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THALAMID SPONGES FROM THE UPPER TRIASSIC (NORIAN-RHAETIAN) NAYBAND FORMATION NEAR WALI-ABAD, SE ABADEH, CENTRAL IRAN (Contribution to Triassic Paleontology of Iran 4)

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Key-words: Sponges, "Sphinctozoa", Triassic, Norian-Rhaetian, Nayband Formation, Iran.

Riassunto. Viene descritta una associazione di spugne thalamidi *Amblysiphonella*, *Nevadathalamia*, *Stylothalamia* e *Neoguadalupia*, comprendente anche l'hexactinellide *Casearia*, proveniente dalla Formaziione Nayband (Triassico Superiore, Norico-Retico) raccolta nelle Hambast Mts. presso la piccola città di Wali-Abad (regione di Abadeh, Iran Centrale). Questo tipo di associazione di età Norico-Retica (*Neoguadalupia, Amblysiphonella, Nevadathalamia*) rinvenuta insieme a *Stylothalamia columnaris*, sinora segnalata solo nel Giurassico Inferiore, è del tutto insolita, non essendo mai stata riportata nè dall'Iran, nè da altre parti del mondo. Vengono inoltre discusse le microfacies e le associazioni degli altri organismi nei calcari contenenti le spugne. Le peculiarità osservate nella composizione della macro- e microfauna, confermano l'interpretazione di Kristan Tollmann et al., di considerare la Formazione di Nayband nella regione di Abadeh come una unità distinta, la "Wali-Abad Faziesregion".

Sono descritte due nuove specie di spugne thalamidi: *Nevadathalamia waliabadensis* sp. n. e *Stylothalamia hambastensis* sp. n.

Abstract. An association of thalamid sponges including *Amblysiphonella*, *Nevadathalamia*, *Stylothalamia*, and *Neoguadalupia*, with the hexactinellid *Casearia* is described from the Upper Triassic (Norian-Rhaetian) Nayband Formation of Hambast-Mts. near the small town of Wali-Abad (Abadeh region, Central Iran). These Norian-Rhaetian (*Neoguadalupia*, *Amblysiphonella*, *Nevadathalamia*) and Liassic (*Stylothalamia columnaris* Le Maitre) thalamid sponge assemblages are exceptional associations, not previously reported from Iran nor from other localities in the world. The microfacies and organism associations in the sponge-bearing carbonates is discussed. Differences of macro- and microfaunal composition, as well as flora, support the recognition of Kristan-Tollmann et al. to classify the Nayband Formation in the Abadeh region as of a distinct unit, termed the "Wali-Abad-Faziesregion".

Following thalamid sponge species are described as new: *Nevadathalamia waliabadensis* n. sp. and *Stylothalamia hambastensis* n. sp..

Introduction.

The Nayband Formation, a series of shales and siliciclastic-carbonate deposits of Norian-Rhaetian age is a widespread geological member outcropping in numerous localities in central Iran (see Seyed-Emami, 1971; Senowbari-Daryan, 1996). Several level of bioconstructions (normally with biostromal, rarely biohermal) are intercalated within the Nayband Formation. Douglas (1929) was the first to report on the rich invertebrate assemblages of these bioconstructions in central Iran. Since then several authors (e. g. Huckriede et al., 1962) have mentioned the bioconstructions and the occurrence of invertebrate association, especially the reef organisms, in the Nayband Formation, but further and detailed investigations about the content and diversity of reef-builders and reef-dwellers have been incomplete. Fenninger (1969) described some reef organisms and a dasycladacean alga from the Golpayegan area (N of Esfahan). Kristan-Tollmann et al. (1979, 1980) investigated some reef builders, such as corals, and reef-dwellers, such as brachiopods and ostracodes. Fallahi et al. (1983) described some bivalves and gastropods from the Bagherabad region (NE of Esfahan). Repin has investigated the ammonites and the bivalves of the Nayband Formation, but unfortunately this work is not yet published. An overview of the bioconstructions within the Nayband Formation and the paleontological content of these bioconstructions was given by Senowbari-Daryan (1996).

Rich invertebrate faunas, including sponges, corals, "hydrozoans" (spongiomorphids, *Heterastridium*), bryozoans, algae, foraminifers, etc. were collected from several localities, including the type locality in the Naybandan area (S Tabas), and several additional localities north and south of Esfahan. The Nayband Formation around the town of Abadeh (Fig. 1) outcrops at several localities, such near the small town of Wali-Abad in the Hambast-Mountains, from which the sphinctozoid sponge fauna, described in this paper, was obtained. Some macro- and microfauna from the same locality was described by Kristan-Tollmann et al. (1979). The

