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DISCOSIPHONELLA MINIMA SENOWBARI-DARYAN & LINK AND *SOLENOLMIA? PARVA* N. SP. ("SPHINCTOZOA", PORIFERA) FROM THE UPPER TRIASSIC (NORIAN) OF THE SOUTHERN APENNINES (NORTHERN CALABRIA/ITALY)

BABA SENOWBARI-DARYAN [1], ALESSANDRO IANNACE [2] & VALERIA ZAMPARELLI [2]

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Abstract. Two hypercalcified sphinctozoan sponges are described from several localities with dolomitic Norian reefs of northern Calabria (southern Italy). *Solenolmia*? *parva* n. sp. occurs as an extremely abundant, albeit local, component in peculiar bioconstructions dominated by serpulids and microbialitic crusts. *Solenolmia? parva* assemblage represents the primary framebuilder of small build-ups which developed on the margins of restricted intraplatform basins. *Discosiphonella minima* Senowbari-Daryan & Link, previously recognized only in the type locality of Turkey, has been now found also as a minor component in association with other typical "Dachstein" reef biota, such as corals, sponges, microbial crusts and fragments of "microproblematica". The distribution of the different reefal assemblages of Northern Calabria can be related to the paleogeographic position of northern Calabria with respect to the evolution of Triassic crustal extension in western Mediterranean.

Riassunto. In questo lavoro vengono descritte, per la prima volta, due spugne calcaree ("sfinctozoi") presenti in diverse località nelle successioni dolomitiche di margine del Triassico superiore (Unità Lungo-Verbicaro) affioranti in Calabria settentrionale. La prima, denominata *Solenolmia? parva* n. sp., localmente molto abbondante, costituisce un componente primario delle biocostruzioni a serpulidi e croste microbialitiche, tipica associazione presente al margine di bacini anossici intrapiattaforma del Trias sup. La seconda, *Discosiphonella minima,* è stata rinvenuta in blocchi risedimentati nei depositi di scarpata, in associazione ("Dachstein" reef) con coralli, spugne, croste microbiche e frammenti di "microproblematica". La distribuzione delle differenti associazioni recifali viene messa in relazione con la particolare posizione della Calabria settentrionale nel quadro dell'evoluzione delle aree di estensione crostale nel Triassico del Mediterraneo occidentale.

Introduction

Hypercalcified sponges, including sphinctozoans, inozoans, chaetetids and spongiomorphids, are the most frequent reef-building organisms in late Paleozoic and Triassic reefs. Scleractinian corals are common both in Norian and Rhaetian reefs and they became dominant in the Rhaetian reefs of the northwestern Tethys (Flügel & Senowbari-Daryan 2001).

Hypercalcified sponges, particulary sphinctozoans and inozoans are not common in Norian-Rhaetian reefs in Calabria, southern Italy. However, some species were previovsly described by Senowbari-Daryan & Zamparelli (1999, 2003). The sponges described in the current paper were collected from two different reef facies, previously studied by Zamparelli et al. (1999). The investigated material is stored in the Department of Scienze della Terra, University of Naples (Sample n. Mx, M8, AC 73, AC75a, SV 109, SV110, SV111, collection Zamparelli).

Geologic setting

The Upper Triassic dolostones of northern Calabria represent the southernmost part of the southern Apennines fold-thrust belt, close to the area where this is overthrust by the Calabrian Arc units (Fig. 1). Whereas the latter mainly consist of metamorphic crystalline and ophiolitic units (Bonardi et al. 2001), the southern Apennines are dominated by successions re-

1 Geozentrum Nordbayern, University Erlangen-Nürnberg, Loewenichstr. 28, 91054 Erlangen/Germany. E-mail: basendar@pal.uni-derlangen.de
2 Dipartimento di Scienze della Terra, Largo San Marcellino 10, 80138 Napoli/Italy. E-mail: valzampa@unina.it

