 1989) is confirmed by the observation of some proloculi (Gaillot, 2006, pl. I.26, fig.10). Another proloculus of *Rectostipulina* was also published as "*Syzrania* sp." by Pronina (1988a: pl. 2, fig. 1; 1989: pl. 1, fig. 1). The proloculi of *Rectostipulina* are very rarely conspicuous, but similarly, Permian *Earlandia* seem to lack of proloculus and were erroneously separated as the distinct genus *Aeolisaccus*, but they exist in approximately 2 for 1000 sections (see Gaillot, 2006). Furthermore, *Rectostipulina* possesses clearly a nodosariin wall, easily comparable with the representatives of this suborder always very abundant with the *Rectostipulina*. It is impossible to conclude if *Giraliarella* Crespin, 1958 is a junior synonym or not of *Rectostipulina*, because another homeomorph exists: *Chitralina* Angiolini and Rettori, 1994, which possesses a microgranular wall, and is probably, although it lacks also of proloculus, an earlandioid foraminifer (see also Arnaud-Vanneau, 1980).
Composition. *Rectostipulina quadrata* Jenny-Deshusses, 1985; *R. pentamerata* Groves, Altiner and Rettori, 2005; *R. syzranaeformis* Gaillot and Vachard, 2007; *R. hexacamerata* Song and Tong in Song et al., 2009.
Occurrence. *Rectostipulina* is Midian-Lopingian in age in Palaeo-Tethys and Neo-Tethys. Pronina (1995) considered its FAD as Djulfian (= Wuchiapingian). Our material demonstrates the presence since the late Midian. Until now, the genus was known in the Lopingian of Cyprus, Afghanistan, Turkey, Greece, Alborz, Zagros, Armenia, Ladakh, West Thailand (Nguyen Duc Tien, 1988; Fontaine and Nguyen Duc Tien, 1989), Cambodgia (Nguyen Duc Tien, 1986a), Saudi Arabia (Vachard et al., 2005), and Yunnan (Ueno et al., 2010).

Rectostipulina quadrata Jenny-Deshusses, 1985
Figure 19.4-19.5

1965 Coupe d'un proloculum (Nodosaridaire?); Sellier de Civrieux and Dessauvagie, fig. 24.41 in text p. 152.

1985 *Rectostipulina quadrata* Jenny-Deshusses, p. 153-157, pl. 1, figs. 1-7.

1986a *Stipulina*?; Nguyen Duc Tien, pl. 1, fig. 4.

1988 *Rectostipulina quatrata* (sic) Jenny-Deshusses; Nguyen Duc Tien, p. 109, pl. 9, figs. 1-6.

1989 *Rectostipulina quadrata* Jenny-Deshusses; Fontaine and Nguyen Duc Tien, p. 120, 122, pl. 1, figs. 1-10, 14, 18 (non figs. 11-13, 15-18 part. = ?*Donezella lutugini*), pl. 2, figs. 1-6, 8-9 (part.) (non figs. 7, 9 (part.), 11-12, 14= ?*D. lutugini*) (with synonymy).

v. 1993a *Rectostipulina quadrata* Jenny-Deshusses; Vachard et al., pl. 7, figs. 10-12.

1995 *Stipulina lysi* Partoazar, pl. 2(1), fig. 19, pl. 1(3), fig. 1 (nom. nud.).

v. 2005 *Rectostipulina* sp.; Vachard et al., p. 166, pl. 6, fig. 8.