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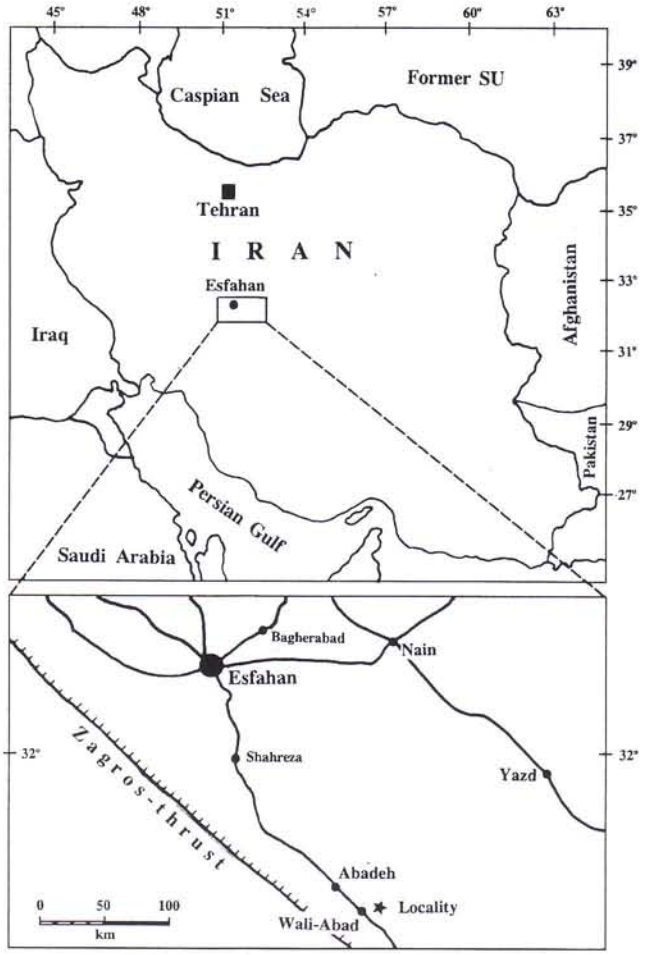


Fig. 1 - Geographic position of the locality in the Hambast-Mts. near the town of Wali-Abad, Abadeh area, central Iran.

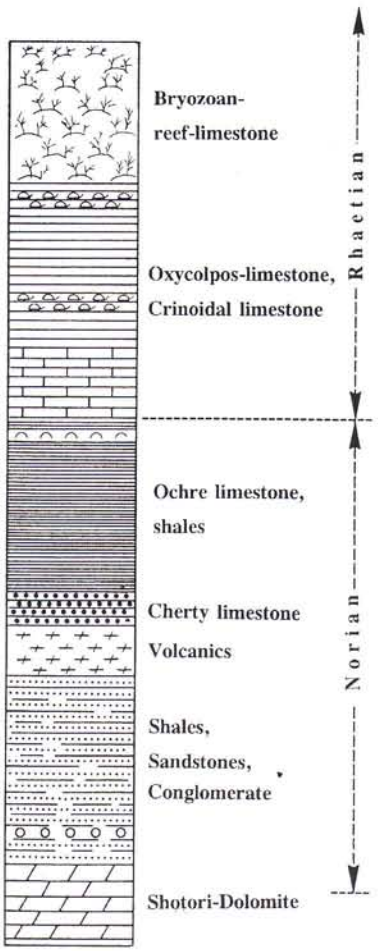


Fig. 2 - Schematic section of Norian-Rhaetian Nayband Formation in the Hambast Mts. near the town of Wali-Abad, Abadeh area (after Kristan-Tollmann et al., 1979).

Nayband Formation in the Abadeh region exhibits some differences of facies types and faunal composition compared with the type locality near the town of Naybandan, and also with localities north of Esfahan. *Oxycolpella*, a very abundant and large brachiopod e. g., was found only in this area (Kristan-Tollmann et al., 1979). Not only the brachiopod fauna but differences also exist in the presence and absence of other fossils in this area (compare Senowbari-Daryan & Hamadani, in press). We note here the total absence of the sphaerical hydrozoan, *Heterastridium*, an abundant fossil in the area north of Esfahan and also at the type locality of the Nayband Formation. Also, sponge and foraminiferal faunas show some differences from the other localities. These differences caused Kristan-Tollmann et al. (1979, p. 130) to classify the Nayband Formation in this area as a distinct unit and to introduce the term "Waliabad facies region" for the Norian-Rhaetian deposits (equivalent to the Nayband Formation) of this region.

The sphinctozoan sponge faunas, described here, were collected from a section (Fig. 2), exposed about two hundred meters from the section studied by Taraz (1974) and Kristan-Tollmann et al. (1979: fig. 5). The sponge-bearing carbonate beds in our section corresponds to the "Oxycolposkalk" of Kristan-Tollmann et al. (1979). The uppermost unit in our section is a crinoidal limestone, called as "Bryozoen-Riffkalk" by Kristan-Tollmann et al. (1979). The majority of reef organisms, interpreted as bryozoans by Taraz (1974) and Kristan-Tollmann et al. (1979), are poorly perserved spongiomorphids and dendroid corals, not bryozoans.

