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A field trip in search for the Jurassic/Cretaceous boundary in the Kopet Dagh range (N Iran) - October 15-28, 2019

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Chapter 1 - Preliminary investigations on the Zard Formation at its type locality (North Khorasan Province, Iran)

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Abstract: This chapter presents a revision of the Zard Formation in its type area, *i.e.*, in the North Khorasan Province (Iran), including at its type locality. It comprises a description of the sedimentological and micropaleontological criteria that permit it to be distinguished from the Mozduran Formation (below) and the Tirgan Formation (above). At its type locality, its lower boundary is a heavily bored surface. Actually, both contacts with the framing formations correspond to transgressive surfaces, which imply that this lithostratigraphic unit is an Unconformity-Bounded Unit. With respect to biostratigraphy, this formation contains a few second-order markers: *Holosporella sugdeni*, *Kopetdagaria sphaerica*, and *Torinosuella peneropliformis*, which are also found in the unit above, *i.e.*, in the Tirgan Formation. Because the latter contains markers that first appear in the Barremian: *Bakalovaella elitzae*, *Pseudoactinoporella iranica*, and *Balkhania balkhanica*, but also *Montseciella arabica*, the total range of which spans the Upper Barremian, the Zard Formation (*i.e.*, the Zardian regional stage) should partly covers the Hauterivian to Barremian interval. Finally, although it cannot be definitely excluded that the lowermost part of the Zard Formation could be Valanginian in age, this option still requires proper documentation.

Keywords:

- Kopet Dagh;
- Mozduran;
- Zard;
- Tirgan;
- Berriasian;
- Hauterivian;
- Barremian

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Résumé : ***Chapitre 1 - Recherches préliminaires sur la Formation Zard dans sa localité type (Province du Nord Khorasan, Iran).*** **In*: Une excursion à la recherche de la limite Jurassique/Crétacé dans la chaîne du Kopet-Dag (N Iran) - 15-28 octobre 2019.-*** Ce chapitre présente une révision de la Formation Zard dans sa région type, c'est-à-dire dans la Province du Nord Khorasan (Iran), avec entre autres sa localité type. Les principaux critères sédimentologiques et micropaléontologiques qui permettent de la distinguer de la Formation Mozduran (sous-jacente) et de la Formation Tirgan (sus-jacente) sont décrits. Dans sa localité type, sa limite inférieure est une surface remarquable, perforée. De fait, les deux contacts avec les formations encadrantes correspondent à des surfaces de transgression, ce qui implique que cette unité lithostratigraphique est une unité délimitée par des discordances, "Unconformity-Bounded Unit" ou UBU des stratigraphes anglo-saxons. En ce qui concerne la biostratigraphie, cette formation contient quelques marqueurs de second ordre : *Holosporella sugdeni*, *Kopetdagaria sphaerica* et *Torinosuella peneropliformis*, également présents dans l'unité sus-jacente, c'est-à-dire dans la Formation Tirgan. Comme cette dernière recèle des marqueurs qui apparaissent pour la première fois au Barrémien : *Bakalovaella elitzae*, *Pseudoactinoporella iranica* et *Balkhania balkhanica*, mais aussi *Montseciella arabica*, dont l'extension stratigraphique serait limitée au seul Barrémien supérieur, la Formation Zard (c'est-à-dire l'étage régional Zardien) devrait couvrir en partie l'intervalle Hauterivien à Barrémien. Enfin, bien que l'on ne puisse définitivement exclure que la partie basale de la Formation Zard puisse être d'âge valanginien, cette hypothèse a encore besoin d'être mieux renseignée.

Mots-clefs :

- Kopet-Dag ;
- Mozduran ;
- Zard ;
- Tirgan ;
- Berriasien ;
- Hauterivien ;
- Barremien

1. Introduction

Searching for a natural system boundary between the Jurassic and the Cretaceous systems within the Tethys realm, the first author (B.G.) initiated an investigation of the lowermost Cretaceous deposits succeeding and hence overlying the "uppermost Jurassic" carbonate platforms in northeastern Iran. The use of quotation marks above is justified by the pending uncertainties regarding the ascription of the Berriasian stage to the Jurassic (*i.e.*, the option that we defend) or to the Cretaceous (see discussion in GRANIER, 2020a). The present publication corresponds to a preliminary account of the results of our investigation on the first Cretaceous deposits of the Kopet Dagh ranges in NE Iran. It comprises a brief description of the lithological successions of the Zard Formation in two localities, including the type locality, supplemented by microfacies and micropaleontological studies, and the documentation of its lower and upper boundaries, respectively with the Mozduran Formation (below) and the Tirgan Formation (above).

2. Some preliminary comments to establish some context

The existing sanctions against the Islamic Republic of Iran hinder international scientific collaboration between Iranian geologists and their counterparts in other countries. In our case, the thin sections, plaster casts of fossils and rock samples collected by one of us (B.G.) from the Mozduran, Shurijeh, Zard and Tirgan formations in 2019 were unfortunately confiscated at the Mashhad airport on his return to France, thus complicating our task, considering the existing postal embargo. Two years later, on September 20th, 2021, the full set of thin sections finally reached its final destination in France while the plaster casts of fossils and rock samples remained in Iran.

Accordingly, contrary to a common belief, it makes sense here to provide the sequence of events of our field investigations (the dates) because that explains some of the incompleteness and flaws as, for instance, the fact that the bored surface (*i.e.*, the hardground) on top of the Mozduran Formation (GRANIER, 2020a, Fig. 3.A-D) was discovered one year after the two studied sections were measured and sampled. This key surface was initially documented on October 24th, 2019, by three of us (B.G., M.T.K.A., F.G.) while visiting an outcrop some 6 km NE of the Chal Bash village, North Khorasan Province. Its GPS coordinates are 37°30'29.6"N, 56°12'59.9"E (Fig. 1.A). Before that, on September 3rd, 2018, a nearby section spanning most of the Zard and Tirgan formations, the "Behkadeh Razavi" section (Fig. 1.B), was measured by the second author (S.S.M.) under the supervision of the third author (M.T.K.A.). This locality was also visited by three of us (B.G, M.T.K.A., F.G.) on October 24th, 2019. Finally, two days later (on October 26th, 2019), the same group (B.G, M.T.K.A., F.G.) was visiting the type locality of the Zard Formation, 2 km South of the Zard village (North Khorasan Province, Iran) and some 35 km E of the Chal Bash village (Fig. 1.C). An earlier mission at the type locality of the Zard Formation (Fig. 1.C) on August 29th, 2018, with the second author (S.S.M.) under the supervision of the third author (M.T.K.A.), permitted collection of samples from both the Zard and the Tirgan formations, but not from the Mozduran Formation.

Figure 1: Location map of the sections studied in the North Khorasan Province (NE Iran). A: first spot with borings, 6 km NE of the Chal Bash village; B: "Behkadeh Razavi" section, 2.5 km SE of the Chal Bash village; C: type section of the Zard Formation, 2 km South of the Zard village.

The main aim of this publication was to make sense of this chaotic sequence of events and this seemingly disparate set of data.

3. Material and methods

The Zard Formation was originally defined by AFSHAR HARB (1979) from western Kopet Dagh. According to the latter, its fossil assemblage at its type locality comprises:

1. at its lower part, the foraminifers "*Brotzenia tenuicostata*, *Haplophragmium aequale*, *Haplophragmoides globosa*, *Lenticulina bettenstaedti*, *L. crepidularis*, *L. saxonica*, *L. nodosa*, *Saracenella vestita*, *Triplasia emsladensis*" (determinations of A. KALANTARI *in* AFSHAR HARB, 1979, p. 98), and the ostracods "*Cytherelloides ovata*, *Prothcythere* [sic] *auriculata*, *P. triplicata*" (determinations of E. KEVARI *in* AFSHAR HARB, 1979, p. 98), said to characterize the Hauterivian stage, and
2. at its upper part, the foraminifers "*Dictyoconus arabicus*, *Gavelinella barremiana*, *Globigerina infracretacea*, *Globorotalites intercedens*, *Lenticulina ouachensis*, *Gavelinella barremiana*, *Marssonella oxycona*, *Tritaxia tricarinata*, *Tritaxia pyramidata*" (determinations of A. KALANTARI *in* AFSHAR HARB, 1979, p. 98), said to characterize the Barremian stage.

The microfossil associations in AFSHAR HARB's list (1979) suggest that he was mostly dealing with specimens freed from soft sediments (*e.g.*, marls) after sieving and washing.

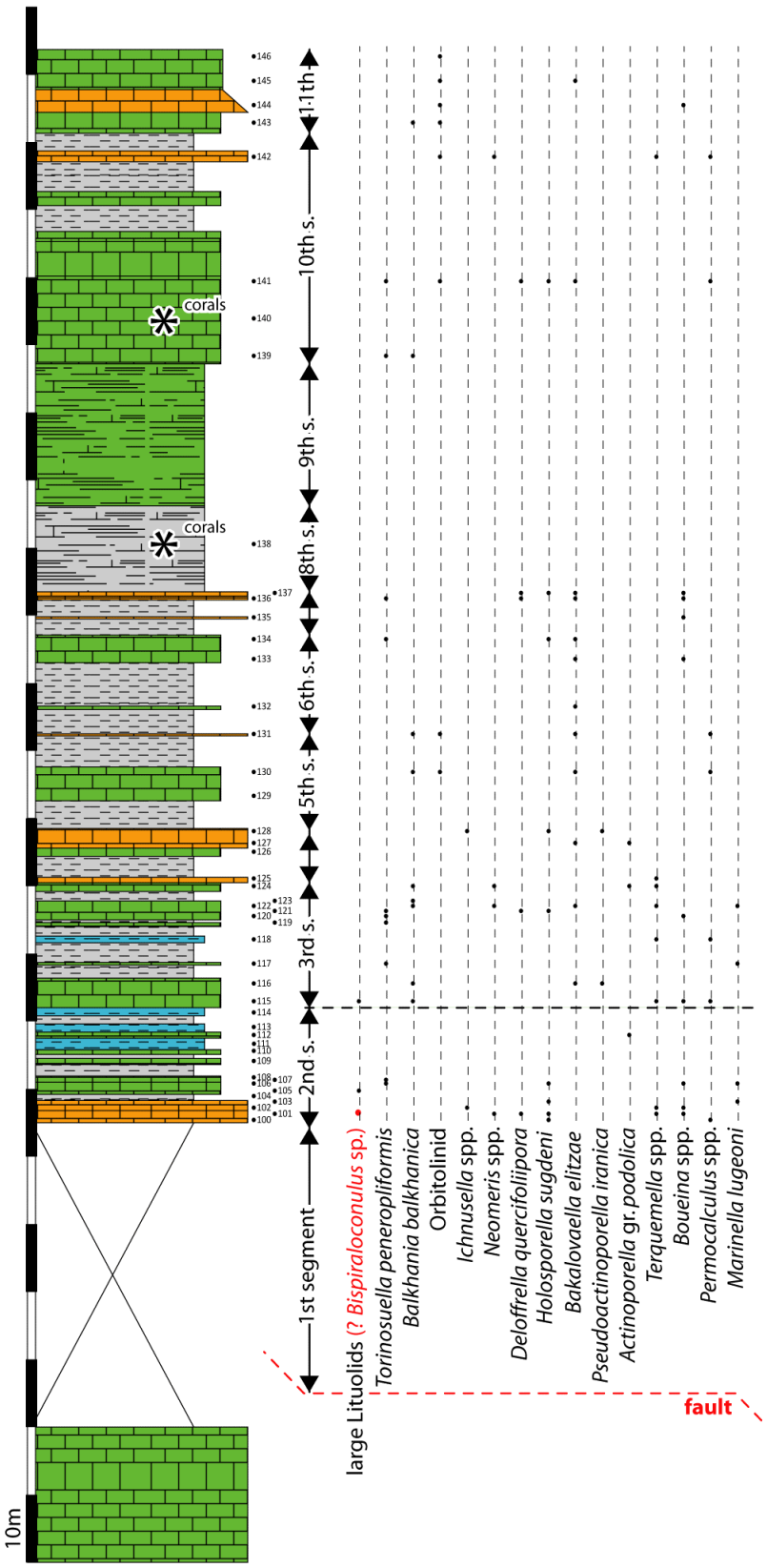
In contrast, our study is based on the analysis of petrographic thin sections. All photomicrographs were taken using a digital MU900 AmScope camera mounted on a Wild M8 stereomicroscope.