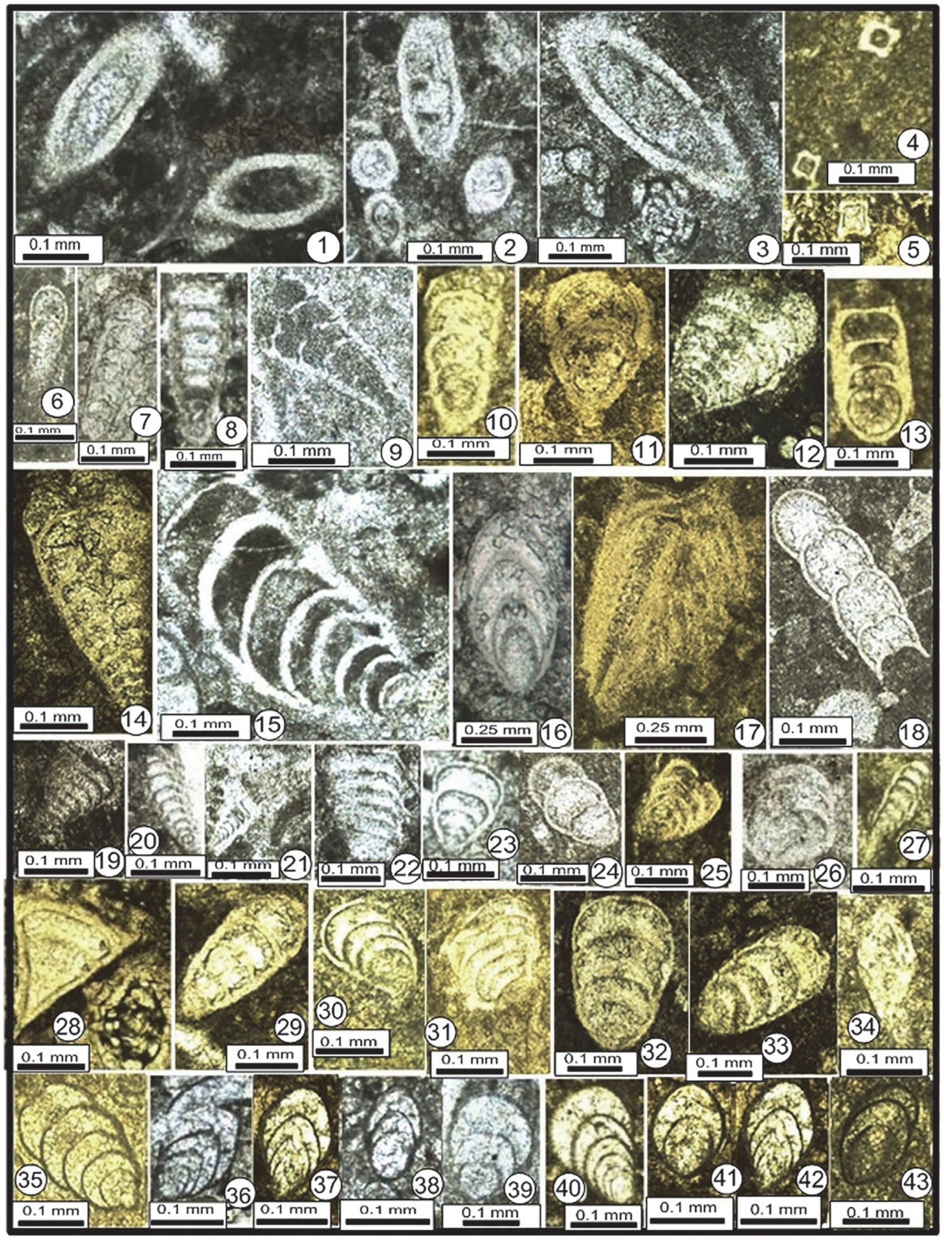

FIGURE 19. 1-3. *Syzrania* n. sp.? 1. P32-14. Midian. 3. With *Globivalvulina* and *Hemigordiellina*. P32-31. Midian. 4-5. *Rectostipulina quadrata* Jenny-Deshusses, 1985. 4. P50-35. Djulfian. 5. P47-6. Djulfian. 6. *Protonodosaria* cf. *sagitta* (Miklukho-Maklay, 1954). P9-11. Murgabian. 7-10, 29. *Nodosinelloides* spp. 7. P25-15. Murgabian. 8. P34-40. Midian. 9. P1-23. Murgabian. 10. P51-19. Djulfian. 29. P41-25. Latest Midian. 11. *Langella perforata* (Lange, 1925). Axial section. P56-9. Djulfian. 12, 19-22, 27, 31. *Geinitzina* sp. 12. P39-9. Midian. 19. P1-23. Murgabian. 20. P6-9. Murgabian. 21. P20-8. Murgabian. 22. P27-50. Murgabian. 27. P50-31. Djulfian. 31. P54-22. Djulfian. 13, 26. *Pachyphloia* ex gr. *ovata* Lange, 1925. 13. Frontal axial section. P54-5. Djulfian. 26. Sagittal axial section. P10-21. Murgabian. 14, 28. *Pseudotristix* sp. 14. Axial section. P41-24. Latest Midian. 28. subtransverse section with *Hemigordiellina regularis*. P47-43. Early Djulfian. 15. *Pseudolangella*? sp. Oblique section. P8-51. Murgabian. 16. *Lingulina* cf. *imaginaria* Pronina, 1999. P3. Early Murgabian. 17. *Pachyphloia* cf. *iranica* Bozorgnia, 1973. P41-46. Latest Midian. 18. *Pseudolangella* sp. P9-46. Murgabian. 23-24, 30, 32-33. *Frondicularia* sp. 23. P8-18. Murgabian. 24. P9-23. Murgabian. 30. P50-32. Djulfian. 32. P41-34. Latest Midian. 33. P39-52. Midian. 25. *Colaniella* aff. *minuta* Okimura, 1988. P41-37. Djulfian. 34. *Robuloides lens* Reichel, 1946. Axial section. P50-15. Djulfian. 35, 39-41, 43. *Frondina permica* Sellier de Civrieux and Dessauvagie, 1965. 35. P54-25. Djulfian. 39. P37-19. Midian. 40. P49-5. Djulfian. 41. P49-8. Djulfian. 43. P50-23. Djulfian. 36-38. *Ichthyofrondina palmata* (Wang, 1974). 36. P34-25. Midian. 37. P34-34. Midian. 38. P34-41. Midian. 42. P49-14. Djulfian.

2005 *Rectostipulina quadrata* Jenny-Deshusses; Groves et al., p. 29-30, fig. 23.5-12 (with synonymy).

v. 2006 *Rectostipulina quadrata* Jenny-Deshusses; Gaillot, p. 127-128, pl. I.27, fig. 17, pl. I.31, figs. 9, 11, pl. I.41, fig. 7, pl. II.27, figs. 1, 12, pl. III.10, fig. 14, pl. III.11, fig. 15, pl. III.12, fig. 12, pl. III.20, figs. 3, 13, pl. III.26, fig. 27, pl. III.27, fig. 14, pl. V.6, fig. 8, pl. VI.13, figs. 4-5.

2007 *Rectostipulina quadrata* Jenny-Deshusses; Groves et al., fig. 6.9, fig. 7.1-3.

v. 2007 *Rectostipulina quadrata* Jenny-Deshusses; Gaillot and Vachard, pl. 63, fig. 27, pl. 73, fig. 17, pl. 75, fig. 7, pl. 76, figs. 1, 12, pl. 77, fig. 14, pl. 78, fig. 15, pl. 79, fig. 12, pl. 80, figs. 3, 13, pl. 81, fig. 14, pl. 82, figs. 4-5, pl. 87, figs. 9, 11.

2009 *Rectostipulina quadrata* Jenny-Deshusses; Song et al., fig. 11.4-11.5.

2009 *Rectostipulina quadrata* Jenny-Deshusses; Ueno and Tsutsumi, figs. 9.20-9.21, 11.22.

2009 *Rectostipulina quadrata* Jenny-Deshusses; Nestell et al., pl. 2, fig. 1.

2010 *Rectostipulina quadrata* Jenny-Deshusses; Angiolini et al., fig. 4.30-4.31.

2010 *Rectostipulina quadrata* Jenny-Deshusses; Ueno et al., figs. 5.17, 6.8.

2012 *Rectostipulina quadrata* Jenny-Deshusses; Wignall et al., fig. 10J.

Remarks. Proloculus in section and complete longitudinal sections are very rare. Hence, the argument of the absence of proloculus is not definitive to exclude this taxon from the foraminifers, compared to the type of microstructure, entirely similar to the well characterized nodosariids contained in the same thin sections.

Occurrence. Lopingian of Turkey, Cyprus, Greece, northern Italy, Alborz, Zagros, Armenia, Saudi Arabia, Afghanistan, Ladakh, western Thailand, Cambodgia, Yunnan, New Zealand (e.g., Nguyen Duc Tien, 1986a, 1988; Fontaine and Nguyen Duc Tien, 1989; Vachard et al., 2005; Groves et al., 2005, 2007; Ueno et al., 2010). Djulfian of Maku (P40?, P47, P50 and P51).

