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LERCARITUBUS PROBLEMATICUS FLÜGEL, SENOWBARI-DARYAN & DI STEFANO AND *VANGIA TELLERI* (FLÜGEL): TWO PROBLEMATIC ORGANISMS FROM THE PERMIAN JAMAL FORMATION OF SHOTORI MOUNTAINS, NORTHEAST IRAN

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Abstract. *Lercaritubus problematicus* Flügel, Senowbari-Daryan & Di Stefano and *Vangia telleri* (Flügel) and enigmatic calcareous fossils, known from the Sicily, Guadalupe Mountains, USA and Oman is described from the Permian Jamal Formation of Shotori Mountains, northeast Iran. The new genus name *Vangia* is introduced for *Uvanella*? *telleri* Flügel. The systematic position of *Vangia telleri* (Flügel) nov. comb. as possibly cyanobaterium and its relationships with *Bacinella irregularis* Radoicic, an abundant enigmatic fossil in Jurassic-Cretaceous shallow water deposits, is discussed.

Riassunto. Vengono descritti *Lercaritubus problematicus* Flügel, Senowbari-Daryan & Di Stefano e *Vangia telleri* (Flügel), fossili calcarei di natura enigmatica conosciuti in Sicilia, Guadalupe Mountains, USA e in Oman e ora rinvenuti nella Formazione Jamal del Permiano delle montagne Shotori, nel nordest dell'Iran. Viene introdotto il nuovo nome generico *Vangia* per inquadrare la specie *Uvanella*? *telleri* Flügel. Sono anche discussi la posizione sistematica di *Vangia telleri* (Flügel) nov. comb. quale possibile cianobatterio ed i suoi rapporti con *Bacinella irregularis* Radoicic, un fossile enigmatico abbondante nelle rocce giurassico-cretacee di acque basse.

Introduction

Lercaritubus problematicus Flügel, Senowbari-Daryan & Di Stefano, a tube-like organism was originally described as "Microproblematicum A" by Flügel (in Flügel et al. 1984) from the Middle Permian of Slovenia, and later as *Lercaritubus problematicus* by Flügel et al. (1990), from the Lower Permian reef boulders embedded within the siliciclastic deposits of the Lercara Formation in Sicily. It was reported also from the Middle Permian reefs in Guadalupe Mountains of Texas and New Mexico by Senowbari-Daryan & Rigby (1996) and from the Permian reef limestones of Oman by Weidlich (1992). *Lercaritubus* occurs within the reef or reefal carbonates of Jamal Formation (Lower and Middle Permian) in the Shotori Mountians, of northeast Iran. It seems to be an index fossil limited to Permian time. The occurrence of *Lercaritubus* in Sicily, Oman, Iran, and in USA indicates to possibly its cosmopolitan importance.

Vangia telleri nov. comb., originally described as possibly chambered sponge *Uvanella*? *telleri* by Flügel (in Flügel et al. 1984) from the Permian of Slovenia, is another problematic and aggregate-building organism (cyanobacteria?). It is composed of numerous irregularly arranged cavities, separated by thin and compact walls. The wall appears dark micritic in transmitted light. *Vangia telleri* occurs as isolated aggregates in sediment or rarely incrusts other organisms.

Geographic position of studied localities

Permian deposits of central Iran, called the Jamal Formation (Stöcklin et al. 1965), crop out in several localities in the Shotori Mountains, northeast Iran. *Lercaritubus problematicus* was found in two sections of Permian Jamal Formation, located about 65 km and 45 km north of the town of Tabas (Fig. 1). These localities

