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Hypercalcified Sphinctozoan Sponges from Upper Triassic (Norian–Rhaetian) Reefs of the Nayband Formation (Central and Northeast Iran)

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15 Text-Figures, 8 Tables and 32 Plates

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Inhalt

Hypercalcifizierte sphinctozoide Schwämme aus obertriadischen (Nor–Rhät) Riffen der Nayband-Formation (zentraler und nordöstlicher Iran)

Zusammenfassung

Die obertriassischen (Nor–Rhät) siliziklastisch-karbonatischen Ablagerungen der Nayband-Formation repräsentieren eine der wichtigsten geologischen Einheiten auf der zentraliranischen Platte, welche einen Teil des Kimmerischen Kontinents darstellt. Die Nayband-Formation wird – nach der kimmerischen Tektonik im Karn (wahrscheinlich im oberen Karn, vor 225–220 Mill. Jahren) – an vielen Stellen von den mitteltriassischen Karbonaten der Schotori-Dolomite (Ladin) unterlagert. Stratigraphisch in verschiedenen Horizonten sind innerhalb der Nayband-Formation kleine, norisch–rhätische, von Korallen oder Schwämmen dominierte Riffe eingeschaltet und treten an mehreren Lokalitäten im Zentral- und Nordostiran auf. Eine hochdiverse Invertebraten-Fauna, zusammengesetzt aus Korallen, Schwämmen (Inozoiden, Sphinctozoiden, Chaetetiden, Hexactinelliden und Spongiomorphiden), Bryozoen, Wurmröhren, Foraminiferen, Brachiopoden, Gastropoden, Bivalven, Ostracoden und verschiedene problematische Organismen sowie Algen bilden die Riff-Assoziationen.

Unter den Schwämmen gehören die corallinen Schwämme (Sphinctozoiden, Inozoiden, Chaetetiden und Spongiomorphiden) zu den wichtigsten Rifforganismen in den Biokonstruktionen innerhalb der Nayband-Formation. Vertreter der beiden, gekammerten (Sphinctozoen) und ungekammerten (Inozoen) Gruppen sind die häufigsten Schwämme. Hexactinellide Schwämme treten zwar auch in Riff-Assoziationen auf, sie sind jedoch nicht häufig. Die hexactinelliden Sphinctozoen sind durch einige Taxa vertreten, die in einer separaten Arbeit beschrieben werden.

Die sphinctozoiden Schwämme der obertriassischen Biokonstruktionen innerhalb der Nayband-Formation sind mit 11 Familien (1 neu), 25 Gattungen (5 neu) und mindestens 46 Arten (20 neu) vertreten. Es sind: Fam. Colospongiidae: *Parauvanella ferdowsensis* nov. sp., *Parauvanella delijanensis* nov. sp., *Colospongia iranica* nov. sp., *Colospongia* cf. *C. ramosa* RIEDEL & SENOWBARI-DARYAN, *Colospongia* sp. 1, *Kashanella irregularis* nov. gen., nov.

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sp.; Fam. Sebargasiidae: *Amblysiphonella* cf. *A. steinmanni* (HAAS), *Amblysiphonella najafiani* nov. sp., *Amblysiphonella* sp. 1, *Amblysiphonella* sp. 2, *Amblysiphonella* sp. 3; Fam. Annaecoeliidae: *Annaecoelia? interiecta* SENOWBARI-DARYAN & SCHÄFER, *Annaecoelia? parva* nov. sp.; Fam. Salzburgiidae: *Salzburgia* sp.; Fam. Polytholosiidae: *Nevadathalamia variabilis* nov. sp., *Fanthalamia aksuensis* SENOWBARI-DARYAN, *Cinnabaria minima* SENOWBARI-DARYAN, *Iranothalamia* nov. gen., *Iranothalamia incrustans* (BOIKO); Fam. Solenolmiidae: *Senowbaridaryana raretrabeculata* (BOIKO), *Senowbaridaryana rectangulata* nov. sp., *Paradeningeria alpina* SENOWBARI-DARYAN & SCHÄFER, *Paradeningeria minor* nov. sp., *Welteria hamedanii* nov. sp., *Deningeria* cf. *D. camerata* WILCKENS, *Deningeria tabasensis* nov. sp.; Fam. Intrasporocoeliidae: *Delijania retrosiphonata* nov. gen., nov. sp.; Fam. Cryptocoeliidae: *Cryptocoelia wurmi* SENOWBARI-DARYAN & DULLO, *Antalythalamia?* cf. *A. riedeli* SENOWBARI-DARYAN, *„Stylothalamia" columnaris* (LE MAITRE), *Stylothalami?* sp.; Fam. Tabasiidae nov. fam.: *Tabasia maxima* nov. gen., nov. sp., *Tabasia media* nov. sp., *Tabasia minima* nov. sp., *Tabasia gregaria* nov. sp., *Tabasia? conica* nov. sp.; Fam. Thaumastocoeliidae: *Naybandella prosiphonata* nov. gen., nov. sp., *Pamirothalamia?* cf. *P. originalis* BOIKO, *Phraethalamia irregulara* nov. sp., *Paravesicocaulis naybandensis* nov. sp. und Fam. Alpinothalamiidae: *Uvanella norica* (SENOWBARI-DARYAN & SCHÄFER).

Die Sphinctozoen-Fauna der obertriassischen Biokonstruktionen im Iran hat – mit 56% auf Gattungsebene – die höchste Ähnlichkeit mit den bekannten Sphinctozoen-Faunen aus den Alpen, gefolgt mit 48% aus dem Pamir-Gebirge und 40% aus Griechenland.

Abstract

The Upper Triassic (Norian–Rhaetian) siliciclastic-carbonate deposits of the Nayband Formation represent an important stratigraphic unit in the central Iranian plate as a part of the Cimmerian Continent. The Nayband Formation overlies the Middle Triassic carbonates of the Shotori Dolomite (Ladinian) and was deposited after the Early Cimmerian tectonic event dated during the Carnian time interval (most probably late Carnian, 225–220 Mill. years ago). Small-scale Noria–Rhaetian coral- or sponge-dominated reefs and reefal limestones occur in different stratigraphic levels within the Nayband Formation cropping out in numerous localities in the central and northeast part of Iran. A high diversity of invertebrate organisms, including corals, sponges (inozoids, sphinctozoids, chaetetids, spongiomorphids and hexactinellids), bryozoans, worm-tubes, foraminifers, brachiopods, gastropods, bivalves, ostracods, and different problematic organisms, as well as algae, are associated within the reefs.

Among the sponges the hypercalcified sponges (including sphinctozoids, inozoids, chaetetids and spongiomorphids) are the most important reef organisms producing the bioconstructions within the Nayband Formation. Representatives of both types, chambered and unchambered hexactinellid sponges occur also in association with coralline sponges and other reef building organisms, but they are not abundant. Hexactinellid sphinctozoan sponges are represented by only a few taxa, which will be described separately from this report.

The Upper Triassic sphinctozoan sponge bioconstructors occurring within the Nayband Formation are represented by 11 families (1 new), 25 genera (5 new) and at least 46 species (20 new) as follows: Fam. Colospongiidae: *Parauvanella ferdowsensis* nov. sp., *Parauvanella delijanensis* nov. sp., *Colospongia iranica* nov. sp., *Colospongia* cf. *C. ramosa* RIEDEL & SENOWBARI-DARYAN, *Colospongia* sp. 1, *Kashanella irregularis* nov. gen., nov. sp.; Fam. Sebargasiidae: *Amblysiphonella* cf. *A. steinmanni* (HAAS), *Amblysiphonella najafiani* nov. sp., *Amblysiphonella* sp. 1, *Amblysiphonella* sp. 2, *Amblysiphonella* sp. 3; Fam. Annaecoeliidae: *Annaecoelia? interiecta* SENOWBARI-DARYAN & SCHÄFER, *Annaecoelia? parva* nov. sp.; Fam. Salzburgiidae: *Salzburgia* sp.; Fam. Polytholosiidae: *Nevadathalamia variabilis* nov. sp., *Fanthalamia aksuensis* SENOWBARI-DARYAN, *Cinnabaria minima* SENOWBARI-DARYAN, *Iranothalamia* nov. gen., *Iranothalamia incrustans* (BOIKO); Fam. Solenolmiidae: *Senowbaridaryana raretrabeculata* (BOIKO), *Senowbaridaryana rectangulata* nov. sp., *Paradeningeria alpina* SENOWBARI-DARYAN & SCHÄFER, *Paradeningeria minor* nov. sp., *Welteria hamedanii* nov. sp., *Deningeria* cf. *D. camerata* WILCKENS, *Deningeria tabasensis* nov. sp.; Fam. Intrasporocoeliidae: *Delijania retrosiphonata* nov. gen., nov. sp.; Fam. Cryptocoeliidae: *Cryptocoelia wurmi* SENOWBARI-DARYAN & DULLO, *Antalythalamia?* cf. *A. riedeli* SENOWBARI-DARYAN, *"Stylothalamia" columnaris* (LE MAITRE), *Stylothalami?* sp.; Fam. Tabasiidae nov. fam.: *Tabasia maxima* nov. gen., nov. sp., *Tabasia media* nov. sp., *Tabasia minima* nov. sp., *Tabasia gregaria* nov. sp., *Tabasia? conica* nov. sp.; Fam. Thaumastocoeliidae: *Naybandella prosiphonata* nov. gen., nov. sp., *Pamirothalamia?* cf. *P. originalis* BOIKO, *Phraethalamia irregulara* nov. sp., *Paravesicocaulis naybandensis* nov. sp., and Fam. Alpinothalamiidae: *Uvanella norica* (SENOWBARI-DARYAN & SCHÄFER).

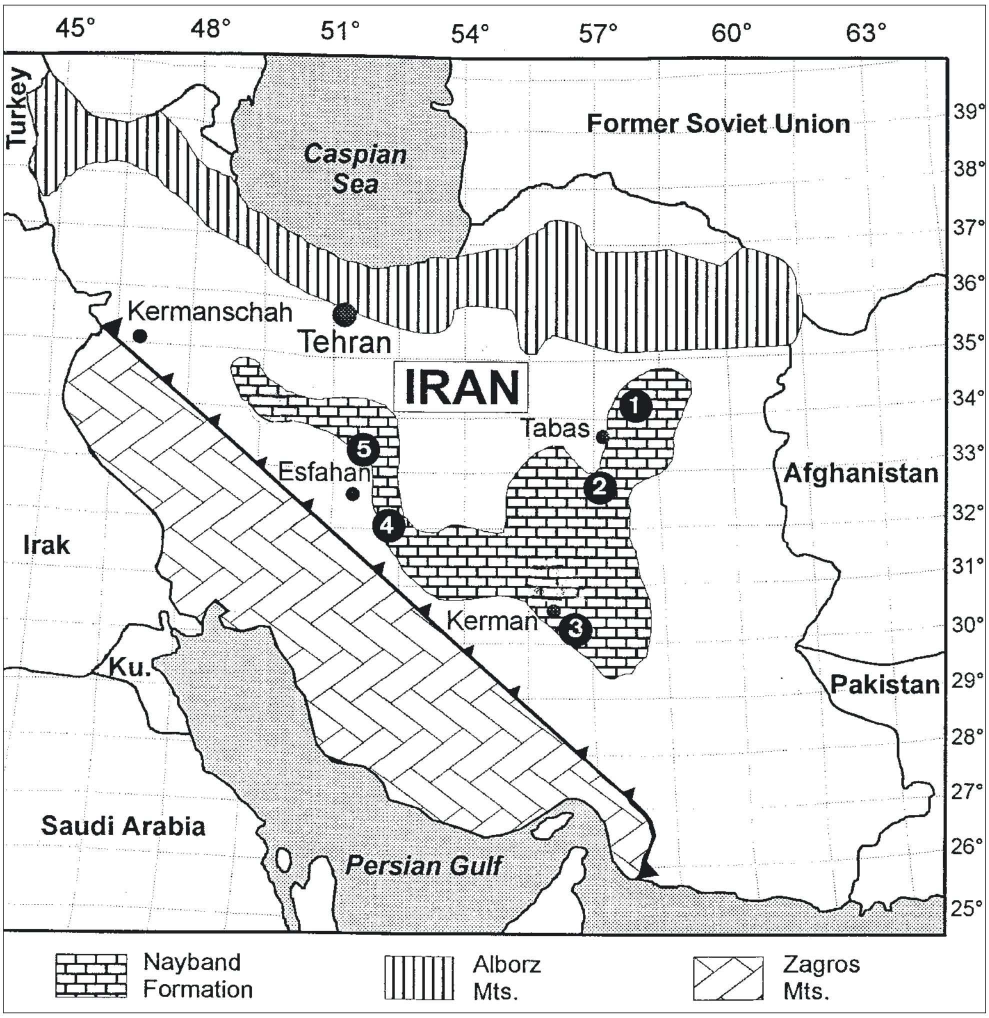
The Upper Triassic sphinctozoan sponge fauna of Iranian bioconstructions has the most similarities – with 56% at the genus level – with the sphinctozoan fauna known from the Alps, followed by that from the Pamir Mountains with 48%, and that from Greece with 40%.

1. Introduction

Detailed investigations on sphinctozoid sponges during the last two decades have shown the polyphyletic nature of this group and, therefore, the term „Sphinctozoa" (STEINMANN, 1882) or „Thalamida" (DE LAUBENFELS, 1955) can not be used as a systemtic category (SENOWBARI-DARYAN, 1989, 1990, 1991; REITNER, 1990; SENOWBARI-DARYAN & GARCIA-BELLIDO, 2002; FINKS & RIGBY in FINKS et al., 2004). The chambered construction of the rigid skeleton is developed in all sponge groups, including demospongids, hexactinellids, calcispongids, heteractinids, and archaeocyathids (WOOD, 1990; SENOWBARI-DARYAN & GARCIA-BELLIDO, 2002). However, the majority of sphinctozoid sponges of the Paleozoic and Triassic Tethys seem to be demosponges (SENOWBARI-DARYAN, 1990; FINKS & RIGBY in FINKS et al., 2004), only few hexactinellid types also occur in Permian (e.g. FINKS, 1960) and Upper Triassic reefs of the eastern (China: X. WU, 1989; WENDT et al., 1989; RIGBY et al., 1998) and central Tethyan realm (BOIKO, 1990; SENOWBARI-DARYAN & HAMEDANI, 1999). Hexactinellid sponges are only sporadically known from Upper Triassic reefs and shallow-water carbonates of the western Tethyan realm (e. g. KEUPP et al., 1989).

Thalamid sponges, in addition to the inozoid and chaetetid groups, are the most important reef builders within the Permian and Triassic reefs, in general, and particularly also in Upper Triassic reefs and reefal limestones within the Nayband Formation in central and northeast Iran. The Upper Triassic (both Carnian as well as Norian–Rhaetian) thalamid sponges are well known from different localities in the western Tethyan realm (e.g. Alps, Carpathians, Sicily, Greece, Turkey), but poorly known from eastern (e.g. WILCKENS, 1937), southern (BERNECKER, 1996; SENOWBARI-DARYAN, BERNECKER, KRYSTYN & SIBLIK, 1999) and northern central Tethys (BOIKO, 1990; BOIKO et al., 1991). A complete literature review and the description of most species were summarized by SENOWBARI-DARYAN (1990). After 1990 several papers about the systematic description of Triassic sphinctozoan sponges and their geographic distribution have been published by several authors (e. g. BOIKO et al., 1991; SENOWBARI-DARYAN et al., 1993; SENOWBARI-DARYAN, 1994a, 1994b, 1994c; SENOWBARI-DARYAN & WURM, 1994; SENOWBARI-DARYAN in STANLEY et al., 1994; SENOWBARI-DARYAN & STANLEY, 1992; STANLEY & SENOWBARI-DARYAN, 1999; SENOWBARI-DARYAN et al., 2001, 2003; SENOWBARI-DARYAN & LINK, 1998; SENOWBARI-DARYAN & ZAMPARELLI, 1999, 2003; REITNER, 1992; SENOWBARI-DARYAN, BERNECKER, KRYSTYN & SIBLIK, 1999; SENOWBARI-DARYAN, ABATE, RENDA & TRAMUTOLI, 1999; BELYAEVA, 2000; FAN et al., 2002). The most important work, however, is the systematic description and geographic distribution of Paleozoic and Upper Triassic sphinctozoan sponges from the Pamirian range published

Text-Fig. 1.
The main structural geology and the distribution of the Nayband Formation in central and northeast Iran. Modified from SEYED-EMAMI (1971).



by BOIKO et al. (1991). Concerning the Triassic sponge fauna, several new taxa were established by these authors from this region. However, poor documentation and partly insufficient description of some taxa make a careful revision of this work necessary. This also applies to the classification and description of Permian sphinctozoid sponges of China published by Y. SH. WU (1991). A complete list of known genera and species of chambered sponges reported up to the year 2000 was given by SENOWBARI-DARYAN & GARCIA-BELLIDO (2002). More information about the occurrence and stratigraphic range of all sphinctozoan and inozoan genera is given by FINKS & RIGBY (in FINKS et al., 2004).

Highly diverse thalamid sponge faunas were collected from the reef and reefal limestones deposited within the Upper Triassic (Norian–Rhaetian) Nayband Formation at different localities in central and northeast Iran (Text-Fig. 1). DOUGLAS (1929) was the first author who published a general work about the invertebrate fossils of Upper Triassic deposits of central Iran. Reports about the sponges are, however, extremely rare from this area (e.g. HUCKRIEDE et al., 1962), although the thalamid sponges (beside other coralline sponge groups) are locally (in sponge dominated reefs) the most abundant reef builders. Detailed investigations of sponges and also some of the other reef organisms of the reefs within the Nayband Formation are totally lacking.

The inozoid sponges of these bioconstructions were described by SENOWBARI-DARYAN et al. (1997) and SENOWBARI-DARYAN (2003a, 2005). The thalamid sponges of the Nayband Formation south of the town Abadeh, central Iran, were described by SENOWBARI-DARYAN & HAMEDANI (1999). Further paleontological works on other Triassic fossils of the Nayband Formation in northeast and central Iran were published recently by NÜTZEL & SENOWBARI-DARYAN (1999), SENOWBARI-DARYAN & HAMEDANI (2000), HAUTMANN (2001), SENOWBARI-DARYAN (2003b), SENOWBARI-DARYAN & MAJIDIFARD (2003), NÜTZEL et al. (2003), SCHÄFER et al. (2003), and CIRILLI et al. (2005). A general review about the Nayband Formation and its depositional environment was carried out by FÜRSICH et al. (2005).

In this paper the thalamid sponges are described in detail. The material investigated is deposited in the Institute of Paleontology, University of Erlangen-Nürnberg (collection SENOWBARI-DARYAN: Triassic of Iran).

2. Upper Triassic Nayband Formation and Geographic Setting of the Localities

The Upper Triassic (Norian–Rhaetian) Nayband Formation was named from the Kuh-e Nayband (Nayband Mount, 3008 m high) on the western area of the small village of Naybandan, approximately 220 km south of the town of Tabas (Text-Fig. 2). The Nayband Formation is one of the most widespread and important geological units that crop out at numerous localities in the central Iranian plate. The deposits of the Nayband Formation are characterized by a series of alternating shales, sandstones and carbonate deposits, reaching a thickness of up to 3,000 m in the type locality on the southern flank of the Kuh-e Nayband (Nayband Mount), about 20 km west of the village Naybandan (BRÖNNIMANN et al., 1971; SEYED-EMAMI, 1971, 2003; KLUYVER et al., 1983a; FÜRSICH et al., 2005). The thickness of the Nayband Formation decreases southward, reaching approximately 1800 m in Kuh-e Murghab, approximately 100 km south of the type locality (KLUYVER et al., 1993b), and about 150 m in the Kerman area (e.g. in Kuh-e Tizi or in Bulbulu section: HUCKRIEDE et al. [1962]; personal observation). For more information about the Triassic deposits and also about the Nayband Formation in Iran see SEYED-EMAMI (1971, 2003), BRÖNNIMANN et al. (1971), ZAHEDI (1973), KLUYVER (1983a, 1983b), and FÜRSICH et al. (2005).

The investigated thalamid sponge fauna, described herein, was collected from several stratigraphic levels of the Nayband Formation in:

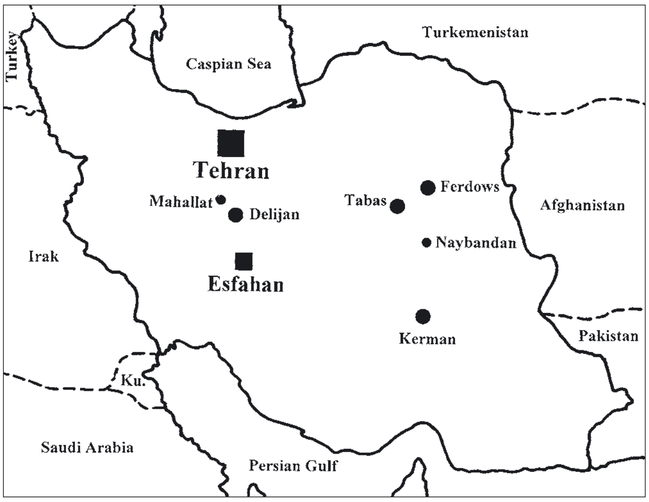
Text-Fig. 2.
View of the southern flank of the Kuh-e Nayband (Nayband Mount, 3009 m) in background composed of Middle to Upper (Carnian) Triassic dolomites, and in front, the siliciclastic-carbonate Nayband Formation (Norian–Rhaetian).

a) The northern and southern area of the town of Tabas (south of Tabas: in the Ali-Abad and Naybandan area, north of Tabas: Ferdows area).
b) From a relatively large reef near the small town of Marawand (NE of Esfahan).
c) From south of the town of Delijan (N of Esfahan).
d) From northwest of the town of Mahallat (N of Esfahan).
e) From the Bagher-Aabad area (NE of Esfahan), and finally
f) From the Kerman area (Text-Fig. 3).

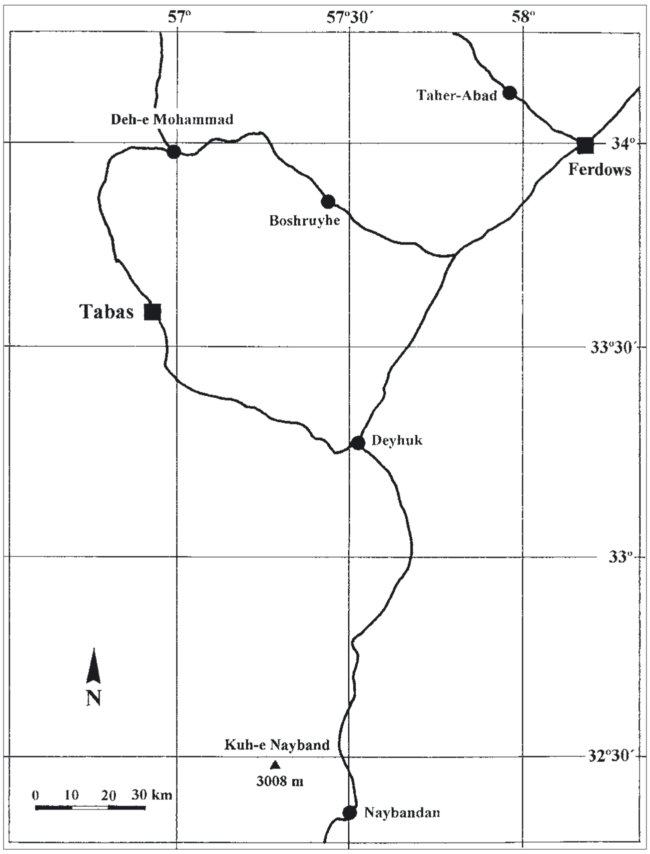
The following is a short description of the individual localities:

a) Northeast area of the town Tabas, and approximately 13 km NW of the town of Ferdows (Text-Fig. 4), the Nayband Formation is exposed at the castle of the small village of Hassan-Abad, near the town of Taher-Abad (geological map of Ferdows, see EFTEKHAR-NEZAD et al., 1977). Bioconstructions of biostromal character were formed mainly by corals and subordinate sponges. Chaetetid type sponges are more frequent. Very abundant are sheet-like organisms (Stromatomorpha?) of about 1 cm thick and more than 30 cm wide, which bind the sediment and stabilized the reef frame. Among the thalamid sponges *Tabasia* nov. gen. and *Iranothalamia* nov. gen. are most dominant. The subordinate genus *Nevadathalamia* also occurs. The sponges from this locality are marked as **"Ferdows Reef"** in this paper.

Approximately 220 km south of Tabas, around the Kuhe-Nayband (Nayband Mount), especially in the

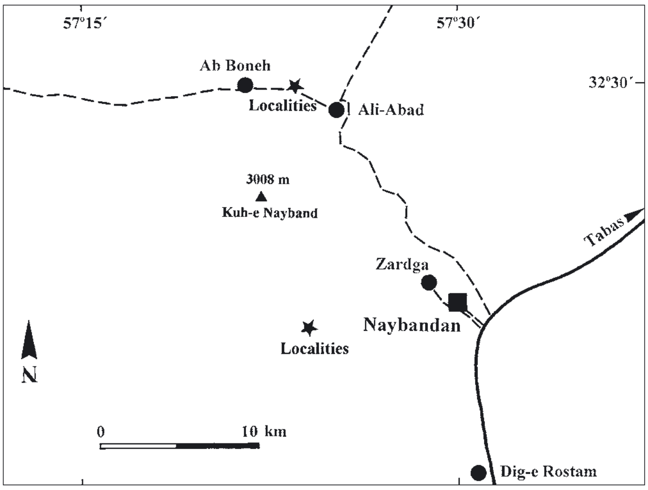


Text-Fig. 3.
Overview of areas from which the thalamid sponges in this paper are described.



Text-Fig. 4.
Geographic position of localities in the northeastern (W of Ferdows) and southern (Kuh-e Nayband) area of Tabas, from which the sponges, described in this paper, were collected.

southern area of the Kuh-e Nayband, the Nayband Formation is a widespread geological unit (geological map J8 of Naybandan: KLUYVER et al. [1983a]). In the northern part of that area, about 10 km north of Kuh-e Nayband, and approximately 7 km northwest of the small town of Ali-Abad, is a well exposed geological section of the Nayband Formation, where at least 6 bioconstructional horizons were observed. These are mainly biostromal buildups with small biohermal reef structures (Text-Fig. 5). This section cuts through the youngest

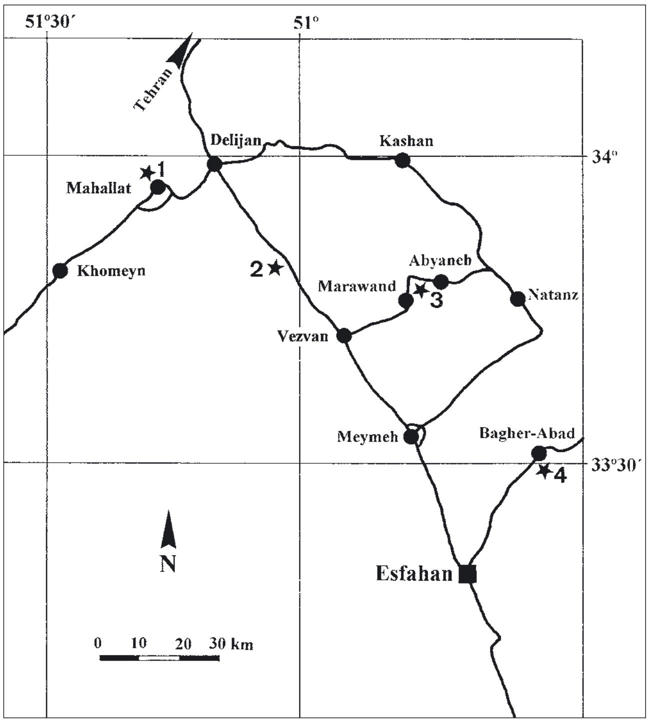


Text-Fig. 5.
Geographic position of localities in the northern and southern area of Kuh-e Nayband.

member of the Nayband Formation, called the Howz-e Khan member by Brönnimann et al. (1971) and Kluyver et al. (1983a). *Heterastridium*, an abundant spherical hydrozoan within the Bidestan member, is absent elsewhere. The biostromal bioconstructions are mainly coral-dominated, and the biohermal bioconstructions are sponge- or coral-dominated. About 6.5 km northwest of the town Ali-Abad, on the north side of the road from Ali-Abad to Ab-Boneh, a relatively large sponge-dominated reef is exposed. It yielded a high diversity fauna of thalamid, as well as inozoid and chaetetid, sponges. *Iranothalamia* nov. gen., particularly, and *Nevadathalamia, Paradeningeria* and *Tabasia* nov. gen. are the most abundant thalamid sponges within this reef. A diverse inozoid sponge fauna is also present, especially *Permocorynella* and *Radiofibra* are abundant (see Senowbari-Daryan et al., 1997). Sponges collected from this and other localities of this area (northern flank of Kuh-e Nayband), are marked as **"Ali-Abad Reefs"** in this paper. Within the marly sediments at this locality, complete specimens of a variety of other reef building organisms, like solitary and colonial corals, different sponge groups (including spongiomorphids) and reef dwellers, like gastropods, bivalves, brachiopods etc. were collected. The gastropods of this locality were described by Nützel & Senowbari-Daryan (1999), and the bivalves were treated by Hautmann (2001).

In the southern part of the Kuh-e Nayband, at the type locality of the Nayband Formation, several horizons of bioconstruction are also exposed (Text-Fig. 5). These bioconstructions also have a biostromal and/or biohermal character, and are developed within the Bidestan member, where several extremely abundant *Heterastridium*-bearing beds of (Middle) Norian age are intercalated with siliciclastic and carbonate beds. Coral-dominated reefs occur mainly within the Kowz-e Khan member, exposed on both sides of the valley leading to the old monument of Howz-e Khan. Sponges, as well as other reef-building organisms, are partly isolated and can be collected in body preservation. One of our localities, easy to reach by car, lies on the small road coming from the police station (at the main highway from Ravar to Tabas) to the small town of Naybandan. Approximately 300 m before reaching the town of Naybandan, on the right side of the road are exposed two small bioherms up to 10 m in lateral expansion and few m thick. They have yielded a variety of sponges. *Nevadathalamia*, particularly, and the inozoid sponges *Peronidella, Permocorynella* and *Disjectopora* are abundant in this locality (Senowbari-Daryan, 2003a). The corals occur mainly at the lower parts and the sponges are dominant in the upper parts of the reefs. The reefs are underlain by oncoid and ooid beds, and are overlain by coquina beds and shales. The sponges, collected from this locality and from the southern area of Kuh-e Nayband are marked as **"Naybandan Reefs"** in this paper.

b) The Nayband Formation with bioconstructions is exposed at several localities NE area of Esfahan (Text-Fig. 6). One of these is a relatively large reef (Text-Fig. 6, locality 3), located near the small town of Marawand, on the geological map of Kashan sheet 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). This locality can be reached from the village of Meymeh by taking the minor road from Meymeh to Marawand, via Vezvan, or the highway from Kashan to Natanz, via the small town of Abyaneh (Text-Fig. 6, locality 3). The Marawand Reef yielded also a large diversity of sponges, including sphinctozoids, inozoids, and chaetetids, as well as spongiomorphids. Sponges from this locality are marked as **"Marawand Reef"** in this paper.



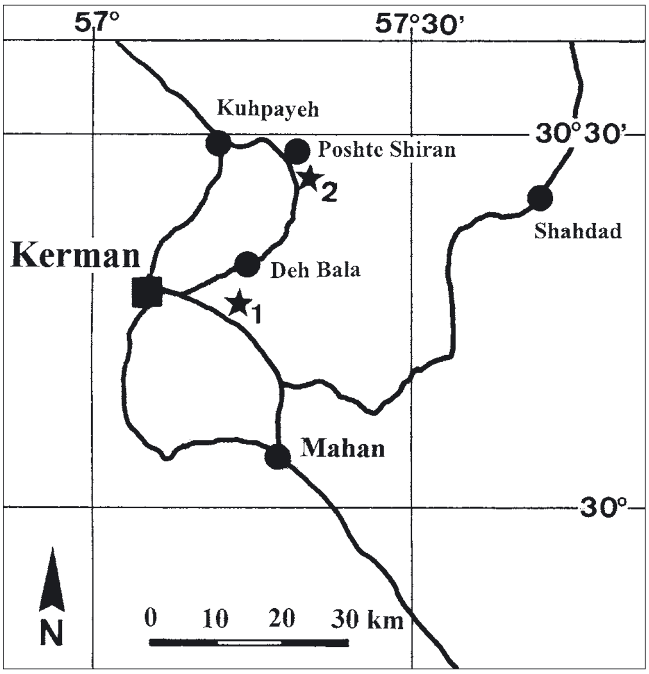
Text-Fig. 6.
Geographic positions of localities north of Esfahan, from which the sponges described in this paper were collected.
1 = Mahallat Reef; 2 = Delijan Reefs; 3 = Marawand Reef; 4 Bagher-Abad Reefs.

c) Along the right side of the highway from Tehran to Esfahan (geological map of Golpayegan, Nr. E7, 1:250,000, completed by Thiele, 1968), approximately 50 km south of Delijan several small reefs of conical geometry, reaching diameters of more than 80 m and thicknesses of more than 50 m, are exposed at the right side of the highway (Text-Fig. 6, locality 2). Diverse corals of solitary and colonial types, as well as a variety of sponges, were collected from these reefs. In addition to different types of hypercalcified sponges, the reefs of Delijan yield a variety of hexactinellid sponges of thalamid and non thalamid types. The abundance and diversity of hexactinellid sponges in these reefs is much higher than in the other reefs contained within the Nayband Formation at other localities noted here. The sponges of these reefs are marked as **"Delijan Reefs"** in this paper.

d) West of the town of Delijan (geological map of Golpayegan, completed by THIELE, 1968), in the northwest part of the relatively large town of Mahallat, some imbedded bioconstructions within the Nayband Formation are exposed (Text-Fig. 6, locality 1). The Nayband Formation in this area is represented mainly by bedded limestone with megalodonts and algal mats ("Loferitic Facies"). Shales and sandstones are not abundant. A small biostromal, coral-dominated (mainly dendroid types) reef is overlain on the "Loferitic Facies" in a section about 180 m thick. The abundance and diversity of sponges in this reef is very low. It yielded only a few specimens of thalamid sponges, mainly *Paradeningeria* and *Nevadathalamia*, and the non-segmented sponges *Permocorynella*. Chaetetid sponges seem to be very abundant. The locality can be reached from Mahalat by taking the road Mahallat – Khomein, taking the small road at the right side about 5 km fair from Mahallat (Text-Fig. 6). The sponges of this reef are marked as **"Mahallat Reef"** in this paper.

e) Around the small town of Bagher-Abad, approximately 60 km northeast of Esfahan, the Nayband Formation is exposed in several localities, particularly in the eastern, southern and northern part of the town (Text-Fig. 6, locality 4). Our samples came from a locality situated near a spring, not far from the "Salzbrunnen-Lokalität" (Salt spring locality) of KRISTAN-TOLLMANN et al. (1980). Some invertebrate fossils from this area have been described by KRISTAN-TOLLMANN et al. (1980) and FALLAHI et al. (1983). An association of dasycladacean green algae from a section of Nayband Formation exposed near the Kuh-e La Kaftari (south of Bagher-Abad) was described by SENOWBARI-DARYAN & HAMADANI (2000). Sponges, collected from the different localities around the town of Bagher-Abad, including the La Kaftari and Salt Spring localities, are marked as **"Bagher-Abad Reefs"** in this paper.

f) The Nayband Formation around the Kerman area reaches a thickness of only about 100 m, and two localities of the Nayband Formation were sampled (Text-Fig. 7). The first locality (Bulbulu: HUCKRIEDE et al., 1962) is situated approximately 10 km southeast of Kerman, via the road from Kerman to Mahan. The small side road, after the granary (elevator), leads 1.2 km to the locality where the section through the Shotori dolomite and Nayband Formation is exposed approximately 20 m behind the bridge, at the left side. The Nayband Formation in this section is approximately 95 m thick. In the middle part of the section there is a carbonate bed with reef organisms, including corals and sponges (inozoans: mostly *Peronidella*, sphinctozoans: *Cinnabaria, Polytholosia*, spongiomorphids and chaetetids). Samples from the Bulbulu locality are marked as **"Bulbulu Reef"** in this paper.
The second locality of Nayband Formation lies in Kuh-e Tizi, near the town of Posht-e Shiran, approximately 30 km northeast of Kerman (Text-Fig. 7). This locality can be reached via the road from Kerman to Posht-e Shiran. South of the town of Posht-e Shiran, on the right side of the road, is the Kuh-e Tizi locality and the section of Nayband Formation is exposed. The Nayband Formation in this section is about 170 m thick with some coral beds. No sponges were found in this locality.



Text-Fig. 7.
Geographic position of localites around the town of Kerman.
1 = Bulbulu locality; 2 = Poshte Shiran locality.

3. Methods

The majority of described sponges were investigated in several hundred thin sections (mostly large sized and 10 × 15 cm) and in polished slabs. If body fossils were available, they were investigated as complete specimens and also in thin sections. Transverse and longitudinal sections were made from the majority of sponges to get the characteristics of sponges in both directions. Because of recrystallization of the sponge skeletons, investigations with a Scanning Electron Microscope were not useful and, therefore, no information is available about the microstructure of the sponge skeleton and about the possibly spicular skeleton. Drawings and reconstructions were made to show external and internal characteristics of the several species of sponges.

4. Systematic Paleontology

Classification

STEINMANN (1882) was the first author, who classified the hypercalcified chambered sponges into four families, based on combination of the presence or absence of a spongocoel and the type of filling skeleton within the chamber interiors. Later, GIRTY (1908) and DE LAUBENFELS (1955) added two families to the sphinctozoid sponges. SEILACHER (1962) established two superfamilies (Porata and Aporata). SEILACHER´s superfamiles were claimed to the suborder by PICKETT & RIGBY (1983). Based on the presence or lack of a spicular skeleton and its chemical composition (siliceous or carbonatic) and on the mineralogical composition of the rigid skeleton (aragonite or Mg-calcite) SENOWBARI-DARYAN (1990) classified the chambered sponges into 6 orders:

❶ **Sphaerocoeliida VACELET 1979**
Calcareous spicular skeleton, calcitic rigid skeleton, primary aragonite?: Calcisponges; Jurassic.

❷ **Verticillitida TERMIER & TERMIER (in TERMIER et al., 1977)**
With or without primary siliceous spicules, rigid skeleton composed of aragonite: Demospongea; Triassic–Recent.

❸ **Permosphinctoa TERMIER & TERMIER 1974**
Without spicular skeleten, aragonitic rigid skeleton):

Demospongea? Calcispongea?; Cambrian–Cretaceous.

❹ **Pisothalamida** SENOWBARI-DARYAN & RIGBY 1988
Siliceous spicular skeleton composed of primary monaxons, aragonitic rigid skeleton, pisolithic internal filling structure: Demospongea; Permian.

❺ **Hadromerida (pars)**
According to REITNER 1987 (probably monactin megascleres and spheraster microscleres): Demospongea, Triassic (the only genus of this taxon – *Cassianothalamia* REITNER – was assigned to the new family Cassianothalamiidae by REITNER 1987, order Hadromerida. MÜLLER-WILLE & REITNER (1993) replaced the genus *Cassianothalamia* to the Family Geoiidae within the order Astrophorida.

❻ **Guadalupiida** TERMIER & TERMIER **(in** TERMIER **et al., 1977)**
Without spicules, calcitic rigid skeleton (according to FINKS, 1983, primary aragonite): Demospongea; Permian.

Finally sphinctozoans with a rigid skeleton composed of high-Mg-calcite mineralogy were united as order incertae sedis by the same author.

Because of their polyphyletic nature the sphinctozoans are assigned to different sponge classes, including Heteractinida, Demospongea, Calcispongea, Hexactinellida and Archaeocyathida by SENOWBARI-DARYAN & GARCIA-BELLIDO (2002). The most sphinctozoans are classified into different orders within the demospongid sponges.

FINKS & RIGBY (in FINKS et al., 2004) follow the frame of the classification of SENOWBARI-DARYAN & GARCIA-BELLIDO (2002) with some revision and modification.

Phyllum: Porifera GRANT, 1872
Class: Demospongea SOLLAS, 1875
Subclass: Ceractinomorpha LEVI, 1973
Order: Agelasida VERRILL, 1907
Suborder: Porata SEILACHER, 1962
Family: Colospongiidae SENOWBARI-DARYAN, 1990

The systematic classification of hypercalcified sponges, suggested by FINKS & RIGBY (in FINKS et al., 2004) is followed in this paper.

Synonymy: Colospongiidae BOIKO & BELYAEVA (in BOIKO et al., 1991); Parauvanellidae Y. SH. WU, 1991; Imbricatocoeliidae Y. SH. WU, 1991 (see FINKS & RIGBY in FINKS et al., 2004: 697).

Discussion: For the genus *Parauvanella* Y. SH. WU (1991: 78) established the new family Parauvanellidae with the following diagnosis: „ ... irregular in form, composed of chambers irregularly arranged, with chamber walls perforated or imperforated with ostia“ (compare Y. SH. WU, 1995).

Different opinions could exist about independence of the family Parauvanellidae or unification of that family with the Colospongiidae, as was done by SENOWBARI-DARYAN (1990). We think that establishment of a separate family based only on chamber arrangement, without attention to sponge similarities and their phylogenetic relationship, does not correspond to the "natural facts". The thalamid sponges without a spongocoel, like *Colospongia* and *Parauvanella*, included in the suborder Asiphonata by Y. SH. WU (1991), seem to be closely related; separation of them into two different families dose not seem to be justified. Representatives of thalamid sponges with an aragonitic skeletal mineralogy and moniliform or glomerate arrangement of the chambers were separated by SENOWBARI-DARYAN (1990: 63) into two subfamilies to show the phylogenetic relationship of these sponges in a "natural system". According to FINKS & RIGBY (in FINKS et al., 2004: 697) the family Imbricatocoeliidae Y. SH. WU (1991) is also a synonym of Colospongiidae SENOWBARI-DARYAN (1990).

Subfamily: Corymbospongiinae SENOWBARI-DARYAN, 1990
Genus: *Parauvanella* SENOWBARI-DARYAN & DI STEFANO, 1988

Type species: *Parauvanella paronai* SENOWBARI-DARYAN & DI STEFANO, 1988.

Additional species: *Parauvanella bimuralis* (= *Colospongia bimuralis* SENOWBARI-DARYAN, 1978), *Parauvanella minima* SENOWBARI-DARYAN, 1990. WU & FAN (2002, p. 166 and 174) mention the species *P. maxima* WU, but we could not find where this species has been described.

Parauvanella ferdowsensis nov. sp.

(Pl. 1, Figs. 1–8; Pl. 2, Figs. 1–2; Pl. 15, Fig. 1/P; Text-Figs. 8–9)

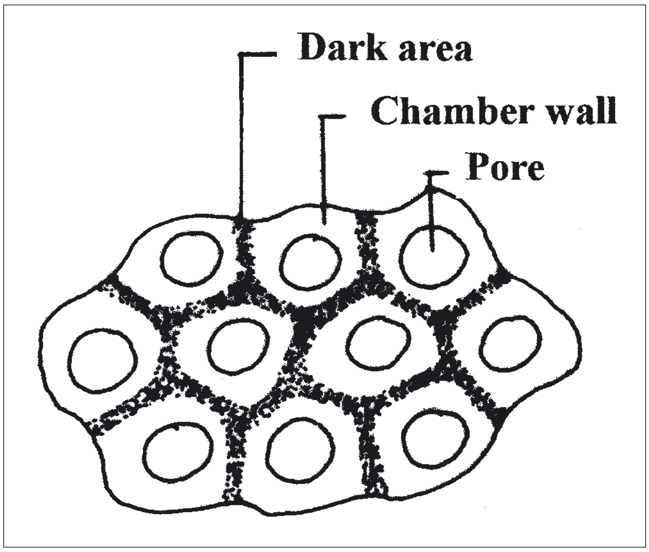
Derivatio nominis: The name of this species refers to the town of Ferdows, the large town closest to the type locality in NE Iran.

Holotype: Pl. 2, Fig. 1 (96/31/5a). Two thin sections (96/31/5a und 96/31/5b) were made from the holotype and the rest of the sponge remains in a rock piece.

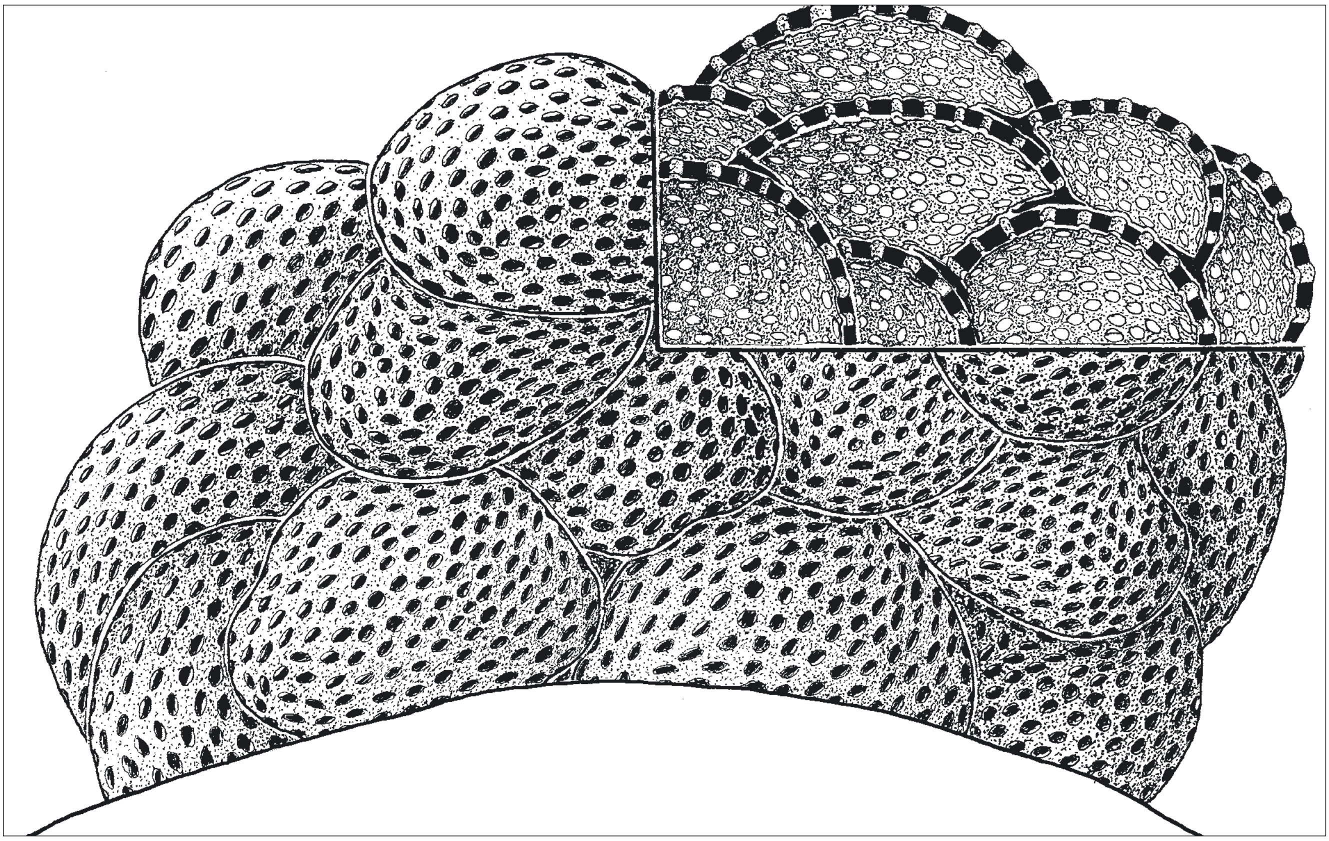
Type locality: Castle of the small town of Hassan-Abad, approximately 13 km northwest of the town of Ferdows (see Text-Fig. 3–4)

Type level: Reefs within the Nayband Formation, Norian–Rhaetian.

Diagnosis: Aggregates composed of a cluster of spherical to subspherical chambers with glomerate arrangement. The relatively thin chamber walls are pierced by numerous, unbranched circular to oval pores. Chamber interiors are without filling structures and usually without vesicular skeleton. Primary aragonitic skeletal mineralogy, spicules are not known.



Text-Fig. 8.
Section through the chamber wall of *Parauvanella ferdowsensis* nov. sp. exhibiting the net-like dark area in the center of the skeleton around the pores. Schematic, not to scale.



Text-Fig. 9.
Reconstruction of *Parauvanella ferdowsensis* nov. sp. with cluster of glomerate chambers.
Schematic, not to scale.

Differential Diagnosis: See discussion after the species description.

Material: In thin sections from Marawand Reef (thin sections M10/l/1, M10/l/2, M10/q/2, M/44, M73) from Delijan Reefs (thin sections P/?, P/173/5/1, P207/1, P/207/2, P/207/4), and the holotype (thin sections 96/31/5a and 96/31/5b) from the reef limestones near the town of Hassan-Abad, NW of the town of Ferdows.

Description: The aggregates of this relatively large parauvanellid sponge composed of a cluster of glomerate chambers which are arranged irregularly beside and above one another (Text-Fig. 9). The chambers are spherical to subspherical, egg-shaped or irregularly spherical with perforated walls. Whole aggregates are usually smaller than 20 mm in diameter, but reaches a maximum of up to 50 mm. Specimens of *P. ferdowsensis* are usually attached on the skeleton of other organisms, such as other sponges, corals or rarely brachiopod shells (Pl. 1, Figs. 2–5; Pl. 2, Fig. 1; Pl. 15, Fig. 1/P).

Individual chambers reach diameters of up to 15 mm, with heights of up to 9 mm. Chambers with small dimensions are marginal sections of the large chambers. Because of glomerate arrangements of the chambers and total overlap of some preceding chambers by the younger chambers, all chambers are not recognizable from the exterior of the sponge.

The chamber walls are very thin, with thicknesses of approximately 0.4 mm to a maximum of 0.5 mm. The walls are pierced by numerous, unbranched pores with circular to oval outlines; pores extend straight to the exterior of the sponge. Diameters of the pores range between 0.12 mm and 0.20 mm. Walls between adjacent chambers (well preserved in thin section 96/31/5a) are single and not double-layered (Pl. 1, Figs. 1–5; Pl. 2, Fig. 1). However, at the bottom of some chambers, especially at edges of chambers, a thin and imperforate wall layer is secreted, producing a double-layered wall between two neighbouring chambers (Pl. 1, Fig. 1: arrows). In sections, through and parallel to the walls the central net-like area of the wall between the pores may appear darker than the surrounding light areas. These net-like areas may be confused with spicules when imbedded within the rigid skeleton (Pl. 2, Fig. 2, see Text-Fig. 8). These dark areas were probably occupied by soft tissue of the sponge during its life time. This feature could not be observed in some paratypes (because of recrystallization?). Dark areas of similar appearance are also known from other sphinctozoid sponges, e.g. the Triassic *Stylothalamia* OTT, or the Cretaceous *Murguiathalamia* REITNER & ENGESER (see REITNER & ENGESER, 1985; SENOWBARI-DARYAN, 1990). *Amblysiphonella* sp. 2, described in this paper, also shows this feature (see Pl. 7, Fig. 4).