Family PROTONODOSARIIDAE Mamet and Pinard, 1992 emend. Gaillot and Vachard, 2007

Subfamily PROTONODOSARIINAE Mamet and Pinard, 1992 nom. translat. Gaillot and Vachard, 2007

Genus PROTONODOSARIA Gerke, 1959 emend. Sellier de Civrieux and Dessauvagie, 1965

Type species. *Protonodosaria proceraeformis* Gerke, 1959 orth. mut. Vachard et al., 2005.

Description. Cylindrical test, initially slightly tapering. Chambers uniseriate, hemispherical, increasing slowly in height, with depressed sutures. Wall fibrous monolayered. Aperture rounded, simple, terminal.

Composition. See Gaillot and Vachard (2007).

Occurrence. Late Pennsylvanian (Kasimovian)-Late Permian, probably cosmopolite.

Protonodosaria cf. *sagitta* (Miklukho-Maklay, 1954)
Figure 19.6

To compare with:

1954 *Nodosaria sagitta* Miklukho-Maklay, 1954, p. 27-28, pl. 2, fig. 14.

?2005 *Nodosinelloides sagitta* (Miklukho-Maklay); Groves et al., p. 17, fig. 18.14-18-21, 18.23-18.30 (with synonymy).

2005 *Polarisella sagitta* (Miklukho-Maklay); Hughes, pl. 3, fig. 12.

2009 *Nodosinelloides sagitta* (Miklukho-Maklay); Song et al., fig. 11.17-21.

2009 *Polarisella sagitta* (Miklukho-Maklay); Ueno and Tsutsumi, fig. 9.17.

Description. This species is characterized by its small test, thin hyaline wall, subquadratic chambers relatively high. Initially tapering, the test becomes rapidly cylindrical. Sutures of chambers are faint. H = 0.500-0.600 mm, w = 0.035-0.050 mm, w/H = 0.25-0.33, n = probably 5-6), h = 0.150-0.200 mm, s = 0.005-0.007 mm. Our unique oblique section is incomplete but its similarity with *P. sagitta* is great. This species was already mentioned among the Alborz microfaunas by Jenny-Deshusses (1983b, p. 158, pl. 5, fig. 7).

Remark. An areal aperture is unquestionably present; therefore, this species belongs to *Protonodosaria* rather than *Nodosinelloides*. Although homeomorph, the specimens of Groves et al. (2005) are doubtful because their test is definitely bilayered. Our specimens are rare and insufficient to confirm the specific name.

Occurrence. Late Permian of northern Caucasus, Croatia, Japan, Ladakh, Taurus, NW Turkey, and South China. Murgabian-Djulfian of Maku (P3, P9?, P54 and P55).

Protonodosaria aff. *globifrondina* Sellier de Civrieux and Dessauvagie, 1965
Figure 19.18

To compare with:

1965 *Protonodosaria globifrondina* Sellier de Civrieux and Dessauvagie, p. 67, pl. 5, fig. 24, pl. 9, fig. 5, pl. 15, fig. 1, pl. 16, fig. 7.

1978 *Protonodosaria globifrondina*; Lys et al., pl. 8, figs. 9, 13.

1979 *Protonodosaria globifrondina*; Nguyen Duc Tien, p. 92-93, pl. 6, fig. 12.

1984 *Protonodosaria globifrondina*; Altiner, pl. 2, fig. 20.

1986a *Protonodosaria globifrondina*; Nguyen Duc Tien, pl. 2, fig. 12.

1989 *Protonodosaria globifrondina*; Köyluoglu and Altiner, pl. 9, fig. 20.

1994 *Protonodosaria globifrondina*; Fontaine et al., pl. 6, fig. 2.

Description. Test characterized by relatively embracing chambers, and septal and wall thicknesses relatively thin, and constant in size. Our unique section is oblique and broken, but might correspond to this species described in this genus.
Occurrence. FAD probably Midian-LAD Changhsingian; southern Turkey, Alborz, Himalaya, Malaysia and Cambodgia (i.e., a Perigondwanan and Indosinian species). Rare in Maku (P9, P35 and P55).

Genus NODOSINELLOIDES Mamet and Pinard, 1992

Type species. *Nodosinelloides potievskayae* Mamet and Pinard, 1996 (nomen novum for *Nodosaria gracilis* Potievskaya, 1962 preoccupied).
Description. Test subcylindrical, chambers generally hemispherical, not enveloping, increasing very slowly in height and width. Wall two layered with an ancestral microgranular inner layer and a typical fibrous outer layer (the corresponding evolutive stage of the archaediscids would be the concavus stage; e.g., Vachard, 1988). Lateral wall and septal wall are equal in thickness. Aperture terminal, simple, rounded, often not observable in section.
Composition. See Gaillot and Vachard (2007).
Occurrence. Late Pennsylvanian-Late Permian.

Nodosinelloides spp.
Figure 19.7-10, 19.29

Remark. Although ordinarily abundant in the Middle/Late Permian limestones, this genus is rare in our material.
Occcurrence. All the series of Maku (P1, P6, P23, P25, P32, P34, P35(2), P41, P50, P51, P55 and P56).

Subfamily LANGELLINAE Gaillot and Vachard, 2007

Genus LANGELLA Sellier de Civrieux and Dessauvagie, 1965

Type species. *Padangia perforata* Lange, 1925.
Description. Test small, medium, large or very large (height from 0.3 to 1.7 mm according to Sellier de Civrieux and Dessauvagie (1965) and up to 3.0 mm (Gaillot and Vachard, 2007)). From 4 to 11 chambers. Tapering cylindrical test, slightly compressed or not. Sagittal axial section oval, to triangular or bitriangular. Frontal axial section similar but more compressed. Transverse section circular to ovate. Absence of test nor proloculus ornementation. Aperture rarely observed in thin section; if present, it is simple, cylindrical, and lacking of particularities. Sutures absent. Chambers increase rapidly in height. Septa increase generally in thickness, except the last one generally thinner than the penultimate. Chambers curved, non-enveloping, relatively low at the beginning but becoming relatively high to high in the last part. Wall thick by covering of the successive layers, occasionally obviously lamellate. Some species seem to exhibit an “angulatus” stage as observed in the genus *Nestellorella* Gaillot and Vachard, 2007 (i.e., *Langella conica* sensu Bozorgnia, 1973 (part.), pl. 34, fig. 1, whereas p. 36, fig. 6 is really a *Nestellorella*).
Composition. See Gaillot and Vachard (2007).
Occurrence. Rare in the Yakhtashian-Bolorian (= Longlingian of South China = Kungurian of Urals), acme in S E Asia during the Midian. LAD in the Changhsingian, Palaeo- and Neo-Tethys.

