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SOME MICROFOSSILS (DASYCLADALES, BENTHIC FORAMINIFERA, SPONGES) FROM THE UPPER JURASSIC MOZDURAN FORMATION (NE IRAN, KOPET-DAGH) AND THEIR BIOSTRATIGRAPHIC AND PALAEOBIOGEOGRAPHIC IMPORTANCE

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Abstract. The Mozduran Formation represents mainly carbonatic shallow-water deposits from the Kopet-Dagh basin of northeast Iran. Longtime considered to be of exclusively Late Jurassic (Oxfordian-Kimmeridgian) age, its ranging into the Early Cretaceous has been demonstrated in recent times. The micropalaeontological inventory and biostratigraphic data however, are still poorly constrained. In the present contribution, some taxa of Dasycladales [*Campbelliella striata* (Carozzi), *Montenegrella florifera* Bernier, *Petrascula bugesiaca* Bernier, *Petrascula* cf. *bursiformis* (Éttalon), *Triploporella* sp.], benthic foraminifera [*Neokilianina rahonensis* (Foury & Vincent), *Spiraloconulus suprajurassicus* Schlagintweit], and sponges (*Paronadella*? sp., *Neuropora lusitanica* G. Termier & H. Termier, *Thalamopora* sp.) are reported. Some taxa are reported for the first time from this formation, some even for the first time from Iran. The identified assemblage is assigned to the Tithonian, although a late Kimmeridgian age for the lowermost part of the section studied is possible. A palaeobiogeographic restriction to the former Neotethysian margin might be possible for the two *Petrascula* species.

Introduction

The Kopet-Dagh mountain range represents a north-east-trending about 650 km long and about 200 km wide active fold belt at the border between Iran and Turkmenia, east of the Caspian Sea. In Mesozoic and Cenozoic times, more than 7000 meters of mostly Jurassic to Miocene sediments (carbonates, siliciclastics and evaporites) have been deposited in the eastern part of the basin (Afshar-Harb 1979; Berberian & King 1981; Golonka 2004). These sediments were deposited in a marginal sea of the northern Tethys ocean, one of the so-called Peri-Tethysian basins (Brunet & Cloething 2003, for an overview), that became close with the suturing of northeast Iran to the Eurasian Turan Plate resulting from the convergence between the Arabian and Eurasian plates (e.g., Berberian & King 1981; Aghanabati 2004). The closing of the Kopet-Dagh basin happened diachronous with emersion processes advancing from east to west (Lyberis & Manby 1999). Like the Zagros Mountains, the Kopet-Dagh was folded into long linear NW-SE trending folds during the last phase of the Alpine orogeny in Plio-Pleistocene times.

The major reservoir in the giant Khangiran gas field in the Kopet-Dagh basin is a porous dolomitic interval of the widely distributed Upper Jurassic Mozduran Formation (Afshar-Harb 1994). The stratigraphy of the Mozduran is treated controversially in the literature. The objectives of the present contribution are new data on the micropaleontology (benthic foraminifera, dasycladalean algae, sponges), and biostratigraphy of one section of the Mozduran Formation located in the central part of the Kopet-Dagh basin.

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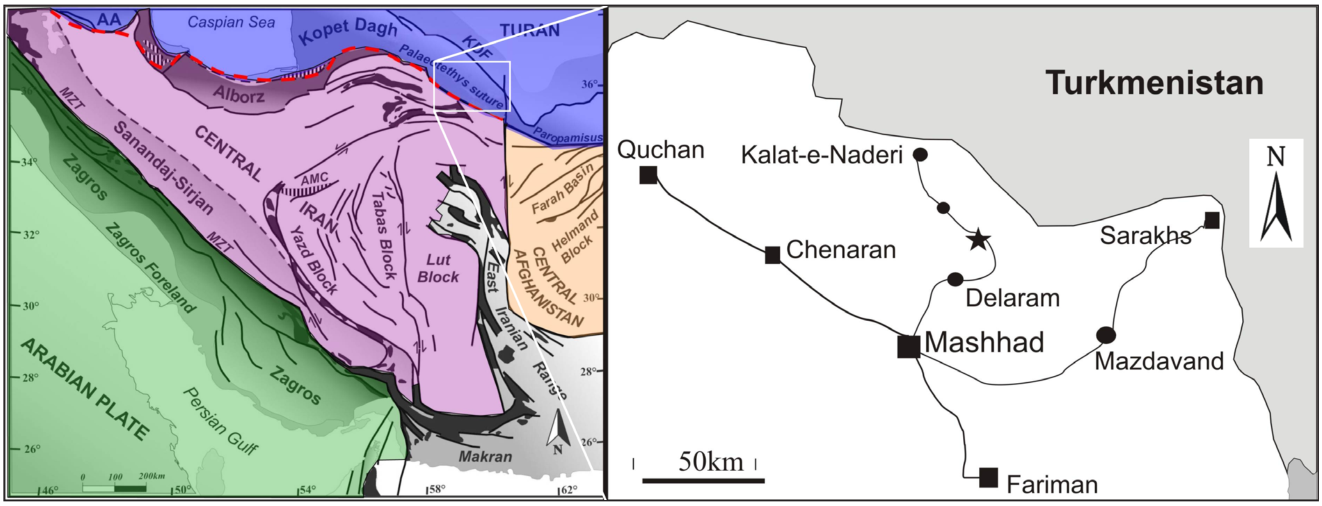

Fig. 1 - Tectonic-structural map of Iran (modified from Zanchi et al. 2003) (left) and location map of the studied section.

Geological setting

The Mozduran Formation is composed mainly of medium- to thick-bedded dark limestones, dolomites, with shale and sandstone intercalations. In the eastern part of the basin, where it is shallower, the Mozduran Formation displays a higher grade of dolomitization and reduced thickness compared to the western part. The Mozduran Formation rests with conformable contact on the Chaman Bid Formation and is overlain by the reddish siliciclastic Shurijeh Formation separated by a paraconformity surface (Aghanabati 2004). The upper boundary of the Mozduran Formation to the Lower Cretaceous Shurijeh Formation is erosional according to some authors (Bucur et al. 2013a; Aghaei et al. 2018) whereas others considered it to be transitional (e.g., Nabavi 1976; Majidifard 2003).

The studied section of the Mozduran Formation is located in the central part of the Kopet-Dagh basin approximately 60 km north to northwest of Mashhad city (Fig. 1). The thickness of the Mozduran Formation here is 268 m, composed of medium- to thick-bedded gray limestones, black marly limestones and some intercalations of black shales and sandstone (Fig. 2). In the present study, a total of 60 samples mainly from limestones were gathered. The Greenwich coordinates of the section base are N 36°34'27.91" and E 60°0'19.35".

