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SOME INOZOID SPONGES FROM UPPER TRIASSIC (NORIAN-RHAETIAN) NAYBAND FORMATION OF CENTRAL IRAN*

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Key-words: Systematic Paleontology, Sponges, Inozoida, Reef, Nayband Formation, Upper Triassic, Norian Rhaetian, Iran.

Riassunto. Nella Formazione Nayband dell'Iran centrale si rinvengono alcune scogliere di piccole dimensioni e banchi a coralli di età Norico-Retica entro sedimenti argillitici, siltitici e carbonatici ibridi. Queste successioni appartengono alla placca dell'Iran centrale, facente parte del Continente Cimmerico. La maggior parte delle rocce biogeniche hanno geometria biostromale, mentre le bioherme sono rare. Oltre ai coralli ed ad altri organismi biocostruttori, gli Inozoi, gli Sfinctozoi e le spugne chetedidi sono i più importanti. In alcuni banchi si trovano anche delle spugne hexactinellidi.

Nel presente articolo sono descritti i seguenti Inozoi: *Radiofibra norica* n. sp., *Permocorynella maxima* n. sp., ? *Sestrostomella robusta*, *Marawandia iranica* n. gen., n. sp. e *Eanaulofungia* ? *triassica* n. sp. I primi quattro taxa sono tra le spugne più abbondanti della Formazione Nayband affiorante nell'Iran Centrale, mentre *Enaulospongia ? triassica* è abbastanza rara. Questi Inozoa non sono mai stati segnalati nel Triassico di questa regione. *Radiofibra*, sinora nota solo nel Permiano superiore del Djebel Tebaga (Tunisia), è segnalata qui per la prima volta in rocce triassiche. Sono inoltre discusse le distribuzioni stratigrafiche e paleogeografiche di tutti i generi trattati.

Abstract. Some small-scaled Norian-Rhaetian reefs and reef mounds are imbedded within the shales, siltstones and siliciclastic-carbonate deposits of the Nayband Formation in central Iran. These deposits belong to the central Iranian plate as part of the Cimmerian Continent. Most of the biogenic rocks have a biostromal geometry, biohermal constructions are rare. Inozoid, sphinctozoid, and chaetetid sponges are, beside of corals and other reef builders, the most important reef organisms within these bioconstructions. In some reefs a variety of hexactinellid sponges also occur.

The following inozoid sponges are described in this paper: *Radiofibra norica* n. sp., *Permocorynella maxima* n. sp., *?Sestrostomella robusta*, *Marawandia iranica*, n. gen., n. sp. and *Enaulofungia? triassica* n. sp. The first four taxa are among the most abundant sponges within the Nayband Formation where it is exposed in several localities in central Iran. *Enaulofungia? triassica*, however, is not an abundant sponge there. These inozoid sponges have never been reported from the Triassic deposits of this region. *Radiofibra*, until now known only from the Upper Permian of Djebel Tebaga (Tunisia), is reported here for the first time from Triassic rocks. The stratigraphic as well as the paleogeographic distribution of all the genera are discussed.

Introduction.

The non-segmented inozoid sponges, in addition to the sphinctozoid and chaetetid groups, are the most important and also among the most abundant reef builders within Permian and Triassic reefs, in general, and also in Upper Triassic reefs and reefal limestones in central Iran. All Paleozoic inozoid sponge species and nearly all genera disappear at the Permo/Triassic-boundary, like some other reef builders, in the end-Permian mass extinction. No inozoid sponges are known from Lower Triassic (Scythian) deposits and only few inozoid sponges have been described from pioneer Triassic reefs (Anisian reefs) and shallow water carbonates (Fois & Gaetani, 1984; Senowbari-Daryan et al., 1993). The diversity of inozoid sponges increased during the Middle (Ladinian) and Upper Triassic, to reach their maximum Triassic abundance in Norian-Rhaetian time (Riedel & Senowbari-Daryan, 1991; Flügel & Senowbari-Daryan, 1996).

Permian inozoid sponges are relatively well known from different localities throughout the world (Rigby et al., 1989; Fan et al., 1991; Finks, 1995; Rigby & Senowbari-Daryan, 1996, 1997). However, taxonomic investigations on Triassic inozoid sponges are carried out poorly. The only comprehensive work about the Triassic inozoid sponges was published by Dieci et al. (1968) who described the Carnian inozoid sponges from the Casssian formation of the Southern Alps (Italy), in detail. The majority of inozoid sponges of Norian-Rhaetian reefs, the so called "Dachsteinkalk"-reefs in the Alps and equivalent reefs in other localities on the world, are still almost unknown. Sporadic reports of inozoid sponges from this time interval may be found in papers of authors, like Vinassa (1901, 1908, 1915), Flügel & Flügel-Kahler (1963), Zankl (1969), Senowbari-Da-

*) Contribution to the Triassic Paleontology of Iran 2. For 1 see Senowbari-Daryan, B. (1996): Upper Triassic Reefs and Reef Communities of Iran.- In Reitner, J., Neuweiler, F. & Gunkel, F. (eds.): Global and Regional Controls on Biogenic Sedimentation. I. Reef Evolution. Research Reports.- *Göttinger Arb. Geol. Paläont.*, Sb2: pp. 299-304, 1 fig, 1 pl, Göttingen.

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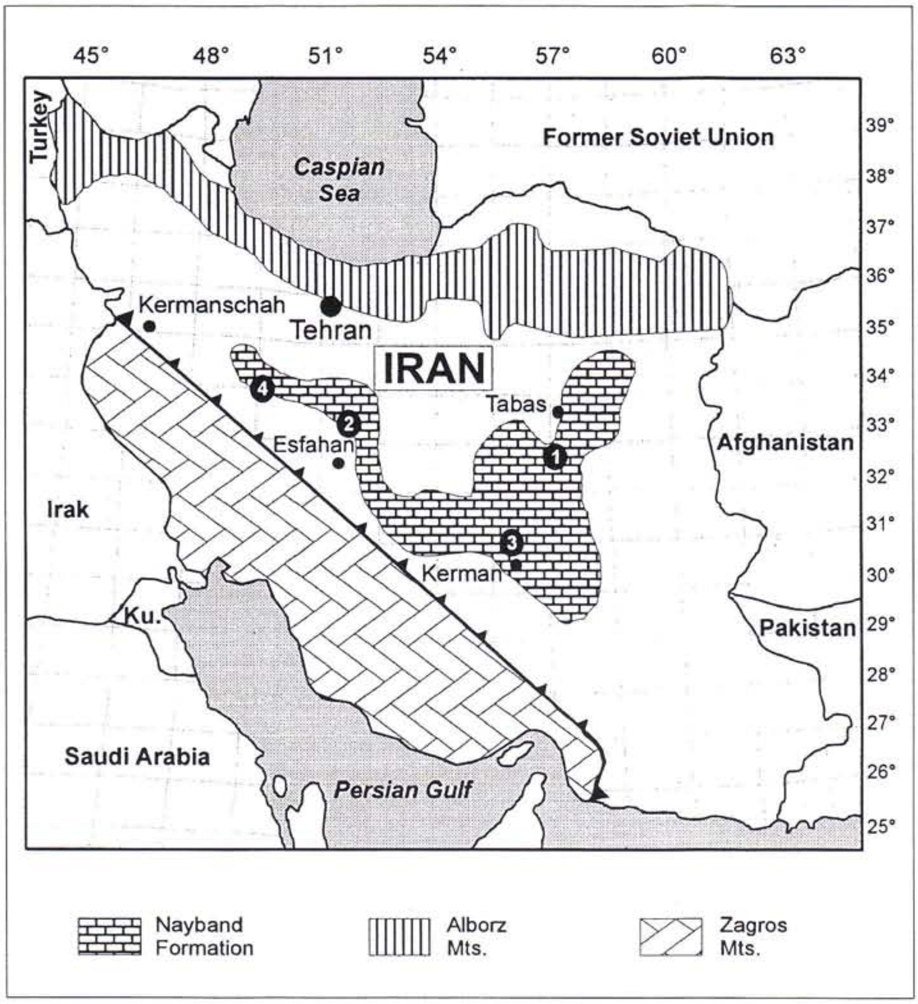


Fig. 1 - Distribution of the Nayband Formation in central Iran (from Seyed-Emami 1971, compare also Darvishzadeh, 1992), and the localities from which the sponges described in this paper were collected 1) Type localities of the Nayband Formation southern of Tabas, called Ali-Abad Reefs and Naybandan Reefs in this paper (see also Figs. 2-3); 2) reef localities near the village Bagherabad northeast of Esfahan; 3) localities (Bulbullu and Kuh-e Tizi) around Kerman, and 4) reefs near Marawand, Delijan and the Mahalat area (see also Figs. 4-5).

ryan (1980) and Wurm (1982), but detailed systematic work is lacking. A summary of occurrences and distributions of Triassic inozoid and sphinctozoid sponges and those of the Norian-Rhaetian was given by Riedel & Senowbari-Daryan (1991).

A rich invertebrate fauna, including sponges, corals, hydrozoans (spongiomorphids, *Heterastridium*), bryozoans, brachiopods, gastropods, bivalves, echinoderms, worm tubes, foraminifers, ostracods, and some problematic organisms, etc., plus a few plants (mainly red algae) occur within the Upper Triassic (Norian-Rhaetian) reefs and reefal limestones within the Nayband Formation outcrops in several localities in central Iran (Fig. 1). Douglas (1929) was the first author who reported on the invertebrate reef fauna of the Upper Triassic in this region. A summary of the Triassic of Iran, in general, was given by Seyed-Emami (1971). Kristan-Tollmann et al. (1979, 1980) who published on the corals and some microfossils from reefal limestones near Bagherabad, NNE of Esfahan and Waliabad, approximately 220 km south of Esfahan. The gastropods and bivalves of Bagherabad locality were described by Fallahi et al. (1983). *Gasaukammerella eomesozica* (Flügel), a relatively abundant strophomenid brachiopod (especially in Marawand-Reef), was reported from Norian-Rhaetian reefs in Iran by Senowbari-Daryan & Flügel (1996). A short note about the reefs and reefal limestones within the Nayband Formation, their composition and the communities of reef organisms was given by Senowbari-Daryan (1996).

Reports about the sponges from the Upper Triassic of Iran are extremely rare (e. g. Huckriede et al., 1962). Until now no inozoid and other sponges has been reported in detail from this time interval in Iran. However, a great variety of sponge taxa, including inozoids, sphinctozoids, chaetetids and hexactinellids, were collected from the different reefs of the Nayband Formation from several localities in central Iran (Fig. 1). In this paper, the second in a series of "contributions of the Triassic Paleontology in Iran" (for the first one see Senowbari-Daryan, 1996), some abundant inozoid sponges are described. The taxonomic description of all other reef organisms, including additional inozoid and other sponge groups, will follow in further publications as the series.

The investigated material is deposited in the Institute of Paleontology, University of Erlangen-Nürnberg (Senowbari-Daryan: Triassic Iran).

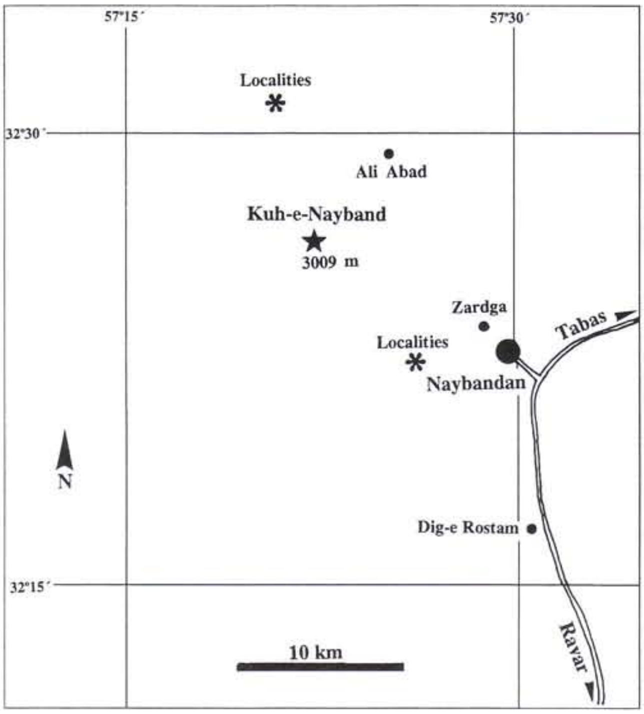


Fig. 2 - Geographic position of bioconstructions within the Nayband Formation in northwest and southeast of Kuh-e Nayban, near the villages of Ali-Abad and Naybandan.

Upper Triassic Nayband Formation in Iran.

The Upper Triassic (Norian-Rhaetian) Nayband Formation was named from the Kuh-e Nayband (Nayband-Mountain) of 3008 m, on the western area of the the small village Naybandan, approximately 220 km in southern area of the town Tabas (Figs. 1, 2). The formation is one of the most widespread and important geological unit outcrops at numerous localities in central Iran (Fig. 1) Sediments of Nayband Formation were deposited in the central Iranian plate, as a part of Cimmerian Continent of Sengör (1984) (see also Stöcklin 1968; Davoudzadeh & Schmidt, 1984; Soffel et al., 1996). A series of alternating shales, sandstones and siliciclastic-carbonate deposits characterize the Nayband Formation, which has a thickness of 2195 m in the type locality on the southern flank of the Kuh-e Nayband (Nayband-Mountain), about 20 km west of the village Naybandan (Brönnimann et al., 1971; Seyed-Emami, 1975; Kluyver et al., 1983b) (Fig. 3). Informations of more than 2200 m thickness of Nayband Fomation, as given by Stöcklin & Nabavi (1971, p. 18) and Taraz (1974, p. 59) seems to be unaccurate data. The thickness of the Nayband Formation decreases southward, reaching only approximately 1800 m in Kuh-e Murghab, approximately 100 km south of the type locality (Kluyver et al., 1983a), and about 100 m in the Kerman area, e. g. in Kuh-e Tizi or in Bulbullu section (Huckriede et al., 1962; personal observations). Whether the enormous thickness of the Nayband Formation in the type locality corresponds to the "true" depositional thickness or reflects duplication by overthrusting is uncertain.

According to Brönnimann et al. (1971) and Kluyver et al. (1983a), the Nayband Formation at the type locality may be subdivided into four members (from youngest to oldest):

a) Howz-e Khan Member: shales and sandstones with limestones and reefs (mainly sponge- and coral-dominated).

b) Howz-e Sheikh Member: mostly shale and sandstone.

c) Bidestan Member: shales, sandstones, and limestones with some biostromal reefs that are sponge- or coral-dominated. This member contains abundant *Heterastridium*-bearing marls and limestone.

d) Gelkan Member: generally shales and sandstone, contains rare oolitic carbonates with extremley rare reef organisms.

Kluyver et al. (1983b, p. 43) reported three additionaly members which can be differentiated in the Lakar Kuh (Lakar-Mountain), almost 45 km south of the Naybandan Quadrangle map. The subdivision of the Nayband Formation in the type locality or in the Lakar Kuh, however, is not feasible everywhere in central Iran.

Geographic setting of localities.