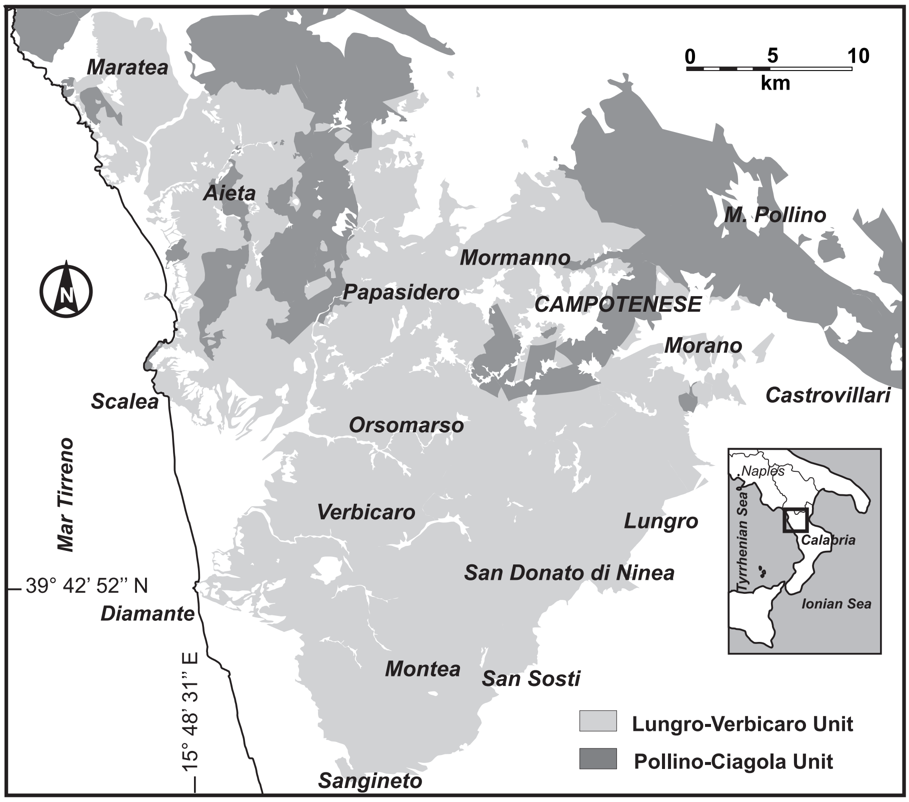


Fig. 1 - Tectonic map of northern Calabria.

presenting remnants of the sedimentary cover of the Afro-Adriatic Mesozoic passive margin. They comprise both shallow-water carbonates and deep-water pelagic and siliciclastic sediments that were affected by NE-directed thrusting during the Neogene (Butler et al. 2004). Iannace et al. (2007) recognized two main tectonic units in northern Calabria: the Pollino-Ciagola and the Lungro-Verbicaro Units (Fig. 1). The tectonically underlying Pollino-Ciagola Unit consists of platform carbonates in the north and northeastern sector (Monti di Lauria and Pollino ridge). Platform facies are replaced by coarse-grained slope carbonates to the southwest (Campotenese area, Monte Ciagola, Cozzo Petrara) and are covered by Langhian siliciclastic deposits.

The Lungro-Verbicaro Unit comprises a Middle Triassic to Lower Miocene, slope to basin succession. This Unit is the only Apenninic unit affected by early HP-LT metamorphism and greenschist facies re-equilibration, a circumstance that can be attributed to its paleotectonic position. In fact, its successions were deposited in the distal part of the continental margin, close to the ocean transition (Iannace et al. 2007).

The stratigraphic succession of the Lungro-Verbicaro Unit consists in its lowermost part, of Middle Triassic phyllites and metarenites with carbonate intercalations. The latter contain locally rich assemblages of strongly recrystallized dasycladacean algae of Anisian and early Ladinian age (Bousquet et al. 1978), suggesting a shallow- water origin. These deposits are followed by Ladinian-Carnian metamorphosed limestones, marly limestones and dolostones; locally build-ups rich in dasycladaceans, crinoids and spongiomorphids and a well-developed reef complex (Iannace et al. 1995) are present. In the Carnian layers there is a significant increase of siliciclastic beds intercalated with metadolostones, metalimestones and evaporites.

This succession is followed by several hundred metres of metadolostones that can be referred to the Norian-Rhaetian, showing abrupt lateral facies changes. Within a few kilometres, inner platform facies grade into marginal build-ups dominated by an unusual assemblage consisting of microbes, serpulids and small calcareous sponges, and then to slope and restricted basin facies (Climaco et al. 1997; Zamparelli et al. 1999; Perri et al. 2003). This peculiar biotic assemblage is considered an ecologic adaptation to the restricted conditions, and possibly to eutrophic conditions (Cirilli et al. 1999). Iannace & Zamparelli (2002) showed that in the Apenninic area a strong paleogeographic control existed on the distribution of these biofacies, if compared to the "Dachstein-type" facies found in other localities. However, in northern Calabria the two assemblages are found in close proximity in the same succession (Zamparelli et al. 1999; Senowbari-Daryan & Zamparelli 2003).