Biostratigraphy of the Mozduran Formation

The stratigraphy of the Upper Jurassic Mozduran Formation is treated controversially in the literature. In many contributions, it is assigned to the late Callovian/Oxfordian-Kimmeridgian interval (e.g., Kavoosi et al. 2009; Robert et al. 2014; Aghaei et al. 2018). Majidifrad (2003, p. 39) mentions the dasycladale *Clypeina jurassica* [= *Aloisalthella sulcata* (Alth); see Granier & Lethiers 2018] from the lower part of the Mozduran Fm. Based on the age of the underlying Chaman Bid Formation (obtained from ammonites of the *eudoxus* zone) he concludes a Kimmeridgian-?Tithonain age for the Mozduran Fm. Whether or not the mentioned *C. jurassica* belongs to this taxon however remains speculative. Two illustrated specimens of "*C. jurassica*" from the upper part of the Mozduran Fm. (Majidifard 2003, pl. 2.8A-B) in fact belong to *Rajkanella bartheli* (Bernier). The foraminifer illustrated as *Pseudocyclammina maynci* (pl. 2.6F) from the middle part of the Mozduran Fm. in fact belongs to *Anchispirocyclina lusitanica* (Egger). Kadivar et al. (2017, fig. 7) illustrated specimens of *Alveosepta jaccardi* (Schrodt) [= indicated as *Pseudocyclammina lituus* (Yokoyama)] and *Frentzenella involuta* (Mantsurova) (= indicated as *Coscinoconus* sp.). In the case study, this would indicate a late Oxfordian-Kimmeridgian and Tithonian age respectively (e.g., Bassoullet 1997; Rigaud et al. 2013).

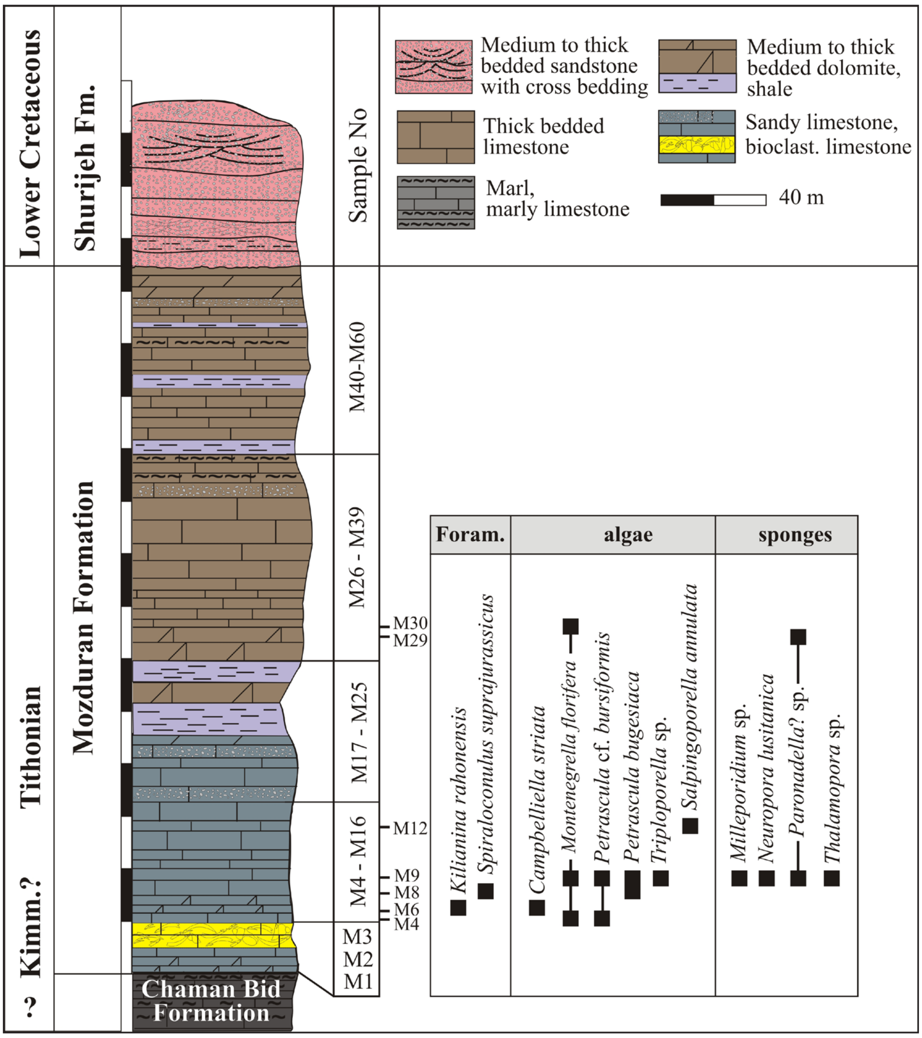

Fig. 2 - Studied section of the Mozduran Formation ~60 km north to north-west of Mashhad city with distribution of the microfossils described herein (Dasycladales, benthic foraminifera, sponges).

Among the microfossils reported in the present study the following are worth mentioning:

* *Neokilianina rahonensis* (Foury & Vincent). Stratigraphy: Kimmeridgian-lowermost Tithonian (Bassoullet 1997)

* *Montenegrella florifera* Bernier. Stratigraphy: Tithonian-Berriasian (Bucur 1999; for the occurrence in the Berriasian see comments in the Systematic Part)

* *Petrascula bursiformis* (Éttalon). Stratigraphy: Kimmeridgian-Tithonian (Bucur 1999)

* *Petrascula bugesiaca* Bernier. Stratigraphy: Tithonian (Bucur 1999).

An early Tithonian age for the top of the Chaman Bid Formation at its type-locality (Schairer et al. 1999) evidences the diachronous character of these formations and their boundaries. Bucur et al. (2013a) reported microfossils (benthic foraminifera, algae) of typically Berriasian (in part Valanginian?) age from the Mozduran Formation. In consequence this means, in a trivial manner, that a general age cannot be indicated *per se* for any section of the Mozduran Formation. Instead each section that has to be investigated individually to obtain data for its range. For the section studied herein the Tithonian (maybe latest Kimmeridgian for the basal part) is well documented. Whether or not the section also comprises parts of the Berriasian is not documented by any kind of (micro)fossils (Fig. 2).

Material and methods

The present study is based on micropalaeontological analysis of thin-sections coming from the Mozduran Formation. The specimens illustrated in the present contribution comprise eight thin-sections made from four rock samples: M4, M4-1, M6, M8, M9, M9-1, M9-2, and M9-3. They are deposited at the Ardakan Payame Noor University, Iran, collection Rashidi, under these numbers.