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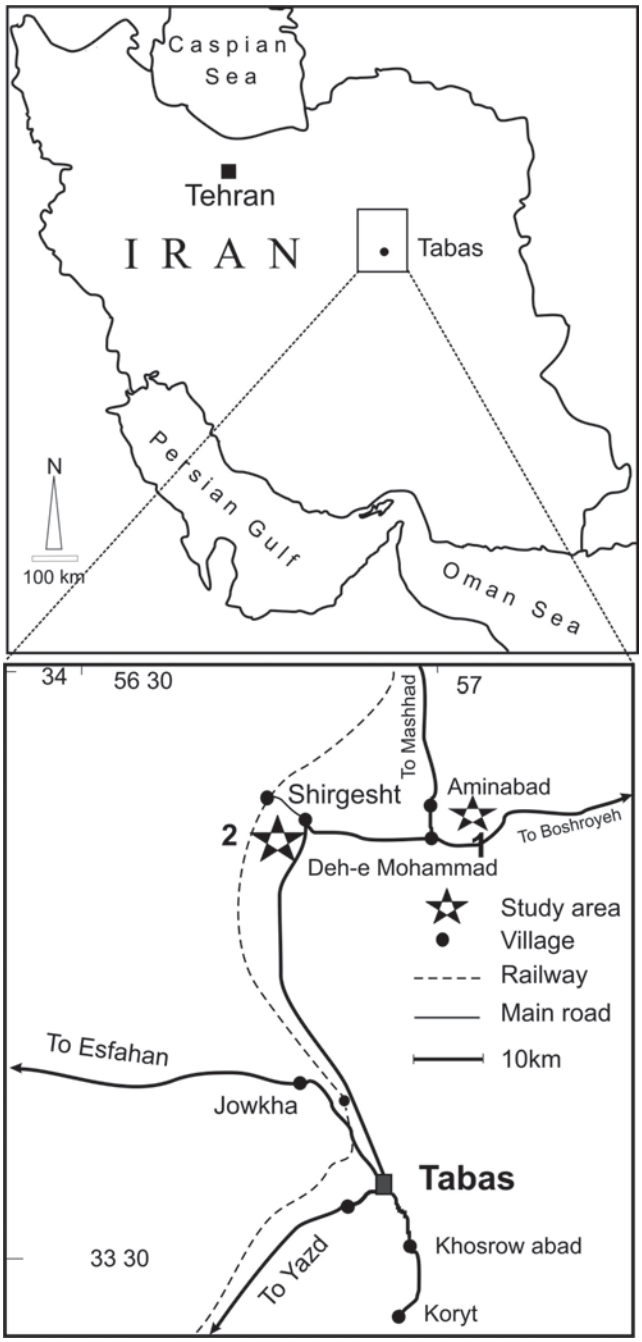

Fig. 1 - Geographic position of the studied sections in northern area of the town of Tabas, Shotori Mountains, northeast Iran. 1) locality near the town of Deh-e Mohammad, 2) Bagh-e Vang locality.

are described briefly below.

1. Deh-e Mohammad locality (Fig. 1, locality 1): this locality lies about 65 km north of the town of Tabas, about 5 km northeast of the small village of Deh-e Mohammad, about 1 km from the road Tabas-Boshruhe, in an area called Agheldun (Fig. 1, 57° 01` 46`` E and 33° 59` 46.6`` N). Here the Permian deposits are 290 m thick and overlie the Carboniferous Sardar Formation, which is about 26 m thick at this locality. The lower and middle 247 m of the Permian deposits were sampled. The Upper 43 m of the Formation is dolomitic and was not sampled.

2. Bagh-e Vang locality (Fig. 1, locality 2): This section of the Kuh-e Bagh-e Vang is located 45 km north of the town of Tabas, near the town of Shirgesht (geological map 1:100.000 of Shirgest completed by Ruttner et al. 1968). A section of the Permian Jamal Formation crops out on the western and southern flank of the Kuh-e Bagh-e Vang (33° 58' 60" N, 56° 47' 66" E, Fig. 1). Also in this section the Permian sediments overlie the Carboniferous Sardar Formation, which includes siltstones, shales and sandstones. The Permian deposits are overlain by the Lower Triassic Sorkh-e Shale Formation.

The Permian section of the Jamal Formation in the Bagh-e Vang locality reaches a thickness of 293 m (Ruttner et al. 1968) to 300 m (Leven & Vaziri Mohaddam 2004), but one of the authors (KR) measured it on the south flank of this mount as about 320 m thick. Generally the Jamal Formation in this locality is composed of sandy limestone with some olistoliths, dark shales, and medium- to thin-bedded marly limestones. Partoazar (1995) introduced the name Bagh-e Vang member for the 60 m of the lower part (being Asselian–Sakmarian in age) of the Jamal Formation of this section. The middle part of the section is characterized by medium-bedded limestone intercalated with chert layers. The summit of the section is covered by massive carbonates (Fig. 2), which is overlain by the Lower Triassic Sorkh-e Shale Formation. Based on Fusulinids, Leven & Vaziri Mohaddam (2004) recognized 10 units within the Jamal Formation in Kuh-e Bagh-e Vang. The sponges of this locality were studied by Senowbari-Daryan et al. (2005, 2006) and the bryozoans by Ernst et al. (2006, 2009).

Thin sections, containing the described specimens of *Lercaritubus problematicus* and *Vangia telleri* (Flügel) nov. comb. are deposited in "Geozentrum Nordbayern, Department of Paleontology, University Erlangen-Nürnberg" ("material: Senowbari-Daryan: Permian Iran, Bagh-e Vang").