4. Studied sections

The bored surface on top of the Mozduran Formation (GRANIER, 2020a, Fig. 3.A-D; Fig. 2.E-F herein) was first reported from an outcrop located some 6 km NE of the Chal Bash village (Fig. 1.A). The nearby "Behkadeh Razavi" is located some 6 km SSW from this spot and 2.5 km SE of the Chal Bash village (Fig. 1.B). It spans the Mozduran (its uppermost part), Zard and Tirgan (its lower part) formations. However, being masked by scree and alluvium, the Mozduran/Zard contact is not visible there; it is probably a tectonic contact because the Zard is rather thin in this locality. The GPS coordinates at the intersection of the dirt road and the section are 37°27'51"N, 56°11'06"E. The section itself was subdivided into 11 segments, from base to top, as follows (Fig. 3):

- 1st segment (ca. 45 m in thickness): this part of the section at the valley bottom is not visible. It is covered by alluvium and scree;
- 2nd segment (ca. 17 m): 3.3 m dominantly grain-supported textures with some quartz sand (samples 100-103), 13.7 m dominantly marly limestones with mud-supported –mudstone- textures (samples 104-114) with fenestrae at its uppermost part (samples 112-114);
- 3rd segment (18.5 m): marls and limestones dominantly mud-supported -wackestone- textures (samples 115-124) with the first *Balkhania balkhanica* MAMONTOVA, 1966, it corresponds to the base of the Tirgan Formation (samples 115-116);
- 4th segment (8.5 m): described as sandy limestones, they consist dominantly of bioclastic grainstones (samples 125-128);
- 5th segment (ca. 14 m): dominantly mud-supported fabrics with *Balkhania balkhanica* and *Bakalovaella elitzae* (BAKALOVA, 1971) [samples 129-131];


A
Tirgan Fm
Mozduran Fm
~0
~17
Zard Fm
~21~24
~14
~13
~12
~11
B
~116
Tirgan Fm
Mozduran Fm
~115
~114
Zard Fm
~112
C
Mozduran Fm
Tirgan Fm
~117
~116
Zard Fm
~115
~114
~112
~110
D
E
Mozduran Fm
Zard Fm
F
G
H



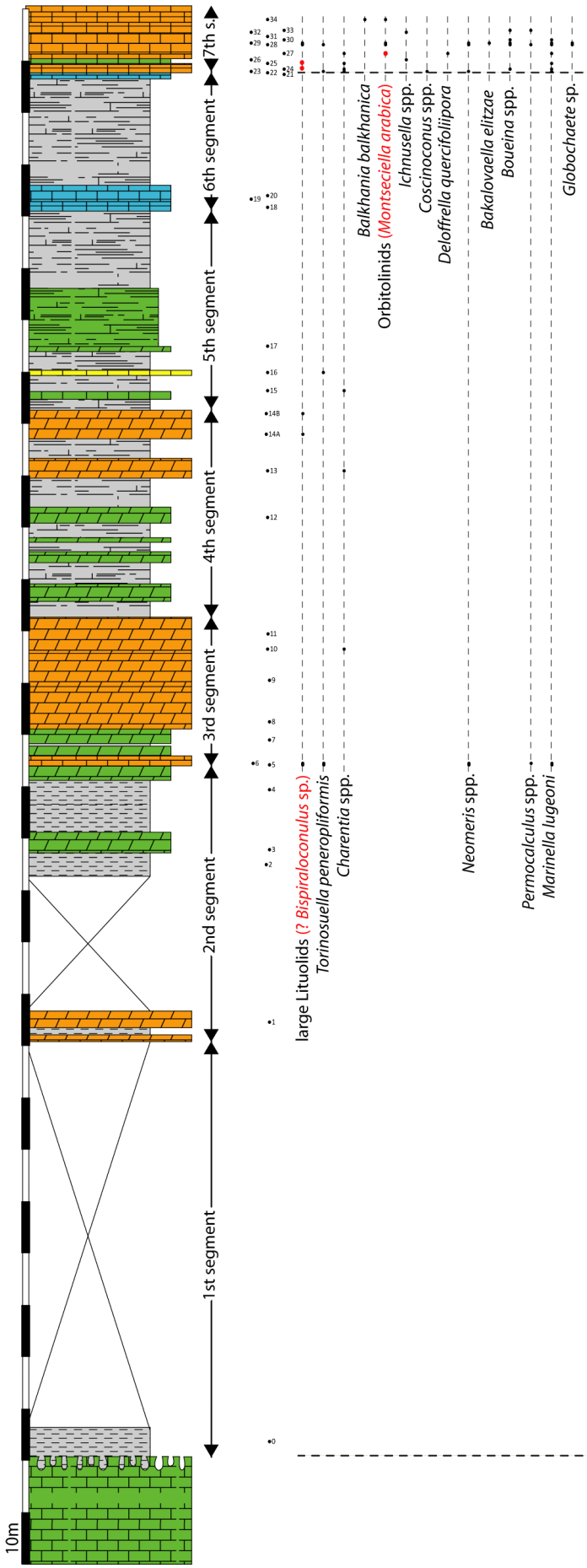
◀ **Figure 3:** Log of the Zard Formation at Behkadeh Razavi (Fig. 1.B). Caption: green, mud-supported fabrics; blue, fenestral fabrics; orange: grain-supported fabrics; grey: marls and marlstones.

- 5th segment (ca. 14 m): dominantly mud-supported fabrics with *Balkhania balkhanica* and *Bakalovaella elitzae* (BAKALOVA, 1971) [samples 129-131];
- 6th segment (21.5 m): dominantly mud-supported fabrics with *Bakalovaella elitzae* (samples 132-134);
- 7th segment (6.5 m): dominantly grain-supported fabrics with *Deloffrella quercifoliipora* GRANIER & MICHAUD, 1987 (samples 135-137);
- 8th segment (12.5 m): alternation of marls and limestones. Sample 138 is from a piece of coral;
- 9th segment (ca. 21 m): alternation of "calcareous siltstones" (probably dolostones) and limestones;
- 10th segment (ca. 30 m): nodular and massive limestones (samples 139-141), dominantly mud-supported fabrics. Sample 140 is also from a piece of coral;
- 11th segment (16.5 m): thick bedded limestones (samples 142-146), either mud- or grain-supported with indeterminate orbitolinids.

At its type locality (Fig. 1.C), the thickness of the Zard Formation is estimated to 280 m according to AFSHAR HARB (1979, p. 95). The section we measured starts at the bored surface that marks the top of the Mozduran Formation (Fig. 2.D) on a spot the GPS coordinates of which are 37°28'59.2"N 56°32'39.6"E. This section was subdivided into 7 segments, from base to top, as follows (Fig. 4):

- 1st segment (ca. 85 m in thickness): most of this part of the section at the valley bottom is not visible. It is covered by scree and alluvium;

◀ **Figure 2: A)** S-N panoramic view of the Zard section (Fig. 1.C) with some bed numbers; **B-C)** W-E view of the Behkadeh Razavi section (Fig. 1.B) with some bed numbers; **D)** bored surface at the top of the Mozduran Formation in the Zard section; **E-F)** bored surface at the top of the Mozduran Formation at the first spot, 6 km NE of the Chal Bash village (Fig. 1.A); **G)** cross-bedded grain-supported limestones in the uppermost bed of the Mozduran Formation in the Zard section (Fig. 1.C); **H)** fenestral mud-supported limestones in the uppermost bed of the Zard Formation in the Zard section (Fig. 1.C).



◀ **Figure 4:** Log of the Zard Formation at its type locality (Fig. 1.C). Caption: green, mud-supported fabrics; blue, fenestral fabrics; orange: grain-supported fabrics; grey: marls and marlstones.

- 2nd segment (ca. 50 m): it starts with pluridecimetric cross-stratified sandy and bioclastic dolograinstones (sample SM 1) followed by bioturbated nodular dolomudstones (samples 2-4), that were initially described as "claystones". No microfossils have been identified there;
- 3rd segment (24.0 m): the first two samples (5-6) are fossiliferous. They consist of bioclastic grainstones with various types of cementation, including questionable anisopachous and questionable miniscus, fibrous calcite cements (marine vadose) representing possible beachrock facies, and an isopachous fibrous palisadic calcite cement (marine phreatic) representing hardground facies. It was originally said to comprise sandy limestones and calcareous sandstone whereas it actually comprises silty dolomudstones (sample 7) and oolitic dolograinstones (samples 8, possibly 9);
- 4th segment (46.7 m): it was said by the second author (S.S.M.) to consist of sandy limestones and marlstones. It mostly consists of oolitic dolograinstones (samples 10 to 14);
- 5th segment (38.4 m): it was said to consist of calcareous silt- and sandstones and silty or sandy limestones, although it actually consists of various types of dolomitized limestones (samples 15 to 17);
- 6th segment (26.7 m): it was originally described as marlstones, but actually consists of mud-supported -mudstone- textures with fenestrae (samples 18, 22) and grain-supported -intraclastic and peloidal grainstone- textures with fenestrae, keystone vugs and possible pseudomorphs after evaporites (samples 19-21). Examples are found in its upper part (Fig. 2.H);
- 7th segment (12.9 m): it consists of thick bedded limestones. It corresponds to the base of the Tirgan Formation (samples 23-35).