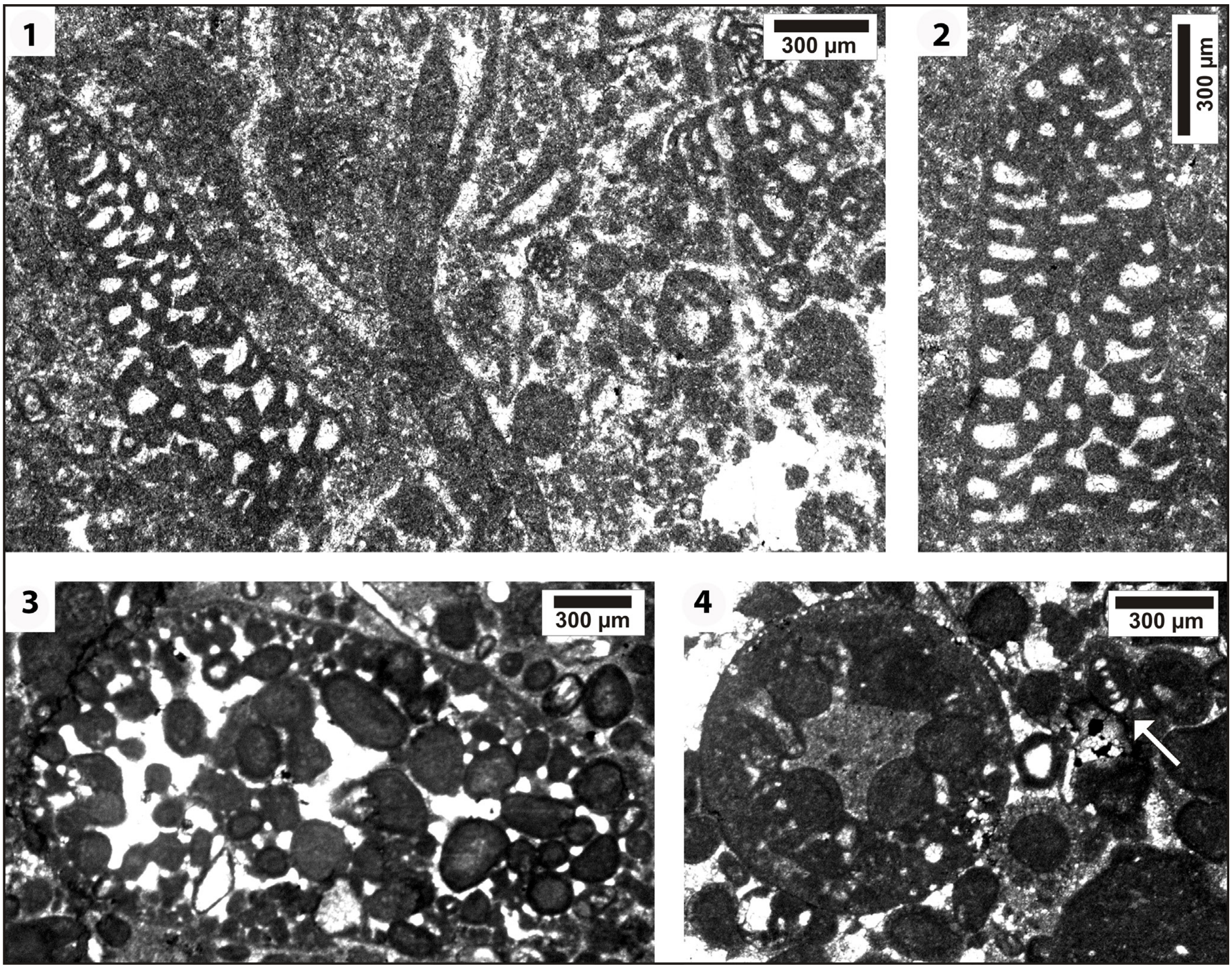

Fig. 3 - Benthic foraminifera from the Upper Jurassic Mozduran Formation, Iran. 3.1-3.2) *Neokilianina rahonensis* (Foury & Vincent). Sample M6. 3.3-3.4) *Spiraloconulus suprajurassicus* Schlagintweit. Note agglutinated ooids in the test and *Nautiloculina* sp. Sample M8.

Systematic Palaeontology

Benthic foraminifera

Phylum **FORAMINIFERA** Orbigny, 1826
Class **Globothalamea** Pawlowski, Holzmann & Tyszka, 2013
Order **Loftusiida** Kaminski & Mikhalevich, 2004
Suborder **Orbitolinina** Kaminski, 2004
Genus *Neokilianina* Septfontaine, 1988

Neokilianina rahonensis (Foury & Vincent, 1967)
Figs 3.1-3.2

1965 *Kilianina iranica* n. sp. - Gollestaneh, p. 356-360, pl. 113, figs 1-6.
*1967 *Kilianina rahonensis* n. sp. - Foury & Vincent, p. 39, pl. 2, figs 1-14.
1988 *Neokilianina rahonensis* (Foury & Vincent) nov. gen., nov. comb - Septfontaine, p. 249.
2014 *Neokilianina rahonensis* (Foury & Vincent) - Schlagintweit, p. 28, fig. 1d (re-illustration from Gollestaneh, 1965) [cum syn.]

Material: Several specimens from sample M6.

Remarks. *N. rahonensis* was described by Gollestaneh (1965) as *K. iranica* from the Kimmeridgian of the Zagros fold and thrust belt. According to the International Code of Zoological Nomenclature (article 8), *K. iranica* is invalid as the thesis of Gollestaneh was unpublished and this taxon has been described by Foury and Vincent (1967) as *Kilianina rahonensis* (see Schlagintweit 2014 for further information). The stratigraphic assignment of Gollestaneh (1965) as Kimmeridgian is in line with the range of *N. rahonensis* indicated by Bassoullet (1997). *N. rahonensis* is reported here for the first time from the Mozduran Formation where it has been observed in a packestone together with articles of the Dasycladale *Campbelliella striata* (Carozzi). The genus *Neokilianina* has been assigned to the Parurgonininae by Septfontaine (1988). This subfamily has been accepted in the classification of Kaminski (2014), but without including *Neokilianina*. For unknown reason this genus has also not been reinstated by Septfontaine in Kaminski (2000). It is worth mentioning that for *Parurgonina*, a pseudokeriothecal wall structure has been evidenced by Schroeder et al. (1975). So far unrecorded from *Neokilianina*, a belonging to the same subfamily therefore seems problematic. Recently, a second species of the genus has been described by Ramalho (2015) as *Neokilianina concava* from the Kimmeridgian of Portugal. In sample M6 *Neokilianina rahonensis* (Foury & Vincent) is associated with *Campbelliella striata* (Carozzi).

Genus *Spiraloconulus* Allemann & Schroeder, 1980

Spiraloconulus suprajurassicus Schlagintweit, 2011
Figs 3.3-3.4

*2011a *Spiraloconulus suprajurassicus* n. sp. - Schlagintweit, p. 399, figs 1b, 3a-c, 4a-f, 5, 7a-d.
2014 *Spiraloconulus suprajurassicus* Schlagintweit - Bucur et al., figs 7a-f.

Material: Four specimens from sample M8.

Remarks. This comparably large-sized species has been reported typically from well-agitated platform margin deposits where it incorporates various (bio)clasts (e.g., ooids, small foraminifera) inside the test. Its stratigraphic range known so far is late Kimmeridgian-Berriasian, based on occurrences in Austria and Romania (Schlagintweit 2011; Bucur et al. 2014). Sample M8 from the Mozduran Formation containing *S. suprajurassicus* represents a packstone with scattered ooids, small nautiloculinids, sponges, and rivulariacean-type cyanobacteria. Ramalho (2015, p. 41) assumes that *Spiraloconulus suprajurassicus* represents a junior synonym of *Otaina magna*. *Otaina magna* from the Kimmeridgian of Portugal was described from lagoonal wackestone-packstone with oncoids and gastropods (Ramalho 1990). Both are clearly different with respect to the foramina and exoskeleton. The multiple foramina of *Otaina magna* are concentrated in the central part of the septum whereas in *Spiraloconulus suprajurassicus* they are very tiny and distributed all over the septum. *Spiraloconulus* displays a thin epiderm, and subepidermal network whereas the small and short excrescences of the lateral rather thick chamber wall in *Otaina magna* are more or less isolated.

Calcareous algae

The abbreviations used are as follows: D = outer thallus diameter, d = inner thallus diameter, l = length primary laterals, l' = length secondary laterals, l'' = length tertiary laterals, p = diameter primary laterals, p' = diameter secondary laterals, p'' = diameter tertiary laterals, w = number of laterals per verticil.