The investigated sponge fauna was collected from different levels of Nayband Formation in central Iran from following localities:

1. Tabas Area (Fig. 2). The collected sponge fauna come from several small bioconstructions imbedded within the Nayband Formation from two localities in this area:

a) The first locality is situated north west of the small village of Ali-Abad. Here the Nayband Formation is well exposed in the northwestern area, starting approximately 5 km west from the village of Ali-Abad, approximately 150 km south of Tabas and approximately 40 km north of the type locality (Fig. 2). A geological map 1:250.000, sheet Naybandan was completed by Kluyver et al. (1983a) and was edited by the Geological Survey of Iran with an Explanatory text. Samples from this area are marked as "Ali-Abad Reefs" in this paper.

b) The second area is located on the southern flank of Kuh-e Nayband (Pl. 9, fig. 1), in the western part of the small village of Naybandan, also located in the same geological map completed by Kluyver et al. (1983a: fig. 5 and 12). This locality nearly corresponds to the section of Brönnimann et al. (1971) from which the miliolid foraminifer *Miliolipora cuvillieri* was described for the first time (see Fig. 3). Bioconstructions in this locality are generally built as biostroms. Small-scaled bioherms (approximately 30 m in diameter and 10 m height or even smaller) occur stratigraphically again

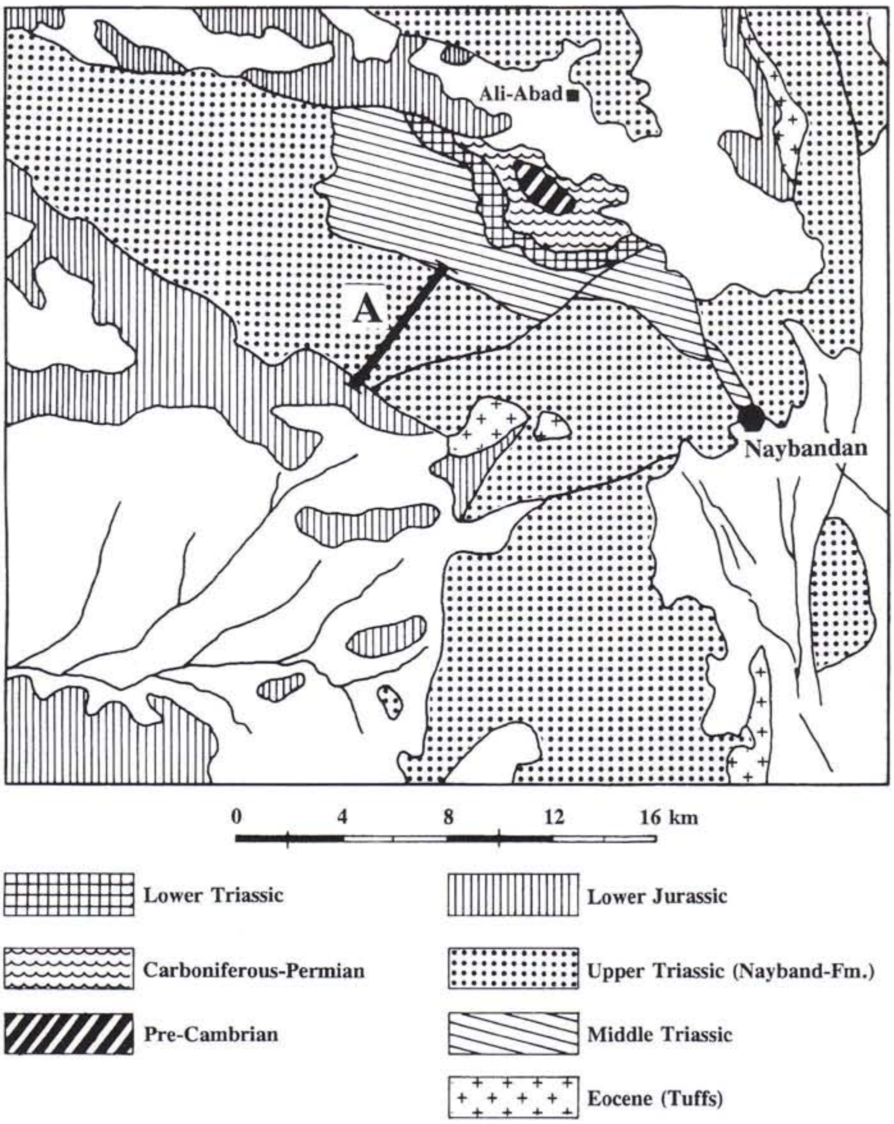


Fig. 3 - Distribution of the Nayband Formation in the type locality around Kuh-e Nayband (from Brönnimann et al., 1971). "A" point to the section of Brönnimann et al., 1971 (see Pl. 9, fig. 1).

and again within the Nayband Formation (Pl. 9, fig. 2). Sponges from this area are marked as "Naybandan Reefs" in this paper.

2. Marawand Area (Fig. 1, 4, Pl. 9, fig. 5): Tectonic structures limited outcrop distribution of the Nayband Formation with small patch reefs and reefal limestones in this area. A relatively large reef complex, almost 60 m thick and a lateral extent of several hundred meters (Pl. 9, fig. 4) is exposed southeast of the small village of Marawand, located on the geological maps of sheet Kashan (Nr. F7, 1: 250.000, completed by Amidi & Zahedi, 1972 or Sheet 6257, 1:100.000 completed by Radfar, 1993 or sheet Soh, completed by Zahedi, 1973) of central Iran published by the Geological Survey of Iran. This locality can be reached from the village Meymeh (not far from the localities in the southern part of Delijan, see Fig. 5) by taking the minor road from Meymeh to Marawand, or the highway from Kashan to Natanz (a relatively large town in southeastern of Kashan) via the small town of Abyaneh (Fig. 4). The Marawand-Reef yielded a large diversity sponge fauna. Samples from this locality are marked as "Marawand Reef" in this paper.

3. Delijan Area (Fig. 1, 5, Pl. 9, fig. 3-4): The area is near the town Delijan where from two localities of the Upper Triassic fauna were collected (geological map Nr. E7, Sheet Golpaygan 1:250.000: Thiele et al., 1968).

a) One locality is along the right side of the road, coming from Delijan to Meymeh, approximately 50 km from Delijan, where several small reefs of conical geometry can be easily recognized (Pl. 9, fig. 3-4, see also Senowbari-Daryan, 1996: pl. 1, fig. 1). These reefs yielded a very diverse fauna of sponges and other invertebrates. Samples from this locality are marked as "Delijan Reefs".

b) The second locality is in the northwestern part of the relatively large town of Mahallat, in the western area of Delijan (same geological map: Thiele et al., 1968). The Norian-Rhaetian deposits of this area show some differences to those of the type locality. Bedded Limestones with Megalodonts and algal mats ("Loferitic Facies") are abundant, shale and sandstones are not

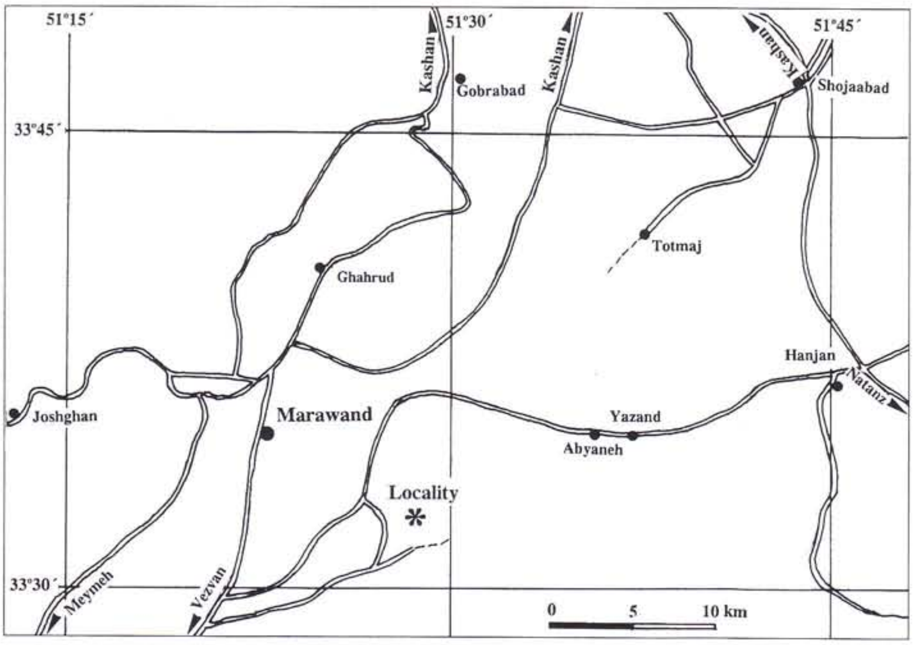


Fig. 4 - Geographic position of the Marawand Reef southeast of the small village of Marawand (see Pl. 9, fig. 5).

abundant. Some sponges were collected from the biostromal bioconstructions of this area but the diversity is extremely low. Some chaetetid sponges and green algae (dasycladaceans) from this area are described by Fenninger (1969). The samples from this locality are marked as "Mahallat Reefs".

4. Bagherabad Area (Fig. 6): The small village of Bagherabad is situated approximately 60 km northeast of Esfahan (Fig. 6). Around the village Bagherabad, in several localities the Nayband Formation, similar to the type locality, is exposed. The ammonite, *Distichites tozeri* was described for the first time from this area by Seyed-Emami (1975). Some Triassic reef organisms and other invertebrate fossils of this area are described by Kristan-Tollmann et al. (1980) and the molluscs by Fallahi et al. (1983). Our samples come from a section located directly at a Spring not far from the "Salzbrunnen-Lokalität" locality (Saltspring locality) of Kristann-Tollmann et al. (1980). Other localities in this area were also sampled during the fieldwork 1997 but their sponges are not taken into account in this paper.

Compared with the Delijan Reefs and Naybandan Reefs diversity of sponges in Bagherabad area is low. Samples from this locality (Saltspring locality) are marked as "Bagherabad Reefs" in this paper.

Other localities.

a) Kerman area: The Upper Triassic Nayband Formation was also sampled in two sections SE (locality: Bulbullu, see Huckriede at al., 1962) and NE (locality Kuh-e Tizi near the village of Kuhbanan), NE of Kerman. The dominance of carbonates characterize also the Nayband Formation in these areas. Its low thickness reaches approximately 80 m (Bullbullu), and 120 m (in Kuh-e Tizi), respectively. In Bulbullu, only one carbonate bed is exposed and it contains a small variety of sphinctozoid, inozoid and chaetetid sponges. The sponge diversity in these localities is also very low. Among the inozoid sponges described in this paper, only ?*Sestrostomella robusta* was prevously found in the Bulbullu locality. Samples from these localities are called "Bulbullu Reef" in this paper.

b) Abadeh-Area: Norian-Rhaetian bioconstructions are also exposed in several localities south area of Abadeh, a relatively large town south of Esfahan (Taraz, 1974). One of these localities is near the small town Waliabad with abundand large brachiopod *Oxycolpella* (see Kristan-Tollmann et al., 1979). Because of some differences in the faunal composition, especially the brachiopods (*Oxycolpella*), in the Nayband Formation in this area in one hand and in Naybandan area (type locality) in other hand the term "Waliabad-Faziesregion" (Waliabad facies region) was introduced by Kristan-Tollmann et al. (1979, p. 130). The sponges of both, Kerman- and Abadeh-area, will be described separately and are not taken into account in this paper. The type locality (including localities near the villages Ali-Abad and Naybandan), the small reef near the town of Marawand, and the reefs in the southern part of Delijan have the most diverse invertebrate fossil faunas. Localities around Bagherabad (Saltspring locality) and Mahallat area have faunas of very low diversity. A variety of hexactinellid sponges were also found in the reefs, and sporadically within the bedded limestones and sandy limestones to carbonate sandstones between the reef in the southern part of the village of Delijan (Pl. 9, fig. 3-4). Hexactinellid sponges are also present in other localities (e. g. in Marawand Reef) but their abundance is much less than in reefs exposed in the south of the town of Delijan.

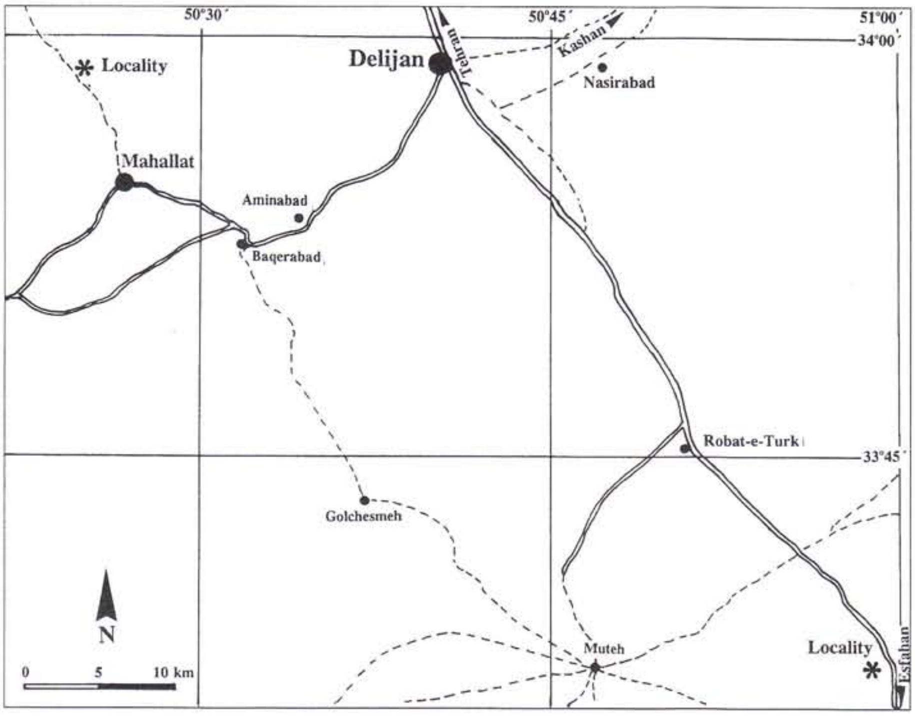


Fig. 5 - Geographic position of bioconstructions in southeast of Delijan (see Pl. 9, fig. 2-4) and northwest of Mahallat.

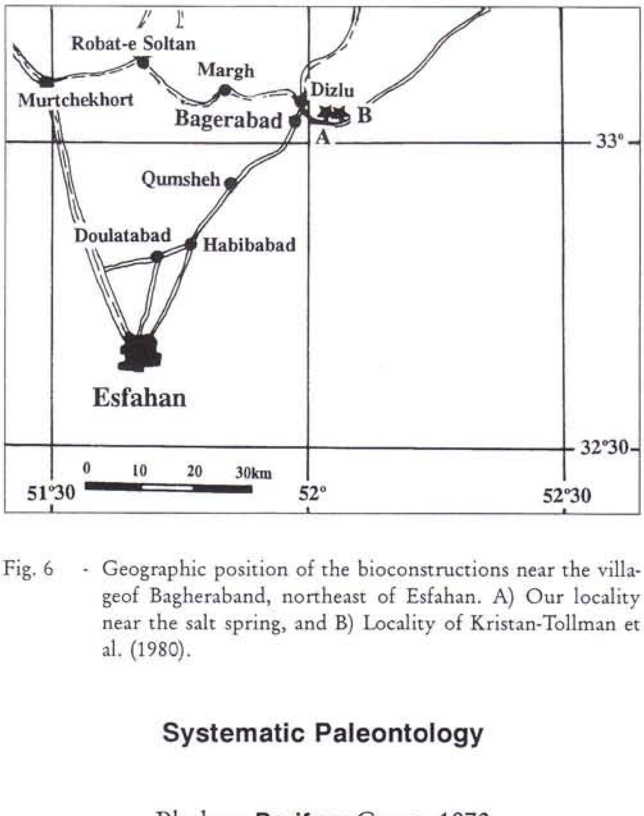


Fig. 6 - Geographic position of the bioconstructions near the villageof Bagheraband, northeast of Esfahan. A) Our locality near the salt spring, and B) Locality of Kristan-Tollman et al. (1980).

Systematic Paleontology

Phylum **Porifera** Grant, 1872

Class Calcarea Bowerbank, 1864

Order Aspiculata Rigby & Senowbari-Daryan, 1996

Suborder Inozoida Rigby & Senowbari-Daryan, 1996

Remarks. Steinmann (1882) introduced the term "Inozoa" for those "pharetronid" sponges (sponges with a rigid skeleton composed of aragonite or calcite, so called "coralline" sponges in modern literature) which do not show any segmentation. "Pharetronid" sponges with a distinct segmentation were included under the term "Sphinctozoa" by Steinmann. Detailed investigations concerning the spicular skeleton and the microstructure of the rigid skeleton have shown that both of Steinmanns groups are polyphyletic in origin and the term "Sphinctozoa" and "Inozoa" cannot be used as taxonomic categories (Senowbari-Daryan 1989, 1990, 1991; Reitner 1990, 1992; Rigby & Senowbari-Daryan, 1996).