Remarks: Many of our field samples effervesce weakly with cold hydrochloric acid. Additionally, rubbing them on a hammer head produces some scratches. Therefore, they may contain few quartz grains (*e.g.*, in agglutinating foraminiferal tests). Initially, our first and second segments were described by Afshar Harb (1979) as "128 metres shale, olive-green and blue-grey, calcareous, gypsiferous". The same author also mentioned thick silt- to sandstone

intervals in the remainder of the lithologic succession. These descriptions do not match our petrographic analyses. Actually, these samples consist of sucrosic dolomites (either dolomud- or dolograinstones (*e.g.*, Pl. 7, fig. J).

5. Systematic micropaleontology

Phylum Foraminifera Orbigny
Class Globothalamea Pawlowski *et al.*
Subclass Textulariana Mikhalevich
Order Loftusiida Kaminski

Suborder Loftusiina Kaminski & Mikhalevich

Superfamily Loftusioidea Brady
Family Cyclamminidae Marie
Subfamily Choffatellinae Maync
Genus *Balkhania* Mamontova, 1966
***Balkhania balkhanica* Mamontova, 1966**
(Pl. 1, figs. AC, AJ; Pl. 2, figs. E-G, I-J; Pl. 4, fig. S)

Selected synonymy:

1966 *Balkhania balkhanica* nov. gen., nov. sp. – Mamontova, p. 146, Fig. 2.21
1967 *Pseudochoffatella gigantica* n. sp. - Kaever, p. 205-207, Pl. 23, fig. 8; Pl. 24, figs. 1-7
2013 *Balkhania balkhanica* - Taherpour-Khalil-Abad *et al.*, p. 269, Figs. 4.a-b, 5.a-g (with synonymy)
2013 *Balkhania balkhanica* - Schlagintweit *et al.*, Fig. 4.B
2016 *Balkhania balkhanica* - Granier *et al.*, Fig. 7, Pl. 6, figs. 1-7
? 2017 *Balkhania balkhanica* - Hemmati *et al.*, Pl. 1, figs. 13, 19
2019 *Balkhania balkhanica* - Bucur *et al.*, Fig. 14.a-d
2020 *Balkhania balkhanica* - Maksoud *et al.*, Fig. 3.P-Q

It is worth mentioning that this foraminifer occupies the same ecological niche as *Choffatella decipiens* Schlumberger, 1905 (see discussion in Granier & Busnardo, 2013: "4.1. Paleontological and paleoecological remarks on the foraminifer *Choffatella*"), which is missing in the Kopet Dagh whereas it replaces *Balkhania balkhanica* in younger strata in Lebanon (Maksoud *et al.*, 2014, 2020; Granier *et al.*, 2015, 2016).

Genus *Torinosuella* Maync, 1959
Torinosuella peneropliformis
(Yabe & Hanzawa, 1926)
(Pl. 1, figs. W-AB, AF-AH; Pl. 2, figs. A-D; Pl. 3, figs. M-AB)

Selected synonymy:

1926 *Choffatella peneropliformis* nov. - Yabe & Hanzawa, p. 11, Pl. II, figs. 1-2
1959 *Torinosuella peneropliformis* - Maync, Pl. 1, figs. 6.a-b, 7-10, 14, 16
non 1959 *Torinosuella peneropliformis* - Maync, Pl. 1, figs. 1-4, 11-13
1967 *Torinosuella peneropliformis* - Neumann, Pl. 26, figs. 1-3, 6-9
non 1967 *Torinosuella peneropliformis* - Neumann, Pl. 26, figs. 4-5
2005 *Torinosuella peneropliformis* - Cherchi & Schroeder, p. 7-8, Pl. 1, figs. 1-13 (with synonymy). Lectotype: Pl. 1, fig. 1 (Pl. II, fig. 1 in Yabe & Hanzawa, 1926)
? 2017 *Balkhania balkhanica* - Hemmati *et al.*, Pl. 1, figs. 13, 19
2017 *Torinosuella peneropliformis* - Hemmati *et al.*, Pl. 1, fig. 7; Pl. 3, fig. 7
2018 *Torinosuella peneropliformis* - Schlagintweit & Wilmsen, Fig. 4.A *pars*, F

First described from the Tithonian-Berriasian of the Torinosu Limestones in Japan, this long-ranging (from the upper Tithonian to the Lower Barremian according to Cherchi & Schroeder, 2005) species was found in both the Zard and the Tirgan intervals of the studied sections. It is found in the Tirgan interval of the Zard section (sample 27) in association with *Montseciella arabica* (Henson, 1948), suggesting that it reached the Upper Barremian.

Suborder Orbitolinina Kaminski

Superfamily Pfenderinoidea Smout & Sugden
Family Hauraniidae Septfontaine
Subfamily Amijellinae Septfontaine
Genus *Bispiraloconulus*
Schlagintweit *et al.*, 2019c

Large "lituoliform" agglutinating tests, including *Ammobaculites* sp. (Pl. 7, figs. G-H), are common among the coarse bioclasts found in the Zard strata. Some specimens (Pl. 7, figs. B, I) are cautiously referred here to ? *Bispiraloconulus* sp. due to their chamber congestion by various agglutinated grains. Similar forms have been illustrated as *Bispiraloconulus serbicus* Schlagintweit *et al.*, 2019 (2019c, 2019d), by Taherpour-Khalil-Abad *et al.* (2019, Pl. 2 *pars*) from the Tirgan Formation in the Gelian section, North Khorasan Province, some 75 km E of the Zard village, our easternmost section. However, we did not observe the branching pattern of the test found in genuine representatives of this species, which casts doubt on the generic ascription of our material.

Superfamily Orbitolinoidea Martin
Family Orbitolinidae Martin
Subfamily Dictyoconinae Schubert
Genus *Montseciella*
Cherchi & Schroeder, 1999
***Montseciella arabica* (Henson, 1948)**
(Pl. 4, figs. Q-R)

Selected synonymy:

1948 *Dictyoconus arabicus* n. sp. - Henson, p. 35-36, Pl. 1, figs. 5-8; Pl. 14, figs. 1-12
1969 *Dictyoconus arabicus* - Sampò, Pl. XXXIV, figs. 1-2; Pl. XXXVII, figs. 1-3
1977 *Dictyoconus balkanicus* n. sp. - Peybernès & Cugny, p. 73-75, Pl. I, figs. 1-7; Pl. II, figs. 1-7. Holotype: Pl. I, fig. 1
1994 *Dictyoconus arabicus* n. sp. - Baud *et al.*, p. 387, Pl. 1, figs. 1-6; Pl. 2, figs. 3, 5 (with synonymy)
2002 *Montseciella arabica* n. comb. - Schroeder *et al.*, Pl. I, figs. 3, 6, 10
2003 *Montseciella arabica* - Granier *et al.*, Fig. 12
2010 *Montseciella arabica* - Schroeder *et al.*, Figs. 4.a.3, 4.b.1-7 (with synonymy)
2019 *Montseciella arabica* - Bucur *et al.*, Fig. 16.b
2021 *Montseciella arabica* - Granier *et al.*, Pl. 93 *pars*, Pl. 113 *pars*

The question of the synonymy of *Rectodictyoconus giganteus* SCHROEDER, 1964, with *Montseciella arabica* (HENSON, 1948), is not addressed here. However, it is suggested here that the axial sections of *Rectodictyoconus giganteus* illustrated in Fig. 2.d of SCHROEDER (1964) or in Fig. 4.a.3 of SCHROEDER *et al.* (2010) could be front axial sections whereas Fig. 4.b.2-3 of SCHROEDER *et al.* (2010) represents a sagittal axial section of the same species.

Phylum Chlorophyta (REICHENBACH)
Class Dasycladophyceae HOEK *et al.*
Order Dasycladales PASCHER

Family Triploporellaceae (PIA, 1920)
Genus *Kopetdagaria*
MASLOV *ex* BUCUR, 2002 (*non* MASLOV, 1960)
Kopetdagaria sphaerica
MASLOV *ex* BUCUR, 2002 (*non* MASLOV, 1960)
(Pl. 7, figs. K-M)

Selected synonymy:

nom. nud. 1960 *Kopetdagaria sphaerica* gen. et sp. n. – MASLOV, p. 940, Figs. 1ɑ, 3ɑ, 3ɓ, 3ɕ
nom. nud. 1973 *Kopetdagaria sphaerica* - SRIVASTAVA, p. 696, Figs. 10-11
1975 *Kopetdagaria bifaria* n. sp. - BAKALOVA, p. 50-51, Pl. II, figs. 1-4. Holotype: Pl. II, fig. 1
2002 *Kopetdagaria sphaerica* - BUCUR, Pl. I, fig. 1; Pl. II, figs. 1-3; Pl. III, figs. 1-9; Pl. IV, figs. 1-11 (with synonymy). Lectotype: Fig. 1ɑ in MASLOV, 1960
2012 *Kopetdagaria sphaerica* - BUCUR *et al.*, p. 614, Fig. 7.a-l
2013 *Kopetdagaria sphaerica* - TAHERPOUR-KHALIL-ABAD *et al.*, p. 271-272, Fig. 6.a-e (with synonymy)
2017 *Kopetdagaria sphaerica* - HEMMATI *et al.*, Pl. 2, fig. 9; Pl. 4, fig. 7
2019 *Kopetdagaria sphaerica* - BUCUR *et al.*, Fig. 9.a-d

Only small fragments of this alga were found in some Tirgan strata of the studied sections.

Genus *Holosporella* (PIA, 1930)

Synonym: *Vederosella* DRAGASTAN, 1999

Holosporella sugdeni
(ELLIOTT, 1957) GRANIER, 2018
(Pl. 5, figs. Q-V; Pl. 6, fig. D)

Selected synonymy:

1957 *Cylindroporella sugdeni* n. sp. - ELLIOTT, p. 227, Pl. 1, figs. 1-6.
1999 *Vederosella alimani* n. gen. n. sp. - DRAGASTAN, p. 129-130, Pl. 3, figs. 1-10. Holotype: Pl. 3, fig. 1
2010 *Holosporella* sp. - TAHERPOUR-KHALIL-ABAD *et al.*, Figs. 6.h, 7.k *pars*
2018 *Holosporella sugdeni* (ELLIOTT) *nov. comb.* – GRANIER, p. 184, Figs. 2.a-d, 3.a-p, 5.a-l (with synonymy).
2018 *Holosporella sugdeni* - SCHLAGINTWEIT & WILMSEN, p. 5-6, Figs. 4.A *pars*, 4.B-E, G-I, 5 (with synonymy).
2020 *Holosporella* aff. *alimani*, n. comb. - FATEH BAHARI *et al.*, p. 121-122, Pl. 2, figs. a, e
2020 *Holosporella* sp. - FATEH BAHARI *et al.*, Pl. 2, fig. l

As reminded by SCHLAGINTWEIT and WILMSEN (2018), "*Holosporella sugdeni* might be confounded with *Montiella* ? *elitzae* (BAKALOVA)". However, there are no sterile laterals in *Holosporella sugdeni* (ELLIOTT, 1957), which belongs to the Family Triploporellaceae, whereas they exist in *Bakalovaella elitzae* (BAKALOVA, 1971), which belongs to the Family Dasycladaceae.