In addition to segmented sponges, some non-segmented inozoids, chaetetids, and exactinellid sponges, as well as corals (solitary, cerioid and dendroid types), "spongiomorphids", bryozoans, algae and other elements of the reef fauna were collected from beds underlying the "Oxycolpuskalk" in this section. Compared to other bioconstructions within the Nayband Formation, bryozoans are relatively abundant at this locality (also at other localities around Abadeh) but they are not important as reef builders at these localities.

The collections investigated are deposited in the Institute of Paleontology, University of Erlangen-Nürnberg (Senowbari-Daryan: Trias, Iran).

Previous contributions to the Triassic Paleontology of Iran are: 1) Senowbari-Daryan B. (1996) - Upper

Triassic Reefs and Reef Communities of Iran.- In: Reitner J., Neuweiler F. & Gunkel F. (eds.): Global and Regional Controls on Biogenic Sedimentation. I. Reef Evolution. Research Reports. *Göttinger Arb. Geol. Paläont.*, Sb2, pp. 299-304, Göttingen. 2) Senowbari-Daryan B., Seyed-Emami K. & Aghanabati A. (1997) - Some inozoid sponges from Upper Triassic (Norian-Rhaetian) Nayband Formation of central Iran. *Riv. Ital. Paleont. Stratigr.*, v. 103, pp. 293-322, Milano. 3) Senowbari-Daryan B. & Hamadani A. (in press): Girvanellid coated Udoteacean oncoids from Upper Triassic (Norian-Rhaetian) Nayband Formation near the towns of Khaneh-Khoreh and Wali-Abad, South of Abadeh (Central Iran).- *Paleopelagos*, Roma.

Systematic Paleontology

Phylum **Porifera** Grant, 1872

Class **Demospongia** Sollas, 1875

Subclass **Ceractinomorpha** Lévi, 1973

Order Permosphincta Termier & Termier, 1974

Suborder Porata Seilacher, 1962

Family Sebargasiidae de Laubenfels, 1955

Subfamily Sebargasiinae

Senowbari-Daryan, 1990

Genus *Amblysiphonella* Steinmann, 1882

Type species: *Amblysiphonella barroisi* Steinmann, 1882

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

(Pl. 1, fig. 1-2, 4-5, Pl. 7, fig. 7)

1909, *Eurysiphonella steinmanni* Haas, p. 162, pl. 6, fig. 10a-10c.

Collection: 13 specimens.

Description. The cylindrical stems of this sponge are composed of numerous rings of chambers arranged around a retrosiphonate spongocoel. The diameter of the stems ranges from 14 mm to 26 mm. The length of the sponge can not be given exactly but it reaches at least 75 mm, as documented by one specimen figured in Pl. 1, fig. 5.

The diameter of the retrosiphonate spongocoel ranges from 6 mm to 13 mm with the ratio of spongocoel diameter/sponge diameter between 43 and 46%.

The height of the ring chambers ranges from 2 mm to 8 mm, but most are about 5 mm. The thickness of the chamber walls remains uniform in a given specimen, but differs between specimens, ranging from 0.5 mm to 1 mm. Chamber walls, as well as the wall of spongocoel, are pierced by numerous equal-sized pores of 0.2-1.0 mm in diameter. Vesiculae were not observed, neither in chamber interiors nor within the spongocoel.

Discussion. *Amblysiphonella* is a sphinctozoid sponge with poorly defined diagnostic features. About 60 species of the genus have been described from Paleozoic and Mesozoic rocks, but most of them occur in the Permian and Triassic. All species of *Ambysiphonella* with diagnostic characteristics and stratigraphic range, known up to 1990, were listed by Senowbari-Daryan (1990, p. 62). The following species have been described after 1990 by different authors:

- *A. benschae* Zhuravleva (in Boiko et al. 1991) (Carboniferous)
- *A. obichingouensis* Boiko (in Boiko et al. 1991) (Permian)
- *A. eleganta* Belyeava (in Boiko et al. 1991) (Permian)
- *A. sahrajensis* Belyaeva (in Boiko et al. 1991) (Triassic)
- *A. tenuiramosa* Boiko (in Boiko et al. 1991) (Triassic)
- *A. tubifera* Senowbari-Daryan, 1994a (Triassic)
- *A. omanica* Weidlich & Senowbari-Daryan, 1996 (Permian)

The dimensions of sponge and skeletal elements of this Iranian species of *Amblysiphonella* are almost identical to those species described as *"Eurysiphonella" steinmanni* (= *Amblysiphonella steinmanni*) by Haas (1909) from the Rhaetian Zlambach beds of Fischerwiese in Austria. However, the abundant vesiculae in *A. steinmanni* from Fischerwiese, as mentioned by Haas, do not occur in our species from the Wali-Abad locality.

Amblysiphonella occurs also in reefs of the Nayband Formation at other localities (e. g. in the southern area of Delijan, north of Esfahan). The occurrence of this genus from the Kerman area was reported by Huckriede et al. (1962).

Amblysiphonella cf. **A. tubifera** Senowbari-Daryan, 1994a

(Pl. 1, fig. 3, Pl. 7, fig. 8, Pl. 8, fig. 2)

1994, *Amblysiphonella tubifera* Senowbari-Daryan, p. 68-69, pl. 5, fig. 5.