Segmentation or "chambered" construction of the rigid calcareous skeleton (aragonite, calcite or Mg-calcite) is a common feature of the "Sphinctozoa" Steinmann or "Thalamida" Laubenfels (1955), and was developed independently in several sponge groups. Such a construction is known from the Cambrian to the Recent: the **archaeocyathids**: e. g. *Polythalamia* (Debrenne & Wood 1990), *Aphrosalpinx* (Myagkova, 1955; see Rigby et al., 1994), *Nematosalpinx* (Myagkova, 1955; see Rigby et al., 1994), the **demospongids** (including lithistids): Recent *Vaceletia* (Vacelet, 1979; Vacelet et al., 1992), most fossil representatives (Senowbari-Daryan 1990, 1994), the **calcispongids** (including the heteractinids): e. g. the Jurassic-Cretaceous genera *Barroisia* or *Thalamopora* and the Cambrian representatives *Jawonya* and *Wagima* (Vacelet 1979; Senowbari-Daryan 1990; Kruse 1987, 1996), and the hexactinellids,: e. g. *Casearea* (see Müller 1974), *Inaecoelia, Caucasocoelia*, and *Pseudoverticillites* (Boiko 1990; Wendt et al., 1989, and our own material presenting several hexactinellid segmented sponges from the Upper Triassic Nayband Formation of Iran).

Steinmanns "Inozoa" is also a polyphyletic group and of convergent nature. Comparisons of the Paleozoic and Triassic representatives with Jurassic-Cretaceous ones (e. g. *Corynella*) show that inozoans of the latter time interval usually possess a spicular skeleton composed primarily of calcite and, therefore, are certainly calcisponges. Paleozoic and most of Triassic representatives of inozoid sponges, however, did not secreted any spicular skeleton (Rigby & Senowbari-Daryan, 1996). Wendt (1974) reported, however, the occurrence of monaxon spicules (but never triaxons which are typical of the calcispongea) in some Triassic taxa, like *Himatella millepo-rata*, *Pharetrospongia* sp., *Stellispongia manon*, *Corynella* sp., and *Sestrostomella robusta*. Because of this observation, Triassic "inozoa" could also belong to the demosponges or those without any spicular skeleton could have been derived from heteractinds by reduction of rays like the Paleozoic representatives (Rigby & Senowbari-Daryan, 1996).

Rigby & Senowbari-Daryan (1996) proposed to limit the term "Inozoa" Steinmann to those "pharetronid" and nonsegmented sponges which possess a spicular skeleton composed primarly of calcite. For all other representatives without a primary spicular skeleton the term Inozoida was used by Rigby & Senowbari-Daryan (1996). Inozoida were probably derived from Paleozoic heteractinida by reduction of spicular skeleton during the Late Paleozoic. This classification scheme is followed in this paper.

Family *Peronidellidae* Wu, 1991
Subfamily *Peronidellinae* Wu, 1991
Genus *Radiofibra* Rigby & Senowbari-Daryan, 1996

Diagnosis: "Cylindrical to subcylindrical sponges, branched in few specimens, all with very narrow, deep, central spongocoel. Interior fibrous skeleton with poorly defined arrangement in transverse cross section but having upwardly divergent, jet-of-water arrangement in longitudinal section. Spaces between fibers appear as canals that diverge upward and outward toward periphery. Short lateral canals may also occur. Microstructure of rigid skeleton composed of spherulites" (Rigby & Senowbari-Daryan, 1996, p. 61).

Type species: *Radiofibra lineata* Rigby & Senowbari-Daryan, 1996

Additional species: *Radiofibra delicata* Rigby & Senowbari-Daryan, 1996

Radiofibra nodosa Rigby & Senowbari-Daryan, 1996

Radiofibra inordinata Rigby & Senowbari-Daryan, 1996

Radiofibra norica n. sp.

(Pl. 1, fig. 1-7, Pl. 2, fig. 1-6)

Derivation of name: Because of the first occurrence of the genus in Norian reefs.

Holotype: The specimen which is documented by a longitudinal and a cross section in Pl. 1, fig. 3 and 5 (thin section M/X/l and M/X/q).

Paratypes: All specimens figured in Pl. 1, fig. 1-2, 4, 6-7, Pl. 2, fig. 1-6.

Type locality: Marawand Reef, central Iran (see Fig. 4).

Type level: Upper Triassic (Norian-Rhaetian) reef limestones, equivalent to the Nayband Formation near Naybandan/Tabas area.

Material: Numerous specimens as isolated bodies as well as in thin sections from Marawand Reef, in reefs in the southern area of Delijan (Delijan Reefs), and from reefs in the type locality of the Nayband Formation, in the western area of the village of Naybandan (Naybandan Reefs) and from the Ali-Abad area (Ali-Abad Reefs) (Fig. 2).

Diagnosis: Relatively large, cylindrical to subcylindrical and dichotomously branched sponge with a spongocoel passing through the whole sponge body. Without distinct dermal layer around the sponge wall or spongocoel wall. The skeletal fibers are arranged upwardly divergent, like a water jet, in longitudinal section. In cross sections the skeletal fibers have a reticular appearance with irregular looking and radially arranged tube-like interfiber spaces. Microstructure, as well as spicular skeleton, are not known.

Description. This cylindrical to subcylindrical and dichotomously branched sponge reachs a diameter of up to 32 mm, but the majority of specimens have a diameter between 20 mm and 30 mm. The exact length of sponge can not be determined because all specimens are broken. The largest specimen reachs a length of at least 120 mm. The outer surface is without a distinct wall or dermal layer and the interior connects with the sponge interior by interfiber spaces of skeleton.

The holotype is a single free specimen but also broken. It was about 90 mm long but now is only 63 mm long, the rest was lost by preparation of a thin section. It reachs a diameter of 26 mm. An axial spongocoel, approximately 5 mm in diameter (in cross section 5 x 3 mm), passes through the whole sponge. The ratio of spongocoel diameter to the sponge diameter is about 1:5.

A relatively narrow axial spongocoel of approximately 3-5 mm passes through other specimens, and as in the holotype the diameter of the spongocoel in most specimens is approximately 20% of the whole sponge diameter (see tab. 1). The spongocoel lacks a distinct wall. In some specimens, however, and also in holotype, skeleton fibers around the spongocoel are a little bit finer and more densely packed than in the main wall (Pl. 1, fig. 1, 5, 6, Pl. 2, fig. 6). Connections between the spongocoel and the sponge wall was produced by inter fiber spaces. The relatively thick sponge wall is composed of skeletal fibers that are upwardly divergent (in axial longitudinal section), arranged like a water-jet toward the exterior of the sponge (Pl. 1, fig. 1-4, 6, Pl. 2, fig. 3). In marginal longitudinal sections, cut through the sponge wall, fibers and tube-like interfiber spaces are arranged parallel to the outer surface of the sponge (Pl. 1, fig. 1, 7, Pl. 2, fig. 3). In axial longitudinal sections spaces between the fibers look like tubes that are also upwardly divergent. In cross sections the skeletal fibers and the spaces between them are radially arranged (Pl. 2, fig. 1, 2, 4), in some cases irregularly and elsewhere with a reticular appearance (Pl. 2, fig. 5). The skeletal fibers are interrupted by numerous pores which form the connections between the interfiber spaces. The fibers are usually 0.1-0.2 mm thick but, because of recrystallization, they appear thicker.

Remarks. *Radiofibra norica* n. sp. may be confused with representatives of *Peronidella*, which occurs also in Upper Triassic reef limestones in central Iran. The skeletal fibers in *Peronidella*, however, are arranged totally irregularly, giving a reticular appearance to the sponge wall in longitudinal sections as well as in transverse sections. Skeletal fibers in *Radiofibra* are upwardly divergent in longitudinal sections and interfiber spaces appear tube-like (see also Rigby & Senowbari-Daryan, 1996). In cross sections *Radiofibra norica* may be easily confused with representatives of the genus *Permocorynella*. Species of the genera can be separated by presence of large inhalant and exhalant canals in *Permocorynella*, but their lack in *Radiofibra*.

Representatives of the genus *Radiofibra* have been known to date only from the Upper Permian deposits of Djebel Tebaga, southern Tunisia (Rigby & Senowbari-Daryan, 1996). Four species of the genus have been described by the same authors. These species are summarized by their main features in table 1.

R. norica is the first known Triassic species of the genus. Dimensions of *R. norica* may be similar to *R. lineata* and *R. delicata* but the Triassic species differs from the Permian species *R. lineata* by having larger dimensions of the sponge and spongocoel and by finer skeletal fibers. *R. norica* is differentiated form *R. delicata* by having a larger spongocoel (approximately 3% in *R. delicata*, 20 % in *R. norica*). The main characteristic of all Permian species of *Radiofibra* are compared with the new species from the Nayband Formation in table 1.

Occurrence and stratigraphic range. *Radiofibra norica* n. sp. is the most abundant sponge species in the type locality (Marawand Reef near the town of Marawand). In addition to the type locality, *Radiofibra norica* n. sp. was also found in the Naybandan area (in both localities, near the village of Ali-Abad: Ali-Abad Reefs, and near the village of Naybandan: Naybandan Reefs), in reefs in the southern area of Delijan (Delijan Reefs) and in the Bagherabad area (Bagherabad Reefs) NE of Esfahan. From Triassic deposits *Radiofibra* is known only from the Upper Triassic (Norian-Rhaetian) reefs of the Nayband Formation in Iran. It is one ot the most abundant sponge in almost all reefs within the Nayband Formation.

Species	Diameter of sponge	Diameter of spongocoel	Thickness of sponge wall	Ratio of the diameter of the spongocoel to sponge	Thickness of skeletal fibers	age
R. lineata	16-22	2-4	7-9	12-20%	0.2-0.8	P
R. delicata	10-27	0.8	4-13	app. 3 %	0.04-0.2	P
R. nodosa	15	1-1.5	colonial	10-15%	0.1-0.4	P
R. inordinata	1.5	1-1.5	colonial	app. 10%	0.1-0.4	P
R. norica	20-32	4-6	6-14	app. 20%	0.1-0.2	T

Tab. 1 - Permian (P) and Triassic (T) species of the genus *Radiofibra*. Measurements in mm.

PLATE 1

Fig. 1-7 - *Radiofibra norica* n. sp. from Upper Triassic (Norian-Rhaetian) reefs within the Nayband Formation in central Iran.

Fig. 1 - Longitudinal section. The axial spongocoel is cut marginally in the lower part, and skeletal fibers are finer around the spongocoel. In the upper part, where the wall is cut, the fibers run parallel to the outside of the sponge. In axial sections, the fibers run (lower part of the photo) diverge upward toward the outside. Marawand Reef, thin section M/47, x 2.

Fig. 2 - Axial longitudinal section shows the characteristics of the sponge. The skeletal fibers are finer around the spongocoel. Another sponge (left) grew epifaunally on the sponge. In the upper left some borings show in the sponge wall. Marawand Reef, thin section M/7, x 2.5.

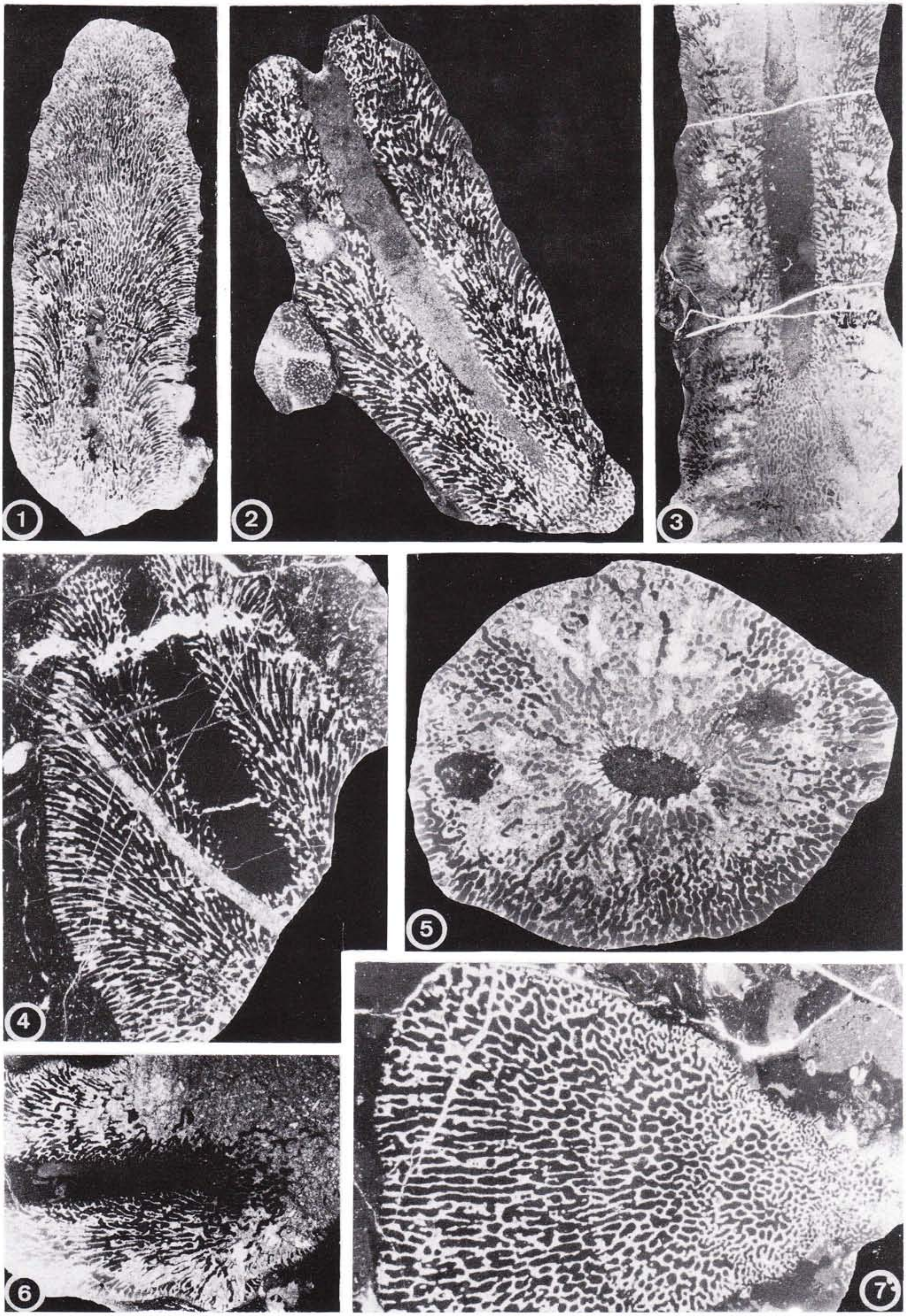
Fig. 3 - Holotype (see also fig. 5). Axial longitudinal section shows the relatively narrow spongocoel and the thick sponge wall around it. In lower part, where the spongocoel is cut marginally, the skeletal fibers are finer. Marawand Reef, thin section M/21/l, x 1.7.

Fig. 4 - Longitudinal section clearly shows the upwardly divergent skeletal fibers. Delijan Reefs, thin section P/158/1, x 2.5

Fig. 5 - Holotype (the upper part of fig. 3). Cross section shows the irregular and curved tube-like interfiber spaces running radially toward the outside of the sponge. The skeletal fibers are finer around the oval spongocoel. The two areas, filled with micritic sediment are borings. thin section M/21/q, x 3.8.

Fig. 6 - Marginal section of axial region of a branched specimen shows the spongocoel and the upwardly divergent skeletal fibers (for cross section see Pl. 2, fig. 4). Marawand Reef, thin section M14/l, x 2.2.

Fig. 7 - Marginal oblique section through the sponge wall shows the parallel skeletal fibers on the left, and reticularly arranged fibers, on the right. Delijan Reefs, thin section P/171/3, x 3.5.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Radiofibra is one of the numerous Permian inozoid sponges that disappears at the end of the Permian and reappears in Norian time. The genus is not known from Middle Triassic and Carnian deposits. From Permian deposits *Radiofibra* is known only from the Upper Permian of Djebel Tebaga, southern Tunisia (Rigby & Senowbari-Daryan, 1996).