Langella perforata (Lange, 1925)
Figure 17.11

1925 *Padangia perforata* Lange, p. 228-229, pl. 1, figs. 21a-b.

v. 2007 *Langella* ex gr. *perforata* (Lange); Gaillot and Vachard, p. 122-123, pl. 89, fig. 23, pl. 94, fig. 5.

Description. Only one immature species was observed but the shape of the chambers and the microstructure of the wall are typical of this species.
Occurrence. Midian of Sumatra, Turkey, Afghanistan, Russia, NW Caucasus, Armenia, Thailand, Sarawak, Malaysia and Iran (Alborz). Lopingian of South China and Zagros, and Djulfian of Maku (P56).

Genus PSEUDOLANGELLA Sellier de Civrieux and Dessauvagie, 1965

Type species. *Pseudolangella fragilis* Sellier de Civrieux and Dessauvagie, 1965.
Description. Test small to submillimetric (Height = 0.300-0.900 mm), with five to nine chambers. Sagittal axial section tapering. Frontal axial section compressed. Transverse section circular. Absence of ornementation of the test or proloculus. Aperture generally absent in thin-section or simple, cylindrical, without peculiar characteristics. Sutures absent. Chambers increase regularly in height. Septa increase weakly in thickness. Chambers curved, non-enveloping, relatively low at the beginning but becoming relatively high in the last part. Wall proportionally thin.
Occurrence. FAD probably Sakmarian-LAD Changhsingian in Palaeo- and Neo-Tethys. Maku (P6, P9, P10, P25, P35, P40 and P49).

Pseudolangella? sp.
Figure 19.15

Remark. Only an oblique section of great size might be related to this genus; nevertheless, all the chambers remain relatively low.
Occurrence. Early Murgabian of Maku (P8).

Family GEINITZINIDAE Bozorgnia, 1973
Genus GEINITZINA Spandel, 1901

Type species. *Geinitzina postcarbonica* Spandel, 1901.
Occurrence. Latest Pennsylvanian (Groves, 2000)-Permian, cosmopolite, up to Changhsingian (Lin et al., 1990).

Geinitzina sp.
Figure 19.12, 19.19-22, 19.27, 19.31

Description. The *Geinitzina* are poorly represented in our material, and apparently by a undetermined small species.
Occurrence. Murgabian-Djulfian of Maku (P1, P6, P8, P9, P20, P21, P23, P27, P31, P35, P35(2), P39, P40, P50 and P54).

Genus FRONDICULARIA sensu Sellier de Civreux and Dessauvagie, 1965

Type species. *Renulina complanata* Defrance, 1824.
Description. Biconical test, with long lower cone and small upper cone. Chambers low, broad and palmate to horseshoe-shaped. Aperture terminal, central, radiate, sometimes with a small neck.
Occurrence. Sakmarian to latest Changhsingian (Gaillot and Vachard, 2007).

Frondicularia sp.
Figure 19.23-19.24, 19.30, 19.32-33

Remark. This undetermined species is sporadic in our material (P8, P9, P39, P41 and P50).

Genus PSEUDOTRISTIX Miklukho-Maklay, 1960

Type species. *Tristix* (*Pseudotristix*) *tcherdynzevi* Miklukho-Maklay, 1960.
Synonym. *Multifarina* Lin, 1984.
Description. Similar to *Geinitzina*, but with an uniseriate development becoming triserial or with three diverging series of chambers.
Occurrence. The taxon is generally cited in the Wuchiapingian/Djulfian, from Turkey to South China (including *Multifarina* where it is indicated as Maokouan in age by Lin et al., 1990, p. 89). Its FAD seems to be late Midian in Sumatra, central Japan and Russia (Podvolzhya, Prekama, and Primorye), and its LAD is Changhsingian in age in Armenia, Italy, Cambodgia, South China, Yunnan, northern Thailand, Japan and Zagros.

Pseudotristix sp.
Figure 19.14, 19.28

Remark. These rare representatives of the genus correspond probably to a new species.
Occurrence. Latest Midian-Djulfian of Maku (P41, P47 and P51).

Family ROBULOIDIDAE Reiss, 1963 nom. translat. Loeblich and Tappan, 1984

Synonym. Eocristellariidae Loeblich and Tappan, 1984 (although this latter family was originally assigned to the Fusulinata).
Description. Planispirally coiled Robuloidoidea, sometimes secondarily uncoiled.
Occurrence. Earliest to latest Permian. Palaeo- and Neo-Tethys.

Genus ROBULOIDES Reichel, 1946

Type species. *Robuloides lens* Reichel, 1946.
Occurrence. Midian-latest Changhsingian of Greece (Hydra, Attica), Cyprus, Hungary, Turkey, NW Caucasus, Armenia, Afghanistan, Salt Range, South China, Primorye, Japan and New Zealand.

Robuloides lens Reichel, 1946
Figure 19.34

1946 *Robuloides lens* Reichel, p. 536, text-figs. 21-26, pl. 19, figs. 6-7.

1981 *Robuloides lens* Reichel; Okimura and Ishii, p. 18-19, pl. 1, fig. 5.

non 1997 *Robuloides lens* Reichel; Kobayashi, pl. 5, figs. 7-10 (= *Robuloides acutus* Reichel or another species).

v. 2005 *Robuloides lens* Reichel; Vachard et al., p. 170-171, pl. 6.9.

2005 *Robuloides lens* Reichel; Groves et al., p. 32-33, fig. 24.3-7, 24.10-13 (with synonymy).

non 2009 *Robuloides lens* Reichel; Song et al., fig. 10.33-35 (= *R. acutus*).

2009 *Robuloides acutus* Reichel; Nestell et al., pl. 2, figs. 22-25.

non 2010 *Robuloides lens* Reichel; Angiolini et al., fig. 4.32 (= *Pararobuloides*).