Collection: Three specimens.

Description. The first specimen (Pl. 1, fig. 3) of this sponge is 40 mm long and 33 mm in diameter, the second one (Pl. 8, fig. 2) is cut obliquely and has a diameter of 23 mm. The third specimen (Pl. 7, fig. 8) is small with a diameter smaller than the others. The diameter of the sponge increases rapidly during growth. The first specimen is composed of 6 crescent-like ring chambers arranged catenulate around a retrosiphonat spongocoel 6 mm in diameter, the second specimen of at least 5 chambers, has a spongocoel 5 mm in diameter. Chamber height ranges between 5 mm and 7 mm. Because of the partial or total overlap of preceeding chambers by younger chambers, the external segmentation is

indistinct and all the chambers are not visible from the exterior of sponge. Chamber walls (exowalls and interwalls) are pierced by numerous pores of 0.2-0.4 mm in diameter. The spongocoel wall (endowall) is pierced by large openings 1.0-1.3 mm in diameter, that extended as short tubes into chamber interiors. Vesiculae are not developed within the chambers or within the spongocoel.

Discussion. The general features of this *Amblysiphonella* correspond to the species described as *A. tubifera* by Senowbari-Daryan (1994a) from the Upper Triassic Pucara Group in Peru. The Iranian species differs from the Peruvian one by being a bit smaller and having straighter chamber walls. In addition, the chamber walls are more regularly perforated in the Iranian species than in the Peruvian one.

Family Polytholosiidae Seilacher, 1962

Subfamily Polytholosiinae Senowbari-Daryan, 1990

Genus *Nevadathalamia* Senowbari-Daryan, 1990

Type species: *Polytholosia cylindrica* Seilacher, 1962

Further species: *N. ramosa* (Senowbari-Daryan & Reid, 1986)
N. alpina Senowbari-Daryan, 1990

Nevadathalamia waliabadensis n. sp.

(Pl. 1, fig. 6; Pl. 6, fig. 1-2; fig. 3)

Derivatio nominis: After the village of Wali-Abad, the town near the type-locality.

Holotype: Pl. 6, fig. 1-2, fig. 3. From the holotype two thin sections were made with the remainder in the rock.

Paratype: Pl. 1, fig. 6.

Locus typicus: Locality near the town of Wali-Abad, south of Abadeh, central Iran.

Stratum typicum: Upper Triassic, Norian-Rhaetian.

Collection: Two specimens.

Diagnosis. Porate Sphinctozoa with an axial canal bundle composed of several (may be 10?) single tubes. Tubular-granular structure fills the chambers, especially the older chambers. Chambers arrangement is catenulate.

Fig. 3 - *Nevadathalamia waliabadensis* n. sp. Prepared from longitudinal section, showing the axial tubes and the structure of the tubular filling in the chambers, especially within the old chambers (scale 1 cm).

Description. Only two specimens of this sponge are available in our collections. The holotype reachs a length of 90 mm and a diameter of 30 mm. It is composed of several catenulate, relatively unequal chambers 6-12 mm high. The contact of the sponge with the surrounding rock is bounded by fissures, therefore some of the outer walls of the chambers is broken away (Fig. 3; Pl. 6, fig. 1-2;).

Chamber walls are thin, 0.4-1.2 mm. Chamber interiors, especially older chambers, are filled by a loose tubular structure.

As shown in Fig. 3, one chamber in the middle is larger and contains more filling than all the others. This probably documents an interruption in the sponge growth. The chamber walls are pierced by pores of unequal diameter.

An axial spongocoel composed of several individual tubes passes through the sponge. The diameter of the canal bundle is about 10 mm, the individual tubes 2