Order **Dasycladales** Pascher, 1931
Family Triploporellaceae (Pia, 1920) Berger & Kaever, 1992
Tribe Salpingoporellinae Bassoullet et al., 1979
Genus *Campbelliella* (Radoičić, 1959)
De Castro, 1993

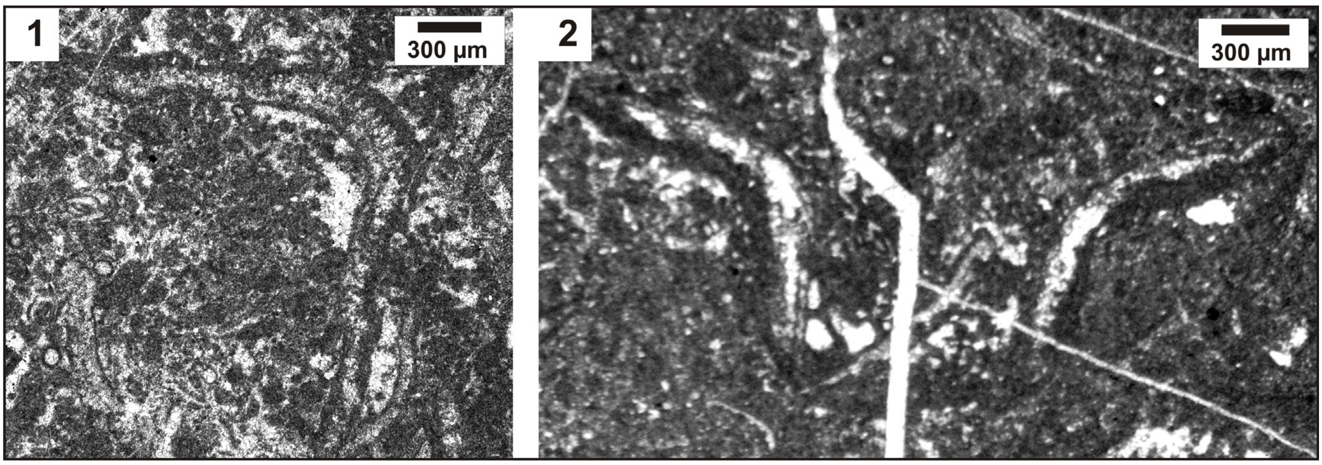

Fig. 4 - Dasycladales from the Upper Jurassic Mozduran Formation, Iran. 4.1-4.2) *Campbelliella striata* (Carozzi). Sample M6.

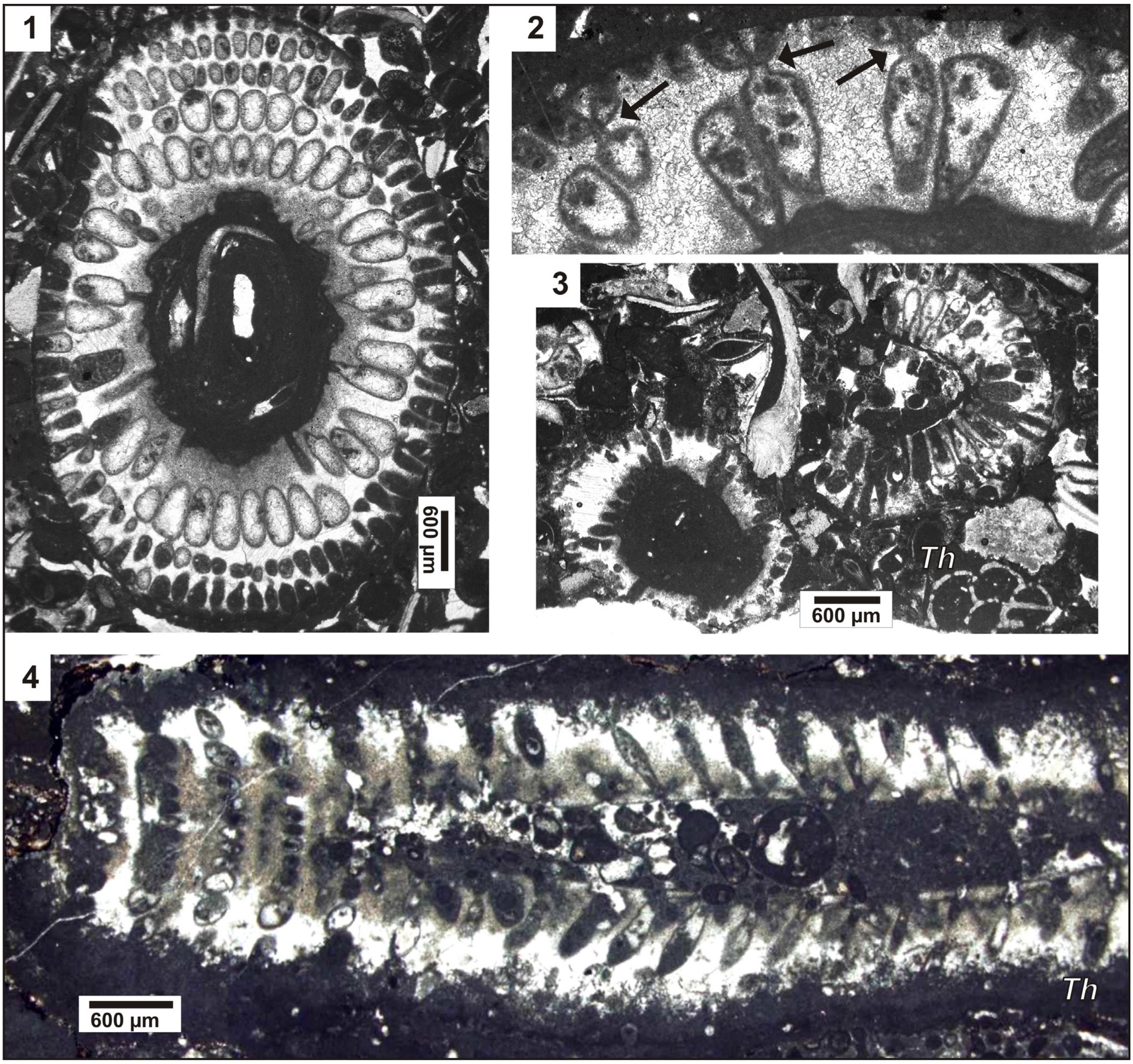

Fig. 5 - Dasycladales from the Upper Jurassic Mozduran Formation, Iran. 5.1-5.4) *Montenegrella florifera* Bernier. Black arrows in 5.2 show the clustering of the secondaries, meaning that they arise from a single point (forming a bunch). Note sponge skeleton of *Thalamopora* sp. in 5.3. Samples M4 (5.1-5.2), M9-1 (5.3), and M8 (5.4).

Campbelliella striata (Carozzi, 1954) emend. De Castro, 1993

Fig. 4

* 1954 *Vaginella striata* n. sp. - Carozzi, text-fig. 1, pl. 1, figs 1-38.
1974 *Campbelliella striata* (Carozzi) – Bernier, pls 32-34.
1993 *Campbelliella striata* (Carozzi) emend. - De Castro, p. 160, pl. 5, figs 1-11, pl. 6, fig. 1-6, pl. 7, figs 2-11, pl. 8, figs 1-9, pl. 9, fig. 3, pl. 10, figs 1-2, 4-6, 8-9, pl. 11., figs 1-3, 5-6, pl. 12, fig. 2, pl. 13, figs 1-8, pl. 14, figs 1-7, 9, pl. 15, figs 5, 7, pl. 16, figs 1-2, 9-14, pl. 17, figs 1-6.
2017 *Campbelliella striata* (Carozzi) – Granier and Bucur, p. 255, pl. 6, figs A-I.

Material: Several isolated articles. Sample M6.

Remarks. *C. striata* has been observed as dispersed articles only in sample M6, a fine grained packstone, together with *Neokilianina rahonensis* (Foury & Vincent).