Systematic Paleontology

Family uncertain

Genus *Lercaritubus* Flügel, Senowbari-Daryan & Di Stefano, 1990

Type species: *Lercaritubus problematicus* Flügel, Senowbari-Daryan & Di Stefano, 1990

Original diagnosis: "Sessile, tube-like, multi-branched organism with a calcareous skeleton, composed of thick wall segments put into one another. The aperture of the tubes widens distally and is

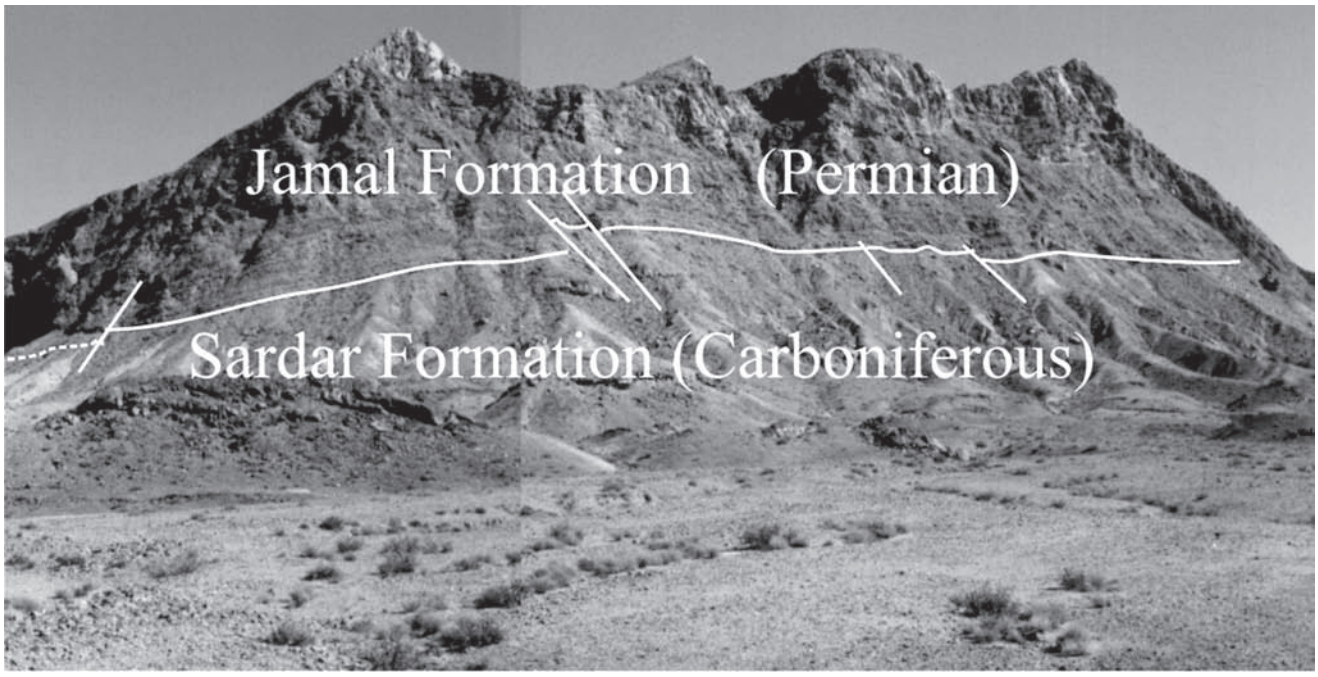

Fig. 2 - View from west to east (west flank of the Mount) of the studied section of the Carboniferous Sardar and Permian Jamal Formation in Kuh-e Bagh-e Vang. The massive carbonate at the top is still Permian, overlain by the Triassic Sorkh-e Shale Formation, which is exposed in the east flank and not visible from this view.

characterized by a distinct collar. The outer surface of skeleton shows small polygonal depressions. The interior of the tubes is subdivided by perforated "tabulae" and shows an additional calcareous tissue. Some specimens show small pores within the outer wall of the tubes" (Flügel, Senowbari-Daryan & Di Stefano 1990: 361).

Lercaritubus problematicus Flügel, Senowbari-Daryan & Di Stefano, 1990

Pl. 1, figs 1-6

1984 Microproblematicum A - Flügel (in Flügel et al.), p. 197, pl. 30, figs. 13-14.

* 1990 *Lercaritubus problematicus* n. sp. - Flügel, Senowbari-Daryan & Di Stefano, p. 361-362, pl. 1, figs. 1-16, text-figs. 2-3.

1991 *Lercaritubus problematicus* Flügel, Senowbari-Daryan & Di Stefano - Flügel et al., p. 176.

1992 *Lercaritubus problematicus* Flügel et al.- Weidlich, p. 44-45, pl. 16, fig. 3.

1996 *Lercaritubus problematicus* Flügel, Senowbari-Daryan & Di Stefano - Senowbari-Daryan & Rigby, p. 23, figs. 3.1-3.7, 4.1-4.8.

2001 *Lercaritubus problematicus*- Weidlich, p. 342.

2005 *Lercaritubus problematicus* Flügel, Senowbari-Daryan & Di Stefano - Senowbari-Daryan et al., p. 401, figs. 13.8/L, 15.8-9.

Material: Numerous specimens in thin sections from the Bagh-e Vang section and from the section near the town of Deh-e Mohammed. For the number of illustrated thin sections see explanation of plates.