Systematic Paleontology

Remarks. The classification of Finks & Rigby (2004) is used to describe the sphinctozoan species discussed below:

Class **Demospongea** Sollas, 1875
Subclass **Ceractinomorpha** Levi, 1973
Order **Verticillitida** Termier & Termier (in Termier et al., 1977)
(synonym: Vaceletida Finks & Rigby, 2004, p. 691)
Suborder **Porata** Seilacher, 1962
Family Sebargasiidae de Laubenfels, 1955
(pro Sphaerosiphoniidae Steinmann, 1882)
Subfamily Cystothalamiinae Girty, 1909
Genus *Discosiphonella* Inai, 1936
Type species: *Discosiphonella manchuriensis* Inai, 1936

Remarks. The genera *Cystauletes* King (1943), *Ascosymplegma* Rauff (1938), and *Lichuanospongia* Zhang (1983) were synonymized to *Discosiphonella* Inai (1936) by Senowbari-Daryan (1990). The status of the first one, however, as younger synonym of *Discosiphonella,* or as an independent genus, has been disputed. Finks & Rigby (2004, p. 686) listed *Cystauletes* with a question mark under the family *Guadalupiidae* Girty (1909). However, one of the authors (RMF) noted (p. 687) that "*Discosiphonella* is poorly known and *Cystauletes* should be retained for tubular, branching forms". The external morphology of the sponge (tubular or conical) and the presence/absence of branching can be considered to distinguish different species within the same genus.

Discosiphonella minima Senowbari-Daryan & Link, 1998

Pl. 1, figs 1?-6

1998 *Discosiphonella minima* n. sp. Senowbari-Daryan & Link, p. 348, figs. 2A-D, 3A- D.

Description. The single (possibly branched) stems of this small species of *Discosiphonella* are composed of several cyst-like chambers arranged in a single layer around a wide axial spongocoel. The diameters of available specimens range between 6 and 12 mm. Diameter of spongocoel varies between 3.5 and 4.5 mm, reaching almost 50% of the whole sponge diameter. The chamber diameters (from 1.2 up to 6.0 mm) of large specimens is also greater than those in small specimens. All these specimens are attributed to *D. minima*, originally described from the Norian of Turkey by Senowbari-Daryan & Link (1998).

The small cyst-like chambers of all five available specimens are egg-shaped, having diameters of 1.2-2.0 mm with a maximum chamber heights of 1.0 mm. Because of a poor preservation of the sponge skeleton, other characteristics, like the thickness of chamber walls and the size of pores, can not be ascertained in detail. Some specimens (Pl. 1, figs. 1, 6) show vesiculae-like structures within the spongocoel. For a detailed description of *D. minima*, see the original description by Senowbari-Daryan & Link (1998).

The sponge diameter and also the size of chambers of the specimen illustrated in Pl. 1, fig. 1 is larger than that of all other specimens illustrated in Pl. 1. The affiliation of this specimen to *D. minima* is uncertain.

Remarks. *Discosiphonella* (known as uncertain *Cystauletes*, see Finks & Rigby 2004, p. 686) is an abundant sphinctozoid sponge in Carboniferous and in Permian deposits (Senowbari-Daryan & Garcia-Bellido 2002; Garcia-Bellido et al. 2004). *Discosiphonella* is not known from the Lower and Middle Triassic. From the Upper Triassic only three species of *Discosiphonella* have been described: *D. torosum* (= *Ascosymplegma torosum* Rauff, 1938) *D. bzhebsi* described as *Cystauletes bzhebsi* by Belyaeva (in Boiko et al. 1991) from northern Caucasus and *D. minima* from Turkey (Senowbari-Daryan & Link 1998). *D. minima* is now described for the first time from Italy (Montea area, northern Calabria). All the known species of *Discosiphonella* are listed by Senowbari-Daryan & Garcia-Bellido (2002) and those of Triassic age are discussed and listed in Senowbari-Daryan & Link (1998).

Family Solenolmiidae Engeser, 1986
Subfamily Solenolmiinae Senowbari-Daryan, 1990
Genus *Solenolmia* Pomel, 1872

Solenolmia? parva n. sp.

Pl. 2, figs 1-7

1997 little sphinctozoans. Climaco et al., pl. 14, figs 1,2
1999 little sphinctozoans. Zamparelli et al., pl. 7, figs. 1, 6.

Derivatio nominis: parvus (= lat. small), because of the extremely small dimensions of the sponge.

Holotype: specimen illustrated in Pl. 2, fig. 3.

Paratypes: all specimens in Pl. 2, figs. 1-2, 4-7.

Locus typicus: La Spartosa, Bocca della Cappella and Piano del Carro (northern Calabria).

Stratum typicum: Upper Triassic “Dolomia Principale”.

Diagnosis: small, moniliform sphinctozoan sponge with reticular filling skeleton. Spongocoel of retrosiphonate type at the chamber top, pseudosiphonate type in the rest of the chamber interior. Chamber walls perforated and thin.