It is worth mentioning that recently a marine worm parasitic in deep-water fishes has been described as *Campbelliella heteropoeciloacantha* by Palm (2004). The independency of the International Code of Zoological Nomenclature (ICZN) and the International Code of Botanical Nomenclature (ICBN) warrants the use of the same genus name.

sample	D	d	d/D	h	l	l'	l/l'	pmax	P'max
M4	3.0	1.45	0.48	-	0.68	0.3	2.27	0.32	0.15
M4-2	3.2	1.2	0.38	-	-	-	-	-	-
M8	2.4	0.55	0.23	0.37	0.61	0.3	2,0	0.19	0.12
M9	4.3	1.7	0.4	-	0.85	0.41	2.1	0.4	0.2
M9-1	2.8	1,0	0.36	-	0.65	0.36	1.8	0.23	0.13
range	2.4-4.3	0.55-1.7	0.23-0.48	-	0.61-0.85				
mean	3.1	1.46	0.37	-					
Bernier 1978	1.7-2.14	0.94-1.32	-	0.21-0.41 mean 0.32	0.2-0.38	0.2-0.31	-	0.102-0.204	0.05-0.204

Tab. 1 - Dimensions of *Montenegrella florifera* Bernier from the Tithonian of the Mazduran Formation compared to the data provided from the type area (Bernier 1978). Note that the ratio length of primaries to secondaries (l/l') is not a general used parameter but seems to be a useful additional feature for comparison.

Tribe Triploporellinae Pia, 1920
Genus *Montenegrella* Sokač & Nikler in Granier & Deloffre, 1993

Montenegrella florifera Bernier in Granier & Deloffre, 1993

Figs 5.1-5.4

*1978 *Montenegrella florifera* n. sp. - Bernier, p. 142, pl. 1, figs 1-7.
2013a *Dissocladella* cf. *intercedens* Bakalova - Bucur et al., fig 6a-d.

Material: Several specimens from samples M4, M8, and M9.

Remarks. The specimens occur in (bioclastic) packstones containing ooids, sponges (*Peronidella*? sp., undetermined stromatoporoids), echinoids, gastropods, pelecypods. The Iranian specimens nicely display the clustering of the secondaries, meaning that they arise from a single point (and forming a bunch constricted at the junction). This characteristic feature defines the difference to the allied genus *Suppiluliumaella* Elliott, 1968. The two taxa have controversely been discussed in the literature for decades (Sokač & Nikler 1973; Barattolo 1984; Sokač & Grgasović 2015). The constriction and arising bunch of secondaries are also discernible in the specimen of *Dissocladella* cf. *intercedens* Bakalova, illustrated by Bucur et al. (2013a, fig. 6b, lower arrow) from Berriasian parts of the Mozduran Formation. Like in *Suppiluliumaella*, the secondaries arise from different parts upon the distal surface of the primaries in *Dissocladella* (see Bassoullet et al. 1978, pl. 9, figs. 11, 13).

Montenegrella florifera is the only known Late Jurassic representative of the genus. The Iranian specimens are distinctly larger than the type-material from the Tithonian of France (Bernier 1978). Several biometric parameters do not show overlapping ranges with the type-material (D, d, h, l) while others do at the lowermost ranges indicated by Bernier (1979, tab. 1). The general aspect (e.g., inclination of laterals, shape of laterals, decalcification phenomena around the proximal parts of the primaries) of the Iranian specimens corresponds to the type-material. So we interpret the observed size differences as simple phenotypic variability (between the French and Iran assemblage) rather than a clear differentiated new species.

Genus *Petrascula* Gümbel, 1873

Petrascula bugesiaca Bernier, 1979

Figs 6.1-6.4

*1979 *Petrascula*? *bugesiaca* n. sp. - Bernier, p. 847, pl. 5, figs 1-5.
1984 *Petrascula*? *bugesiaca* Bernier - Bernier, p. 479, pl. 11, figs 3-5.
2017 *Petrascula bugesiaca* Bernier - Bucur, Săsăran and Pascariu, p. 2, figs 2a-g, figs 3a-j, figs 4a-g, fig. 5 (reproduction from Bernier 1979, pl. 5, fig. 2).

Material: Nine specimens from samples M8 and M9.

Remarks. The poorly known species *Petrascula bugesiaca* was originally described by Bernier (1979) from the Tithonian of the Southern Jura Mountains (France). Besides the characteristics of the genus (e.g., head-stalk morphology, three orders of laterals), the intusannulation (and the spherical tertiaries) is the main specific feature (Bernier 1979; Bucur et al. 2017). The intusannulation of the species is due to a discontinuous calcification being stronger at the levels of the verticils (Bucur et al. 2017). Between the verticils it is expressed by large voids, often enlarged by micritization, and affecting up to ¾ of