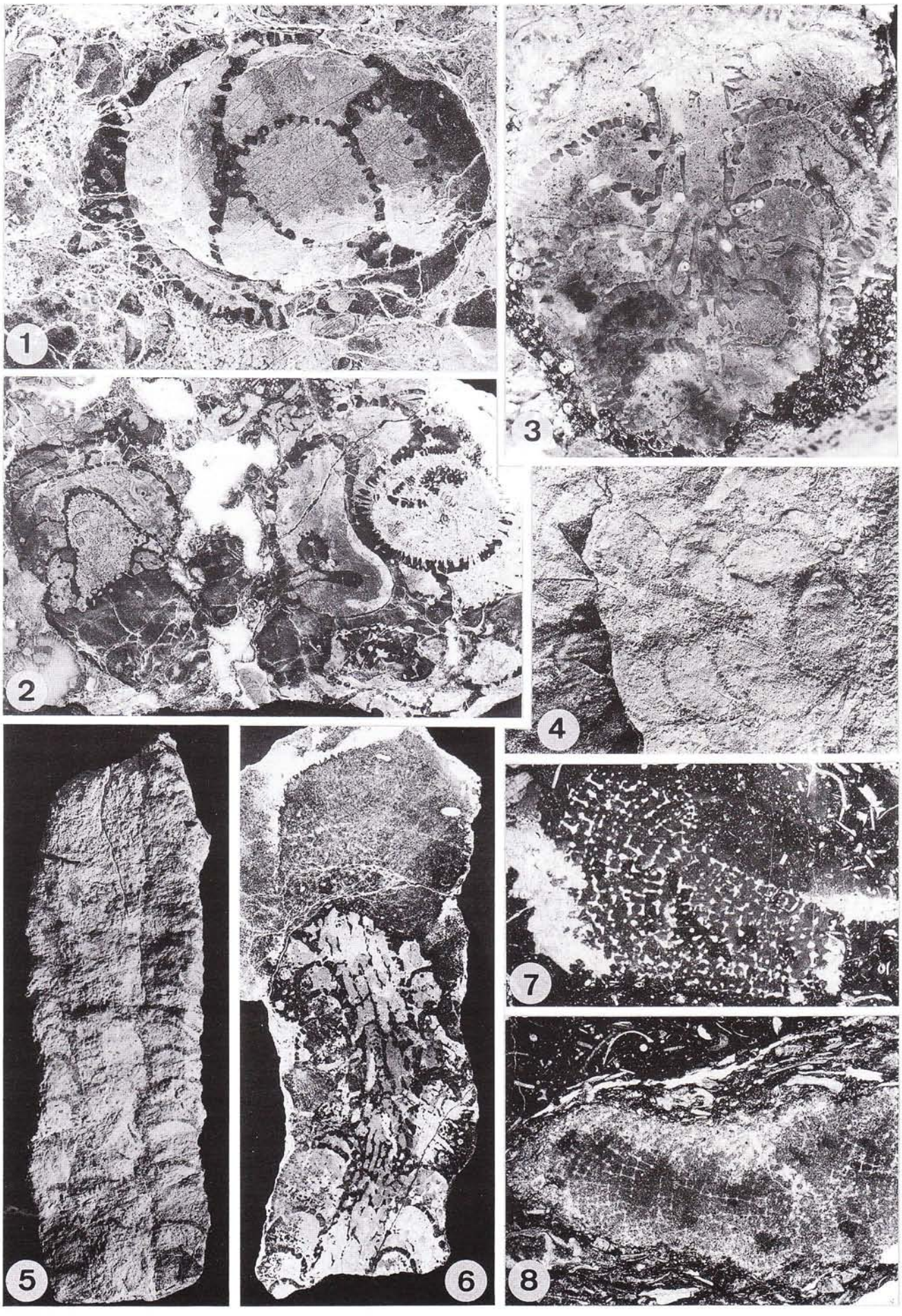
PLATE 1

Fig. 1-2, 4-5 - *Amblysiphonella* cf. *A. steinmanni* (Haas). Fig. 1) Oblique transverse section through three chambers and the spongocoel. Polished slab. 4X. Fig. 2) Oblique sections through two specimens. Polished slab. 1.8X. Fig. 4) Oblique longitudinal section through a specimen on natural weathered rock surface. 4X. Fig. 5) Longitudinal section through a specimen on natural weathered rock surface. 1.8X.

Fig. 3 - *Amblysiphonella* cf. *A. tubifera* Senowbari-Daryan. Longitudinal section showing the crescent-like chambers, spongocoel, and the large pores that extend as tubes into the chambers. Polished slab. 2.2X.

Fig. 6 - *Nevadathalamia waliabadensis* n. sp.. Longitudinal section showing the ring chambers arranged around an axial spongocoel composed of a bundle of tubes. The chambers contain some granular to tubular filling structures. Polished slab. X1.8.

Fig. 7-8 - *Hexactinellid sponge* gen. et sp. indet. Fig. 7) Section through the spicular lattice of a hexactinellid sponge, because of diagenesis the spicular skeleton appears thicker. X8. Fig. 8) Like fig. 7. X8.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mm in diameter. The number of tubes can not be accurately determined, but there appear to be as many as 10.

The paratype is smaller than the holotype with a length of 42 mm and a diameter of 20 mm. It is composed of 9 ring chambers in a catenulate arrangment around an axial spongocoel composed of a bundle of tubes. Individual chambers are between 3 mm and 11 mm high. Chambers are filled with a granular-tubular structure. The chamber walls, 0.5-1 mm thick, are pierced by numerous pores 0.4 mm in diameter. A bundle of tubes 1.2-1.5 mm in diameter form the axial spongocoel that is 6 mm in diameter, which passes through the whole sponge. These tubes extend, like in holotype, partly as tubular structures into the chamber interiors. The tube walls are thinner than the chamber walls and are pierced by numerous pores of different sizes.

Discussion. *Nevadathalamia* is an abundant Norian-Rhaetian thalamid sponge in the North American continent (Nevada: Seilacher, 1962; Kristan-Tollmann & Tollmann, 1983; Senowbari-Daryan & Stanley, 1992; Yukon/Canada: Senowbari-Daryan & Reid, 1986; Sonora/Mexico: Senowbari-Daryan in: Stanley et al., 1994) and also occurs less abundantly in the Alps (Wurm, 1982; Senowbari-Daryan, 1990). *Nevadathalamia* occurs also in reefs in the Nayband Formation at other localities in central Iran.