Material: Numerous specimens in thin sections, polished slabs, and in naturally weathered rock surfaces.

Repository: Dip. Scienze della Terra, sample n. AC73, AC75a, SV109, SV110, SV111, collection Zamparelli.

Description. *Solenolmia? parva* n. sp. is one of the smallest known sphinctozoan sponges. On the natural weathered rock surfaces these sponges appear as small chains of pearls and are easily recognizable (Pl. 2, figs. 5-6). The single or dichotomously branched sponges are composed of either small, poorly segmented stems or well-defined segmented specimens. Both varieties occur together in the same sample and have the same chamber diameters (Pl. 2, figs. 1-2, 5-7).

The well- segmented specimens are composed of several spherical chambers arranged in a moniliform pattern, one above the others (Pl. 2, figs. 2-4, 6-7). The largest specimen (20 mm long) is dichotomously branched, with at least 9 spherical chambers (Pl. 2, fig. 6). The holotype (Pl. 2, fig. 3) is a specimen composed of 6 chambers, with a total length of 10 mm. The chambers are spherical, reaching a maximum diameter of 2.5 mm and a maximum height of 1.8 mm (Fig. 2). As recognizable in two chambers of the holotype (Pl. 2, fig. 3) and in some other paratypes, the chambers roof turns down (retrosiphonate) only less than 1.0 mm into the chamber. The osculum at the top continues as an axial spongocoel (pseudosiphonate *sensu* Seilacher 1962) through the sponge. Thus, nearly one fourth of each chamber belongs to the retrosiphonate type and about three fourth to the pseudosiphonate type; therefore the spongocoel lacks a true wall. A fine reticular structure is visible in the interior of the chambers. The chamber walls are usually difficult to recognize as a consequence of the strong recrystallization. However, in well-preserved specimens the walls are relatively thin, being 0.1-0.14 mm thick. The size of the pores of the chamber walls cannot be exactly determined.

Discussion. Based on the reticular structure within the chamber interiors *Solenolmia? parva* n. sp. should be attributed to the family Solenolmiidae Engerser, 1986. Based on the backward bend of the segment walls at the top of the segment into the chambers interior (retrosiphonate type of the spongocoel), this sponge should be attributed to the genus *Solenolmia* Pomel, which is characterized by retrosiphonate spongocoels. However, in *S.? parva* the chamber walls turn back only for a short distance, so that three fourth of the chamber is developed as pseudosiphonate. Pseudosiphonate type spongocoels occur e. g. in the Permian genus *Preverticillites* Parona, which is characterized by very low chambers (see Senowbari-Daryan 1990, pl. 31, figs. 4-6). Therefore, we prefer to attribute this sponge to the genus *Solenolmia* Pomel, with question.

S.? parva n. sp. differs from all other species of the genus by the retrosiphonate-pseudosiphonate type of the spongocoel. For its small dimensions *S.? parva* may be compared with *Solenolmia radiata* Senowbari-Daryan & Riedel (1987). However, *Solenolmia radiata* differs from *S.? parva* by having a coarse and radially arranged filling skeleton and by the type of perforation of the chamber walls.

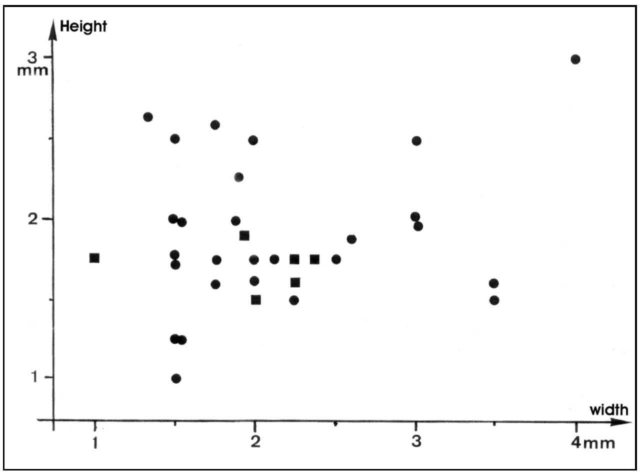


Fig. 2 - The ratios of chamber heights/widths in *S.? parva* n. sp., based on 33 chambers. The chambers of holotype are marked with a square.

Organism association and paleoenvironmental considerations

As a reef builder organism *Solenolmia? parva* n. sp. occurs with serpulids and abundant microbial crusts

PLATE 1

Figs. 1-6 *Discosiphonella minima* Senowbari-Daryan & Link. Scale in figs. 3 and 5 is 5 mm, and in all other figures scale bar: 10 mm.