Description. Sessile, tube-like, single or branched organism composed of several segments inserted into one another. Each individual segment shows a distinct collar around the aperture of that segment. This feature was observed only in some Iranian specimens.

Tube walls of Iranian specimens, like specimens from Sicily and Guadalupe Mountains, are strongly re-crystallized. Individual crystals appear light to yellow-brown in transmitted light and are relatively large. Flügel (in Flügel et al. 1984) gives the size of the crystals as up to 750 µm. Strong re-crystallisation of the tube walls suggests the primary aragonite skeletal mineralogy.

In cross sections, the tube interior is circular, but the outer surface is distinctly wavy (Pl. 1, figs 3-6) to spiny (Pl. 1, figs 1-2). Internal surfaces of the tubes are smooth, but outer surfaces are honeycomb, appearing wavy or with spine-like elements in sections. These elements are the edges of polygonal depressions of the tube surface. A construction of the tube is given by Flügel et. al. (1990)

Tube interiors of the Iranian specimens are usually without any internal infilling structure, but some specimens, like most specimens of the type material from the Lower Permian of Sicily and specimens from the Middle Permian of Upper Capitan Limestone of the Guadalupe Mountains in New Mexico, USA, contain "tabulae"-like or concentric structures. In some specimens in the type material from Sicily (Flügel et al. 1990: pl. 1, fig. 7) the "tabulae" are perforated, but perforation was not observed in the Iranian material.

Tubes reach lengths of up to 30 mm, with an outer diameter of up to 10 mm, an inner diameter up to 6

Fig. 3 - *Vangia telleri* (Flügel). Drawn from pl. 2, fig. 1 showing details of the specimen imbedded in micritic matrix. The compact "chamber" walls appear dark micritic in submitted light and are without any perforation.

mm, and thicknesses of the walls up to 1 mm. Weidlich (1992) gives the wall thickness of up to 1.7 mm in material from Oman.

Associated organisms. *Lercaritubus problematicus* occurs in reef or reefal biotopes, like other reef builder (e. g. sponges). It is associated with hypercalcified sponges (Senowbari-Daryan et al. 2005, 2006), rarely corals, abundant bryozoans (Ernst et al. 2009), rare green algae such as *Anchicodium* sp., *Epimastoporella* sp., and *Imperiella* sp. Associated problematic organisms include: *Tubiphytes obscurus* Maslov and *Tubiphytes carinthiacus* Flügel. Fusulinids of the locality were described by Leven & Vaziri Mohaddam (2004). Almost all specimens of *Lercaritubus* were incrusted by *Archaeolithoporella,* or different types of other microbial crusts.

Discussion. The systematic position of *Lercaritubus* is uncertain. Flügel et al. (1990) compared *Lercaritubus* with bryozoans, annelids, cribricatheans, and with the Jurassic problematic alga "*Bankia*" (*Campbelliella*), but because of different morphological features the affiliation of *Lercaritubus* to these groups of organisms seems to be questionable. The systematic position of *Lercaritubus* is still uncertain.

Occurrence and stratigraphical range. *Lercaritubus problematicus* is known from the Lower and Middle Permian reef boulders of Sicily (Flügel et al. 1990, 1991), Middle Permian of Guadalupe Mountains (Senowbari-Daryan & Rigby 1996), Upper Permian of Oman (Weidlich 1992, 2001), and now from the Jamal Formation (Lower and Middle Permian) in the Shotori Mountians, of northeast Iran. It is restricted to the tropical reef or reefal deposits and seems to be an index fossil of Permian age.

Vangia nov. gen.

Type species: *Uvanella*? *telleri* Flügel (in Flügel et al. 1984)

Derivatio nominis: Named from the type locality Kuh-e Bagh-e Vang (Bagh-e Vang Mount) in the Shotori Mountains, northeast Iran.

Diagnosis: Nodules of aggregates, which are composed of irregularly chambers. Chamber walls are thin and imperforate, appearing dark micritic in transmitted light. Some chambers contain vesiculae-like structures.

Comparison: See discussion after description of the species.

Vangia telleri (Flügel in Flügel et al. 1984), nov. comb.

Pl. 1, figs 7-9; Pl. 2, figs 1-8; Text-fig. 3

? 1981 *Bacinella* sp.- Vachard & Montenat, p. 33, pl. 2, figs 11-12.

1984 *Uvanella*? *telleri* n. sp.- Flügel (in Flügel et al.), p. 205, pl. 37, figs 4-7.

1991 *Tubiphytes* forming a net-like structure - Flügel et al., pl. 40, fig. 5.

1992 *Uvanella telleri* Flügel - Weidlich, pl. 16, fig. 2.

2002 Spider-web-like microproblematicum - Wahlman, Fig. 15.

2005 "Aggregates or lumps"- Senowbari-Daryan et al., Fig. 8.7.