Because of internal tubular filling structure our sponge should be classified within genus *Nevadathalamia*. The Iranian species differs from other known species of this genus by its axial bundle of tubes.

Rauff (1938) described a thalamid sponge as *Polytholosia complicata* from the Norian of Peru that is also characterized by a bundle of axial tubes. However, the Iranian species differs from the Peruvian one by the structure of its internal filling and by lacking radial oriented tubes within the segment walls as seen in *P. complicata*.

Family Colospongiidae Senowbari-Daryan, 1990

Subfamily Corymbospongiinae Senowbari-Daryan, 1990

Genus *Neoguadalupia* Zhang, 1987

Type species: *Neoguadalupia elegana* Zhang, 1987 (Permian)

Further species: *N. explanata* Rigby, Fan and Zhang, 1989 (Permian)

N. incrustans Boiko (in Boiko et al. 1991) (Norian)

N.? norica Senowbari-Daryan & Stanley, 1992 (Norian)

N. oregonensis Senowbari-Daryan & Stanley, 1998 (see discussion!)

Remarks. *Neoguadalupia* was first described by Zhang (1987) from the Middle Permian reefs of the Maokou Formation in Yunnan, South China. Later, four species of *Neoguadalupia* (see above) were described from Permian and from Upper Triassic (Norian) deposits.

Neoguadalupia elegana, the type species of the genus, is characterized by a tabular body composed of numerous spherical to subspherical chambers of the same size, arranged regularly in one layer, one above the other. The chamber walls are pierced by strong, regularly uniform, pores of equal diameters. Also, the Permian species *Neoguadalupia explanata*, like *N. elegana*, has chambers of equal size that are regularly arranged, but the perforation pattern of the chamber walls is totally different from that in *N. elegana*. The pattern of perforation of the chamber walls in *N. explanata* is more similar to sponges described as *Imbricatocoelia* by Rigby et al. (1989).

Norian thalamid sponges, described as *Neoguadalupia* (see above), have the chambers arranged one above the other in one layer (see Senowbari-Daryan & Stanley, 1992: fig. 9/3), in common with Permian species of *Neoguadalupia*. However, the irregular shape of the chambers and, especially, the perforation pattern of the chamber walls is different in Norian species described as *Neoguadalupia*. The affiliation of Permian *Neoguadalupia* and Triassic species of *Neoguadalupia* in the same genus is doubtful.

Neoguadalupia incrustans Boiko in: Boiko et al., 1991

(Pl. 2, fig. 1-2; Pl. 3, fig. 1, 3-6; Pl. 4)

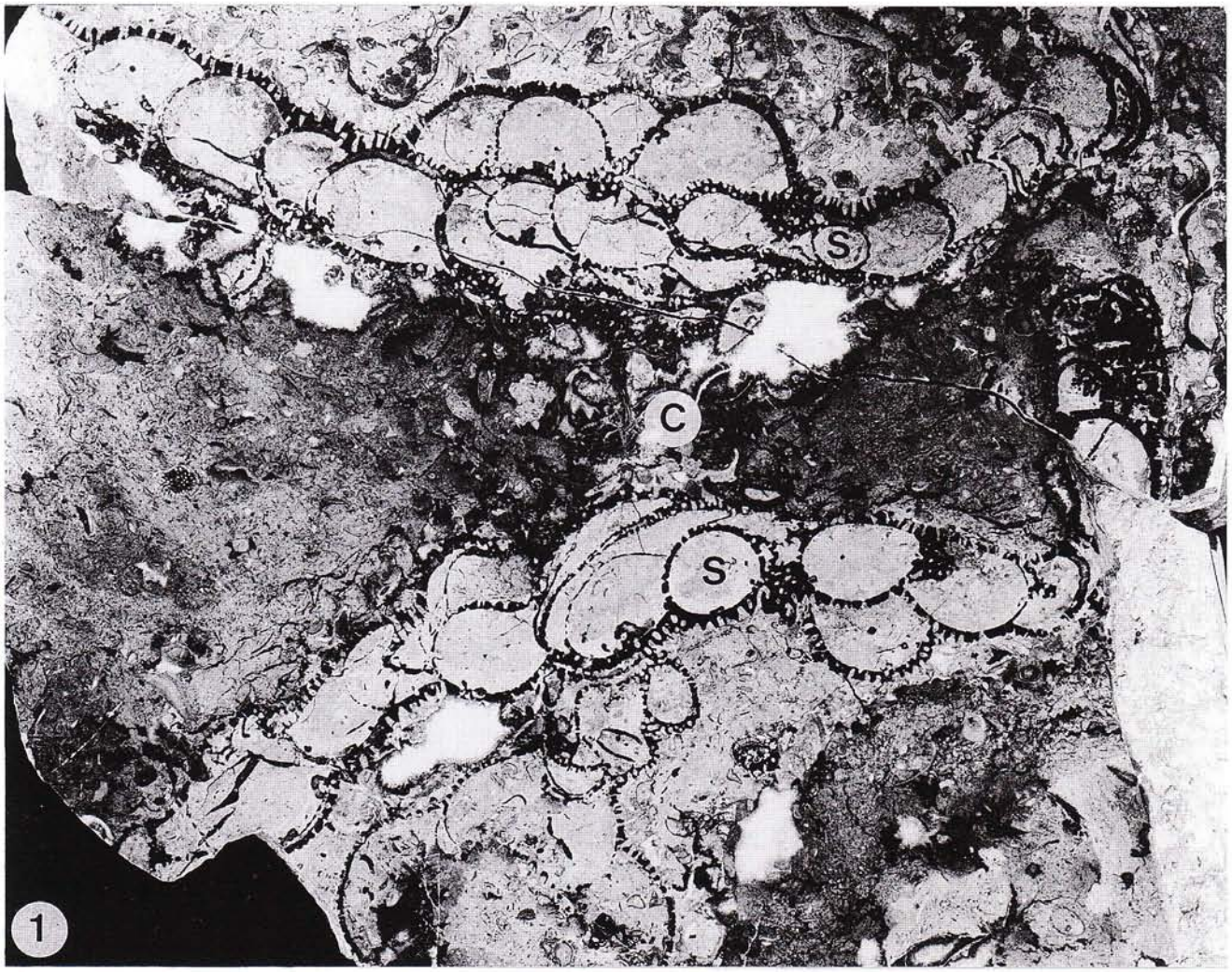
1991, *Neoguadalupia incrustans* - Boiko (in: Boiko et al.), p. 163, pl. 60, fig. 2-9.