Fig. 1 Longitudinal section through a possibly branched specimen with a relatively wide axial spongocoel cut in lower and upper part. The chambers of this specimen are much larger than in other specimens (compare fig. 2). Sample Mx.

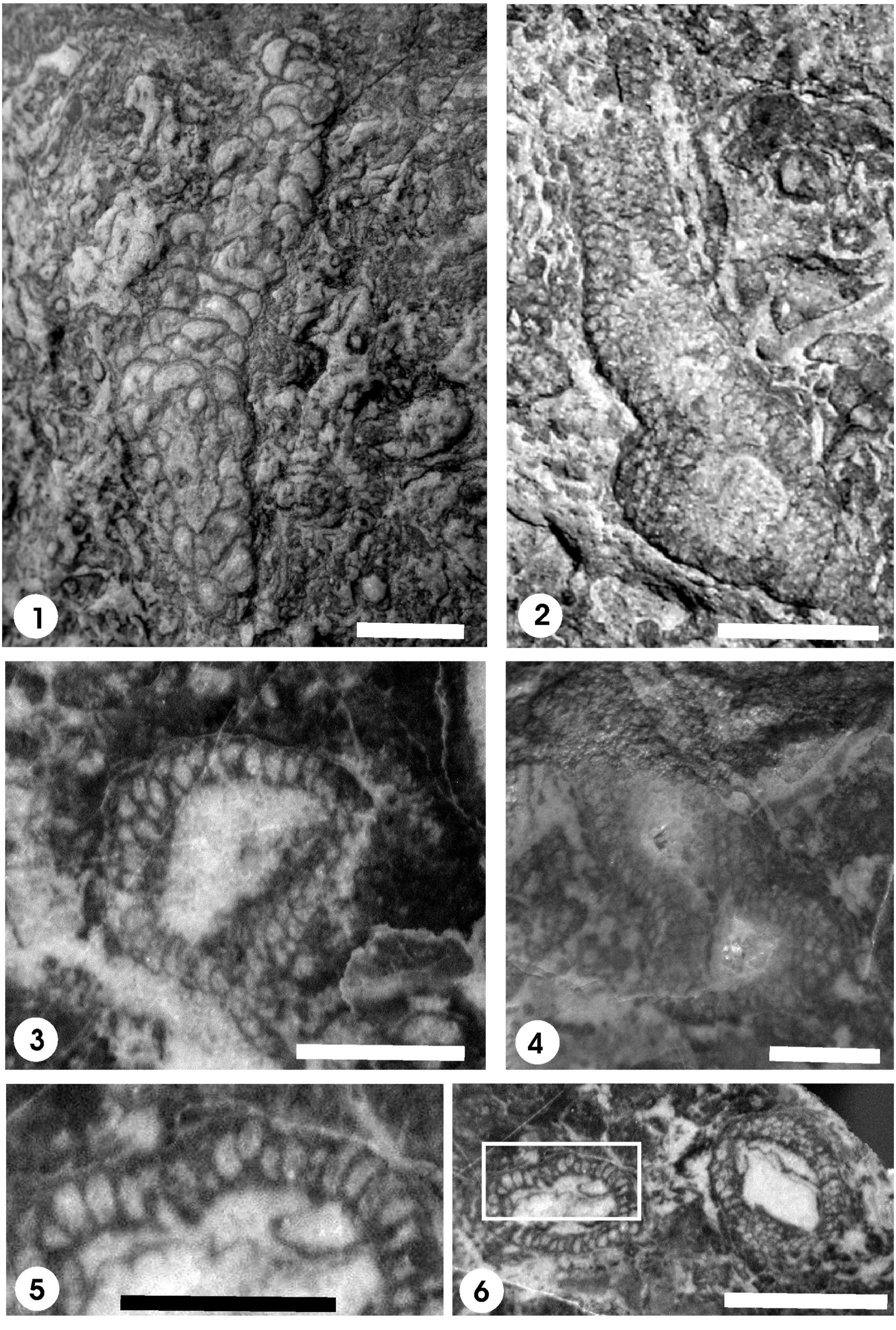
Fig. 2 Similar section like fig. 1. This specimen also seems to be branched. Chambers are smaller than those in specimen shown in fig. 1. Sample M8.

Fig. 3 Cross section through a specimen showing the cyst-like chambers arranged on one layer around the wide spongocoel filled with calcite cement. Sample M8.

Fig. 4 Longitudinal to oblique section through a specimen showing the cyst-like chambers and the wide spongocel. Sample M8.

Fig. 5 Magnification from fig. 6 (white quadrangle) shows the chambers arranged on one layer around the spongocoel. Vesiculae-like skeleton located within the spongocoel.