Material: Numerous specimens in several thin sections. For the number of thin sections containing the illustrated specimens see plate explanations.

Description. Aggregates of this organism reach dimensions of several mm and are composed of numerous circular, oval, tube-shaped or irregularly cavities or "chambers", separated from each other by thin walls. Not only the shape of cavities, but also their size is very variable. Tube-shaped cavities were observed in almost all specimens. Aggregates of *Vangia telleri* occur either

as isolated "lumps" within the micritic matrix (Pl. 1, figs. 7; Pl. 2, figs. 1-2, 7-8) or they rarely incrusts other reef organisms (Pl. 1, fig. 8; Pl. 2, figs 4, 6). The abundant occurrence of *Vangia telleri* in micritic matrix indicates such to be its growth position, possibly on the sediment surface. It also occurs as a nodular organism that was rarely grown around other organisms and stabilized them to form larger and compacted aggregates. Large cavities (e. g. Pl. 1, fig. 7C, 9C; Pl. 2, figs. 3, 5, 6), filled with sparry calcite cement occur with aggregates of *Vangia telleri* and were formed by the activity of this organism, but do not belong to it.

Discussion. Aggregates of *Vangia telleri* which are composed of chambers with thin, compact and micritic walls, were described as *Uvanella*? *telleri* from the Middle Permian of Slovenia by Flügel (in Flügel et al. 1984). *Uvanella* - with the type species *U. irregularis* Ott - is a sphinctozoan sponge with Mg-calcite skeletal mineralogy and was originally described from the Ladinian-Carnian of the Northern Calcareous Alps (Austria) by Ott (1967). Detail descriptions of all *Uvanella* species, with their stratigraphic ranges and geographic distributions are given by Senowbari-Daryan (1990). The following characteristics of *Vangia telleri* (Flügel) do not justify an affiliation of this fossil with the sphinctozoan sponge *Uvanella*:

a) Wall of cavities or chambers. The chamber walls in *Uvanella* are distinctly thick and pierced by opening or pores. The wall in *Vangia telleri* is much thinner without any openings or pores. The "very scarce connecting pores", noted by Flügel (in Flügel et al. 1984: 203) were not observed within the wall in Iranian materials. Some small and white-appearing points within the wall of *Vangia telleri* are interpreted, in agreement with Flügel (in Flügel et al. 1984), as sedimentary particles or grains.

b) Small, circular cavities within the walls of *Vangia telleri* (see Flügel et al. 1984: pl. 37, fig. 7: arrows), which are also present in Iranian material, are not known in specimens of *Uvanella* species.

c) Large cavities indicated with C in Pl. 1, figs 7, 9, Pl. 2, figs 3, 5, 6 and produced by the activity of *Vangia telleri* were not observed in specimens of the Triassic genus *Uvanella*.

d) The skeleton of *Uvanella* is composed of Mg-calcite (Senowbari-Daryan 1990). Sphinctozoan sponges with Mg-calcite mineralogy appeared in the Middle Triassic (Anisian) and became extinct at the end of Triassic (Senowbari-Daryan & Rigby in press). Sphinctozoan sponges with Mg-calcite mineralogy are not known in the Permian record.

e) *Uvanella* seems to be limited to the Middle and Upper Triassic and is not known from the Lower Triassic and Permian time.

General shape and the morphology of *Vangia telleri* are similar to that fossil named *Bacinella irregularis* by Radoicic (1959) and which is known from the Upper Triassic? Jurassic to the Tertiary of numerous localities on the world. The validity of *Bacinella* as an independent genus or its synonymy or consortium with *Lithocodium* Elliott (1956) has been discussed by numerous authors, and finally by Banner et al. (1990) who synonymized *Bacinella* with *Lithocodium*. *Bacinella* was accepted as a synonymous of *Lithocodium* by later workers (e. g. Neuweiler & Reitner 1992). Koch et al. (2002) accept not only the synonymy of both genera, but they presume that other genera (e. g. *Bacinellacodium* Dragastan, 1985 or *Radoicicinellopsis* Banner, Finch & Simmons 1990) are also synonymous with *Lithocodium*. Most authors (e. g. Schmid & Leinfelder 1996; Cherchi & Schröder 2006; Védrine et al. 2007, and Schlagintweit 2010) do not accept that *Bacinella* and *Lithocodium* are synonymous.

Radoicicinellopsis was established by Banner et al. (1990) designating *Bacinella*? *sterni* Radoicic (1972) as type species. Other known species of *Bacinella*, including *B. ordinata* Pantic (1972), *B. bicellularis* Sadati (1981), and *B. crispa* Eliasova (1981) were not treated by Banner et al. (1990). *Bacinella crispa* is similar to *Lithocodium*/*Bacinella irregularis*, but *B. bicellularis* and *B. ordinata* are different and may be were erroneously assigned to *Bacinella*. All three species are different and a comparison with *Vangia telleri* (Flügel) is urgent.