The chamber interiors are without filling structures. However, in some chambers short pillar-like structures extend for a short distance from the chamber roofs into the chamber interiors. These elements never reach the chamber bottoms. Only in one specimen, in addition to the holotype, rare vesiculae (especially in old chambers) were observed. Text-Fig. 9 shows a reconstruction of *P. ferdowsensis* nov. sp.

Discussion: *Parauvanella* (with type species *P. paronai* SENOWBARI-DARYAN & DI STEFANO,1988) was originally established for aragonitic sphinctozoid sponges composed of clusters of perforated chambers with glomerate arrangement, from the Lower Permian reef limestones embedded within the Lercara Formation in western Sicily (SENOWBARI-DARYAN & DI STEFANO, 1988). SENOWBARI-DARYAN (1990) also assigned *Colospongia bimuralis* to this genus. It is a sponge with glomerate chamber arrangement, described by him (1978) from the Upper Triassic

(Rhaetian) reef limestones of the Northern Calcareous Alps (Austria). He (1990) also described the new species, *P. minima*, from the Permian reef limestones of Guadalupe Mountains in Texas and New Mexico (see also RIGBY et al., 1998). The last mentioned species is also known from Permian reefs from other localities in Greece (FLÜGEL & REINHARD, 1989), China (FAN & ZHANG [1985]: described as *Uvanella*, FLÜGEL & REINHARD [1989]; RIGBY et al. [1994]), and from Oman (WEIDLICH & SENOWBARI-DARYAN [1996]). WU & FAN (2002, p. 166 and 174) mention the species *Parauvanella maxima* WU, but we could not find where and when this species was described by WU.

Parauvanella ferdowsensis nov. sp. differs from all other species of the genus, especially from the Upper Triassic species *P. bimuralis*, by the large dimensions of the sponge, its chambers and its relatively large pores in the chamber walls. The dark areas within the chamber walls and the short pillar-like structures extending from the chamber roofs into the chamber interiors, described above, are not known from other parauvanellid sponges either, from the Permian or from the Triassic deposits. The main characteristics of all species of the genus *Parauvanella* are summarized in Tab. 1.

Table 1.
Species characteristics of the genus *Parauvanella* from the Permian, and Triassic deposits.
DA = Dimensions of sponge aggregates; CH = chamber height; CW = chamber width or diameter; TCW = thickness of chamber walls (all measurements in mm).

Species	DA	CH	CW	TCW	Age
P. bimuralis	max. 10	0.65–2.5	0.75–2.6	0.08–0.2	Rhaetian
P. paronai	max. 14	max. 2	max. 40	0.1–0.3	Lower Permian
P. minima	5–20	- -	0.5–1.2	0.15	Mid.-U. Permian
P. ferdowsensis n. sp.	max. 50	max. 5	max. 15	0.3–0.55	Norian–Rhaetian
P. delijanensis n. sp.	50	1–2	2–10	up to 1	Norian–Rhaetian

Occurrence (see Tab. 7): *Parauvanella ferdowsensis* nov. sp. was found in reefs at the type locality (castle of the town of Hossein-Abad near Ferdows, Ferdows Reef, Text-Fig, 4), in the reefs north of Esfahan (Marawand Reef, Text-Fig. 6, locality 3), and in reefs to the south of the town of Delijan (Delijan Reefs, Text-Fig. 6, locality 2).

Parauvanella delijanensis nov. sp.

(Pl. 2, Fig. 5; Pl. 4, Figs. 4–6; Pl. 5, Figs. 5–6; Text-Fig. 10)

Derivatio nominis: Named from the closest relatively large town of Delijan, approximately 50 km north of the type locality.

Holotype: Pl. 5, Fig. 5 (compare Text-Fig. 10, thin section P272/1a).

Paratypes: All Figs. illustrated in Pl. 2, Fig. 5; Pl. 4, Figs. 4–6; Pl. 5, Fig. 6.

Type locality: Reefs about 50 km south of the town of Delijan, at the right side of the Tehran – Esfahan highway (see Text-Fig. 6, locality 2).

Type level: Norian reefs imbedded within the Upper Triassic (Norian–Rhaetian) Nayband Formation.

Material: 4 specimens in thin sections P/271/1a, P272/1b, P272/3a, and P272/3b.

Diagnosis: Dome-shaped or irregular sponges composed of aggregates of numerous, irregularly flattened, crescent-like chambers. Outer segmentation is poorly recognizable. Chamber walls are pierced by different sizes of pores with uneven distribution. Several exhalant canals may be developed in the sponge aggregate. Without internal filling structure and vesiculae. Primary skeletal mineralogy was most probably aragonite, spicules are not known.

Description: Generally the dome-shaped aggregates of this sponge reach heights of more than 50 mm, with diameters up to 20 mm. The sponge skeleton is composed of numerous, flattened and crescent-like chambers, with glomerate or partly moniliform arrangement of the chambers. Heights of the chambers are usually about 1 mm, maximally 2 mm; lengths of the chambers are very variable, between 2 mm and 10 mm. Because of overlap of preceding chambers by the younger ones, outer segmentation may be lacking, or poorly recognizable from the outside.

The chamber walls are relatively thick, having a thickness of up to 1 mm. They are pierced by pores of uneven distribution and of various sizes (0.2–1.5 mm in diameter). The walls are usually strongly recrystallized. A characteristic feature of the sponge is the development of relatively large exhalant canals up to 3 mm in diameter, with irregular spacing and position within the sponge body (Pl. 5, Figs. 5–6: arrows). Filling structures, as well as vesiculae, are lacking within chamber interiors.

Text-Fig. 10.
Section through *Parauvanella delijanensis* nov. sp.
The irregular and flattened chambers exhibit also irregular perforation of chamber walls (thin section P272/1a).
Holotype (compare Pl. 5, Fig. 6). Scale 1 cm.

Remarks: *Parauvanella delijanensis* nov. sp. differs from *P. ferdowsensis* nov. sp. and from all other species of the genus by having strongly irregular chambers, uneven sizes of pores within the chamber walls, their irregular distribution and, finally, by the possession of exhalant canals at irregular distances.

Occurrence (see Tab. 7): *P. delijanensis* nov. sp. was found only in reefs in the area south of the town of Delijan (Delijan Reefs, Text-Fig. 6, locality 2).

Subfamily: Colospongiinae SENOWBARI-DARYAN, 1990
Genus: *Colospongia* LAUBE, 1865

Type species: *Manon dubium* MÜNSTER, 1841.

Further species: See SENOWBARI-DARYAN & GARCIA-BELLIDO, 2002.

Colospongia iranica nov. sp.

(Pl. 2, Fig. 3/C; Pl. 3, Figs. 1–7; Pl. 4, Figs. 1/C, 2/C, 3, 7; Text-Fig. 26)

Derivatio nominis: Named for the occurrence of the sponge in Iran.

Holotype: Pl. 3, Fig. 1 (thin section M/110/10).

Type locality: Marawand Reef near the town of Marawand, NE of Esfahan, central Iran (Text-Fig. 6, locality 3).

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

Diagnosis: Porate, single or branched stems with moniliform arrangement of the chambers. Chambers spherical to hemispherical. Interior of chambers is usually filled with organic(?) filling structure or cement, rarely with micrite. In some chambers rare pillar-like elements extend from the chamber roofs into the chamber interior. Primary aragonitic skeletal mineralogy, spicules are not known.

Material: Numerous specimens from Marawand Reef in thin sections M/44, M106/3, M/110/10 (holotype), M/110/10/1, M/10/q, M/10/q/1, M110/10B, M/110/12, M/134e, M/326, and M/339.

Description: The single or branched stems of this sponge are composed of spherical to hemispherical chambers arranged one above the other (moniliform). The holotype (Pl. 3, Fig. 1), is composed of 7 chambers, attached to an other specimen. The sponge seems to be branched after the fourth chamber, where the two specimens grew together. Here the shape of the chamber was modified by the intergrowth of both sponges. Diameter of the chambers range between 2 mm and 3.2 mm. Heights of the chambers are relatively constant measuring about 3 mm. The chamber walls (0.2–0.35 mm thick) are pierced by uniform sized, unbranched, and circular pores having diameters of 0.12–0.20 mm. In the interior of some chambers (Pl. 4, Fig. 7: arrow) rare pillar-like elements were observed to extend from the roof or bottom of the chamber into the chamber interior.

Interiors of chambers are filled with organic filling structures or with “cement”, in some cases with micrite or with both filling materials. The sharp boundary between the filling structure and micrite in the chamber interiors indicates organic secretion of the “cement”. Chambers that are totally filled with filling structures do not exhibit all the characteristics of the sponge, including the perforation of the chamber walls and their thicknesses. In such chambers, the chamber walls appear as thin dark lines (Pl. 3, Figs. 4–7). In most cases the chamber interiors are filled partly or totally with cement showing rod-like or irregularly shaped hollows with micrite filling which are interpreted as micrite filling between the vesiculae. The interpretation of these hollows as a result of boring activities seems unlikely because they do not extend through the chamber walls to the outside of the sponge.

Remarks: *Colospongia* is a diagnostically poor sponge genus occurring from the Carboniferous up to the end of the Triassic (SENOWBARI-DARYAN & GARCIA-BELLIDOK, 2002). About 30 species have been described from Paleozoic and Triassic deposits. All species described up to 1990 were listed by SENOWBARI-DARYAN (1990). Since 1990 the following species have been described (compare SENOWBARI-DARYAN & GARCIA-BELLIDO, 2002):

Colospongia arakeljani ZHURAVLEVA (in BOIKO et al.; 1991)
Colospongia composita BELYAEVA (in BOIKO et al.; 1991)
Colospongia globosa BELYAEVA (in BOIKO et al.; 1991)
Colospongia leveni ZHURAVLEVA (in BOIKO et al.; 1991)
Colospongia nachodkiensis BELYAEVA (in BOIKO et al.; 1991)
?Colospongia polytholosiaformis BOIKO (in BOIKO et al.; 1991)
Colospongia regularia ZHURAVLEVA (in BOIKO et al.; 1991)

The following species of *Colospongia* are comparable to *C. iranica* nov. sp., with regard to dimensions of the sponge (see SENOWBARI-DARYAN, 1990, p. 65): *C. catenulata catenulata* OTT (1967), *C. menulensis* SENOWBARI-DARYAN & SCHÄFER (1986), *C. paramolensis* KÜGEL (1987), *Colospongia (= Waagenella) simplex* (DENG, 1982).

The Ladinian–Carnian species *C. catenulata catenulata* differs from the Iranian species in the shape of the chambers, large pores and the thickness of the chamber walls. In addition *C. catenulata catenulata* is limited to Ladinian and Carnian and does not occur in Norian–Rhaetian deposits. *Colospongia menulensis*, until now known from Norian–Rhaetian of Sicily, differs from *C. iranica* by the uneven perforation of the chamber walls, indistinct outer segmentation, and by the lack of vesiculae in chamber interiors. The Carboniferous species, *C. paramolensis*, differs from the Triassic species of Iran in having a totally different pattern of perforation of segment walls. *C. iranica* nov. sp. differs from the Permian species *C. simplex* in shapes of the chambers and patterns of perforation of the chamber walls.

Occurrence (see tab. 7): *Colospongia iranica* nov. sp. has been found only in Marawand Reef, NE of Esfahan (Text-Fig. 6, locality 3).

Colospongia cf. *C. ramosa* RIEDEL & SENOWABARI-DARYAN, 1989

(Pl. 6, Figs. 1–6; Pl. 31, Fig. 4)

1989 *Colospongia ramosa* n. sp. – RIEDEL & SENOWBARI-DARYAN, p. 184, Figs. 3–5.

Material: Several specimens from the “Salt spring” locality near the town of Bagher-Abad (Text-Fig. 6, locality 4), north of Esfahan (thin sections SB12) and from the Ali-Abad Reefs south of Tabas (Text-Fig. 5, thin sections Ab/9/1, A/18, Ab/19/a, Ab/19b, Ab/22, Ab/46 and Ab/47).

Description: The single or branched(?) stems of this sponge are composed of numerous crescent-like low chambers arranged one above the other. Heights of the chambers range between 1 mm and 3 mm (generally 2 mm). The older chambers are usually overlapped by the younger chambers, so the exowall is thicker than the chamber roofs, and the segmentation of the sponge can not be recognized from the outside. Chamber interiors were open and no vesiculae were observed.

The chamber walls are thick, generally 1 mm, and pierced by unevenly distributed pores. Diameters of the pores range between 0.1 mm and 0.4 mm.

Remarks: *Colospongia ramosa* was described originally by RIEDEL & SENOWBARI-DARYAN (1989) from the Carnian reef limestones of western Carpathians and from the Carnian "Pantokrator"-limestones of the Island of Hydra (Greece). Until now, *C. ramosa* has not been known from other Carnian localities nor from Norian–Rhaetian deposits.

The general features of this Iranian species correspond to those characteristic of the original description of *Colospongia ramosa*. However, because of the branched mode and because of the strongly overlap of the preceding chambers by younger chambers we are not absolutely sure about the identity of the both species.

Occurrence (see Tab. 7): *Colospongia* cf. *ramosa* is a relatively abundant sponge in reefs near the town of Ali-Abad (Ali-Abad Reefs, Text-Fig. 5). The sponge was found also in only one sample from the Salt Spring locality (SB/12) near the town of Bagher-Abad (Bagher-Abad Reefs, Text-Fig. 6/4), NE of Esfahan.

Colospongia sp. 1

(Pl. 7, Fig. 1)

Material: One specimen found in Delijan Reefs.

Description: Only one specimen of this species was found in the Delijan Reefs. It is a well preserved specimen in body preservation. One thin section (Pl. 7, Fig. 1) was made and the remainder of the sponge is kept in two pieces.

The sponge is composed of four chambers arranged one above the other. The length of the sponge is 37 mm. The diameter of the sponge and, consequently, the diameter of the chambers is approximately 42 mm. Chamber height ranges between 7 mm and 10 mm. The chamber walls (exo- and endowalls) are pierced by pores approximately 0.6 mm in diameter. The chamber interiors are filled with sediment. Two chambers (Pl. 7, Fig. 1) are partly filled with calcite cement having a sharp boundary with the micrite, which filled the rest of the chambers. This could indicate the presence of vesiculae within the interior of these chambers but diagenesis has removed them.

Remarks: Numerous species of *Colospongia* are described from Triassic deposits (see discussion above). However, this species is the largest known *Colospongia* from the Triassic. Until now, the largest *Colospongia* was described from the Permian of China as *C. maxima* by RIGBY et al. (1989). *C. maxima* has a maximum diameter of 36 mm (17–36 mm), which is smaller than our species from the Delijan Reefs. Most probably it represents a new species but because only one specimen was collected, we describe it here, preliminarily as *Colospongia* sp. 1.

Occurrence (see Tab. 7): The one known specimen of this sponge was found in Delijan Reefs, N of Esfahan (Text-Fig. 6, locality 2).

Subfamily: Kashanelliinae nov. subfamily

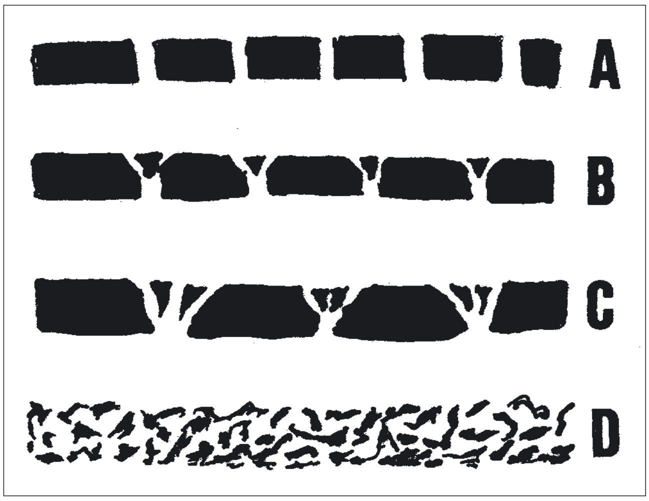
Diagnosis: Stems with moniliform arrangement of the chambers. Chamber walls with complicated branched canal system (labyrinth-like). Chamber roofs may contain one or several large openings (osculi). Chamber interiors without filling structures but vesiculae may occur. Most probably the primary skeleton was composed of aragonite. Spicules were not observed.

Discussion: SENOWBARI-DARYAN (1990) attributed two subfamilies to the family Colospongiidae with the following diagnosis:

a) Colospongiinae: Moniliform arrangement of the chambers and
b) Corymbospongiinae: Glomerate or stratiform arrangements of the chambers. Both subfamilies have perforated chamber walls with simple (not branched), dichotomously- or dichotomously multi-branched pores.

The new subfamiliy differs from both of these subfamilies by having a complicated (labyrinth-like) canal system of the chamber walls. The perforation pattern of *Kashanella* nov. gen. is very similar or almost identical to the genus *Calabrisiphonella* described by SENOWBARI-DARYAN & ZAMPARELLI (2003), but differs from this genus in the lack of an axial spongocoel. In Text-Fig. 11 perforation patterns in *Colospongia* (A–C) and in *Kashanella* nov. gen. (D) is shown schematically.

Type genus: *Kashanella* nov. gen.



Text-Fig. 11.
Perforation patterns in *Colospongia* LAUBE (A–C) and *Kashanella* nov. gen. (D).
A = Single perforated wall; B = dichotomously branched perforated wall; C = dichotomously multibranched perforated wall; D = complicated perforated (labyrinthic-like) wall.
Schematic, not to scale.

Kashanella nov. gen.

Derivatio nominis: The genus is named from the large town of Kashan to the north of the type locality (see Text-Fig. 6).

Diagnosis: Chambered sponge composed of several irregularly shaped chambers arranged moniliform one above the other. The most characteristic feature of the sponge is the perforation pattern of the chamber walls which are pierced by labyrinth-like complicated canal systems. The chamber roofs may contain one or several osculi. Lacks filling structures and vesiculae.

Type species: *Kashanella irregularis* nov. sp.

Kashanella irregularis nov. sp.

(Pl. 5, Fig. 4; Pl. 19, Fig. 6; Pl. 20, Fig. 7; Pl. 21, Figs. 6–7)

Derivatio nominis: Named for the irregular shape of the chambers.

Holotype: Pl. 5, Fig. 4 (Thin section M110/12).

Paratypes: All specimens illustrated in Pl. 19, Fig. 6; Pl. 20, Fig. 7; Pl. 21, Figs. 6–7.

Type locality: Marawand Reef (see Text-Fig. 6, locality 3).

Type level: Norian reef limestones within the Nayband Formation.

Diagnosis: See diagnosis of the genus.

Material: Several specimens from Marawand-, Delijan- and Ali-Abad Reefs (see Text-Figs. 5–6).

Description: The straight or curved stems of this sponge are composed of several spherical, subspherical, rectangular or irregularly shaped chambers arranged one above the others (moniliform). The holotype (Pl. 5, Fig. 5) is composed of at least four chambers reaching a length of 12 mm. The base of the first chamber has a tube-like prolongation (cut marginally?). The following chambers are subspherical to irregular, reaching a diameter of 3 mm in the fourth chamber. The fourth chamber is extended to a tube-like prolongation. The chamber roofs are pierced by at least two (possibly more) large openings (osculi) of approximately 0.2 mm in diameter (cryptosiphonate sensu SEILACHER [1962]). The most important feature of the sponge is the labyrinthic-like complicated canal system of the chamber walls (Text-Fig. 11D). The chamber interiors are connected with the outside of the sponge by interspaces between fibre structures. No distinct separate pores are developed.

All paratypes exhibit the labyrinth-like canal system of the chamber walls, but they show only some of other characteristics of the sponge. For example the specimen shown in Pl. 19, Fig. 6 shows the irregular chambers but not the osculi between two chambers. The specimens figured in Pl. 21, Figs. 6–7 exhibit the chamber prolongations (Fig. 6) like in one chamber of the holotype, and the osculi between the chambers (Fig. 7), like in the holotype.

Occurrence (see Tab. 7): *Kashanella irregularis* nov. sp. was found in Marawand- (Text-Fig. 6, locality 3), Delijan- (Text-Fig. 6, locality 2), and in Ali-Abad Reefs (Text-Fig. 5). We found this species also in the Norian–Rhaetian Dachstein reef limestones of Hohe Göll/Austria (unpublished material) and in Greece (unpublished material).

Family: Sebargasiidae LAUBENFELS, 1955 (pro Sphaerosiphonidae STEINMANN, 1882)
Subfamily: Sebargasiinae SENOWBARI-DARYAN, 1990
Genus: *Amblysiphonella* STEINMANN, 1882

For synonymy and diagnosis of the genus see SENOWBARI-DARYAN (1990: 61).

Discussion: *Amblysiphonella* is a common sponge genus in Late Paleozoic and Triassic deposits. HUCKRIEDE et al. (1962) first mentioned the occurrence of *Amblysiphonella* within the Nayband Formation of the Bulbullu-locality near Kerman (see Text-Fig. 7). We could not find this sponge in this locality. However, the thalamid sponge *Nevadathalamia*, a sponge similar to *Amblysiphonella* but with internal filling structures, is relatively common in this locality.

The genus *Amblysiphonella* – with two species – was reported from the Nayband-Formation near the town of Wali-Abad, south of Abadeh by SENOWBARI-DARYAN & HAMEDANI (1999). *Amblysiphonella* occurs also very commonly in Permian deposits south of Bagher-Abad (SENOWBARI-DARYAN & HAMEDANI, 2002), and also in Bagh-e Vang locality in the Shotori Mts. (SENOWBARI-DARYAN et al., 2005). Several species of *Amblysiphonella* occur in Upper Triassic reefs within the Nayband Formation in central Iran and are described in this paper.

Amblysiphonella cf. *A. steinmanni* (HAAS), 1909

(Pl. 8, Figs. 1–2)

1909 *Eurysiphonella steinmanni* n. sp. – HAAS, p. 162, Pl. 6, Figs. 10a–10c.

1999 *Amblysiphonella* cf. *A. steinmanni* (HAAS). – SENOWBARI-DARYAN & HAMEDANI, p. 81, Pl. 1, Figs. 1–2, 4–5; Pl. 7, Fig.7.

Material: Two specimens from Delijan Reefs (Text-Fig. 6, locality 2).

Description: Only two specimens were collected of this species. The first specimen is exposed in a naturally weathered rock surface. The second specimen was studied on a polished slab. Both specimens are cut in oblique section. The first specimen (Pl. 8, Fig. 1) is composed of at least 5 chambers and the second specimen (Pl. 8, Fig. 2) has three ring-like chambers arranged around a wide retrosiphonate spongocoel. The whole lengths of both sponges are not known. The diameter of the first sponge is almost 27 mm and almost 20 mm in the second specimen. The spongocoel is 9 mm in diameter in the smaller second specimen or 10 mm diameter in the larger first specimen and apparently passes through the whole sponge. Chamber heights range between 4 mm and 10 mm. The exo-, inter-, and endowalls all have the same thickness of 0.5–0.6 mm and are pierced by numerous pores 0.2–0.5 mm in diameter. Vesiculae or other kinds of internal structures are lacking.

Remarks: Dimensions and other features of this species of *Amblysiphonella* from the Delijan Reefs correspond to the species described as *A. steinmanni* (HAAS 1909) from the Nayband Formation near Wali-Abad (south of Abadeh) described by SENOWBARI-DARYAN & HAMEDANI (1999). For comparison between *A. steinmanni* and the Iranian species from the Nayband Formation see the same authors.

Occurrence (see Tab. 7): *Amblysiphonella* cf. *A. steinmanni* was found only in the Delijan Reefs (Text-Fig. 6, locality 2).

Amblysiphonella sp. 1

(Pl. 8, Figs. 3–4, 5/A)

Material: Two specimens. Both specimens came from Delijan Reefs, north of Esfahan (Text-Fig. 6, locality 2).

Description: The first specimen of this sponge occurs as an internal mold and the other one was cut and discovered by chance. The internal mold is composed of 7 chambers that are arranged obliquely to the axis, or to the spongocoel, of the sponge. This could be a result of compaction.

Both specimens are composed of crescent-like chambers that are 3–5 mm high, measured directly on the wall of the spongocoel. Heights of the chambers decrease toward the periphery of sponge. Because of the crescent-like shape of the chambers, outer segmentation of the sponge is poorly defined.

Chamber walls and the wall of the spongocoel have the same thickness, 0.4–0.6 mm, and are pierced by pores that have diameters of approximately 0.25 mm. A spongocoel of retrosiphonate type passes through the whole sponge. The diameter of the spongocoel is 7 mm in the large specimen, which is 30 mm in diameter, and 4 mm in the small one, with a sponge diameter of 16 mm. Chamber interiors are without vesiculae.

Occurrence (see Tab. 7): *Amblysiphonella* sp. 1 was found only in Delijan Reefs (Text-Fig. 6, locality 2).

Amblysiphonella sp. 2

(Pl. 7, Figs. 3–5; Pl. 8, Fig. 5/B?)

Material: Two (three?) specimens.

Description: The first specimen (Pl. 7, Figs. 3–4) of this species comes from the La-Kaftari locality (Fig. 6, locality 4) near the town of Bagher-Abad, NE Esfahan, and the second specimen (Pl. 8, Fig. 5) from the Delijan Reefs (Fig. 6, locality 2). The specimen from La-Kaftari is broken and has a length of at least 30 mm, with a diameter of 20 mm. It is composed of several ring-like chambers that are 4–5 mm high. A spongocoel, approximately 7 mm in diameter, passes through the whole sponge. The exo-, inter- and endowalls are pierced by pores of 0.1–0.2 mm in diameter. The chamber walls have the same thickness as the wall of spongocoel and measure 0.4–0.7 mm. Vesiculae are lacking

The second specimen is almost complete, having a length of 40 mm with a diameter of almost 30 mm. Chamber heights of this specimen are about 5 mm, but they are wider than in the specimen from La-Kaftari. All other features, especially the dark area in the middle of the walls are like the specimen from the La-Kaftari locality.

The distinct feature of this species are the dark areas – like those described before in *Parauvanella ferdowsensis*, see Text-Fig. 8 – in the center of the exo- and interwalls (Pl. 7, Fig. 4). This feature was not observed in other species of *Amblysiphonella* in the collection. We interpret these dark areas as primary hollows filled by organic material during the life time of the sponge.

Occurrence (see Tab. 7): This species was found in the La-Kaftari locality (Text-Fig. 6, locality 4) near the town of Bagher-Abad (Bagher-Abad Reefs), NE Esfahan and in the Delijan Reefs (Text-Fig. 6, locality 2).

Amblysiphonella? sp. 3

(Pl. 9, Fig. 3)

Material: One specimen from Marawand Reef.

Description: The only known specimen of this species has a length of 26 mm and is composed of 6 chambers, which are oriented obliquely to the axis of the sponge. The chambers, and consequently the sponge, have a diameter of 17 mm, with chamber heights of 2–4 mm. Chamber walls are pierced by dichotomously branched pores. Abundant vesiculae occur within the chamber interiors. Individual tubes from the axial part of the chamber roofs lead to several axial canals (Pl. 9, Fig. 3: visible at the top of the sponge) which pass through the sponge. Because only one specimen of the species is known, determination is not carried out.

Remarks: This species of a possible *Amblysiphonella* differs from other species of the genus by having an axial spongocoel composed of several individual tubes. Also the tubes, leading to the axial canals were not observed in other species. Tubes, extended from the spongocoel or from the interwalls into the chamber interiors are developed in *Phraethalamia* SENOWBARI-DARYAN & INGAVAT-HELMCKE (1994) (see Text-Fig. 24) or in *Girtyocoeliana* RIGBY, KARL, BLODGET & BAICHTAL (2005), but these genera are aporate, differing from the porate *Amblysiphonella*? sp., described here.

Occurrence: The species was found only in Marawand Reef (Fig. 6, locality 3).

Amblysiphonella najafiani nov. sp.

(Pl. 7, Figs. 2, 6–7; Text-Fig. 12)

Derivatio nominis: This species is dedicated to Bahram NAJAFIAN (Ph. D. student of Shahid Beheshti University in Tehran) for his help in the field.

Holotype: Longitudinal section illustrated in Pl. 7, Fig. 6 (thin section 99Dj11) (Text-Fig. 12).

Paratypes: Pl. 7, Figs. 2, 7.

Text-Fig. 12.
Amblysiphonella najafiani nov. sp.
Holotype (compare Pl. 7, Fig. 6).
The exowalls of the sponge are pierced by very fine pores. The endo- and interwalls are imperforate and interrupted only by large openings. The chambers are connected with the spongocoel by large, partly sieve-like openings. Apparently the formation of the third chamber (from bottom) was disturbed.
Thin section 99Dj11.
Scale 2 mm.

Type locality: Delijan Reefs. Approximately 50 km south of the town of Delijan, reefs are exposed on the right side of the highway from Delijan to Esfahan (see Text-Fig. 6, locality 2)

Type level: Upper Triassic (Norian) reefs imbedded within the Nayband Formation.

Diagnosis: Smallest species of the genus *Amblysiphonella* with very fine perforated exowalls. The inter- and endowalls are pierced only by large openings. Interwalls are thickened. Vesiculae are lacking.

Material: Three specimens. Two of them (both in thin section 99Dj11) came from the Delijan Reefs and the third specimen from the La-Kaftari locality, near the town of Bagher-Abad, NE Esfahan (Text-Fig. 6, locality 4).

Description: The stem diameter of this smallest known species of *Amblysiphonella* ranges between 4 mm and 6 mm. The holotype (Pl. 8, Fig. 6) is 19 mm long and has a diameter of 4 mm. It is composed of at least 11 chambers. Chamber heights range between 1 mm and 2 mm.

The exowall is 0.2–0.3 mm thick and is pierced by very small, unbranched pores approximately 0.02 mm in diameter. However, the size of exopores in both paratypes, illustrated in Pl. 7, Figs. 2 and 6, are three times larger than those in the holotype. The interwalls (the walls between the chambers) and the endowalls (wall of spongocoel) are pierced only by larger and possibly sieve-like openings up to 0.6 mm in diameter (see Text-Fig. 12). The endowall is double-layered, having a thickness of up to almost 1 mm. Vesiculae and other filling structures are lacking within chamber interiors.

Discussion: In addition to approximately 50 species of *Amblysiphonella* listed by SENOWBARI-DARYAN (1990, p. 62) the following species of *Amblysiphonella* have been described more recently (see SENOWBARI-DARYAN & GARCIA-BELLIDO, 2002): *Amblysiphonella benschae* ZHURAVLEVA (in: BOIKO et al., 1991), *Amblysiphonella obichingouensis* BOIKO (in: BOIKO et al., 1991), *Amblysiphonella sahrajenis* BELYAEVA (in: BOIKO et al., 1991), *Amblysiphonella tenui-*

Table 2.
Dimensions and characteristics of species of *Amblysiphonella* found in Norian–Rhaetian reefs within the Nayband Formation in central and northeast Iran. DS = diameter of sponge; DSP = diameter of spongocoel; CH = chamber height; DPO = diameter of the pores; WT = wall thickness; CSH = chamber shape. All measurements in mm.

Species	DS	DSP	CH	DPO	WT	CSH
A. sp. 1	20-27	9-10	4-10	0.2-0.25	0.5-0.6	crescent-like
A. sp. 2	16-30	4-7	3-5	0.25	0.4-0.6	crescent-like
A.? sp. 3	20	7	4-5	0.1-0.2	0.4-0.7	barrel-shaped
A. cf. *steinmanni*	20-27	9-10	4-10	0.5-0.6	0.2-0.5	barrel-shaped
A. najafiani nov. sp.	4-6	0.8-1.8	1-2	0.02-0.06	see text	barrel-shaped

ramosa BOIKO (in: BOIKO et al., 1991), *Amblysiphonella omanica* WEIDLICH & SENOWBARI-DARYAN (1996), *Amblysiphonella iranica* SENOWBARI-DARYAN & HAMEDANI (2002), and *Amblysiphonella rigbyi* (SENOWBARI-DARYAN et al., 2005).

The diameter of the whole sponge of *Amblysiphonella najafiani* nov. sp. is the smallest known of the genus. Three previously described species of *Amblysiphonella* have sponge diameters less than 10 mm: *A. carinthiaca* DULLO & LEIN (1980) from the Carnian of Austria; *A. yoshinoi* AKAGI (1958) from the Permian of Japan; and *A. omanica* WEIDLICH & SENOWBARI-DARYAN (1996) from the Permian of Oman. In comparison to *A. najafiani* nov. sp., all three of these species are at least twice the size of the new species. In addition *A. najafiani* differs from the above mentioned species in the size of exopores, and in the pattern of perforation of the spongocoel wall. The Iranian species *A. iranica*, from the Perm of Iran, described by SENOWBARI-DARYAN & HAMEDANI (2002) differs from *A. najafiani* by being almost three times larger. *A. rigbyi* SENOWBARI-DARYAN et al. (2005), described from the Permian of Bagh-e Vang in Shotori Mts. (NE Iran), has the same sponge diameter (4–6 mm), but differs from *A. najafiani* nov. sp. in having a totally different perforation pattern in the chamber walls.

Occurrence (see Tab. 7): *A. najafiani* nov. sp. was found in Delijan Reefs and in the La-Kaftari locality near the Town of Bagher-Abad, NE Esfahan (see Text-Fig. 6, localities 2 and 3).

Family: Annaecoeliidae SENOWBARI-DARYAN, 1978
Genus: *Annaecoelia* SENOWBARI-DARYAN, 1978

Type species: *Annaecoelia maxiama* SENOWBARI-DARYAN, 1978.

Additional species: *A. interiecta* SENOWBARI-DARYAN & SCHÄFER, 1979.
A. mirabilis SENOWBARI-DARYAN & SCHÄFER, 1979.

Annaecoelia? interiecta SENOWBARI-DARYAN & SCHÄFER, 1979
(Pl. 32, Figs. 5, 7)

1979 *Annaecoelia interiecta* n. sp. – SENOWBARI-DARYAN & SCHÄFER, p. 27–28, Pl. 2, Figs. 1, 3; Pl. 3, Figs. 2–3; Pl. 5, Fig. 5; Pl. 7, Figs. 3, 5.

Material: Four specimens.

Description: Aggregate chambers of this sponge have overgrown other reef-building organisms, like corals or sponges, and are composed of numerous spherical to subspherical chambers arranged one above and beside another. Heights of the chambers are usually 1 mm, and their diameters range up to 2 mm. The thin chamber walls are pierced by extremely small pores. Additional small openings of ambisiphonate type are also observable on the chamber walls (Pl. 32, Fig. 7: arrows). Chamber interiors lack vesiculae and other type of filling structures.

Remarks: The sponge shape, size of the chambers, and especially the extremely fine perforation of the chamber walls of this species, correspond to that of *Annaecoelia interiecta* SENOWBARI-DARYAN & SCHÄFER (1979). However, two or several bundles of tubes passing through the sponge and the vesiculae observed in type material of *A. interiecta* from the Rhaetian reefs of the Northern Calcareous Alps (Austria) were not observed in these Iranian specimens. Therefore, the affiliation of this sponge to *A. interiecta* in uncertain.

Occurrence (see Tab. 7): This species was found in the Marawand and Naybandan Reefs (see Text-Figs. 5, 6).

Annaecoelia? parva nov. sp.
(Pl. 29, Figs. 4, 6)

Derivatio nominis: Parvus (lat. =) small. Named for the small dimensions of the sponge.

Holotype: We designate as holotype the specimen illustrated in Pl. 29, Fig. 6.

Paratype: Specimens illustrated in Pl. 29, Fig. 4.

Type locality: Small reef located about 6 km NW of the town of Ali-Abad (see Text-Fig. 5)

Type level: Norian–Rhaetian reef imbedded within the Nayband Formation.

Diagnosis: Small sphinctozoid sponge with irregular to glomerate arrangement of the chambers, and prosiphonate type of spongocoel. Chamber interiors without vesiculae or other filling skeletons. Very finely perforated(?) chamber walls.

Material: Several specimens from the type locality.

Description: This smallest thalamid sponge, found in the Nayband Formation, is probably the smallest known sphinctozoid sponge. It has a maximum length of 7 mm, with a diameter of only 4 mm. Chambers have heights of 1–1.5 mm, and diameters of 0.7–1.4 mm. The arrangement of the chambers appears to be glomerate and a spongocoel of ambisiphonate type passes through the sponge. Walls of the chambers are approximately 0.04 mm thick. Chamber interiors contain neither vesiculae nor a filling skeleton.

Because of recrystallization of the sponge skeleton and the chamber walls the character of the chamber walls (imperforate or perforate) can not be certainly determined. Some relict structures suggest the very fine perforation of the chamber walls. Such fine perforation of chamber walls is characteristic for the family Annaecoeliidae and, therefore, the affiliation of this species to that family is probable, but uncertain.

Occurrence (see Tab. 7): *A. ? parva* nov. sp., is a rare sponge found only in the type locality (Ali-Abad Reefs, see Text-Fig. 5).

Family: Salzburgiidae SENOWBARI-DARYAN & SCHÄFER, 1979
Genus: *Salzburgia* SENOWBARI-DARYAN & SCHÄFER, 1979

Type species: *Salzburgia variabilis* SENOWBARI-DARYAN & SCHÄFER, 1979.

Additional species: *S.? irregularis* WEIDLICH & SENOWBARI-DARYAN, 1996.
S.? nana RIGBY, FAN & ZHANG, 1989.

Salzburgia sp.

(Pl. 9, Fig. 7)

Material: A thin section through a few chambers of a specimen from the Ali-Abad Reefs.

Description: Only a few chambers of a specimen of this sponge were found in thin section Ab19a from the Ali-Abad Reefs. It is composed of chambers with an agglomerate arrangement. The most conspicuous feature of this sponge, and also the genus *Salzburgia*, is the double-layered chamber walls. The outer layer has a complicated labyrinthic canal system and the secondary inner layer shows a laminated structure. Because of very limited material, a species determination is not possible.

Occurrence (see Tab. 7): This species was found only in the Ali-Abad Reefs (see Text-Fig. 5).

Family: Polytholosiidae SEILACHER, 1962
Subfamily: Polytholosiinae SENOWBARI-DARYAN, 1990
Genus: *Nevadathalamia* SENOWBARI-DARYAN, 1990

Type species: *Polytholosia cylindrica* SEILACHER, 1962.

Additional species: *Nevadathalamia alpina* SENOWBARI-DARYAN, 1990
Nevadathalamia cylindrica (SEILACHER 1962)
Nevadathalamia ramosa (SENOWBARI-DARYAN & REID 1987)
Nevadathalamia waliabadensis SENOWBARI-DARYAN & HAMEDANI, 1999

Nevadathalamia variabilis nov. sp.

(Pl. 10, Figs. 1–6, 7?; Pl. 11, Figs. 1–6; Pl. 28, Figs. 12–14)

2005 *Nevadathalamia* sp. – FÜRSICH et al., Pl. 7, Fig. 5.

Derivatio nominis: Named for the variable features of the sponge.

Holotype: We designate as holotype the specimen cut in longitudinal section and documented in Pl. 10, Fig. 1/H (see also FÜRSICH et al. 2005, Pl. 7, Fig. 5).

Paratypes: All specimens in Pl. 10, Figs. 2–6; 7?, Pl. 11, Figs. 1–6; Pl. 28, Figs. 12–14.

Type locality: Naybandan Reefs, south of Tabas (see Text-Fig. 4). The holotype came from a small reef exposed on the right side of the road, about 300 m before the town of Naybandan (compare SENOWBARI-DARYAN, 2003).

Type level: Upper Triassic (Norian–Rhaetian) reefs deposited within the Nayband Formation.

Diagnosis: Single or branched(?) species of the genus *Nevadathalamia* composed of ring-chambers arranged around an axial retrosiphonate spongocoel. Chamber walls perforated with pores having spine-like elements extending from the wall into the pore interior. The wall of the spongocoel (endowall) has the same thickness as the exowall in some specimens, but in other specimens (like the holotype) it is much thinner than the exowall. The endowall has relatively large and rimmed openings that extend into the chamber interior. Chamber interiors may contain some granular or tubular filling structures.

Material: Numerous specimens in body preservation, polished slabs and in thin sections from the Marawand and Delijan Reefs (northern Esfahan), and from the Naybandan area, south of Tabas (reefs on the southern area of Nayband Mt. and near the town of Ali-Abad). This sponge was found in all localities described in section 3 and may be the most abundant sphinctozoid sponge in Norian–Rhaetian bioconstructions within the Nayband Formation.

Description: The specimens of this sponge are about 20 mm in diameter with lengths of more than 110 mm.
The cylindrical sponge is composed of numerous ring-chambers arranged one above the other (catenulate) that reach heights of 7–9 mm relatively constantly in all specimens. A wide retrosiphonate spongocoel, 10 mm in diameter in large specimens, but only 9 mm in diameter in small specimens, extends through the whole sponge.
The holotype (Pl. 10, Fig. 1/H; see also FÜRSICH et al. [2005: Pl. 7, Fig. 5]), cut in longitudinal section, exhibits the thick exo- and interwalls (about 0.5 mm), but thin endowalls (about 0.25 mm). This feature was also observed in some other specimens (Pl. 10, Fig. 6; Pl. 11, Figs. 4–5). Some specimens show exo-, inter- and endowalls of the same thickness.
The exowalls are pierced by pores having spine-like elements that extended into the pore interior (Pl. 11, Fig. 1; Pl. 28, Figs. 12–14). The endowall (spongocoel wall) of some specimens exhibit relatively large and rimmed openings that extended into the chamber interiors (Pl. 11, Fig. 3: arrows), but other specimens do not show this feature.
The interior of the chambers, especially the older chambers, are partly or totally filled with granular (Pl. 10, Figs. 1–2) or tubular (Pl. 11, Fig. 6) filling skeleton. The younger chambers do not exhibit any filling structure.

Discussion: *Nevadathalamia* is a cosmopolitan sphinctozoan sponge genus known from several localities in western North America (USA, Nevada: SEILACHER, 1962; STANLEY, 1979; KRISTAN-TOLLMANN & TOLLMANN, 1983; SENOWBARI-DARYAN & STANLEY, 1992; Canada: SENOWBARI-DARYAN & REID, 1987; Mexico: SENOWBARI-DARYAN, in: STANLEY et al., 1994) and from the Tethyan realm (Northern Calcareous Alps: ZANKL, 1969; WURM, 1982; Sicily: SENOWBARI-DARYAN & SCHÄFER, 1986) and now from Iran. All mentioned localities are Norian in age.
Nevadathalamia varabilis nov. sp. is a small species, having diameters of 20–23 mm. This species differs from the type species *N. cylindrica* (SEILACHER), an abundant sponge in North America, in its small dimensions, and its variable features of the wall of spongocoel, but mainly by its granular internal filling structure. *N. ramosa* SENOWBARI-

DARYAN & REID (1987) is differentiated from the Iranian species by its distinctly branched modus and by its well developed tubular filling structure. *N. alpina* SENOWBARI-DARYAN (1990) has almost the same dimensions as *N. variabilis*, but it differs from the new species by having a well developed tubular filling structure, a narrow spongocoel and thick exowalls.

Specimens of *N. variabils* nov. sp. without filling structure and other distinct features are very similar to some representatives of the genus *Amblysiphonella* and, therefore, it may be changed with this genus (Pl. 10, Fig. 7).

Occurrence (see Tab. 7): *Nevadathalamia variabilis* nov. sp. is the most abundant thalamid sponge species in the Iranian reefs imbedded within the Nayband formation. The sponge is extremely abundant in the reefs south of Tabas, in the Naybandan and Ali-Abad Reefs. It was found in all localities mentioned in section 3.

Subfamily: Fanthalamiinae SENOWBARI-DARYAN & ENGESER, 1996 (pro Faniinae SENOWBARI-DARYAN, 1990)

Genus: *Fanthalamia* SENOWBARI-DARYAN & ENGESER, 1996 (pro *Fania* SENOWBARI-DARYAN, 1990; non *Fania* BARNES & MCDUNNOUGH, 1911)

Diagnosis: “Moniliforme bis unregelmäßige Stämmchen ohne Spongocoel. In unterschiedlichen Abständen können Austrittsöffnungen (Osculi) entwickelt sein. Ein Füllskelett von tubulärem Typ rudimentär oder fehlend. Poren sind mehrfach verzweigt. Vesiculae wurden nicht beobachtet” (SENOWBARI-DARYAN, 1990: 83) (Moniliform to irregular stems without spongocoel. Exhalant openings (osculi) may be developed with different spacings. Filling skeleton of tubular type is rudimentary or absent. Pores are multibranched. Vesiculae were not observed).

Type species: *Polytholosia astoma* SEILACHER, 1962.

Additional species: *F. aksuensis* SENOWBARI-DARYAN (1990).
F. multicanalis SENOWBARI-DARYAN, STANLEY & GONZALES-LEON (2001).
F. polystoma (SEILACHER, 1962).
F. utriculus (VINASSA DE REGNY, 1915).
F. kadiri SENOWBARI-DARYAN, LINK & GARCIA-BELLIDO (2003) (for revision see SENOWBARI-DARYAN, 1990; SENOWBARI-DARYAN & GARCIA-BELLIDO, 2002).

Fanthalamia aksuensis SENOWBARI-DARYAN, 1990

(Pl. 12, Fig. 3; Pl. 13, Fig. 2/A)

1990 *Fania? aksuensis* n. sp. – SENOWBARI-DARYAN, p. 84, Pl. 27, Fig. 1–7, Text-Fig. 28.

Material: Two specimens.

Description: The straight or curved stems of this sponge are composed of numerous chambers arranged moniliform one above the other. The chambers are spherical to subspherical in shape having diameters up to 7 mm and heights of 8 mm. A spongocoel is lacking. The most characteristic feature of this sponge are the exhalant canals that are composed of a bundle of small openings developed with variable spacing on one(?) side of the sponge (Pl. 12, Fig. 3; Pl. 13, Fig. 2/A). After development of exhalant openings the “normal” growth of the sponge is disturbed and an asymmetrical chamber arrangement follows (Pl. 13, Fig. 2/A). Diameters of exhalant canals measure approximately 3 mm, with individual openings about 0.4 mm in diameter.

Chamber walls are usually pierced by single, rarely dichotomously branched pores. Diameters of the pores range between 0.1 mm and 0.2 mm. Interwalls between two chambers may develop as single or double-layered. The interior of some chambers may contain granular filling structure. Vesiculae are lacking.

Discussion: *Fanthalamia aksuensis* was originally described from Carnian(?) reef boulders near the small town of Aksu (Antalya area, Turkey) by SENOWBARI-DARYAN (1990) and attributed, with question, to the invalid genus named *“Fania”* (valid name *Fanthalamia*; see SENOWBARI-DARYAN & ENGESER [1996]). We believe now that this sponge can be attributed to the genus *Fanthalamia* without question. The age of the boulders of the type locality in Turkey was given as Upper Carnian (Tuvalian). Further investigations do not exclude a Norian age of these boulders. SENOWBARI-DARYAN et al. (2003) have described an additional species, *F. kadiri*, from the Carnian of the Taurus Mts. (Turkey).

Genus: *Cinnabaria* SENOWBARI-DARYAN, 1990

Occurrence (see Tab. 7): *Fanthalamia aksuensis* SENOWBARI-DARYAN was found in the Ali-Abad- and Marawand Reefs (see Text-Figs. 5 and 6).

Diagnosis: „Plattenförmiger Schwamm, bestehend aus mehreren aufeinander gereihten (moniliformen) und tubenförmigen Segmenten. Segmentwände mit verzweigten Poren. Füllskelett rudimentär und vom körnigen Typ, durch dessen Verdickung Tuben entstehen können. Ohne Spongocoel und Vesiculae” (SENOWBARI-DARYAN. 1990: 85). (Flattened sponge composed of several tube-like chambers arranged one above the other (moniliform). Chamber walls with branched pores. Filling skeleton is rudimentary and of granular type, from which thickened tubes may arise. Without spongocoel and vesiculae).

Type species: *Ascosymplegma expansum* SEILACHER, 1962.

Additional species: *C. minima* SENOWBARI-DARYAN, 1990.
C.? adnetensis SENOWBARI-DARYAN, 1990

Cinnabaria minima SENOWBARI-DARYAN, 1990

(Pl. 31, Fig. 3)

1990 *Cinnabaria minima* n. sp. – SENOWBARI-DARYAN, p. 86–87, Pl. 24, Figs. 6–9; Pl. 28, Fig. 1–7.

Material: One specimen from the Marawand Reef.

Description: The only specimen of this sponge in the collection has a conical shape and is cut in longitudinal sections parallel to the sheet. The tube-like chambers are up to 60 mm long in the upper part of the sponge, with heights of 3–5 mm. The chamber walls are thick (up to 1 mm) and pierced by numerous pores similar to those described for *Nevadathalamia variabilis* (compare Pl. 28, Figs. 12–14). Chamber interiors contain a few granular filling structures.

Occurrence (see Tab. 7): *C. minima* was found only in the Marawand Reef (see Text-Fig. 6, locality 3). The sponge, illustrated as *Colospongia catenulata* OTT from the Norian of Spiti-Kinnaur, Himachal Himalaya (India), by BHARGAVA & BASSI (1985: Pl. 25, Fig. 7) represents a specimen of *Cinnabara*, may be *C. minima*.

Genus: *Iranothalamia* nov. gen.

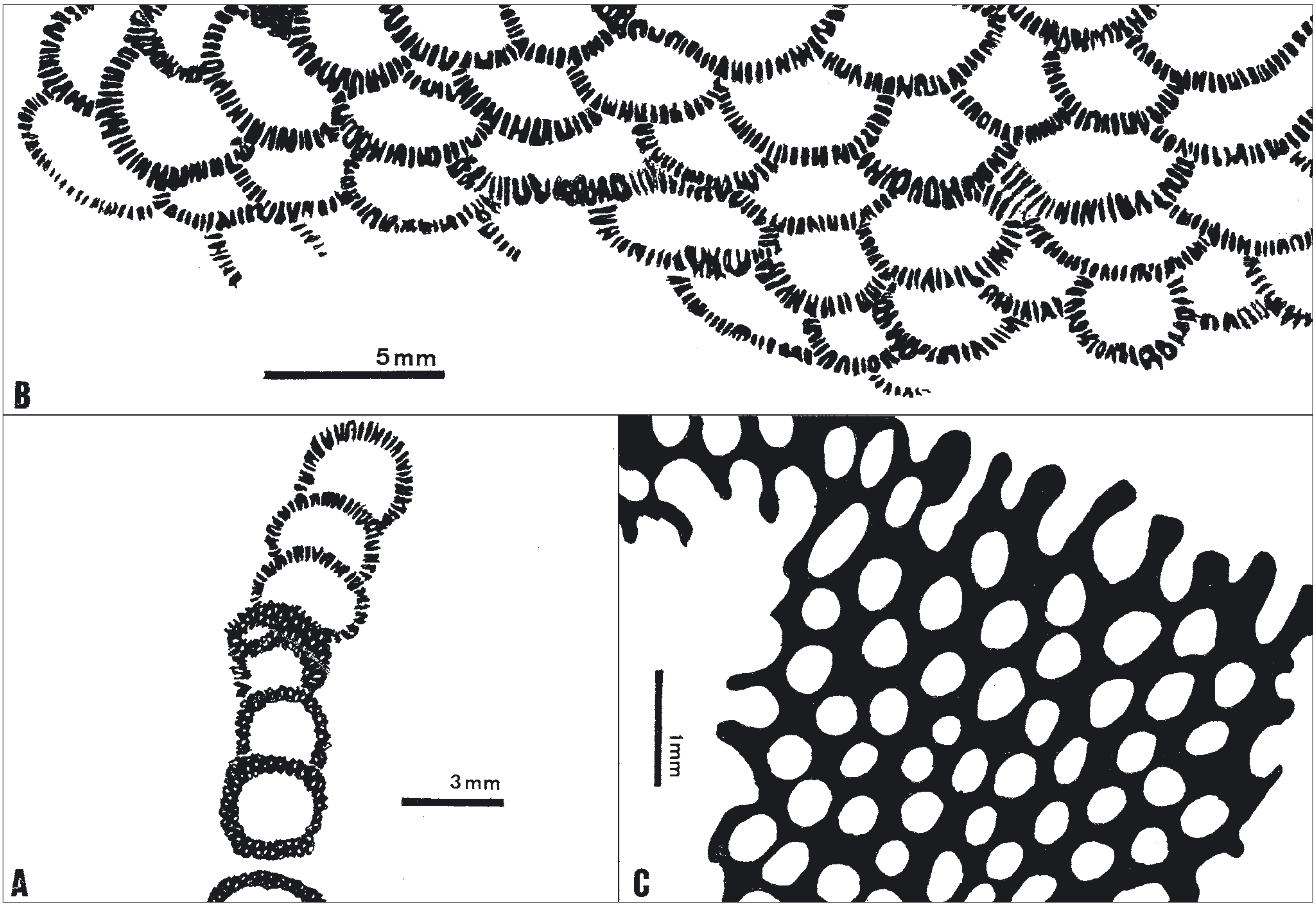
Derivatio nominis: Named for the abundant occurrence of this sponge in Upper Triassic reefs in Iran.