Subfamily *Permocorynellinae*
Rigby & Senowbari-Daryan, 1996

Genus *Permocorynella* Rigby & Senowbari-Daryan, 1996

Diagnosis: See Rigby & Senowbari-Daryan, 1996, p. 65.

Type species: *Corynella ovoidalis* Parona, 1933 (Permian).

Additional species: Several Permian and Triassic species are assigned to this genus:

Permian: *Permocorynella osculifera* (Rigby & Senowbari-Daryan, 1996), *Permocorynella fruticosa* (Rigby & Senowbari-Daryan, 1996), *Permocorynella tuberosa* (Rigby & Senowbari-Daryan, 1996), *Permocorynella (= Corynella) gusongensis* (Deng, 1982).

Triassic: The following Triassic species were assigned to *Corynella* by Zittel (1878, p. 126 126): *Myrmecium gracile* (Münster,1841); *Cnemidium pyriforme* (Klipstein, 1843); *Eudea rosa* (Laube, 1865), *Cnemidium astroides* (Münster, 1841), *Scyphia capitata* (Münster, 1841) and *Stellispongia clavosa* (Laube, 1865).

From the mentioned species *Cnemidium pyriforme*, *Cnemidium astroides*, *Scyphia capitata* and *Stellispongia clavosa* are, in contrast to *Corynella* or *Permocorynella*, characterized by possession of an axial bundle of tubes. Dieci et al. (1968) removed these species to their new genus *Precorynella*. The species *Eudea rosa* (Laube, 1865, p. 232, Pl. 1, fig. 4, a) is characterized by possession of very distinct furrows at the summit of the sponge and may be not a representative of *Corynella*. The species *Myrmecium gracile* (Münster, 1841, p. 31-32, pl. 1, fig. 26-27) does not show the features of the genus *Corynella* as defined by Zittel (1878) and by Rigby & Senowbari-Daryan (1996). The following Triassic species of *Corynella* remain and could be moved to the genus *Permocorynella* (Jurassic species of *Corynella* are excluded here):

Corynella rauffi (Vinassa, 1901, p. 8-9, pl. 2, fig. 1-4)
Corynella ritae (Vinassa, 1908, p. 7, pl. 2, fig. 2-5, text-fig. 1)
Corynella timorica (Vinassa, 1915, p. 79, pl. 64, fig. 4-6, pl. 65, fig. 3, 7c)
Corynella magnifica (Wilckens, 1937, p. 203-204, pl. 10, fig. 2, pl. 12, fig. 3)
Corynella penetrata (described by Dieci et al., 1968: p. 122, pl. 22, fig. 1a-3)
Corynella sp. (Dieci et al., 1968, p. 123, pl. 22, fig. 4a-5)
Corynella sp. (Wurm, 1982, p. 217, pl. 35, fig. 1)
Corynella sp. (Di Stefano et al., 1990, pl. 1, fig. 1: described as *Precorynella* sp.)

Corynella ritae possesses several bundle of canals and is very similar to representatives of *Stellispongia*. It can not be assigned to *Corynella*. According to Vinassa (1915, p. 79) *Corynella timorica* possesses also an axial bundle of canals and should be placed in *Precorynella*.

The genus *Permocorynella* was established by Rigby & Senowbari-Daryan (1996) for those Permian and Triassic inozoid sponges assigned to the genus "*Corynella*" by Zittel and by later authors (e. g. Dieci et al., 1968). However, *Corynella*, which was described first from the Jurassic by Zittel (1878, p. 35), possesses diactine and triactine spicules (Zittel, 1978; Hinde, 1893; Wagner, 1964a; Hurcewicz, 1975) that are missing primarily in the morphologically similar sponges of Permian and Triassic age. For that reason the new genus *Permocorynella* was created. It is characterized by a cylindrical, mushroom- or club-shaped sponges with rigid skeleton, but without any spicular skeleton. An axial spongocoel with additional exhalant and inhalant canals within the sponge wall are characteristic features of the genus *Permocorynella*. Primary skeletal mineralogy was aragonite with spherulitic microstructure (see Rigby & Senowbari-Daryan, 1996, p. 65).

Permocorynella maxima n. sp.

(Pl. 3, fig. 1-8, Pl. 6, fig. 5, Pl. 7, fig. 1-3, 6, text-fig. 7)

1982 *Corynella* sp.- Wurm, p. 217, pl. 35, fig. 1.

PLATE 2

Fig. 1-6 - *Radiofibra norica* n. sp. from Upper Triassic (Norian-Rhaetian) reefs within the Nayband Formation in central Iran.

Fig. 1 - Cross section shows the indistinct, radially arranged, skeletal fibers and also the indistinct tube-like interfiber spaces. The skeletal fibers are finer at the surface of the sponge and give it a dermal-like layer. Delijan Reefs, thin section 319/1, x 4.

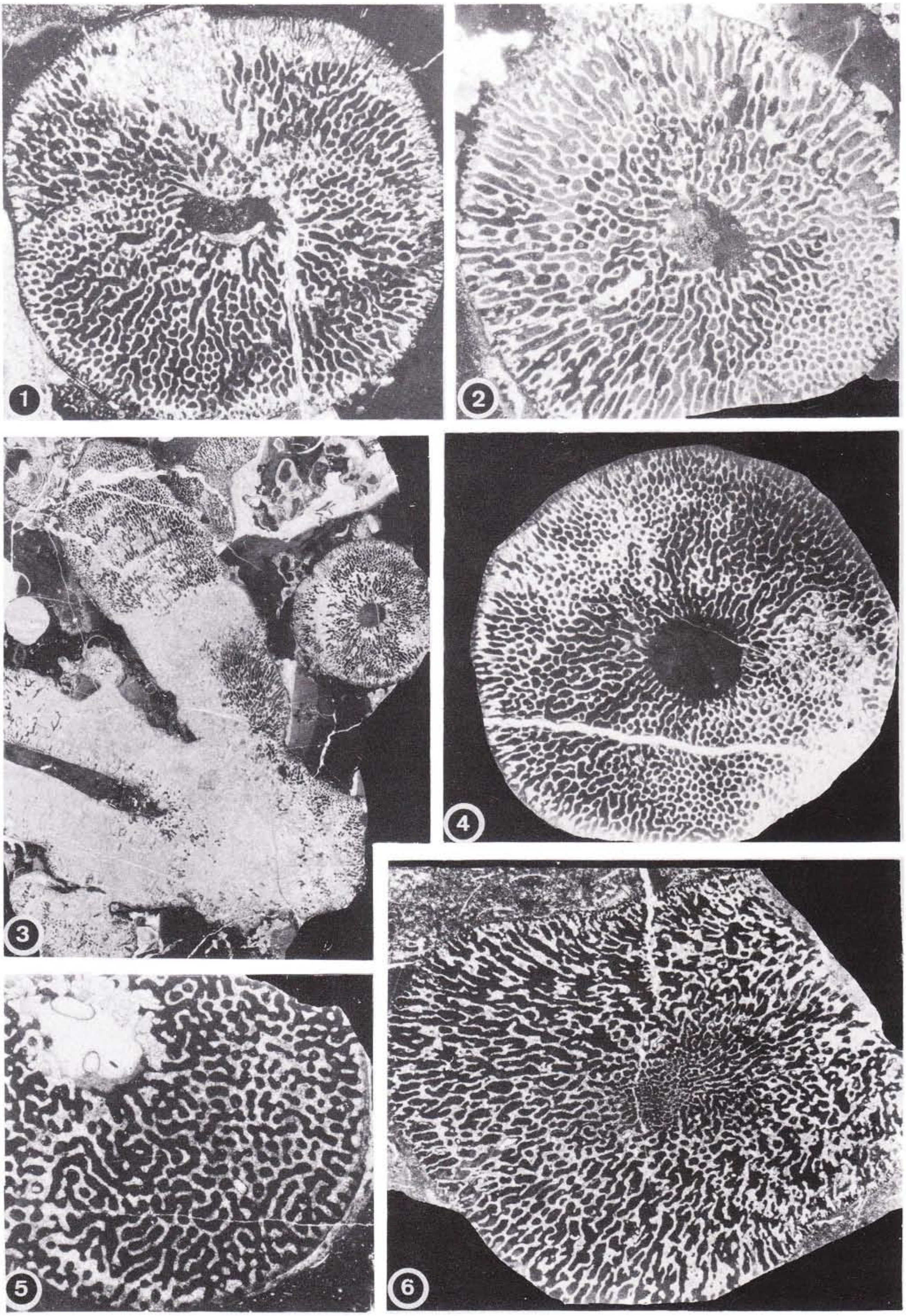
Fig. 2 - Similar section to fig. 1 shows the same characteristics. Delijan Reefs, thin section P/339, x 4.

Fig. 3 - Longitudinal (axial and marginal) section through a dichotomously branched specimen. The marginal section shows skeletal fibers which are arranged relatively parallel to the sponge surface. On the right, a specimen is cut in cross section and shows the same characteristics as mentioned for fig 1. Delijan Reefs, thin section P/318/2, x 1.3.

Fig. 4 - Cross section of specimen whose longitudinal section is figured in Pl. 1, fig. 6. The specimen shows the same charcteristics as mentioned for fig. 1. Marawand Reef, thin section M/14/q, x 4.

Fig. 5 - Oblique cross section through half of a specimen which shows well the reticular skeletal fibers. Ali-Abad area (Tabas), thin section P/5, x 5.

Fig. 6 - Marginal oblique section shows the indistinct radially arranged skeletal fibers in the sponge wall, and the finer fibers around the spongocoel (middle part) and on the sponge surface (most evident in the upper part of the photo). Delijan Reefs, thin section P/208/1, x 2.5.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Derivation of name: Named for the large dimensions of the sponges compared to other Triassic species of *Permocorynella*.

Holotype: The holotype, figured in Pl. 7, fig. 1-2, 6 is a bodily preserved specimen that was investigated only in a polished slab.

Type locality: Type locality of the Nayband Frmation (Naybandan Reefs), west of the village of Naybandan, south flank of the Kuh-e Nayband (Fig. 2).

Type level: Nayband Formation, Norian-Rhaetian.

Diagnosis: Large, single or dichotomously branched, cylindrical to club-shaped sponge with an axial spongocoel that extends deeply into the sponge body. Inhalant and exhalant canals well developed. Skeletal fibers are relatively coarse.

Material: Numerous specimens in free preservation and in thin sections from the type locality near the village of Naybandan (Naybandan Reefs) and near the village of Ali-Abad (Ali-Abad Reefs), from the Delijan Reefs, and from the Marawand Reef.

Description. Cylindrical to conical stems of this single or dichotomously branched sponge reach diameters of up to 60 mm, but most specimens have diameters between 30 mm and 40 mm. Stems in branched specimens are usually oriented parallel to the others. Because all specimens are broken true lengths of the sponges are not known. The largest specimen has a length of almost 110 mm, and a diameter of 43 x 35 mm.

Outer surface of the sponge, in some cases (also indistinct in holotype: Pl. 7, fig. 2), is characterized by annulations spaced 10-15 mm apart (Pl. 7, fig. 3, 8). The outer annulation continues as a thin line into the interior of sponge wall and the sponges might be confused with sphinctozoid sponges (Pl. 7, fig. 1). We interpret these annulations as only interruptions in growth.

A dermal layer (cortex) covers the outer surface of the sponge. This layer is composed of irregularly arranged skeletal grains that give a granular appearance to the fibers on the sponge exterior. At outer ends of the inhalant canals, the dermal layer is pierced by small star-like openings (Pl. 7, fig. 2-3, 6, Fig. 7). Where this layer is weathered away, the sponge wall is pierced by numerous relatively large pores, corresponding to cross sections of the inhalant canals. They reach diameters of 0.4 - 0.6 mm (Pl. 7, fig. 3: upper part). Inhalant canals have a distinct wall approximately 0.1 mm thick. Those walls are pierced by openings which connect the inhalant tubes with spaces between the skeletal fibers (Pl. 3, fig. 1-8, Pl. 6, fig. 5, Pl. 7, fig. 1).

A relatively wide spongocoel (24-37% of the whole sponge diameter) passes through the whole sponge body (Pl. 3, fig. 1, 3, 7, Pl. 6, fig. 5, Pl. 7, fig. 1). Diameter of the spongocoel is variable depending on the sponge diameter. In a specimen with 60 mm diameter, the spongocoel has a diameter of 14 mm (approximately 24% of the sponge diameter); in a second specimen 40 x 34 mm in diameter the spongocoel is 11 mm across (approximately 26%); in the third and fourth specimens with a diameter of 40 mm the spongocoel reaches a diameter of 14 mm (approximately 34%) or 15 mm (approximately 37%). In the holotype (Pl. 7, fig. 1) the spongocoel has a maximum diameter of 15 mm where the sponge measures 40 mm in diameter (ratio: 37.5 %).

Longitudinal axial sections exhibit a thick wall around the spongocoel (Pl. 3, fig. 1, 3, 6-7, Pl. 6, fig. 5, Pl. 7, fig. 1). In addition to spaces between the skeletal fibers two kinds of large canals characterize the canal system within the sponge wall: the first one is upwardly divergent in the sponge wall and arches toward the periphery of the sponge (Pl. 3, fig. 1, 6-7, Pl. 6, fig. 5, Pl. 7, fig. 1). These canals are multibranched toward the pheriphery of the wall (Pl. 3, fig. 1, 6-7, Pl. 7, fig. 1). The second kind are oriented perpendicular to the first and are parallel to the sponge summit or to internal annulation layers (Pl. 7, fig. 1). These canals end in the interior at the axial spongocoel, and at the other end at the sponge surface. The spongocoel may also have (at least partly), a gastral layer, like the outer dermal layer, and is pierced by small pores (Pl. 3, fig. 2, 3: arrows, Pl. 7, fig. 1). These large canal systems are connected with interfiber spaces by numerous small pores (Pl. 2, fig. 4, 6-8).

In cross sections the canals of the first system appear mostly as circular or oval openings. Those of the

PLATE 3

Fig. 1-8 - *Permocorynella maxima* n. sp. from the Norian-Rhaetian reefs within the Nayband Formation in central Iran

Fig. 1 - Longitudinal section shows the relatively thick wall around the axial spongocoel. Inhalant and exhalant canals are concentric and upward-divergent and surrounded by a reticular fiberous skeleton. Delijan Reefs, thin section P/137/l, x 2.2.

Fig. 2 - Enlargement of area shown in fig. 3 by arrows includes exhalant canals and multibranched exhalant pores opening into the spongocoel. x 13.

Fig. 3 - Longitudinal section through a relatively large specimen shows the axial spongocoel, the thick sponge wall around the spongocoel, and the inhalant and exhalant canals. The arrows show the portion of canals in fig. 2. Marawand Reef, P/318/2, x 1.