Neoguadalupia? norica - Senowbari-Daryan & Stanley, p. 190-192, fig. 8.4-8.5

Collection: Numerous specimens from this locality and from other localities of the Nayband Formation in the Abadeh area.

PLATE 2

Fig. 1-2 - *Neoguadalupia incrustans* Boiko. Fig. 1) Section parallel to Fig. 2 (separation of 2 sections: 4 cm) showing the wide cavity, sprouts or layers (recognisable by the convex side or chambers) of an other sponge plate on the surface of the one-layered chambered sponge plate. Chambers in the lower part seems to surround a cavity (C) (spongocoel?). The growth of the sponge seems to extend from the spherical chambers (S) in both direction, recognizable by the convex wall of the chambers. Exowalls are thick and pierced by pores of equal size, but interwalls are thin and pierced by pores of different sizes. The older(?) chambers (right in picture) contains some filling structure of *Nevadathalamia*-type (tubular-type?). Polished slab. Approximately natural size. Fig. 2) Section parallel to Fig. 1 (distance between 2 sections: 4 cm) showing the glomerate chambers (right in picture), a cavity between the chamber chain (left) and the perforation of the exowalls (in center part of the picture). The endowalls are distinctly thin and not equal perforated. A) Specimen of *Stylothalamia columnaris* (Le Maitre). Polished slab. Natural size.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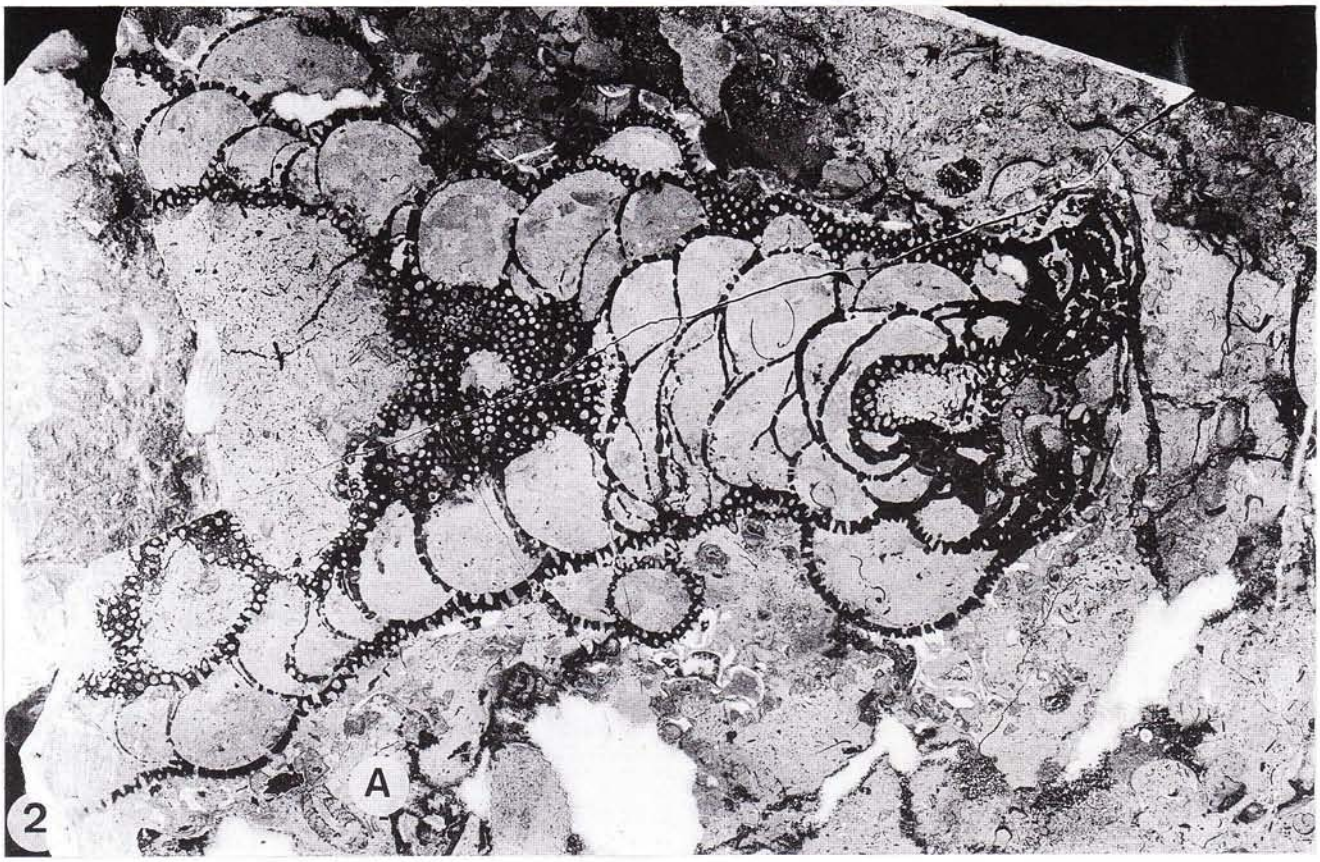
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Description. This flattened tabular sponge reachs gigantic dimensions. The total dimensions of the sponge are unknown because all specimens are fragments, but they reach a height (growth direction) of more than 200 mm and a width (perpendicular to growth direction) of more than 180 mm. Dimensions of the plates in small specimens are only about 40 mm.