Diagnosis: Sheet-like, perforated thalamid sponge with numerous spherical, hemispherical, tubular or irregular rounded chambers arranged in one to two layers beside and above the others. One side of the sheet is usually more flattened than the other side. Chamber interiors contain some filling structures of granular or tubular(?) type. Vesiculae are lacking.

Type species: *Neoguadalupia incrustans* BOIKO (in BOIKO et al., 1991).

Discussion: *Neoguadalupia* was first described by ZHANG (1987) from Middle Permian reefs of the Maokou Formation in Yunnan, South China. The type species of *Neoguadalupia, N. elegana*, is characterized by sheets composed of numerous, strongly spherical to subspherical chambers arranged string-like in one layer, beside and above one another. Chamber walls are pierced by distinctly regular uniform pores of the same diameter (Text-Fig. 13). The Permian species *Neoguadalupia explanata* RIGBY, FAN & ZHANG (1989) also exhibits these features. As mentioned by SENOWBARI-DARYAN & HAMEDANI (1999) thalamid sponges described as *Neoguadalupia incrustans* from the Norian of the Pamirian range by BOIKO (in BOIKO et al., 1991), Nevada (SENOWBARI-DARYAN & STANLEY, 1992) and from the Nayband Formation of central Iran (south of Abadeh: SENOWBARI-DARYAN & HAMEDANI, 1999) differ from the Permian genus *Neoguadalupia* in the following ways:

a) Chamber shape: The shape and the variable size of chambers in the Norian *"Neoguadalupia" incrustans*, and the perforation pattern (Text-Fig. 14) differentiates this sponge from the Permian species of *Neoguadalupia*, which have markedly uniform chamber size and chamber shape (Text-Fig. 13/a–b).
b) Chamber walls: The chamber walls (endo- and exowalls) in Permian species have consistently the same thicknesses, but in the Norian species thicknesses of chamber walls are variable (compare Text-Figs. 13a,b and 14). This feature is clearly visible in specimens illustrated in Pl. 12, Fig. 1 and in specimens illustrated by SENOWBARI-DARYAN & HAMEDANI (1999: Pl. 2, Figs. 1–2; Pl. 3, Figs. 3–6).
c) Perforation of chamber walls: The chamber walls in the Norian *"Neoguadalupia" incrustans* are not pierced by regular uniform pores of even size, such as are developed in Permian species (compare Text-Figs. 13a–c, 14).
d) Construction of the sponge sheet: In the Permian species of *Neoguadalupia* both sides of the sponge sheets are uniform (Text-Fig. 13/a), but in Norian representatives one side of the sheets is usually flattened. This feature may be seen in specimens of BOIKO (in: BOIKO et al., 1991: Pl. 60, Figs. 6, 9), SENOWBARI-DARYAN & HAMEDANI (1999: Pl. 3, Fig. 1) and also in some specimens illustrated here (Pl. 12, Fig. 2; Pl. 13, Figs. 3–4; Text-Fig. 14).
e) Filling structure: In Permian species of *Neoguadalupia* filling structures are totally lacking within chamber interiors. However, some Norian species contain filling structures of granular type within the chambers, especially in the old chambers (Pl. 12, Figs. 1–2, Pl. 13, Figs. 3–4, compare also original description by



Text-Fig. 13.
Neoguadalupia elegana ZHANG from the Permian of South China.
A) Section perpendicular to the sponge sheet shows the hemispherical chambers of almost the same size arranged in one layer, above and beside each other.
B) Section parallel to the sponge sheet exhibits the hemispherical chambers of almost the same size. The chamber walls are evenly perforated.
C) Section through a chamber wall exhibits the circular or oval pores with almost the same size.
Drawn from ZHANG (1987, Pl. 1, only parts of Figs. 3 and 4–5).

BOIKO: Pl. 60, Figs. 5–7 and SENOWBARI-DARYAN & HAMEDANI, 1999: Pl. 2, Fig. 1).

f) Arrangement of the chambers: In the Permian species of *Neoguadalupia* the chambers are distinctly arranged in one layer (Text-Fig. 13/a), but in Norian species there is an observable tendency for two layered sheets (Text-Fig. 14, Pl. 13, Fig. 3, compare also SENOWBARI-DARYAN & HAMEDANI, 1999).

In addition to these mentioned differences between the Permian *Neoguadalupia* and Triassic representatives, we emphasize the similarities of Norian species of *Iranothalamia* with *Nevadathalamia* and *Fanthalamia* that occur together in Iranian reefs, and also in other Norian localities. These similarities are:

a) Internal filling structure: The genus *Nevadathalamia* is characterized by a tubular (if the filling structure is well developed) or granular-like filling structure (if the filling structure is incompletely developed). This is also true for representatives of the genera *Fanthalamia* and *Cinnabaria*. The filling structure (if developed) of *Iranothalamia* is also of granular type, indicating its relationship to representatives of the three mentioned Triassic genera.
b) Tendency to build tube-like chambers: The genus *Cinnabaria* is characterized by tube-like chambers. In *Iranothalamia* the tendency to build tube-like chambers is also observable (Pl. 13, Fig. 1). This feature also indicates a close relationship between these two genera.
c) Perforation pattern: The perforation pattern of representatives of the three genera *Nevadathalamia, Fanthalamia* and *Cinnabaria* and the new genus *Iranothalamia* is almost identical.
d) Contrast of chamber walls: The chamber walls of representatives of all four genera have the same appearance in transmitted light.

Finally, the stratigraphic occurrence and the absence of *Neoguadalupia* in the time interval of Skythian to Carnian force us to separate the Norian sponges described as *"Neoguadalupia"* from the Permian *Neoguadalupia* and to establish for Triassic representatives the new genus *Iranothalamia*, which shows close relationships to the Norian *Nevadathalamia, Fanthalamia* and *Cinnabaria*. The genus *Iranothalamia* is attributed to the family Poytholosiidae SEILACHER (1962).

Iranothalamia incrustans (BOIKO) (in BOIKO et al., 1991), nov. com.

(Pl. 12, Figs. 1–2, Pl. 13, Figs. 1, 3–4, Text-Fig. 14)

1991 *Neoguadalupia incrustans* n. sp. – BOIKO (in BOIKO et al.), p. 163, Pl. 60, Figs. 2–9.
1992 *Neoguadalupia? norica* n. sp. – SENOWBARI-DARYAN & STANLEY, p. 190–192, Figs. 8.4.–8.5.
1999 *Neoguadalupia incrustans* BOIKO. – SENOWBARI-DARYAN & HAMEDANI, p. 6, Pl. 2, Figs. 1–2; Pl. 3, Figs. 1, 3–6; Pl. 4.

Material: Numerous specimens.

Description: We avoid here a detailed description of this sponge and refer to the recent treatment of SENOWBARI-DARYAN & HAMEDANI (1999). However, the tendency to build tube-like chambers was observed in this new material (Pl. 13, Fig. 1). All other characteristics of sponge correspond to those mentioned by SENOWBARI-DARYAN & HAMEDANI (1999).

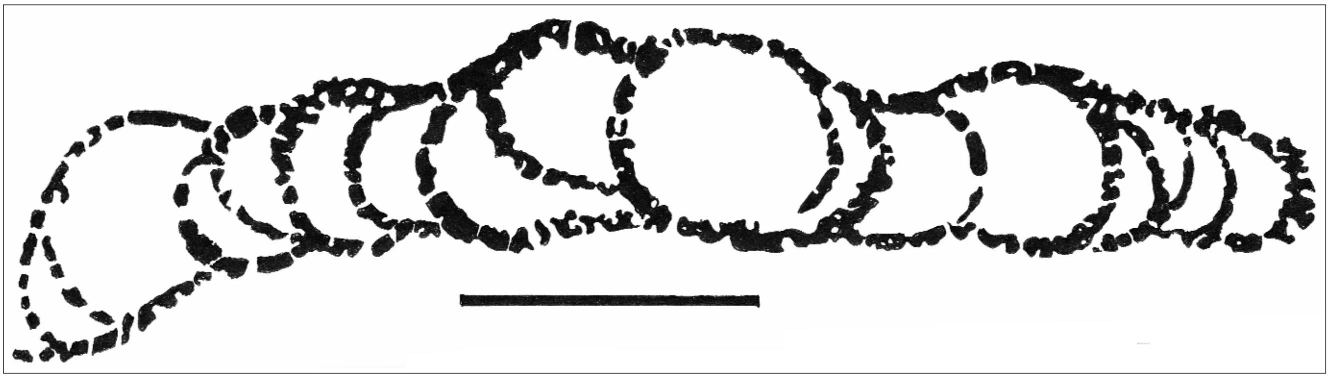
Occurrence (see Tab. 7): Specimens of *Iranothalamia incrustans* (BOIKO) were found in all Norian–Rhaetian bioconstructions within the Nayband Formation, except in reefs south of the town of Delijan. The sponge is most abundant in reefs located in the area west of the town of Ali-Abad (south of Tabas), especially in one reef, located about 7 km west of Ali-Abad. The species is also relatively abundant in the Bulbullu locality near Kerman (see Text-Fig. 7). The occurrence of the species in reefs near the town of Wali-Abad (south of Abadeh) was reported by SENOWBARI-DARYAN & HAMEDANI (1999).

Remarks: In thin sections the three genera of the family Polytholosiidae – *Fanthalamia, Cinnabaria* and *Iranothalamia* nov. gen. – appear similar and may be confused in sections cut perpendicular to the plates in *Cinnabaria* and *Iranothalamia. Fanthalamia* is composed of moniliform chambers, like *Colospongia*, but differs from *Colospongia*, in addition to a granular-tubular filling structure by possessing exhalant canals with variable spacing. *Cinnabaria* is composed of tubular segments. *Iranothalamia* is characterized by a tabular shape with moniliform (like the Permian genus *Neoguadalupia*) chambers arranged beside and above one another. The differences of five, in thin section similar looking genera, including *Fanthalamia, Colospongia, Cinnabaria, Neoguadalupia*, and *Iranothalamia* are shown schematically in Text-Fig. 15.

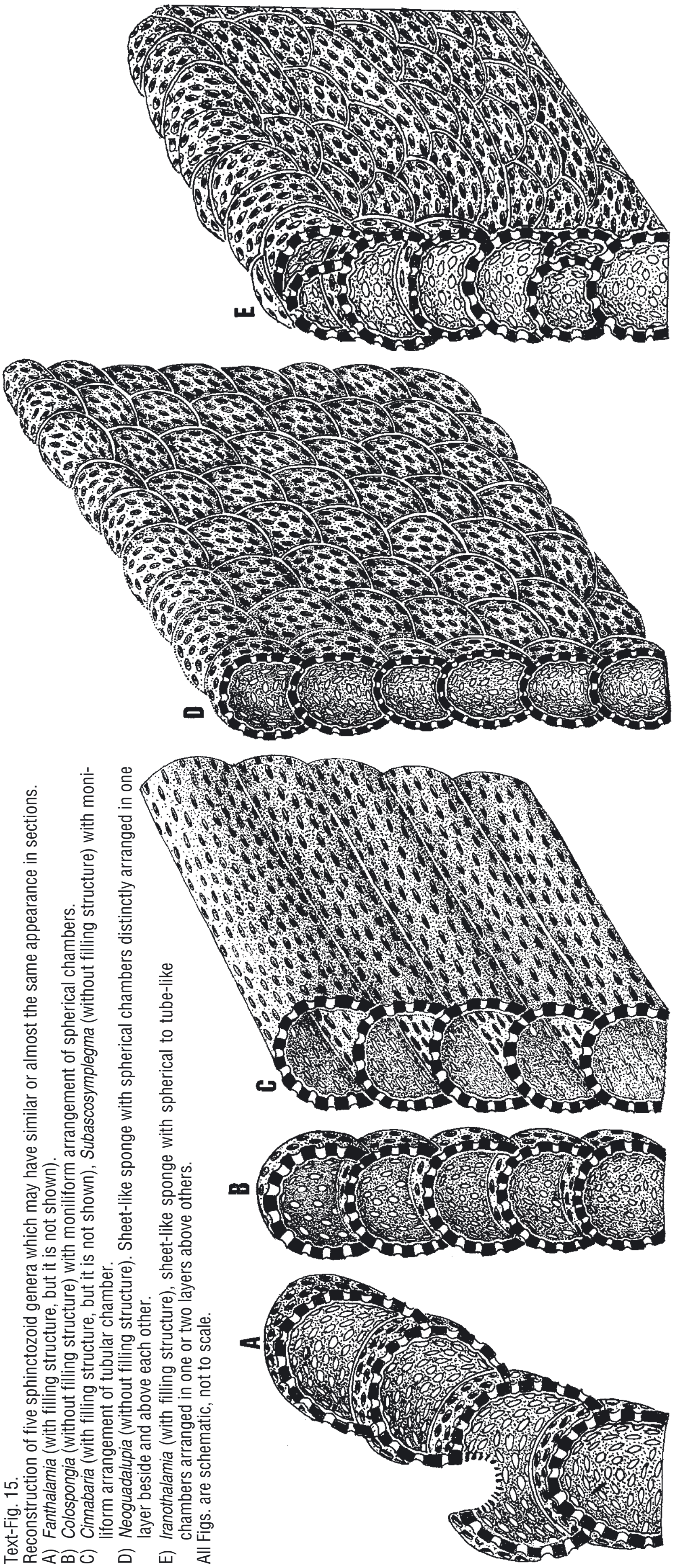
Family: Solenolmiidae ENGESER, 1986

Synonymy: Deningeriidae BOIKO 1991 (in BOIKO et al., 1991)

Remarks: For the definition of the family Deningeriidae BOIKO 1991 (in BOIKO et al., 1991) and Solenolmiidae ENGESER (1986) and the differences in the two families see SENOWBARI-DARYAN & INGAVAT-HELMCKE (1994) and SENOWBARI-DARYAN & ZAMPARELLI (1999). FINKS & RIGBY (in FINKS et al., 2004) synonymied Deringeriidae BOIKO



Text-Fig. 14.
Iranothalamia incrustans (BOIKO).
Section perpendicular to the sponge sheet exhibits the chambers of different size and shape (spherical, hemispherical, crescent-like) and the irregular pores of chamber walls with uneven distribution and size. In comparison with the Permian genus *Neoguadalupia* ZHANG (see Text-Fig. 13), *Iranothalamia* nov. gen. has only part of the chamber arrangement in common, but all other characteristics of both genera are different (from SENOWBARI-DARYAN & HAMEDANI, 1999, Pl. 3, Fig. 1). Scale 1 cm.



Text-Fig. 15.
Reconstruction of five sphinctozoid genera which may have similar or almost the same appearance in sections.
A) *Fanthalamia* (with filling structure, but it is not shown).
B) *Colospongia* (without filling structure) with moniliform arrangement of spherical chambers.
C) *Cinnabaria* (with filling structure, but it is not shown), *Subascosymplegma* (without filling structure) with moniliform arrangement of tubular chamber.
D) *Neoguadalupia* (without filling structure). Sheet-like sponge with spherical chambers distinctly arranged in one layer beside and above each other.
E) *Iranothalamia* (with filling structure), sheet-like sponge with spherical to tube-like chambers arranged in one or two layers above others.
All Figs. are schematic, not to scale.

with the family Solenolmiidae ENGESER. This systematic classification is followed in this paper.

Genus: *Senowbaridaryana* ENGESER & NEUMANN, 1986

Diagnosis: "Sphinctozoa'' mit einem thalamiden Bau und reticulärer Internstruktur. Die einzelnen Kammern sind verhältnismäßig flach. Das Spongocoel ist retrosiphonat (ENGESER & NEUMANN, 1986:153) ("Sphinctozoa" with thalamid construction and internal structure of reticular type. The individual chambers are relatively flat. The spongocoel is retrosiphonate).

Type species: *Verticillites triassicus* KOVACS, 1978 (see ENGESER & NEUMANN, 1986: 153)

Additional species: *Senowbaridaryana conica* (= *Verticillites conicus* SENOWBARI-DARYAN & SCHÄFER, 1986).
Senowbaridaryana gruberensis (= *Verticillites gruberensis* SENOWBARI-DARYAN, 1978).
Senowbaridaryana caucasica (= *Verticillites caucasicus* MOISEEV, 1944).
Senowbaridaryana hydriotica SENOWBARI-DARYAN, 1990.

Remarks: According to ENGESER & NEUMANN (1986) the genotype of *Verticillites* DEFRANCE 1829 (*V. cretaceous*) has a trabecular filling structure. Similar sponges, however, with a reticular internal structure occur in Triassic deposits which were described as *Verticillites*. These sponges are attributed to the genus *Senowbaridaryana*. BOIKO (in BOIKO et al., 1991) described a thalamid sponge with few reticular or trabecular(?) internal structures as *Polycystocoelia raretrabeculata*. Comparing this species with *Polycystocoelia norica* SENOWBARI-DARYAN & REID (1987), described from the Norian of Yukon/Canada, they noted that weak trabecular filling structures extend from the chamber walls into the chamber interiors. This kind of weakly developed filling stucture is typical of representatives of the genus *Senowbaridaryana* and also for species described in this paper. *Polycystocoelia raretrabeculata* is attributed to the genus *Senowbaridaryana* in this paper.

Senowbaridaryana raretrabeculata (BOIKO) (in BOIKO et al., 1991), nov. com.

(Pl. 14, Figs. 1–4, 6)

1991 *Polycystocoelia raretrabeculata* sp. nov. – BOIKO (in BOIKO et al.), p. 155, Pl. 46, Figs. 1–2.

Material: Several specimens from the reefs located on the southern flank of Kuh-e Nayband (Naybandan Reefs), and from Delijan- and Marawand Reefs.

Description: The stems of this branched sponge have diameters that usually range between 10 mm and 18 mm. However, at branching points diameters increase up to 22 mm. The sponge is composed of numerous crescent-like ring-chambers, with chamber heights that range between 0.4 mm and 1.2 mm. Chamber heights decrease toward the periphery of the sponge. Because of overlap of preceding chambers by younger chambers, the exowall is much thicker (up 1.2 mm) than the endowalls (the walls between the chambers) and outer segmentation is totally lacking.

A narrow spongocoel, with a diameter of 1.0–3 mm, passes through the whole sponge. The ratio of spongocoel diameter to stem diameter varies between 10 % and 20 % (see Tab. 3). The wall of the spongocoel (endowall) is thicker than the interwalls, but thinner or has the same thickness as the exowall.

The interior of the young chambers contain only a few fine-structured filling skeletal elements. However, the older chambers are filled with filling skeleton.

The thin interwalls (0.05–0.12 mm) are pierced by pores (diameter: 0.04–0.2 mm). Vesiculae are lacking.

Table 3.
Biometrical measurements of A) *Senowbaridaryana raretrabeculata* (BOIKO, in BOIKO et al., 1991) and B) *Senowbaridaryana rectangulata* nov. sp.
DST = diameter of the stems; DSR = diameter of the spongocoel; R = ratio spongocoel diameter/stem diameter; CH = height of the chambers [measured at the spongocoel wall]; P = diameter of the pores; TCH = thickness of the chamber walls. All measurements in mm.

DST	DSR	R	CH	DP	TCH
A/B	A/B	A/B	A/B	A/B	A/B
17/16	3/5	17.6/31	0.4-1.2/0.08-0.12	0.04-0.20/0.1-0.3	0.05-0.12/0.08-1.12
14/16	2/5	14.2/31	0.3-1.2/0.08-0.12	0.03-0.15/0.1-0.3	0.05-0.12/0.08-1.12
12/18	2/5	16.6/27.7	0.4-1.4/0.7-0.12	0.04-0.22/0.1-0.4	0.05-0.14/0.08-1.10
11/22	2/8	18.1/27.5	0.4-1.2/0.08-0.12	0.04-0.20/0.1-0.3	0.04-0.10/0.07-1.10
11/22	2/7	11.1/31.4	0.4-1.0/0.08-0.10	0.04-0.20/0.1-0.3	0.05-0.12/0.08-1.12
12/21	2.5/7	20.8/30	0.3-1.2/0.08-0.10	0.04-0.20/0.1-0.3	0.04-0.12/0.08-1.10
11/18	1.5/5	13.6/31	0.4-1.2/0.07-0.12	0.04-0.20/0.1-0.3	0.05-0.12/0.08-1.12
10/22	1.0/7	10.0/41.4	0.4-1.0/0.08-0.10	0.03-0.15/0.1-0.3	0.04-0.12/0.08-1.12
2/18	1.5/5	12.5/27.5	0.4-1.2/0.08-0.12	0.04-0.20/0.1-0.3	0.05-0.12/0.08-1.12
13/16	2.5/5	19/31	0.3-1.0/0.07-0.10	0.04-0.20/0.1-0.3	0.04-0.10/0.07-1.10

Remarks: MOISEEV (1944: 25–25, Pl. 1, Figs. 1a–1b) has described, from the Norian of Caucasia, a sphinctozoan sponge with flattened low chambers and reticular filling skeleton as *Circopora caucasica*. The chamber shape and the filling skeleton of this sponge are similar to *Senowbaridaryana raretrabeculata* (BOIKO). However, the axial spongocoel, a characteristic feature of the genus *Senowbaridaryana*, is lacking in *Circopora caucasica*. *Circopora* was described with two species – *C. faveolata* and *C. tubulosa* – from the Permian Productus limestones of the Salt Range (Pakistan) by WAAGEN & WENTZEL (1888) and they were attributed to the hydrozoans. The affiliation of MOISEEV´s species from the Norian of Caucasia to *Circopora* is doubtfull.

Occurrence (see Tab. 7): *S. raretrabeculata* was found in Naybandan, Delijan and Marawand Reefs (Text-Figs. 5, 6).

Senowbaridaryana rectangulata nov. sp.

(Pl. 14, Fig. 5/S; Pl. 15, Figs. 1–3; Pl. 16, Figs. 1–6)

1991 *Verticillites* sp. – BOIKO (in BOIKO et al.), Pl. 64, Fig. 1b (not ?*Verticillites* sp. as given in Pl. 63, Fig. 1 by her).
1996 *"Stylothalamia"* sp. 1. – SENOWBARI-DARYAN, Pl. 1, Fig. 5.

Derivatio nominis: Named for the rectangular chamber edge on the outside of the skeleton.

Holotype: The branched specimen cut in longitudinal section and figured in Pl. 15, Fig. 2 (Dj99/11).

Paratypes: All specimens documented in Pl. 14, Fig. 5/S; Pl. 15, Figs. 1, 3; Pl. 16, Figs. 1–6.

Type locality: Reefs imbedded within the Nayband Formation about 50 km south of the town of Delijan, at the right side of the highway between Delijan and Esfahan (see Text-Fig. 6, locality 2).

Type level: Norian reef limestones imbedded within the Nayband Formation.

Diagnosis: Multibranched stems with low and rectangular ring-chambers arranged around a wide retrosiphonate spongocoel. Chamber interiors contain weakly developed reticular filling structure. Endowall is a little thicker than the inter- and exowalls.

Material: Several specimens from the type-locality and from reefs located on the southern flank of Kuh-e Nayband.

Description: The multibranched specimens of this sponge reach lengths of more than 120 mm. Diameter of the stems range between 10 mm and 20 mm. The sponge may reach a diameter of more than 30 mm at the branching points.

A wide spongocoel of retrosiphonate type passes through the whole sponge. The diameter of the spongocoel ranges between 5 mm and 8 mm. For further dimensions of sponge elements see Tab. 3.

Chamber heights are relatively constant, ranging between 0.8 mm and 1.2 mm. Heights of chambers are constant in the axial region and at the periphery of sponge, and do not decrease toward the periphery as in earlier species.

The exo- and interwalls have the same thickness (see Tab. 3) but the endowall (wall of spongocoel) is up to 1 mm thicker.

Interiors of the chambers contain some reticular filling skeleton but chamber interiors are never totally filled, as noted also in old chambers for the preceding species. Vesiculae are lacking. The dimensions and the biometrical ratios of *S. rectangulata* nov. sp. with the similar species *S. raretrabeculata* are given in Tab. 3.

Occurrence (see Tab. 7): *S. rectangulata* found in the Delijan and Naybandan Reefs (see Text-Figs. 5 and 6, locality 2).

Remarks: Among the representatives of the genus *Senowbaridaryana* the new species is similar to *S. raretrabeculata* described as *Polycystocoelia raretrabeculata* from the Norian of the Pamier Mts. by BOIKO (in: BOIKO et al., 1991), and here from the Norian of the Nayband Formation. *S. rectangulata* nov. sp. differs from *S. raretrabeculata* by its wide spongocoel, rarely developed internal filling structure, and especially, by its rectangular chambers. Contrary to *S. rectangulata*, the chamber heights in *S. raretrabeculata* decrease toward the periphery of the sponge, and the younger chambers overlap the preceding chambers, causing thickening of the exowall.

Genus: *Paradeningeria* SENOWBARI-DARYAN & SCHÄFER, 1979

Type species: *Paradeningeria alpina* SENOWBARI-DARYAN & SCHÄFER, 1979.

Additional species: *Paradeningeria gruberensis* SENOWBARI-DARYAN & SCHÄFER, 1979.
Paradeningeria martaensis BELYAEVA (in BOIKO et al., 1991).
Paradeningeria weyli SENOWBARI-DARYAN & SCHÄFER, 1979.

Paradeningeria alpina SENOWBARI-DARYAN & SCHÄFER, 1979

(Pl. 17, Figs. 1–3; Pl. 18, Figs. 5, 6?; Pl. 19, Figs. 1, 2A)

1979 *Paradeningeria alpina* n. g., n. sp. – SENOWBARI-DARYAN & SCHÄFER, p. 22–24, Pl. 2, Figs. 2, 4–5, 7; Pl. 4, Fig. 6; Pl. 5, Fig. 6.

Material: In several thin sections from the Marawand, Delijan, Mahallat, Ali-Abad and Naybandan Reefs.

Description: Stems of this multibranched sponge are composed of numerous globular to barrel-like chambers of about 5 mm in diameter. The chambers are usually higher than wide, or have approximately the same ratio. An axial spongocoel, that is almost the half of the sponge diameter, passes through the whole sponge. A reticular filling structure fills between the exo- and endowall of the chambers.

Remarks: *Paradiningeria alpina* was first described from the Upper Rhaetian reefs in the Northern Calcareous Alps (Austria) by SENOWBARI-DARYAN & SCHÄFER (1979). It is a cosmopolitian sponge known from numerous Norian–Rhaetian reef localities in the western Tethys (Alps, Greece, Sicily, see SENOWBARI-DARYAN & SCHÄFER, 1990), northern Tethys (Pamir range: see BOIKO, in BOIKO et al., 1991), India (BHARGAVA & BASSI, 1985) North America (Canada: SENOWBARI-DARYAN & REID, 1987), and from Iran (this paper).

Occurrence (see Tab. 7): Specimens of *P. alpina* were found in the Marawand (Text-Fig. 6, locality 3), Delijan (Text-Fig. 6, locality 2), Mahallat Reefs (Text-Fig. 6, locality 1) and in reefs around the Kuh-e Nayband (Ali-Abad and Nayband Reefs) (Text-Fig. 5).

Paradeningeria minor nov. sp.

(Pl. 18, Figs. 2–3; Pl. 19, Figs. 4–5)

Derivatio nominis: Named for the small size of the sponge.

Holotype: We designate the specimen cut in longitudinal section illustrated in Pl. 18, Fig. 3.

Paratypes: Specimens illustrated in Pl. 18, Fig. 2; Pl. 19, Figs. 4–5.

Type locality: Sponge-dominated reef, approximately 6.5 km northwest of the small town of Ali-Abad (see Text-Fig. 5).

Type level: Bioconstructions within the Nayband-Formation (Norian–Rhaetian).

Diagnosis: Small, single or branched? specimen with spherical to barrel-shaped chambers. Skeleton fibres are very fine. Axial spongocoel is of retrosiphonate type. A secondary skeleton fills the interior of the spongocoel.

Material: Several specimens in thin section 96/31/3 from the Ali-Abad Reefs.

Description: The single or branched? specimens of this sponge reach lengths of up to 20 mm. The small ring-chambers are subspherical to barrel-shaped and arranged catenulate around an axial spongocoel that passes through the whole sponge. The chambers are usually 1–2 mm high, rarely up to 3 mm, and their diameters range between 2 mm and 3 mm, maximally 4 mm. The skeleton fibres are very fine. Characteristic of the sponge is the filling skeleton within the spongocoel (usually less than 1 mm in diameter), which was not observed in other species of the genus (Pl. 18, Figs. 2–3; Pl. 19, Fig. 5).

Remarks: *Paradeningeria minor* nov. sp. differs from *P. alpina, P. weyli* and *P. gruberensis* described by SENOWBARI-DARYAN & SCHÄFER (1979) from the Upper Rhaetian reefs of the Alps (Austria), by its small dimensions, fine fibre skeleton and especially by the filling skeleton within the axial spongocoel. *P. martaensis* with a diameter of more than 10 mm, described by BELYAEVA (in BOIKO et al., 1991) from the Permian of Crimea, is documented only by a cross section (this could be also another sphinctozoid or even inozoid sponge), is much bigger than our species. The affiliation of *P. martaenis* to *Paradeningeria* is uncertain.

Occurrence (see Tab. 7): *Paradeningeria minor* nov. sp. was found only in the Ali-Abad Reefs (see Text-Fig. 5).

Genus: *Welteria* VINASSA DE REGNY, 1915

Diagnosis: See SENOWBARI-DARYAN (1990: 94).

Type species: *Welteria repleta* VINASSA DE REGNY, 1915.

Additional species: *W. fluegeli* SENOWBARI-DARYAN, 1990.
W.? hawasinensis WEIDLICH & SENOWBARI-DARYAN, 1996.
W. rhaetica SENOWBARI-DARYAN, 1990.

Welteria hamedanii nov. sp.

(Pl. 13, Fig. 2c; Pl. 20, Figs. 1–2, 4–5, 6?)

Derivatio nominis: This species is dedicated to Prof. Dr. ALI HAMEDANI (University of Esfahan) for his help with the field work for this study.

Holotype: We designate as holotype the specimen cut in longitudinal section and illustrated in Pl. 20, Fig. 4.

Paratypes: All specimens illustrated in Pl. 13, Fig. 2c; Pl. 20, Figs. 1–2, 5, 6?

Type locality: Reefs imbedded within the Nayband Formation about 50 km south of the town of Delijan, on the right side of the highway from Delijan to Esfahan (see Text-Fig. 6, locality 2).

Type level: Bioconstructions within the Nayband Formation (Norian).

Diagnosis: Sponge composed of numerous ring-chambers arranged catenulate one above the other. Chamber walls with complicated canal system (labyrinth-like). Axial spongocoel of retrosiphonate (ambisiphonate?) type is formed by dense axialy oriented fibre skeleton. Chamber interior with loose reticular filling structure.

Material: From the Delijan Reefs (DJ1/0: holotype) and Ali-Abad Reefs (Ab9/1, Ab9/2, Ab29, and Ab33[?]).

Description: Stems of this sponge are composed of several ring-chambers with catenulate arrangement. The holotype (Pl. 20, Fig. 4), with a length of 28 mm and a diameter of 12 mm, is composed of at least 7 chambers. Heights of the chambers range between 2.5 mm and 5 mm. One of the paratypes (Pl. 20, Fig. 1) is composed of 11 chambers and has a length of 40 mm. Diameter of other paratypes range between 8 mm and 11 mm.

The chamber exowalls, which are up to 1 mm thick, are pierced by a complicated canal system (labyrinth-like). The chamber roofs (interwalls) are pierced at the periphery by a labyrinthic pore system like that in the exowalls, but toward the spongocoel they are pierced by large openings passing to the spongocoel. These openings are elongated individual tubes that form a bundle of tubes within the spongocoel that passes through the whole sponge. These tubes are bounded by loose and vertically oriented skeletal fibres. It is difficult to determine the type of spongocoel (retro- or ambisiphonate?). The holotype and one of the paratypes (Pl. 20, Fig. 1) exhibit a retrosiphonate type of spongocoel.

The chamber interiors are filled with a loosely packed reticular fibre skeleton. Fibre of the filling structure, especially in the holotype, shows vertically orientation. Vesiculae are lacking.

Discussion: The following species of *Welteria* have been described to date: *W. repleta* VINASSA DE REGNY (1915), *W. fluegeli* SENOWBARI-DARYAN (1990), *W.? hawasinensis* WEIDLICH & SENOWBARI-DARYAN (1996), and *W. rhaetica* SENOWBARI-DARYAN (1990). *Welteria hamedanii* nov. sp. differs from all mentioned species of *Welteria* by the kind of multitubular formation of the spogocoel. All three other species have only an axial spongocoel with an endowall but the new species has a bundle of canals forming the spongocoel without an endowall. Additionally *W. hamedanii* differs from *W. repleta* by its regular chambers, from *W. rhaetica* by a much finer filling structure and shape of the chambers, and from *W. fluegeli* by a looser filling skeleton and by the kind of canals passing through the chambers (see SENOWBARI-DARYAN, 1990).

Occurrence (see Tab. 7): *Welteria hamedanii* nov. sp. was found in Ali-Abad Reefs (Text-Fig. 5) and in Delijan Reefs (Text-Fig. 6, locality 2).

Genus: *Deningeria* WILCKENS, 1937

Diagnosis: "Asiphonate, perforate to coarse perforate sponge with a reticular filling structure within the interior of the chambers. The filling structure is coarse and densely packed at the peripheral part of the chambers, getting finer and loose to the central part of the chamber interiors. Skeletal mineralogy was most probably aragonite. Microstructure and spicules are not known" (SENOWBARI-DARYAN & ZAMPARELLI, 1999: 148).

Type species: *Deningeria camerata* (pars) WILCKENS, 1937 (see SENOWBARI-DARYAN, 1990: 97).

Additional species: *Demingeria mirabilis* WILCKENS, 1937
Deningeria temeticus (HURCEWICZ, 1975).
Deningeria tenuireticulata SENOWBARI-DARYAN, ZÜHLKE, BECHSTÄDT & FLÜGEL, 1993.
Deningeria crassireticulata SENOWBARI-DARYAN, ZÜHLKE, BECHSTÄDT & FLÜGEL, 1993.
Deningeria iannacei SENOWBARI-DARYAN & ZAMPARELLI, 1999.

Deningeria cf. *D. camerata* WILCKENS, 1937

(Pl. 8, Figs. 6–7)

1937 *Deningeria camerata* n. g. n. sp. – WILCKENS, p. 200–201, Pl. 13, Figs. 3–5.

Material: Only one specimen from Delijan Reefs (Text-Fig. 6, locality 2).

Description: The only specimen of this sponge came from Delijan Reefs. It is totally surrounded by an inozoid sponge of *Stellispongia*-type. Apparently the branched sponge is composed of numerous flattened and crescent-like chambers. The outer segmentation of sponge is poorly developed. The interior of the chambers are filled with reticular filling structure. The chamber walls are pierced by numerous pores. Spongocoel is absent.

Remarks: Because of its perforated chamber walls and possession of reticular filling structure, and because of the lack of a spongocoel, this sponge is attributed to the genus *Deningeria*. It is very similar to the type species – *D. camerata* – known from the Norian of the island of Seran (WILCKENS, 1937). Because of the large dimensions of our sponge, and, since only one specimen is available, we are not sure about the identity of this specimen with *D. camerata* WILCKENS.

Occurrence (see Tab. 7): *Deningeria* cf. *D. camerata* was found only in the Delijan Reefs (Text-Fig. 6, locality 2).

Deningeria tabasenis nov. sp.

(Pl. 18, Figs. 1, 4, Pl. 20, Fig. 3)

Derivatio nominis: Named from the town of Tabas, the closest large town to the type locality.

Holotype: We designate as holotype the multibranched specimen figured in Pl. 18, Fig. 4.

Paratypes: Pl. 18, Fig. 1, Pl. 20, Fig. 3.

Type locality: The small sponge-dominated reef about 6.5 km northwest of the town Ali-Abad, at the right side of the road from Ali-Abad to Ab-Boneh (see Text-Fig. 5).

Type level: Bioconstruction within the Nayband Formation, Norian–Rhaetian.

Diagnosis: Multibranched thalamid sponge composed of numerous funnel-shaped chambers. Chambers usually wider than high. Chamber interiors contain a reticular filling structure. Lacks a spongocoel.

Material: Several specimens from the type locality in thin sections Ab31 and Ab17/97/67.

Description: This multibranched sponge reaches lengths of up to 40 mm and is composed of funnel-shaped chambers arranged in moniliform series one above the other. The chamber interiors contain a reticular filling structure with an orientation of the skeletal fibres parallel to the axis of the sponge. The chambers are sometimes quadrangular and depressed on the middle part of the roofs. They are about twice as wide as high. The chambers have diameters of 4–5 mm and heights of 2–3 mm. A spongocoel is lacking. The sponge shows common borings produced by small bivalves.

Remarks: *Deningeria tabasensis* nov. sp. differs from all other known species (see above) by the dimensions and shape of the chambers, and by the orientation of filling skeletal fibres within the chamber interiors.

Occurrence (see Tab. 7): *D. tabasensis* nov. sp. was found only in the type locality (see Text-Fig. 5).

Genus: *Panormida* SENOWBARI-DARYAN, 1980b

Diagnosis: See SENOWBARI-DARYAN 1990: 93, FINKS & RIGBY (in FINKS et al., 2004: 692).

Type species: *Panormida priscae* SENOWBARI-DARYAN, 1980b.

Further species: *Panormida gautretae* SENOWBARI-DARYAN, 1990.

Panormida? sp.

(Pl. 18, Fig. 7)

Material: Only one specimen from the Delijan Reefs in thin section P/213.

Description: The dichotomously branched specimen of this species has a length of at least 80 mm. It is composed of numerous funnel-shaped chambers with heights of 6–8 mm and diameters of up to 15 mm. The chamber walls appear to be up to 2 mm thick. Chamber interiors are filled with a reticular filling skeleton. Due to strong recrystallization of the skeleton, details of the sponge are not recognizable. Because of the funnel-shaped chambers, the affiliation of this sponge to *Panormida* is possible, but not sure.

Occurrence: The only specimen of this species was found in the Delijan Reefs (Text-Fig. 6, locality 2).

Family: Intrasporeocoeliidae FAN & ZHANG, 1985

Discussion: Intrasporeocoeliidae was established by FAN & ZHANG (1985) for those Permian sphinctozoid sponges with a spore-like filling structure within the chamber interiors (see also RIGBY et al., 1988, 1989). Two genera, *Intrasporeocoelia* FAN & ZHANG (1985) and *Rhabdactinia* YABE & SUGIYAMA (1934) were assigned to this family by FAN & ZHANG (1985). FINKS & RIGBY (in FINKS et al., 2004) added the genera *Rahbahthalamia* WEIDLICH & SENOWBARI-DARYAN (1996), and *Belyaevaspongia* SENOWBARI-DARYAN & INGAVAT-HELMCKE (1994) to this family. All genera are known only from Permian deposits. Sphinctozoid sponges with a spore-like internal structure are not known from the Triassic. The spore-like internal filling structure of the sphinctozoid sponge, described below, is identical with those occurring in Permian representatives. All other characteristics of the Iranian intrasporeocoelid sponge (e. g. retrosiphonate spongocoel, chamber walls and their perforation pattern) are different from Permian representatives of the intrasporeocoeliids. We are not sure about the certain attribution of the Triassic genus, described here as *Delijania* nov. gen., to the Intrasporeocoeliidae.

The Triassic intrasporeocoeliid genus *Delijania*, described below, differs from the Permian genera, *Intrasporeocoelia* FAN & ZHANG and *Rhabdactinia* YABE & SUGIYAMA, by having a retrosiphonate spongocoel and by the perforation pattern of the chamber walls.

Delijania nov. gen.

Derivatio nominis: Named for the town Delijan, the closest large town to the type locality.

Diagnosis: Single or branched sphinctozoid sponge with spore-like internal filling skeleton within the chamber interiors, as well as within the spongocoel. Relatively wide spongocoel of retrosiphonate type. Walls between two chambers (interwalls) are double-layered, and the contact between the chamber layers appears as a dark line.

Type species: *Delijania retrosiphonata* nov. sp.

Delijania retrosiphonata nov. sp.

(Pl. 5, Figs. 1–3)

Derivatio nominis: Named for the retrosiphonate type of the spongocoel.

Holotype: Specimen cut in longitudinal section and figured in Pl. 5, Fig. 1 (thin section P223).

Paratype: Pl. 5, Fig. 2.

Type locality: Reefs at the right side of the highway from Delijan to Esfahan, approximately 50 km south of Delijan (Text-Fig. 6, locality 2).

Type level: Norian reefs imbedded within the Nayband Formation.

Diagnosis: See diagnosis of the genus.

Material: In addition to the holotype, another sample with three individuals(?) or a multibranched(?) specimen was collected from the type locality.

Description: This single or branched(?) sponge is composed of numerous ring-like chambers arranged catenulate around a wide spongocoel. The diameter of the sponge is about 23 mm. Because of broken specimens, the length of the sponge is not known.

The holotype (Pl. 5, Fig. 1) represents an oblique longitudinal section composed of at least 16 chambers. It reaches a length of 45 mm with a stem diameter of 22 mm. The low, ring-like chambers are crescentic and have a height of 2–4 mm. Chamber interiors are filled (especially the older chambers) with spore-like internal filling structure, which may be easily recognizable in younger chambers, if they are not totally filled with an internal skeleton. Individual „spores“ reach diameters of 0.2–1 mm (Pl. 5, Fig. 3). Both, the chamber walls and the filling structure are strongly recrystallized. Some radially oriented relic structures within the „spore“ interiors indicate, most probably, a spherulitic microstructure of the spore-like elements.

Indistinct chamber walls seem to grade into the filling structure and the interwalls between two chambers are double-layered. The spaces between layers of chamber walls appear as thin dark lines in thin sections (see Pl. 5, Figs. 1–2). The walls are perforated with multibranched pores, but because of the recrystallization they are not well defined.

A relatively wide spongocoel of retrosiphonate type passes through the whole sponge. In one paratype, 23 mm in diameter, the spongocoel is approximately 8 mm in diameter (about 34 % of the whole sponge diameter), and in another one of 22 mm in diameter the spongocoel is only 4 mm across (about 18 % of the whole sponge). In the holotype, the spongocoel appears to be very wide because another sphinctozoid sponge has grown beside the spongecoel and is surrounded by the chambers of *Delijania* (Pl. 5, Fig. 1: arrow). Also a sphinctozoid sponge is colonized or has overgrown the youngest part of the holotype. The holotype, which is 22 mm in diameter, has a spongocoel that is about 6 mm across (27 % of the whole sponge diameter). The endowall (spongocoel wall) has the same thickness as the inter- or exowalls. In both, the holotype and the paratype, the interior of spongocoel is filled by spore-like filling structures, like the interior of the chambers.

The sponge skeleton was most probably composed primarily of aragonite. The radially arranged relic structures in spore-like elements within the chamber interiors indicate, most probably, a spherulitic microstructure of the filling skeleton.

Occurrence (see Tab. 7): *Delijania retrosiphonata* nov. gen., nov. sp. was found only in reefs in the southern part of the town of Delijan (Delijan Reefs, see Text-Fig. 6, locality 2). Here it is a rare sponge.

Family: Cryptocoeliidae STEINMANN, 1882
Genus: *Cryptocoelia* STEINMANN, 1882

Diagnosis: „Einzeln, selten verzweigte, asiphonate oder retrosiphonate Stämmchen mit trabeculärem Füllskelett. Pfeiler massiv, dicht stehend und lamellar gestreift. Vesiculae sowohl in den Segmenten als auch im Zentralrohr. Skelett besteht aus Aragonit mit irregulärer Mikrostruktur. Spiculäres Skelett nicht bekannt" (SENOWBARI-DARYAN, 1990: 102) (Single, rarely branched, asiphonate or retrosiphonate stems with trabecular filling skeleton. Massive pillars, densely packed and lamellar striped. Vesiculae occur in the interior of segments, as well as in axial canal. Skeleton composed of aragonite with irregular microstructure. Spicules not known).

Type species: *Cryptocoelia zitteli* STEINMANN, 1882.

Additional species: *C. kovacsi* FLÜGEL, VELLEDITS, SENOWBARI-DARYAN & RIEDEL, 1992.
C. crassiparietalis SENOWBARI-DARYAN & SCHÄFER, 1986.
C. cylindrica SENOWBARI-DARYAN, 1990.
C. lata SENOWBARI-DARYAN & SCHÄFER, 1983.
C. multisiphonata SENOWBARI-DARYAN & ABATE, 1986.
C. siciliana SENOWBARI-DARYAN, 1990.
C. *tenuiparietalis* SENOWBARI-DARYAN, 1980.
C. wurmi SENOWBARI-DARYAN & DULLO 1980.

Cryptocoelia wurmi SENOWBARI-DARYAN & DULLO, 1980
(Pl. 17, Figs. 4–9)

1980 *Cryptocoelia wurmi* n. sp. – SENOWBARI-DARYAN & DULLO, p. 206, Pl. 1, Figs. 1–6.

Material: In thin sections from the Marawand (M34, M55, M84) and Delijan Reefs (P308/1 and P326).

Description: The moniliform and usually curved stems of this asiphonate sponge reach lengths of more than 30 mm, with diameters of 4–7 mm. Heights of the crescent-like, elliptical to tongue-like segments range between 2 mm and 5 mm. The ratio of chamber height to chamber width is usually larger than 1. Chamber walls are pierced by numerous uniformly unbranched pores. Chamber interiors are filled by thick pillar (trabecular) structures having punctate appearing (especially in the center of chambers) in sections perpendicular to the axis of the sponge. Some vesiculae may occur, especially within the older chambers.

Discussion: Until now *Cryptocoelia wurmi* has been known from the Norian Dachstein reef limestones of Gesäuse, Austria (SENOWBARI-DARYAN & DULLO, 1980; DULLO, 1980) and possibly from Gosaukamm, Austria (WURM, 1982). It occurs also in Norian reef limestones of Sicily (unpublished material). All localities are Norian in age.

Occurrence (see Tab. 7): *C. wurmi* was found in the Marawand (M34, M55, M84) and Delijan Reefs (P308/1, P326).

Genus: *Antalythalamia* SENOWBARI-DARYAN, 1994b

Diagnosis: "Moniliforme und asiphonate Stämmchen mit poraten Segmentwänden. Die groben und nicht verzweigten Poren verleihen dem Schwamm eine rauhe und bienenwabenähnliche Oberfläche. Das Füllskelett besteht aus relativ massiven, jedoch aus wenigen Pfeilern (trabeculäres Füllskelett). Häufige Vesiculae im Segmentinneren" (SENOWBARI-DARYAN, 1994b: 418) (Moniliform and asiphonate stems with perforated chamber walls. The coarse and unbranched pores give the sponge a rough and honeycomb-like surface. The filling skeleton is composed of massive, but few pillars (trabecular filling skeleton). Abundant vesiculae within the chamber interiors).

Type species: *Antalythalamia riedeli* SENOWBARI-DARYAN, 1994b.

Antalythalamia? cf. *riedeli* SENOWBARI-DARYAN, 1994b
(Pl. 9, Fig. 4, 5?)

Material: One or two specimens from the Delijan Reefs.

Description: Only one or two broken specimens of this sponge occur in the collection and are composed of three spherical to subspherical chambers, with a diameter of 6 mm and a height of 5 mm. The perforated chamber walls, the pattern of perforation, and the pillar-like filling skeleton correspond largely to the type species – *Anthalythalamia riedeli* – described from the Norian reefs of the Taurus Mts. (Turkey) by SENOWBARI-DARYAN (1994b), but we are not sure about the identity of the species.

Occurrence (see Tab. 7): *Anthalythalamia?* cf. *riedeli* was found only in Delijan Reefs (Text-Fig. 6, locality 2).

Order: Uncertain
Family: Cryptocoeliidae? STEINMANN, 1882
Genus: *Stylothalamia* OTT, 1967

Type species: *Stylothalamia dehmi* OTT, 1967.

Additional species: *Stylothalamia budensis* WELLS, 1934.
Stylothalamia caniegoensis (REITNER & ENGESER, 1985).
Stylothalamia columnaris (LE MAITRE, 1935).
Stylothalamia eleganta RIGBY et al., 1994.
Stylothalamia hambastensis SENOWBARI-DARYAN & HAMEDANI, 1999.
Stylothalamia hydriotica SENOWBARI-DARYAN, 1990.
Stylothalamia lehmani ENGESER & NEUMANN, 1986.
Stylothalamia permica SENOWBARI-DARYAN, 1990.
Stylothalamia polysiphonata SENOWBARI-DARYAN, 1994b.

"Stylothalamia" columnaris (LE MAITRE, 1935)
(Pl. 21, Figs. 1–5)

1935 *Stromatomorpha californica* SMITH var. *columnaris* nov. var. – LE MAITRE, p. 41, Pl. 7, Figs. 3–10.
1990 *Stylothalamia columnaris* LE MAITRE. – SENOWBARI-DARYAN, p. 49, Pl. 16, Figs. 1–3, 5 (Synonymy-list!).

1999 *Stylothalamia columnaris* LE MAITRE. – SENOWBARI-DARYAN & HAMEDANI, p. 88, Pl. 2, Fig. 2/A; Pl. 3, Fig. 3; Pl. 5, Figs. 3?, 4–5; Pl. 6, Fig. 3.

Material: Specimens of this species occur in thin sections from the Delijan (Dj16, P207/2b), Ali-Abad (Ab24) and Naybandan Reefs (N6/1, T29/3B).