Family Dasycladaceae KÜTZING, 1843
Genus *Bakalovaella* BUCUR, 1993

Synonym: *Turkmenaria* MASLOV, 1960, *nomen oblitum*

Type species: *Cylindroporella elitzae* BAKALOVA, 1971

Species included: *Cylindroporella benizarensis* FOURCADE *et al. ex* JAFFREZO *in* BASSOULLET *et al.*, 1978; *Bakalovaella deloffrei* GRANIER & BUCUR, 2019; *Cylindroporella elitzae* BAKALOVA, 1971; *Montiella filipovici* RADOIČIĆ, 2006; and possibly (pending revisions) *Cylindroporella faronensis* MASSE *et al.*, 1999, and *C. massiliana* MASSE *et al.*, 1999.

The species *Cylindroporella elitzae* BAKALOVA, 1971, is probably a junior synonym of *Turkmenaria adducta* MASLOV, 1960. Accordingly, *Turkmenaria* MASLOV, 1960, should have been treated as senior synonym of *Bakalovaella* BUCUR, 1993. However, both the generic name *Turkmenaria* and its specific epiteth *adducta* should be treated as *nomina oblita* whereas the generic name *Bakalovaella* BUCUR, 1993, should be declared as *nomen protectum*. The above statement is justified because since 1960 1) both MASLOV's names were never reused for any new find and 2) further to recent enquiries it appears that MASLOV's type material is probably lost (Alina IAKOVLEVA, personal communication, 2022/12/08).

Bakalovaella elitzae
(BAKALOVA, 1971) BUCUR, 1993
(Pl. 5, figs. W-X; Pl. 6, figs. A-C, E-F)

Selected synonymy:

1960 *Turkmenaria adducta* gen. et sp. n. - MASLOV, p. 940, Fig. 1ɓ
1971 *Cylindroporella elitzae* n. sp. - BAKALOVA, p. 126-127, Pl. III, figs. 1-8. Holotype: Pl. III, fig. 1
non 1972 *Cylindroporella benizarensis* n. sp. - FOURCADE *et al.*, p. 236, Pl. 3, figs. 4-6
nom. nud. 1973 *Cylindroporella maslovi* n. sp. – SRIVASTAVA, p. 699, Figs. 16 *pars*, 17-18. Several specimens selected as the "holotype": Figs. 17-18
nom. nud. 1978 *Cylindroporella barbui* n. sp. – DRAGASTAN, p. 126, Fig. 2.a-e
1980 *Montiella* ? *elitzae* nov. comb. - RADOIČIĆ, p. 114, Pl. I, figs. 1-2; Pl. II, figs. 1-4; Pl. III, figs. 1-4
nom. nud. 1982 *Cylindroporella chayüensis* n. sp. - MU, p. 221-222, Pl. X, figs. 6-11
1986 *Cylindroporella* cf. *elitzae* - MU, Pl. V, figs. 3, 6-8
1986 *Cylindroporella* sp. - MU, Pl. V, fig. 5
nom. nud. 1986 *Cylindroporella chayuensis* n. sp. - MU, Pl. V, fig. 4

1993 *Bakalovaella elitzae* n. comb. - BUCUR, p. 100-102, Pl. 7, figs. 1-18 (with synonymy)
1995 *Cylindroporella barbui* n. sp. - DRAGASTAN, p. 106, Fig. 2b (typification)
1999 *Cylindroporella barbui* - DRAGASTAN, p. 129, Pl. 2, figs. 14-15
1999 *Bakalovaella elitzae* - DRAGASTAN, p. 129, Pl. 2, figs. 16-17
2003 *Bakalovaella elitzae* - BUCUR *et al.*, p. 218, 220, Pl. 40, fig. 6 (with synonymy)
2010 *Montiella* ? *elitzae* - TAHERPOUR-KHALIL-ABAD *et al.*, Fig. 8.a-d
2011 *Montiella* ? *elitzae* - BUCUR, p. 627-628, Pl. 6, figs. 2-3 (with synonymy)
2012 *Montiella elitzae* - BUCUR *et al.*, p. 616, 618, Fig. 8.a-p (with synonymy)
2013 *Montiella elitzae* - SCHLAGINTWEIT *et al.*, Fig. 4.G
2014 *Montiella elitzae* - MAKSOUD *et al.*, Pl. 4, figs. C-D
2017 *Montiella* ? *elitzae* - HEMMATI *et al.*, Pl. 2, fig. 3; Pl. 4, figs. 1, 5
2017 *Hoposporella* sp. - HEMMATI *et al.*, Pl. 4, fig. 8
2018 *Montiella* ? *elitzae* - SCHLAGINTWEIT & WILMSEN, Fig. 6.A-B
2019 *Montiella* ? *elitzae* - BUCUR *et al.*, Fig. 8.a-d
2019 *Bakalovaella elitzae* - GRANIER & BUCUR, Pl. 3, fig. I
2020 *Bakalovaella elitzae* - FATEH BAHARI *et al.*, p. 118-119, Pl. 2, figs. b-d, g

Bakalovaella elitzae was found here only in the Tirgan Formation.

Family Thyrsoporellaceae
GRANIER & BUCUR *in* GRANIER *et al.*, 2013
Genus *Deloffrella* GRANIER & MICHAUD, 1987
Deloffrella quercifoliipora
GRANIER & MICHAUD, 1987
(Pl. 5, figs. A-P)

Selected synonymy:

1987 *Deloffrella quercifoliipora* n. gen., n. sp. - GRANIER & MICHAUD, p. 1093-1095, Pl. I, figs. 1-10.
2003 *Deloffrella quercifoliipora* - BUCUR *et al.*, p. 218, Pl. 40, figs. 1-3 (with synonymy)
2011 *Deloffrella quercifoliipora* - BUCUR, p. 626-626, Pl. 6, fig. 1 (with synonymy)
2012 *Deloffrella quercifoliipora* - BUCUR *et al.*, p. 611, 613, Fig. 6.b-i (with synonymy)
2013 *Deloffrella quercifoliipora* - GRANIER, Fig. 2.7, 2.10-12, 2.14
2013 *Deloffrella quercifoliipora* - SCHLAGINTWEIT *et al.*, Fig. 4.F
2017 *Deloffrella quercifoliipora* - HEMMATI *et al.*, Pl. 2, fig. 7; Pl. 4, figs. 2-3
2019 *Deloffrella quercifoliipora* - BUCUR *et al.*, Fig. 7.c-f

This long-ranging species first described from the Tithonian of Mexico was found here in both the Zard and the Tirgan formations.

Family Polyphysaceae KÜTZING, 1843
Genus: *Pseudoactinoporella*
(CONRAD, 1970) CONRAD & PEYBERNÈS, 1976
Pseudoactinoporella iranica
BUCUR *et al.*, 2012
(Pl. 3, fig. AC; Pl. 7, fig. A)

Selected synonymy:

1973 *Triploporella* sp. - SRIVASTAVA, p. 702, Fig. 21
2012 *Pseudoactinoporella* ? *iranica* n. sp. - BUCUR *et al.*, p. 610, Figs. 5.a-j, l
2019 *Pseudoactinoporella*? *iranica* - BUCUR *et al.*, Fig. 9.a-c
2020 *Pseudoactinoporella iranica* - FATEH BAHARI *et al.*, p. 118, Pl. 2, fig. j
2021 *Pseudoactinoporella iranica* - SCHLAGINTWEIT *et al.*, Figs. 1.D, 3.D-F, 4.C, Pl. 1, figs. A-I; Pl. 2, figs. A-K

Although SCHLAGINTWEIT *et al.* (2021) recently re-ascribed this species to Family Bornetellaceae GRANIER & BUCUR *in* GRANIER *et al.*, 2013, the opinion of the first author (B.G.) did not change regarding its original ascription to the Family Polyphysaceae KÜTZING, 1843. The short expansion at the base of each lateral is interpreted as a sterile element of the whorl of laterals, the assemblage of which forms a corona structure. The elongated part of each lateral is interpreted as a spiculiform fertile ampulla similar to those found in *Actinoporella* (GÜMBEL *in* ALTH, 1881), *Acicularia* (ARCHIAC, 1843), or *Acetabularia* (LAMOUROUX, 1812), for instance.

6. Sedimentary petrography

This short subchapter deals only with two specific facies-types observed in the Zard Formation:

1) Sample 5 from the Behkadeh Razavi section is a coarse bioclastic grainstone. Its last cementation phasis is represented by a drusy calcite (probably burial) cement. The latter was preceded by several diagenetic events. The earliest event is represented by an isopachous cloudy calcite (probably phreatic marine) cement. In turn, it is followed by partial intergranular micritic infills that in turn follows a thin isopachous calcite (probably phreatic marine) cement around the allochems (Pl. 8, figs. A, E). It looks like the unique thin section was not cut perpendicularly to the bedding but obliquely because, locally, the early thin fibrous calcite cement is missing or varies in thickness (Pl. 8, figs. B-D). That suggests we are dealing with an early anisopachous calcite (probably vadose marine) cement, which marks the occurrence of a beachrock here within the Zard Formation.

2) Samples 19 to 22 and 114 display characteristic fenestral fabrics. When the texture is grainy (peloidal or instraclastic) some of the fenestrae may look like keystone vugs. Miliolids with thin tests are commonly found in the matrix - evidence of harsh environmental conditions. Some cavities are partly cemented by thin isopachous calcite cement followed by micrite or clotted micrite infills that percolated through the porous network. Some tiny shells of endobionthic ostracods are also observed in these partial infills. Although most cemented cavities are smoothly elongated or subrounded to rounded, there are some, *e.g.*, in samples 21 (Pl. 8, figs. F-G) and 35 (Pl. 8, fig. H), that have angular shapes and brownish inclusions, which suggest that the calcite crystals replaced an evaporitic precursor.

7. Discussion and conclusions

The Shurijeh Formation and the Zard Formation were originally defined by AFSHAR HARB (1979) respectively from eastern (*op. cit.*, p. 87 *et seq.*) and western (*op. cit.*, p. 94 *et seq.*) Kopet Dagh. Because both formations are equally sandwiched between the Mozduran Formation below and the Tirgan Formation above, it is assumed here that they are partly coeval with the Shurijeh representing the Eastern succession and the Zard the Western counterpart (see their respective isopach maps in AFSHAR HARB, 1979). Accordingly, we recommend abandonment of the use of the Shurijeh Formation that should be considered as a hotch-potch because its definition is too elastic (see discussion in STÖCKLIN & SETUDEHNIA, 1991, p. 229-230). In addition, according to AFSHAR HARB (1979, p. 88), the Shurijeh Formation at its type locality spans the Valanginian - Barremian interval whereas, according to STÖCKLIN and SETUDEHNIA (1991, p. 229-230), the age of its strata varies from the Kimmeridgian to the "Neocomian".