Lithocodiun was interpreted as a codiacean alga by Elliott (1956). Following this idea, Banner et al. (1990) classified *Lithocodium* as a green alga (Chlorophyceae family Codiaceae, subfamily Lithocodiaidea). *Lithocodium* was interpreted as association of cyanobacateria/microbes/porostromata by Maurin et al. (1985) and Camoin & Maurin (1988), cyanobacteria/algae/foraminifera (Leinfelder et al. 1993), as foraminifer by Schmid & Leinfelder (1995, 1996) or as possibly "colonies of calcified cyanobacteria" by Cherchi & Schroeder (2006).

Recently Schlagentweit et al. (2010) discussed the systematic position of *Lithocodium* attributing it to "filamentous-septate heterotrichale ulvophyceaen alga". Assigning to "endolithic ulvophycean alga" these authors separate *Bacinella* from *Lithocodium*, which was synonymed by Banner et al. (1990). With separation of *Lithocodium* and *Bacinella* the systematic classification proposed by Schlagintweit et al. (2010) is followed here to describe the Permian species from Bagh-e Vang in Iran (see above).

Vangia telleri occurs always separate and never together with *Lithocodium* like the type species of *Bacinella* – *B. irregularis* Radoicic - in Mesozoic deposits. Because of the compact wall of the "chambers" a sponge interpretation for *Bacinella* is urgent. An

interpretation of *Bacinella* as a foraminifer – interpretation of some worker for *Lithocodium/Bacinella* – seems to be also unlikely. Most probably *Bacinella* should be classified as cyanobacteria. The systematic position of *Lithocodium/Bacinella*, however, as an animal (e. g. possibly sponge: Koch et al. 2002 or hydrozoas: Turnsek & Buser 1966), foraminifer (Schmid & Leinfelder 1995, 1996) or plant (algae: Elliott 1956; Radoicic 1959; Schlagintweit et al. 2010; *Lithocodium* as juvenile stage of *Bacinella irregularis*: Fenninger 1972, *Bacinella irregularis* as juvenile stage of *Lithocodium*: Segonzac & Marin 1972), cyanobacteria; Cherchi & Schroeder 2006) remains still uncertain.

This mentioned difference justifies the establishment of a separate genus for this Permian organism, named *Vangia* nov. gen. The twice mass extinctions (at the boundaries of Permian/Triassic and Triassic/Jurassic) and their strong influence during the time interval of Permian and Jurassic-Cretaceous supports the separation of *Bacinella*-like organism of Permian time as *Vangia*. Because of the compact wall of the "chambers" a sponge interpretation for *Vangia* is uncertain.

Occurrence. *Vangia telleri* (Flügel) is known from the Permian of Karawank (Kochansy-Devidé (1970), Slovenia (Flügel in Flügel et al. 1984), Oman (Weidlich 1992, 2001), Sicily (Flügel et al. 1990, 1991: pl. 40, fig. 5) and now also from the Permian Jamal Formation of northeast Iran. It was first reported as "aggregate or lumps" from Iran by Senowbari-Daryan et al. (2005).

Wahlman (2002: fig. 15) described *Vangia telleri* from the Lower Permian (Wolfcampian) of west Texas as "Spider-web-like microproblematicum". In fact, the irregular aggregate of his "microproblematicum" or of *Vangia* is similar to some fistuliporid bryozoans colonies, but details of bryozoans, like apertures lack in *Vangia*.

Vachard & Montenat (1981: pl. 2, figs. 11-12) described from the Upper Permian of Afghanistan an organism as *Bacinella* sp. which is similar or almost identical to *V. telleri* (Flügel).

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PLATE 1

Lercaritubus problematicus Flügel, Senowbari-Daryan & Di Stefano (1-6) and *Vangia telleri* (Flügel) (7-9) from the Permian Jamal Formation of Bagh-e Van, Shotori Mountains, northeast Iran. Scale: 1 mm.

Fig. 1 - Longitudinal section through a specimen showing the thick wall with smooth internal, but wavy external wall. The wall is strongly re-crystallized in all specimens and is composed of large crystals. DM27/1.
Fig. 2 - Oblique section clearly showing the wavy external wall. DM27/1.
Fig. 3 - Longitudinal section of a broken(?) specimen with wavy outer surface. DM27/1
Fig. 4 - Longitudinal section of a specimen, which shows an open end (left in photograph). 7/1.
Fig. 5 - Longitudinal to oblique section. The specimen is colonized by a small specimen (right in photograph). 7/1.
Fig. 6 - Longitudinal section of a specimen with budding at the left side. 7/1.
Fig. 7 - Section through an aggregate showing numerous irregularly cavities. C indicates a cavity formed by the activity of *Vangia telleri*, but does not belong to this organism. 12/3
Fig. 8 - Section through a spherical specimen, which is growing on a *Tubiphytes carinthiacus* (Flügel). The boundary between *Tubiphytes carinthiacus* (Flügel) and *Vangia telleri* (Flügel) is marked with a white dotted line. *T. carinthacus* grew around some chambers of *Vangia telleri*. Bs38
Fig. 9 - Section through an aggregate with numerous cavities. Arrows indicate two specimens of *Tubiphytes obscurus* Maslov. For explanation of the letter C see Fig. 7. Bs58.