Description: The stems of this sponge are composed of several crescent-like ring chambers, arranged in catenulate fashion one above the other, around an axial spongocoel of retrosiphonate type. The diameter of the sponge is less than 10 mm. The exo-, inter- and endowalls are pierced by unbranched pores of equal size. The chamber interiors contain slender pillar structures. A detailed description of the sponge species was given by SENOWBARI-DARYAN & HAMEDANI (1999).

Discussion: *Stylothalamia columnaris* (LE MAITRE) has been reported from Liassic deposits of numerous localities in the world (see SENOWBARI-DARYAN & HAMEDANI, 1999). SENOWBARI-DARYAN & HAMEDANI (1999) have described this sponge from the reefs within the Nayband Formation exposed near the town of Wali-Abad, south of Abadeh. Here the sponge is associated with the brachiopod *Oxycolpella oxycolpus*, which indicates a Rhaetian age (KRISTAN-TOLLMANN et al., 1979). The possibly Liassic age of carbonates south of Abadeh was discussed by SENOWBARI-DARYAN & HAMEDANI (1999). As noted by SENOWBARI-DARYAN & HAMEDANI, that time the sponge had not been found in other localities in central Iran. Now, however, we report that *Stylothalamia columnaris* occurs in other Norian–Rhatian reef localities of central Iran.

Occurrence (see Tab. 7): In addition to the occurrence of *Stylothalamia columnaris* in the Wali-Abad area (south of Abadeh: SENOWBARI-DARYAN & HAMEDANI, 1999) we found this species only in the Delijan and Naybandan Reefs (see Text-Figs. 5 and 6, locality 3).

"Stylothalamia"? sp.

(Pl. 30, Fig. 4)

Material: Only one specimen, from the Delijan Reefs (P/83).

Description: Only one weathered specimen of this sponge was recovered and cut in longitudinal section, having a length of 70 mm. It is composed of at least 8 crescent-like chambers with chamber heights of 6–8 mm and a maximum diameter of 31 mm, which corresponds to the sponge diameter. A spongocoel of retrosiphonate type is cut in the central part and it has a minimum diameter of 8 mm. Interiors of the chambers are filled with a pillar-like filling skeleton. The chamber walls are thin, having thicknesses of less than 1 mm.

Remarks: The slender pillars within the chamber interiors indicate affinities of this sponge to the genus *Stylothalamia* OTT. Dimensions of sponge and sponge elements of the Iranian specimen are almost identical with the species described as *Stylothalamia hydriotica* from the Carnian reefs of Hydra (Greece) by SENOWBARI-DARYAN (1990). However, the skeletal mineralogy of Ladinian–Carnian stylothalamid sponges was composed of high-Mg-calcite. In contrast, the skeletal mineralogy of this sponge and other Iranian stylothalamid sponges, as well as all Liassic stylothalamid sponges from other localities, was most probably primary aragonite. Therefore, assignment of this sponge to *Stylothalamia* is uncertain. A revision of stylothalamid sponges is urgently needed.

Occurrence (see Tab. 7): The only specimen of this species in the current collection was found in the Delijan Reefs (Text-Fig. 6, locality 2).

Stylothalamia? or *Cryptocoelia?* sp. (nov. sp.?)

(Pl. 30, Fig. 2, Pl. 31, Fig. 6)

Material: Two specimens, from the Delijan Reefs.

Description: Branched specimens of this species are composed of numerous flattened, crescent-like chambers 2–3.5 mm high. Because of recrystallization the chamber- and spongocoel walls appear much thicker than they are in reality. In the specimen illustrated in Pl. 30, Fig. 2, where the sponge branched, the spongocoels are composed of at least two tubes. These spongocoels have internal diameters of 2–3 mm, and 5–6 mm in diameter including the spongocoel wall. The specimen illustrated in Pl. 31, Fig. 6 also exhibits spongocoels composed of several tubes. Chamber interiors contain pillar-like filling structure.

Remarks: This sponge represents a new species belonging to the genus *Stylothalamia?* or *Cryptocoelia?.* Since there are not enough specimens available and because of recrystallization of the available specimens we describe it as a questionable species of the genus *Cryptocoelia?* or *Stylothalamia?*

Occurrence (see Tab. 7): This species was found only in the Delijan Reefs (Text-Fig. 6, locality 2).

Family: Tabasiidae nov. fam.

Diagnosis: Sphinctozoid sponge with flattened chambers and one or more exhalant canal bundles, with additional tubes that are more or less parallel to the sponge axis and are distributed through the whole interwalls. The canal bundles end at an osculum that may be astrorhizal-like at the top of the sponge. The exowall is pierced by a complicated (labyrinth-like branched) canal system. The primary skeletal mineralogy was most probably aragonite. Microstructure and spicules are not known.

Type genus: *Tabasia* nov. gen.

Genus: *Tabasia* nov. gen.

Derivatio nominis: Named from the town of Tabas, the closest large town to the type locality.

Diagnosis: Single or branched, conical to cylindrical or aggregates of irregularly shaped sphinctozoid sponges with indistinct internal segmentation. Outer segmentation has the appearance of growth lines. Chambers flattened. Outer wall with complicated pore system. Internally the sponge body is composed of one or more canal bundles and tubes that are more or less parallel to the sponge axis. Canal bundles may end at star-like (astrorhizal-like) osculi in the depressed top of the sponge. Spicular skeleton is not known. The mineralogical composition of the rigid skeleton was most probably aragonite.

Type species: *Tabasia maxima* nov. sp.

Discussion: Representatives of sphinctozoid sponges with tubular filling skeletons were assigned to the family Polytholosiidae by SEILACHER (1962). All representatives of Polytholosiidae are characterized by single or dichotomously branched pores in outer and inner walls. In addition, in polytholosiid sponges the tubes are oriented more or less perpendicularly to the spongocoel or sponge axis and are usually horizontally extending from the outer wall toward the axial spongocoel or sponge axis.

The tubes in *Tabasia*, which are oriented parallel to the sponge axis, are not comparable to those in the Polytholosiidae.

A labyrinthic branched pore system of the chamber walls occurs in some sphinctozoid genera (e.g. in *Welteria*

Text-Fig. 16.
Tabasia maxima nov. sp.
Longitudinal section through the holotype (see Pl. 24, Fig. 4) exhibits the indistinct internal segmentation with at least 7 canal bundles and numerous tubes, cut mainly in transverse or oblique sections. The outer segmentation is more or less recognizable. The complicated canal system (labyrinth-like) of the outer wall is not shown.
Scale 1 cm.

VINASSA DE REGNY, 1915, and *Calabrispongia* SENOWBARI-DARYAN & ZAMPARELLI, 2003), but these genera are characterized by having an axial spongocoel without internal filling structure (*Calabrispongia*), with reticular filling structure (*Welteria*), or by lack of a spongocoel (*Kashanella* nov. gen.). *Tabasia* nov. gen. differs from these genera, and is characterized by a labyrinthic pore system in the outer wall, and from all other known sphinctozoid sponges by possession of one or several canal bundles and numerous tubuli distributed through the whole sponge. Astrorhizal systems are not known from polytholosoiid sponges and the mentioned genera, but occur, for example in Permian genera *Guadalupia*, which has a totally different construction from that in *Tabasia* (see SENOWBARI-DARYAN, 1990).

Canal system similarities exist between the genera *Tabasia* and *Yukonella**), a Norian sphinctozoid sponge known from Yukon, Canada (SENOWBARI-DARYAN & REID, 1987). *Yukonella* has only an axial canal bundle but species of *Tabasia* may have several canal bundles distributed within the whole sponge body. The other numerous tubes distributed through the whole sponge body in *Tabasia*, are totally lacking in *Yukonella*. The most distinct features separating the two genera are the kinds of perforations in the outer wall (exowall). The exowall of *Yukonella* is imperforate, with only some large ostia, but the outer wall of *Tabasia* is characterized by a labyrinthic branched canal system. Chamber walls in *Yukonella* appear dark in transmitted light (Mg-calcite?) but in *Tabasia* they appear light. The top of *Yukonella* could be like that of *Tabasia*, having a star-like appearing canal system (astrorhizal system) but this feature is not proven.

Tabasia-like sphinctozoid sponges with vertical canal bundles and tubes, distributed through the whole sponge, and with astrorhizae-like osculi located at the top of sponge are not known in Mesozoic sphinctozoid sponge genera. However, the low chambers, canal systems and the astrorhizal-like excurrent canals show similarities between the Ordovician genus *Cliefdenella* WEBBY (1969) and *Tabasia*. *Tabasia* differs from *Cliefdenella* by lack of vesiculae in chamber interiors and, especially, by the labyrinthic perforated pore system within the exowalls. The exowalls of *Cliefdenella* are imperforate (see also WEBBY & MORRIS, 1976; STOCK, 1981; DONG & WANG, 1984; RIGBY & POTTER, 1986; WEBBY & LIN BAOYU, 1988).

BOIKO (in BOIKO et al., p. 151, Pl. 53, Figs. 1–4) described sphinctozoid sponges from the Norian of the Parmir Mts. as *Polytholosia* cf. *polystoma* SEILACHER. This sponge exhibits the characteristics of the genus *Tabasia* and should be included in this genus. Because of strong skeletal recrystallization, however, the species determination is uncertain.

Tabasia maxima nov. sp.

(Pl. 24, Fig. 4; Pl. 25, Fig. 5; Pl. 28, Figs. 10–11; Text-Fig. 16)

Derivatio nominis: Named because of the large dimensions of the sponge as compared with other described species of the genus.

Holotype: We designate as holotype the specimen illustrated in Pl. 24, Fig. 4 (longitudinal section) and Pl. 25, Fig. 5 (outer surface). Two thin sections (one longitudinal and the other transverse) were made from the holotype. The rest of the holotype remains in two rock pieces.

Paratypes: Specimens illustrated in Pl. 28, Figs. 10–11.

Type locality: A small reef, approximately 6.5 km northwest of the town of Ali-Abad (see Text-Fig. 5).

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

Diagnosis: Conical to V-shaped sponge with flattened chambers. Exhalant canals consist of several bundles of tubes ending at star-like (astrorhizal-like) appearing

*) In addition to the sphinctozoid sponge *Yukonella*, the name *Yukonella*, with the species *Y. bamberi* was also given to a Carboniferous alga by MAMET & RUDLOFF (1972). According to "International Rules of Zoological Nomenclature" and the "International Code of Botanical Nomenclature" both names of *Yukonella* are valid.

osculi at the top of the sponge. Numerous small tubes, distributed between the exhalant canal bundles through the whole sponge, running parallel to the axis of sponge. Neither internal nor external segmentation clearly recognizable.

Material: Several specimens in body preservation and in thin sections from the type locality.

Description: This conical to V-shaped sponge is composed of numerous, moniliform, flattened chambers with heights of only 2–3 mm (mostly 2 mm). Diameters of the chambers are dependent upon the sponge diameter and are variable. The diameter of the sponge, and consequently of the chambers, increased rapidly during growth. Heights of chambers may vary between chambers and also in the same chamber.

Because of flattened chambers, outer segmentation (Pl. 25, Fig. 5, Pl. 28, Figs. 10–11) has an appearance of growth lines, but in sections is more or less easily recognizable (Pl. 24, Fig. 4, Text-Fig. 16). Because numerous tubes are distributed through the whole sponge and pass through the interwalls, internal segmentation is also indistinct. Because of strong recrystallization the exowall (approximately 1 mm thick) seems to be imperforate, but well preserved parts of specimens exhibit the labyrinthic pore system within the walls (Pl. 30, Figs. 6–7). Large "openings", observed in some specimens of the genus (Pl. 27, Fig. 4) are borings.

Internally, the sponge is characterized by having several canal bundles of about 1–2 cm in diameter, each composed of approximately 20 individual tubes about 1 mm in diameter. These tubes are pierced by pores connecting them with the interspaces of chambers. Additionally numerous tubes 0.4–1 mm in diameter, are distributed throughout the whole sponge, and they are more or less parallel to the canal bundles, or to the sponge axis. These tubes have wall thicknesses of 0.02–0.1 mm, and are pierced by pores having diameters of 0.02–0.2 mm. In recrystallized specimens, however, walls of the tubes appear much thicker. The canal bundles end as osculi in several depressions in the sponge top and may be developed as star-like (astrorhizal) osculi.

The holotype (Pl. 24. Fig. 4, Pl. 25, Fig. 5, Text-Fig. 16) is a conical specimen in body preservation, having a height of 80 mm and a maximum diameter of 60 mm, measured on the widest part. Internally, the sponge exhibits several canal bundles (Pl. 24, Fig. 4, Text-Fig. 16).

Generally the majority of specimens of the species are poorly preserved and, therefore, the internal characteristics of the sponge cannot be recognized in all specimens in detail.

Occurrence (see Tab. 7): This species was found in bioconstructions near the town of Hassan-Abad (Ferdows Reef, see Text-Fig. 4), and in the Ali-Abad Reefs (see Text-Fig. 5). Especially in the Ali-Abad Reefs, the species is abundant.

Tabasia media nov. sp.

(Pl. 23, Figs. 1, 6; Pl. 24, Figs. 1–2, 5–6; Pl. 26, Figs. 1–5; Pl. 27 Figs. 1–7; Pl. 30, Figs. 6–7)

Derivatio nominis: medius (lat. =) at the middle. Named because the sponge size is intermediate between the other described species *T. maxima* and *T. minima*.

Holotype: Specimen illustrated in Pl. 27, Figs. 6–7 (views of side and top).

Paratypes: All specimens illustrated in Pl. 24, Figs. 1–2, 5–6; Pl. 26, Figs. 1–5, Pl. 27; Figs. 1–5, Pl. 30, Figs. 6–7.

Type locality: A small reef, northwest of the town of Ali-Abad (see Text-Fig. 5).

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

Diagnosis: Conical, single or branched species with relatively high and easily recognizable chambers. Usually about the half of chamber roofs (the middle part) are pierced by tubes that extend through the chamber interiors. Only one or two canal bundle(s) is(are) developed. Chamber walls with complicated canal system.

Description: The cylindrical to conical and branched specimens of this medium-sized species of the genus *Tabasia* reach maximum length of up to 50 mm, with maximum diameters of 35 mm (Pl. 24, Fig. 6). Most specimens are approximately 20 mm high, and reaching a maximum diameter of 15 mm (Pl. 26, Figs. 1–5; Pl. 27). Some specimens exhibit longitudinal grooves with two distinct summits, indicating two specimens may have grown together on their sides or branched (Pl. 27, Fig. 3). Others show two or three depressed areas at the top of sponge, which may indicate the presence of two or three canal bundles (Pl. 24, Fig. 6; Pl. 27, Fig. 2). The outer segmentation is more clearly recognizable and the chambers are distinctly higher than in the preceding species (Pl. 24, Figs. 2, 5; Pl. 26, Figs. 4–5; Pl. 27, Figs. 1, 4, 6). Heights of chambers range between 1 and 2.5 mm.

Outer walls, with thicknesses of 0.2–0.4 mm, seem to be imperforate but well-preserved specimens exhibit the complicated (labyrinthic) canal system (Pl. 31, Figs. 6–7). Chamber roofs are pierced by numerous tubes. In some specimens only approximately half of the chamber roof is pierced by relatively large tubes, 0.3-0.65 mm in diameter (Pl. 26, Figs. 4–5; Pl. 30, Fig. 7). In other specimens almost whole roofs are pierced by smaller tubes of 0.5 mm (Pl. 24, Fig. 6; Pl. 27, Figs. 3, 5, 7). Like in the preceding species, these tubes continue longitudinally throughout the whole sponge body.

Occurrence (see Tab. 7): *Tabasia media* nov. sp. is a very abundant sponge in the Ali-Abad Reefs. It is also relatively abundant in the Ferdows and Naybandan Reefs. It was found also in the Marawand and Delijan Reefs.

Tabasia minima nov. sp.

(Pl. 28, Figs. 1–3, 4?, 5–9)

? 1991 *Polytholosia* cf. *polysthoma* SEILACHER. – BOIKO (in BOIKO et al.), p. 151, Pl. 53, Figs. 1–4.

Derivatio nominis: Named for the small size of the sponge.

Holotype: Specimen illustrated in Pl. 28, Fig. 9.

Paratypes: All specimens illustrated in Pl. 28, Figs. 1–8.

Type locality: Ali-Abad Reefs (see Fig. 5).

Diagnosis: Smallest specimen of the genus *Tabasia*, with well developed outer segmentation. The chambers are usually oriented obliquely to the sponge axis.

Material: Numerous specimens from the type locality.

Description: The moniliform specimens of this species reach maximum heights of 35 mm and maximum diameters of 10 mm. The holotype (Pl. 28, Fig. 9) is a specimen having a height of 17 mm and a maximum diameter of 9 mm in its upper part, but is only 3 mm in the first basal chamber. The outer segmentation is well developed and easily to recognize from the outside. Chamber heights range usually between 2–4 mm, but up to a maximum of 5 mm. Because of the arrangement of the chambers obliquely to the axis of the sponge it looks like a screw.

This seems to be a characteristic feature of the species. The top and the base of almost all specimens are even, and in only a few specimens the perforation of chamber roofs, described for the preceding species, is recognizable.

Occurrence (see Tab. 7): The naturally isolated, weathered out specimens of *Tabasia minima* nov. sp. were collected only from the type locality.

Tabasia gregaria nov. sp.

(Pl. 24, Fig. 3; Pl. 25, Figs. 1–4; Text-Figs. 17–18)

Derivatio nominis: Gregarius (lat. = in clusters). Named because of several specimens growing together.

Holotype: Specimen illustrated in Pl. 25, Figs. 1–4 (all Figs. are taken from the same specimen [compare Text-Figs. 17–18]).

Paratype: Specimen illustrated in Pl. 24, Fig. 3.

Type locality: Ali-Abad Reefs (see Fig. 5).

Diagnosis: Clusters composed of several gregarious specimens. The top of each specimen with clearly developed astrorhizal canals located in depressions. Outer segmentation is more or less distinct. Because of numerous tubes oriented parallel to the axis and passing through the whole sponge the internal segmentation is indistinct. In the center of sponge the tubes may unite to form a canal bundle.

Material: Two specimens from the type locality.

Description: The spherical or irregular clusters of this gregarious species are composed of several branched specimens occurring together. Individual specimens grew in all directions and tops of specimens are visible on all sides of the clusters. The holotype is an aggregate of 60 x 40 x 45 mm exhibiting at least 8 individual specimens (Pl. 25, Figs. 1–4, Text-Figs. 17–18). The largest individuum has a diameter of 25 x 35 mm, the smallest, a diameter of only 8 mm. The spherical aggregate of a paratype, illustrated in Pl. 24, Fig. 3, is composed of at least 6 specimens growing in all directions. The diameter of individual specimens is different, ranging from 4 mm up to 20 mm in the paratype. The top of each individual specimen is depressed and shows the well developed astrorhizal canal system and outlines of the vertical tubes that appear as small pores (Pl. 24, Fig. 3, Text-Fig. 18). Internally, individual specimens are grown together in the center of clusters (Pl. 25, Fig. 4, Text-Fig. 17–18). Each specimen shows more or less the distinct outer segmentation and indistinct internal segmentation. Chamber interiors and chamber roofs are pierced by numerous tubes that are parallel to the axis of the sponge. These tubes may unite into a canal bundle at the axis of the individual specimens (Text-Fig. 17). The perforation of exowalls corresponds to that seen in other preceding described species.

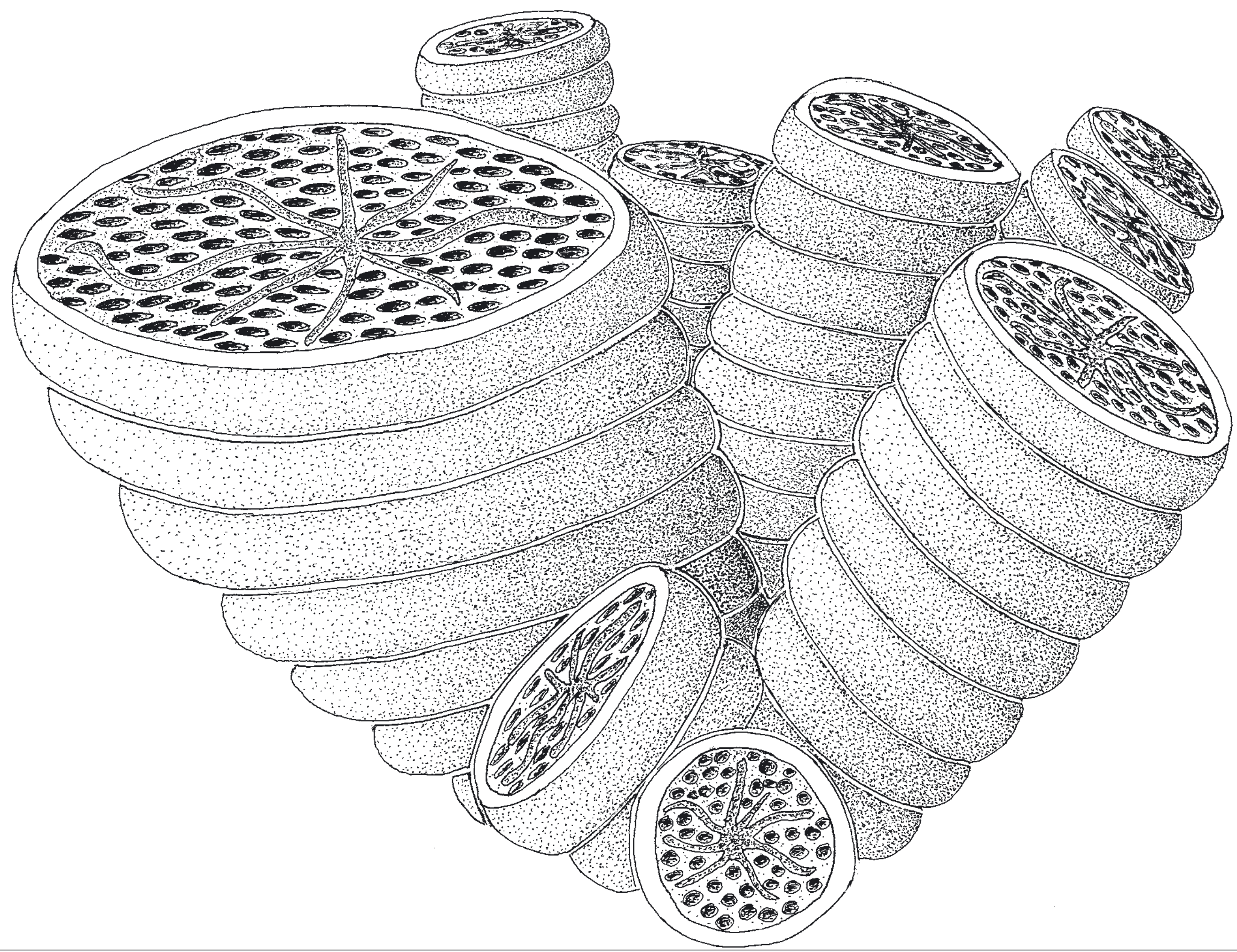
Occurrence (see Tab. 7): Both specimens were found at the type locality (see Text-Fig. 5).

Tabasia? conica nov. sp.

(Pl. 23, Figs. 2–4, 5?; Text-Figs. 19–21)

Derivatio nominis: Named for the obconical shape of the sponge.

Text-Fig. 17.
Tabasia gregaria nov. sp.
Section through the holotype (see Pl. 25, Fig. 4) exhibits the longitudinal sections of three branches with more or less well recognizable outer and inner segmentation of the sponge. Numerous tubes, oriented parallel to the sponge axis, pierce the segment roofs. The complicated canal system (labyrinth-like) of the outer walls is not shown.
Scale 1 cm.



Text-Fig. 18.
Reconstruction of *Tabasia gregaria* nov. sp. showing several branches and the perforation of the segment roofs with star-like (astrorhizal) exhalant canals in each branch. Perforation of outer walls is not shown.
Schematic, not to scale.

Holotype: Specimen is cut in logitudinal section and illustrated in Pl. 23, Fig. 4A, compare Text-Fig. 19 (thin section P/168/1).

Paratypes: Specimens in Pl. 23, Fig. 2–3, 5?.

Locus typicus: Marawand Reefs (see Text-Fig. 6, locality 2).

Stratum typicum: Reefs (Norian) imbedded within the Nayband Formation.

Diagnosis: Aporate(?) obconical sponge with several axial tubes of ambisiphonate type. Additional tubes extend from the axial tubes into the chamber interiors.

Differential Diagnosis: See comparison after the description of the species.

Material: Several specimens in thin sections from the Marawand (M36, M48/l1), Ferdows (96/31/23) and Delijan Reefs (P168/1).

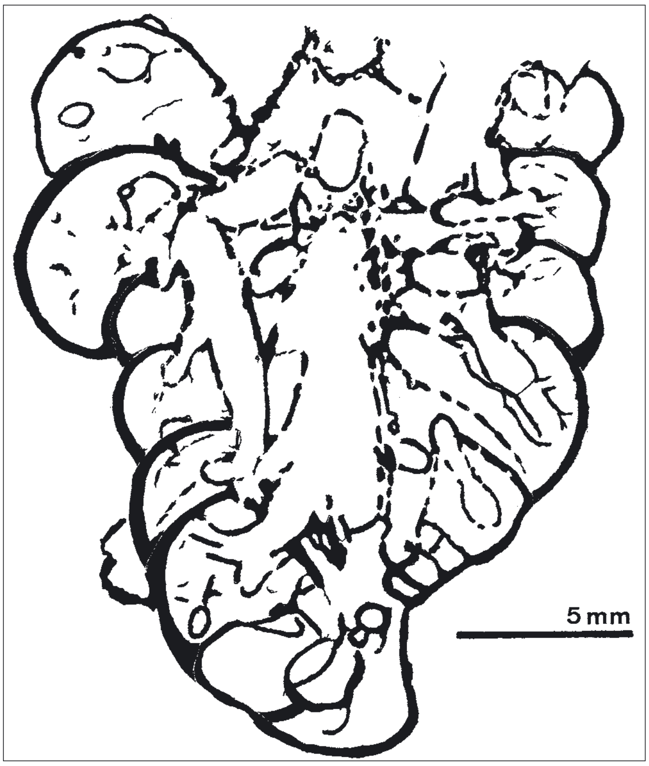
Description: This obconical, V-shaped sponge in longitudinal section is composed of several ring-chambers arranged around several axial tubes. Because the characteristics of holotype (Pl. 23, Fig. 4A, Text-Fig. 19) deviate a little from the paratypes, we will describe first the holotype and then the paratypes, separately.

The holotype, with a height of 23 mm and a maximum diameter of 17 mm, is cut more or less in axial longitudinal section exhibiting 5 ring-chambers arranged around several axial tubes which form the spongocoel. These tubes are vertical or diverge upward and outward of the upper part of the sponge. From these tubes, numerous additional tubes extend downwards and into the chamber interiors. All tubes are perforated. The axial tubes are of ambisiphonate type.

The chambers are irregular and heights (0.3–0.6 mm) of chambers vary within the same chamber. Chamber walls are 0.14–0.3 mm thick. The interwalls are double-layered. Because of recrystallization, the porate or aporate nature of the chamber walls is not recognizable, but appear to be imperforate.

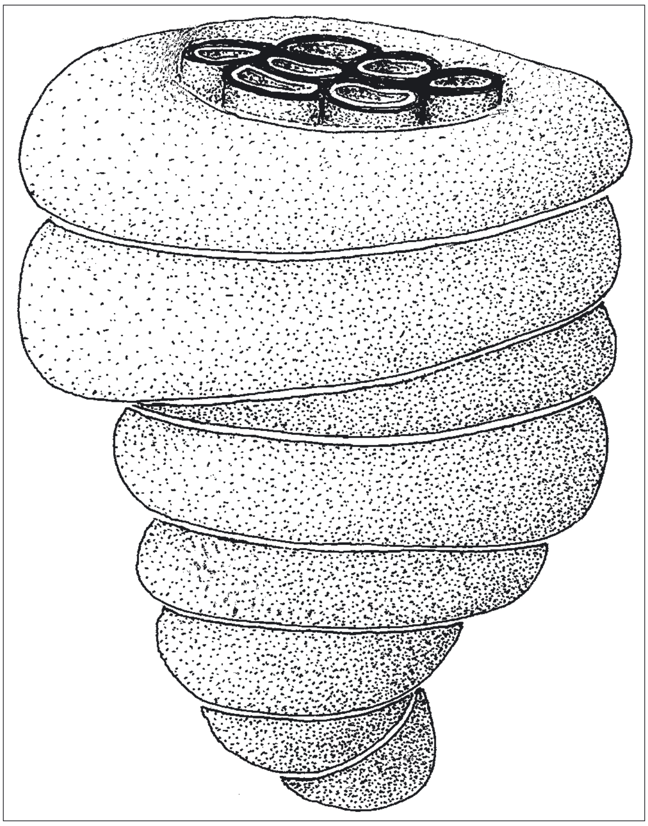
One of the paratypes (Pl. 23, Fig. 2) shows almost the same characteristics as the holotype. However, a large rimmed ostium, which was not observed in the holotype and other paratypes, is cut in one chamber. This paratype clearly shows the ambisiphonate formation of axial canals.

The specimen, illustrated in Pl. 23, Fig. 3, shows more or less the same characteristics as the holotype, but in this specimen the chamber walls are thicker than in the holotype. The shape of the specimen illustrated in Pl. 23, Fig. 5 (Text-Fig. 20) corresponds to the holotype but the regular chambers and the lack of intercameral tubes distinguishes this specimen from the holotype and other paratypes. The assignment of this specimen to *Tabasia? conica* nov. sp. is uncertain. Text-Fig. 21 represents a reconstruction of *Tabasia? conica* nov. sp.



Text-Fig. 19.
Longitudinal section of *Tabasia? conica* nov. sp. (holotype, see Pl. 23, Fig. 4/A) shows the axial canals and additional tubes that extend from the axial tubes into the chamber interiors. Heights of the chambers vary in the same chamber (see Text-Fig. 26). Thin section P161/1. Scale 5 mm.

Text-Fig. 20.
Axial longitudinal section of sponge determined as uncertain *Tabasia? conica* nov. sp. It shows the numerous openings in the chamber roofs and possible tubes within the peripheral part of the chambers. The chamber walls are thick and doubled-layered between adjacent chambers.



Text-Fig. 21.
Reconstruction of *Tabasia? conica* nov. sp. shows the bundle of axial tubes and the irregular chambers arranged around the tube-bundle. Possible ostia or pores? in the exowall are not shown.
Schematic, not to scale.

Comparision: *Tabasia? conica* nov. sp. differs from other species of *Tabasia* described above by the obconical shape of the sponge (V-shaped in longitudinal section), marginal tubes extend from axial tubes into chamber interiors, the irregular chambers, and possibly imperforate chamber walls. *T.? conica* reaches the same dimensions as *T. media* or *T. minima* (see Tab. 4), but differs from both of these species by the mentioned features and by the chamber shape. Canal bundles, beside numerous tubes in *T. media*, are lacking totally in *T.? conica* (compare Text-Fig. 16).

Occurrence (see Tab. 7): Specimens of *Tabasia? conica* nov. sp. were found in the Marawand, Ferdows and Delijan Reefs. It is a very rare sponge in all these reefs.

Tabasia ssp.

(Pl. 32, Figs. 1–4, 6)

In addition to the preceding described species, numerous specimens occur in thin sections and they can not be determined in detail. A few of these specimens are documented

Table 4.
Main characteristics of species of *Tabasia*.
SD = sponge diameter; CH = chamber height; CA = chamber arrangement.
*) Diameter of individual sponges. All measurements in mm.

Species	shape	SD	canal bundle	CH	CA
T. maxima	conical	up to 50	several	3-6	moniliform
T. media	cylind.-conical	15-20	1-2	1-2.5	moniliform
T. minima	cylindrical	max. 10	lack	2-5	monil. oblique
T. gregaria	clusters	max. 35*	1-2	2.5-5	moniliform
T.? conica	conical	up to 17	Lack	max. 1.5	moniliform

to demonstrate the abundance and the importance of this genus within the Upper Triassic bioconstructions in Iran.

Family: Thaumastocoeliidae OTT, 1967
Subfamily: Enoplocoeliinae SENOWBARI-DARYAN, 1990
Genus: *Naybandella* nov. gen.

Derivatio nominis: Named from the Nayband Formation in central Iran.

Diagnosis: Aporate thalamid sponges with an axial spongocoel of prosiphonate type. Both the endowall (wall of the spongocoel) and the exowall (outer wall) are pierced by large openings. These openings are united to clusters in the exowall. Catenulate arrangement of the chambers. Chamber interiors without filling structure and vesiculae. Skeletal mineralogy was most probably aragonite. Microstructure and spicules are not known.

Type species: *Naybandella prosiphonata* nov. sp.

Discussion: Several aporate sphinctozoan genera are placed to the family Spiciidae TERMIER & TERMIER (in TERMIER et al., 1977) or Thaumastocoeliidae OTT (1967) (see SENOWBARI-DARYAN, 1990). Representatives of both families, however, are very similar. The family Thaumastocoeliidae is characterized by the spherulitic microstructure of the rigid skeleton. Because of the prosiphonate type of the spongocoel (like *Girtyocoelia*) and other morphological characteristics we assign the genus *Naybandella* to Thamastocoeliidae, athough the microstructure of *Naybandella* is unknown.

Among the aporate sphinctozoid genera, the general morphology of *Naybandella* nov. gen. is similar to the Paleozoic genus *Girtyocoelia* COSSMANN, but differs from it by possessing groups of large openings in the exowall. These openings (ostia) in *Girtyocoelia* are developed as single openings (see SENOWBARI-DARYAN, 1990), but in *Naybandella* they are grouped to sieve-like constructions. These openings with extended rims from the spongocoel wall into the chamber interior in *Naybandella* are lacking in *Girtyocoelia*. Other aporate sphinctozoid sponges with a spongocoel are not comparable to the new genus.

BOIKO (in BOIKO et al., 1991) described an asiphonate sphinctozoid sponge from the Norian of the Pamirian range as *Pamirocoelia sphaerica* and it has similar or identical groups of openings in the chamber walls. However, *Pamirocoelia* lacks a spongocoel, which is well developed in *Naybandella*. In addition *Pamirocoelia* possesses small openings (as cortex) on the individual large openings (see BOIKO, in BOIKO et al., 1991: Pl. 30, Fig. 4), which are not developed in *Naybandella*. The chamber arrangement in *Naybandella* is catenulate but in *Pamirocoelia* it is moniliform to irregular.

The Triassic genus *Follicatena* OTT (1967) and the Ordovician genus *Porefieldia* RIGBY & POTTER (1986) also have groups of pores in the exowalls, but both these genera lack spongocoel.

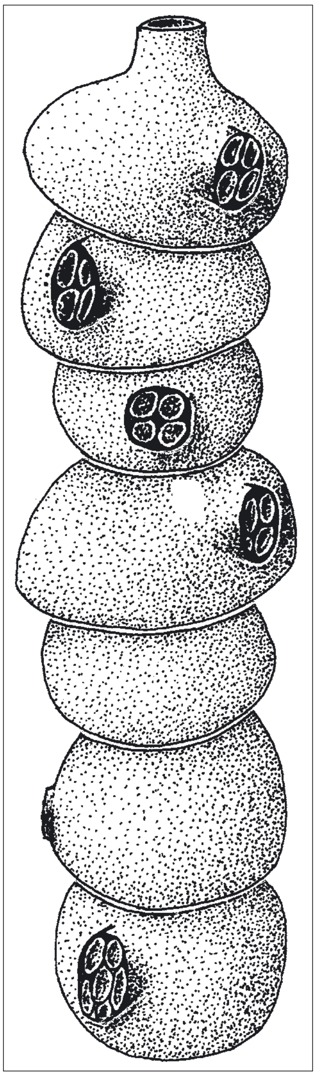
Among the porate sphinctozoid sponges, the genus *Cribrothalamia* SENOWBARI-DARYAN (1990), described from the Norian–Rhaetian reefs of Sicily, has a similar group of ostia like *Naybandella*, but *Cribrothalamia* differs from *Naybandella* by having perforate chamber walls and by the glomerate arrangement of the chambers.

Naybandella prosiphonata nov. sp.

(Pl. 9, Fig. 6?; Pl. 22, Figs. 1–8; Pl. 23, Fig. 4B; Text-Fig. 22–23)

Derivatio nominis: Named for the prosiphonate type of the spongocoel.

Text-Fig. 22.
Naybandella prosiphonata nov. gen., nov. sp.
Holotype (see Pl. 23, Fig. 4B).
Oblique longitudinal section shows the spherical chambers, the groups of openings in the exo- and endowalls, and the prosiphonate spongocoel, recognizable at the upper part of the sponge.



Text-Fig. 23.
The reconstruction of *Naybandella prosiphonata* nov. gen., nov. sp. shows the arrangements of the chambers, and the groups of openings in the exowall.
Schematic, not to scale.

Holotype: Pl. 23, Fig. 4B (Thin section P/168/1) (compare Text-Fig. 22).

Paratypes: All the specimens in Pl. 22, Fig. 1–8.

Type locality: Reefs at the right side of the highway from Delijan to Esfahan, approximately 50 km south of the town of Delijan (see Text-Fig. 6, locality 2).

Type level: Norian reefs imbedded within the Nayband Formation.

Diagnosis: Aporate segmented sponge with a spongocoel of prosiphonate type and catenulate arrangement of the chambers. Without filling structure and vesiculae. Both, the exo- and endowalls (wall of the spongocoel) are pierced by large openings. These openings are united to sieve-like clusters in the exowalls. The openings have an expanded rim that continues into the interior of the chambers.

Material: Several specimens in thin sections from the type locality (P/64P/166/2, P/168/1 [holotype], P/209) and from the Marawand Reef (M/101/5B, M125 and M/131).

Description: The holotype is cut in oblique longitudinal section, and shows the catenulate arrangement of the chambers, in the lower part, and the axial spongocoel in the upper part of the sponge (Pl. 23, Fig. 4B, compare Text-Fig. 22). It is composed of 7 spherical, catenulate chambers, which are oriented slightly obliquely to the axial spongocoel in the upper part of the sponge. The oblique arrangements of the chambers are also evident in one paratype (Pl. 22, Fig. 1).

An axial spongocoel of approximately 1.7 mm in diameter passes through the sponge. As shown in Text-Fig. 22 (compare Pl. 22, Fig. 1) the spongocoel is of prosiphonate type sensu SEILACHER (1962). At the summit of the holotype (Pl. 23, Fig. 4B: right in photo) the ring-chamber around the spongocoel is lacking and only the spongocoel is developed, indicating the prosiphonate formation of the spongocoel.

The exowalls, as well as the wall of the spongocoel, are pierced by large openings. These openings are united into groups (sieve-like) in the exowall. The diameters of the individual openings range between 0.33 mm and 1 mm, and the diameter of the major openings of the groups range up to 2 mm across. Towards the chamber interiors the openings of the spongocoel as well as of the exowalls are prolongated tube-like or have a distinct rim (Pl. 22, Figs. 1, 3; Pl. 23, Fig. 4B; Text-Fig. 22). Chamber walls are double-layered between two adjacent chambers. Chamber interiors lack filling structures and vesiculae.

The paratypes are cut in different directions and exhibit the different characteristics of the sponge. The specimen shown in Pl. 22, Fig. 1 is a marginal axial section exhibiting almost all charcteristics mentioned for the holotype. All other paratypes are cut in different directions and exhibit only parts of the sponge features (see explanation of the plates). Text-Fig. 23 shows the reconstruction of *Naybandella prosiphonata* nov. gen., nov. sp.

Occurrence (see Tab. 7): *Naybandella prosiphonata* nov. gen., nov. sp. occurs within the reefs located south of the town of Delijan (Delijan Reefs) and in the Marawand Reef (see Text-Fig. 6).

Genus: *Pamirothalamia* BOIKO (in BOIKO et al.) 1991

Diagnosis: “Catenulate sponge with spherical chambers around axial canal that is cryptosiphonate; ostia in distal parts of chambers and on lateral surface, chamber walls fragile, in form of possible bars; interwalls double where two chambers juxtaposed and each chamber with complete wall” (translated from Russian by FINKS & RIGBY, in FINKS et al., 2004: 666).

Type species: *Pamirothalamia originalis* BOIKO (in BOIKO et al.) 1991.

Pamirothalamia? originalis BOIKO (in BOIKO et al.) 1991

(Pl. 30, Fig. 3)

1991 *Pamirothalamia originalis* gen. nov. sp. nov. – BOIKO (in BOIKO et al.), p. 135, Pl. 47, Figs. 1–2.

Material: One specimen (thin section P163/1).

Description: The only one specimen of this sponge in the collection is composed of 17 chambers and has a length of 47 mm with a diameter of 7–8 mm. The chambers are quadrangular and almost twice as wide as high. The sponge skeleton is strongly recrystallized and the cryptosiphonate type of axial canal can be recognized only in the middle part and between the uppermost chambers. The upper chamber also exhibits two large ostia (1.5 and 2 mm in diameter) in the outer walls. The ostia are composed of several small openings (sieve-like). Walls between adjacent chambers seem to be double-layered.

Remarks: *Pamirothalamia* was established by BOIKO (in BOIKO et al., 1991) with only one species – *P. originalis* – from the Upper Triassic (Norian–Rhaetian) deposits of SE Pamir for those sponges with a catenulate arrangement of the chambers and cryptosiphonate type of axial canals. These characteristics, and also the dimensions of specimen described above, correspond largely to those of *P. originalis* from the Pamirian range. The major difference between the two species is the nature of the chamber walls. The chamber walls in our species are imperforate, but in the species from Pamir seems to have a complicated canal system. BOIKO (in BOIKO et al., 1991: 135) described the chamber walls as “massive but loose”. For this reason we are not sure about the identity of our species with *P. originalis* BOIKO. However, the affiliation of *Pamirothalamia* by BOIKO to the Thaumastocoeliidae indicates imperforate walls of the chambers.

Occurrence (see Tab. 7): This species was found only in the Delijan Reef (see Text-Fig. 6, locality 2).

Genus: *Phraethalamia* SENOWBARI-DARYAN & INGAVAT-HELMCKE, 1993

Diagnosis: “Aporate thalamid sponge with two or more axial spongocoels and ring-like chambers. Numerous, occasionally dichotomous, branched tubes extended from the spongocoel wall into the hollow chambers. Chamber interiors without vesiculae and filling structure” (SENOWBARI-DARYAN & INGAVAT-HELMCKE, 1994: 21).

Types species: *Phraethalamia tubulara* SENOWBARI-DARYAN & INGAVAT-HELMCKE, 1994.

Phraethalamia irregulara nov. sp.

(Pl. 15, Fig. 4; Pl. 29, Figs. 1, 2?, 3?, 5?, 7A; Text-Fig. 24)

Derivatio nominis: Named for the irregular arrangement of the chambers.

Holotype: We designate as holotype the specimen cut in longitudinal section and illustrated in Pl. 29, Fig. 1 (compare Text-Fig. 24).

Paratypes: Specimens illustrated in Pl. 15, Fig. 4; Pl. 29, Figs. 2?, 5?, 7A.

Locus typicus: Reefs at the right side of the highway from Delijan to Esfahan, approximately 50 km south of the town of Delijan (see Text-Fig. 6, locality 2).

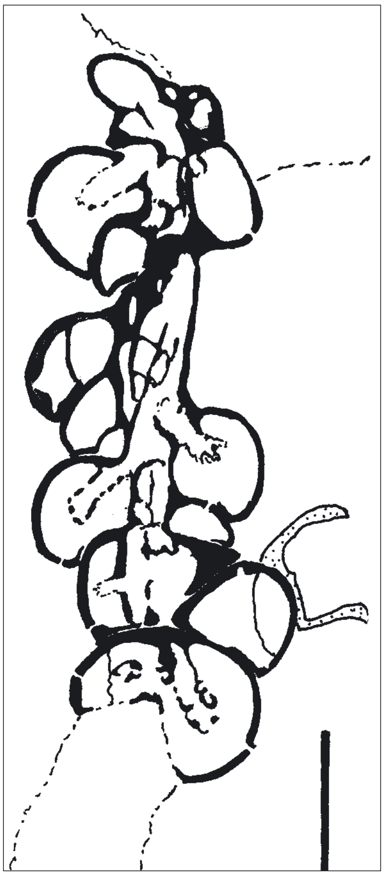
Stratum typicum: Norian reef limestones imbedded within the Nayband Formation.

Diagnosis: Aporate thalamid sponge with several (maybe four?) axial spongocoels of ambysiphonate type. The chambers are arranged around the spongocoels, usually unilaterally (zigzag-like), or rarely ring-like. Perforated tubes extend from the spongocoel wall into the hollow chambers. Chamber walls are relatively thin and pierced by sporadic ostia. Chamber interiors may contain rare vesiculae but lack filling structures.

Material: At least 3 specimens from Delijan Reefs.

Description: The specimens of this sponge are composed of several spherical to hemispherical chambers arranged around the bundle of the axial spongocoel. Typical of this sponge is the chamber arrangement, unilateral and zigzag-like, glomerate, around the bundle of spongocoel tubes. The chambers are rarely ring-like.

Text-Fig. 24.
Phraethalamia irregulara nov. sp. shows irregularly arranged chambers, perforated tubes extending from the axial tubuli into the hollow chambers. Chamber walls with irregularly occurring ostia (see Pl. 29, Fig. 1).
Scale 1 cm.



The height of the chambers ranges between 3 mm and 8 mm, and their diameter also ranges between 3 mm and 8 mm. The small chambers, measured in thin sections, are probably the marginal sections. Chamber interiors are without filling structures and usually without vesiculae; only in one chamber of the holotype vesiculae were observed.

The chamber walls are thin, with a thickness of approximately 0.4 mm. They are pierced by sporadic ostia of approximately 0.2 mm in diameter. An axial canal bundle composed of several (in the holotype at least 3 or 4?) tubes passes through the whole sponge. The diameter of individual tubes is about 1 mm, and the diameter of the bundle is about 3 mm in the holotype and 5 mm in one paratype (Pl. 29, Fig. 7/A). Tubes of approximately 1.5 mm extend from the spongocoel wall into the chamber interiors. These tubes are perforated by pores about 0.5 mm in diameter. Such tubes apparently extend also from the chamber walls, as observed in one chamber of the holotype (Pl. 29, Fig. 1, Text-Fig. 24).

Remarks: *Phraethalamia* is a thalamid sponge like *Girtyocoelia*, but differs from that genus by having a bundle of axial tubes (two or more) and by tubes that extend from the spongocoel wall into the chamber interiors. *Phraethalamia* was previously known only from the type species – *Ph. tubulara* – from the Upper Permian of Phrae Province in northern Thailand (SENOWBARI-DARYAN & INGAVAT-HELMCKE, 1994). The genus was not known from Triassic deposits.

Based on the aporate chamber walls, possession of a bundle of axial tubes, the ambisiphonate type of the tubes, and the tubes that extend from the spongocoel wall into the chamber interiors justified placing our species from Iran into *Phraethalamia*. The Iranian species differs from the Permian species by its irregular and zigzag-like arrangement of the chambers.

Occurrence (see Tab. 7): This species was found only in the Delijan Reef (see Text-Fig. 6, locality 2).

Genus: *Paravesicocaulis* KOVACS, 1978

Diagnosis: "Catenulate stem. Wall imperforate, consists of several layers. Central chanel cryptosiphonate. Chambers filled with more or less concentrically developed vesciular structure" (KOVACS: 1978: 689).

Remarks: As mentioned by SENOWBARI-DARYAN (1990: 118) the relatively thin chamber wall of *Paravesicocaulis* consists, in reality, of only one layer and not of "several layers" as noted in the diagnosis of the genus by KOVACS. The layers on the inside of the chambers are concentrically developed vesiculae, also recognizable in the holotype documented by KOVACS (1978: 6/B).

Type species: *Paravesicocaulis concentricus* KOVACS, 1978.

Additional species: *Paravesicocaulis multiosculatus* SENOWBARI-DARYAN, 1980b.

Paravesicocaulis naybandensis nov. sp.

(Pl. 2, Fig. 3P; Pl. 4, Fig. 1P, 2P; Pl. 9, Figs. 1, 2?; Pl. 31, Figs. 1–2; Text-Figs. 25–26)

Derivatio nominis: Named from the type locality (Kuh-e Nayband: Nayband Mountain) near the town of Naybandan, south of Tabas (see Text-Fig. 5).

Locus typicus: Southern flank of Kuh-e Nayband (see Text-Fig. 5)

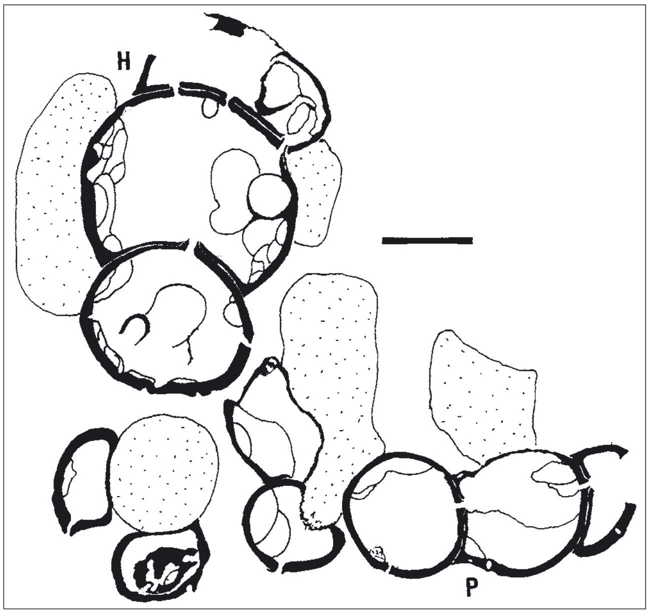
Stratum typicum: A small sponge-dominated reef imbedded within the Nayband-Formation (Bidestan member, Norian).

Holotype: Pl. 31, Fig. 2, Text-Fig. 25H.

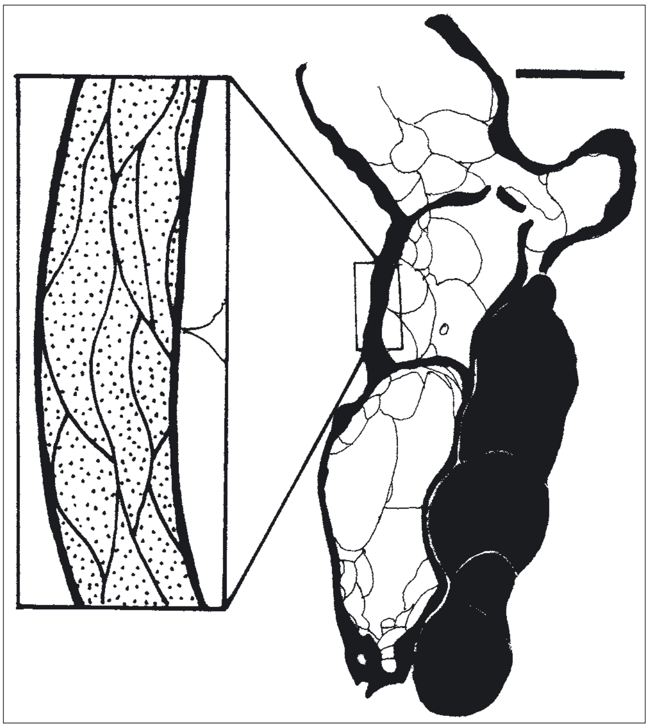
Paratypes: All specimens illustrated in Pl. 2, Fig. 3P; Pl. 4, Figs. 1P, 2P; Pl. 9, Figs. 1–2; Pl. 31, Fig. 1.