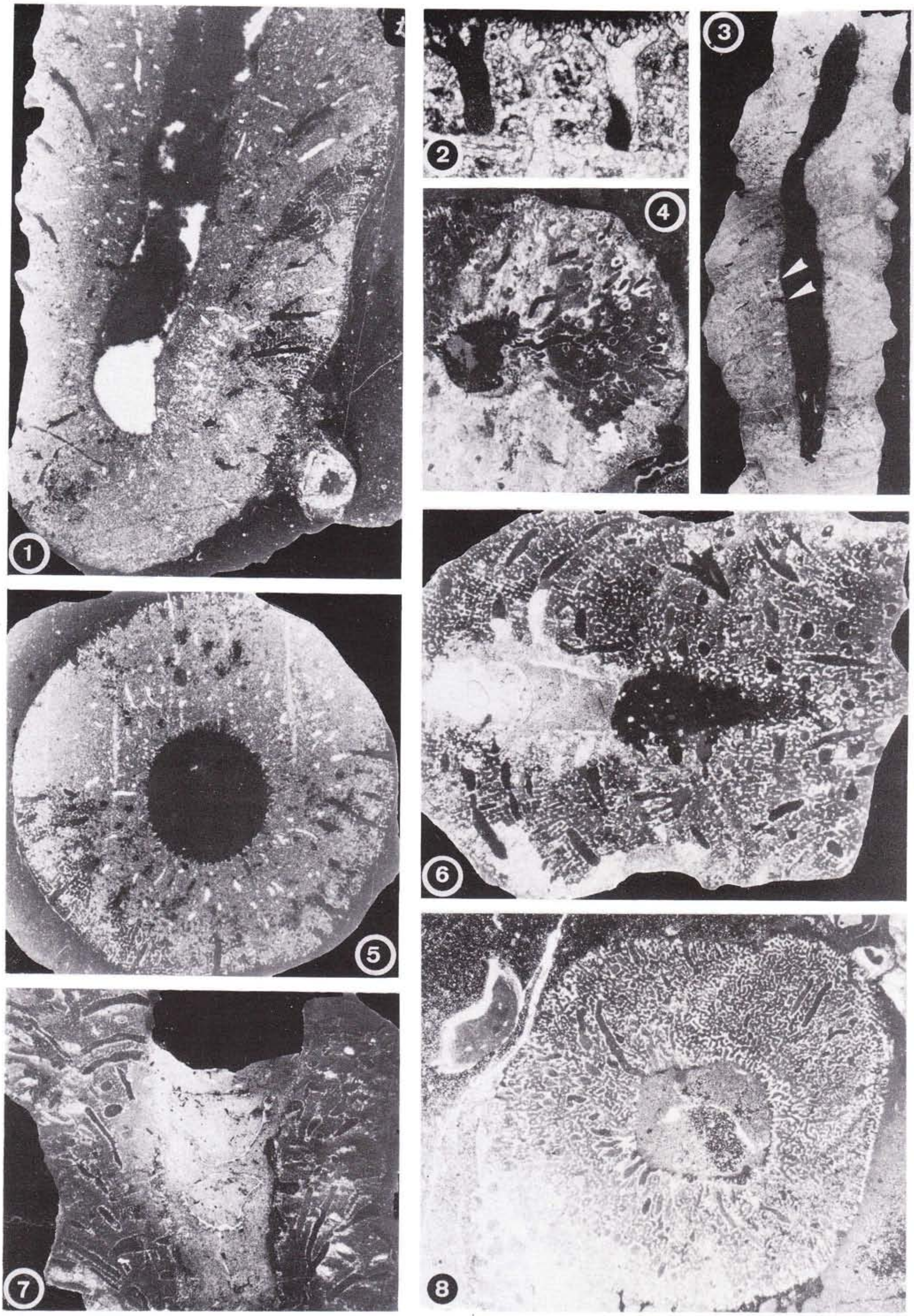
Fig. 4 - Cross section through the half of a specimen showing well preserved and radially arranged inhalant and exhalant canals and the reticular fiber skeleton between them. Marawand-Reef, thin section M10/q, x 2.5.

Fig. 5 - Cross section through the same specimen shown in fig. 1. Radial inhalant and exhalant canals appear as large tubes within the thick sponge wall composed of a reticular fiberous skeleton. Delijan Reefs, thin section P/137/q, x 2.5.

Fig. 6 - Oblique section through the sponge wall and the spongocoel, which is filled with sediment and calcite cement. The single or dichotomously multibranched inhalant and exhalant canals are clearly shown. Marawand Reef, thin section 19, x 3.

Fig. 7 - Section similar to fig. 6. Ali-Abad Reefs, thin section 12, x 2.5.

Fig. 8 - Cross section shows the thick sponge wall, the wide spongocoel and the radially arranged inhalant and exhalant canals surrounded by the reticular fiberous skelteon. Marawand Reef, M44, x 5.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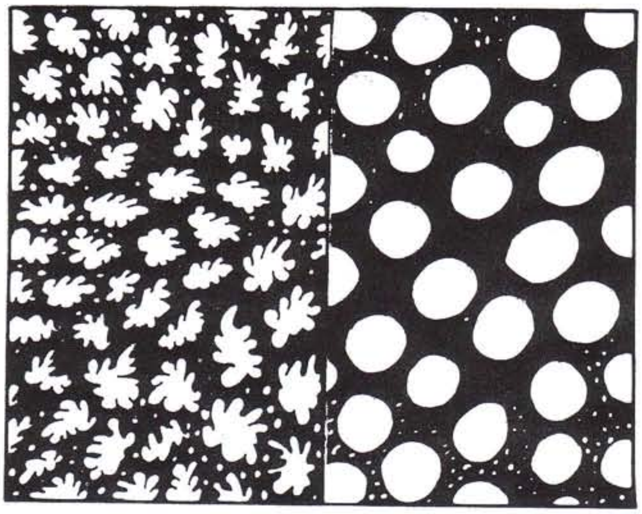


Fig. 7 - The perforation pattern in the outer surface of *Permocorynella maxima* n. sp. Left, the star-like openings in the outer dermal layer. Right, surface from which the dermal layer has been removed shows circular openings that represent inhalant pores in cross section. The skeletal fibers, between, are pierced by very small pores or canal system in both parts. Not to scale.

second system appear as radially arranged canals that open into the spongecoel or to the exterior of sponge (Pl. 3, fig. 4-5, 8). Diameter of both kinds of canals ranges between 0.7 mm and 1 mm, and up to a maximum of 1.5 mm.

The skeleton is recrystallized and is composed of neomorphic calcite. Microstructure of the skeletal fibers, as well as, whether spicules were present, is not known.

Discussion. The affiliation of Triassic species of *Corynella* listed by Zittel (1878, p. 126) and those species which are described later by Vinassa (1901, 1908, 1915) and Wilckens (1937) to *Permocorynella* were discussed above. *Permocorynella maxima* n. sp. differs from *Corynella rauffi* described by Vinassa (1901) by having a cylindrical or conical shape (globular in *C. rauffi*), and by differences in sizes of the sponges and the spongocoel. *Corynella magnifica* Wilckens (1937) differs from the Iranian species by being of small size and having a small spongocoel. Dieci et al. (1968) have described two sponge species from the Carnian Cassian reef boulders of Dolomites/Italy as *Corynella penetrata* and *Corynella* sp.. Compared to *Permocorynella maxima,* both species from the Cassian boulders are much smaller. Dieci et al. (1968, p. 122, 123) cite maximum diameters of 15 mm for *Corynella penetrata* and 13 mm for *Corynella* sp..

Permocorynella is very rare within the Norian-Rhaetian reef limestones ("Dachsteinkalk"-reefs) and is known poorly from this time interval. Wurm (1982, p. 217, pl. 35, fig. 1) described an inozoid sponge as *Corynella* sp. from the Norian Dachsteinkalk-reef limestone of Gosaukamm (Austria). The maximum diameter of the Austrian species given by Wurm is 32 mm. We found another species from the same locality that has a diameter of 65 mm. Because of the large dimensions of those Austrian specimens we think they should be asssigned to *Permocorynella maxima* n.sp.

Di Stefano et al. (1990, pl. 1, fig. 1) figured an inozoid sponge from Norian-Rhaetian reef limestones of Monte Genuardo (western Sicily) as *Precorynella* sp.. It is characterized by a single axial spongocoel and belong also to the genus *Permocorynella*. The Sicilian species differs from *Permocorynella maxima* by having a densely packed fiber structure and by its relatively small exhalant and inhalant canals.

Occurrence and stratigraphic range. *Permocorynella* is known from the Lower-Upper Permian of Sicily (Parona, 1933; Flügel et al., 1991, pl. 46, fig. 1, described as *Corynella ovoidalis,* and our own unpublished material from Lower Permian); and from the Upper Permian of Djebel Tebaga (Rigby & Senowbari-Daryan, 1996). Flügel et al. (1984, p. 203, pl. 38, fig. 1) have

PLATE 4

Fig. 1-7 - ?*Sestrostomella robusta* Zittel from Upper Triassic (Norian-Rhaetian) reefs within the Nayband Fomation in Central-Iran

Fig. 1 - Oblique and transverse sections through three (two?) specimens that are partly fused (upper part, left). They show axial canal bundles and the reticular distinct, upwardly divergent skeletal fibers within the sponge wall. Delijan Reefs, thin section P/137/11/2, x 2.5.

Fig. 2 - Oblique section through a branched specimen shows the axial canal bundle, and inhalant and exhalant canals. Delijan Reefs, thin section P/224/3, x 2.5.

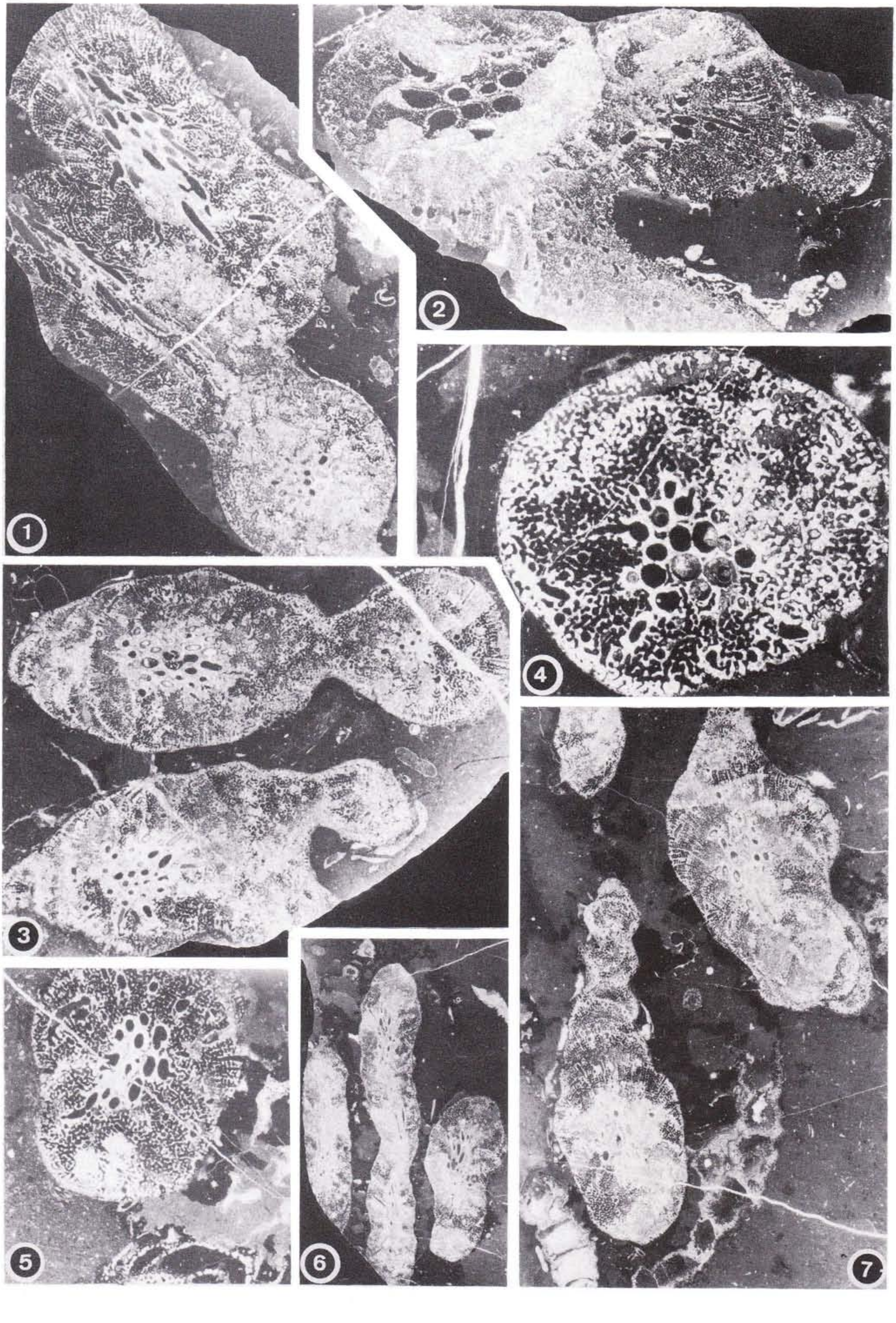
Fig. 3 - Oblique and transverse sections through two or three specimens (similar to fig. 1) show their axial canal bundles which are fused in the upper part. Indistinct segmentation in the oblique section, in the upper left, represents growth stages. Delijan Reefs, thin section P/207/4, x 2.5.

Fig. 4 - Transverse section exhibits the axial canal bundle, with one central canal and seven others around it, some of which are smaller. Ali-Abad Reefs, thin section P/92/2, x 6.

Fig. 5 - Oblique section shows the axial bundle of canals, indistinct inhalant canals in the peripheral part, and skeletal fibers with indistinct, upwardly divergent, arrangement. A sphinctozoid sponge is cut in the lower part of the picture. Delijan Reefs, thin section P/207/2. x 9.

Fig. 6 - Section through three parallel specimens shows characteristics of the species. Delijan Reefs, thin section P/207/3, x 1.

Fig. 7 - Oblique sections through 2 specimens showing their axial canal bundles, and their thick sponge walls with upward divergent skeletal fibers. Inhalant and exhalant canals are well developed in both specimens. Indistinct segmentation, visible in the specimen in upper part, represents growth stages. Sections of two sphinctozoid sponges show in the lower part. Delijan Reefs, thin section P/207/5, x 2.5.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described an inozoid sponge from the Middle Permian reef limestones of Bled/Julian Alps (Slovenia) as *Corynella fabianii*, which can not be assigned to the genus *Permocorynella*.

Permocorynella has not been reported from the Middle Triassic deposits until now. Representatives of the genus are relatively abundant in Carnian Cassian reef boulders wihtin the Cassian Formation (Dolomites/Italy). Occurrences of *Permocorynella* in other Upper Triassic localities were discussed before.

Permocorynella is, perhaps, the most abundant inozoid sponge genus in the reefs and reefal limestones within the Nayband Formation in central Iran. It was found in all investigated material, but it is more abundant in the Marawand reef and in the Naybandan area than in other mentioned localities.

Family *Sestrostomellidae* Laubenfels, 1955

Diagnosis: "Parenchymal fibers comprising triactines and tetractines of variable size and shape, as well as occasional diactines. Paragaster cavity present or lacking; in the latter case it is replaced by set of apochetes" (Hurcewicz, 1975, p. 249). For more infomation about the spicular and fiber skeleton of the type genus (*Sestrostomella*) see Reitner (1992) and the following remarks.

Subfamily *Precorynelliinae* Termier & Termier (in: Termier et al., 1977) genus *Sestrostomella* Zittel, 1878

Diagnosis: "Schwamm einfach, häufiger zusammengesetzt, bushig oder aus warzigen Individuen gebildet, die auf gemeinsamer Basis stehen. Einzelindividuen deutlich geschieden, cylindrisch keuleförmig oder halbkugelig, auf dem Scheitel mit einem seichten, zuweilen gestrahlen Osculum, in welchem eine grössere Anzahl runder Ostien von verticalen, röhrenförmigen Ausfuhrcanälen münden. Oberfläche porös, nackt oder an der Basis, zuweilen auch auf einem Theil der Seiten mit Dermalschicht bekleidet" (Zittel 1878, p. 40).

Type species: *Sestrostomella robusta* Zittel, 1878.

Additional species (Triassic): *Sestrostomella aureolata* Dieci, Antonacci & Zardini, 1968.

In additon to Triassic representatives, other species have been described from Jurassic deposits (e. g. *Sestrostomella wartae* Hucewicz, 1975) which are not taken in consideration in this paper.

Remarks. In addition to the representatives of the genus *Sestrostomella*, which possesses an axial canal bundle, other inozoid and *Sestrostomella*-like sponges with similar characteristics also occur in Triassic reefs. These are assigned to the genera *Precorynella* Dieci, Antonacci & Zardini (1968) and *Stollanella* Bizzarini & Russo (1986). Most probably the skeletal mineralogy of *Stollanella* was composed of Mg-calcite and, therefore, can be differentiated relatively easy from the other two genera by its light colour in rock surfaces, or its dark colour in thin section. However, *Sestrostomella* and *Precorynella* may be confused very easily and separation of two genera needs special attention. This sponge was determinated as *Precorynella* sp. by Senowbari-Daryan (1996). The differences between all three genera, mentioned above, are discussed by Bizzarini & Russo (1986, p. 131-132).