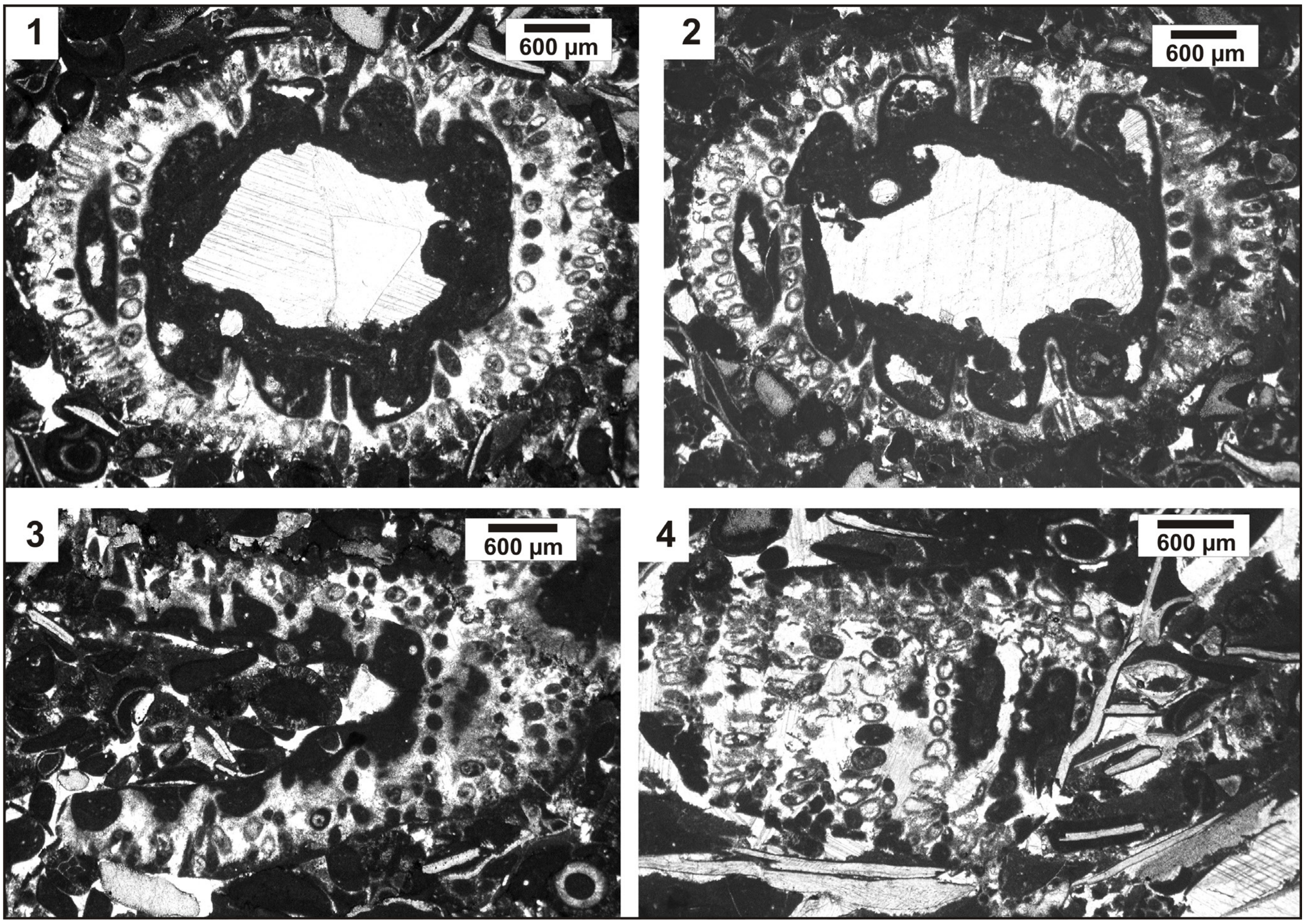

Fig. 6 - Dasycladales from the Upper Jurassic Mozduran Formation, Iran. 6.1-6.4) *Petrascula bugesiaca* Bernier. All specimens nicely display the intusannulation caused by discontinuous calcification. Sample M9.

the wall thickness. *P. bugesiaca* was so far only reported from the Tithonian of France (type-locality) and the Upper Jurassic of Romania (Bucur et al. 2017).

Petrascula cf. ***bursiformis*** (Éttalon, 1859)

Figs 7.1-7.6, 8.1-8.3

* 1858 *Conodictyum bursiforme* n. sp. - Éttalon, p. 530.
1873 *Petrascula bursiformis* (Éttalon) nov. comb. - Gümbel, p. 284, pl. 1, figs 1-15.
1979 *Petrascula bursiformis* (Éttalon) 1858, Pia, 1920 - Bernier, p. 843, pl. 2, figs 1-5.
2011b *Petrascula bursiformis* (Éttalon) - Schlagintweit, p. 196, pl. 3, fig. H, text-fig. 4.
2012 *Petrascula bursiformis* (Éttalon, 1859) Pia, 1920 - Bucur & Săsăran, p. 233, figs A-H, I?, J?.
2018 dasycladacean algae - Ricci et al., fig. 7D-E.

Material: Thirteen specimens from samples M4, M9, M9-1, M9-2, and M9-3.

Remarks. A detailed description of the species has been provided by Bucur and Săsăran (2012). Head and stalk are only rarely preserved unbroken, often separated. The three orders of laterals are only discernible in the stalk (and transition to the head), whereas the head is poorly calcified and represents a classical example of an "empty room" *sensu* Barattolo (2017) as reported from some Jurassic Dasycladales with club-shaped thallus morphology. The head may be recorded only by the terminal parts of the last order laterals covered by a thin calcitic envelope (Fig. 7.5). The Iranian specimens may show a comparably high number of laterals (w = 42), previously unreported from this species (Bernier 1979, w = up to 32). The transverse section shown in Fig. 8.3 may be at the transition stalk-head accounting for the high w value.

Dimensions. The dimensions indicated refer to the transverse section shown in Fig. 8.1 displaying the three orders of laterals. D= 3.8 mm, d= 2.0 mm, d/D= 0.53, l= 0.38 mm, l'= 0.38 mm, l''= 0.12-0.22 mm, p = 0.16-0.17 mm, p' = 0.12-0.16 mm, p'' = 0.08-0.1 mm, w = 42.

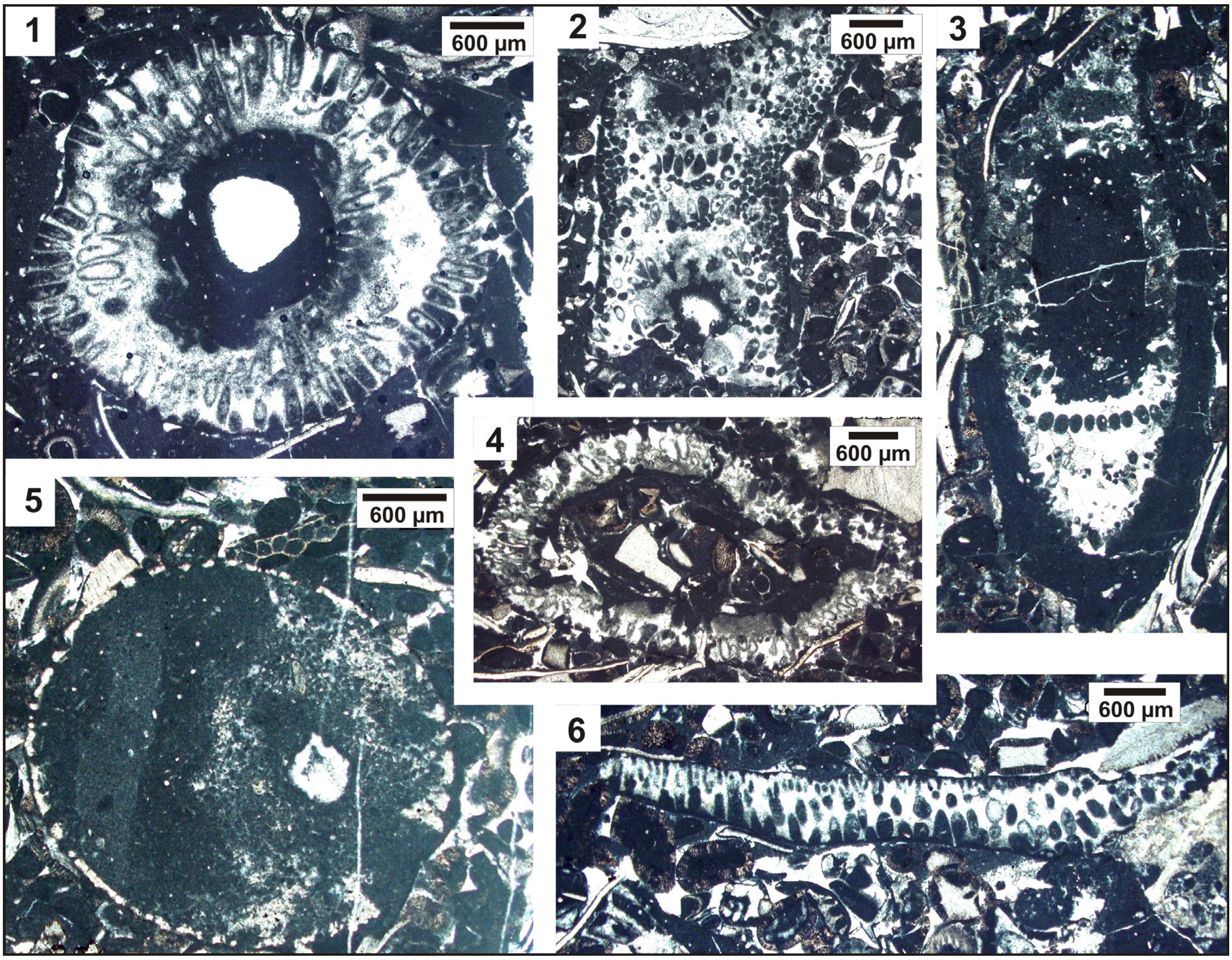

Fig. 7 - Dasycladales from the Upper Jurassic Mozduran Formation, Iran. 7.1-7.6) *Petrascula* cf. *bursiformis* (Éttalon). Samples M9-1 (7.1), M9-2 (7.2-7.3, 7.5-7.6), M9 (7.4).