PLATE 2

Vangia telleri (Flügel) from the Permian Jamal Formation of Bahg-e Vang and Deh-e Mohammed Section in Shotori Mountains, northeast Iran. Scale 1 mm.

Fig. 1 - Section through an aggregate with irregularly chambers. Almost all chambers are filled with calcite cement. BM58;
Fig. 2 - Section through several(?) specimens with irregular and tube-like chambers. BM58;
Fig. 3 - Similar to Fig. 2. For explanation of the letter C see plate 1, Fig. 7. BM58;
Fig. 4 - Aggregate of *Vangia telleri* (Flügel) incrusts other organism marked with A. For explanation of C see plate 1, Fig. 7. BM58;
Fig. 5 - An organism (A) is incrusted by *Vangia telleri* (Flügel) with several tube-like chambers. For explanation of the letter C see plate 1, Fig. 7. BM58;
Fig. 6 - Similar to Fig. 4. A indicates an organism surrounded by *Vangia telleri* (Flügel). For explanation of the letter C see plate 1, Fig. 7. BM58;
Fig. 7 - Similar to Fig. 2. BM58;
Fig. 8 - Similar to Fig. 7. BM58.

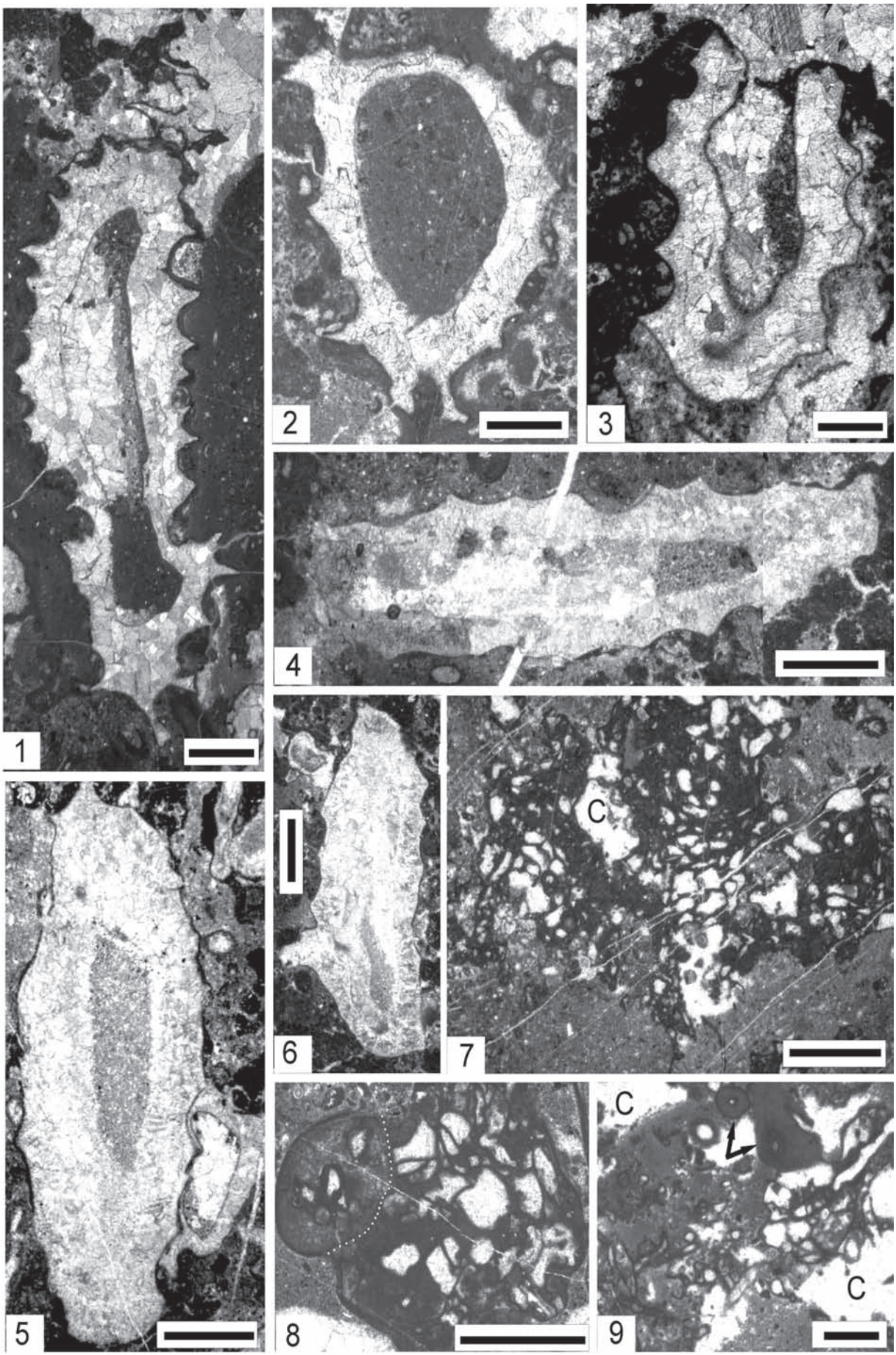

PLATE 1

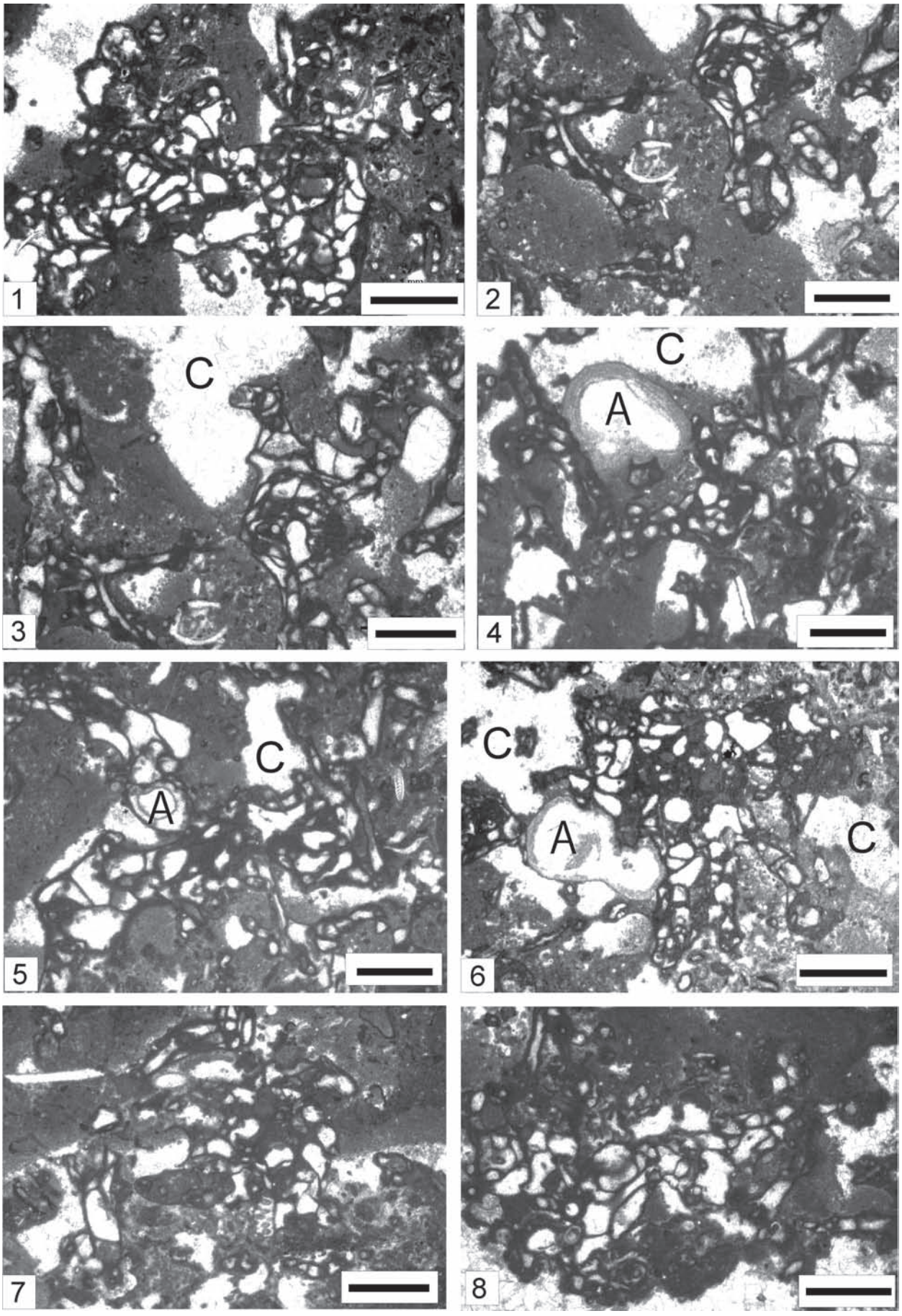

PLATE 2

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