Two sponge species were assigned to the genus *Sestrostomella* by Zittel (1878): *Palaeoierea gracilis* Laube (1865) (not with "j"as written *Paleojerea* incorrectly in Zittel, 1878, not *Palaeojerea* Gerth (1927): and *Sestrostomella robusta* Zittel (1878). The type material of *Palaeoierea gracilis* of Laube was investigated by Senowbari-Daryan (1990, p. 127). He concluded that *Palaeoierea gracilis* is a sphinctozoid sponge and placed it in synonymy with *Thaumastocoelia cassiana* Steinmann. Therefore *Sestrostomella* is a monospecific inozoid sponge genus for a long time.

According to Ziegler & Rietschel (1970) the spicular skeleton of *Sestrostomella* is composed of regular tripods, in addition to three-rayed tuning-fork spicules. Re-

PLATE 5

Fig. 1-7 - *Marawandia iranica* n. gen., n. sp., an inozoid sponge from Upper Triassic (Norian-Rhaetian) reefs within the Nayband Formation in central Iran.

Fig. 1 - Cross section through a specimen (lower part) exhibiting 7 canals (one axial and 6 symmetrically arranged in peripheral part) of almost the same size. The outer wall and its labyrinthic canal system are clearly shown. Longitudinal(?) or transverse(?) section or the branched point of a specimen (upper part) shows numerous circular canals, a well defined outer wall with a labyrinthic canal system, and the loose, relatively coarse fiberous skeleton in the sponge interior. 1) A specimen of "chaetetid" sponge, 2) sessile brachiopods growing on the sponges, and 3) a worm tube. Delijan Reefs, thin section P/330/2, x 10.

Fig. 2 - Transverse section through a specimen exhibiting 8 internal canal outer wall with labyrinthic canal system, and the loosely packed skeletal fibers within the sponge interior. The internal canals also show their own walls pierced by pores. Delijan Reefs, thin section P/324/1, x 16.

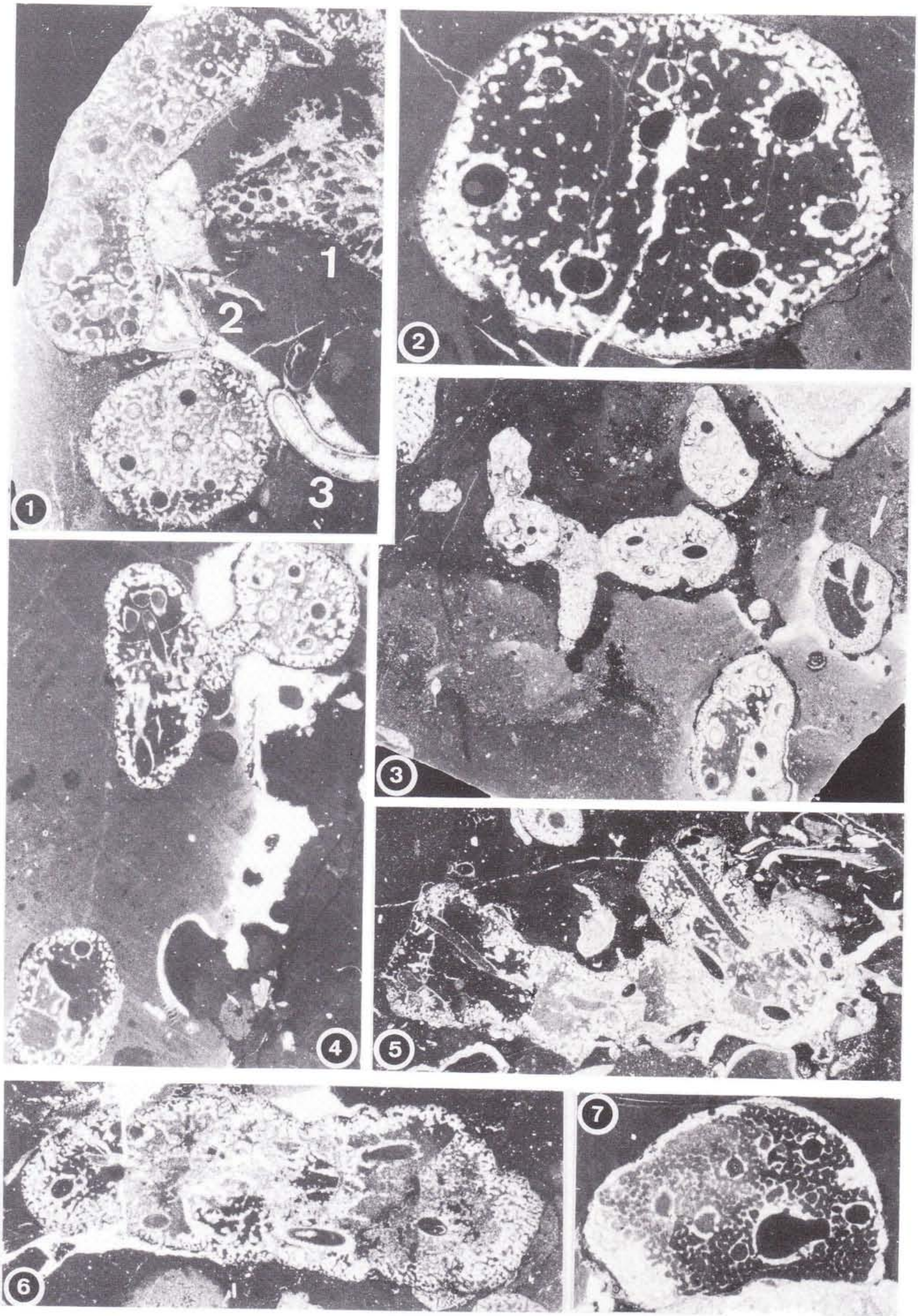
Fig. 3 - Transverse and oblique sections through several specimens. The arrow points to an inozoid sponge (gen. et sp. indet.) with a wide spongocoel, and a thin wall with a labyrinthic canal system. Delijan Reefs, thin setion P/308/2, x 5.

Fig. 4 - Transverse and oblique sections through three specimens, one in the lower part shows only one canal in the peripheral part of the sponge. Delijan Reefs, thin section P/324/1, x 10.

Fig. 5 - Longitudinal to oblique section of a branched specimen shows several exhalant canals surrounded by skeletal fibers. Delijan Reefs, thin section P/332/1, x 7.

Fig. 6 - Holotype. Oblique section exhibits the internal canals (at least 6) surrounded by skeletal fibers and the outer wall with a labyrinthic canal system. The canals each have a distinct wall. Marawand Reef, thin sction M/73, x 7.

Fig. 7 - Cross section through a specimen exhibits one large and several smaller canals each with its own wall, the loose reticular skeletal fibers of the wall interior and the dense outer wall. Marawand Reef, thin section M/108, x 8.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itner (1992, p. 253) reported, however, that the spicular skeleton of *Sestrostomella* is composed of diactines, which are arranged in spicule tracts limited to the center of skeletal fibers (see the diagnosis of the family Sestrostomellidae above). The skeletal fibers of *Sestrostomella* is composed of spherulites of different sizes. According to Reitner (1992) *Sestrostomella* is not a calcisponge and because of the arrangment of diactine spicules, *Sestrostomella* shows a relationship to the haplosclerid sponges Oceanapiidae.

Morphologic characteristics of these sponges from Nayband Formation, described below, correspond to those of *S. robusta*, known from Carnian reef boulders within the Cassian Formation in the Southern Alps/Italy. However, neither spicular skeleton nor spherulitic microstructure can be proven in the Iranian material. Assignment of the Iranian speceis to *Sestrostomella* is based on morphological criteria, therefore certain affiliation of this sponge to *Sestrostomella* and the systematic position of *Sestrostomella* remains a question of discussion.

?**Sestrostomella robusta** Zittel, 1878

(Pl. 4, fig. 1-7, Pl. 6, fig. 6, Pl. 8, fig. 6)

1878 *Sestrostomella robusta* n. sp.- Zittel, p. 41, pl. 2.
1968 *Sestrostomella robusta* Zittel.- Dieci, Antonacci & Zardini, p. 131-132, pl. 25, fig. 3a- 5, pl. 26.
1974 *Sestrostomella robusta* Zittel.- Wendt, p. 507, fig. 6.
1982*Sestrostomella robusta* Zittel.- Turnsek, Buser & Ogorelec, pl. 9, fig. 1-2.
1991 *Sestrostomella robusta* Zittel.- Riedel & Senowbari-Daryan, fig. 1/a.
1992 *Sestrostomella robusta* Zittel.- Reitner, p. 252, pl. 47, pl. 48, fig. 1-3, Fig. 75.
1996 *Precorynella* sp.- Senowbari-Daryan, pl. 1, fig. 6.

Description. These single, cylindrical or dichotomously branched sponges have diameters of 10 - 15 mm, and reach a heights of more than 60 mm. The true heights of the sponges was surely more than 60 mm because all of specimens are broken pieces or they are cut obliquely in thin sections.

The outer surface of sponge is smooth and coarsely annulated in distances of less than 10 mm. Evidence of this outer annulation continues, like in *Permocorynella maxima* n. sp. into the interior of the sponge and gives a coarse and indistinct "segmentation" similar to that in sphinctozoid sponges (Pl. 4, fig. 3, 6). We interpret these annulations as breaks betwee/ growth pulses. Transverse and longitudinal sections show a very thin indistinct outer wall, which is formed by dense packing of fibers of the skeleton.

An axial bundle of 10-20 small individual tubes, which are circular or oval in outline passes, through the whole sponge body. Diameters of individual tubes range between 0.6 and 0.8 mm, with a maximum of 1.0 mm. Each tube has wall that is pierced by pores, which connecting the tubes with interfiber spaces. In some cases, concentric and symmetrical arrangements of the tubes were observed (Pl. 4, fig. 4). In most cases the large tubes are in the center of the bundle, and small tubes in the peripheral parts of the bundle (Pl. 4, fig. 3-4). A thin wall is usually formed between the individual tubes (Pl. 4, fig. 1-5), and in some cases a reticular skeletal fibers occupy intertube spaces (Pl. 6, fig. 6).

A thick sponge wall is developed around the axial canal bundle. That wall is formed of the fine skeletal fibers of reticular type. Longitudinal and oblique sections show arrangements of fibers, which are oriented water-jet-like, and one upwardly divergent toward the outer surface of the sponges (Pl. 4, fig. 1, 3, 7). Cross sections show the fibers as indistinctly radially arranged appearance (Pl. 4, fig. 3, 5). Some inhalant and exhalant canals may occur between the skeletal fibers (Pl. 4, fig. 2, 5, 7, Pl. 6, fig. 6). Both the microstructure of the rigid skeleton and the spicular skeleton are not known.

Occurrence and stratigraphic range. *Sestrostomella* is a typically Jurassic-Cretaceous sponge. The species *S. robusta* has been described only from the Carnian reef

PLATE 6

Fig. 1-7 - The inozoid sponges *Marawandia*, *Permocorynella* and ?*Sestrostomella* from Upper Triassic (Norian-Rhaetian) reefs within the Nayband Formation in central Iran.

Fig. 1-4, 7 -*Marawandia norica* n. gen., n. sp.

Fig. 1 - Oblique section through a specimen shows several exhalant canals, each with its own wall, and the reticular skeletal fibers. Delijan Reefs, thin sectin P/308/2/1, x 8.

Fig. 2 - Transverse and oblique sections through two specimens show the characteristics of the species. Marawand Reef, thin section A/8, x 10.

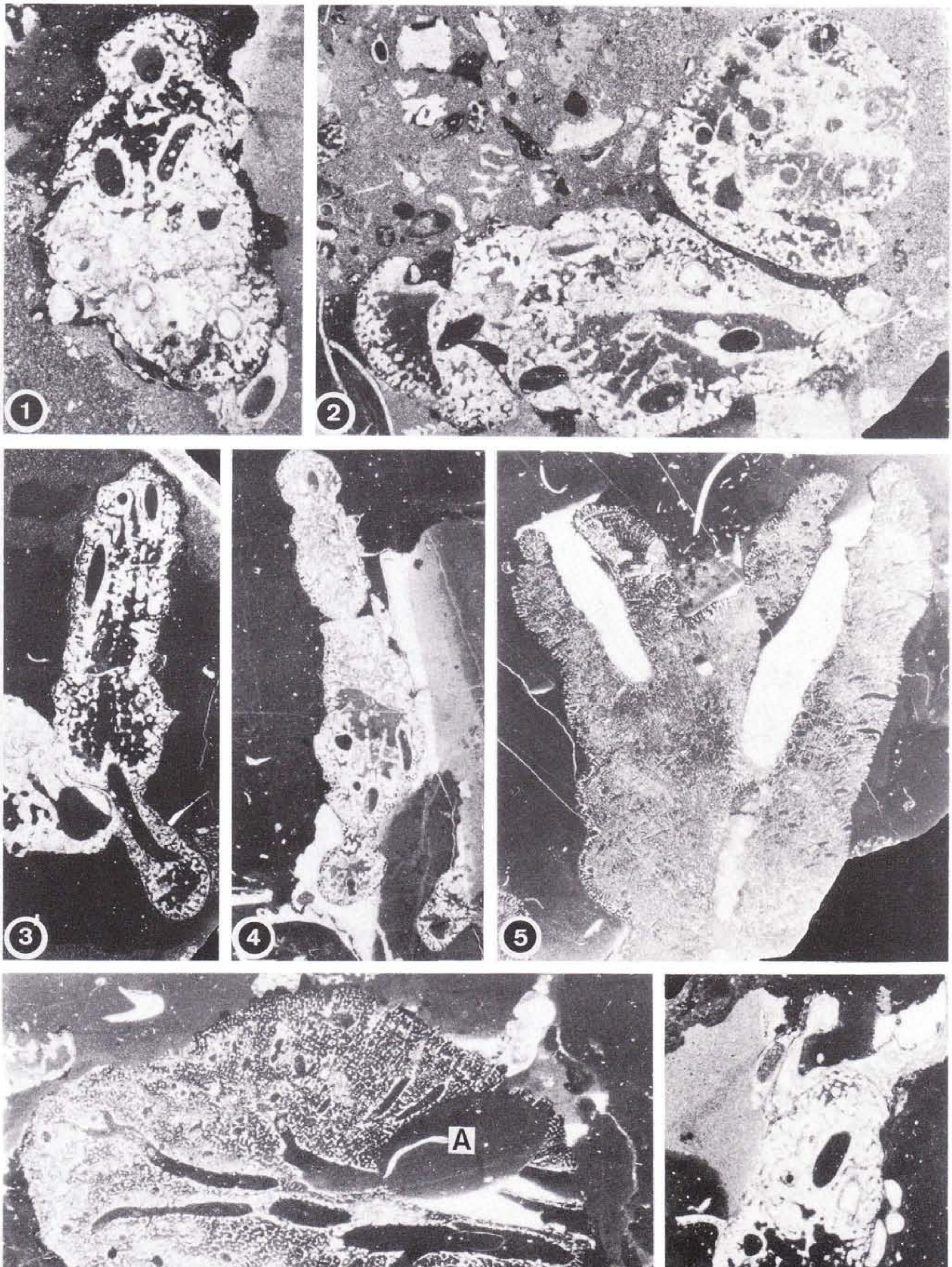
Fig. 3 - Oblique to longitudinal section through a specimen showing the relatively large exhalant canals. Marawand Reef, M/73, x 5.

Fig. 4 - Section similar to fig. 3. Delijan Reefs, thin section 324/4, x 4.

Fig. 7 - Oblique section shows the relatively large internal canals and the distinct outer wall with a labyrinthic canal system. The sponge was overgrown by brachiopods (upper and left part) and worm tubes (right part). Delijan Reefs, thin section P/308/2/1, x 8.