During the 2019 reconnaissance mission, more specifically on October 24th and 26th, we identified: 1) the lower boundary of the Zard Formation as an unconformity locally consisting of a flat bored surface on top of the Mozduran Formation and 2) its upper as an abrupt change of facies from a regressive sequence ending with fenestral limestones to a transgressive sequence, beginning with oolitic calcarenites of the Tirgan Formation. It is genetically obvious that both transgressive facies (*i.e.*, base Zard and base Tirgan) were set up diachronically and that the durations of the related hiatuses vary laterally from one location to another. Because the Zard Formation is framed by two discontinuities, it should be considered as an Unconformity-Bounded Unit, as well as an Alloformation, and even as a Regional Stage, namely the Zardian (see MAKSOUD *et al.*, 2014, for a similar topical discussion).

Below the sommital bored surface of the Mozduran Formation, the microfossil assemblage of the uppermost limestones comprises the foraminifer *Coscinoconus alpinus* LEUPOLD *in* LEUPOLD & BIGLER, 1936 (Pl. 4, figs. M-P) and the Dasycladales *Actinoporella podolica* (ALTH, 1878) (Pl. 4, figs. I-L), *Rajkaella bartheli* (BERNIER, 1971) [Pl. 4, figs. A, E], and *Salpingoporella annulata* CAROZZI, 1953 (Pl. 4, fig. F), which points to a middle-late Berriasian age. For their part, BUCUR *et al.* (2013) listed the foraminifers *Anchispirocyclina lusitanica* (EGGER, 1902), *Mohlerina basiliensis* (MÖHLER, 1938), and *Pseudocyclammina lituus* (YOKOYAMA, 1890), as well as the Dasycladales *Otternstella lemmensis* (BERNIER, 1971) and *Zergabriella embergeri* (BOUROULLEC & DELOFFRE, 1968), *i.e.*, typical species of the Tithonian - lower Berriasian and middle - upper Berriasian intervals. In turn, SCHLAGINTWEIT *et al.* (2019b) added the foraminifer *Neokilianina rahonensis* (FOURY & VINCENT, 1967) and the Dasycladales *Campbelliella striata* (CAROZZI, 1954), *Montenegrella florifera* BERNIER *in* GRANIER & DELOFFRE, 1993, and *Petrascula* spp., *i.e.*, typical taxa of the ? Kimmeridgian – Tithonian interval. In accordance with the latest constrained microfossil ranges documented by GRANIER (2019a), we can definitely exclude a Valanginian age for the uppermost strata of the Mozduran Formation contrary to BUCUR *et al.* (2013) who wisely left this option open although questionable. To summarize, the Mozduran Formation is an overall regressive sequence documenting the progradation of an "Upper Jurassic" carbonate platform that ends in Berriasian times. Its ultimate strata could be missing, as in the section studied by SCHLAGINTWEIT *et al.* (2019b), due to subaerial non-deposition or erosion.

Microfossils are commonly poorly preserved (due to recrystallisation - mostly dolomitization) in the Zard Formation. Age diagnostic fossils are almost non-existant. In addition, there are no first-order biostratigraphic markers (*e.g.*, ammonites) within the Zard and the Tirgan formations. There only are few second-order markers (*e.g.*, benthic foraminifers and Dasycladales), the ranges of which commonly lack a calibration on the ammonite biostratigraphic scale.

Some microfossils that first appeared in the Zard Formation are still present in the Tirgan Formation:

1. *Torinosuella peneropliformis* (YABE & HANZAWA, 1926) [Pl. 1, figs. AF-AH; Pl. 2, figs. A-D], is reported from Tithonian to lower Barremian strata (CHERCHI & SCHROEDER, 2005; SCHLAGINTWEIT & WILMSEN, 2018).
2. *Holosporella sugdeni* (ELLIOTT, 1957) [Pl. 5, figs. Q-V; Pl. 6, fig. D] is known with certainty at least from the Hauterivian and lower Barremian interval in the Middle East (GRANIER, 2018; SCHLAGINTWEIT & WILMSEN, 2018)
3. According to GRANIER and DELOFFRE (1993), the range of *Kopetdagaria sphaerica* MASLOV, 1960, spans the Barremian - Aptian interval. This species is only known from Afghanistan, Bulgaria, Georgia, Iran, Romania, and Turkmenistan, on the northern margin of the Neotethys (TAHERPOUR-KHALIL-ABAD *et al.*, 2013).
4. The genus *Neomeris* (Pl. 1, figs. AD-AE), which still has living representatives, first appeared in the early Valanginian (GRANIER & BERTHOU, 2002).

Other microfossils are restricted to the Tirgan Formation:

1. Until its recent sporadic record in Lebanon (GRANIER *et al.*, 2016), *Balkhania balkhanica* MAMONTOVA, 1966 (Pl. 1, figs. AC, AJ; Pl. 2, figs. E-G, I), was only known from Afghanistan, Iran, and Turkmenistan, on the northern margin of the Neotethys (TAHERPOUR-KHALIL-ABAD *et al.*, 2013).
2. *Montseciella arabica* (HENSON, 1948) [Pl. 4, figs. Q-R] is as a subzonal marker of the Up-

per Barremian (according to CLAVEL in GRANIER *et al.*, 2021) of the *Palorbitolina lenticularis* Zone (SCHROEDER *et al.*, 2010).

3. According to GRANIER and DELOFFRE (1993), the range of *Bakalovaella elitzae* (BAKALOVA, 1971) [Pl. 5, figs. W-X; Pl. 6, figs. A-C, E-F] spans the Barremian - early Aptian interval.
4. *Pseudoactinoporella iranica* BUCUR *et al.*, 2012, was described from the Barremian - Aptian Taft Formation from Central Iran.

Bakalovaella elitzae, *Pseudoactinoporella iranica*, *Balkhania balkhanica*, and *Montseciella arabica*, all first occur in the lowermost part of the Tirgan Formation. Considering the above notes, it is also assumed today that none occur in Hauterivian strata. Accordingly, the lowermost part of the Tirgan should be ascribed a Barremian age. Although AFSHAR HARB (1979) mentioned the occurrence of "*Dictyoconus arabicus*" (*i.e.*, *Montseciella arabica*) in the upper part of the Zard Formation, we did not identify it there but rather in the lower part of the Tirgan Formation. In western Europe, thanks to ammonite calibration (see GRANIER *et al.*, 2021), the stratigraphic range of *Montseciella arabica* is restricted solely to the Upper Barremian. Although it should not be excluded that this foraminifer may occur earlier in the Middle East, it is suggested here that the lowermost part of the Tirgan could be ascribed a Late Barremian age.

Because the lowermost strata of the Tirgan have been ascribed a Late Barremian age, the uppermost strata of the Zard Formation should be Barremian in age too. Typical biostratigraphic markers of the Valanginian, *e.g.*, *Barkerina dobrogiaca* NEAGU, 2000 (SCHLAGINTWEIT, 2019a; GRANIER, 2020b), have not been reported yet in the Kopet Dagh. Accordingly, the lower part of the Zard Formation is mostly Hauterivian in age, although it should not be excluded that it goes down into the Valanginian.

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▶ **Plate 1: A-N:** small foraminifer with a thin agglutinated planispiral involute test; **Q-V:** small foraminifer with a thicker agglutinated planispiral involute test, *Charentia* ? sp.; **W-AB, AF-AH:** *Torinosuella peneropliformis* (YABE & HANZAWA, 1926); **AC, AJ:** macrospheric specimens of *Balkhania balkhanica* MAMONTOVA, 1966; **AD-AE,** *Neomeris* spp.; **AI:** ? textulariid. All photomicrographs with the same bar = 250 µm (on AC). A, E: sample 10; B-C, G-I, L-N: sample 13; F: sample 15, J-K; O-P, R-U: sample 25; Q: sample 27; V: sample 23; W, Y, AE-AG: sample 5; X, Z: sample 6; AA-AB, AH: sample 16; AC, AJ: sample 34; AD: sample 29; AI: sample 28. Zard Fm: A-M, W-AB, AE-AH; Tirgan Fm: O-V, AC-AD, AI-AJ.

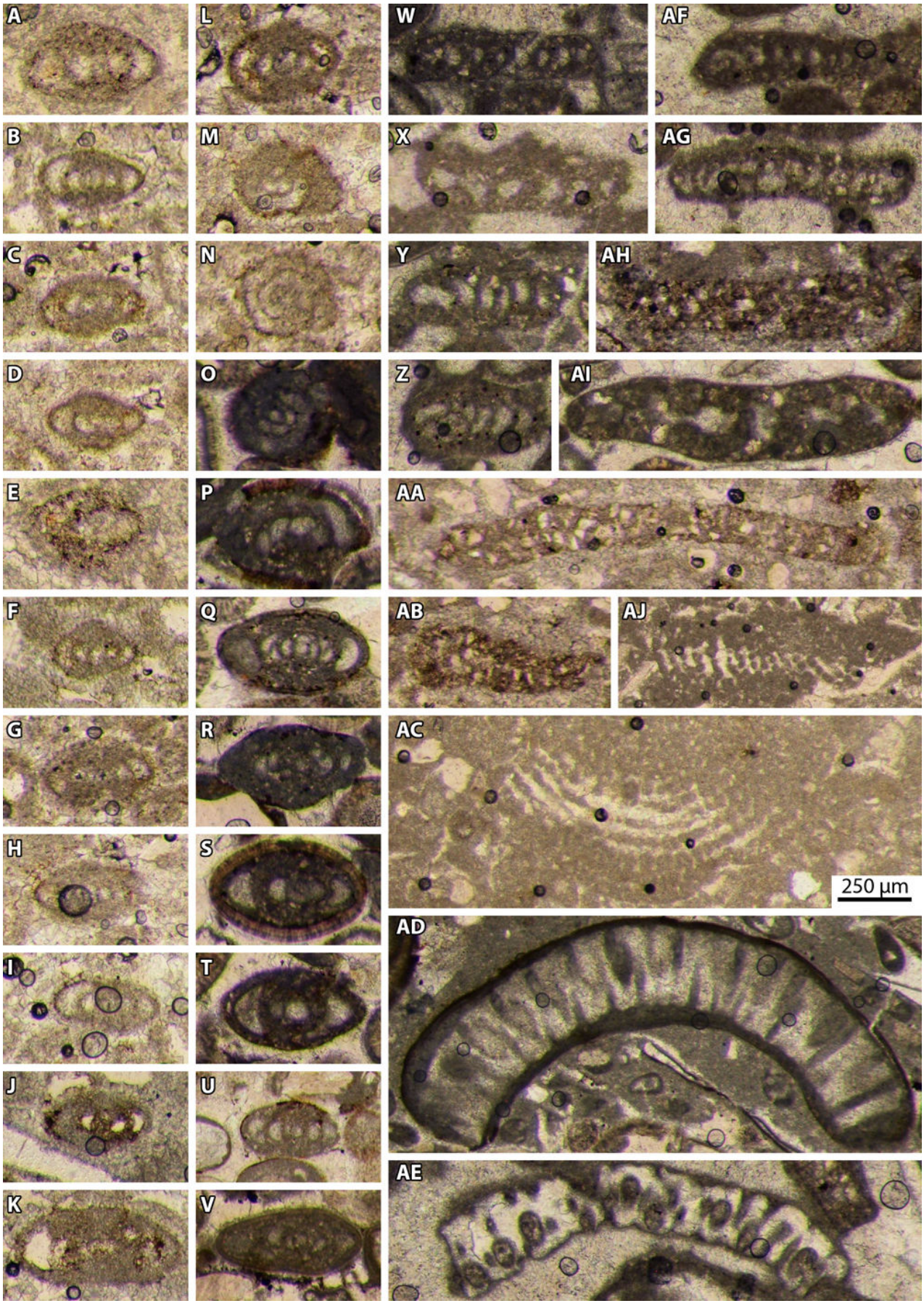
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Plate 2: A-D: *Torinosuella peneropliformis* (YABE & HANZAWA, 1926); **E-G, I:** macrospheric specimens of *Balkhania balkhanica* MAMONTOVA, 1966; **H, L-M:** *Neomeris* spp.; **K:** textulariid; **J:** microspheric specimen of *Balkhania balkhanica* MAMONTOVA, 1966. All photomicrographs with the same scale bar = 250 µm (on K), except J with scale bar = 500 µm. A-B, M: sample 5; C: sample 16; D, H: sample 28; E-G, I-J: sample 34; K: sample 27; L: sample 29. Zard Fm: A-C, M; Tirgan Fm: D-L.