Fig. 6 Cross to oblique sections through two specimens showing the chambers and the wide spongocoels filled with calcite cement. Within the spongocoels of both specimens the vesiculae-like skeleton is secreted. For magnification of the area marked with white quadrangle see fig. 5. Sample M8.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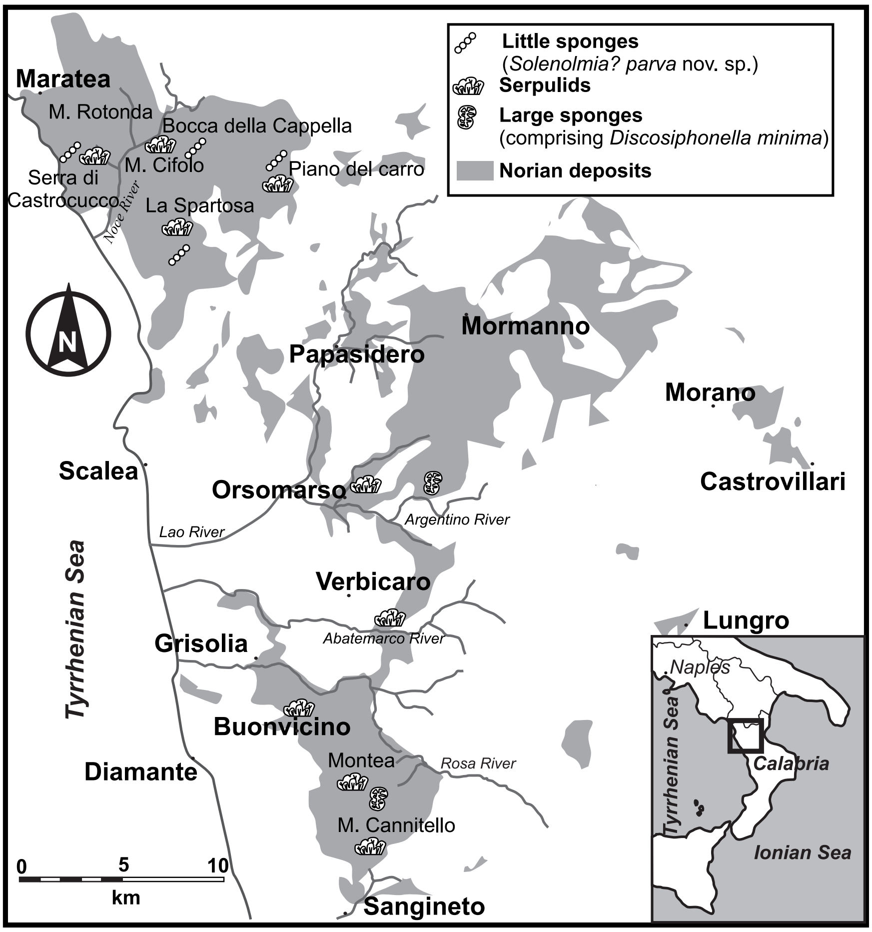


Fig. 3 - Northern Calabria Norian distribution of *Solenolmia? parva* n. sp. and *Discosiphonella minima* Senowbari-Daryan & Link.

in several localities of northern Calabria (Fig. 3) (Serra di Castrocucco, La Spartosa, Piano del Carro, Bocca della Cappella; Climaco et al. 1997, pl. 14; Zamparelli et al. 1999, pl. 6, fig. 4) and has also been recognized in the Picentini mountains (Iannace & Zamparelli 1996, fig. 6, a), about 200 km to the north. Small peloids are abundant as abiogenic components occurring with *S.? parva* n. sp. This reef facies represents a peculiar biotic assemblage developed on the margin of intraplatform basins. The small size of the sponges and the oligotypic association could represent the specific ecological adaptation to basins with restricted circulation and, possibly, eutrophic waters. This reef assemblage represents a minor, yet significant bioprovince of the shallow- water realm of the Western Tethys (Cirilli et al. 1999; Kiessling et al. 1999; Flügel 2002), which extends from Southern Alps through the Apennines to the Betic Cordillera. It contrasted with the "normal" Dachstein-type" reefs of Sicily and Souterh Apennines located respectively on the margin of the Imerese and Lagonegro pelagic basins, both well connected to the tethyan oceanic areas to the east (Iannace & Zamaprelli, 2002).

In contrast to the *S. parva* assemblage, *Discosiphonella minima* occurs within richer associations comprising fragments of other large sponges, corals, microbial crusts, and fragments of "microproblematica".

PLATE 2

Fig. 1-7 *Solenolmia? parva* n. sp. from the Norian reef limestones of Spartosa, Bocca della Cappella and Piano del Carro area, (northern Calabria/Italy). Scale in all figs.: 2 mm.