Description. Very rare but typical specimens.

Occurrence. Midian-Late Permian of Turkey, Greece (Attica), northern Italy, NW Caucasus, Armenia, Iran (Abadeh), Salt Range, Japan, South China, New Zealand (according to Groves et al., 2005, p. 33). Duhaysan Member (late Djulfian) of Saudi Arabia (Vachard et al., 2005). Djulfian of Maku (P45? and P50).

Family FRONDINIDAE Gaillot and Vachard, 2007

Description. A family of Nodosarioidea relatively common during the Midian/Capitanian and Late Permian. This family is characterized by its dark (microgranular hyaline) wall and the embracing shape of the chambers. The apertures, areal and simple, are smooth or accompanied by an internal neck.

Comparison. This family differs from all other ones of the Nodosarioidea by the return to a dark wall (i.e., that of the earliest ancestor *Earlandia*; see Vachard, 1994), whereas the members of the family are rigorously homeomorphous with some typical Nodosarioidea such as *Ichthyolaria* Wedekind, 1937. The link between Protonodosariidae and Frondinidae can be represented by the genus *Tauridia* Sellier de Civrieux and Dessauvagie, 1965 emend. Gaillot and Vachard, 2007 which exhibits a partial disappearance of the yellow external layer of the wall.

Occurrence. Capitanian-Changhsingian. Palaeo- and Neo-Tethys.

Genus FRONDINA Sellier de Civrieux and Dessauvagie, 1965

Type species. *Frondina permica* Sellier de Civrieux and Dessauvagie, 1965.

Synonyms. *Ichthyofrondina* (part.); *Lingulina* (part.); *Pseudoglandulina* sp.; *Ichthyolaria* (part.); *Frondicularia* (part.).

Description. Test uniseriate with rectilinear axis of development. Chambers horseshoe shaped to semi-ellipsoidal, weakly enveloping to evolute. Wall hyaline but apparently dark. Aperture simple, terminal, central, with two inner oral tongues.

Composition. See Gaillot and Vachard (2007).

Occurrence. Late Midian-Changhsinghian, Palaeo- and Neo-Tethyan (Turkey, Iran, NW Caucasus, Armenia, NWThailand, South China, Japan, New Zealand; Gaillot and Vachard, 2007)

Frondina permica Sellier de Civrieux and Dessauvagie, 1965
Figure 19.35, 19.39-19.41, 19.43

1965 *Frondina permica* Sellier de Civrieux and Dessauvagie, p. 59-60, pl. 5, figs. 17-18, 21-23, 26-28, 32-33.

?1981 *Lingulina* sp. cf. *L. elegantula* (M-Maklay); Okimura and Ishii, p. 17-18, pl. 1, fig. 12.

1995 *Frondina permica* Sellier de Civrieux and Dessauvagie; Partoazar, pl. 2(1), figs. 12, 18.

1997 *Lunucammina* sp. B; Kobayashi, pl. 3, fig. 11.

2004 *Frondina permica* Sellier de Civrieux and Dessauvagie; Jenny et al., pl. 8, fig. 17.

2005 *Frondina permica* Sellier de Civrieux and Dessauvagie; Groves et al., p. 27, fig. 21.12, 21.20, figs. 22.6-22.13, 22.14 (with synonymy).

2005 *Frondina permica* Sellier de Civrieux and Dessauvagie; Hughes, pl. 2, figs. 9, 17-18.

v. 2005 *Frondina permica* Sellier de Civrieux and Dessauvagie; Mohtat-Aghai and Vachard, pl. 2, figs. 22-25.

v. 2006 *Frondina permica* Sellier de Civrieux and Dessauvagie; Insalaco et al., pl. 2, fig. 22.

v. 2007 *Frondina permica* Sellier de Civrieux and Dessauvagie; Gaillot and Vachard, p. 138-139, pl. 4, fig. 23, pl. 74, figs. 1-2, pl. 77, figs. 16, 22, pl. 83, fig. 22, pl. 84, fig. 23 pl. 91, fig. 20 (with synonymy).

2009 *Frondina permica* Sellier de Civrieux and Dessauvagie; Song et al., fig. 11.37-39.

2009 *Frondina palmata* Sellier de Civrieux and Dessauvagie; Ueno and Tsutsumi, figs. 9.19, 11.31.

?2009 *Frondina laxa* (Lin, Li and Sun); Nestell et al., pl. 2, figs. 18-19.

?2009 *Frondina* cf. *F. paraconica* (Lin, Li and Sun); Nestell et al., pl. 2, figs. 20-21.

v. 2009 *Frondina permica* Sellier de Civrieux and Dessauvagie; Mohtat-Aghai et al., pl. 2, figs. 25-26.

?2010 *Pseudolangella*? sp.; Ueno et al., fig. 5.26.

? 2011 "*Pseudoglandulina*"; Song et al., fig. 6.44.

Description. Test uniseriate with rectilinear axis of development. Chambers horseshoe shaped to semi-ellipsoidal, weakly enveloping to evolute. Wall hyaline but apparently dark. Aperture simple, terminal, central, with two inner oral tongues.

Dimensions. H = 0.200-0.430 mm, w = 0.40-0.090 mm, w/H = 0.50-0.60, p = 0.020-0.030 mm, chambers: (2) 4-5, h = 0.035-0.060 mm, s = 0.007-0.010 mm.

Occurrence. Lopingian of Turkey, Greece, Iran (Abadeh, Zagros), ?Yunnan and Cambodgia; and according to Groves et al. (2005, p. 27): northern Italy, Alborz, Koryak upland, NW Caucasus, Armenia, Lamayuru Block (Himalaya, Japan and Indochina). Midian-Djulfian of Maku (P31, P34, P37, P49, P51 and P54).

Genus ICHTHYOFRONDINA Vachard in Vachard and Ferrière, 1991 emend. Gaillot and Vachard, 2007

Type species. *Ichthyolaria latilimbata* Sellier de Civrieux and Dessauvagie, 1965.

Synonyms. *Frondina* Sellier de Civrieux and Dessauvagie, 1965 (part.); *Lingulina* (part.), *Pseudoglandulina* (part.); *Ichthyolaria* (part.); *Frondicularia* (part.).