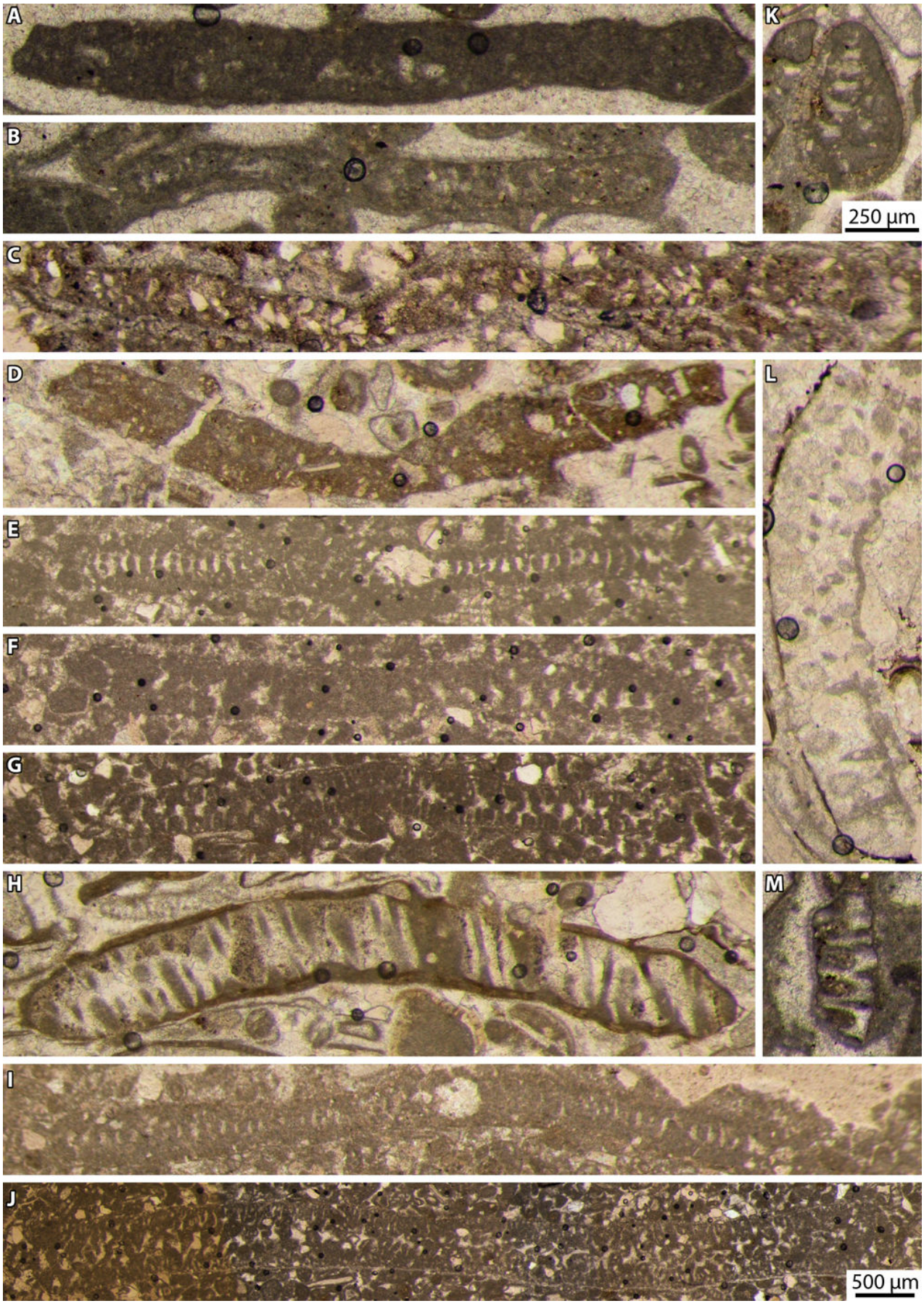
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Plate 3: A-E: *Ichnusella* spp.; **F-K:** cayeuxia-like structures, microbial encrusters (see arrows pointing to the encrusting surface); **L:** *Vercorsella* ? sp.; **M-AB:** *Torinosuella peneropliformis* (YABE & HANZAWA, 1926); **AC:** *Pseudoactinoporella iranica* BUCUR *et al.*, 2012. All photomicrographs with the same scale bar = 250 µm (on T). A: sample 102; B: sample 128; C-E: sample 32 (from Zard type-locality); F: sample 101A; G-K: sample 132; L: sample 115A; M: sample 117; N: sample 121; O-P, R, Z: sample 134A; Q: sample 120; S, AA: sample 136; T: sample 119; U, Y: sample 106; V-W: sample 139; X: sample 141; AB: sample 107; AC: sample 116. Zard Fm: A, F, U, Y; Tirgan Fm: B-E, G-T, V-X, Z-AC.

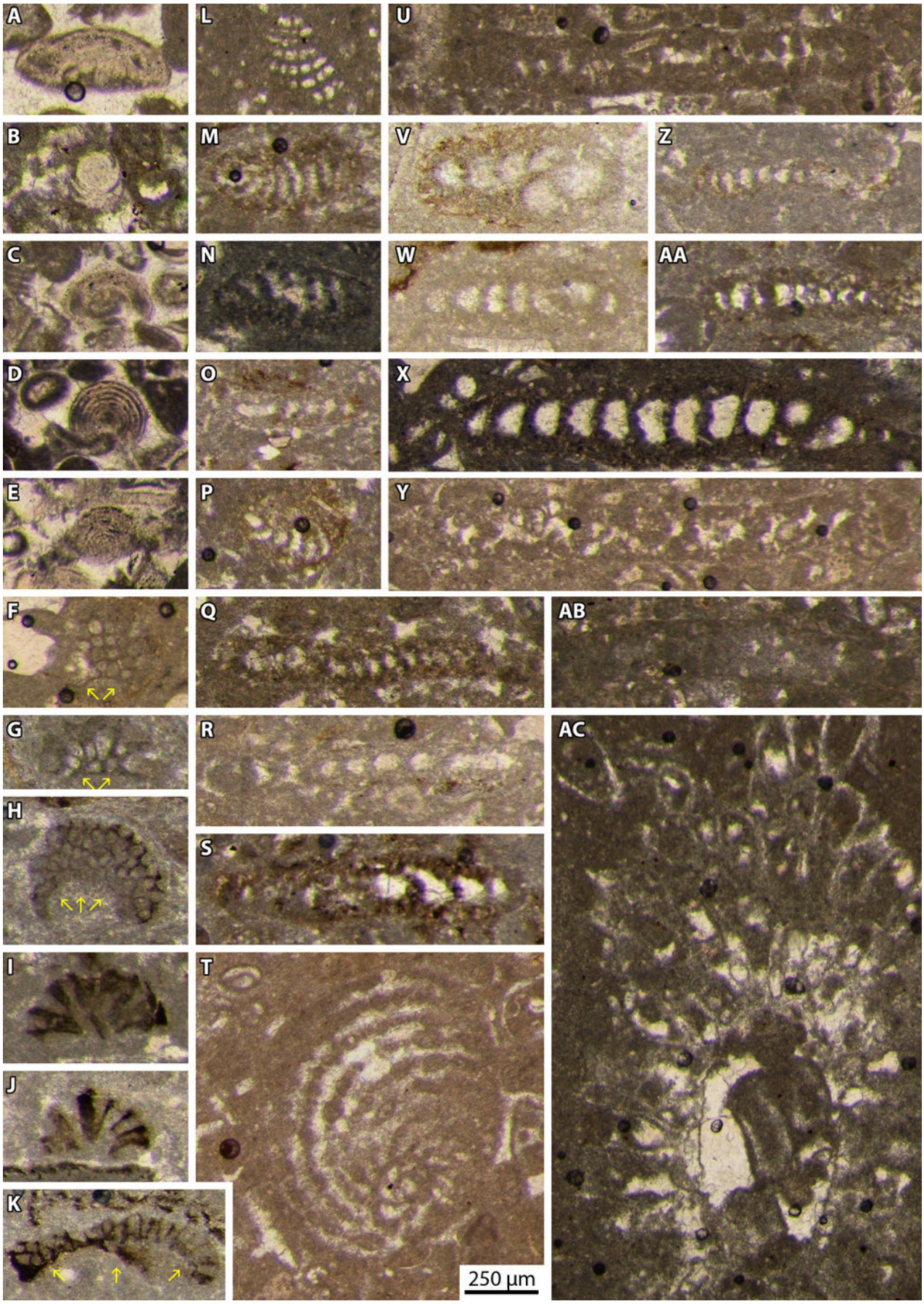
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Plate 4: A, E: *Rajkaella bartheli* (BERNIER, 1971); **B-C:** *Vercorsella* sp.; **D:** *Coscinoconus* sp.; **F:** *Salpingoporella annulata* CAROZZI, 1953; **G-H:** *Scythiolina* sp.; **I-L:** *Actinoporella podolica* (ALTH, 1878); **M-P:** *Coscinoconus alpinus* LEUPOLD *in* LEUPOLD & BIGLER, 1936; **Q-R:** *Montseciella arabica* (HENSON, 1948); **S:** macrospheric specimens of *Balkhania balkhanica* MAMONTOVA, 1966; **T:** *Bulbobaculites felixi* Pleş *et al.*, 2016. All photomicrographs with the same scale bar = 250 µm (on Q). A, D, F, M-P: sample JUR A; B-C, H-L: sample JUR B; E, G: sample JUR C; Q-R: sample 27 (from Zard type-locality); S: sample 115A; T: sample 22 (from Zard type-locality). Mozduran Fm: A-P; Zard Fm: T; Tirgan Fm: Q-S.