Fig. 1 Section through numerous specimens in association with microbial crusts. Some specimens are well segmented, but other are poorly or almost not segmented. Bocca della Cappella. Thin section AC 75a.

Fig. 2 Section through numerous, partly branched specimens with subparallel orientation. Piano del Carro. Sample SV110, polished slab.

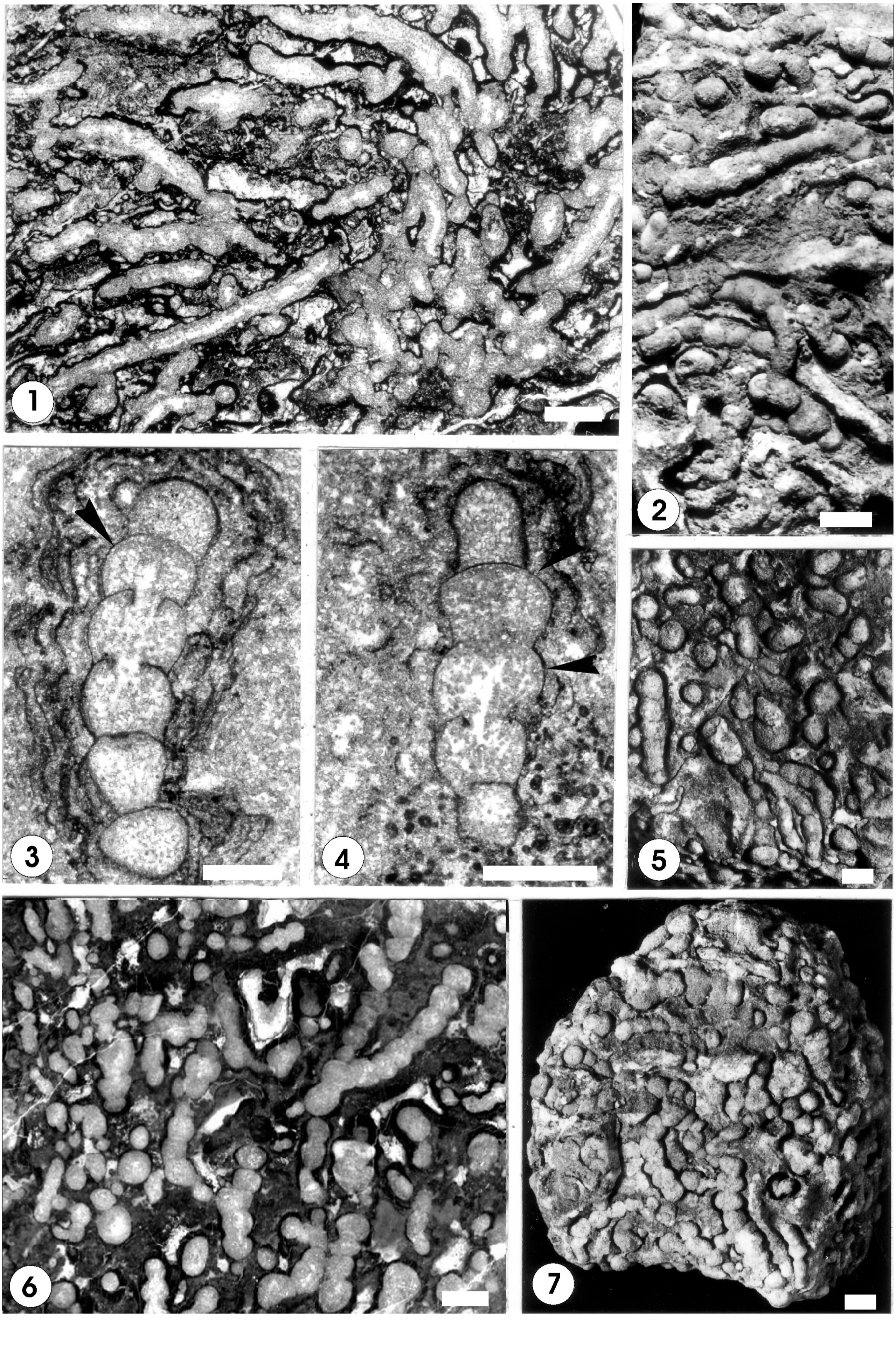
Fig. 3 Holotype. Longitudinal section through six segments exhibiting the axial canal of retrosiphonate-pseudosiphonate type, the very thin chamber walls (arrow) and the recrytallized filling structure within the chamber interiors. La Spartosa. Thin section AC 73.