Description. Test uniseriate. Chambers palmate, strongly enveloping, rarely evolute. Wall hyaline but apparently dark. Aperture simple, terminal, central, with two inner oral tongues, or absent.

Composition. See Gaillot and Vachard (2007, p. 139).

Occurrence. Late Midian-Changhsinghian, Palaeo- and Neo-Tethyan (Turkey, northern Caucasus, Armenia, Iran, South China, Thailand, New Zealand).

Ichthyofrondina palmata (Wang, 1974)
Figure 19.36-38

1974 *Ichthyolaria palmata* Wang, p. 287, pl. 149, fig. 11.

? 1995 *Ichtyolaria latilimbata* de Civrieux and Dessauvagie; Partoazar, pl. 1(1), fig. 12, pl. 2(2), fig. 4, pl. 3(1), fig. 13, pl. 3(2), fig. 7.

1997 *Lunucammina palmata* (Wang); Kobayashi, pl. 3, figs. 13-14.

2005 *Ichthyofrondina palmata* (Wang); Groves et al., p. 25, fig. 22.1-22.5 (with synonymy).

2006b *Frondina palmata* Wang; Kobayashi, fig. 9.4-9.8.

v. 2007 *Ichthyofrondina palmata* (Wang); Gaillot and Vachard, p. 139-140, pl. 10, fig. 11, pl. 73, fig. 6 (with synonymy).

2009 *Ichthyofrondina palmata* (Wang); Song et al., fig. 11.33-36.

2009 *Ichthyofrondina palmata* (Wang); Ueno and Tsutsumi, fig. 9.17.

2010 *Ichthyofrondina palmata* (Wang); Angiolini et al., fig. 4.24.

?2010 *Ichthyofrondina* sp.; Ueno et al., fig. 5.31.

? 2011 "*Ichthyofrondina*"; Song et al., fig. 6.31.

Description. Test uniseriate with rectilinear axis of development. Chambers palmate, strongly enveloping. Wall hyaline but apparently dark. Aperture simple, terminal, central.

Dimensions. Very small test with palmate chambers. H = 0.120-0.150 mm; w = 0.060-0.090 mm; w/H = 0.60-0.75; p = 0.010-0.020 mm; chambers: 5-6; h = 0.030-0.060 mm; s = 0.007-0.010 mm.

Occurrence. Lopingian of South China, Armenia, Turkey and Zagros (Gaillot and Vachard, 2007). Lopingian of Yunnan (Ueno et al., 2010). Midian-Djulfian of Maku (P34, P39, P49, P50 and P51).

Family COLANIELLIDAE Fursenko in Rauzer-Chernousova and Fursenko, 1959
Genus COLANIELLA Likharev, 1939

Type species. *Pyramis parva* Colani, 1924.

Occurrence. Late Midian-Dorashamian (Kotlyar et al., 1989; Jenny-Deshusses and Baud, 1989). Late Djulfian-Dorashamian (Vachard et al., 2002). Limited to the Changhsingian of South China (Lin et al., 1990, p. 83).

Colaniella aff. *minuta* Okimura, 1988
Figure 19.25

To compare to:

1988 *Colaniella minuta* Okimura, p. 719, 721, figs. 6.1-6.4.

v. 2005 *Colaniella* cf. *minuta* Okimura; Vachard et al., p. 173, pl. 6.6-6.7.

v. 2007 *Colaniella* aff. *minuta* Okimura; Vachard et al., p. 142, pl. 73, figs. 12-13, pl. 74, figs. 9-10, 18, pl. 75, fig. 6, pl. 78, fig. 11, pl. 83, figs. 16-17, 30, pl. 87, fig. 12, pl. 91, fig. 5 (with synonymy).

Remark. Only one specimen, but totally similar to the taxon described by Gaillot and Vachard (2007, p. 142) which constitutes probably a new species useful for the biozonation of Pakistan, NW Iran, Armenia and Saudi Arabia.

Occurrence. Very rare in Maku (P41).

Superfamily NODOSARIOIDEA Ehrenberg, 1838
nom. translat. Loeblich and Tappan, 1961
Famly NODOSARIIDAE Ehrenberg, 1838
Genus LINGULINA d'Orbigny, 1826

Type species. *Lingulina carinata* d'Orbigny, 1826.

Lingulina cf. *imaginaria* Pronina, 1999
Figure 19.16

1999 *Lingulina imaginaria* Pronina, p. 12, pl. fig. 19.

Description. H = 0.200-0.250 mm; w = 0.105-0.120 mm; H/w = 1.50-1.85; number of whorls: 5; proloculus diameter: 0.020-0.030 mm; h = 0.350-0.400 mm.

Remarks. Our specimens are similar in size to *L. imaginaria*, although more compressed and with chevron-shaped rather than horseshoe-shaped chambers. The dating differs also since *L. imaginaria* is Dorashamian (i.e., latest Permian) in age.

Occurrence. Early Murgabian of Maku (P3).

Family PACHYPHLOIIDAE Loeblich and Tappan, 1984

Description. Test uniseriate, thick walled, with radiate aperture. Frontal and sagittal axial sections are very different in aspect. Sagittal axial sections show enveloping curved septa, whereas frontal axial sections show the thickened walls. Aperture stellate.

Occurrence. Sakmarian to Jurassic. The FAD of *Pachyphloia* is discussed: probably Middle Permian according to Pinard and Mamet (1998), late Early Permian: Chihsian (Lin et al., 1990) or Artinskian (Groves, 2000), may be early Early Permian (Sakmarian) (Vachard and Krainer, 2001). The LAD is Dorashamian (e.g., Lin et al., 1990; Pronina-Nestell and Nestell, 2001; Wang and Ueno, 2003; Shang et al., 2003).

Genus PACHYPHLOIA Lange, 1925

Type species. *Pachyphloia ovata* Lange, 1925 (see Loeblich and Tappan, 1987, non Sellier de Civrieux and Dessauvagie, 1965).

Occurrence. FAD in the Sakmarian; LAD: latest Permian. Acme and specific diversification: Midian-Lopingian in Hazro (Turkey) and Zagros (Iran).