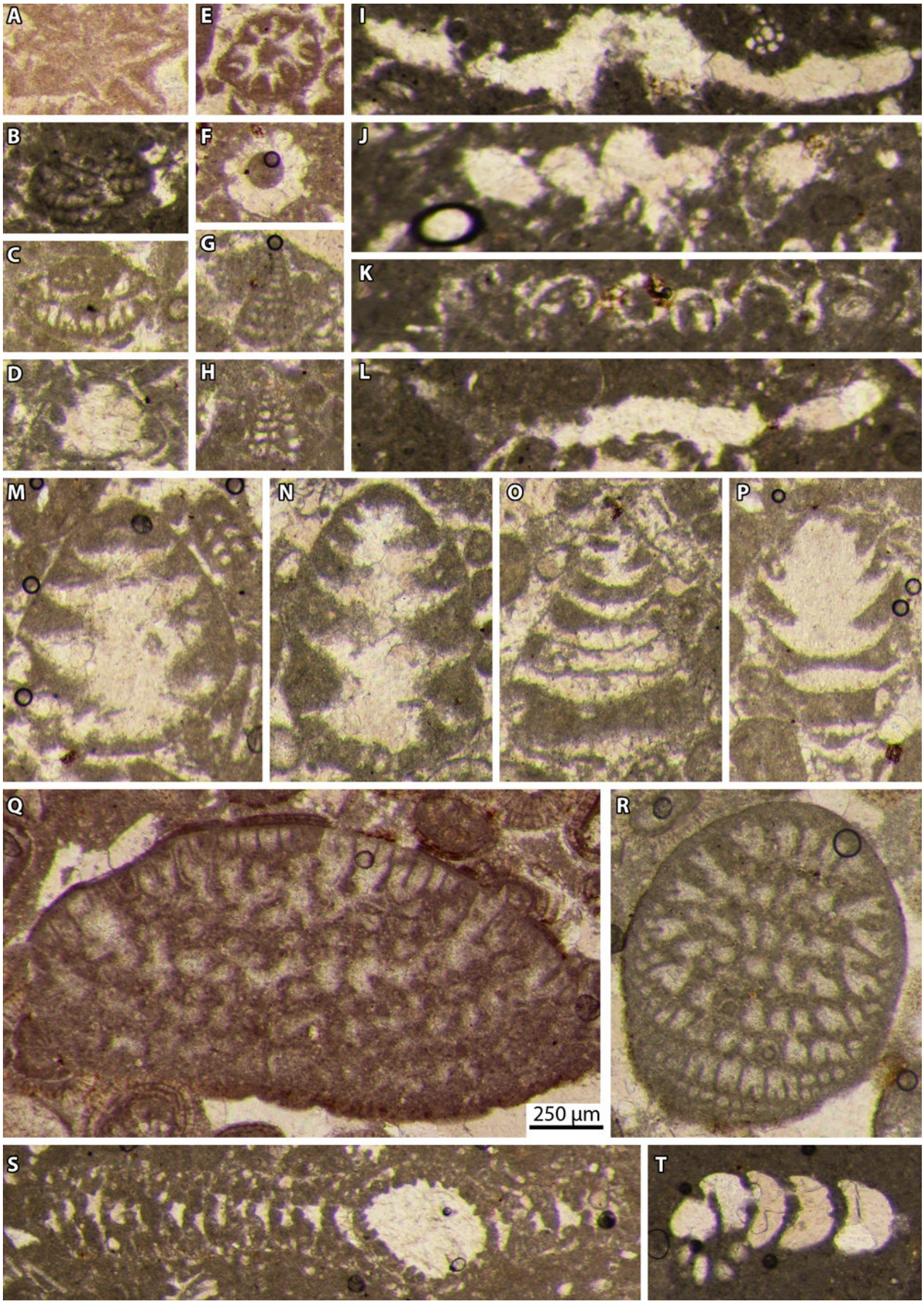
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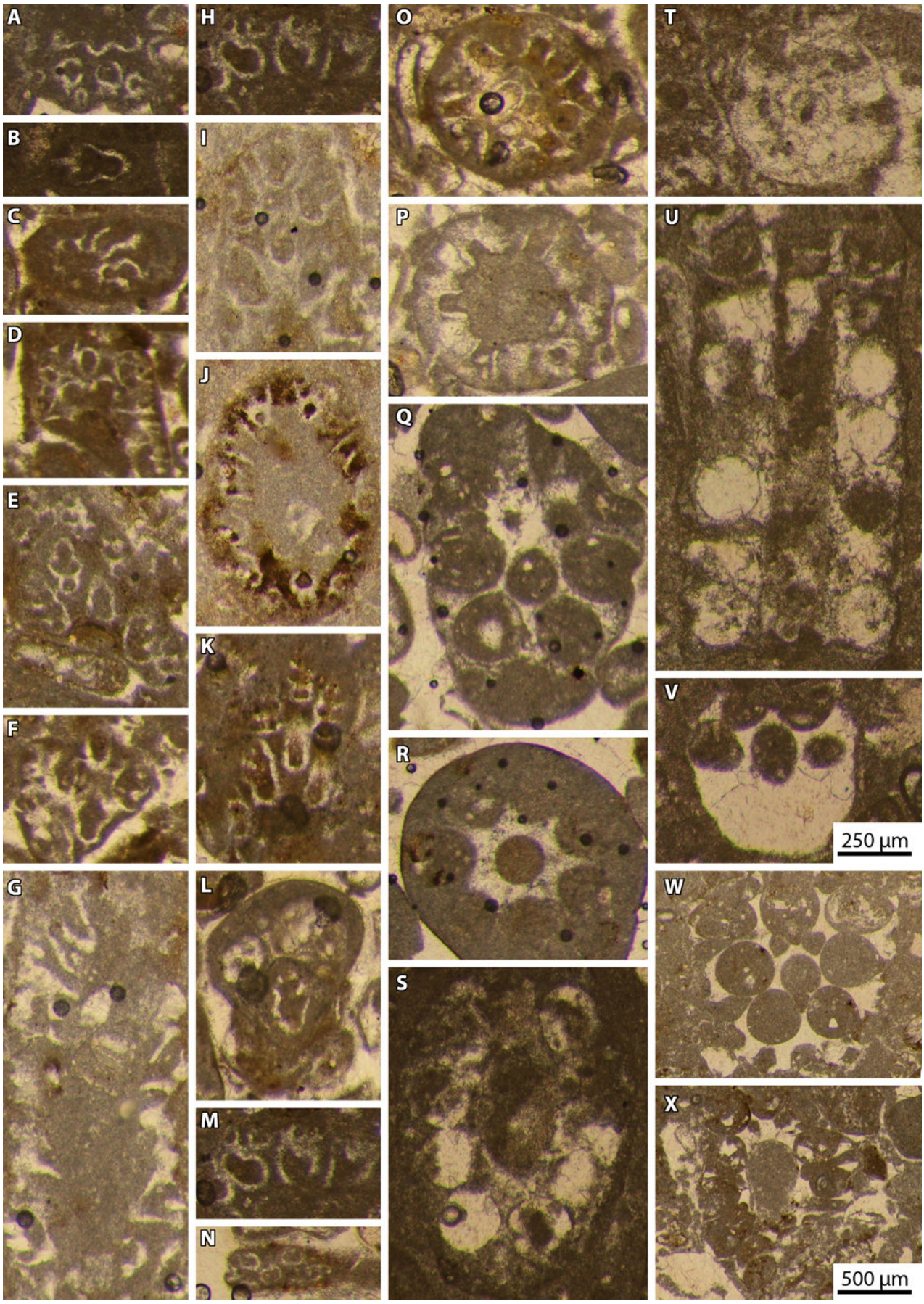
Plate 5: A-P: *Deloffrella quercifoliipora* GRANIER & MICHAUD, 1987; **Q-V:** *Holosporella sugdeni* (ELLIOTT, 1957); **W-X:** *Bakalovaella elitzae* (BAKALOVA, 1971). All photomicrographs with the same scale bar = 250 µm (on K), except J with scale bar = 500 µm. A: sample 101A; B: sample 121; C-G, I-J: sample 136; H, M: sample 141; K-L, Q-R: sample 137; N: sample 27 (from Zard type-locality); S-V: sample 121; W-X: sample 127. Zard Fm: A; Tirgan Fm: B-X.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250 µm
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X
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Plate 6: A-C, E-F: *Bakalovaella elitzae* (BAKALOVA, 1971), with possible cysts (in F); **D:** *Holosporella sugdeni* (ELLIOTT, 1957); **G-O:** *Actinoporella* gr. *podolica* (ALTH, 1878), a form that differs from the genuine Tithonian-Berriasian *Actinoporella podolica* (see Granier, 2019b, for comparison). All photomicrographs with the same scale bar = 250 µm (on E). A-B: sample 131A; C, E: sample 131B; D, F: sample 137; G-I: sample 116; J-K: sample 124A; L: sample 122; M: sample 127; N-O: sample 128. All specimens (A-O) from the Zard Fm.