Genus *Triploporella* Steinmann, 1880

Triploporella **sp.**
Figs 8.4-8.6

Material: Three specimens in sample M9.

Remarks. The genus *Triploporella* is reported from the Tithonian–Paleocene interval, with a peak in the Aptian–Albian (e.g., Steinmann 1903; Barattolo 1982; Barattolo et al. 2013; Bucur et al. 2013b; Maksoud et al. 2017). The comparably large-sized taxa are typically found in often reefal (e.g., associated with corals), external often platform/ramp habitats. Sample M9 represents a packstone with an assemblage of large-sized dasycladales (*Montenegrella*, *Petrascula*, *Triploporella*), calcareous sponges, bryozoans, echinoids, ooids.

From the Upper Jurassic only one species is reliably recorded, the type-species *Triploporella remesi* (Steinmann 1903; Barattolo et al. 2013). This species has overall larger dimensions, a higher d/D ratio, and a higher number of laterals per vertical (Barattolo et al. 2013, tab. 1).

Dimensions. D = 3.0 mm, d = 1.4-1.5 mm, d/D = 0.47-0.50, l = 0.7 mm, p = 0.27-0.28 mm, p” = 0.13 mm, w = ?35.

Sponges

The suprageneric systematic for *Thalamopora* is adopted from Hillmer & Senowbari-Daryan (1986). The one from *Paronadella* follows Senowbari-Daryan (2009).

Class **Calcispongia** Blainville, 1834
Order **Sphinctozoa** Steinmann, 1882
Superfamily Porata Seilacher, 1962

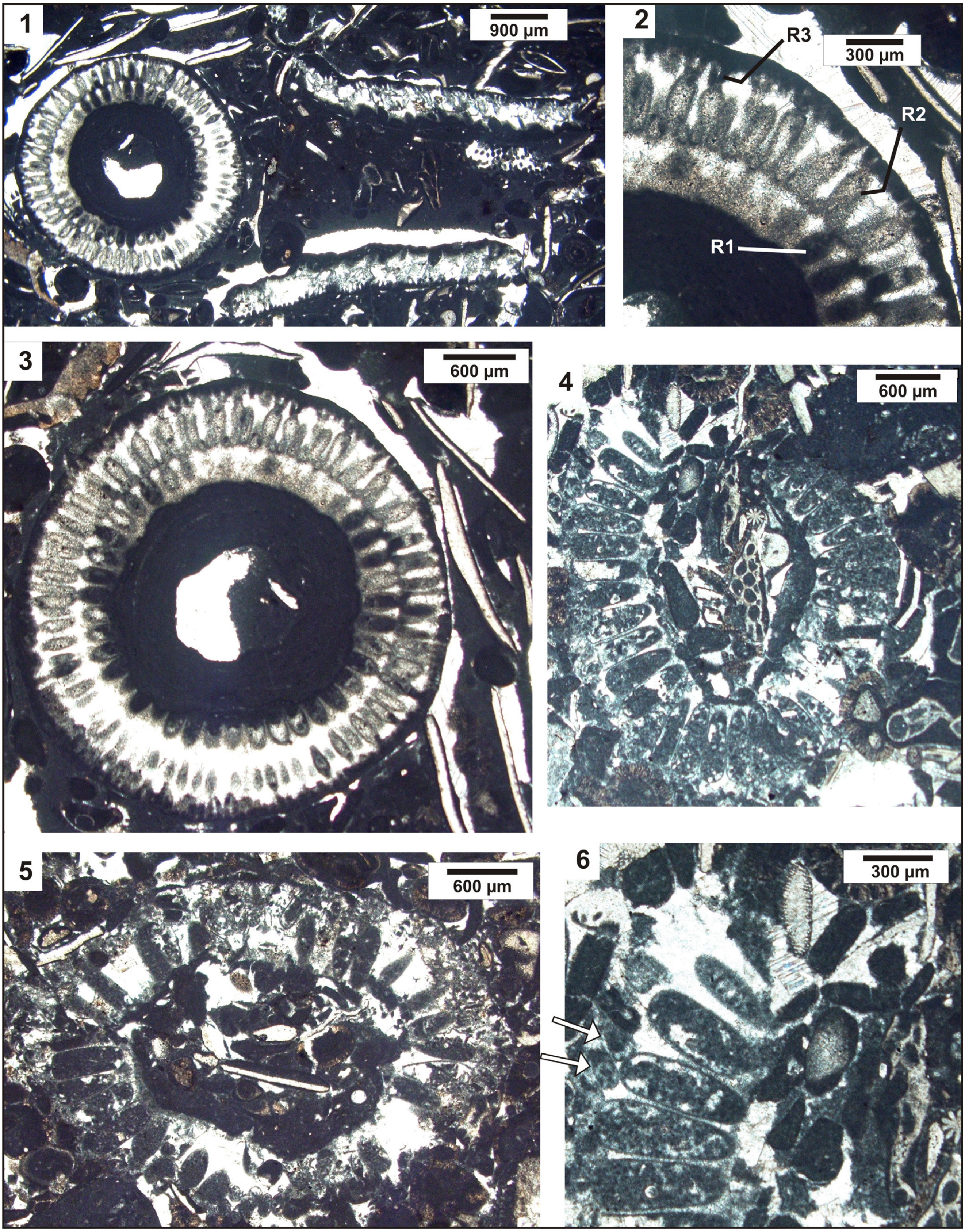

Fig. 8 - Dasycladales from the Upper Jurassic Mozduran Formation, Iran. 8.1-8.3) *Petrascula* cf. *bursiformis* (Éttalon). Abbreviations: R1, R2, R3 = primary, secondary, tertiary laterals. Sample M9. 8.4-8.6) *Triploporella* sp. Arrows in 7.6: secondary laterals. Sample M9.

Family Sphaerocoeliidae Steinmann, 1882
Genus *Thalamopora* Römer, 1841

Thalamopora sp.
Figs 5.3 pars, 9.1-9.5

Material: Ten specimens in sample M9.

Remarks. Kimmeridgian–Berriasian representatives of *Thalamopora* have repeatedly been confounded with *Barroisia* in the literature (Ramalho 1971; Dragastan 1975, 2010; Bodrogi et al. 1994; Schneider et al. 2013). Whereas *Thalamopora* possesses a glomerate chamber arrangement around the central spongocoel, individual chambers are arranged one above the other (uniserial) in *Barroisia* (e.g., Hillmer & Senowbari-Daryan 1986).

There are four Late Jurassic representatives of the genus (Senowbari-Daryan & García-Bellido 2002, tab. 3): *Thalamopora lusitanica* G. Termier & H. Termier in Termier et al., 1985 (Upper Oxfordian of Portugal), *Thalamopora squamata* (Quenstedt, 1858, Upper Jurassic of Germany), *Thalamopora zitteli* Zeise, 1897, and *Thalamopora hoheneggeri* Zeise, 1897 (Tithonian of Poland and Czech Republic). The latter form is very poorly known and not convenient for detailed conclusions. The reduced description was based on a single specimen and therefore no thin-section was prepared (Zeise 1897, p. 338). Also *Thalamopora squamata,* originally described as *Spongites squamatus*, was based on a single isolated specimen (Quenstedt 1858, tab. 84, fig. 23) hindering further comments. What can be clearly stated however that the Iranian forms are different from *T. lusitanica* by its lower number of chambers in transverse sections (6-8 versus 11-13). Whether or not the Iranian specimens represent a new species must be left open until a more in depth systematic review has been conducted. In any case *Thalamopora* occurs in a shallow-water depositional setting witnessed by its association with dasycladales. The co-occurrence of *Thalamopora* with calcareous green algae in the Upper Jurassic is also reported from other areas, the Plassen Formation and Ernstbrunn Limestone of Austria (e.g. Kügler et al. 2003; Schneider et al. 2013).