Material: Four(?) or two specimens from the type locality (thin section 96/100) and several specimens from the Marawand Reef (see Text-Fig. 6, locality 3).

Diagnosis: Catenulate stems, consists of spherical chambers with thin walls. Chamber walls imperforate but with rimmed ostia. Asiphonate? or cryptosiphonate? A spongocoel is lacking. Chamber walls are double-layered between two adjacent chambers. Chamber inte-



Text-Fig. 25.
Paravesicocaulis naybandensis nov. sp. (see Pl. 31, Fig. 2).
H) Holotype.
Note the cryptosiphonate canal cut in the youngest chamber, the ostia with elevated rims, the double-layered wall, the contacts between chambers, and the vesiculae concentrically developed inside the chamber walls.
P) The paratype clearly exhibits every ostia with an elevated rim. Two single chambers at the left represent the third specimens?
Scale 1 cm.



Text-Fig. 26.
Section through four chambers of *Colospongia iranica* nov. sp. (dark) and through three or four(?) chambers of *Paravesicocaulis naybandensis* nov. sp. (see Pl. 4, Fig. 1). The magnification of the chamber wall of *Paravesicocaulis naybandensis* shows the internal laminated wall structure.
Marawand-Reef, thin section M110/10A. Scale 3 mm.

riors with concentrically developed vesiculae, that usually cover the ostia.

Description: As shown in Text-Fig. 25, two or four specimens of this sponge are cut in thin section 96/100. The holotype (Pl. 31, Fig. 2; Text-Fig. 25H) is composed of three chambers exhibiting the important characteristics of the sponge. The chambers are spherical in shape, with diameters of 6–7.5 mm and heights of about 5 mm. The thickness of chamber walls is relatively constant and about 0.3–0.4 mm. The last chamber is incompletely developed and exhibits a large opening of approximately 1 mm at the top, indicating the possibly cryptosiphonate type of the canal (see Text-Fig. 25).

One of the paratypes (Pl. 2, Fig. 3P) consists also of three chambers but with smaller dimensions than the holotype. The imperforate chamber walls are pierced by rimmed ostia (diameter 0.2–0.3 mm). Chamber walls are double-layered between adjacent chambers.

Vesiculae occur concentrically developed on the chamber walls, covering the ostia, and occur also within the chamber interiors. Chamber walls appear dark in transmitted light and exhibit a laminated structure (see Text-Fig. 26). The specimens illustrated in Pl. 9, Figs. 1–2, show identical chamber walls and rimmed ostia, but vesiculae do not occur in these specimens directly on the chamber walls, as characteristic for the genus.

Remarks: The known representatives of *Paravesicocaulis* are limited to the Middle?–Upper Triassic. *P. naybandensis* nov. sp. differs from the Ladinian–Carnian species *P. concentricus* KOVACS (1978) by having large chambers, less vesiculae within the chamber interiors, and, especially, by the abundant rimmed ostia in the chamber walls. The new species differs from the Norian species *P. multiosculatus* (SENOWBARI-DARYAN, 1980) by the chamber shape, less vesiculae and especially by the rimmed ostia. The characteristics of three known species of the genus *Paravesicocaulis* is summarized in Tab. 5.

The rimmed ostia of *P. naybandensis* are similar to those in *Celyphia submarginata*, an abundant thalamid sponge in Carnian reefs of the western Tethys. However, in contrast to *P. naybandensis*, the segment walls of *C. submarginata* appear light in transmitted light and the laminated structures of the walls are lacking in the second species.

Occurrence (see Tab. 7): *Paravesicocaulis naybandensis* nov. sp. was found in the Marawand and Naybandan Reefs at the type locality of the Nayband Formation (see Text-Fig. 5, 6, locality 3).

Table 5.
Characteristics of *Paravesicocaulis* species known from Ladinian–Carnian and Norian occurrences.
CD = Chamber diameter. CH = chamber height; WT = wall thickness; DC = diameter of canal; DO = diameter of ostia, L = Ladinian; C = Carnian; N = Norian.

Species	CD	CH	WT	DO	DC	age
P. concentricus	2.0-3.9	0.85-3.2	0.15-0.35	0.15-0.20	0.5-0.8	L-C
P. multiosculatus	4-6	4-4.5	0.15-0.25	0.25	-	N
P. naybandensis	2.5-2.7	2.5-5.0	0.3-0.4	0.2-0.3	1	N

Order: Uncertain
Family: Alpinothalamiidae SENOWBARI-DARYAN, 1990
Subfamily: Jablonskyinae SENOWBARI-DARYAN, 1990
Genus: *Uvanella* OTT, 1967

Uvanella norica (SENOWBARI-DARYAN & SCHÄFER), 1978

(Pl. 2, Figs. 4, 6; Pl. 26, Fig. 7)

1978 *Follicatena irregularis* n. sp. – SENOWBARI-DARYAN & SCHÄFER, p. 315, Figs. 1–10.

1990 *Uvanella norica* nom. nov. (pro *Follicatena irregularis*). – SENOWBARI-DARYAN, p. 141, Pl. 30, Fig. 1 (see for complete synonymy list).

Material: Numerous specimens.

Description: This species is the only thalamid sponge in the bioconstructions within the Nayband Formation with a skeleton composed of Mg-calcite mineralogy. The bubble-like to tubular chambers of this sponge usually grew on and between the other reef organisms stabilizing the reef frame. The irregularly shaped sponge has a glomerate arrangement of the chambers. The imperforate chamber walls are pierced by sporadically by large ostia of various different sizes. Vesiculae are abundant within the chamber interiors.

Occurrence (see Tab. 7): This species was found in all localities discussed in chapter 3.

Undetermined Taxa

The number of sphinctozoan sponge taxa in the Upper Triassic bioconstructions in Iran is surely higher than the number of species described above. In addition of those taxa described in detail above, in more than 600 large thin sections (7.5 x 10 cm, 10 x 15 cm), numerous sphincozoan sponges are cut in different sections, but they can not be determined in detail. In the following section we describe and illustrate some of them as sponge gen. et sp. indet.

Family: Solenolmiidae ENGESER, 1986

Gen. et sp. indet. 1

(Pl. 31, Figs. 5, 7)

Material: Two specimens from the Delijan Reefs in thin sections Dj2000/38 and Dj2000/24.

Description: Two incomplete specimens, cut in oblique sections, are available from this sponge in collection. It is composed of several flattened, very wide, chambers (up to 20 mm wide, and 20 mm high). The chamber walls are thick and pierced by numerous pores. Chamber interiors contain coarse reticular filling skeleton. A spongocoel is lacking, but (several?) laterally arranged large openings (Pl. 31, Fig. 5 and 6: arrows) seem to have served as exhalant canals.

Remarks: Because of the reticular filling skeleton, this sponge is attributed to the family Solenolmiidae. Such asiphonate sponges with flattened chambers, but without a spongocoel, are not reported from this family. BOIKO (in BOIKO et al. 1991: 185, Pl. 54, Fig. 3) has described similar sponges from the Norian of Pamir Mountains as *Platysphaerocoelia aksuensis*, but with uncertain attribution to a family. *Platysphaerocoelia* differs from the Iranian species by the spherical appearance of the internal filling skeleton. Similar internal skeleton occurs in the sponge described as *Amblysiphonella lorentheyi* VINASSA DE REGNY by DIECI et al. (1968: Pl. 29, Fig. 4a).

Occurrence: The sponge was found only in the Delijan Reefs (see Text-Fig. 6, locality 2).

Gen. et sp. indet. 2

(Pl. 30, Fig. 1)

Material: Only one specimen from the Delijan Reefs (thin section P148/3).

Description: Sponge similar to preceding species, also composed of flattened low chambers with reticular internal structure within the chamber interiors. It differs from the preceding species by having fine and closely packed internal structures. The chamber walls are perforated.

Occurrence: The sponge was found only in the Delijan Reefs (see Text-Fig. 6, locality 2).

Sphinctozoan Sponge Family, gen. et sp. indet. 3

(Pl. 19, Fig. 3)

Material: Only one specimen, from the Marawand Reef (M101/14A and M101/14b).

Description: From this isolated sponge two longitudinal thin sections (M101/14A, M101/14b) were made. The axial longitudinal section illustrated in Pl. 19, Fig. 3, shows the very low crescent-like chambers, with heights of about 2 mm, arranged around a narrow spongocoel with a diameter of 1.5 mm. The sponge has a diameter of 16–17 mm and an incomplete height of 45 mm. The interwalls are thick, with thicknesses of about 0.1–0.3 mm, and, they are pierced by unevenly distributed pores of 0.1–0.4 mm in diameter. The sponge is annulaed (not clearly visible in Pl. 19, Fig. 3) on the exterior with a spacing of 6–7 mm, but this does not correspond to the internal segmentation. Because of overlap of early chambers by younger ones, the exowall is thick (1 mm) and seems to be perforated. Some pillar-like internal structures are present within chamber interiors.

Remarks: The low chambers of this sponge resemble those of sponges included in *Senowbaridaryana*, but this sponge differs from representatives of that genus by development of the annulation in the outer wall and by the lack of a reticular filling skeleton. The pillar-like internal skeleton observed in the sponge resembles that in representatives of the genus *Stylothalamia*.

Occurrence: This sponge was found only in the Marawand Reef (see Text-Fig. 6, locality 3).

Sphinctozoan Sponge Family, gen. et sp. indet. 4

(Pl. 30, Fig. 5)

Material: Only one specimen, in thin section P?/2/1 from the Delijan Reefs.

Description: The only available specimen of this species is cut in longitudinal section and exhibits 5 chambers with aporate chamber walls. Outer segmentation is lacking or is poorly developed. Chamber roofs are pierced by a large opening and chamber interiors exhibit some small pillar-like structures.

Occurrence: This sponge was found only in the Delijan Reefs (see Text-Fig. 6, locality 2).

5. Diversity and Abundance of Thalamid Sponges within the Upper Triassic Bioconstructions in Central and Northeast Iran

Among the hypercalcified sponges, the thalamid sponges (hexactinellid thalamid sponges are not considered here) are the most important group of sponges within the Upper Triassic bioconstructions in central Iran. This group is represented by at least 46 species (20 new) belonging to 25 genera (5 new) and 11 families (1 new). Twelve species could not be identified to species level and 4 species could not be identified to genus level (Tab. 6).

Table 6.
Number of families, genera, and species, and total taxa of sphinctozoid sponges recognized in Upper Triassic (Norian–Rhaetian) reefs within the Nayband Formation in central and northeast Iran.

Taxa	total	new	“old”	indet
Family	11	1	10	--
Genus	25	5	16	4
Species	46	19	15	12

The reefs located about 50 km south of the town of Delijan (see Text-Fig. 6, locality 2) yielded about 20 genera and 26 species. This is the most diverse thalamid sponge locality, followed by reefs exposed on the northern and southern flanks of the Kuh-e Nayband (Nayband Mt., see Text-Fig. 5) and by the small reef near the town of Marawand (see Text-Fig. 6, locality 3). The diversity of thalamid sponges, as well as other sponge groups, is not high in other localities discussed in chapter 3.

The most abundant taxa belong to the family Polytholosiidae, with four genera *Nevadathalamia, Fanthalamia, Cinnabaria*, and *Iranothalamia* nov. gen. Of these and all other described genera, the genus *Nevadathalamia* is the most abundant thalamid sponge found in all localities discussed in chapter 3. *Iranothalamia* is the next most abundant genus, followed by *Paradeningeria*, at least in reefs in the type locality of the Nayband Formation. The occurrences of sphinctozoid sponges in Iranian reefs in different localities are listed in Table 7. Of the 25 genera, 5 genera (20 %) belong to the aporate, and 20 genera (approximately 80 %) to the porate representatives. Porate sphinctozoans, with approximately 35 species (approximately 87 %), are clearly the dominant group.

6. Comparison of the Thalamid Sponge Fauna of Iranian Reefs with Some Other Norian–Rhaetian Reefs of the Tethyan Realm

Upper Triassic (Norian–Rhaetian) reefs are widely distributed throughout the world, both within and outside the Tethyan realm (KIESSLING et al., 1999; FLÜGEL & SENOWBARI-DARYAN, 2001; FLÜGEL, 2002). The sphinctozoid sponges are among the most important reef builders in all paleontologically well-investigated Norian–Rhaetian reefs.

Comparison of the sphinctozoid sponges of Norian–Rhaetian reefs of Iran with those known from other Norian–Rhaetian localities in the western (Alps, Sicily, Greece), southern (Oman) and northern Tethys (Pamier Mountains), and in North America (Nevada/USA, Yukon/Canada) shows that 14 of the Iranian genera (= 56 %) are known from the Alps, 9 genera (= 36 %) from Sicily, 10 from Greece (= 40 %), 4 genera (= 16 %) from Oman, 12 genera (= 48 %) from the Pamir Mountains, and 9 genera (= 36 %) from North America. The Iranian sphinctozoid sponge faunas show the most similarity to sphinctozoan faunas from the Alps, followed by those from the Pamir Mountains and Greece.

Some sphinctozoid sponges (e. g. A*mblysiphonella, Paradeningeria, Colospongia*) are more or less cosmopolitian and are known from all or from the majority of the reefs of the world. About 20 % of Iranian sphinctozoid sponge genera and almost 40 % of the species, are endemic and not known from other localities (see Table 8).

7. Evolution of the Thalamid Sponges in the Time Interval between Two Mass Extinctions (Permian/Triassic and Triassic/Jurassic)

Until three decades ago it was believed that the geological record of thalamid sponges ranged from the Carboniferous to the late Cretaceous. During the last 30 years, however, numerous thalamid sponges have been reported from the Cambrian (PICKETT & JELL, 1983; KRUSE, 1987; DEBRENNE & WOOD, 1990), the Ordovician (RIGBY & POTTER, 1986; RIGBY & WEBBY, 1988; RIGBY et al., 1988), the Silurian (FREITAS, 1987; RIGBY et al., 1994), the Devonian (RIGBY & BLODGETT, 1983; PICKETT & RIGBY, 1983), the Tertiary (PICKETT, 1982; CLAUSEN, 1982) and Recent (VACELET, 1977). For a complete list of sphinctozoid sponge genera see FINKS & RIGBY (in RIGBY et al., 2004) and for a complete list of species, their geographic distribution and stratigraphic range until 2000, see SENOWBARI-DARYAN & GARCIA BELLIDO (2002).

Table 7.
Distribution of thalamid sponges in Upper Triassic bioconstructions imbedded within the Nayband Formation, at different localities in central and northeast Iran.
1 = Ferdows Reef; 2 = Naybandan Reefs (southern flank of Kuh-e Nayband); 3 = Ali-Abad Reefs (northern flank of Kuh-e Nayband); 4 = Marawand Reef; = Delijan Reefs; 6 = Mahallat Reef; 7 = Bagher-Abad Reefs; 8 = Bulbulu locality.
For geographic positions of the localities see Text-Figs. 4-7.

Taxa	1	2	3	4	5	6	7	8	9
Amblysiphonella najafiani nov. sp.	-	-	-	-	x	-	x	-	-
Amblysiphonella cf. *steinmanni*	-	-	-	-	x	-	-	-	-
Amblysiphonella sp. 1	-	-	-	-	x	-	-	-	-
Amblysiphonella sp. 2	-	-	-	-	x	-	x	-	-
Amblysiphonella? sp. 3	-	-	-	x	-	-	-	-	-
Annaecoelia? interiecta	-	x	-	x	-	-	-	-	-
Annaecoelia? parva nov. sp.	-	-	X	-	-	-	-	-	-
Antalythalamia cf. *riedeli*	-	-	-	-	x	-	-	-	-
Cinnabaria minima	-	-	-	x	-	-	-	-	-
Colospongia iranica nov. sp.	-	-	-	x	-	-	-	-	-
Colospongia cf. *ramosa*	-	-	X	-	-	-	x	-	-
Colospongia sp. 1	-	-	-	-	x	-	-	-	-
Cryptocoelia wurmi	-	-	-	x	x	-	-	-	-
Delijania retrosiphonata nov. sp.	-	-	-	-	x	-	-	-	-
Deningeria cf. *camerata*	-	-	-	-	x	-	-	-	-
Deningeria tabasensis nov. sp.	-	-	X	-	-	-	-	-	-
Fanthalamia aksuensis	-	-	X	x	-	-	-	-	-
Iranothalamia incrustans	x	x	X	x	x	x	x	x	X
Kashanella irregularis nov. sp.	-	-	-	x	x	-	-	-	-
Naybandella prosiphonata nov. sp.	-	-	-	x	x	-	-	-	-
Nevadathalamia variabilis nov. sp.	x	x	X	x	x	x	x	x	x
Pamirothalamia? originalis	-	-	-	-	x	-	-	-	-
Panormida? sp.	-	-	-	-	x	-	-	-	-
Paradeningeria alpina	-	x	X	x	x	x	-	-	-
Paradeningeria minor nov. sp.	-	-	X	-	-	-	-	-	-
Parauvanella delijanensis nov. sp.	-	-	-	-	x	-	-	-	-
Parauvanella ferdowsensis nov. sp.	x	-	-	x	x	-	-	-	-
Paravesicocaulis naybandensis nov. sp.	-	x	-	x	-	-	-	-	-
Phraethalamia irregulara nov. sp.	-	-	-	-	x	-	-	-	-
Salzburgia sp.	-	-	X	-	-	-	-	-	-
Senowbaridaryana raretrabeculata	-	x	-	x	x	-	-	-	-
Senowbridaryana rectangulata nov. sp.	-	x	-	-	x	-	-	-	-
Stylothalamia columnaris	-	x	-	-	x	-	-	-	-
Stylothalamia? sp.	-	-	-	-	x	-	-	-	-
Tabasia maxima nov. sp.	x	x	-	-	-	-	-	-	-
Tabasia media nov. sp.	x	x	X	x	x	x	-	-	-
Tabasia minima nov. sp.	-	-	X	-	-	-	-	-	-
Tabasia gregaria nov. sp.	-	-	X	-	-	-	-	-	-
Tabasia? conica nov. sp.	x	-	?	x	x	-	-	-	-
Uvanella irregularis	x	x	X	x	x	x	x	x	x
Welteria hamedanii nov. sp.	-	-	X	-	x	-	-	-	-

Almost all Permian sphinctozoan sponge species and the majority of genera disappeared at the end of the Paleozoic as a result of the phenomenal mass extinction at the Permian/Triassic boundary. The Triassic reefs started with pioneer reefs in the Middle Anisian (Pelsonian) and ended at the end of the Triassic, caused by another phenomenal mass extinction at the Triassic/Jurassic boundary. No common Permian holdover sphinctozoid sponge species are known in pioneer reefs of Anisian age (FOIS & GAETANI, 1984; SENOWBARI-DARYAN et al., 1993; FLÜGEL & SENOWBARI-DARYAN, 2001; FLÜGEL, 2002). The Triassic reef and sphinctozoan faunas differ generally from those of the Permian, some of them differ in higher categories too (e. g. scleractinian corals). The evolution of most Triassic reef faunas, in general, and particularly the sphinctozoid sponges seem to be a complete epoch (RIEDEL, 1990; FLÜGEL & SENOWBARI-DARYAN, 2001). During the Triassic time intervall, from Anisian to Rhaetian, not only did the number of species increase, but also dimensions of sponges and their biological complexity, as documented in their rigid skeletons, increased too (e. g. the possession of internal skeletons, and inhalant and exhalant canal systems) (RIEDEL & SENOWBARI-DARYAN, 1991).

Four distinct time-dependent biotic units can be recognized between the two major global mass extinctions at the Permian/Triassic and Triassic/Jurassic boundary (FLÜGEL & SENOWBARI-DARYAN, 1996):

a) Anisian,
b) Ladinian–Cordevalian,
c) Julian–Tuvalian (Lower Norian?), and
d) Norian–Rhaetian.

These biotic units are also valid for the innovation of different sphinctozoan sponges and other coralline sponges. The rigid skeleton of all Permian sphintozoid sponges were aragonitic, but, in addition to aragonitic skeletons, the sphinctozoid sponges with a high-Mg-calcite skeleton appeared at the end of the Anisian and are abundant in Ladinian and Carnian reefs. Only one sphinctozoid sponge (*Uvanella norica*) with high-Mg-calcite mineralogy is known from Norian and Rhaetian reefs. As for morphological features there are not many similarities between Permian and Triassic sphinctozoid sponges, especially in the Anisian–Carnian time interval. However, a few Norian–Rhaetian sphinctozoid sponges show similar or identical morphologic construction to some of the late Permian forms (“Lazarus taxa”). For example *Discosiphonella*, an abundant Carboniferous and Permian sphinctozoid sponge with a retrosiphonate axial spongocoel and small cyst-like chambers arranged in one layer around the spongocoel, reappears again in the Norian (SENOWBARI-DARYAN, 1990; SENOWBARI-DARYAN & LINK, 1998; FLÜGEL & SENOWBARI-DARYAN, 2001; SENOWBARI-DARYAN & GARCIA-BELLIDO, 2002). Another example is *Parauvanella*, a perforated sphinctozoid sponge with irregularly arranged chambers is known from the Permian and Norian, but not from the Lower or Middle Triassic.

A major taxonomic change in the composition of sphinctozoid sponges during the Triassic took place in the time interval between late Carnian and early Norian. About 95 % of the Carnian sphinctozoid species became extinct during this time interval. Especially those taxa with Mg-calcite skeletons disappeared (SENOWBARI-DARYAN, 1990; FLÜGEL & SENOWBARI-DARYAN, 2001). New sphinctozoid taxa originated during the Norian and Rhaetian time interval. Norian–Rhaetian sphinctozoid sponges differ from those of Middle Triassic and Carnian representatives mainly by their aragonitic skeletal mineralogy, large dimensions, and by their complexity. Endemic faunas of sphinctozoid sponges in Norian–Rhaetian reefs are more common than those in Carnian reefs. FLÜGEL & SENOWBARI-DARYAN (2001) favor a two-step development (Anisian–Ladinian– Carnian and Norian–Rhaetian) for the Triassic biotic composition of Triassic reefs. This is also true for the composition and development of sphinctozoid sponges.

The mass extinction at the end of the Triassic caused the extinction of almost all Norian–Rhaetian sphinctozoid sponge genera. Apparently only the genus *“Stylothalamia”*, known from several lower Jurassic localities of the world, survived the Triassic/Jurassic boundary (HILLEBRANDT, 1971; PALLINI & SCHIAVINOTTO, 1981; SCHROEDER, 1984; BECARELLI BAUCK, 1986, SENOWBARI-DARYAN, 1990; SENOWBARI-DARYAN & STANLEY, 1994).

The dominant constituents of Norian–Rhaetian bioconstructions in Iran are hypercalcified sponges without any spicules. Siliceous sponges are rare and represented by hexactinellid types. Both chambered and unchambered hexactinellids occur. Hexactinellid-type sphinctozoid sponges are not known from the Middle Triassic,

Table 8.
Comparison of Iranian sphinctozoid sponges with other Norian–Rhaetian localities in the Tethyan realm and North America.
I = Iran; A = Alps and Carpathians; S = Sicily; G = Greece; O = Oman; P = Pamir; NA = North America. x = known; – = not known; ? = questionably known.

Genus/Species	I	A	S	G	O	P	NA
Amblysiphonella	x	x	x	x	-	x	x
A. najafiani nov. sp.	x	-	-	-	-	-	-
A. cf. *steinmanni*	x	x	-	-	-	-	-
A. sp. 1	x	?	?	?	?	?	?
A. sp. 2	x	?	?	?	?	?	?
A. sp. 3	x	-	-	-	-	-	-
Antalythalamia	?	-	-	-	-	-	-
A. riedeli	?	-	-	-	-	-	-
Annaecoelia	?	x	?	?	?	?	?
A.? interiecta	x	x	-	-	-	-	-
A.? parva	x	-	-	-	-	-	-
Cinnabaria	x	x	?	?	?	?	?
C. minima	x	?	?	?	?	?	?
Colospongia	x	x	x	x	X	x	x
C. iranica nov. sp.	x	-	-	-	-	-	-
C. cf. *ramose*	x	-	-	x	-	-	-
C. sp.	x	-	-	-	-	-	-
Cryptocoelia	x	x	x	x	X	x	-
C. wurmi	x	x	-	x	-	-	-
***Delijania* n. gen.**	x	-	-	-	-	-	-
D. retrosiphonata n. sp.	x	-	-	-	-	-	-
Deningeria	x	x	-	-	-	-	-
D. cf. *camerata*	x	-	-	-	-	-	-
Fanthalamia	x	-	-	-	-	x	x
F. adsuensis	x	-	-	-	-	-	-
Iranothalamia	x	-	-	-	-	x	x
I. incrustans	x	-	-	-	-	x	x
***Kashanella* n. gen.**	x	-	-	x	-	-	-
K. irregularis nov. sp.	x	-	-	x	-	-	-
***Naybandella* n. gen.**	x	-	-	-	-	-	-
N. prosphonata nov. sp.	x	-	-	-	-	-	-
Nevadathalamia	x	x	-	-	-	-	x
N. variabilis nov. sp.	x	?	-	-	-	-	-
Pamirothalamia	?	-	-	-	-	x	-
P. originalis	?	-	-	-	-	x	-
Panormida	?	-	x	-	-	-	-
P. sp. 1	x	?	?	?	?	?	?
Paradeningeria	x	x	x	x	-	x	x
P. alpine	x	x	x	x	-	x	x
P. minor n. sp.	x	-	-	-	-	-	-
Parauvanella	x	x	x	x	X	x	x
P. ferdowsensis n. sp.	x	-	-	-	-	-	-
P. delijanensis	x	-	-	-	-	-	-
Paravesicocaulis	x	-	x	-	-	x	-
P. Naybandensis n. sp.	x	-	-	-	-	-	-
Phraethalamia	x	-	-	-	-	-	-
P. irregulara	x	-	-	-	X	-	-
Salzburgia	?	x	-	x	-	-	-
S. sp.	x	?	?	?	?	?	?
Senowbaridaryana	x	x	-	x	-	x	-
S. raretrabeculata	x	-	-	-	-	x	-
S. rectangulata n. sp.	x	-	-	-	-	?	-
Stylothalamia	x	x	x	x	?	x	x
St. columnairis	x	x	-	-	-	-	-
***Tabasia* n. gen.**	x	-	-	-	-	-	-
T. maxima n. sp.	x	-	-	-	-	-	-
T. media n. sp.	x	-	-	-	-	-	-
T. minima n. sp.	x	-	-	-	-	-	-
T. gregaria n. sp.	x	-	-	-	-	-	-
T.? conica n. sp.	x	-	-	-	-	-	-
Uvanella	x	x	x	x	?	x	x
U. norica	x	?	?	?	?	?	?
Welteria	x	x	-	x	X	-	-
W. hamedanii	x	-	-	-	-	-	-

but they are relatively abundant in Upper Triassic reefs and are also known from a few localities in China (WU, 1989; RIGBY, WU & FAN, 1998), the Pamir range (BOIKO, 1990), and from Iran (SENOWBARI-DARYAN & HAMEDANI, 1999, this paper). Hexactinelliid-type sphinctozoid sponges in Iranian reefs are relatively abundant in the Delijan Reefs, but in other bioconstructions they are very rare.

8. Paleoecology

Sphinctozoans, described in this paper, occur together with other reef-builder organisms and reef dwellers within the Norian–Rhaetian reefs that developed as bioherms or biostromes in different stratigraphic levels within the Nayband Formation. These reefs crop out in several localities in central and northeast Iran. Among the hypercalcified sponges that occur in these reefs, are the groups of sphinctozoans, inozoans, chaetetids and spongiomorphids. Hexactinellids are represented rarely by both chambered and unchambered groups and they occur in reefs and in surrounding sediments in the Nayband Fomation. A relatively high occurrence of hexactinellids was found in reefs south of the town of Delijan (north of Esfahan, see Figs. 3, 6, locality 2).

Sponges are accompanied in the reefs by other reef building organisms, such as corals, bryozoans, algae etc. Sponges are most abundant in the stratigraphic middle portion of the Nayband Formation, the Bidestan Member, which is most probably of middle Norian age. An abundance of corals was found in reefs exposed in the upper portion of the Nayband Formation, called the Howz-e Khan Member, which is dated as Rhaetian. Corals are represented by three main groups of solitary, dendroid and cerioid types. The cerioids are more abundant in the Bidestan member, and dendroids in the Howz-e Khan member (FÜRSICH et al., 2005).

Bryozoans are very rare. Solenoporacean red algae were found within the reefs, usually associated with corals, dasycladaceans and, rarely, codiaceans which occur generally within the bedded limestones. Additional accompanied organisms are serpulid worm tubes, different problematic organisms, such *Microtubus communis* FLÜGEL, *Radomura cautica* SENOWBARI-DARYAN & SCHÄFER, *Lithocodium* sp., and *Tabasosphaera pustulosa* SENOWBARI-DARYAN. Serpulids and sessil brachiopods, like *Gosaukammerella* SENOWBARI-DARYAN & FLÜGEL, are particulary abundant within the reefs (e.g. in Marawand Reef), and are usually associated with sponges. Foraminifers are generally rare within the reefs, but they may be abundant in some surrounding carbonate beds. Gastropods, bivalves and brachiopods are the main reef dwellers. Finally, the spherical hydrozoan *Heterastridium* should be mentioned. It is extremely abundant within the Bidestan Member, and also occurs with reef-builder organisms and in surrounding bedded carbonates.

Microbial crusts, so called "Spongiostromata", stabilizing the reef frame, may occur around the reef builders reaching thicknesses of up to 1 cm. Spongiostromata are usually abundant in sponge-dominated reefs, but may occur also in coral dominated structures. Generally sponges are not associated with corals, so different small patch reefs, dominated by sponges or corals, can be differentiated. Both types exhibit characteristic organism associations.

Secondary cements are not abundant in the Iranian reefs, as is known from other time equivalent reefs (e.g. Dachstein reef limestones of the Northern Calcareous Alps). The primary mud between the reef organisms was not or rarely washed out. The micritic matrix between the reef builders indicates formation of the reefs in relatively deeper and quite water, perhaps below the storm base. This assumption is supported by the occurrence of hexactinellid sponges, especially in reefs south of the town of Delijan, which favour deeper water biotopes than do the hypercalcified sponges. Detrital angular components, mostly quartz, occur between the reef-building organisms, indicating input from the land near the depositional sites.

Hypercalcified sponges colonized the hard substrata formed by bivalves, corals or other hypercalcified sponges. The reef biotopes, particularly those that were sponge-dominiated were closely colonized. In most cases, the sponges did not have enough room to build their own shape and morphology, so they grew in the available remained spaces. This fact makes it more difficult to determine the systematic positions of the sponges. As primary reef builders, the hypercalcified sponges, especially the inozoans and sphinctozoans grew upward and served, in most cases, as the substratum for other hypercalcified sponges and other reef builders. The observations of WOOD et al. (1994) from the Permian reefs of Guadalupe Mountains in Texas and New Mexico, that the hypercalcified sponges were cryptic organisms and grew downward, cannot be confirmed in these Upper Triassic reefs in Iran.

The number of reef-building organisms (except reef dwellers) in the Upper Triassic reefs exposed in the Nayband Formation in Iran amount to approximately 150 species. The hypercalcified sponges represent about half of this number, followed by corals.

9. Conclusions

Small-scaled Upper Triassic (Norian–Rhaetian) sponge- or coral-dominated reefs of bistromal and biohermal character are exposed in different stratigraphic levels within the siliciclastic-carbonate deposits of the Nayband Formation in several localities in central and northeast Iran.

The sponge fauna of these reefs is composed of hypercalcified sponges, including "Sphinctozoida", "Inozoida", "Chaetetida", "Spongiomorphida", and rarely Hexactinellida. Hypercalcified sponges are the most abundant organisms in sponge-dominated reefs of the Middle Norian Bidestan Member, but corals are more abundant in the coral-dominated reefs of the Rhaetian Howz-e Member. Sphinctozoid sponges, described in this paper, are important contributors to the formation of these bioconstructions. The occurrence of 11 families, 25 genera and at least 46 species documents one of the most diverse sphinctozoid sponge fauna of the Upper Triassic reefs in the world. Approximately 80 % of the genera and about 60 % of the sphinctozoid species described from Upper Triassic Iranian bioconstructions are known from other Upper Triassic reefs or shallow water deposits in the world. However, 40 % of the species are endemic and, as yet, are not known from other localities.

The sphinctozoan sponge fauna of these Iranian reefs is most similar to those known from the Upper Triassic reefs in the Alps, followed by those from Pamir Mountains and Greece.

In addition to the sponges, solitary, cerioid and dendroid corals, bryozoans, sessil brachiopods, algae, different problematic organisms, and microbial crusts have had important roles in the formation of the reefs. Foraminifers are rare. The number of reef-building organisms amount to approximately 150 species.

The paleontological and sedimentological characteristics of the sponge-dominated reefs indicate the depositional environments of the reefs were in normal marine quiet water and moderately deeper water below wave base.

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Plate 1

Parauvanella ferdowsensis nov. sp.
from the Upper Triassic Nayband-Formation of central Iran.

Fig. 1: Section through several spherical to subspherical chambers that are filled with sediment or spary calcite cement. The fine and even perforations of chamber walls are clearly shown. Small arrows indicate the thickening of chamber walls at the corners of chambers (small arrows); large arrow points to the thickening at the bottom of one chamber.
Delijan Reefs, P137/5/1, ×7.

Fig. 2: Section through several chambers of *Parauvanella ferdowsensis* nov. sp. (A) attached on an other sponge (possibly a broken specimen of *Kashanella* nov. gen. nov. sp. and a cross section of *Spongiomorpha* sp. (B)
Delijan Reefs, P/166/2, ×5.

Fig. 3: Section through several chambers of *Parauvanella ferdowsensis* nov. sp., which is attached to an inozoid sponge (I). The chambers in the lower right part are filled with spary calcite cement. Clearly evident is the fine and even perforation of chamber walls in larger, younger upper chambers.
Marawand Reef, M134/e, ×8.

Fig. 4: Section through several chambers of *Parauvanella ferdowsensis* nov. sp. (P), chambers of undetermined sphinctozoid sponge (S), and two chambers of sphinctozoid sponge *Paradeningeria?* sp. (D) on which *Parauvanella ferdowsensis* is attached.
Marawand Reef, M73, ×4.

Fig. 5: *Parauvanella ferdowsensis* nov. sp. (P) is attached on a inozoid sponge (I).
P207/2, Delijan Reefs, ×2.5.

Fig. 6: Magnification of specimen illustrated in Pl. 15, Fig. 1P.
Section through several chambers. The perforations of the chamber walls are clearly recognizable.
Naybandan Reefs, PNN, ×10.

Fig. 7: Section through several chambers that are filled with sediment.
Delijan Reefs, P148/16/2, ×10.

Fig. 8: Similar section to Fig. 7.
The arrows indicate several specimens of a *"Tubiphytes"*-like organism colonizing on and between the chambers of *Parauvanella ferdowsiensis* nov. sp.
Delijan Reefs, P137/5/1, ×12.5.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

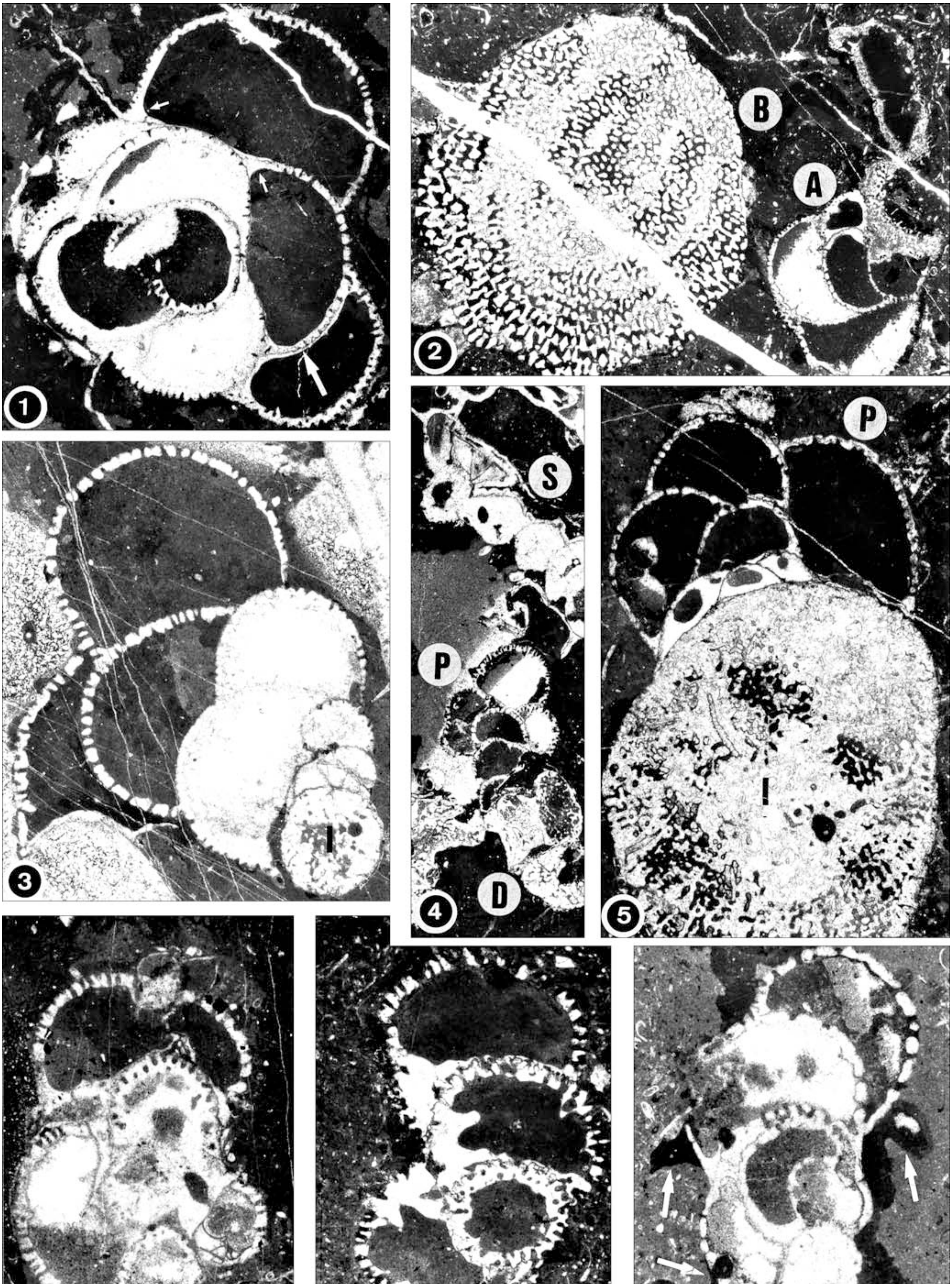
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Plate 2

Parauvanella ferdowsensis nov. sp., *Uvanella norica* (Senowbari-Daryan & Schäfer), and *Parauvanella delijanensis* nov. sp.

Figs. 1–2: ***Parauvanella ferdowsensis* nov. sp.**
Fig. 1: Holotype. Section through numerous hemispherical to crescent-like chambers with distinct thin and evenly perforated chamber walls.
Ferdows Reef, 96/31/5a, ×3.
Fig. 2: Enlargement of chamber walls of the holotype exhibits the net-like interconnected dark areas in the chamber walls (compare Text-Fig. 8). These areas were probably filled with organic material during the life-time of the sponge.
Ferdows Reef, 96/31/5a, ×20.

Fig. 3: **Parallel section to Figure illustrated in Pl. 4, Fig. 1. (C).**
Longitudinal and transverse sections through several specimens of *Colospongia iranica* nov. sp. (C) and a specimen of *Paravesicocaulis naybandensis* nov. sp. (P) composed of four chambers filled with vesiculae (compare Text-Fig. 26).
The specimen of *C. iranica* without the secondary skeleton on the lower right shows the perforated chamber walls.
Marawand Reef, M/110/10a, ×7.

Fig. 4: ***Uvanella norica* (Senowbari-Daryan & Schäfer).**
Section through several chambers. The specimen has overgrown a hexactinellid sponge (H). Chamber interiors are filled with calcite cement or with gray silty sediment.
Delijan Reefs, P/171/3, ×8.

Fig. 5: ***Parauvanella delijanensis* nov. sp.**
Section through numerous irregulary arranged chambers. The chamber walls are pierced by irregular and uneven pores.
Delijan Reefs, P/272/3, ×2.5.

Fig. 6: ***Uvanella norica* (Senowbari-Daryan & Schäfer).**
Section through several irregular chambers filled with spary calcite cement. The chamber interiors contain vesiculae, well shown in the lower right.
Marawand Reef. M/134/D, ×7.

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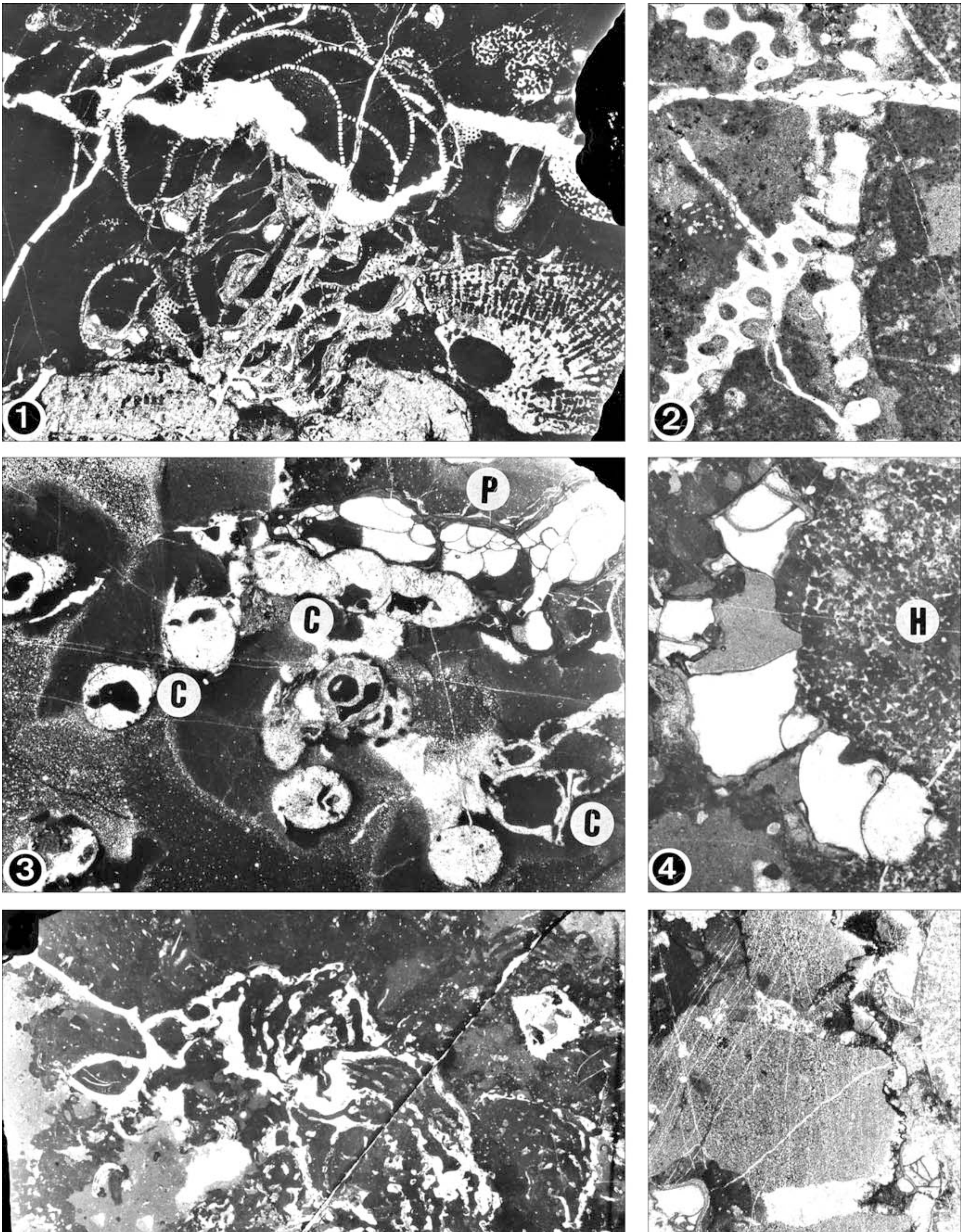
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Plate 3

Colospongia iranica nov. sp.

Fig. 1: Holotype.
Section through several spherical to hemispherical chambers of a curved specimen. The majority of chambers are filled with secondary skeleton. Perforations of chamber walls are evident in chambers with dark micritic filling.
Marawand Reef, M/110/10, ×10.

Fig. 2: Section through several specimens.
Some chambers in the upper part are without secondary skeleton and filled with dark micritic sediment which emphasizes the perforated chamber walls.
Marawand Reef, M/110/10/A, ×5.

Fig. 3: Section through three specimens showing the spherical to hemispherical chambers filled with secondary skeleton.
Marawand Reef, M/134/l, ×7.

Fig. 4: Oblique sections through two specimens.
Some of the dark areas within the calcite cement in the interior of the chambers are borings.
Marawand Reef, M/110/12, ×7.

Fig. 5: Oblique and transverse sections through several specimens.
Marawand Reef, M/110/12, ×5.

Fig. 6: Longitudinal section through a specimen in upper part with spherical to hemispherical chambers totally filled with secondary skeleton.
Marawand Reef, M134/l, ×7.

Fig. 7: Transverse and longitudinal sections.
Marawand Reef, M110/10B, ×7.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

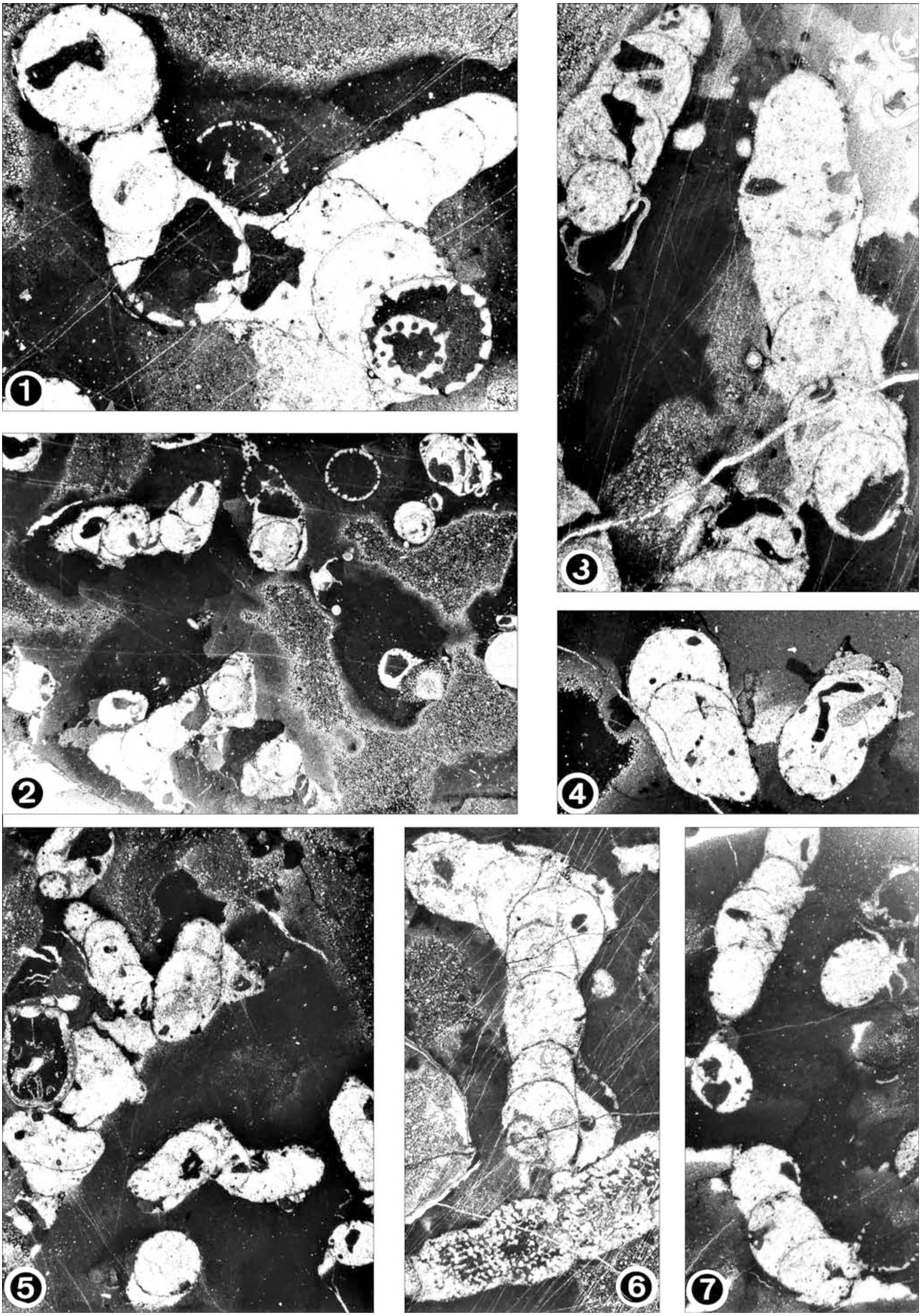
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Plate 4

Colospongia iranica nov. sp., *Paravesicocaulis naybandensis* nov. sp., and *Parauvanella delijanensis* nov. sp.,

Fig. 1: **Parallel section to specimen illustrated in Pl. 2, Fig. 3.**
C) ***Colospongia iranica* nov. sp.**
Longitudinal and oblique sections through several specimens. In some chambers (specimen on the left) filling structure is lacking and the perforations of the segment walls are recognizable.
P) ***Paravesicocaulis naybandensis* nov. sp.**
Chamber interiors are filled with vesiculae (compare Text-Fig. 26).
Marawand Reef, M/110/10b, ×5.

Fig. 2: ***Colospongia iranica* nov. sp. (C) and *Paravesicocaulis naybandensis* nov. sp. (P) with prominent vesiculae.**
Marawand Reef, M/110/10/B, ×10.

Fig. 3: ***Colospongia iranica* nov. sp.**
Longitudinal, transverse and oblique sections. Perforations of chamber walls are easily recognizable in specimens in the upper part (cross section).
Marawand Reef, M/110/1, ×7.

Figs. 4–6: ***Parauvanella delijanensis* nov. sp.**
Fig. 4: Section through numerous irregularly arranged chambers with variously sized pores in the segment walls.
Upper left, a large brachiopod shell is attached to the sponge (left upper part).
Delijan Reefs, P272/3a, ×2.3.
Fig. 5: Similar to Fig. 4.
Delijan Reefs, P272/1b, ×2.
Fig. 6: Two specimens show the irregularly flattened and glomerate chambers, with uneven pores in the segment walls.
Delijan Reefs, P272/2, ×2.3.