Pachyphloia ex gr. *ovata* Lange, 1925
Figure 19.13, 19.26

1925 *Pachyphloia ovata* Lange, p. 231, pl. 1, fig. 24a-b.

v. 1993a *Pachyphloia ovata* Lange; Vachard et al., pl. 7, fig. 13.

p. 1997 *Pachyphloia ovata* Lange; Kobayashi, pl. 3, figs. 615, 20.27 (with synonymy).

2006b *Frondina palmata* Wang; Kobayashi, fig. 9.25-9.31

v. 2007 *Pachyphloia ovata* Lange; Gaillot and Vachard, p. 143-144, pl. 72, figs. 5, 23, pl. 73, figs. 4, 8 (with synonymy).

2009 *Pachyphloia ovata* Lange; Song et al., fig. 10.28-30.

2012 *Pachyphloia ovata* Lange; Wignall et al., fig. 10G.

Description. This species is the smallest *Pachyphloia*; it is subelliptical in axial section and fan-shaped in transverse section. This species is relatively tolerant and well adapted; hence, it occupies all the occurrence zone of this genus. H = 0.180-0.300 mm; w = 0.120-0.200 mm; w/H = 0.75-0.80; p = 0.020-0.040 mm; n chambers: 4-6; h = 0.010-0.020 mm.

Occurrence. Midian-Lopingian: Taurus, Zagros, Azarbaijan, Greece, Armenia, Italy, NW Caucasus, Pakistan, Indonesia, South China, Indochina, Japan, New Zealand. Murgabian- Djulfian in Maku (P9, P10, P14?, P17, P19, P32, P35, P35(2), P37, P40, P41, P52, P54 and P55).

Pachyphloia cf. *iranica* Bozorgnia, 1973
Figure 19.17

To compare to:

1973 *Pachyphloia iranica* Bozorgnia, p. 155-156, pl. 37, figs. 1-6.

1980 *Pachyphloia iranica* Bozorgnia; Lys et al., p. 88-89, pl. 4 (non pl. 4, fig. 10: *Pachyphloia iranica colcheni* n. subsp. = a colaniellid and probably a true *Colaniella*).

non 2005 *Pachyphloia iranica* Bozorgnia; Hughes, pl. 3, figs. 11, 22, pl. 4, figs 2, 4-5 (other nodosariates).

Description. Rare sections of this large forms with many chambers.

Occurrence. Murgabian-Djulfian of Alborz, Taurus, Ladakh (Himalaya), and New Zealand. Midian of Maku (P41).

REGIONS	TURKEY	IRAN	AFGHANISTAN	PAMIR
PERIHERCYNIAN	PONTIDES	MASHHAD area	HINDU KUSH	NORTHERN PAMIR
CIMMERIAN (= EXTRAGONDWANAN)	SARAKAYA block	ALBORZ	BAND-E BAYAN	RUSH KOL ZONE
intermediary	?	?	CENTRAL MOUNTAINS of AFGHANISTAN	S.E. PAMIR
PERIGONDWANAN	TAURUS (+ KARABURUN + CHIOS	NW IRAN (this study), ABADEH area, ZAGROS	KABUL BLOCK	?
GONDWANAN	ARABIA	ARABIA	INDIA	INDIA

FIGURE 20. Attempt of palaeogeographical correlations between the terranes separated by the Tethys ocean during the Permian (after Vachard, 1980; 1996; Vachard and Montenat, 1981, 1996; and D. Vachard (unpublished data)).

DISCUSSION AND CONCLUSIONS

The foraminiferal microfaunas of NW Iran are generally well-known and well-studied. Nevertheless, the section of Maku is permitted to find some new taxa and to accurately define the range of some other ones. No endemic forms have been encountered and the smaller foraminiferal microfauna is similar to that of the other regions of Iran (Bozorgnia, 1983; Partoazar, 1995; Gaillot, 2006; Insalaco et al., 2006; Gaillot and Vachard, 2007; Mohtat-Aghai et al., 2009; Kolodka et al., 2012; Parvizi et al., 2013; Filimonova, 2013). The fusulinids remain rare as in all the Palaeo-Tethys and Neo-Tethys western branches, compared to the central (e.g., Pamir) and western (e.g., South China) branches of these oceans. Some narrow similarities of the NW Iran microfauna with that of South China are confirmed in this study. Because of the foraminiferal assemblages, a palaeobio- and palaeogeographical location of NW Iran in the Perigondwanan Realm is suggested, contrary to many current reconstructions, which emplaced this area in the Cimmerian Continent located between Palaeo- and Neo-Tethys. Similarly, Armenia is a Perigondwanan territory because it contains Late Permian smaller foraminifer "*Angelina*" Altiner, 1988 discovered by Pronina and Gubenko (1990). This genus was first defined in the Taurus Mountains in southern Turkey, which are unquestionably a part of the Perigondwanan border, and because the radiation centre of "*Angelina*" occurs in this area with the following lineage: (a) Lazarus effect of *Pseudovidalina* in the Murgabian-Midian (Zaninetti et al., 1981; Güvenç, 1988; Pronina and Gubenko, 1990); (b) primitive "*Angelina*" during the Midian time (Pronina and Gubenko, 1990); (c) advanced "*Angelina*" during the Late Permian subsystem (Güvenç, 1988). "*Angelina*" must be renamed because it is preoccupied by a Cambrian trilobite; it was synonymized by Pinard and Mamet (1998) with *Xingshandiscus* but this homeomorphous genus seems to be different due to its (primitive) bilayered wall. "*Angelina*" might be present in NW Iran and Zagros but it has not been yet discovered in both areas. As another explanation, "*Angelina*" can be restricted to Armenia and Taurus and constitutes a subprovince of the Perigondwanan Realm, probably isolated by sea currents or some continental barriers.