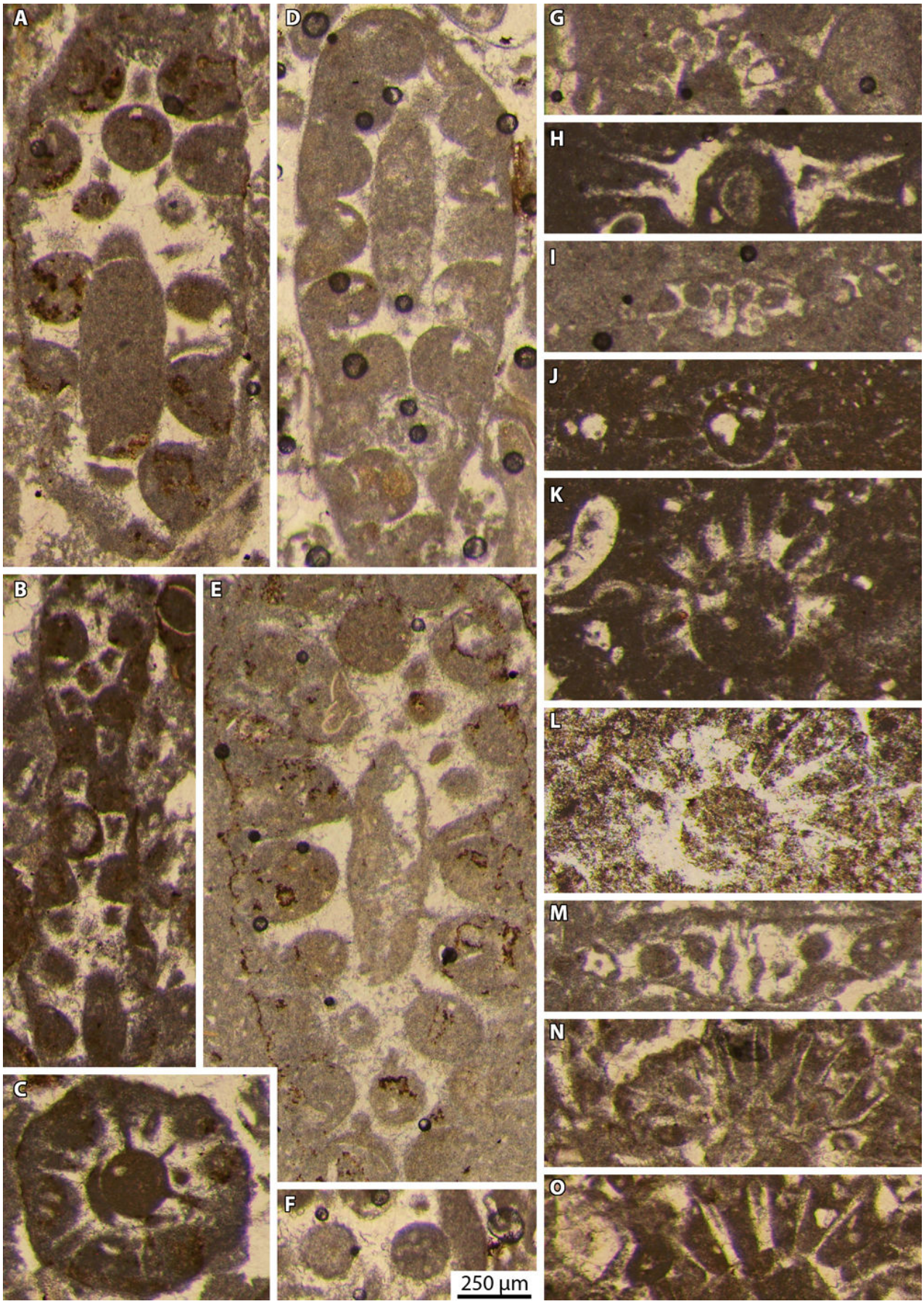
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Plate 7: A: *Pseudoactinoporella iranica* BUCUR *et al.*, 2012; **B, I:** ? *Bispiraloconulus* sp.; **C-E:** *Globochaete* sp.; **F:** *Carpathocancer* sp.; **G-H:,** *Ammobaculites* sp.; J: oolitic dolograinstone; **K-M:** *Kopetdagaria sphaerica* MASLOV *ex* BUCUR, 2002; **N:** *Terquemella* sp.; **O:** Girvanella-like microbial filaments. Photomicrographs A, C-F, J-O with the same scale bar = 250 µm (on O) and B, G-I with the same scale bar = 500 µm (on O). A: sample 127; B, K: sample 101B; C, E: sample 28; D: sample 29; F-H: sample 5; I: sample 24; J: sample 8; L: sample 101A; M: sample 121; N: sample 102; O: sample 128. Zard Fm: B, F-H, J-L, N; Tirgan Fm: A, C-E, I, M, O.

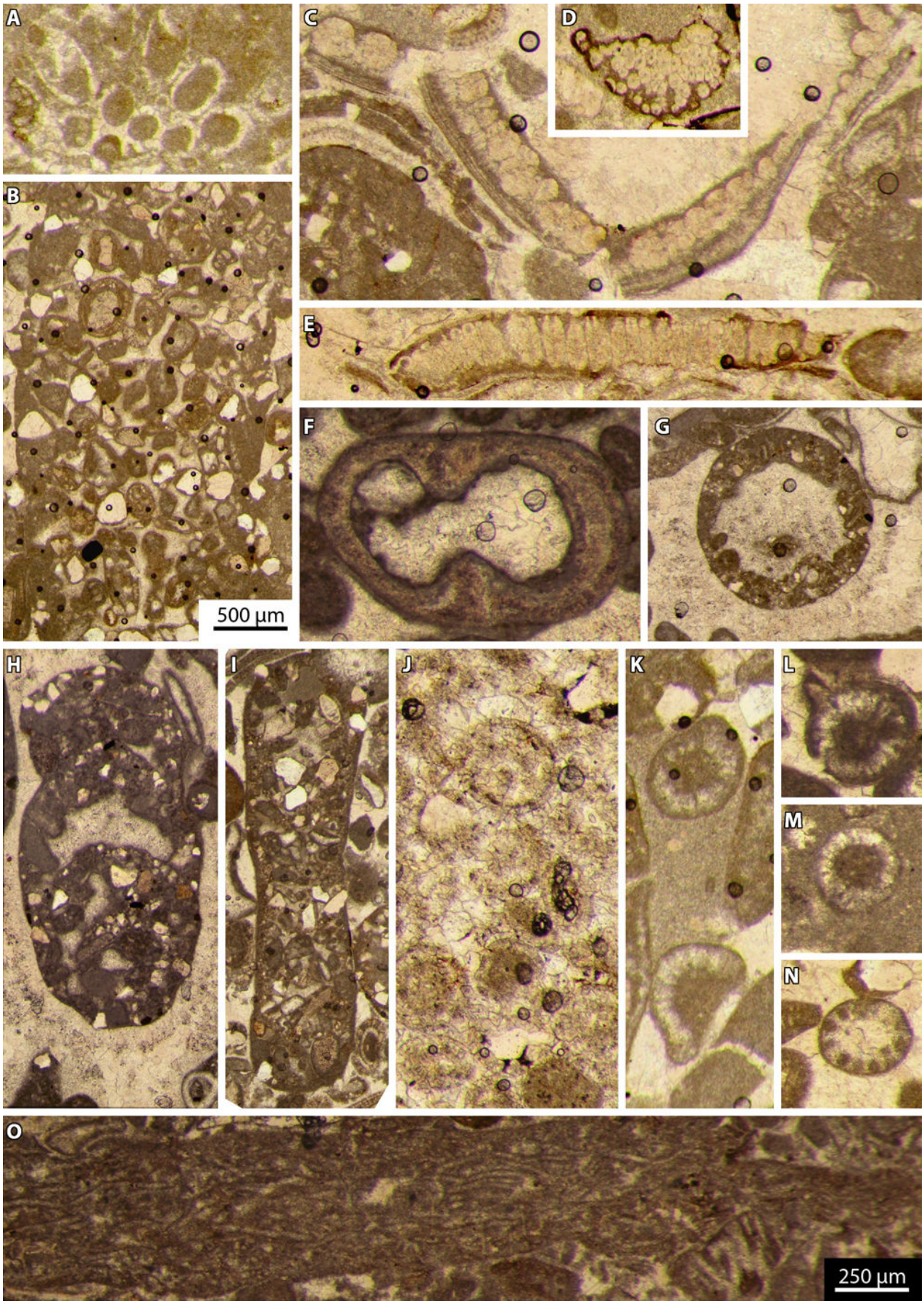
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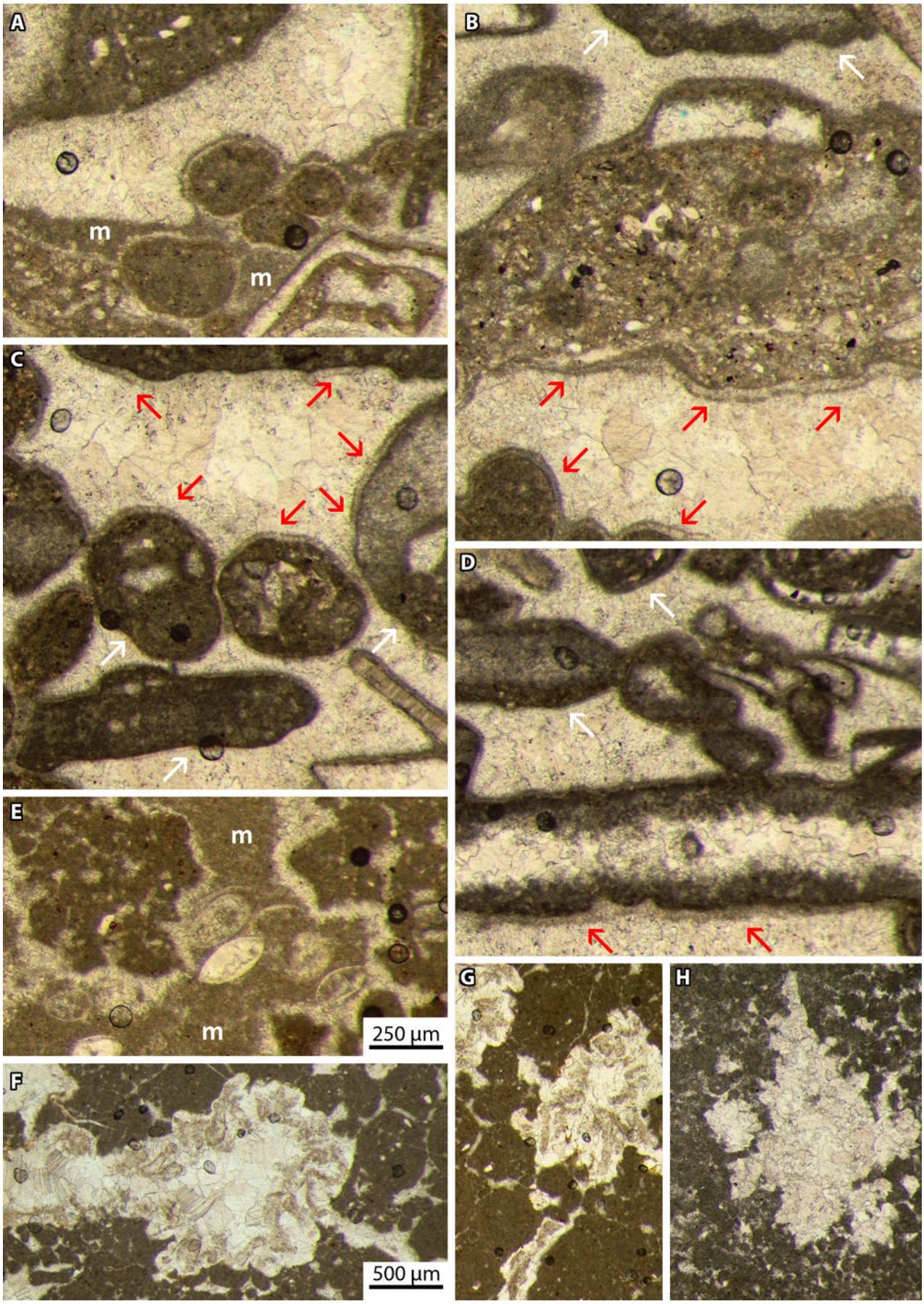
Plate 8: A, E: cemented grainstone with partial micritic infills (with endobionthic ostracods in E) of the primary intergranular pores; **B-D:** early anisopachous cement; F-H: possible evaporitic pseudomorphs in fenestral fabrics. m: micritic infills; red arrows: anisopachous cement; white arrows: no cement. Photomicrographs A-E with the same scale bar = 250 µm (on E) and F-H with the same scale bar = 500 µm (on F). A-D: sample 5; E: sample 20; F-G: sample 21B; H: sample 35. All specimens (A-G) from the Zard Fm, except H from the Tirgan Fm.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