Fig. 7: ***Colospongia iranica* nov. sp.**
Longitudinal section through several chambers partly filled with filling structure or micrite. The arrow points to pillar-like structure extending from the chamber roof into the chamber interior.
Marawand Reef, M110/12, ×8.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

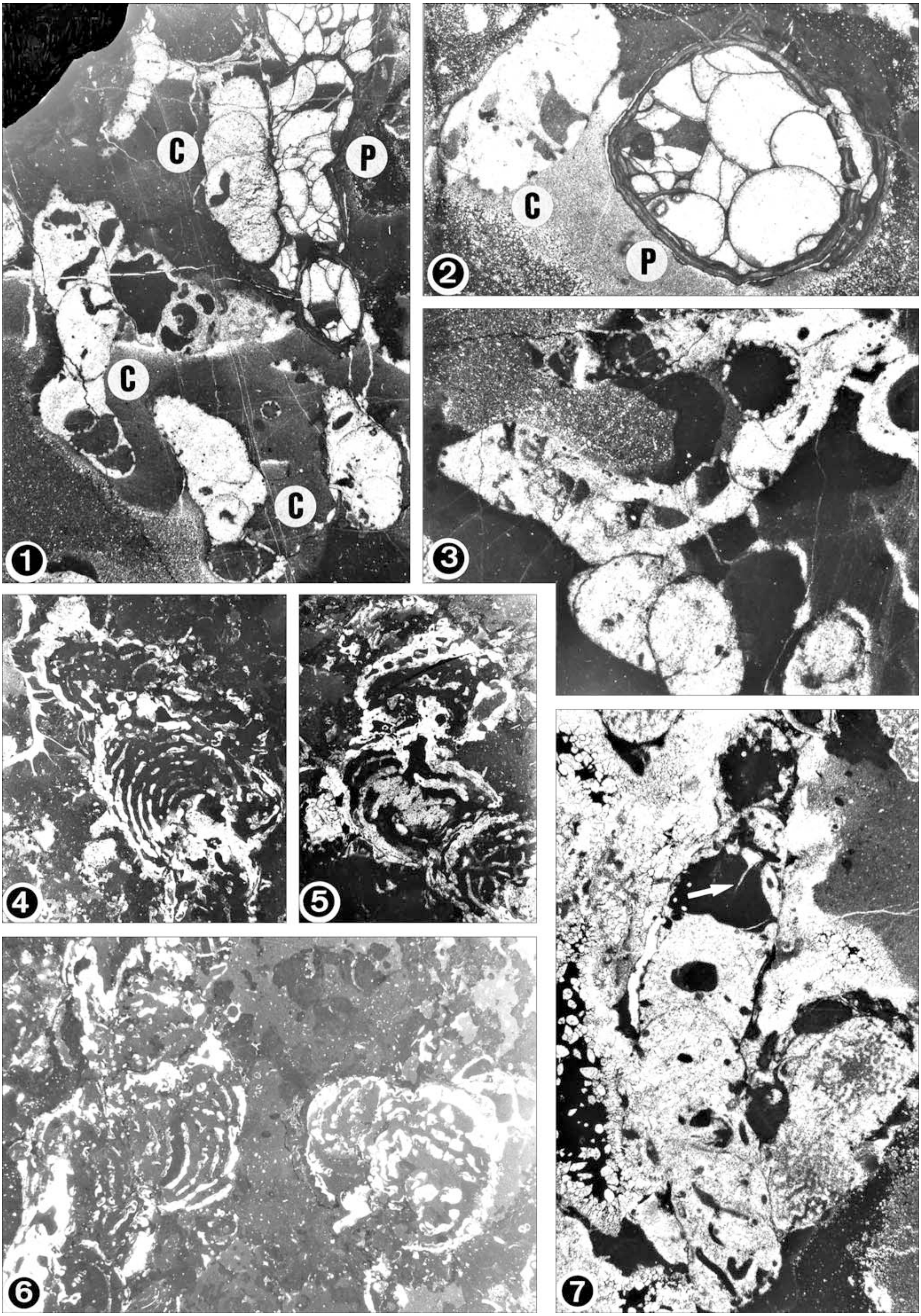
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Plate 5

Delijania retrosiphonata nov. gen., nov. sp., *Kashanella irregularis* nov. gen., nov. sp., and *Parauvanella delijanensis* nov. sp.,

Figs. 1–3: ***Delijania retrosiphonata* nov. gen., nov. sp.**

Fig. 1: Holotype.
Marginally axial longitudinal section through numerous crescent-like chambers, whose roofs appear as dark lines. The relatively wide spongocoel is cut in the middle part. The retrosiphonate nature of the spongocoel is indicated by the downward flexed endowalls. On the right side of the spongocoel, the black arrow points to a sphinctozoid sponge between the spongocoel and chambers of *D. retrosiphonata*. The chamber interiors are totally filled with a spore-like filling structure.
Delijan Reefs, P223, ×2.8.

Fig. 2: Section through a branched(?) specimen or three(?) specimens.
The spore-like filling structure is recognizable in chamber interiors.
Delijan Reefs, P/202, ×3.

Fig. 3: Magnified view of part of Fig. 1.
Third chamber from the bottom (see white arrows) shows the spore-like filling structure of the sponge. The dark lines correspond to the chamber walls.
Delijan Reefs, P223, ×10.

Fig. 4: ***Kashanella irregularis* nov. gen., nov. sp.**
Holotype.
Longitudinal section through several irregular chambers with complicated (labyrinthic-like) pore systems in the chamber walls. Chamber roofs are pierced by at least two osculi. Chamber interiors are filled with micritic sediment containing abundant sponge spicules.
Marawand Reef, M/110/12, ×10.

Figs. 5–6: ***Parauvanella delijanensis* nov. sp.**

Fig. 5: Holotype.
The irregular and flattened chambers have uneven perforations in chamber walls. White arrows point to exhalant canals developed with irregular spacing.
Delijan Reefs, P272/1a, ×2.5.

Fig. 6: Section through numerous irregular and not well defined chambers.
The white arrows indicate the exhalant canals.
Delijan Reefs, P272/3a, ×2.3.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

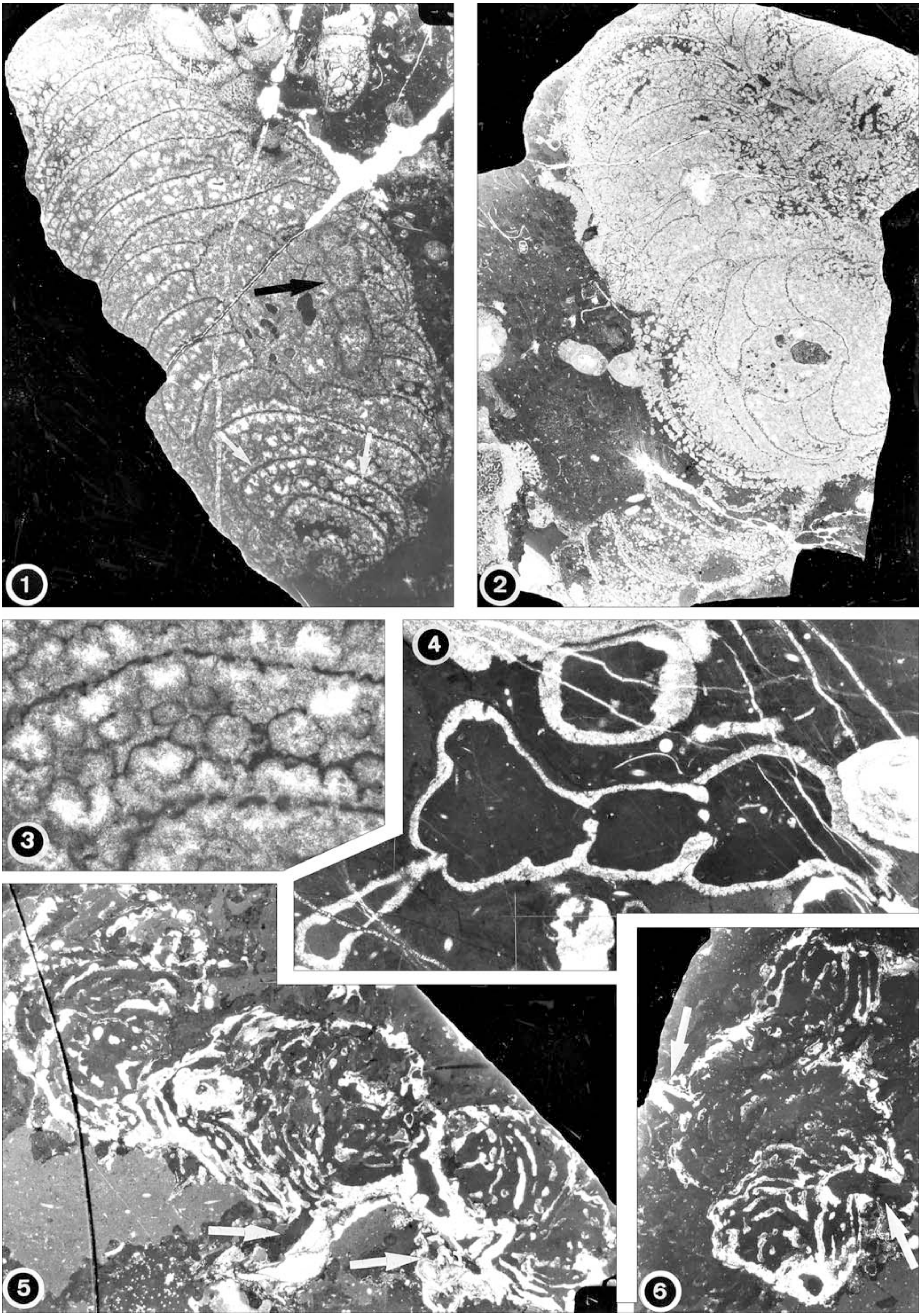
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Plate 6

Colospongia cf. *ramosa* RIEDEL & SENOWABARI-DARYAN.

Fig. 1: Longitudinal and transverse sections through two specimens show numerous crescent-like chambers.
Chamber walls are pierced by unevenly distributed pores of different sizes. Generally, earlier chambers are overlapped by younger chambers, causing the lack of visible outer segmentation.
Ali-Abad Reefs, AB/19a, ×4.

Fig. 2: Longitudinal, cross and oblique sections of three specimens that show the general characteristics of the thick walled sponge.
Ali-Abad Reefs, AB/18, ×2.5.

Fig. 3: Section through two sponges or a branched specimen.
Ali-Abad Reefs, AB/19b, ×2.5.

Fig. 4: Sections through two branched specimens.
The specimen on the right shows rejuvenescence in the upper part.
Ali-Abad Reefs, AB/22, ×2.5.

Fig. 5: Longitudinal section through a specimen shows the crescent-like and flattened chambers arranged one above the other.
Bagher-Abad Reefs, SB12, ×2.8.

Fig. 6: Section through several crescent-like chambers whose interiors are filled with dark micrite.
Ali-Abad Reef, AB/9/1, ×4.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

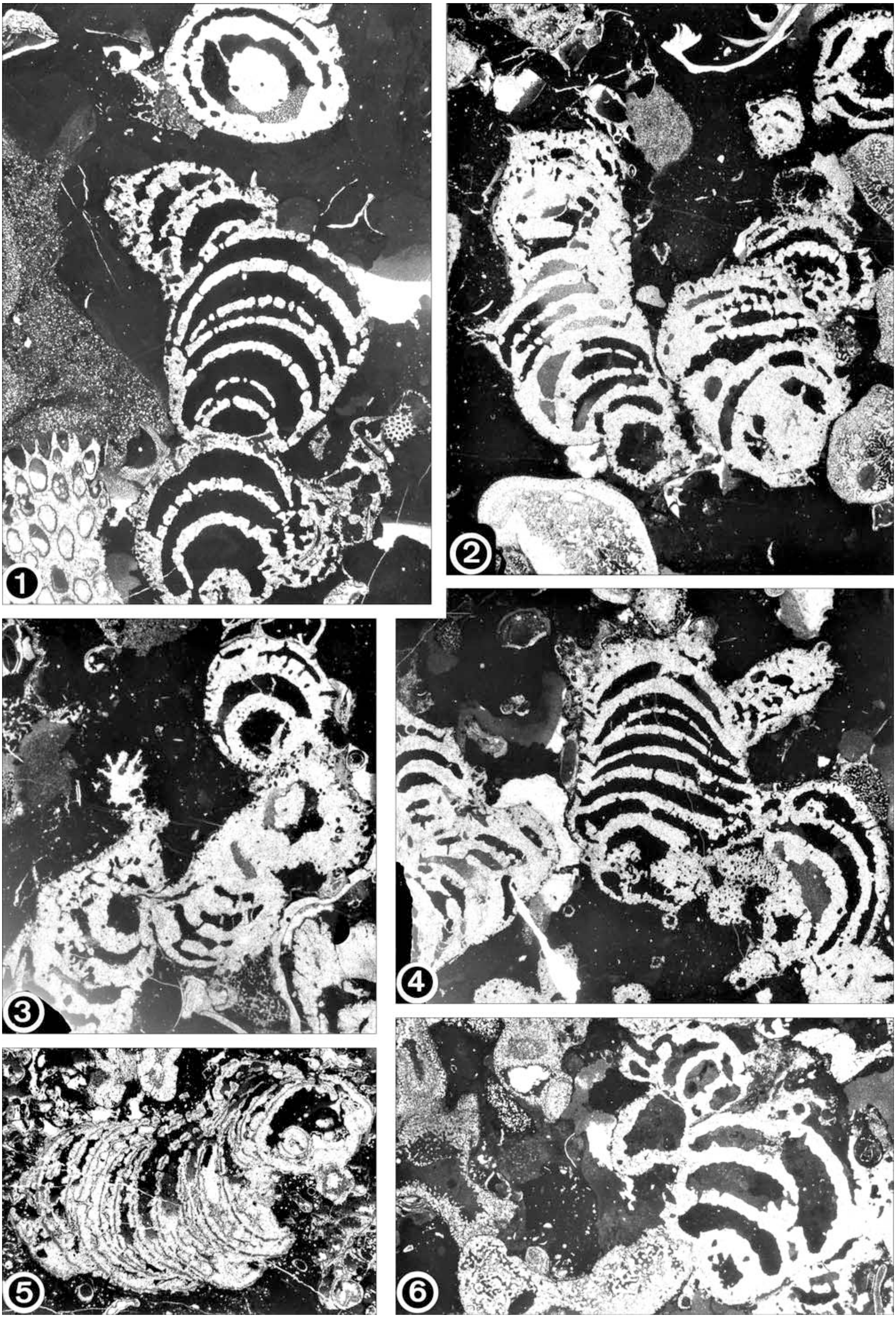
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Plate 7

Colospongia sp. 1, *Amblysiphonella najafiani* nov. sp., and *Amblysiphonella* sp. 2.

Fig. 1: ***Colospongia* sp. 1.**
Section through four chambers. The thin chamber walls are pierced by more or less evenly distributed pores.
Bagher-Abad Reefs (La Kaftari locality), La12, ×2.5.

Figs. 2,6,7: ***Amblysiphonella najafiani* nov. sp.**
Fig. 2: Marginal longitudinal section through eight chambers. The axial spongocoel is cut in the lower part.
Bagher-Abad Reefs (La Kaftari locality), La18, ×4.
Fig. 6: Holotype (compare Text-Fig. 12).
Longitudinal axial section exhibits the imperforate interwalls (chamber roofs) and the endowall (spongocoel wall) with large sieve-like openings. The exowalls are pierced with evenly distributed small pores.
Delijan Reefs, 99 Dj11, ×5.
Fig. 7: Transverse section shows the perforation of the exowalls and the large openings in the spongocoel wall.
Delijan Reefs, 99Dj11, ×7.

Figs. 3–5: ***Amblysiphonella* sp. 2.**
Fig. 3: Longitudinal axial section through several chambers.
Note the dark lines or layers (compare Fig. 4) in the middle of the chamber walls.
Bagher-Abad Reefs (La Kaftari locality), La22, ×4.
Fig. 4: Enlargement of two chambers of the sponge shown in Fig. 3, which clearly exhibits the dark lines in the middle of both the exo- and interwalls.
×8.
Fig. 5: Longitudinal section shows the spongocoel and some incomplete chambers with thick doubled interwalls.
Delijan Reefs, Dj4, ×2.8.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

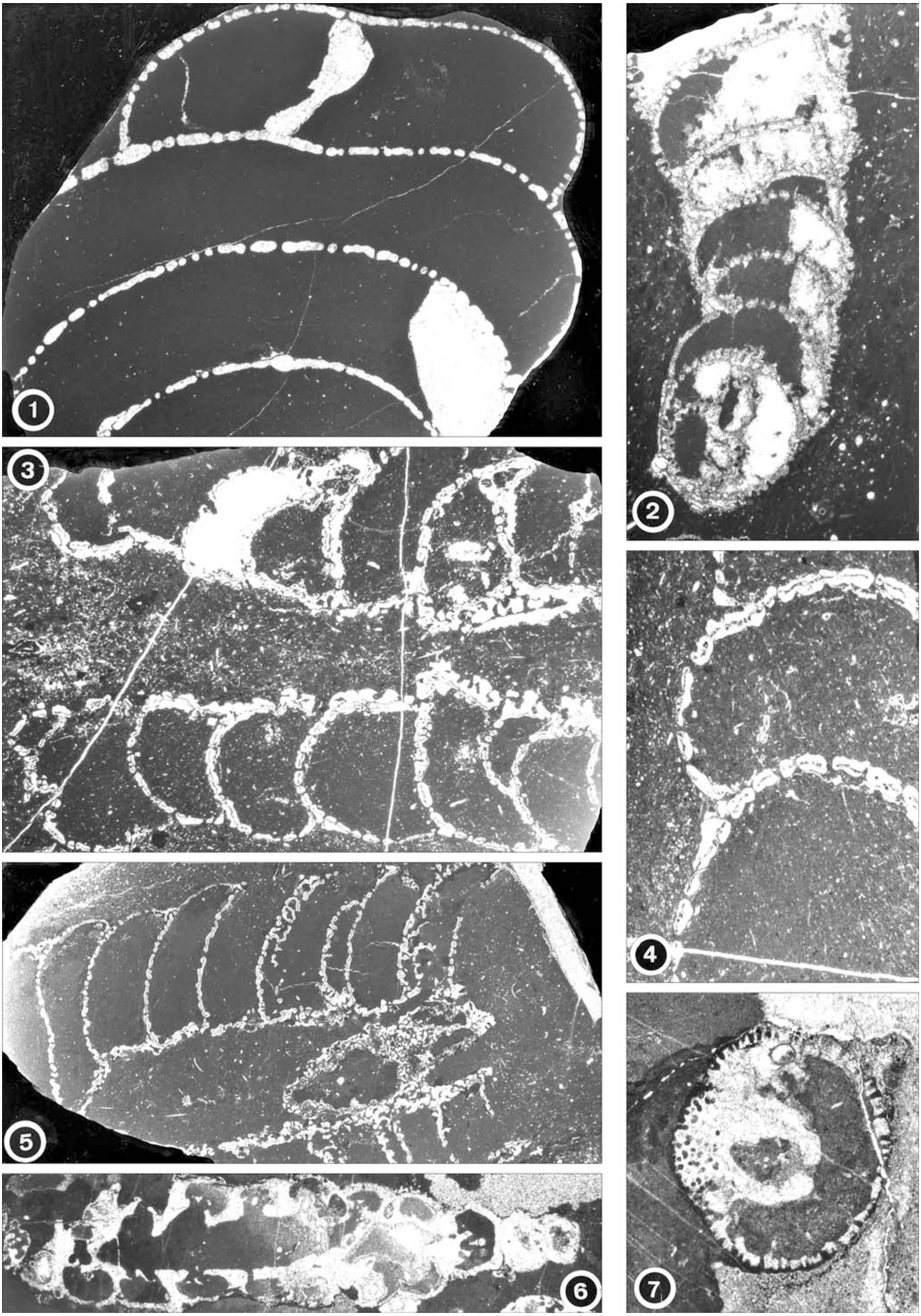
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Plate 8

Amblysiphonella cf. *A. steinmanni* (HAAS), *Amblysiphonella* sp. 1, and *Deningeria* cf. *camerata* (WILCKENS).

Figs. 1,2: **Amblysiphonella cf. A. steinmanni (HAAS).**
Fig. 1: Oblique section of a specimen on a natural weathered rock surface that shows the ring-chambers around a wide retrosiphonate spongocoel.
Delijan Reefs, ×2.
Fig. 2: A polished specimen exhibits the perforation of chamber and spongocoel walls and other characteristics of the sponge like the specimen illustrated in Fig. 1. A small bivalve is imbedded in the spongocoel.
Polished slab, Delijan Reefs, P/73, ×2.

Figs. 3,4,5: ***Amblysiphonella* sp. 1.**
Fig. 3: View of the exterior of a steinkern.
In some areas the outer wall of the sponge is still preserved. Note the oblique arrangement of the ring-chambers.
Delijan Reefs, Dj5, ×2.
Fig. 4: Polished slab of the axial section through the same specimen illustrated in Fig. 3, which shows the spongocoel and the thin-appearing (compaction?) chamber walls.
Delijan Reefs, ×2.
Fig. 5: A) *Amblysiphonella* sp. 1.
B) *Amblysipnonella* sp. 2?.
Delijan Reefs, Dj99/7, ×3.

Figs. 6,7: ***Deningeria* cf. *D. camerata* WICKENS.**
Fig. 6: Magnification of part of Fig. 7 which exhibits the crescent-like chambers and the reticular filling skeleton within the chamber interiors.
Delijan Reefs, ×2.
Fig. 7: Section through numerous crescent-like chambers.
The sponge is surrounded totally by an inozoid sponge of *Stellispongia*-type. The arrow in the upper left indicates the bundled exhalant canals of this latter sponge.
Delijan Reefs, Dj99/3, ×1.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

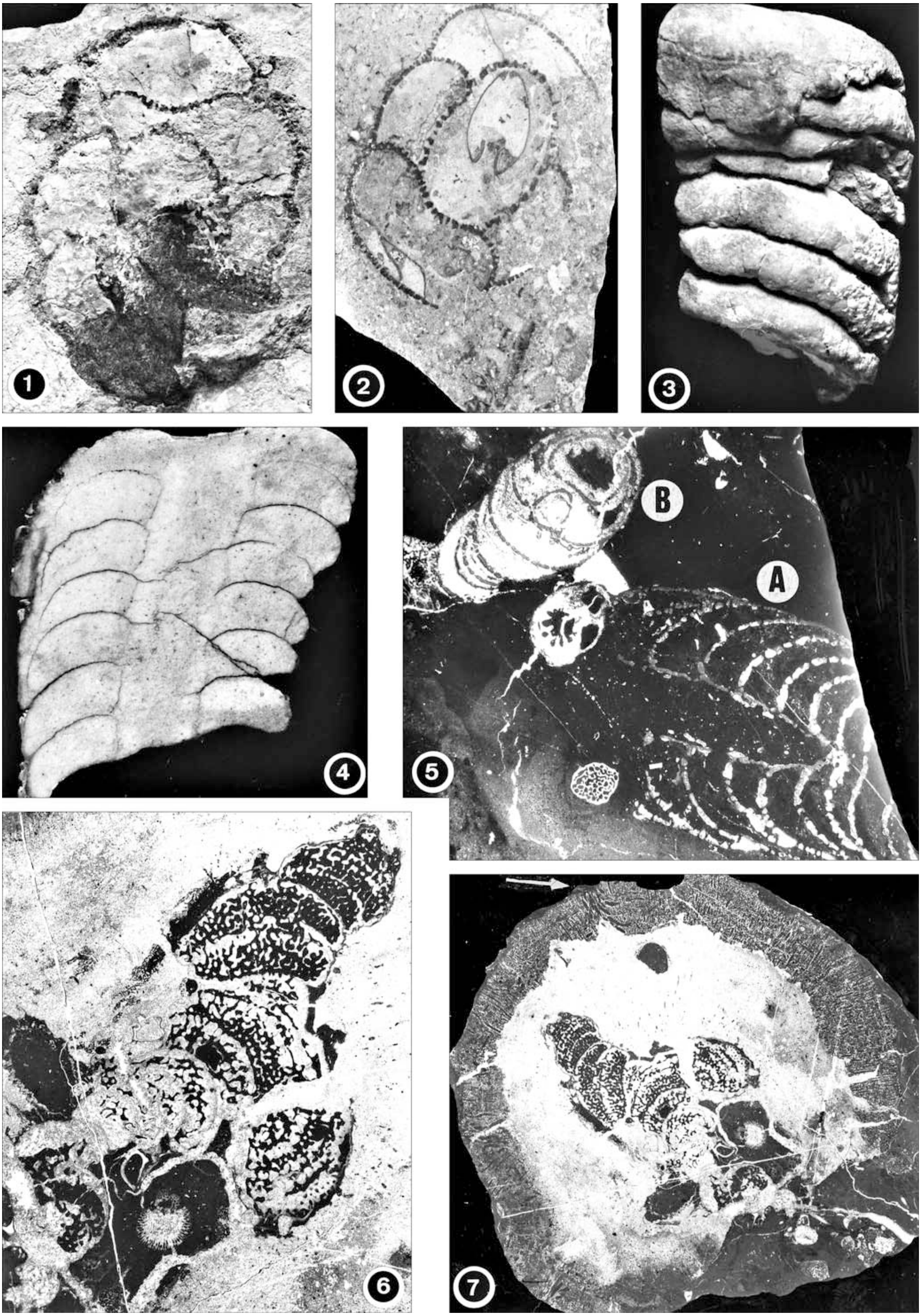
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Plate 9

Paravesicocaulis naybandensis nov. sp., *Amblysiphonella?* sp. 3,
Antalythalamia cf. *A. riedeli* SENOWBARI-DARYAN, *Antalythalamia* sp.,
Naybandella prosiphonata? nov. sp., and *Salzburgia sp*.

Figs. 1,2?: ***Paravesicocaulis naybandensis* nov. sp.**
Fig. 1: Section through several chambers shows the imperforate thin chamber walls, the rimmed ostia (arrows), and the abundant vesiculae within the chamber interiors.
Marawand Reef, M34, ×4.5.
Fig. 2: Section through some chambers.
S) Crust of solenoporaceans.
K) brachiopod shell.
Marawand Reef, M34, ×5.

Fig. 3: ***Amblysiphonella?* sp. 3.**
Longitudinal section shows the ring-like chambers arranged obliquely to the axis of the sponge, the perforated chamber walls, and the axial spongocoel composed of several individual tubes (see the uppermost chamber roof).
Marawand Reef, M131, ×5.

Fig. 4: ***Antalythalamia* cf. *A. riedeli*** SENOWBARI-DARYAN.
Longitudinal section through three chambers exhibits the fine perforated chamber walls, and the massive pillar structure within the chamber interiors.
Delijan Reefs, Dj10/0, ×7.5.

Fig. 5: ***Antalythalamia?* sp.**
Section through four chambers with finely perforated chamber walls and vesiculae within the chamber interiors.
Delijan Reefs, 99Dj10/1, ×2.5.

Fig. 6: ***Naybandella prosiphonata?* nov. sp.**
Longitudinal section through several, partly incomplete chambers.
Delijan Reefs, P/64, ×5.

Fig. 7: ***Salzburgia* sp.**
Section through several chambers exhibits the double-layered appearance of chamber walls.
Ali-Abad Reefs, Ab19a, ×6.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

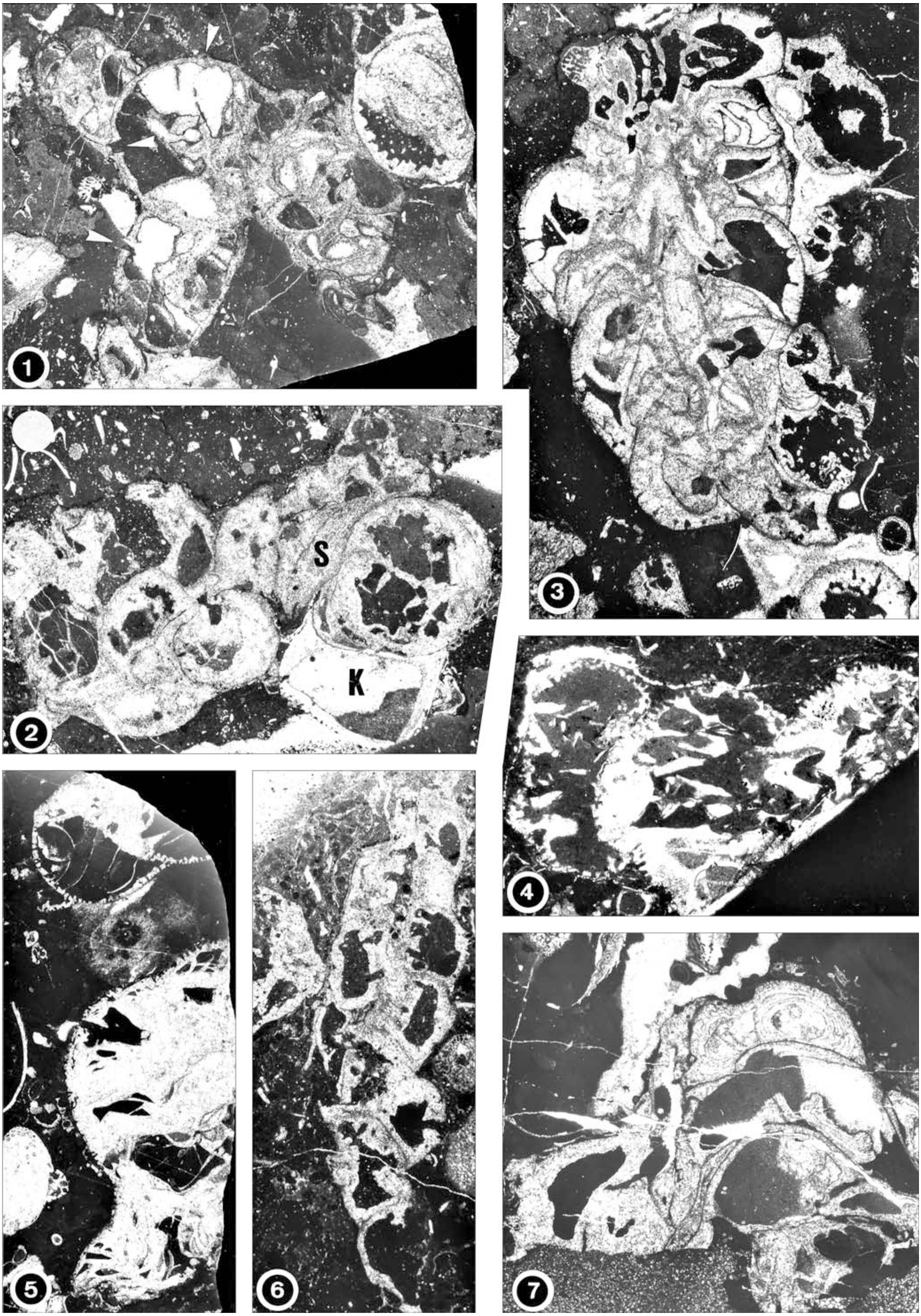
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Plate 10

Nevadathalamia variabilis nov. sp.

Fig. 1: Transverse and longitudinal sections through several specimens (H = Holotype).
Both specimens, cut in longitudinal section, show a thin spongocoel wall and a few filling structures of granular type in older chambers.
Naybandan Reefs, PR3/3/1, ×1.3.

Fig. 2: Transverse and oblique sections through several specimens that exhibit the clearly perforated chamber walls and the granular filling structure within chamber interiors.
Naybandan Reefs, N28, ×1.6.

Fig. 3: Longitudinal section through a specimen that exhibits the ring-chambers and the spongocoel wall with large pores. The older chambers contain some granular to tubular(?) type filling structure.
Naybandan Reefs, P339/1, ×2.5.

Fig. 4: Oblique sections through several specimens show relatively narrow spongocoels and some filling structure of granular type within the chamber interiors.
Ali-Abad Reefs, T25/3, ×2.5.

Fig. 5: Longitudinal section through several ring-chambers that exhibits the spongocoel with large pores and chambers with a few internal granular filling structures.
Polished slab, Delijan Reefs, P272/1b, ×3.

Fig. 6: Longitudinal section through a specimen with thin walled spongocoel, like specimens illustrated in Fig. 1, above.
Marawand Reef, M16, ×2.5.

Fig. 7: *Nevadathalamia?* or *Amblysiphonella?*
Oblique cross section through two chambers and a wide spongocoel.
Delijan Reefs, P308/2/2, ×4.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

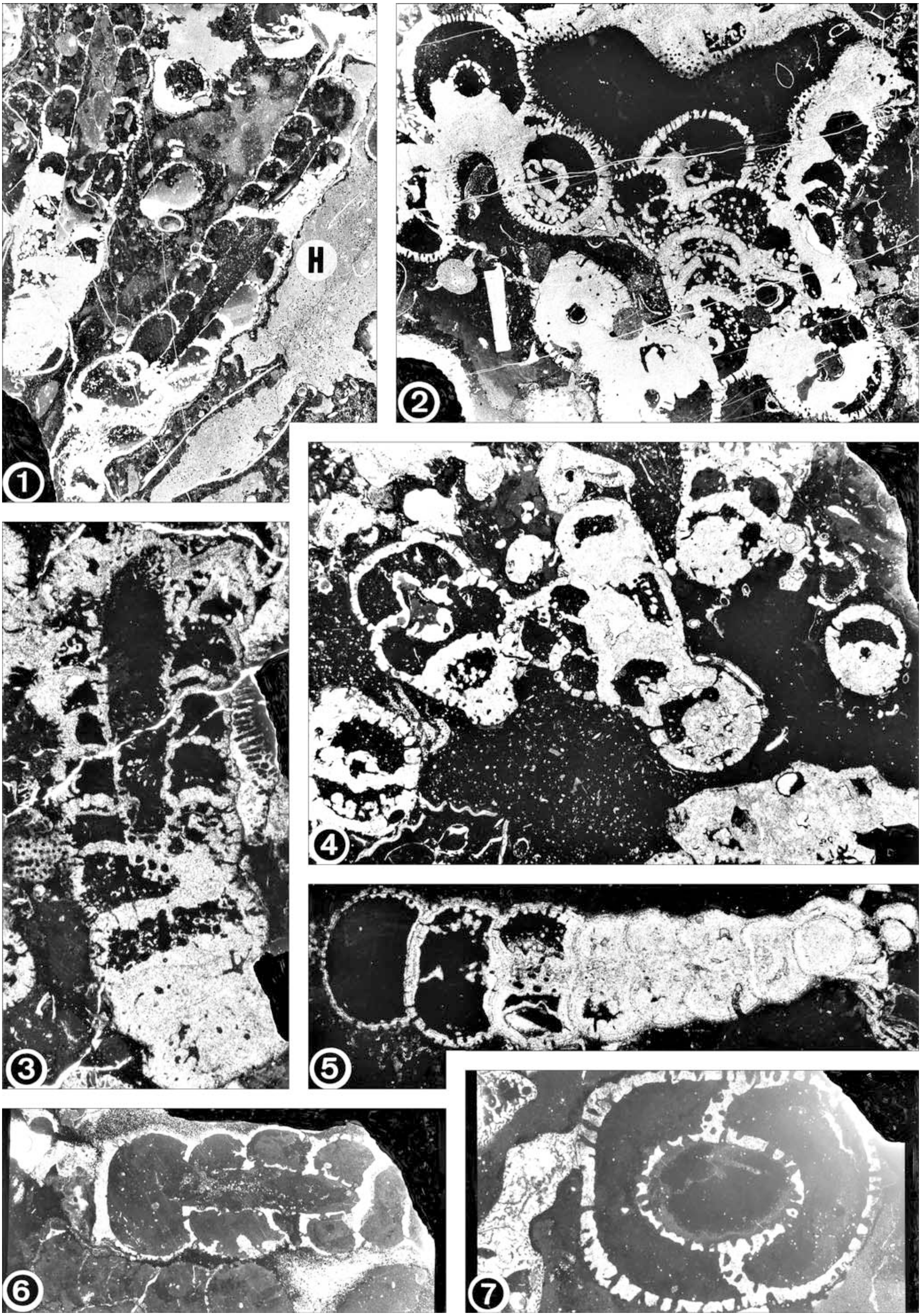
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Plate 11

Nevadathalamia variabilis nov. sp.

Fig. 1: View of the sponge surface showing the spine-like (septal-like) elements in the dermal part of the skeleton that extend laterally into the interiors of the pores.
Circular or oval outlines of the inner parts of these pores (see upper part of the photograph) do not show these spine-like elements.
Sample T21, Ali-Abad Reefs, ×4.

Fig. 2: Longitudinal and transverse sections of relatively large specimens exposed on weathered rock surface.
Chamber interiors are partly filled with filling structure of granular type.
Naybandan Reefs, approximately ×1.5.

Fig. 3: Similar section to that shown in Fig. 2, exhibiting the relatively wide spongocoel, on the left part of the photograph, and the ring-like chambers with partly internal filling structure.
Arrows indicate tubes that extend from the spongocoel into the chamber interiors.
Naybandan-Reefs, polished slab, approximately ×1.

Fig. 4: Transverse sections through two specimens (or one branched specimen?) of naturally weathered rock surface.
Naybandan Reefs, ×2.

Fig. 5: Transverse and oblique sections through several specimens showing the clearly perforated chamber walls.
Chamber interiors are partly filled with granular internal structure.
Naybandan Reefs, polished slab, approximately ×0.8.

Fig. 6: Sections through several specimens showing some granular to tubular filling structures within the chamber interiors.
Polished slab, Naybandan Reefs, ×0.8.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

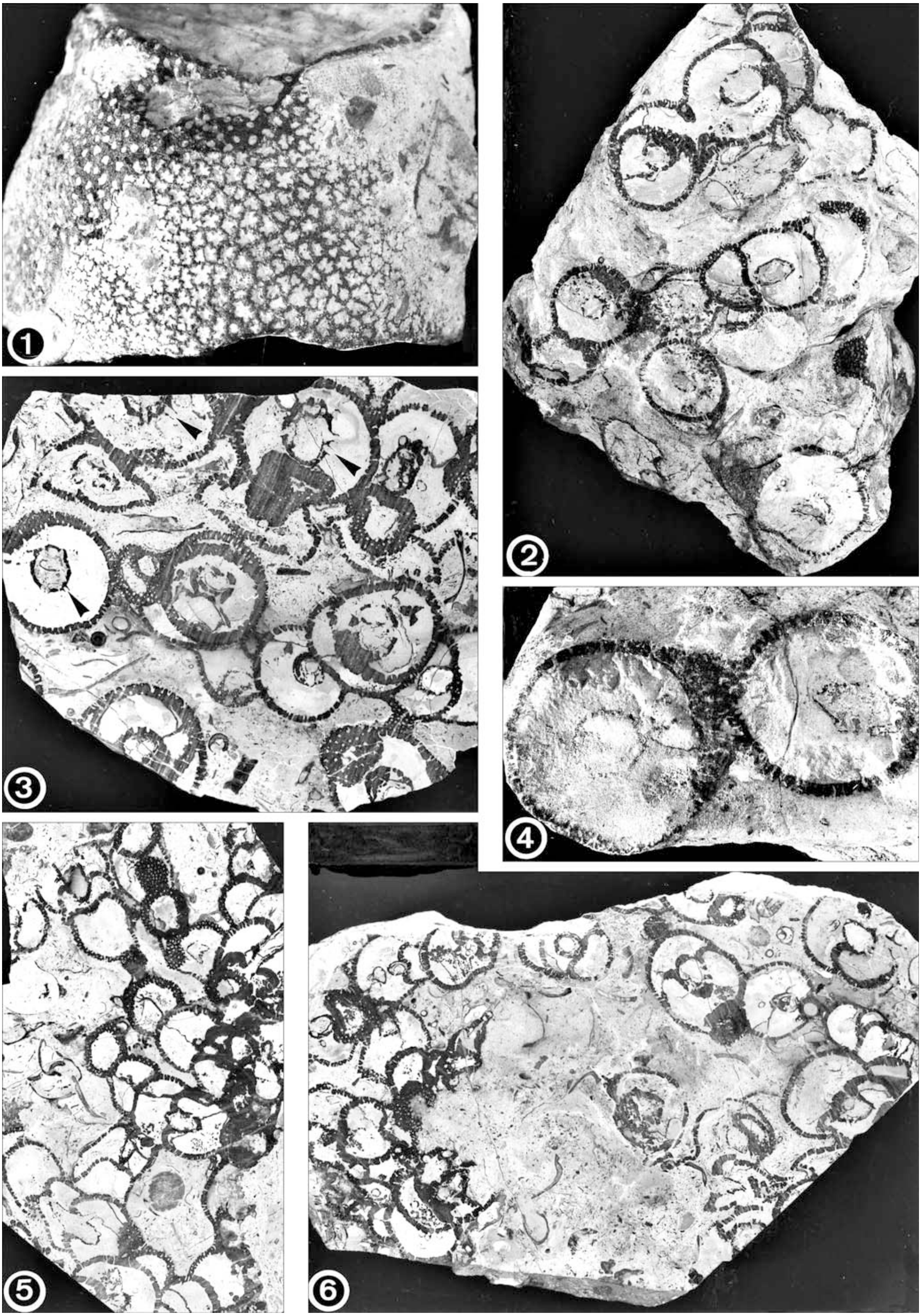
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Plate 12

Iranothalamia incrustans (BOIKO), and *Fanthalamia aksuensis* SENOWBARI-DARYAN.

Figs. 1,2: ***Iranothalamia incrustans* (BOIKO).**

Fig. 1: Section parallel to the plate of a natural weathered specimen with spherical, hemispherical to irregular chambers. Some chambers totally overlap the preceding chambers. Interiors of some chambers contain filling structures of granular type.
Ali-Abad Reefs, ×1.

Fig. 2: Section through several chambers with varying thicknesses of chamber walls.
Interiors of the chambers contain a few granular filling structures.
Marawand Reef, M61, ×2.5.

Fig. 3: ***Fanthalamia aksuensis* SENOWBARI-DARYAN.**
Section through several chambers. In some chambers the sieve-like exhalant tubes (arrows), typical of the genus *Fanthalamia*, are well developed.
No filling structure occurs within interiors of the chambers.
Marawand Reef, M48, ×4.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

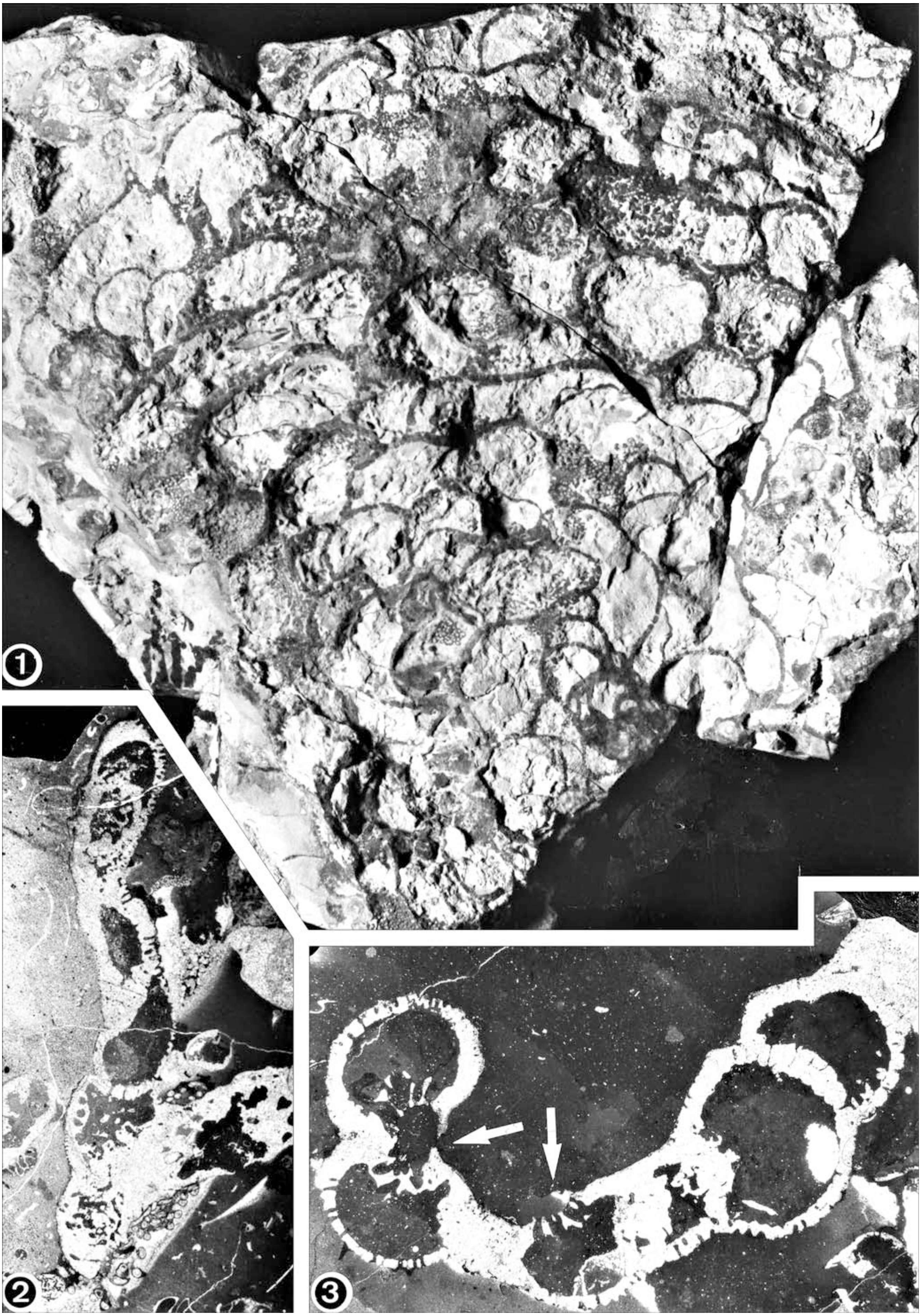
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Plate 13

Iranothalamia incrustans (BOIKO), and *Fanthalamia aksuensis* SENOWBARI-DARYAN.

Figs. 1,3,4: ***Iranothalamia incrustans*** **(BOIKO).**

Fig. 1: Section parallel to the plate shows numerous chambers arranged one above the other.
Some chambers, especially in the upper part are of tubular shapes. Porous nature of chamber walls shows in the lower part of the specimen.
Ali-Abad Reefs, naturally weathered specimen, ×1.5.

Fig. 3: Section perpendicular to the plate on the naturally weathered rock surface.
Bulbulu-locality near Kerman, 96/56, length of photo 28 cm.

Fig. 4: Similar to 3, with porous chamber wall evident in upper chambers.
Naturally weathered rock surface, Bulbulu-locality near Kerman, 96/57, length of photo 18 cm.

Fig. 2: A) ***Fanthalamia aksuensis*** **SENOWBARI-DARYAN.**
Longitudinal section shows the moniliform arrangement of the chambers.
Arrow points to the exhalant canal.
B) ***Colospongia*** **cf.** ***C. ramosa*** **RIEDEL & SENOWBARI-DARYAN.**
C) ***Welteria hamedanii*** **nov. sp.**
D) **Sphinctozoid? sponge gen. et sp. indet.**
E) **Inozoid sponge** ***Marawandia norica*** **SENOWBARI-DARYAN, SEYED-EMAMI & AGHANABATI.**
Ali-Abad Reefs, AB9/2, ×1.2.

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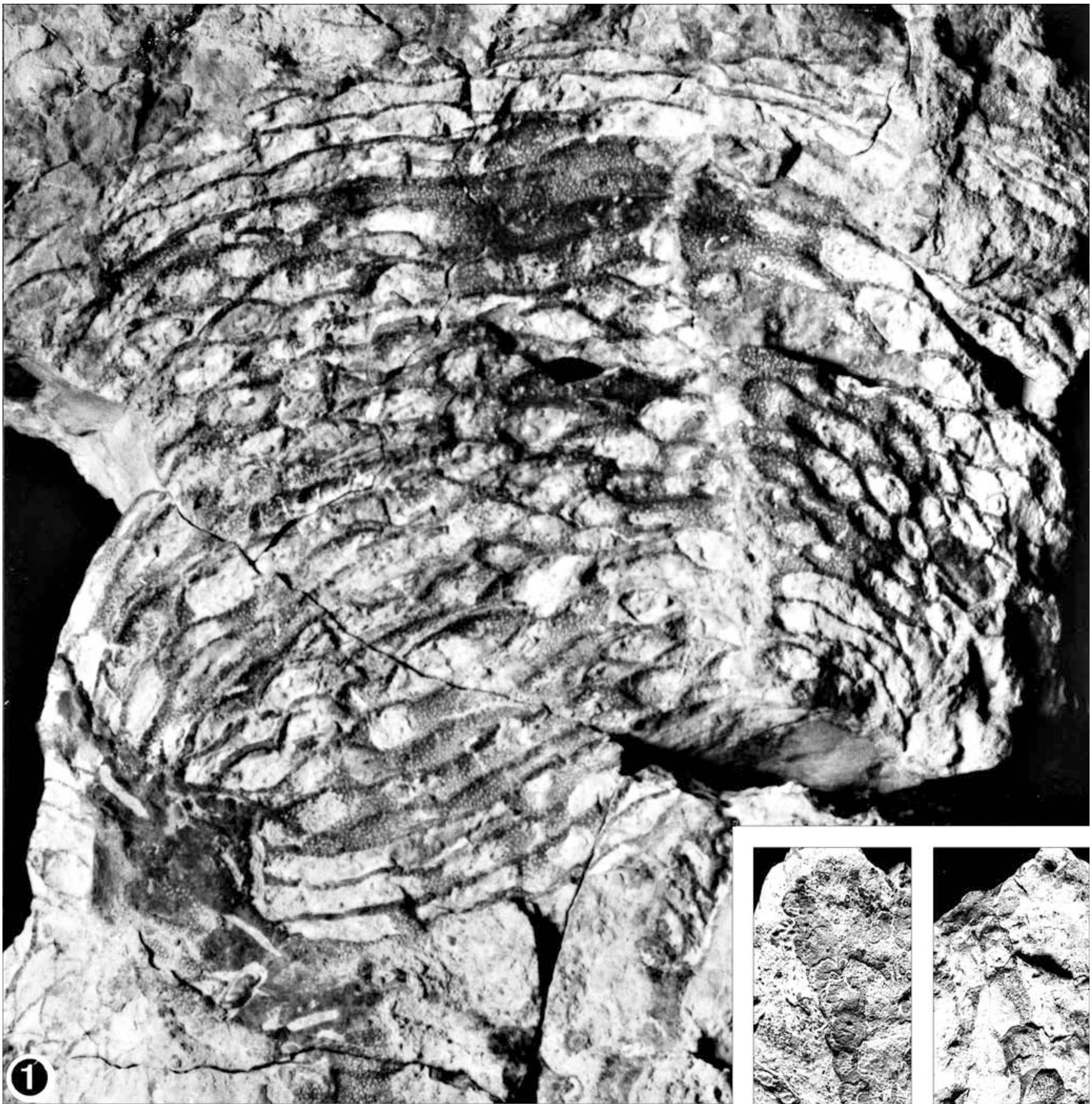

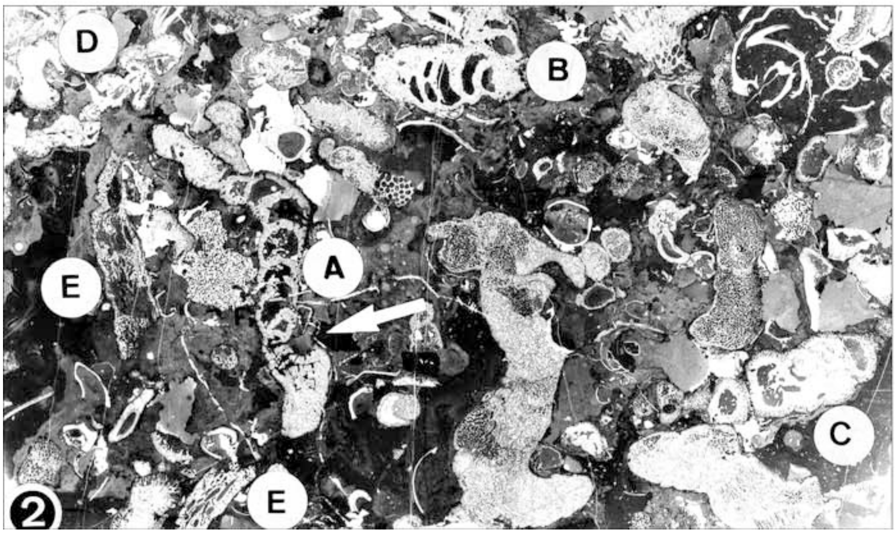
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Plate 14

Senowbaridaryana raretrabeculata (Boiko), and *Senowbaridaryana rectangulata nov. sp.*

Figs. 1–4,6: ***Senowbaridaryana raretrabeculata* (Boiko).**

Fig. 1: Section through several specimens showing the sponge characteristics in general.
The crescent-like chambers are turned down at the periphery and the preceding chambers are totally or partly overlapped by younger chambers causing the disappearance of outer segmentation and the formation of a distinct thick outer wall. The indistinct spongocoel is very narrow, having a diameter of about 1/5–1/6 of the whole sponge diameter.
Naybandan Reefs, PN/2, ×1.2.