As in Zagros and Taurus, a primitive species of *Paradagmarita*, *P.* sp., has been found. Similarly,

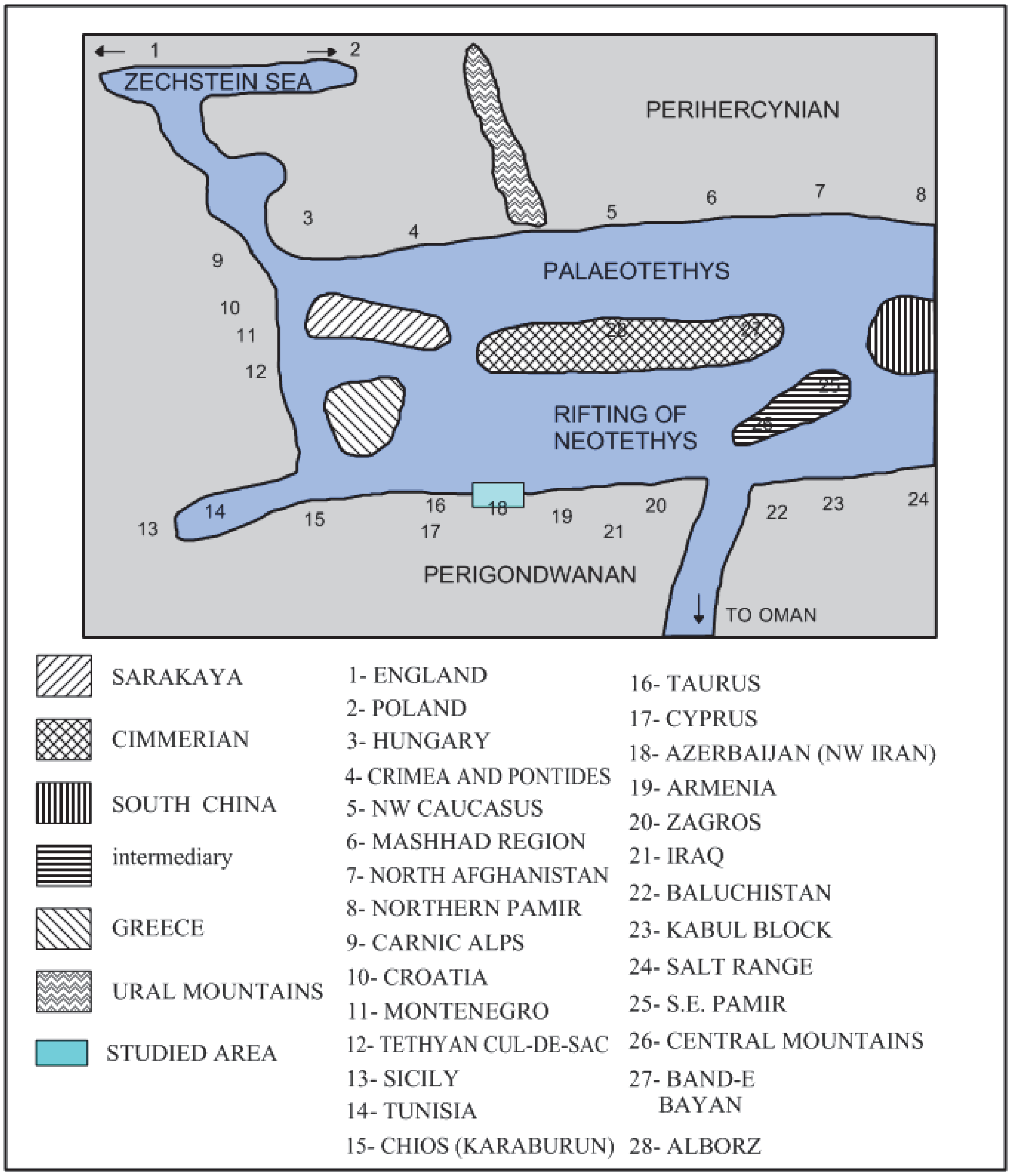

FIGURE 21. Proposed palaeomap of the Tethyan regions from western Europe to central Asia (according to Théry et al., 2007 modified; and D. Vachard (unpublished data)).

Frondina and *Ichthyofrondina* are common in the three regions (Zagros, NW Iran, Taurus), as well in Armenia.

Although the NW Caucasus belongs to the northern border of the Palaeo-Tethys, it is closely related with South China during the late Changhsingian, but its algal and foraminiferal populations differ sensibly from those of Armenia and NW Iranian Azerbaijan. These latter have been generally correlated with southern Crimea and Alborz Mountains as part of Cimmerian blocks (e.g., Wignall and Twichett, 2002; Théry et al., 2007). Bükk Mountains and Greece are poorly constrained but seem to belong to one or two independent microplates.

The Perigondwanan Domain is considered here as it was interpreted by Vachard et al. (2005). It extends to the Tebaga in Tunisia. The eastern border of the Palaeo-Tethys-Neo-Tethys confluence is constituted by Italy and ex-Yugoslavia. Within the Peri-Hercynian Domain exist two confined seas: the Zechstein Sea and the Bellerophon Sea (e.g., Théry et al., 2007, fig. 8). This palaeogeography (Figures 20-21) was consistent with the distribution of the Permian markers first emphasized by Sengör et al. (1988), namely *Eopolydiexodina*, *Shanita*, *Palaeofusulina* and *Colaniella*, but is not consistent with some of our markers: e.g., *Sumatrina*, *Glomomidiella* transitional to *Baisalina* or to *Neodiscopsis*, *Okimuraites* (= *Brunsispirella*), primitive *Paradagmarita* and *Colaniella* aff. *minuta*.

As in Armenia, in Iranian Azerbaijan and especially in the Kuh-e Ali Bashi area, the Dorashamian (= Changhsingian) is represented by red nodular limestone rich in ammonoids and conodonts but poor in foraminifers (Altiner et al., 1980; Baud, 2008; Leda et al., 2013). That confirms the geographical affinities of Armenia and Azerbaijan, and their assignment to the Perigondwanan border.

If the Neo-Tethys, as an oceanic spreading area, opened in the Middle Permian (see Sharland et al., 2001), the Cimmerian Continent sensu lato (more exactly the Extragondwanan Realm of Vachard, 1980) was individualized as an island or archipelago since at least the late Viséan (Vachard, 1980; Okuyucu et al., 2013) with the following constitutents: Sarakaya Terrane in Turkey, Alborz in Iran and Band-e Bayan in Afghanistan (Figures 20-21).

As indicated by Théry et al. (2007), both Palaeo- and Neo-Tethyan branches during the Middle-Late Permian belong to the same tropical/subtropical climatic zone, and the foraminiferal and algal assemblages do not permit to individualize each branch accurately. Nevertheless, due to some biomarkers, NW Iran, Armenia, Zagros and Abadeh appear geographically related, whereas they appear not connected with the Alborz (Figure 21).

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