Fig. 5 - *Permocorynella maxima* n. sp. Longitudinal to oblique section through a branched specimen exhibits, each branch with a relatively wide axial tube filled with spary calcite cement, and inhalant and exhalant canals with skeletal fibers between them. Delijan Reefs, thin section P/301/1, x 2.5.

Fig. 6 - ?*Sestrostomella robusta* Zittel. Oblique section shows the axial tube bundle, inhalant and exhalant canals, and the reticular skeletal fibers in the sponge wall. The cavity (A) filled with micrite is a result of boring activity. Delijan Reefs, thin section P/324/2, x 6.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boulders imbedded within the Cassian Formation in the Southern Alps, Dolomites/Italy (Dieci et al., 1968; Wendt, 1974; Riedel & Senowbari-Daryan, 1991; Reitner, 1992). Turnsek et al. (1982) have described this sponge from the Carnian *Amphyclina*-beds in Slovenia. Kovacs (1978) has described a questionable *Sestrostomella* from the West-Carpathian which differs from *S. robusta* by having a lower number of axial tubes. *Sestrostomella* is not known from Norian-Rhaetian reefs either in the Alps or from other localities (e. g. Sicily, Turkey, Oman, etc.).

The occurrence of *Sestrostomella* in Iran is the first report of the genus in Norian-Rhaetian deposits. We found it in the Marawand Reef, in reefs exposed in the southern area of the village of Delijan (Delijan Reefs), and in reefs near the village of Ali-Abad (Ali-Abad Reefs) and Naybandan areas (Naybandan Reefs).

The genus *Sestrostomella* has been reported from Carnian-Norian and from Jurassic-Cretaceous deposits. The relationship of the Triassic sponges known as *Sestrostomella* with those representatives from the Jurassic-Cretaceous remains uncertain.

Subfamily *Heptatubispongiinae* Rigby & Senowbari-Daryan, 1996

genus *Marawandia* n. g.

Derivation of name: Named from the small town of Marawand, the nearest village to the sponge locality, called "Marawan Reef" in this paper (see Fig. 4).

Diagnosis: Cylindrical, branched inozoid sponge with several (up to 10) exhalant tubes, usually of the same size and not located in the axial part of the sponge, that pass through the sponge. Each tube has its own wall pierced by openings leading to the sponge interior. Outer surface of the sponge is characterized by a distinct wall perforated by a labyrinthic canal system. Loosely packed skeletal fibers of reticular type fill the interior of the sponge body. Microstructure, as well as spicular skeleton, is not known.

Type species: *Marawandia iranica* n. sp.

Remarks. The following inozoid sponge genera are characterized by possession of several tubes that pass through the sponge body:

Triassic: *Sestrostomella* (Zittel, 1878), *Precorynella* (Dieci, Antonacci & Zardini, 1968), *Preeudea* (in: Termier et al., 1977), *Polysiphonella* (Russo, 1981; not *Polysiphonella* Belyaeva, 1991 in Boiko et al., 1991, see Senowbari-Daryan & Ingavat-Helmcke, 1994), and *Stolanella* (Bizzarini & Russo, 1986).

Permian: *Intratubospongia* (including: *Paracorynella* and *Paristellispongia*, in Wu, 1991), *Grossotubenella* (Rigby, Fan & Zhang, 1989), *Ramostella* (Rigby & Senowbari-Daryan, 1996), *Heptatubispongia* (Rigby & Senowbari-Daryan, 1996), *Medenina* (Rigby & Senowbari-Daryan, 1996), *Polytubifungia* (Rigby & Senowbari-Daryan 1996), and *Pseudohimatella* (Rigby & Senowbari-Daryan, 1996).

In contrast to *Marawandia*, the Triassic genera *Sestrostomella*, *Precorynella*, and *Stolanella* have the tubes located as a bundle in the axial part of sponge. *Polysiphonella* and the Permian genera *Intratubospongia*, *Pseudohimatella*, and *Polytubifungia* differ from *Marawandia* by possession of numerous small tubes which are distributed throughout the whole sponge body. In addition, these genera do not have a labyrinthic canal system in the outer sponge wall, as a characteristic feature of *Marawandia*. *Marawandia* is similar to *Heptatubispongia* (*H. symmetrica*) described from the Upper Permian of Djebel Tebaga, southern Tunisia. *Heptatubispongia* occurs also in Carboniferous Auernig beds in the Carnic Alps

PLATE 7

Fig. 1-5 - *Permocorynella maxima* n. sp., *Enaulofungia? triassica* n. sp., and *Marawandia iranica* n. gen., n. sp. from Upper Triassic (Norian-Rhaetian) reefs within the Nayband Formation in central Iran.

Fig. 1 - *Permocorynella maxima* (holotype). Longitudinal section exhibits the relatively wide axial spongocoel, inhalant and exhalant canals that are upwardly divergent and also parallel to the growth stages (parallel to the sponge summit), and the skeletal fibers between the canals. Indistinct outer annulation continue as dark lines into the sponge wall, documenting breaks in growth. Nayband Reefs, polished slab, PE/1 x 1.2.

Fig. 2 - *Permocorynella maxima* n. sp. (holotype). Reverse side specimen shown in fig. 1. The outer surface shows the indistinct annulation and the star-like openings in the dermal layer. x 1.1

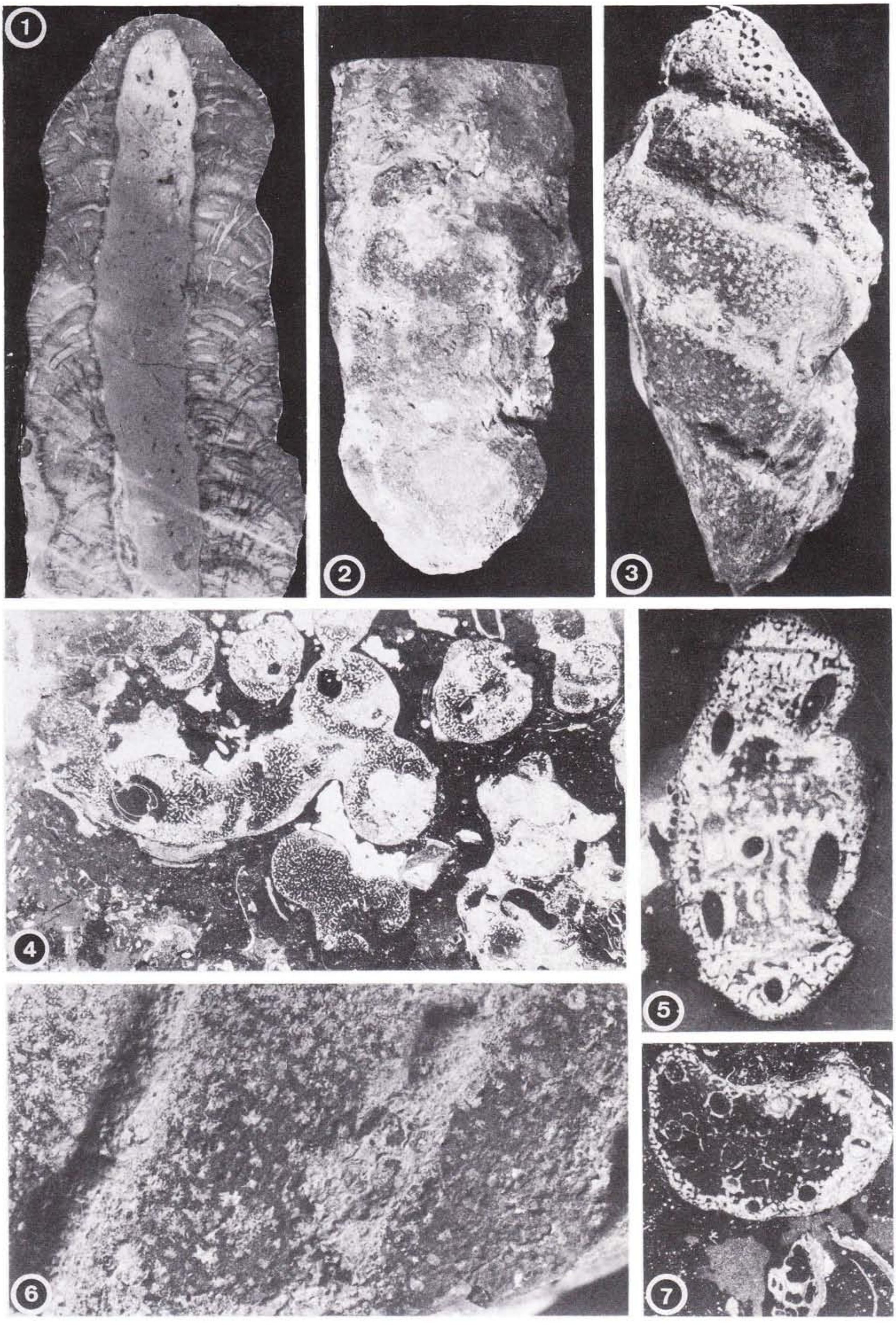
Fig. 3 - *Permocorynella maxima* n. sp.. The natural weathered outer surface of a paratype exhibits the outer annulations, the star-like openings produced by ostia in the dermal layer (in the middle part, compare fig. 6), and circular pores corresponding to outlines of inhalant tubes in cross section (upper part), where the dermal layer is weathered away. Naybandan Reefs, P/2, x 1.6.

Fig. 6 - Enlagement of part of fig. 3 shows the star-like openings on the exterior and the granular structure of the fiberous skeleton in the interior (left part). x 4.

Fig. 4 - *Enaulofungia? triassica* n. sp.. Cross and oblique sections through several branched specimens. Some of them exhibit a star-like axial canal. Large "cavities", filled by micritic sediment or cement, are results of boring activities. Ali-Abad Reefs, thin section T/25D, x 5.

Fig. 5 - *Marawandia iranica* n. gen., n. sp.. Oblique section showing the outer annulation, the exhalant canals and the fiberous skeleton in the interior of the sponge. Marawand Reef, thin section 110/9/A, x 8.

Fig. 7 - *Marawandia iranica* n. gen., n. sp.. Cross section exhibits the well preserved, loosely packed, skeletal fibers in the sponge interior, the outer wall with labyrinthic canal system, and the exhalant tubes. Delijan Reefs, thin section P/308/1, x 10.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(Austria), as well as in Lower Permian reef boulders imbedded in the Lercara Formation in western Sicily (personal material, not published). The Paleozoic genus *Heptatubispongia*, however, is characterized by a large axial tube and usually 6-8 small tubes that are arranged concentrically and symmetrically in the peripheral part of the sponge, around the main canal that is located in the axial part. Further differences between two genera include the loose skeletal fibers and the distinct outer wall developed in *Marawandia*. The outer surface in *Heptatubispongia* bears a few ostia but it is labyrinthically perforated in *Marawandia*.

Marawandia iranica n. sp.

(Pl. 5, fig. 1-7, Pl. 6, fig. 1-4, 7, Pl. 7, fig. 5, 7)

Derivation of name: Named for the occurrence of the sponge in several Norian-Rhaetian reef localities in Central Iran.

Holotype: Longitudinal section figured in Pl. 5, fig. 6.

Paratypes: All specimens illustrated in Pl. 5, fig. 1-7, Pl. 7, fig. 1-4, 7, Pl. 7, fig. 5, 7.

Type localitiy: Small reef near the town of Marawand (Marawand Reef), in central Iran (see Fig. 4, Pl. 9, fig. 5).

Type level: Norian-Rhaetian reef limestones within the Nayband Formation.

Material: Numerous specimens in more than 20 thin sections from the type locality (Marawand Reef), and from the Naybandan area (Naybandan Reefs), Delijan Reefs, and from the Mahallat Reefs.

Diagnosis: see diagnosis of the genus.

Description. This cylindrical and dichotomously branched inozoid sponge is characterized by the possession of several (up to 10) exhalant canals passing through the sponge body. Individual canals are usually of the same size, but canals with different sizes may occur in the same specimen. The canals do not show a definite distribution pattern within the sponge interior, but in one case a strictly symmetrical arrangement of the tubes was observed (Pl. 5, fig. 1: cross section in the lower part). Each canal has a wall that is pierced by openings, which lead to spaces between skeletal fibers in the sponge interior. One cross section of a specimen shows only one canal (Pl. 5, fig. 4: specimen in lower part). This could be a section through the younger part of a sponge where skeletal elements are not formed completely. Internal diameters of the canals generally range from 0.4 to 0.8 mm in the same specimen. The maximum diameter of the canals is 1 mm.

The outer surface of the sponge is annulated in some specimens, but internal segmentation is lacking totally (Pl. 5, fig. 6, Pl. 7, fig. 5). Annulations on the exterior could point to the breaks in growth stages. The external surface is characterized by a distinct wall produced by densely packed skeletal fibers. The outer wall is pierced by a labyrinthic branched canal system. Loosely packed skeletal fibers of reticular type fill spaces between the canals in the interior of the sponge.

Individual stems reach diameters of approximately 4 mm, and up to 6 mm at branching points. The maximal height of the sponge is 18 mm (thin section P/332/1). The holotype (Pl. 5, fig. 6) is 5 mm in diameter and 15 mm tall.

The sponge interior is occupied by relatively coarse and loosely packed skeletal fibers surrounding the internal canals. Vesiculae or other skeletal elements between the fibers and elsewhere in the interior of canals are lacking. Skeletons of *Marawandia* are recrystallized, pointing out a most probably aragonitic original skeleton. Microstructure and any possible spicular skeleton are not known.

Occurrence. *Marawandia iranica* n. gen., n. sp. is one of the most abundant sponge species in the reefs and reefal limestones within the Nayband Formation in central Iran. In additon to the type locality (Marawand Reef near the town of Marawand, see Fig. 4), the sponge was found also in the Naybandan area (Naybandan- and Ali-Abad Reefs), in reefs in the southern part of the village of Delijan (Delijan Reefs), and in western area of Delijan (Mahallat Reefs). It is a very abundant sponge species especially in the Marawand Reef.

PLATE 8

Fig. 1-5 - *Enaulofungia? triassica* n. sp., and *?Sestrostomella robusta* Zittel (6) inozoid sponge from Upper Triassic (Norian-Rhaetian) reefs within the Nayband Formation in central Iran.

Fig. 1 - Oblique and transverse sections through several specimens. In most specimens the star-like axial spongocoel is recognizable. A fine reticular fiber skeleton around the spongocoel has indistinct concentric and radially arrangement in the thick sponge wall. An extra inhalant canal system is absent. Delijan Reefs, thin section P/328/1, x 2.