Fig. 2: Magnification of the upper left of Fig. 3 (arrow) shows longitudinal sections of two specimens.
In the specimen on the right, the relatively wide spongocoel is clearly visible, but in the other specimen the spongocoel is only cut marginally. At the periphery of the stems, the chambers and chamber walls are down turned and show considerable chamber flattening and overlap of preceding chambers by the younger chambers, so that the outer segmentation disappears. A direct connection of chamber interiors to the exterior is lacking in the majority of the chambers. The filling structure of reticular type is rudimentary and not well developed.
PN/2, ×4.5.

Fig. 3: Section similar to Fig. 1.
The narrow spongocoel is cut in almost all specimens.
Naybandan Reefs, PN1, 1.2.

Fig. 4: Section through the initial(?) part of a specimen that does not show a spongocoel.
Chamber interiors contain some filling structure of reticular type.
Ali-Abad Reefs, AB7, ×5.

Fig. 6: Section similar to Fig. 4.
A narrow spongocoel in the upper part is cut marginally. Chamber interiors contain only few filling structures.
Naybandan Reefs, PN2, ×5.

Fig. 5: **S) *Senowbaridaryana rectangulata* nov. sp. and A) *Amblysiphonella?* or *Nevadathalamia?*.**
Specimen in which internal filling structure is lacking and, therefore, a detailed determination is not possible.
T) Sphinctozoan sponge gen. et sp. indet. 2 (see Pl. 30, Fig. 5).
Delijan Reefs, P?/2/1, ×2.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

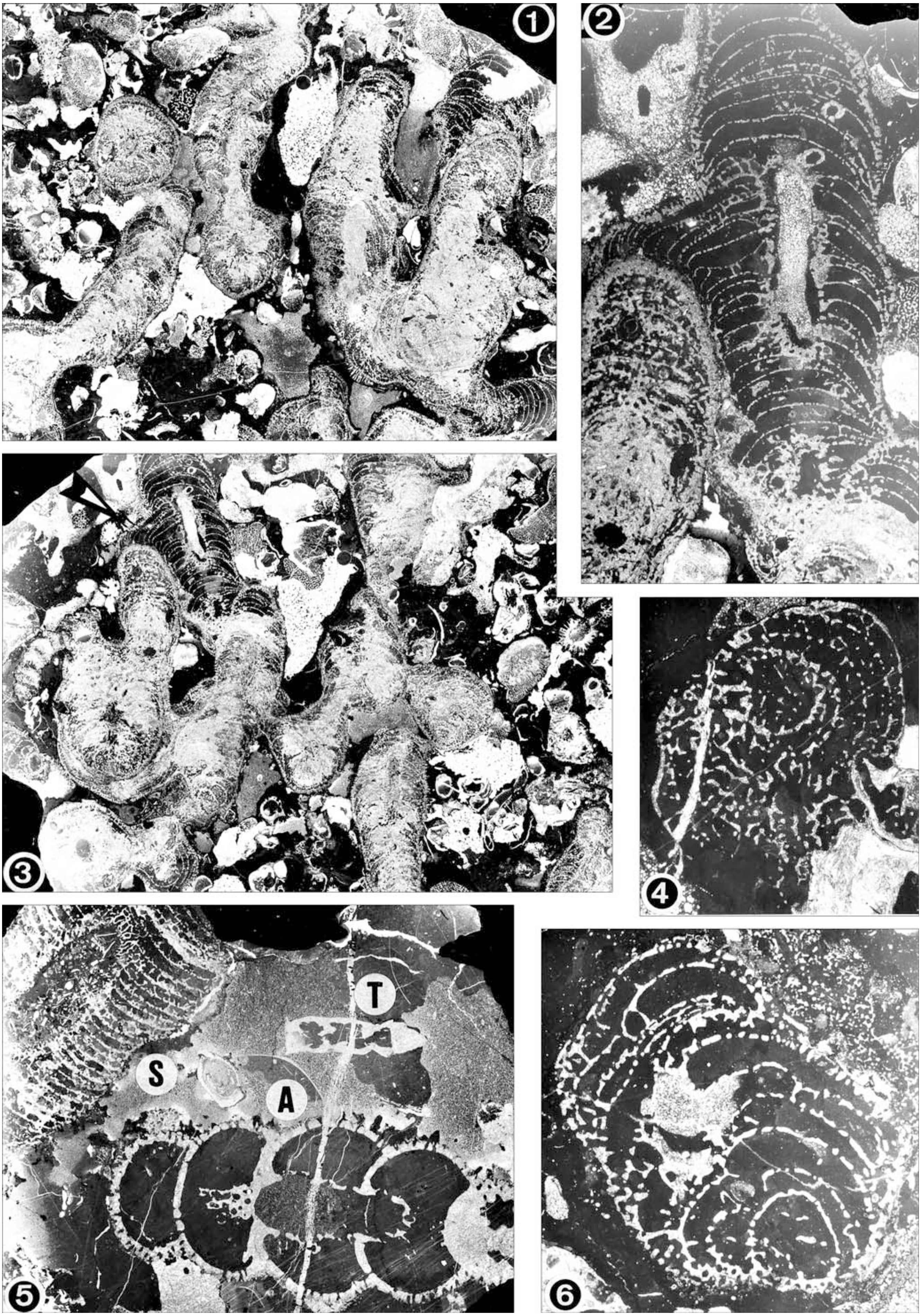
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Plate 15

Senowbaridaryana rectangulata nov. sp., and *Phraethalamia irregulara* nov. sp.

Figs. 1–3: ***Senowbaridaryana rectangulata*** **nov. sp.**

Fig. 1: Section through a multibranched specimen exhibits the flattened chambers each with the same height in the axial and peripheral parts. The wide spongocoel occupies almost $^1/_3$ of the whole sponge diameter. The reticular filling structure is well developed within the chamber interiors.
P) Two specimens of *Parauvanella ferdowsensis* nov. sp.
C) Chaetid sponges that have colonized on *S. rectangulata* (compare Pl. 16, Fig. 5).

Fig. 2: Holotype.
Longitudinal section through a branched specimen shows the low chambers, with the same heights around the spongocoel and in peripheral parts. A wide spongocoel passes through the whole sponge. Note the rectangular chamber shape of the sponge.
Delijan Reefs, DJ99/11, ×1.5.

Fig. 3: Oblique section through a specimen at a branching point.
M44A, ×2.5.

Fig. 4: ***Phraethalamia irregulara*** **nov. sp.**
Longitudinal to oblique section shows the spongocoel composed of axial tubes and irregularly arranged chambers around the spongocoel. The last chamber (left in photograph) shows tubes passing from the spongocoel into the chamber interiors. The tubes are cut in cross sections in the first chamber (right in photograph). Some ostia are recognizable in walls of the last chambers.
Delijan Reefs, 99Dj5, ×5.

Fig. 5: C) Section through a undeterminable sphinctozoid sponge with imperforate chamber walls, but with several openings in the chamber roofs.
B) Brachiopod shell, which colonized an inozoid sponge (A).
Delijan Reefs. Dj99/15.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

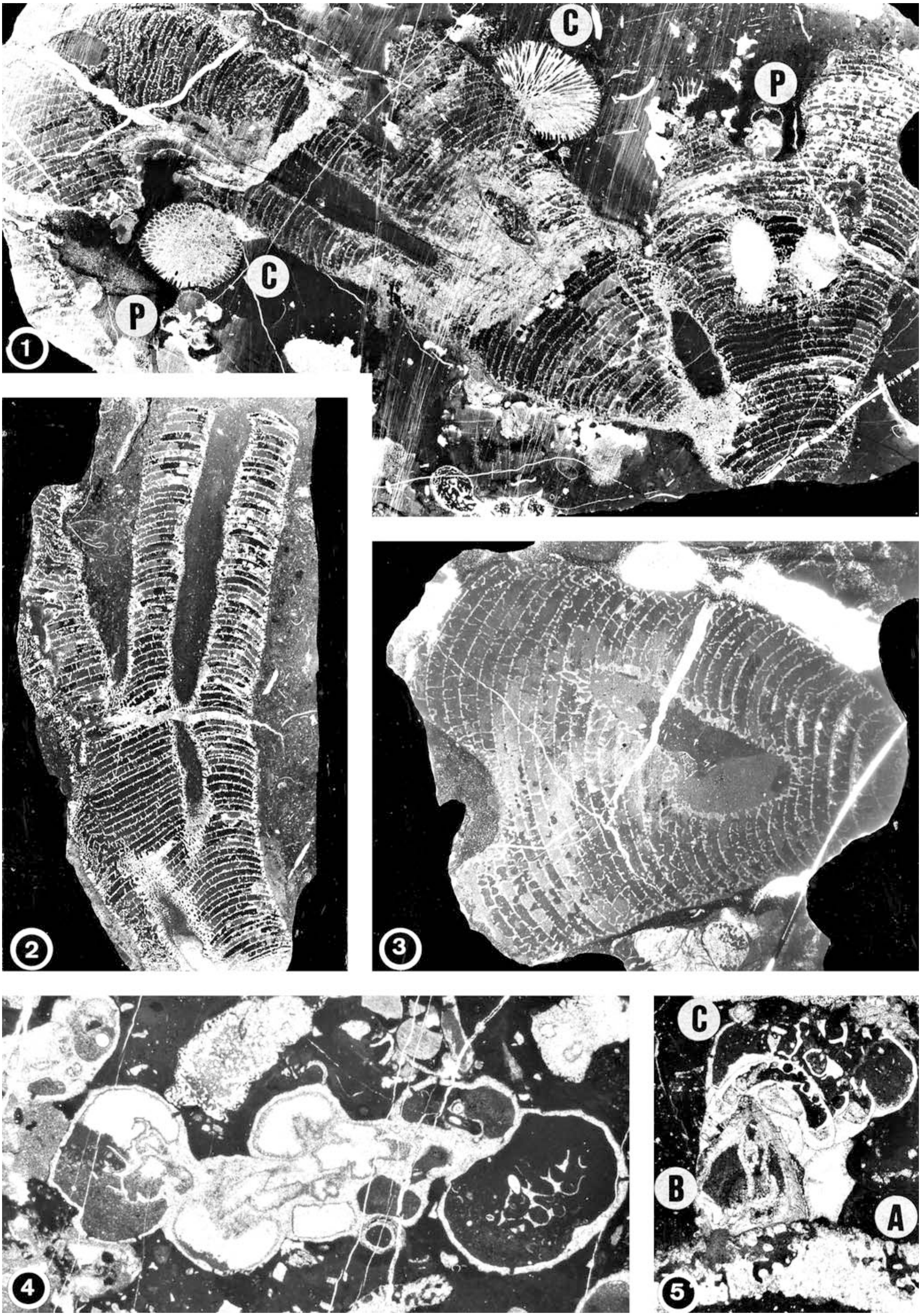
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Plate 16

Senowbaridaryana rectangulata nov. sp.

Fig. 1: Oblique cross section shows the flattened and uniform chambers, and the wide spongocoel.
Chamber interiors contain well-developed reticular filling structure.
Marawand Reef, M101/q, ×5.

Fig. 2: Section through two specimens shows their wide spongocoels with well developed internal structure within the chamber interiors.
The specimen on the right is cut at a branching point.
Delijan Reefs, P?/1, ×1.5.

Fig. 3: Longitudinal section.
The sponge may have branched where the spongocoel becomes wider.
Delijan Reefs, P216, ×1.8.

Fig. 4: Section similar to Fig. 3.
Delijan Reefs, ×5.

Fig. 5: Magnification of part of specimen illustrated in Pl. 15, Fig. 1, shows the colonization of a chaetetid sponge on the surface of *Senowbaridaryana rectangulata*.
The spongocoel is cut on the left. The chambers around the spongocoel and at the periphery have the same heights.
P?/2, ×6.

Fig. 6: Magnification of part of specimen illustrated in Pl. 15, Fig. 1, shows the uniform chamber height, the perforation of chamber walls, and the reticular filling structure within the chamber interiors.
×5.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

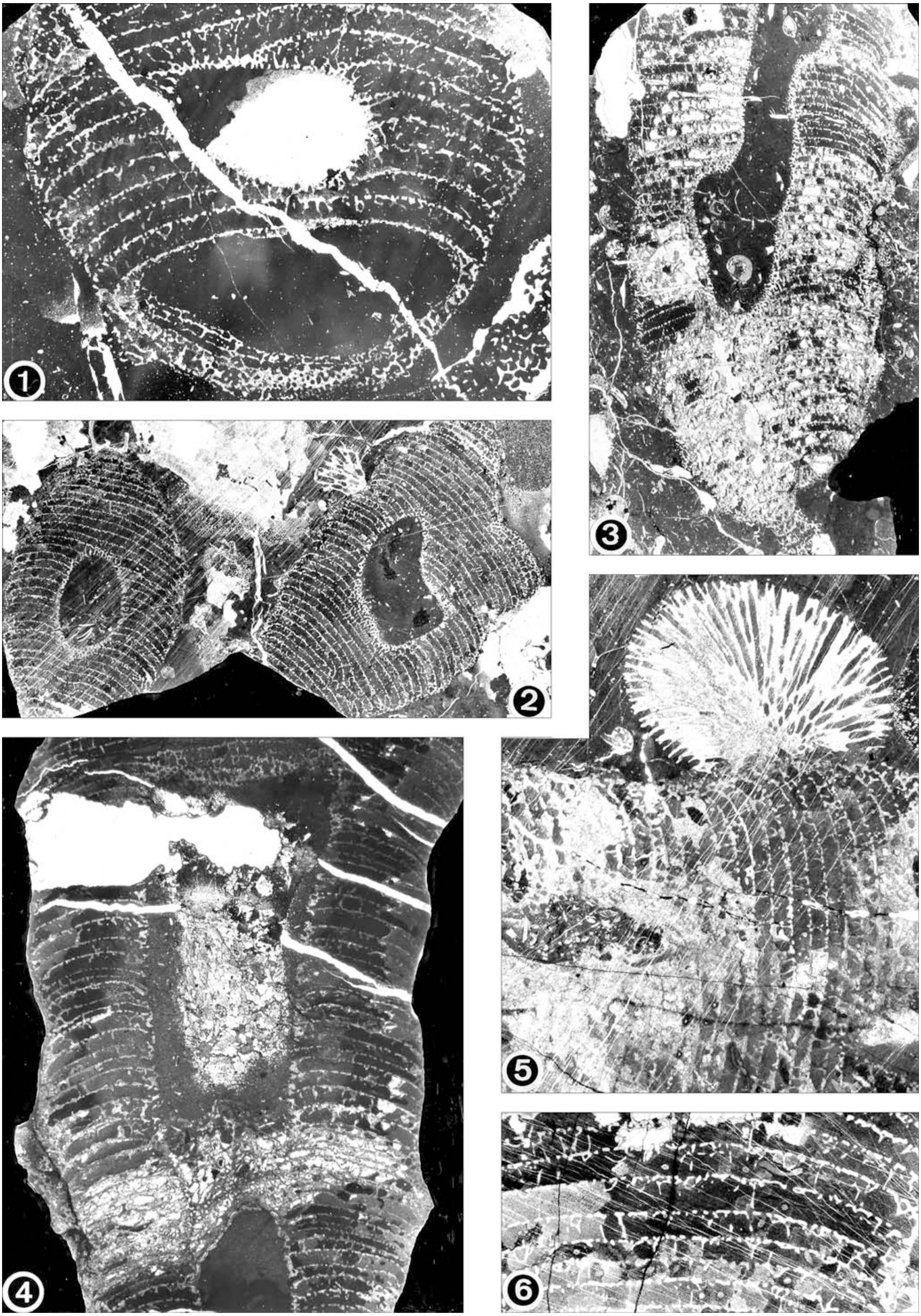
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Plate 17

Paradeningeria alpina SENOWBARI-DARYAN & SCHÄFER,
and *Cryptocoelia wurmi* SENOWBARI-DARYAN & DULLO.

Figs. 1–3: ***Paradeningeria alpina*** **SENOWBARI-DARYAN & SCHÄFER.**
Fig. 1: Longitudinal and transverse sections through several specimens.
Marawand Reef, M110/9B. ×5.
Fig. 2: Longitudinal sections through multiple chambers of three specimens.
Marawand Reef, 96?/0 ×3.
Fig. 3: Longitudinal and oblique sections through three specimens.
Marawand Reef, M110/9B, ×3.

Figs. 4–9: ***Cryptocoelia wurmi*** **SENOWBARI-DARYAN & DULLO.**
Fig. 4: Oblique section through three chambers.
Delijan Reefs, P/324/4,×8.
Fig. 5: Oblique section through two specimens.
Marawand Reef, M84, ×8.
Fig. 6: Oblique section through two chambers.
Marawand Reef, M110/9B, ×12.5.
Fig. 7: Section through two chambers.
Marawand Reef, M110/9A, ×8.
Fig. 8: Longitudinal section through several chambers.
Marawand Reef, M84, ×4.5.
Fig. 9: Oblique sections through 3 specimens.
Marawand Reef, M55, ×4.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

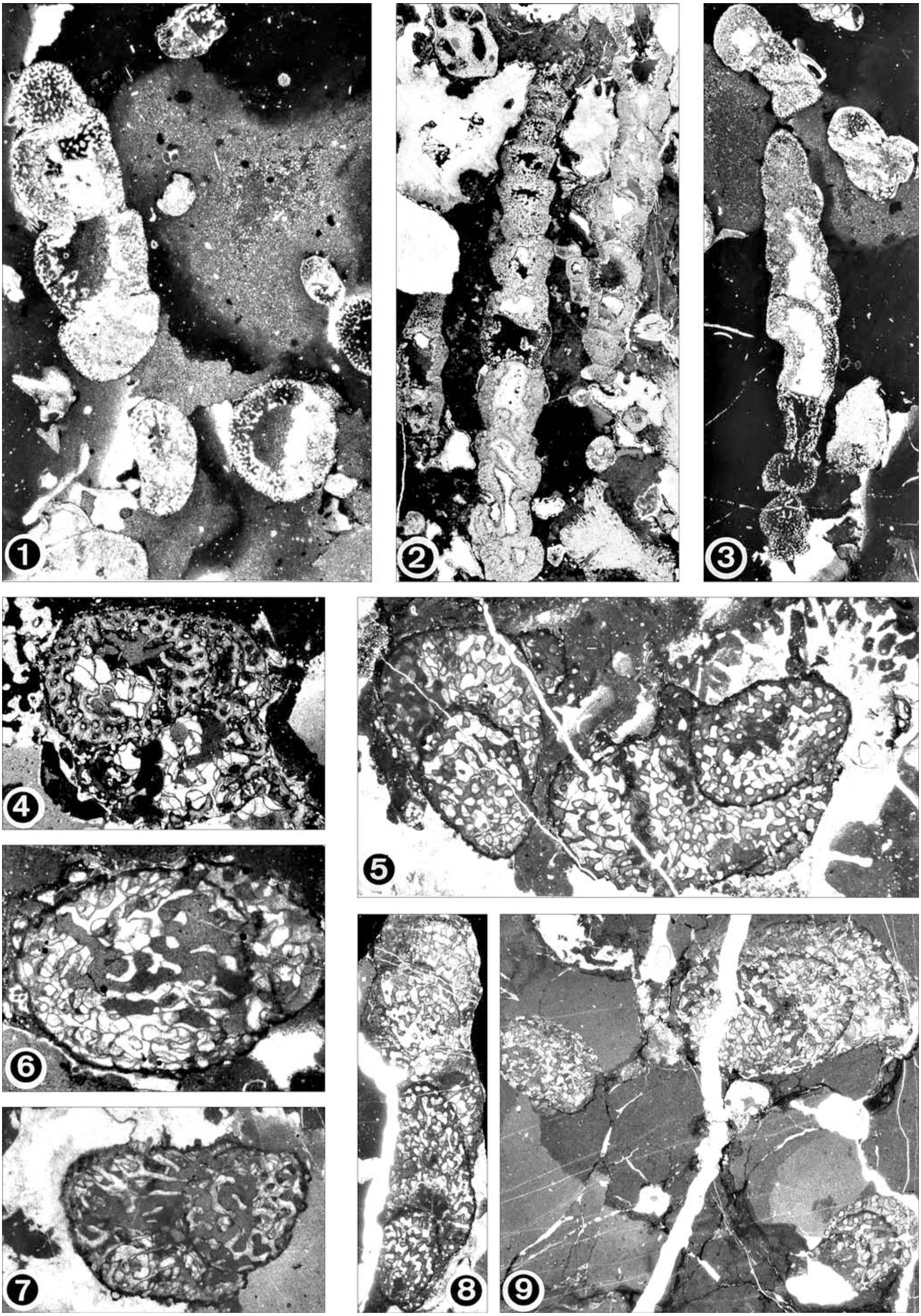
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Plate 18

Deningeria tabasensis nov. sp., Paradeningeria alpina SENOWBARI-DARYAN & SCHÄFER, and *Panormida* sp.

Figs. 1,4: ***Deningeria tabasensis* nov. sp.**
Fig. 1: Longitudinal and oblique sections through several, partially branched specimens. Almost all specimens have been penetrated by boring organisms.
Ali-Abad Reefs, Ab97/67, ×2.5.
Fig. 4: Holotype (H).
Longitudinal section through a multibranched specimen(?) or several specimens.
Ali-Abad Reefs, Ab31, x2.5.

Figs. 2,3: ***Paradeningeria minor* nov. sp.**
Fig. 2: Longitudinal section through a branched? specimen shows the fine reticular skeleton and the axial canal cut in several segments.
Ferdows Reef, 96/31/3/3, ×4.5.
Fig. 3: Holotype.
Longitudinal section shows the axial canal filled with secondary skeleton.
Ferdows Reef, 96/31/3/3, ×5.5.

Figs. 5,6?: ***Paradeningeria alpina* SENOWBARI-DARYAN & SCHÄFER.**
Fig. 5: Section through four chambers of a specimen attached to a *Spongiomorpha ramosa?*.
Ferdows Reef, 96/31/37. ×5.
Fig. 6: Section through a specimen whose growth was disturbed by the colonization of a brachiopod (right upper corner of the picture).
Marawand Reef, M110/9/A, ×4.5.

Fig. 7: A) ***Panormida?* sp.**
Longitudinal section through a dichotomously branched and poorly preserved specimen with numerous funnel-shaped chambers.
B) **Inozoid sponge *Anguispongia parva* SENOWBARI-DARYAN.**
Delijan Reefs, P213, ×1.5.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

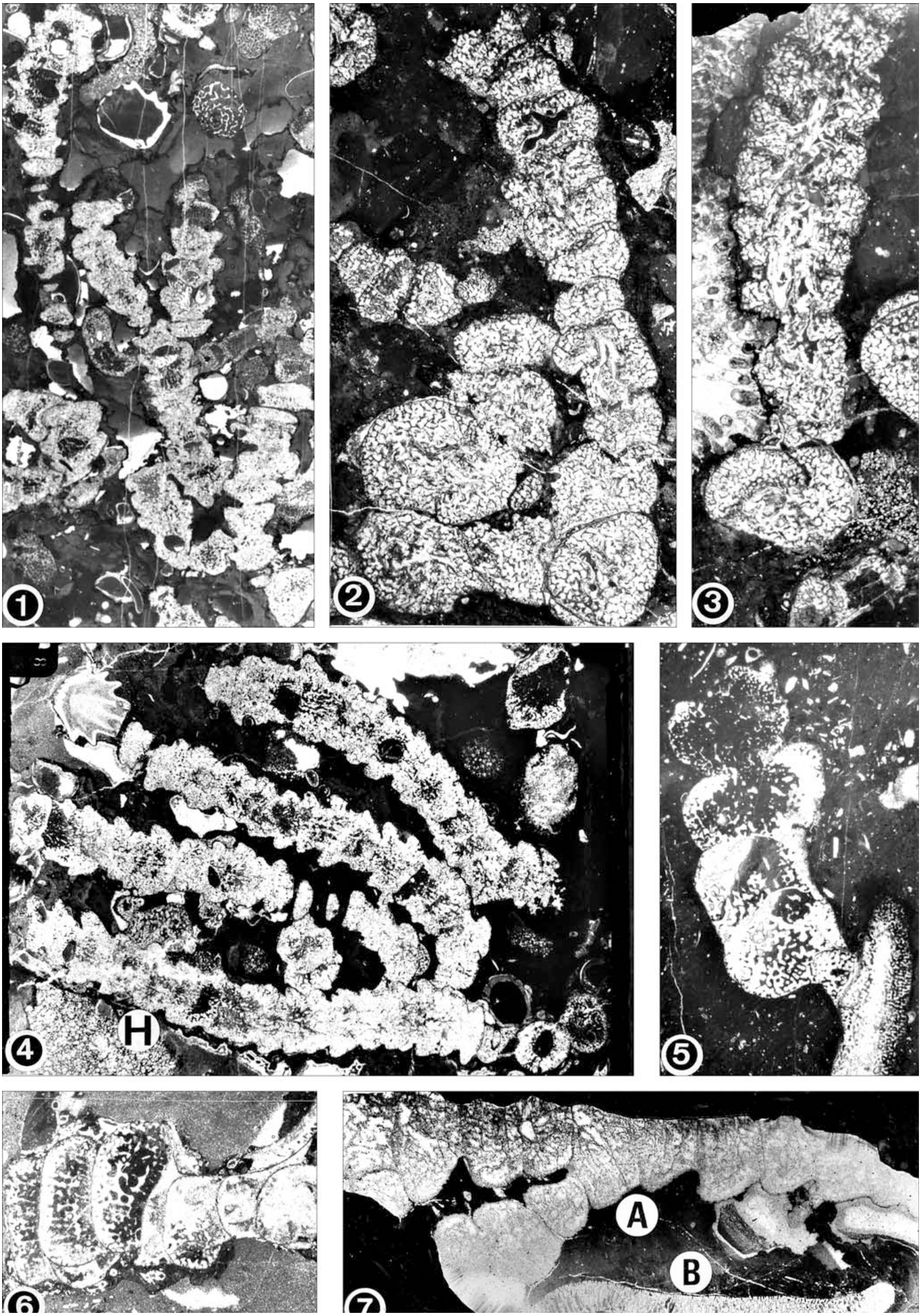
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Plate 19

Paradeningeria alpina SENOWBARI-DARYAN & SCHÄFER, *Paradeningeria minor* nov. sp., and *Kashanella irregularis* nov. sp.

Fig. 1: ***Paradeningeria alpina*** **SENOWBARI-DARYAN & SCHÄFER.**
Longitudinal and oblique sections through several specimens.
A) thalamid sponge gen. et sp. indet.
Delijan Reefs, 99Dj10, ×3.

Fig. 2: A) ***Paradeningeria alpina*** **SENOWBARI-DARYAN & SCHÄFER.**
Longitudinal section through four chambers.
B) **Inozoid sponge** ***Marawandia norica*** **SENOWBARI-DARYAN, SEYED-EMAMI & AGHANABATI.**
Marawand Reef, M/110/9, ×2.5.

Fig. 3: **Sphinctozoan sponge gen. et sp. indet. 1.**
Axial longitudinal section exhibits numerous crescent-like chambers arranged around a narrow spongocoel. Some pillar-like internal structures are visible within the upper middle chambers. Marawand Reef, M101/14, ×2.5.

Figs. 4,5: ***Paradeningeria minor*** **nov. sp.**
Fig. 4: Section through several specimens.
Some of them show the secondary filling skeleton within the axial canal.

Fig. 5: Sections through two specimens.
Both specimens exhibit secondary filling skeleton within the axial canals.
Ferdows Reef, 96/31/3/2, ×7.5.

Fig. 6: ***Kashanella irregularis*** **nov. gen., nov. sp.**
Section through several irregular chambers.
The thin chamber walls are pierced by a labyrinthic branched canal system.
Ferdows Reef, 96/31/22, ×5.

Fig. 7: ***Pamirocoelia? sphaerica*** **BOIKO (in BOIKO et al.).**
Section through four chambers.
In upper chamber, the sieve-like canal system, composed of at least three openings, is cut.
Delijan Reefs, Dj99/31, ×8.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

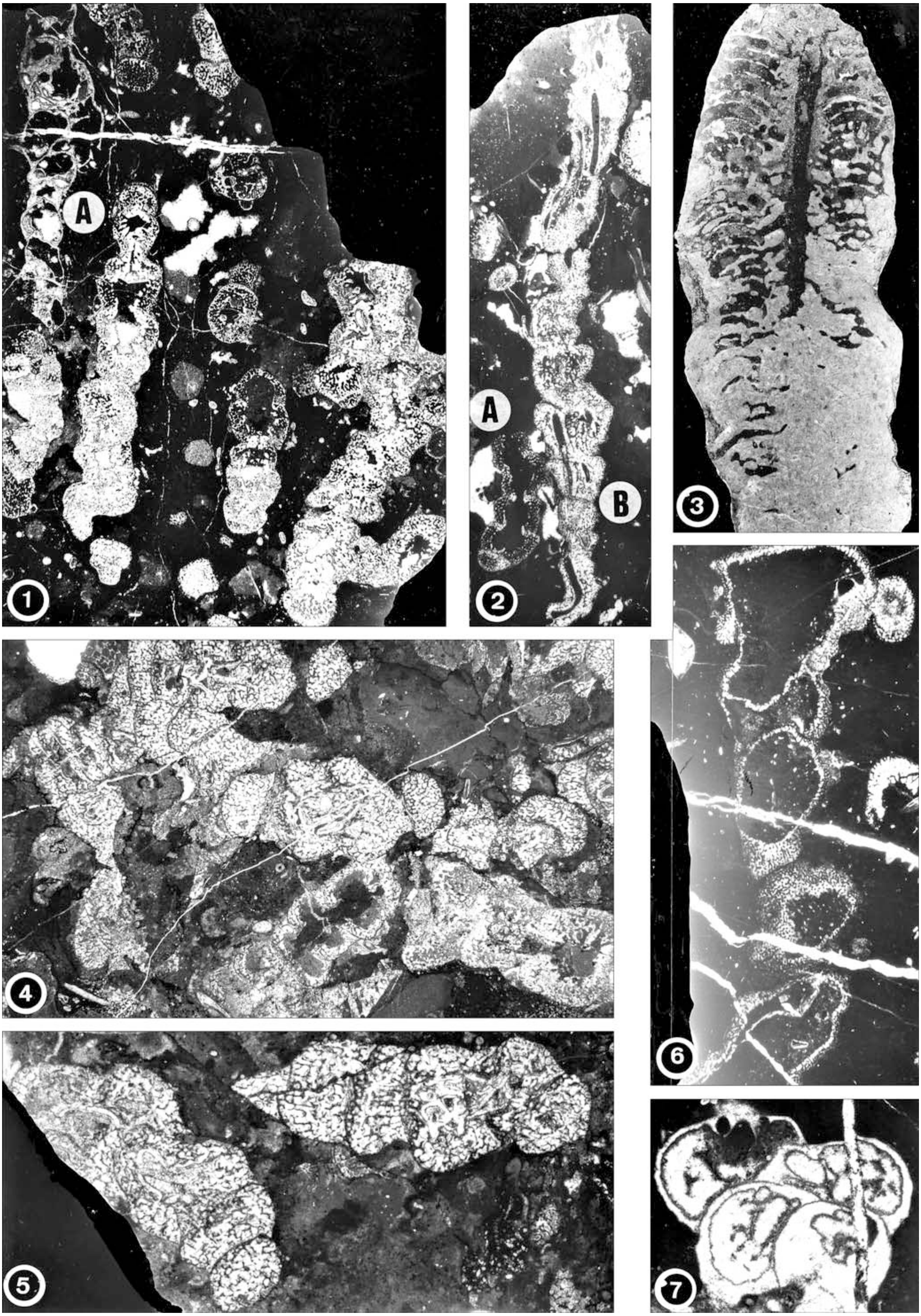
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Plate 20

Welteria hamedanii nov. sp., *Deningeria tabasensis* nov. sp.,
Kashanella irregularis nov. gen, nov. sp., and *Paradeningeria?* sp.

Figs. 1,2,4,5,6?: ***Welteria hamadanii* nov. sp.**

Fig. 1: Axial section through a specimen exhibiting the ring-chambers, the labyrinthic branched canal system of the chamber walls, and the loose filling structure within the chamber interiors.
Ali-Abad Reefs, Ab29, ×2.8.

Fig. 2: Oblique section through three chambers shows the loose filling structure within the chamber interiors and the labyrinthic canal system of the chamber walls.
Ali-Abad Reefs, Ab9/1, ×8.

Fig. 4: Holotype.
Axial longitudinal section shows the distinct characteristics of the sponge: Ring-chambers, the reticular filling structure within the chamber interiors, the labyrinthic branched pores in the chamber walls, and the axial spongocoel defined by thickening of the vertical skeleton elements. Note the kind of perforation of chamber roofs around the spongocoel, especially of the uppermost chamber.
Delijan Reefs, Dj1/0, ×4.

Fig. 5: Marginal longitudinal section through 6 chambers.
Ali-Abad Reefs, Ab33, ×5.

Fig. 6: Marginal longitudinal section.
Marawand Reef, M 64, ×4.5.

Fig. 3: ***Deningeria tabasensis* nov. sp.**
Longitudinal section through several chambers, some of which were bored by bivalves.
Ali-Abad Reefs, AB/17/97/67, ×5.

Fig. 7: ***Kashanella irregularis* nov. gen., nov. sp.**
Ferdows Reef, 96/31/22, ×7.5.

Fig. 8: ***Paradeningeria?* sp.**
Marawand Reef, M/110/7, ×8.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

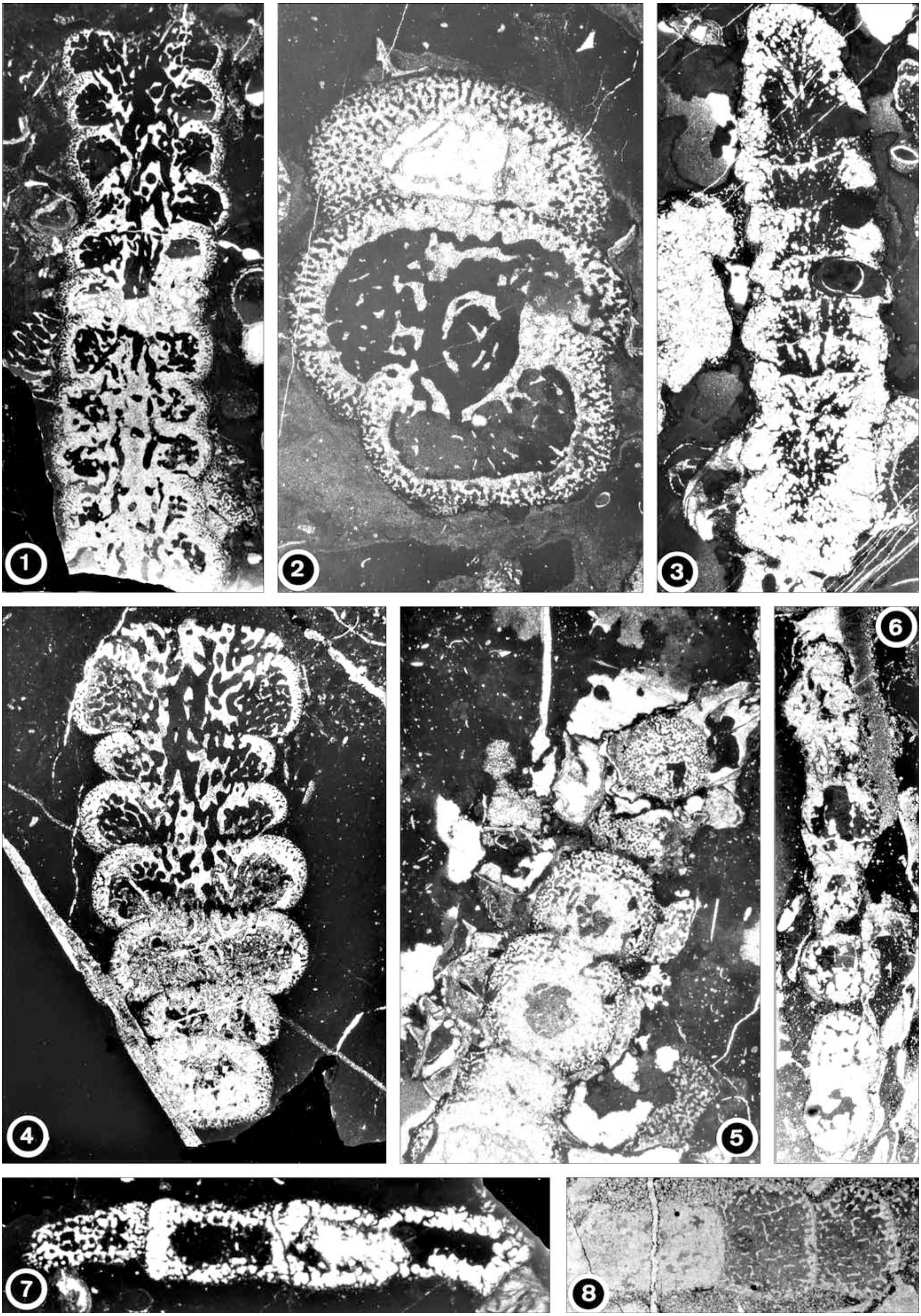
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Plate 21

*"Stylothalamia" columnaris (*Le Maitre*)* nov. sp., *and Kashanella irregularis* nov. gen., nov. sp.

Figs. 1–5: ***"Stylothalamia" columnaris* (Le Maitre).**

Fig. 1: Marginal axial longitudinal section through several chambers of a specimen that have grown on an inozoid sponge. White points within chamber interiors are pillar-like filling structures cut in oblique or transverse sections.
Delijan Reefs, P207/2b, ×4.

Fig. 2: Marginal section through several chambers.
In the lower part, the spongocoel is cut marginally. Pillar-like filling structures show in chamber interiors.
Ali-Abad Reefs, AB24, ×4.

Fig. 3: Marginal section through several chambers.
The sponge is overgrown by some serpulid worms and brachiopods (upper part).
Delijan Reefs, P/207/2, ×4.

Fig. 4: Marginal section.
The pillar-like filling structures are cut in cross section, on the right and in longitudinal section, on the left in the picture.
Ali-Abad Reefs, T29/3B, ×10.

Fig. 5: Marginal axial section through numerous ring-chambers.
The trabecular (pillar) internal skeleton is rudimentary and not clearly shown.
Delijan Reef, Dj16,×3.

Figs. 6–7: ***Kashanella irregularis* nov. gen., nov. sp.**

Fig. 6: Section through four chambers.
The upper two chambers show large tubular openings in the elongated wall.
Marawand Reef, M134/B, ×4.

Fig. 7: Section through three chambers with recrystallized walls.
One chamber roof in the center exhibits the axial exhalant opening.
Delijan Reefs, 99/Dj5, ×7.5.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

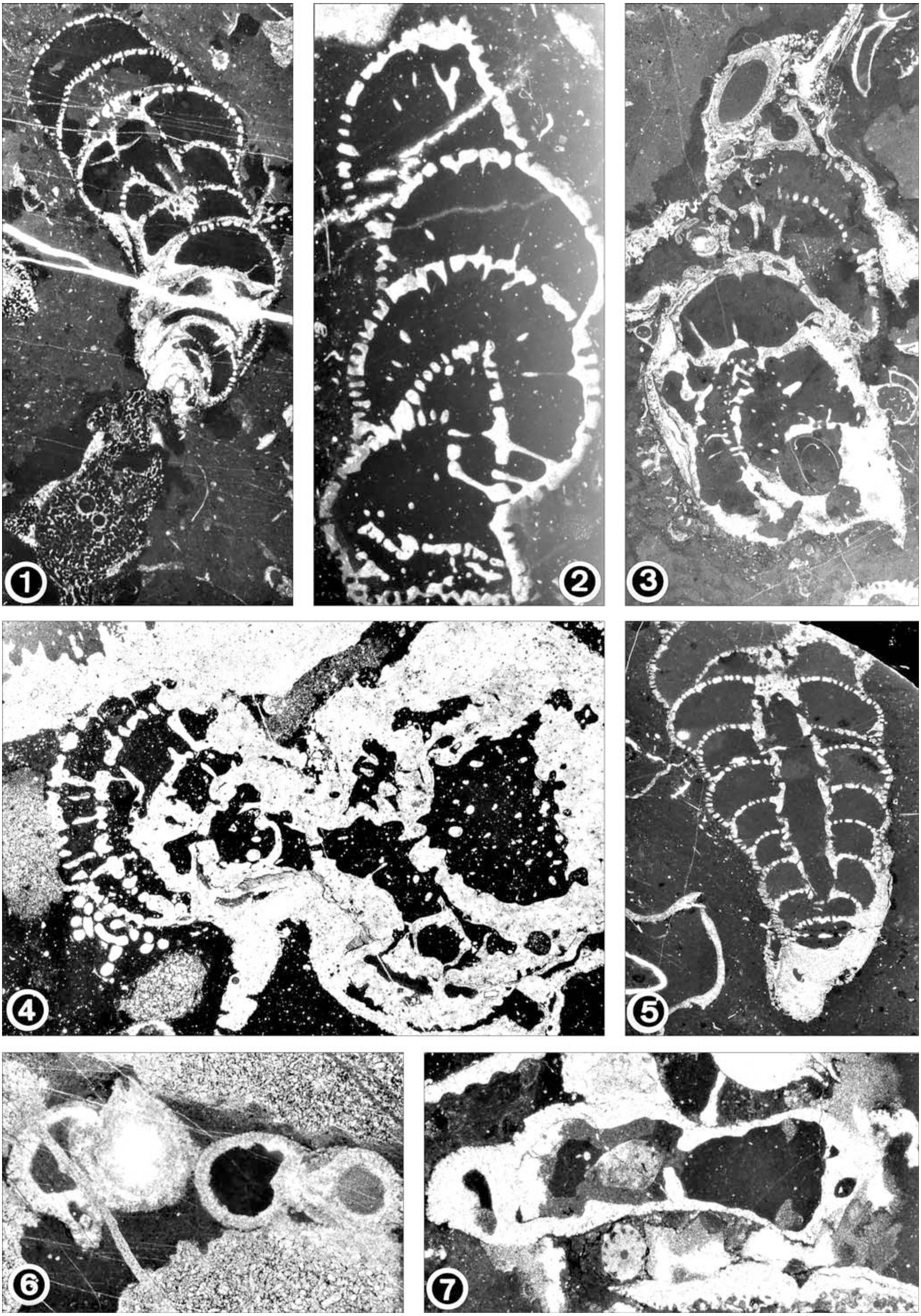
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Plate 22

Naybandella prosiphonata nov. gen., nov. sp.

Fig. 1: Longitudinal axial section exhibiting the prosiphonate axial spongocoel, the large lateral openings grouped in clusters, and the catenulate chambers.
Delijan Reefs, P/209, ×13.

Fig. 2: Section through three or four? chambers showing the clusters of openings in the chamber exowalls.
Marawand Reef, M/131, ×8.

Fig. 3: Section through two chambers exhibiting the grouped openings in the exowalls, above a diagonally cut inozoan sponge.
Delijan Reefs, P/209, ×8.

Fig. 4: Oblique transverse section through two chambers shows the axial canal, and two ostia in the right chamber.
Delijan Reefs, P164/2, ×20.

Fig. 5: Marginal(?) section through two chambers exhibiting sections through lateral clusters of openings in walls of both chambers.
Marawand Reef, M/125, ×8.

Fig. 6: N) Sections through 2 specimens showing the clusters of openings.
S) transverse section of a sphinctozoid sponge gen. et sp. indet.
Marawand Reef, M/119/5B, ×5.

Fig. 7: Marginal section through several chambers exhibiting the clusters of openings in the exowalls.
Marawand Reefs, P/64, ×5.

Fig. 8: Section through three chambers of a specimen exposed on a natural weathered rock surface showing the groups of openings in the dark appearing exowalls of all three chambers.
Delijan Reefs, ×8.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

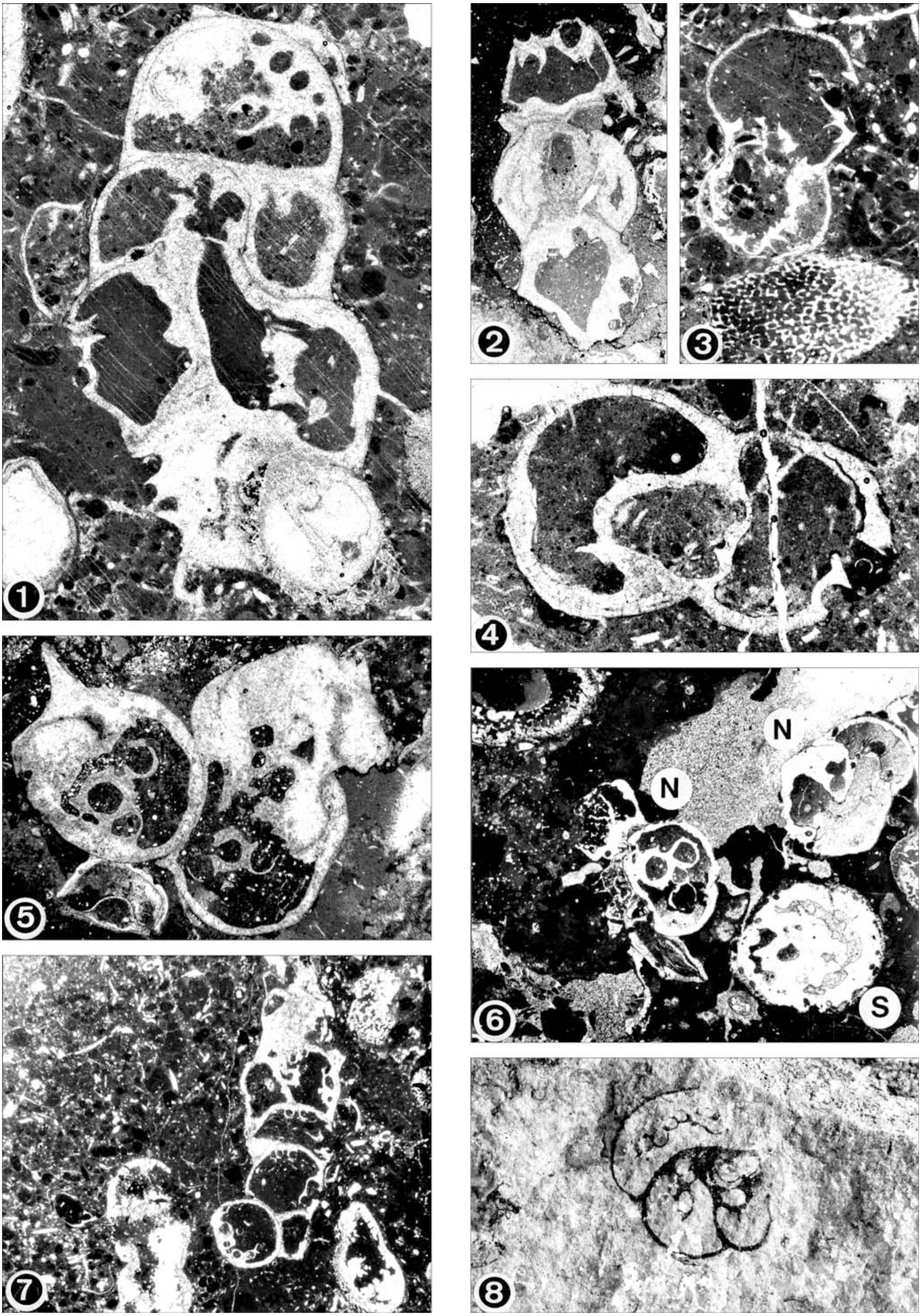
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Plate 23

Tabasia media nov. sp., and *Tabasia? conica* nov. sp.

Figs. 1,6: ***Tabasia media* nov. sp.**

Fig. 1: Longitudinal sections through two specimens (or one branched specimen) show the chamber roofs with numerous tubes appearing as pores. (for the magnified view of the labyrinthic perforated chamber walls see Pl. 30, Fig. 7).
Ferdows-Reef, 96/31/9, ×2.5.

Fig. 6: Longitudinal section through three chambers exhibits tubes of the axial canal and those that extend into the chamber interiors.
Marawand Reef, P316, ×8.

Figs. 2–4,5?: ***Tabasia? conica* nov. sp.**

Fig. 2: Longitudinal section exhibits the tubes of axial canal and those that lead from chamber interiors to the canals. The ambisiphonat type of canal formation is well shown. A large rimmed ostium of a chamber is cut in the right.
Ferdows-Reef, 96/31/23, ×8.

Fig. 3: Longitudinal section shows tubes of the axial canal and the convergent tubes from the chamber interiors. Chamber walls are thicker than in the holotype.
Naybandan Reefs, N7, ×7.

Fig. 4: A) *Tabasia? conica* nov. sp. (holotype).
Longitudinal section shows several tubes of the axial canal and the tubes that extend into the chamber interiors (for magnification of half of the last chamber, see Pl. 25, Fig. 6). The thin chamber walls are totally recrystallized.
B) *Naybandella prosiphonata* nov. sp. (Holotype). Oblique longitudinal section shows the spherical chambers, the groups of openings in the exo- and endowalls, and the prosiphonate spongocoel in the lower right side of the photograph.
Delijan Reefs, P/168/1, ×3.