Fig. 4 Like the holotype, longitudinal section through a paratype exhibits almost the same characteristics. The arrows indicate the thin recognizable chamber walls. La Spartosa. Thin section AC 73.

Fig. 5 Naturally weathered surface of a sample shows numerous, partly branched specimens. Piano del Carro. Sample SV111.

Fig. 6 Section through numerous, partly branched specimens show the well defined spherical chambers with moniliform arrangement. All specimens are oriented upward, as in growth position. Piano del Carro. Sample SV109.

Fig. 7 Sample with structure similar to that of the sample shown in fig. 6.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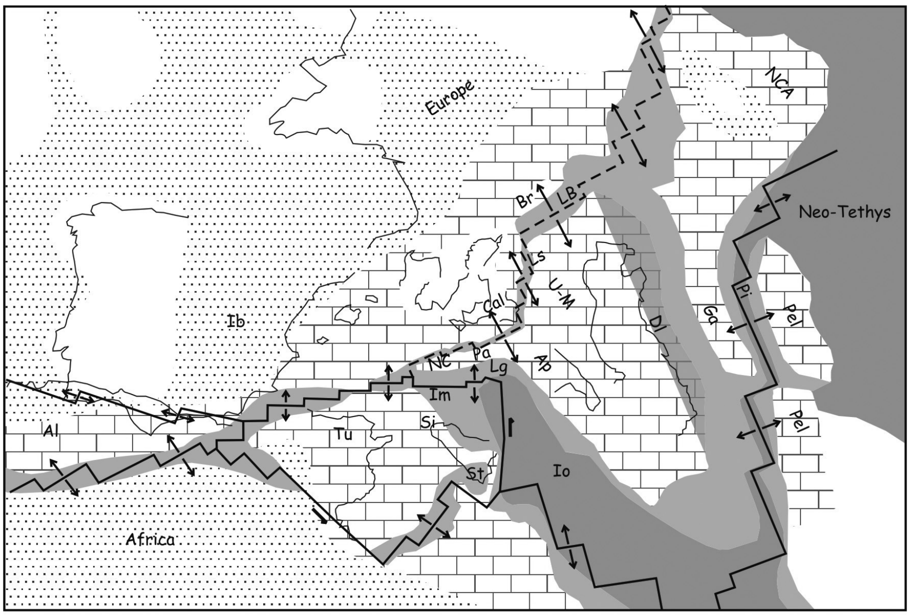

Fig 4 - Paleogeographic reconstruction of the western Mediterranean at the Triassic-Jurassic transition. The map is based on Turco et al (2007) and Schettino & Turco (in press). Key: white areas: emergent land; dotted: shallow siliciclastics; brick: shallow carbonates; light grey: pelagic on continetnal crust; dark grey: oceanized areas; Ap: Apulia; Br: Brianconnais; Cal: Calabria basement; Di: Dinarides; Ga: Gavrovo; Ib: Iberia; IM: Imerese basin; Io: Ionian basin; LB: Lombardy basin; Lg: Lagonegro; NCA: Northern calcareous Alps; NC: northern Calabria carbonates; Pa: Apenninic platform; Pel: Pelagonian; Pi: Pindos basin; Si: Sicily platform; St: Streppenosa basin; UM: Umbria-Marche.

These assemblages are more similar, in terms of diversity and size of organisms, to those found in the typical Dachstein-type reefs. The existence in the Norian of Northern Calabria of reef assemblages intermediates between the typical Dachstein-type and the serpulid-microbial type has been already observed by Zamparelli et al. (1999) and Senowbari-Daryan & Zamparelli (1999, 2003) based on outcrops from the Argentino river valley (Fig. 3).

It is interesting to think about the paleogeographic distribution of these reef assemblages. Our data show that the assemblages with the small sponge *Solenolmia parva* is restricted to northernmost outcrops of Calabria (Fig. 3), in a belt extending northward to the Picentini mountains. On the contrary, the assemblages with larger sponges occur only to the south. Iannace et al. (2007) suggested that these southernmost areas were the closest to the continent-ocean transition during the Jurassic. Thus, we may speculate that this ecological zonation was probably controlled by the proximity to the areas of most intense extension during the Late Triassic, and better connected to the already oceanized areas to the east. In a more regional framework, the carbonates of Northern Calabria represented the southernmost part of the Apeeninic shallow water domain, close to the seaways that separated it from the shallow water reefal domain of Sicily. This seaway, both in the Stampfli et al. (2001) and Schettino et al (in press) reconstructions (Fig. 4), represented a bridge between an older area of oceanization (Neo-Tethys) to the east, and the Jurassic Ligurian-Penninic spreading to the west. The peculiar position of the northern Calabria in this framework could explain the high variety of reef assemblages in such a small area.

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