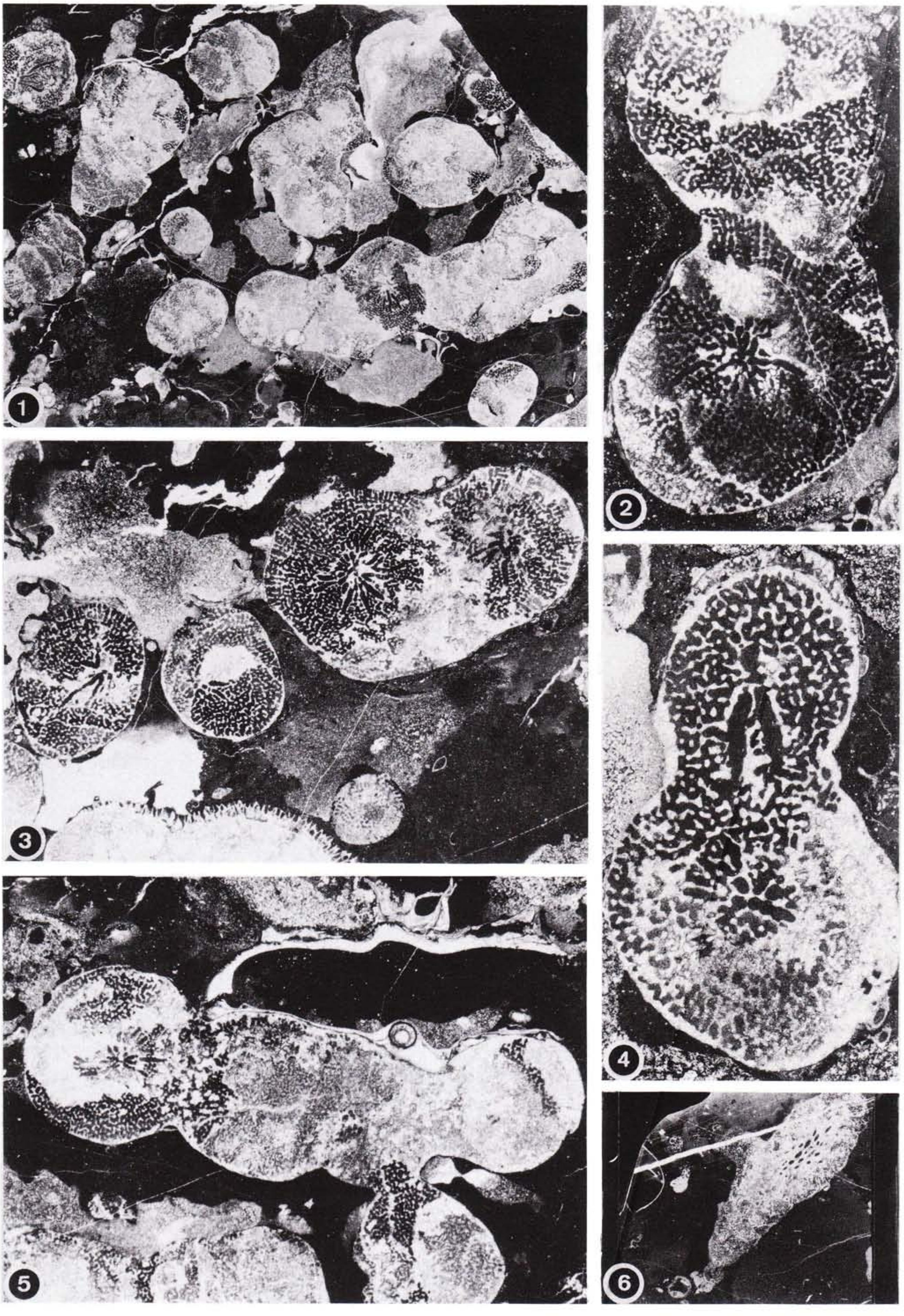
Fig. 2 - Section through a branched(?) stem exhibiting the star-like axial canal in one branch, but with the other one destroyed by boring, and the fine fiberous skeleton around the spongocoel. Delijan Reefs, thin section P/328/2, x 6.

Fig. 3 - Sections through three specimens clearly show the star-like axial spongocoels and the fine reticular fiberouis skeleton within the sponge wall. Delijan Reefs, thin section P/328/1, x 4.

Fig. 4 - Cross section through a specimen (at a branching point?) shows the well developed star-like axial canal and the reticular fiberous skeleton around the canals. Delijan Reefs, P/328/2, x 13.

Fig. 5 - Section through a multibranched(?) specimen. Delijan Reefs, thin section P/328/2, x 4.

Fig. 6 - *?Sestrostomella robusta* Zittel. Oblique section shows the axial canal bundle and some inhalant canals in the peripheral part of the wall. Delijan Reefs, thin section P/207/3, x 1.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Family *Stellispongiidae* De Laubenfels, 1955
Genus *Enaulofungia* Fromentel, 1859

Type species: *Enaulofungia corallina*, Fromentel 1859, p. 48.

Discussion. The systematic assignment of the sponge described below is a subject of controversy. **a)** The majority of morphologically similar or identical sponges with star-like spongocoels, like *Enaulofungia* (Formentel, 1859), *Stellispongia* (D'Orbigny, 1849), *Holcospongia* (Hinde, 1893), *Eusiphonella* (Zittel, 1878), and *Myrmecidium* (Vinassa, 1901) have been described from Jurassic-Cretaceous deposits. **b)** The diagnosis of these genera are not well defined; the independence of individual genera is uncertain, and questions about the synonymy of some genera are inconsistent. **c)** The relationships of similar sponges of Triassic age, on one hand, and those of Jurassic-Cretaceous age, on the other, are not clear. **d)** Finally the establishment of these mentioned genera was based of spicular skeleton, which is lacking or not preserved in the Iranian material.

According to Zittel (1878) *Stellispongia* and *Enaulofungia* are synonyms. Wagner (1964b) discussed this problem in part. According to him, the genera *Enaulofungia* and *Myrmecidium* are identical and *Enaulofungia* has priority. Hurcewicz (1975) discussed this problem again and summarized opinions of previous authors about the genera included in the family Elasmostomatidae. She proposed to keep the genus *Myrmecidium* as an independent genus that differs from other genera of the family by its "spicular composition, structures of parenchymal skeleton and pattern of water system" (Hurcewicz 1975, p. 253). Müller (1984) discussed this problem in detail and proposed to keep *Enaulofungia* and *Stellispongia* as separate and independent genera. He synonymised the genera *Enaulofungia* and *Holcospongia*, which were separeted by Hurcewicz.

The morphologic characteristics, especially the star-like spongocoel, of the Upper Triassic inozoid sponges of Iran, described here, are close to those of the genus *Enaulofungia* (compare Wagner 1964b, p. 25). However, we are not sure about the assignment of our sponge to this genus, because no spicular skeleton has been proven in the Iranian species, and no representatives of *Enaulofungia* have been described from Triassic deposits from other regions. This sponge is assigned with question to *Enaulofungia*.

Enaulofungia? triassica n. sp.

(Pl. 7, fig. 4, Pl. 8, fig. 1-5)

Derivation of name: Named for the occurrence of the new species in Triassic deposits.

Holotype: We designate as holotype the branched specimen cut in cross section and figured in Pl. 8, fig. 3A.

Paratypes: All specimens figured in Pl. 5, fig. 1-5 and in Pl. 8, fig.4.

Type locality: The small biohermal reefs in the southern part of the village of Delijan (Delijan Reefs), central Iran (see Fig. 5, Pl. 9, fig. 3-4).

Type level: Upper Triassic (Norian-Rhaetian) reefs, embedded within the Nayband Formation.

Material: In thin sections P/228/1, P/228/2 und P/330/2.

Diagnosis: Plump, globular to cylindrical and multibranched sponges with an undistinct star-like axial spongocoel produced by convergence of not well developed exhalant canals. A fine reticular fibrous skeleton, with a radially and concentric arrangement in cross section, forms the thick sponge wall. Without inhalant canals. A thin exowall as a cortex cover the outer surface of the sponge. Microstructure, as well as spicular skeleton, is not known.

Description. Individual branches of this multibranched and "colonial" inozoid sponge are plump, globular to cylindrical in shape. Diameters of individual branches range between 4 mm and 10 mm. Lengths of branches generally reach the same dimensions as diameters of the branches.

A thick wall is composed of a fine reticular fibrous skeleton, and surrounds an axial star-like spongocoel. In cross sections the fine reticular fibers of the skeleton are arranged (especially in the peripheral part of the wall) radially and concentrically around the spongocoel (Pl. 8, fig. 2-3). Thicknesses of skeletal fibers range between 0.05 mm and 0.1 mm.

Each branch possesses an axial star-like spongocoel, which passes through the individual branches. The spongocoel is formed by convergence of several exhalant canals in the center of sponge body. Diameters of spongocoels ("stars") are almost 50 % of the sponge diameter (Pl. 8, fig. 2-4). Exhalant canals have diameters of 0.14 - 0.2 mm. Each exhalant canal possesses its own wall (Pl. 8, fig. 3-4), which is approximately 0.08 mm (0.05-0.12

PLATE 9

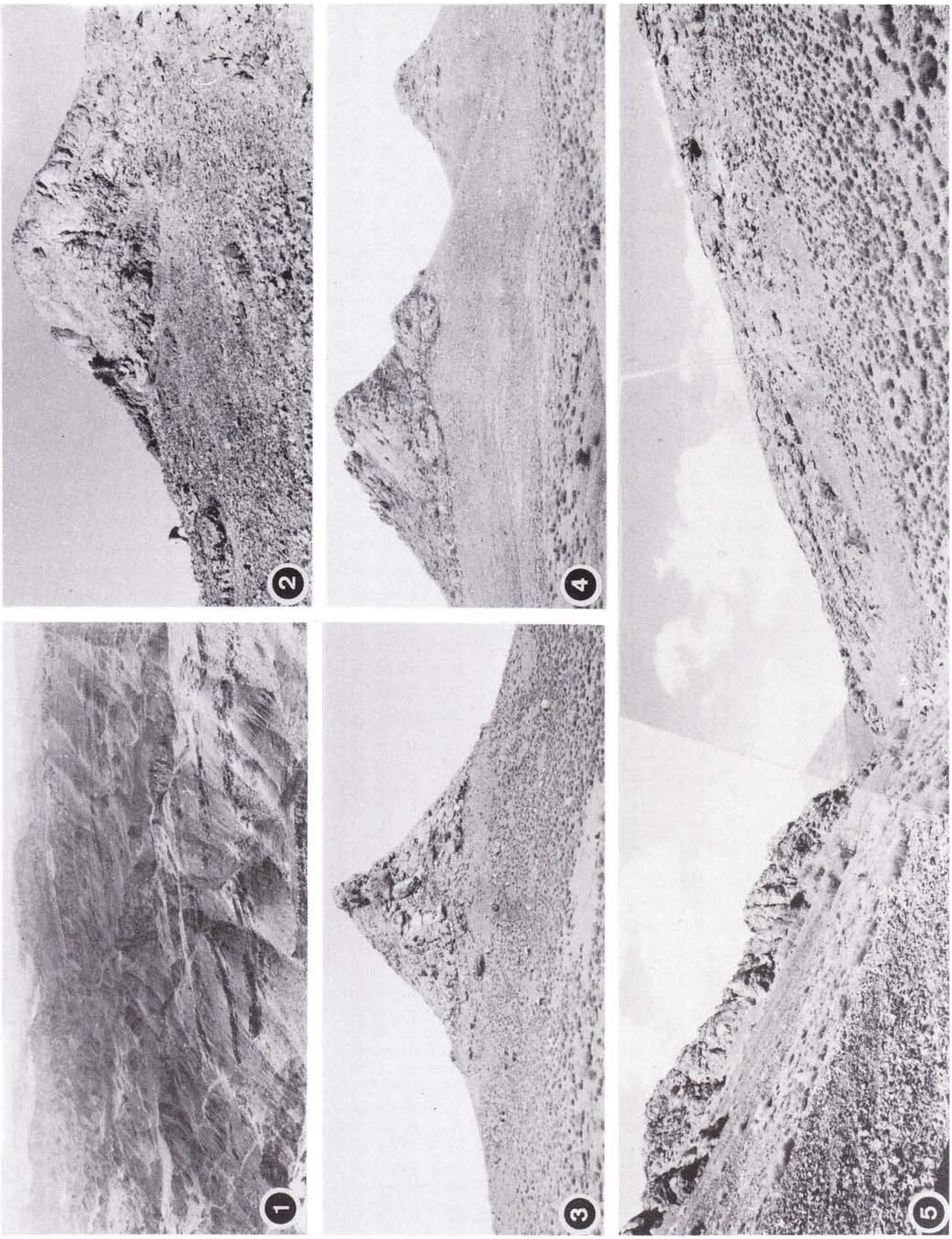
Fig. 1 - View of the Nayband Formation from Kuh-e Nayband in the type locality at the south flank of Kuh-e Nayband in the western area of the small village of Naybandan.

Fig. 2 - A small coral-sponge-bioherm within the Nayband Formation in the type locality, western of the small village of Naybandan.

Fig. 3 - Erosional remnant held up by small bioherm (on the right side of the road from Delijan to Meymeh) within the Nayband Formation in the southern area of Delijan in in central Iran.

Fig. 4 - Two hills held up by small bioherms in the same area as fig. 3.

Fig. 5 - View of the Marawand Reef, which is cut by a small wadi in central Iran.



mm) thick. Large inhalant openings, as well as inhalant canals, are lacking.

A thin dermal layer, reaching a thickness of approximately 0.1 mm (0.06-0.2 mm), covers the outer surface of the sponge (Pl. 8, fig. 3-5). Outer wall have sporadicly occurring pores approximately 0.1 mm in diameter. Because of recrystallization of the skeleton, microstructure could not be determined. A Spicular skeleton is not known.

Occurrence and stratigraphic range. *Enaulofungia? triassica* n. sp. was found in reefs in the southern part of Delijan (Delijan Reefs). Questionable specimens were collected from the neighbouring area in the Marawand Reef. This sponge has not been prevously found in other Upper Triassic reefs in Iran.

According to Laubenfels (1955, p. 97), *Enaulofungia* is limited to the Jurassic-Cretaceous deposits of Europe. The genus is not known from the Triassic Europe or in other regions in the world.

Conclusions.

The sponges (sphinctozoid, inozoid, chaetetid and hexactinellid) are, at least locally, the main reef-builder organisms in the bioconstructions embedded within the shaly siliciclastic-carbonate deposits of the Norian-Rhaetian Nayband Formation which exposed in numerous localities in central Iran (Fig. 1). Inozoid sponges occur with approximately the same diversity and abundance as sphinctozoid types. In all investigated localities, inozoids are associated with other sponges (sphinctozoid and chaetetid), and in Delijan and Marawand Reefs they also occur with hexactinellid group.

Most of the sponges described in this paper represent the most abundant inozoid sponge taxa in Iranian reefs exposed in Nayband Formation in several localities in central Iran.

Permocorynella may be is the most abundant genus among these genera and is found in all localities, except in biostromes in the Kerman area, where sponge diversity is very low and the Nayband Formation reaches an approximately thickness of only 100 m. *Permocorynella* is also an abundant genus in the Permian, especially in Upper Permian reefs in Djebel Tebaga (Rigby & Senowbari-Daryan, 1996). *Permocorynella* is not known as yet from Middle Triassic time. The genus reappears first in the Carnian and seems to be an abundant sponge in Carnian reefs boulders within Cassian Formation in the Southern Alps (Dieci et al., 1968). *Permocorynella* occurs also in Norian-Rhaetian "Dachsteinkalk"-reefs in the Alps, in Sicily, and may be in other localities but its frequency is much less than in Carnian deposits in the Alps or in the Norian-Rhaetian reefs in Iran.

Radiofibra, a *Peronidella*-like inozoid sponge, was first described from Upper Permian reefs of Djebel Tebaga of southern Tunisia by Rigby & Senowbari-Daryan (1996). The Upper Triassic Nayband Formation in Iran ist the first occurrence of this genus in Triassic deposits. This sponge is an abundant reef builder in this area. It is extremely abundant in Marawand Reef near the small town of Marawand (see Fig. 4).

Sestrostomella has been reported until now from Carnian deposits, especially from the reef boulders embedded within the Cassian Formation in the Southern Alps (Dolomite/Italy). The genus has not been reported from the Norian-Rhaetian reefs either in the Alps or in other localities in the world. This is the first report of *Sestrostomella robusta* from the Norian-Rhaetian time. *Sestrostomella* is not known from the Permian deposits.

Marawandia seems to be an endemic sponge, occurring only in Upper Triassic reefs in central Iran. This sponge has not been found in Upper Triassic reefs in the western Tethys (e. g. in Alps, Sicily, Turkey, Oman).

Enaulofungia? triassica n. sp. represents a rare sponge species found in reefs in the southern part of the village of Delijan (Delijan Reefs) and as some questionable specimens in the neighbouring Marawand Reef.

Among the inozoid sponges described in this paper, the genera *Permocorynella* and *Radiofibra,* like some other inozoid or sphinctozoid genera, represent sponges that disappear at the end of the Permian but reappear in the Carnian (*Permocorynella*) or Norian (*Radiofibra*) records. The relationship of Permian and Upper Triassic representatives of both genera as "Lazarus-" (Batten, 1973; Jablonsky, 1986) or "Elvis-Taxa" (Erwin & Droser, 1993) remains uncertain. We will discuss this question in detail later when all sponge taxa of the Norian-Rhaetian reefs in Iran are determinated and described in the further publications.

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