Fig. 5: Longitudinal section exhibits the relatively thick chamber walls and perforated interwalls.
Delijan Reefs, P209, ×7.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

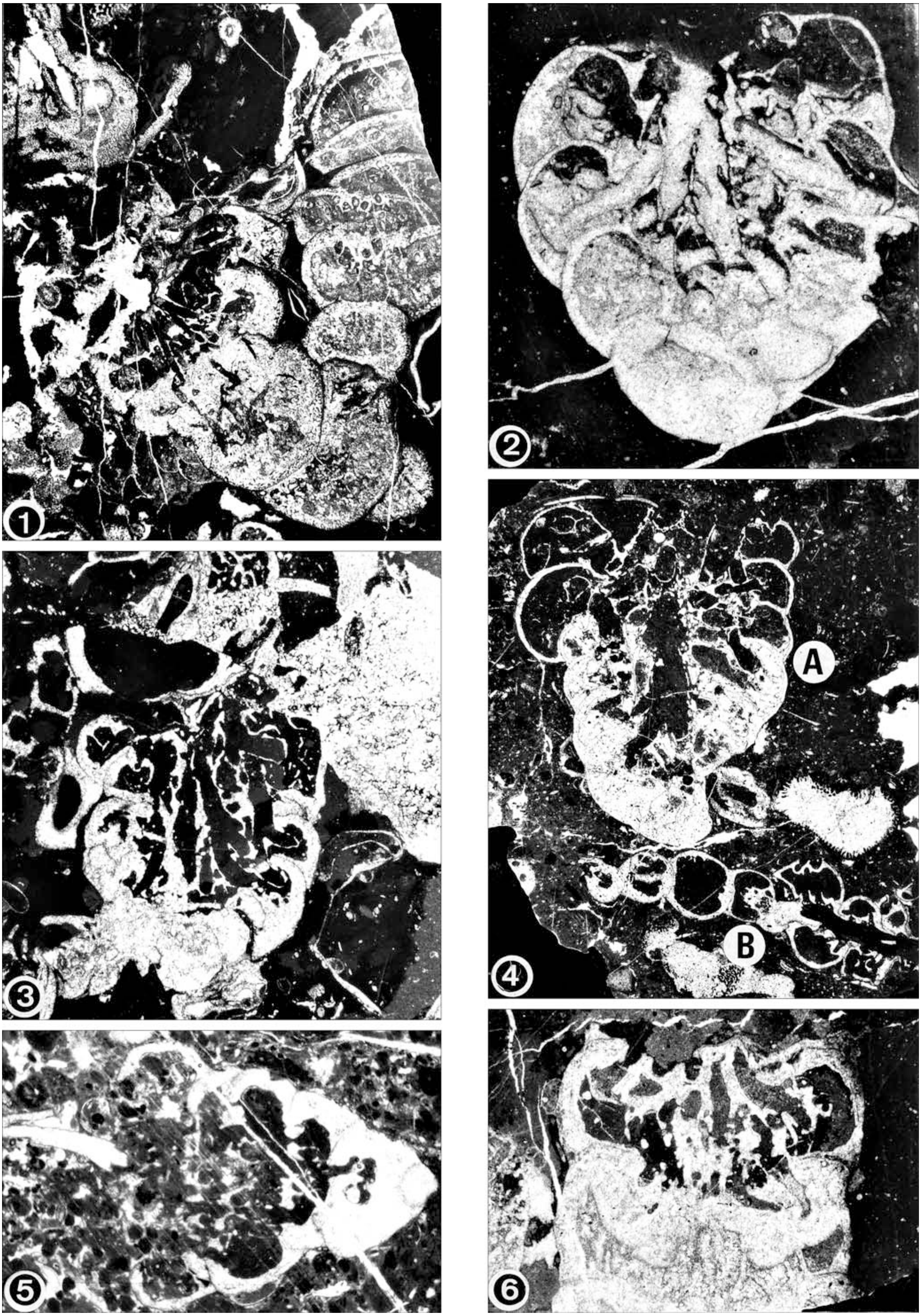
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Plate 24

Tabasia media nov. sp., *Tabasia gregaria* nov. sp., and *Tabasia maxima* nov. gen., nov. sp.

Figs. 1,2,5,6: ***Tabasia media* nov. sp.**

Fig. 1: Longitudinal and oblique sections through three specimens.
The outer segmentation corresponding to the internal segmentation is clearly shown.
Polished slab, ×1.2.

Fig. 2: Three specimens on a naturally weathered rock surface show the relatively high chambers.
Marawand Reef, ×1.2.

Fig. 5: Side view of the specimen illustrated in Fig. 6, exhibiting the relatively high chambers.
Delijan Reefs, ×1.5.

Fig. 6: Longitudinal section through a cylindrical to conical, poorly preserved specimen, that (see Fig. 5) shows the internal segmentation and structures with two canal bundles.
Delijan Reefs, M18, ×1.5.

Fig. 3: ***Tabasia gregaria* nov. sp.**
The summits of three grouped specimens, all characterized by well-developed, star-like (astrorhizal) canals located in depressed areas.
Naybandan Reefs, ×2.5.

Fig. 4: ***Tabasia maxima* nov. gen, nov. sp.**
Holotype.
Longitudinal section through a conical specimen shows several canal bundles and the numerous tubes distributed through the entire sponge (compare Text-Fig. 16). For the outer morphology see Pl. 25, Fig. 5.
Ali-Abad Reefs, polished slab, M19, ×1.3.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

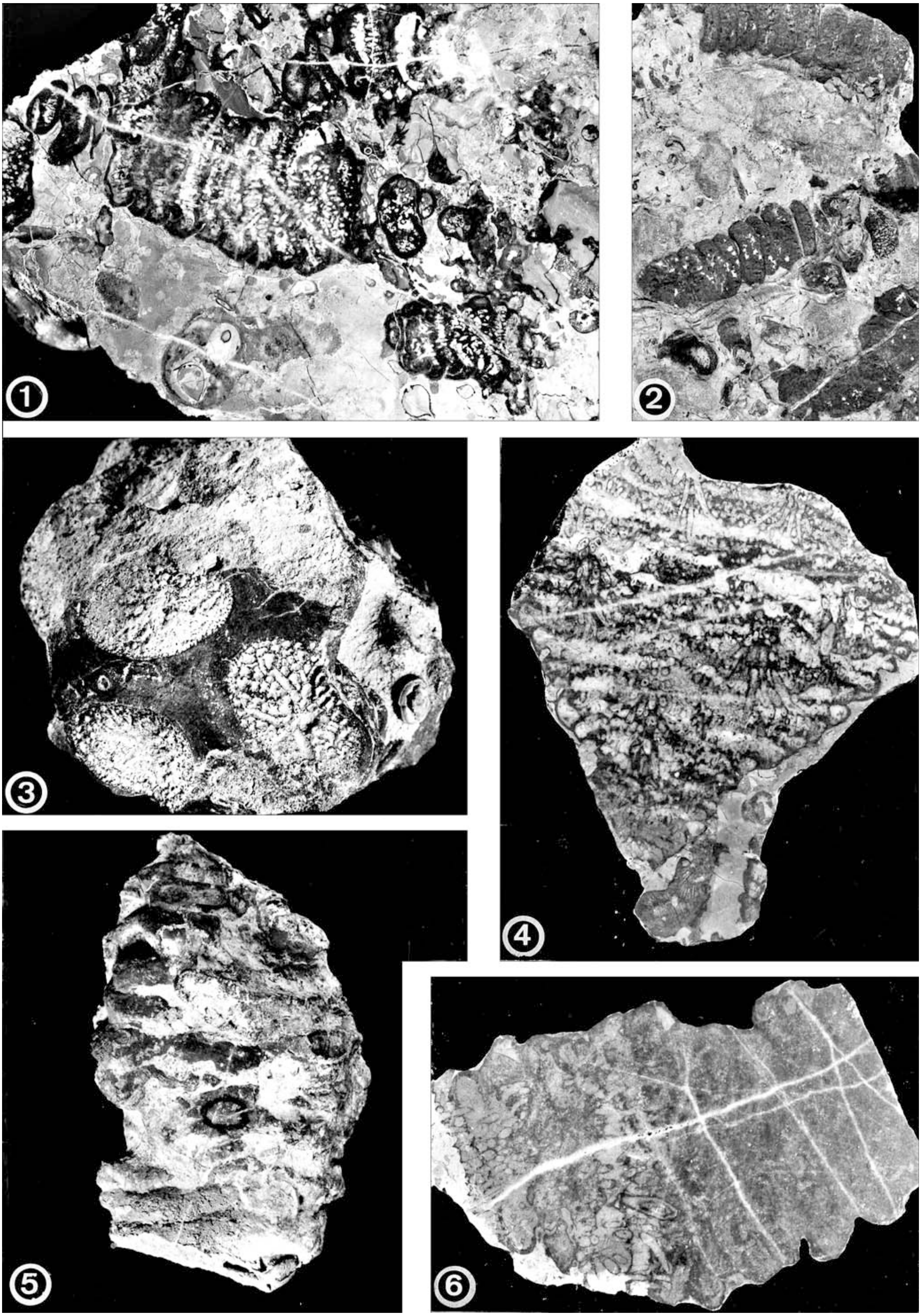
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Plate 25

Tabasia gregaria nov. sp., *Tabasia maxima* nov. sp., and *Tabasia? conica* nov. sp.

Figs. 1–4: ***Tabasia gregaria* nov. sp.**
Holotype; all Figs. are from holotype.
Fig. 1: Side view shows summits of five top of branches of the multibranched holotype.
M16, ×1.5.
Fig. 2: The top of the weathered aggregate shows summits of four individuals of the holotype.
The astrorhizal-like canal system, are still recognizable.
M16, ×2.5.
Fig. 3: Tops of two individuals from the holotype show the indistinct, but still recognizable astrorhizal systems.
M16, ×3.
Fig. 4: Section through the holotype shows three individuals cut in longitudinal section (compare Text-Fig. 17).
Polished slab, M16, ×1.8.

Fig. 5: ***Tabasia maxima* nov. sp.**
Holotype, outer surface (for internal construction see Pl. 24, Fig. 4).
Ali-Abad Reefs, M19, ×1.1.

Fig. 6: ***Tabasia? conica* nov. sp.**
Magnified view of two chambers of the specimen illustrated in Pl. 23, Fig. 4 (upper left chambers) exhibits the tubes within the chamber interior and the double wall between two chambers.
P168/1, ×10.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

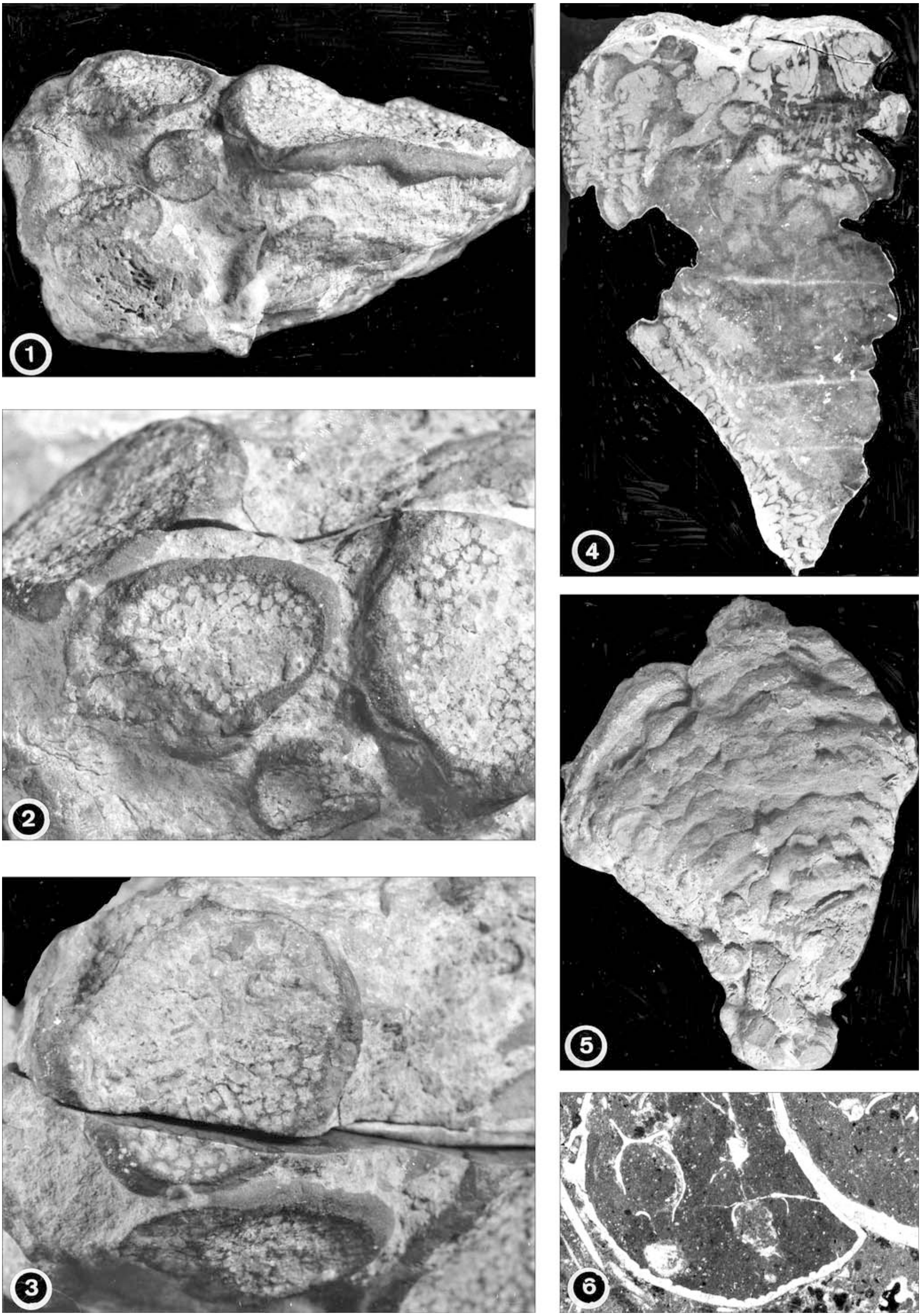
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Plate 26

Tabasia media nov. sp., and *Uvanella norica* (SENOWBARI-DARYAN & SCHÄFER).

Figs. 1–5: ***Tabasia media* nov. sp.**
- Fig. 1: Longitudinal section through two specimens that show the distinct segmentation with relatively high chambers. Delijan Reefs, P304, ×5.
- Fig. 2: Longitudinal, oblique, and transverse sections show the tubes and perforated roof of the chambers. Ferdows Reef, 96/31/9, ×1.
- Fig. 3: Longitudinal section of a specimen overgrown by *Parauvanella maxima* n. sp. (A). Delijan Reefs, P/173/6, ×5.
- Fig. 4: Longitudinal section shows the relatively high chambers and the perforation of the two last chamber roofs. Marawand Reef, M124, ×8.
- Fig. 5: Section similar to Fig. 4. Delijan Reefs, P/209, ×5.

Fig. 6: **Section through several chambers of an undetermined sphinctozoan sponge.**
Marawand Reef, M109, ×10.

Fig. 7: **Section through a tube-like chamber of *Uvanella norica* (SENOWBARI-DARYAN & SCHÄFER).**
It contains some vesiculae.
Delijan Reefs, P268, ×6.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

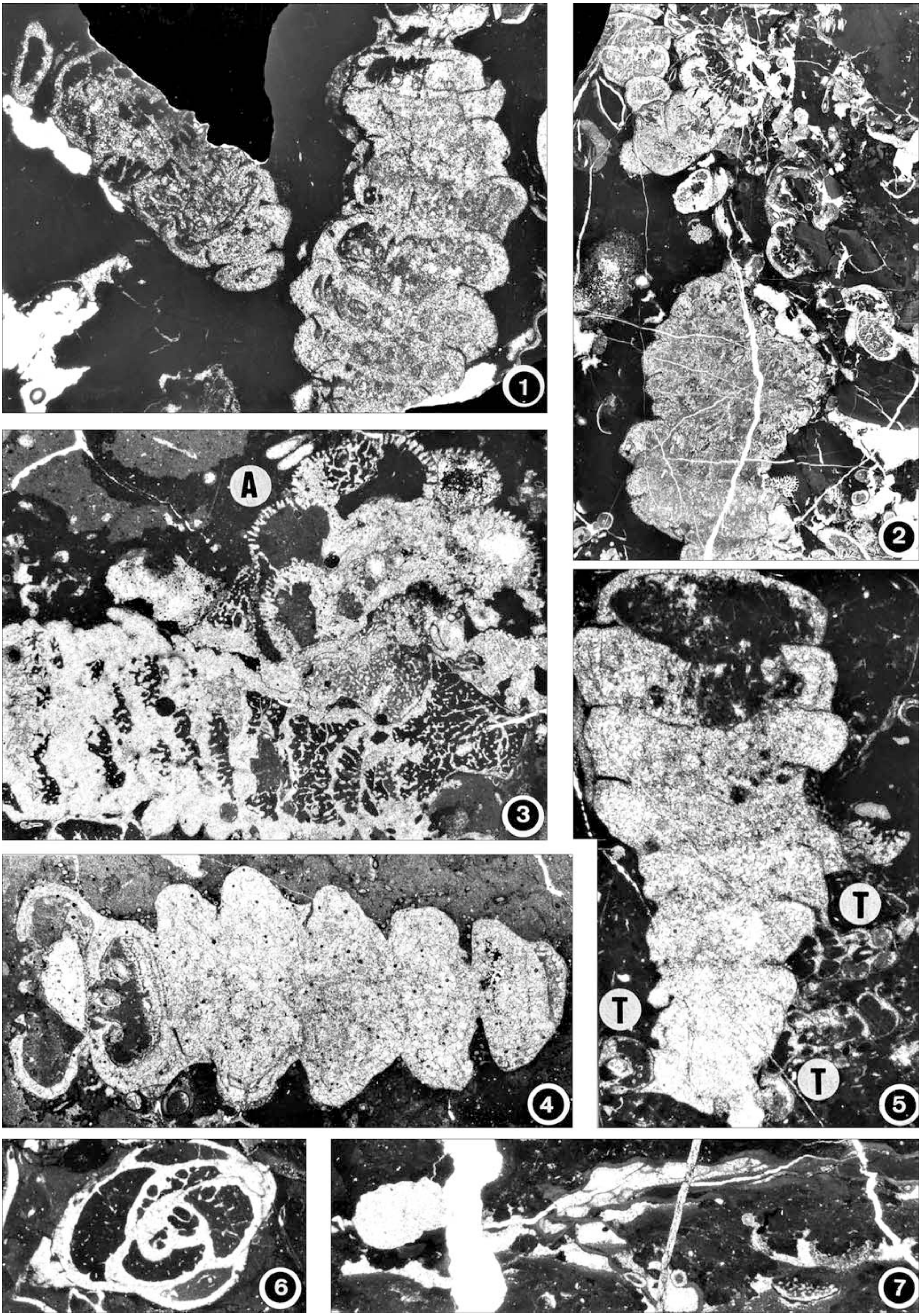
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Plate 27

Tabasia media nov. sp.

Fig. 1: Side view of a conical specimen shows the flattened low chambers arranged one above the other. Some incomplete and wedge-like chambers cause the oblique arrangement of upper chambers. For summit view see Fig. 2. Ali-Abad Reefs, M12, ×4.

Fig. 2: Summit of the same specimen (Fig. 1) with three depressions indicating positions of three possible canal bundles(?). ×4.

Fig. 3: The summit of a specimen with the depressed area showing openings in the last chamber wall. Ali-Abad Reefs, M15, ×3.

Fig. 4: Side view of a conical specimen with numerous, partly wedged-shaped and irregular chambers. Openings in the exowall are borings and not inhalant ostia. For summit view see Fig. 5. Ali-Abad Reefs, M13, ×4.

Fig. 5: Summit of the same specimen (Fig. 4) shows the openings in the last chamber roof. For side view see Fig. 4. Ali-Abad Reefs, ×4.

Fig. 6: Holotype. Side view of a conical specimen whose lower part is broken away. Some chambers are wedge-like and chamber heights are variable within the same chamber. For summit view see Fig. 7. Ali-Abad Reefs, M14, ×4.

Fig. 7: Holotype. Summit of the same specimen (Fig. 6) shows the perforated roof of the last chamber. The depression on the left may indicate the position of an astrorhizal canal system. For side view see Fig. 6. Ali-Abad Reefs. ×4.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

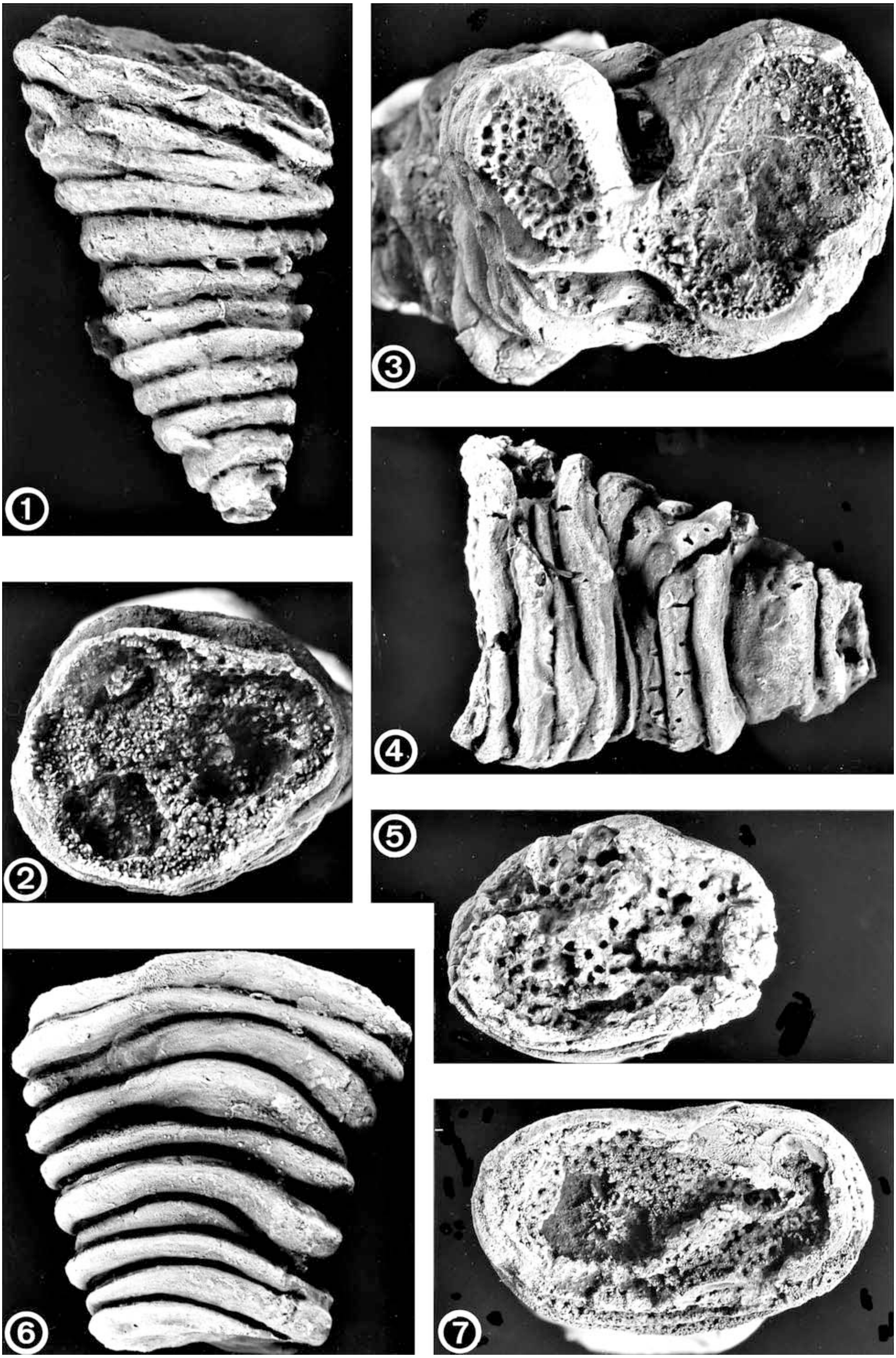
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Plate 28

Tabasia minima nov. sp., *Tabasia maxima* nov. sp., and *Nevadathalamia variabilis* nov. sp.

Figs. 1–3,4?,5–9: ***Tabasia minima* nov. sp.**
All Figs. represent side views of naturally weathered specimens. All specimens show the oblique arrangement of the chambers and were collected from the Ali-Abad Reefs.
Fig. 1: Holotype.
External view of a specimen composed of 9 chambers with screw-like appearance.
M1, ×2.
Fig. 2: View similar to Fig. 1.
M2, ×2.5.
Fig. 3: M3, ×3.
Fig. 4: M4, ×2.5.
Fig. 5: Specimen with relatively high chambers.
M5, ×2.
Fig. 6: Simil×2.5.
Fig. 7: M7, ×2.5.
Fig. 8: M8, ×2.5.
Fig. 9: A specimen with soupplate-like chambers.
M9, ×2.5.

Figs. 10,11: ***Tabasia maxima* nov. sp.**
Fig. 10: Side view of a reference specimen exhibits numerous low flattened chambers.
The sponge has an oval cross section. The diameter of the sponge increases rapidly upward and it has at least three individual excurrent canal systems at the summit.
Ali-Abad Reefs. M10, ×0.8.
Fig. 11: Holotype.
A large specimen composed of numerous flattened and wave-like chambers, that has an ovate cross section. The surface of the sponge was bored or colonized by other sessile organisms.
Ali-Abad Reefs. M11, ×1.

Figs. 12–14: ***Nevadathalamia variabilis* nov. sp.**
All specimens were collected from Ali-Abad Reefs.
Fig. 12: Side view of outer surface of a broken specimen composed of four chambers.
Note the star-like shapes of the pores.
N4, ×1.4.
Fig. 13: View, similar to Fig. 12, of three specimens that are grown together laterally.
N3, ×1.4.
Fig. 14: View of a specimen like the one shown in Fig. 12.
N5, ×2.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

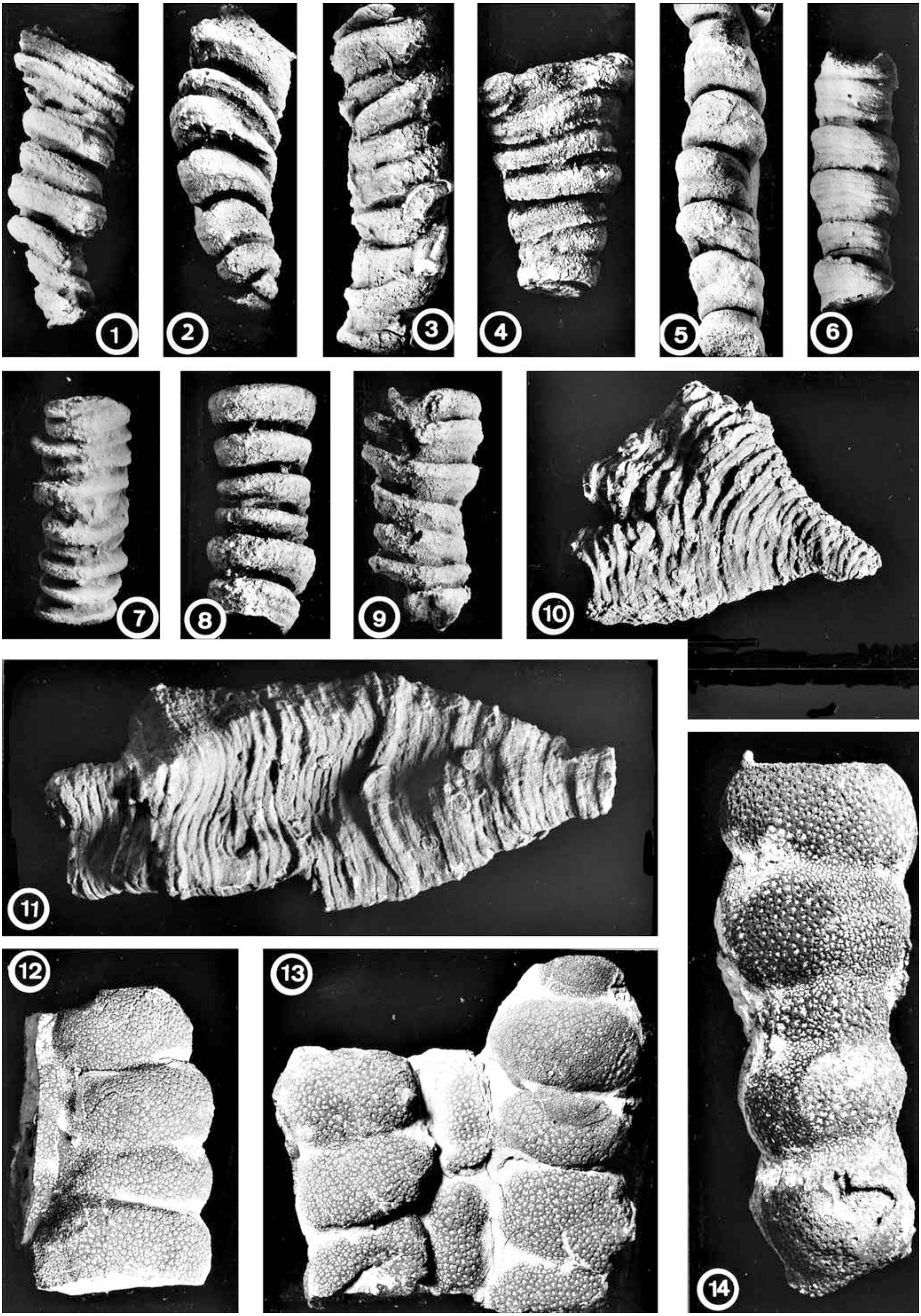
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Plate 29

Praethalamia irregulara nov. sp., and *Annaecoelia? parva* nov. sp.

Figs. 1,2?,3?,5?,7A: ***Phraethalamia irregulara* nov. sp.**

Fig. 1: Holotype (see Text-Fig. 24).
Longitudinal section through numerous spherical to subspherical chambers arranged unilaterally zigzag-like around a bundle of axial tubes. The sponge overgrew an inozoid sponge and is overgrown by another inozoid.
Delijan Reefs, P272/3/b, ×2.5.

Fig. 2: Oblique section through a recrystallized specimen.
Delijan Reefs, P137/5/1, ×9.

Fig. 3: Oblique section through a specimen exhibits three chambers with at least two spongocoels, cut in the lower part.
Identification as *Phraethalamia irregulara* is uncertain.
Delijan Reefs, P/207/5, ×6.

Fig. 5: Field photograph of a weathered surface shows a specimen with almost spherical chambers.
×3.

Fig. 7: Weathered rock surface shows
A) *Phraethalamia irregulara* nov. sp., with zigzag-like arranged chambers around of least three axial tubes.
B and C) Inozoid sponges gen. et sp. indet.
Sample Dj010, ×1.

Figs. 4,6: ***Annaecoelia? parva* nov. sp.**

Fig. 4: Oblique to longitudinal sections through two specimens show the spherical chambers with thin chamber walls.
Ferdows Reef, 96/31/9, ×7.5.

Fig. 6: Holotype.
The branched specimen exhibits the glomerate chamber arrangement, the prosiphonate type of the spongocoel, and the thin chamber walls.
Ali-Abad Reefs, AB29, ×8.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

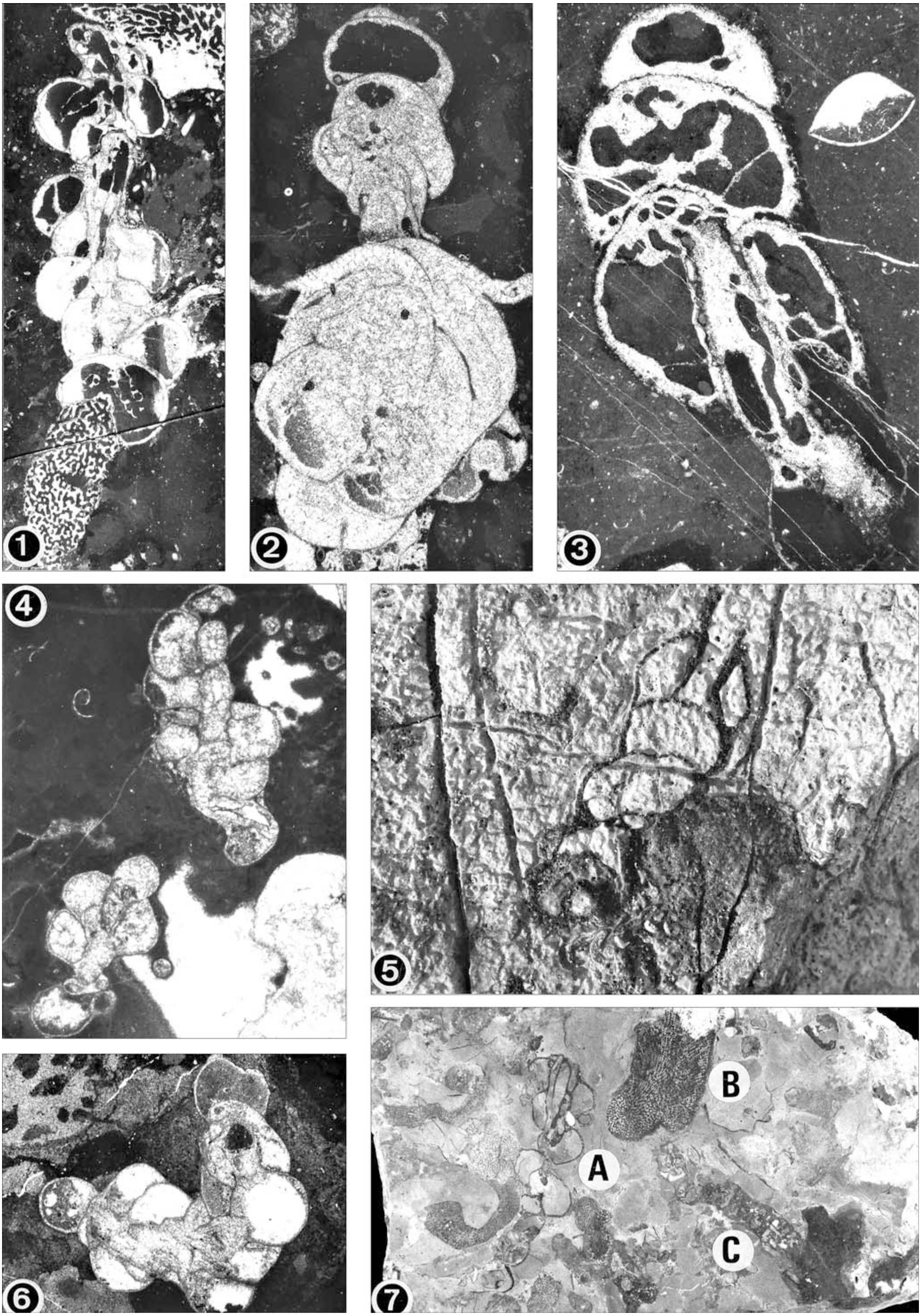
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Plate 30

Tabasia media nov. sp., *Praethalamia? originalis* BOIKO,
and other not exactly determined thalamid sponges.

Fig. 1: **Solinolmiidae gen. et sp. indet 2.**
Section through four flattened chambers with perforated chamber walls and reticular filling skeleton within the chamber interiors.
Marawand Reef, P148/3, ×5.

Fig. 2: ***Stylothalamia?* or *Cryptocoelia?* sp.**
Section through a branched specimen shows the low chambers with pillar-like filling skeleton.
In contrast to specimen illustrated in Pl. 31, Fig. 6, this specimen has a single spongocoel.
DJ-?, ×1.5.

Fig. 3: ***Pamirothalamia? originalis* BOIKO.**
Longitudinal section through numerous, strongly recrystallized chambers.
Delijan-Reefs, P163/1, ×2.5.

Fig. 4: **"*Stylothalamia*" sp.**
Marginal axial section.
The retrosiphonate spongocoel is cut in the central part.
Delijan Reefs, P/83, ×1.3.

Fig. 5: **Sphinctozoan sponge gen. et sp. indet. 2.**
Compare Pl. 14, Fig. 5T.
Delijan Reefs, P?/2/1, ×2.

Figs. 6,7: ***Tabasia media* nov. sp.**
Fig. 6: Section through two broken chambers shows the complicated canal system of the outer walls and the tubes cut in transverse section.
Ferdows Reef, 96/31/9, ×6.
Fig. 7: Magnification of specimen illustrated in Pl. 23, Fig. 1.
Longitudinal to oblique section through 7 chambers shows the complicated canal system of the outer walls and the chamber roofs pierced by numerous tubes cut in cross section, appearing as pores. About half of the chamber roofs are pierced by tubes.
Ferdows Reef, 96/31/9, ×6.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

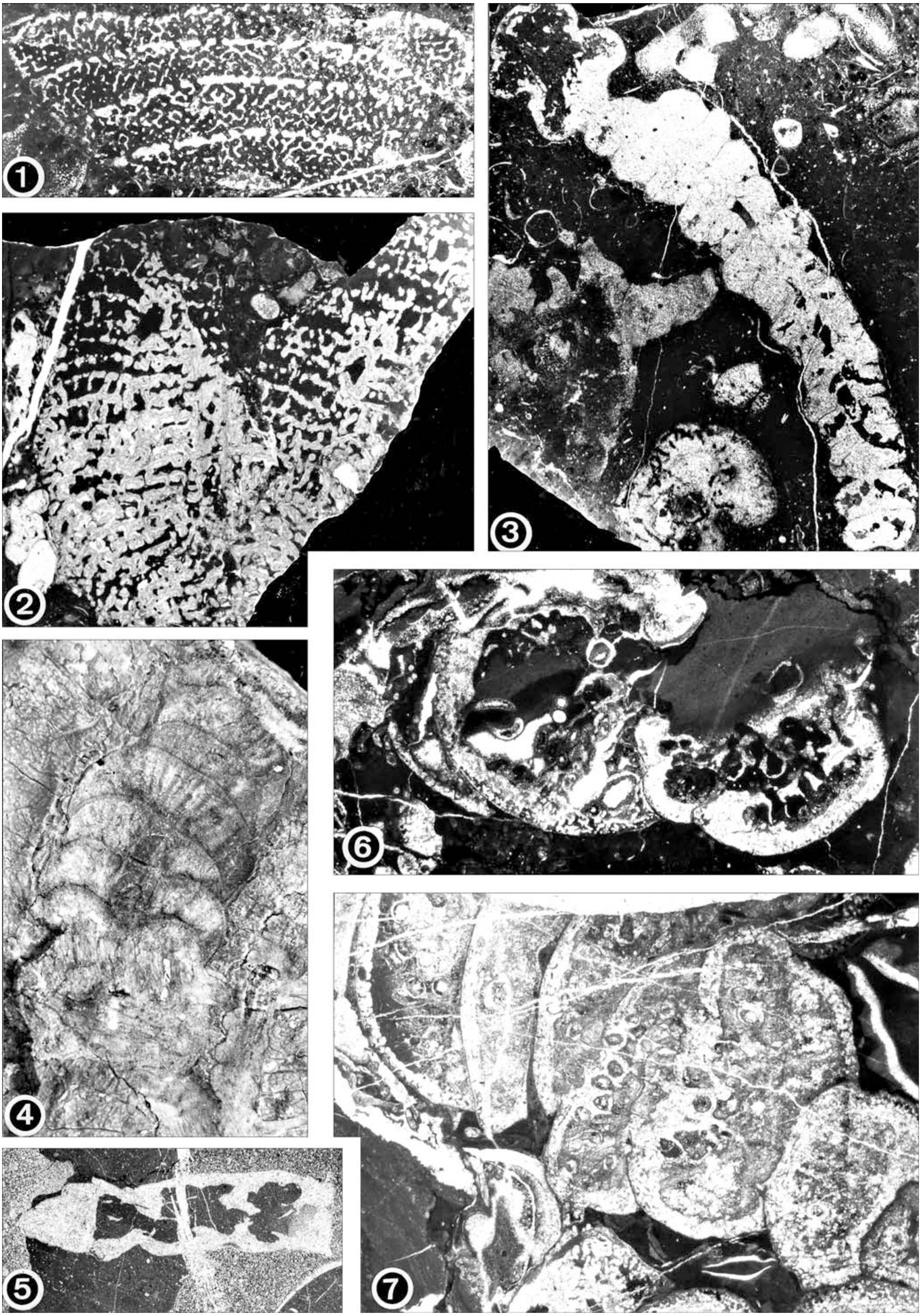
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Plate 31

Paravesicocaulis naybandensis nov. sp., *Cinnabaria minima* Senowbari-Daryan, *Colospongia* cf. *ramosa* Riedel & Senowbari-Daryan, and other not exactly determined thalamid sponges.

Figs. 1,2: ***Paravesicocaulis naybandensis*** **nov. sp.**
Fig. 1: Section through several spherical chambers.
The roof of the last chamber (left in photograph) is pierced by a large opening.
Naybandan Reefs, 96/102, ×3.5.
Fig. 2: Section through several chambers of two (or more) specimens (see Text-Fig. 25).
Naybandan Reefs, 96/100, ×2.7.

Fig. 3: ***Cinnabaria minima*** **Senowbari-Daryan.**
Longitudinal section through a conical specimen exhibits the tube-like chambers with perforated chamber walls. Natural weathered rock surface.
Marawand Reef, ×1.

Fig. 4: ***Colospongia*** **cf.** ***C. ramosa*** **Riedel & Senowbari-Daryan.**
Longitudinal section through numerous crescent-like chambers exhibits the perforation of the chamber walls. Three specimens of a small brachiopod have colonized the sponge.
Delijan Reefs, DJ/2000/34, ×4.

Fig. 5: **Sphinctozoan sponge (Solenolmiidae) gen. et sp. indet. 1.**
Longitudinal or oblique section through several flattened chambers with perforated chamber walls and reticular filling structure within the chamber interiors. Arrow indicates a large opening (exhalant canal).
Delijan Reefs, Dj/2000/38, ×2.5.

Fig. 6: ***Stylothalamia?*** **or** ***Cryptocoelia?*** **sp. (nov. sp.?).**
Longitudinal section through a branched specimen exhibits the low chambers and the axial canals composed of several tubes.
Because of recrystallization, the type of filling skeleton is not recognizable.
Delijan Reefs, 99, ×2.5.

Fig. 7: **Sphinctozoan sponge (Solenolmiidae) gen. et sp. indet. 1.**
Oblique section through three flattened chambers filled with a reticular filling skeleton.
Arrows indicate the large exhalant openings.
Delijan Reefs, Dj2000/24, ×2.5.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.

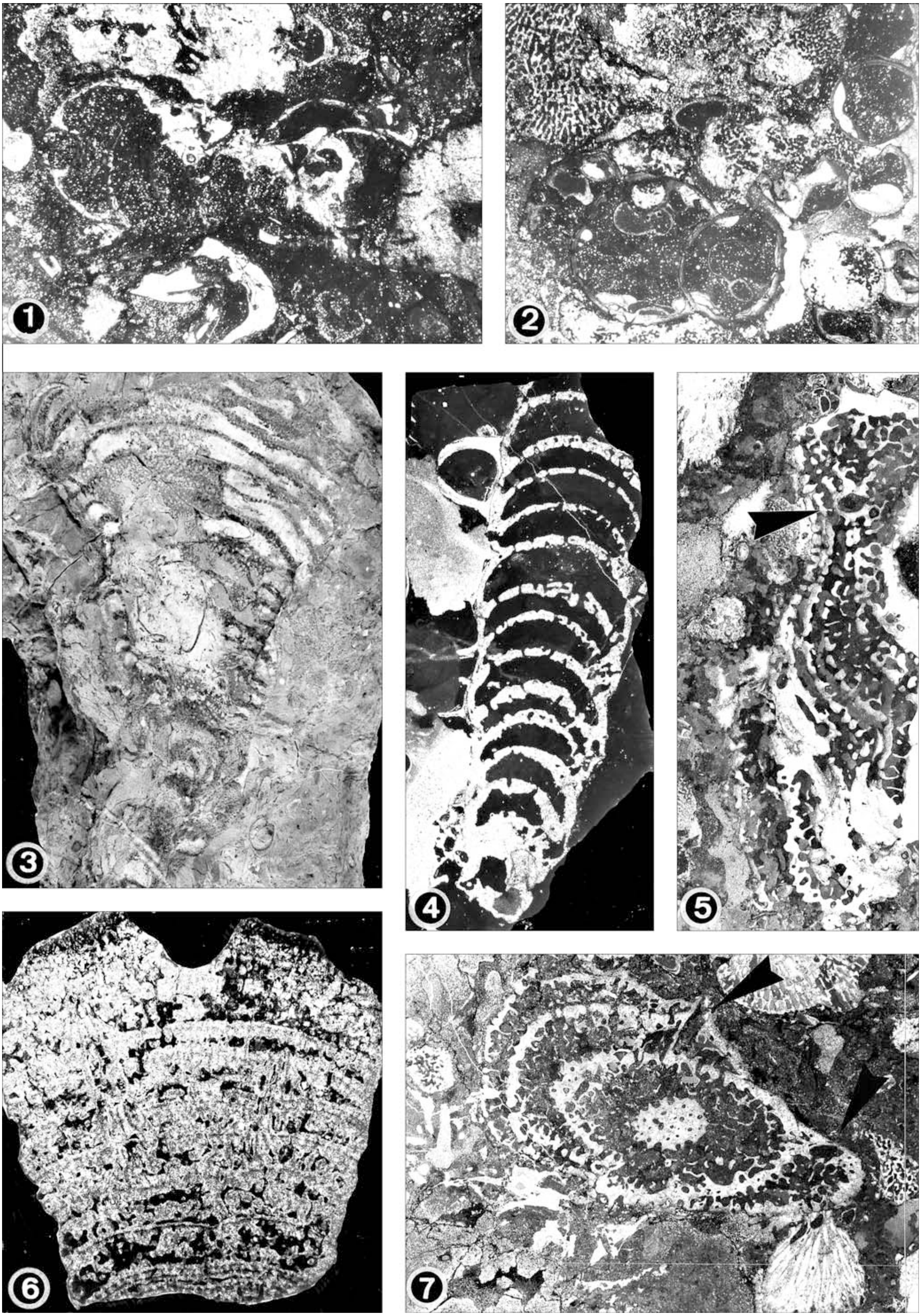
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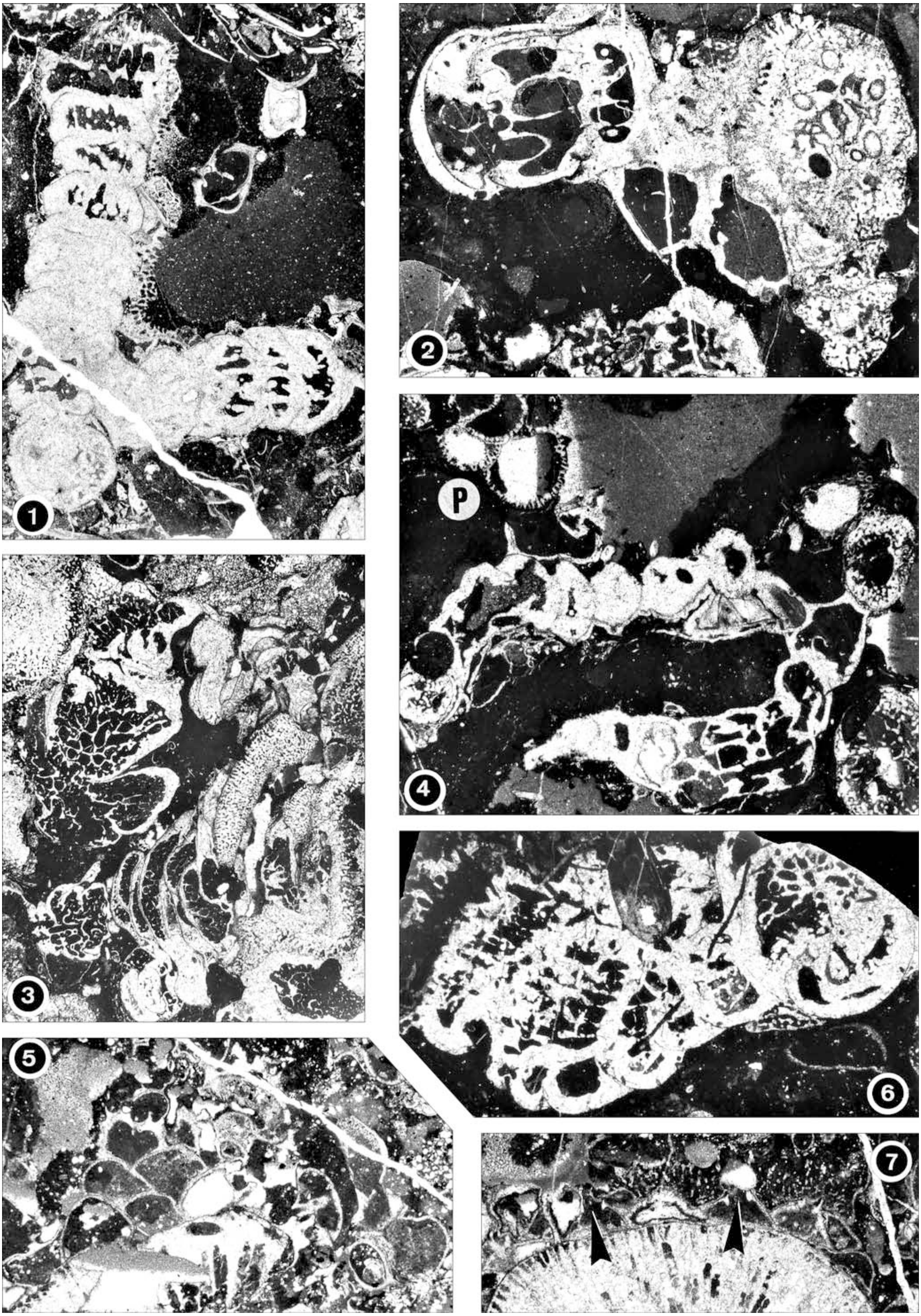
Plate 32

Annaecoelia? interiecta SENOWBARI-DARYAN & SCHÄFER,
and different species of the genus *Tabasia*.

Figs. 1–3,4?,6: ***Tabasia* ssp.**
Fig. 1: Longitudinal section through a branched specimen shows the vertical tubes in the two last chambers in the left branch.
Delijan Reefs, P332/1,×5.
Fig. 2: Section through two chambers exhibiting the large vertical tubes within the chambers.
M110/2, ×7.
Fig. 3: Transverse to oblique sections through several specimens.
Naybandan Reefs, N4, ×4.
Fig. 4: Longitudinal sections through two specimens, or through a branched specimen.
Marawand Reef, M73, ×5.
Fig. 6: Longitudinal section through a specimen shows the vertical tubes and thick chamber walls.
Ferdows Reef, 96 /31/872, ×5.

Figs. 5,7: ***Annaecoelia? interiecta* SENOWBARI-DARYAN & SCHÄFER.**
Fig. 5: Section through numerous subspherical and thin-walled chambers.
Naybandan Reefs, P/131/41, ×10.
Fig. 7: Section through numerous chambers grown on a coral calyx.
Arrows indicate the openings of ambisiphonate type.
Ferdows Reef, 96/31/41, ×8.

In all Figures the locality and the number of thin section is given after the explanation. Figures without a number represent specimens in body preservation and are kept separately from thin sections.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