Dimensions (in mm). Length: 7.0; Outer diameter (D): 2.2-3.4; spongocoel diameter (d): 0.72-1.00; ratio d/D: 0.22-0.31; wall thickness: 0.12-0.15; number of chambers in transverse sections: 6-8; diameter of wall pores: 0.050-0.075.

Class **Demospongea** Sollas, 1875
Superorder **Aspiculata** Rigby & Senowbari-Daryan, 1996
Order **Inozoa** Rigby & Senowbari-Daryan, 1996
Family Auriculospongiinae Rigby & Senowbary-Daryan, 1996
Genus *Paronadella* Rigby & Senowbari-Daryan, 1996

***Paronadella*?** sp.
Figs 9.6-9.7

Material: Sixteen specimens in samples M4, M9, and M29.

Remarks. Due to the the aspiculate Triassic type-species, Rigby & Senowbari-Daryan (1996) proposed the genus name *Paronadella* for the Jurassic representatives displaying a spicular skeleton. *Paronadella*? sp. is associated with other sponges (*Thalamopora*, *Neuropora*) and large-sized dasycladaleans in the Mozduran Formation.

Dimensions (in mm). Outer diameter (D): 2.8-5.4; spongocoel diameter (d): 0.55-1.26; ratio d/D: 0.2-0.23.

Conclusive remarks

The current study adds distribution records of some taxa of benthic foraminifera, dasycladalean algae, and sponges from the Upper Jurassic of the Mozduran Formation. The assemblages indicate a Tithonian age for the studied sample interval. Some taxa are recorded for the first time from Iran, some of them for the first time from the Mozduran Formation. Among the Dasycladales we identified monospecific inner platform associations with *Campbelliella striata*, and *Salpingoporella* cf. *annulata*. Open marine, outer platform deposits include an assemblage of large-sized taxa with several orders of laterals (*Montenegrella, Petrascula*, *Triploporella*) and assigned to the Triploporellaceae. The associated ooids document near-by high-energy shoals. This assemblage of Upper Jurassic large dasycladaleans compares to the Lower Cretaceous Niksic triploporellacean association (*Montenegrella, Suppiluliumaella,* and others) from the Dinaric realm (Sokač & Nikler 1973; Schindler & Conrad 1994). The association of the dasycladaleans with sponges referred to *Thalamopora* on the other side allows cross checking to the Upper Jurassic Ernstbrunn

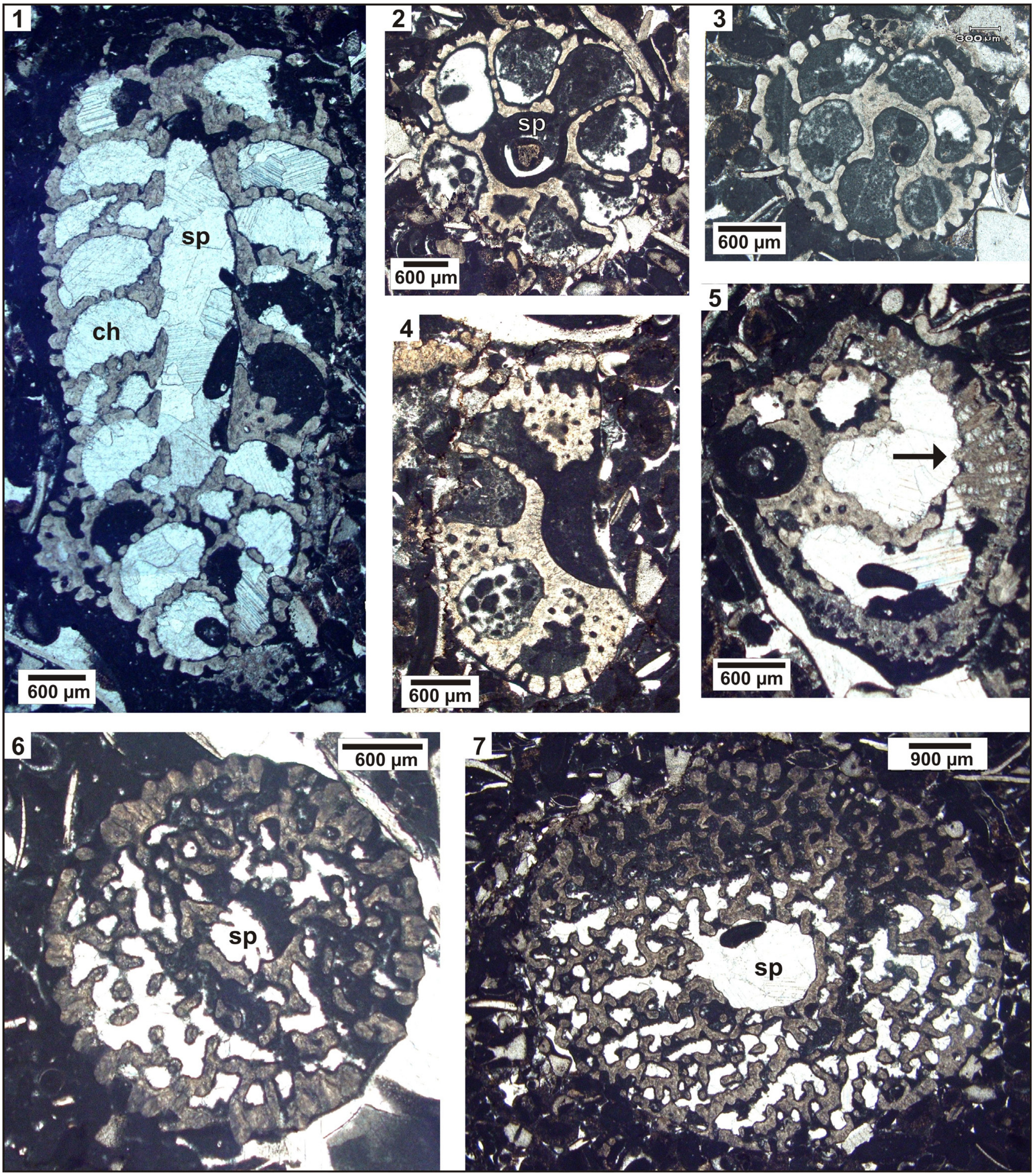

Fig. 9 - Sponges from the Late Jurassic Mozduran Formation, Iran. 9.1-9.5) *Thalamopora* sp. Note encrusting sclerosponge *Neuropora lusitanica* Termier & Termier (arrow in 9.5). Samples M9-2 (9.1, 9.3) M9-3 (9.2, 9.5), M9 (9.4). 9.6-9.7) *Paronadella*? sp. Sample M9. Abbreviations: sp = spongocoel, ch = chamber.

Limestone of Austria and the Czech Republik (Schneider et al. 2013). The distributional data of *Petrascula bugesiaca* point to a palaeobiogeographic restriction to the former Neotethysian margin.

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