The sponge is composed of numerous chambers stacked one above the other in a single series. Thickness of the plates corresponds to the widths of the chambers, usually 7-15 mm. The chambers are arranged in one layer, but younger chambers may overlap older chambers only on one side and on this side segmentation is not well defined. The chambers are shaped like loaves of bread, appearing subspherical in sections parallel or perpendicular to the plates. In most specimens they usually are 10 mm high, but reach a maximum of 20 mm, with a width of up to 17 mm in one direction (the thickness of the whole sponge plate) and up to 40 mm in the other direction, respectively. Chamber heights in the smallest specimens range between 3 and 7 mm, and the chamber width (corresponding to the thickness of the plates) is 6-7 mm. Exowalls of the chambers are thicker than the endowalls. Exowalls are usually 1 mm thick, but reach a thickness of up to 2 mm; endowalls are usually 0.5 mm but range up to maximum of 1 mm in thickness. The walls are pierced by numerous pores 0.2-1 mm in diameter. Pores in the exowall are equally distributed but pores have unequal distributions in the endowalls. Some filling of granular or tubular(?) structure may be developed within the older chambers (Pl. 2, fig. 1-2, Pl. 3, fig. 2). Chamber interiors lack vesiculae.

Some features of the specimen documented in Pl. 2, fig. 1-2, Pl. 3, fig. 3-6, deviate from all other investigated specimens and it is described here separately. This sponge is attached to a multibranched(?) specimen or to three individual specimens of *Stylothalamia columnaris* (Pl. 3, fig. 3). After formation of some glomerate chambers the sponge developed a cavity (spongocoel?). The diameter of that cavity, as well as of the sponge increased rapidly, reaching a diameter of 135 mm with a cavity 90 mm in diameter in the upper part. The summit of sponge is not preserved and therefore the youngest part is unknown. The chambers are not strongly arranged in one layer. Some sprouts (recognizable by the convex direction of the chamber roofs) or colonization of other specimens on the surface of sponge caused the two- or three- layered chambers of the plate (Pl. 2, fig. 1-2, Pl. 3, fig. 4, 6). This characteristic is not seen in other investigated specimens of the species, whose chambers are arranged more or less in one layer. In addition, interwalls of this specimen are thinner than the exowalls (Pl. 2, fig. 1-2; Pl. 3, fig. 2, 4, 6).

Discussion. As mentioned before, the affinity of Norian-Rhaetian thalamid sponges described as *Neoguadalupia* to this genus, which was described first from the Permian, is uncertain. *Neoguadalupia incrustans* described first by Boiko (in Boiko et al., 1991) from the Norian of the Pamir Range seems to include some smaller specimens, with plates 3-5 mm thick and chamber heights of only 2-6 mm. Thalamid sponges described as *Neoguadalupia? norica* by Senowbari-Daryan & Stanley (1992) from the Norian of Nevada are larger than the specimen from Pamir, but dimensions of both specimens are included in the range of variation in our Iranian specimens. We think *Neoguadalupia incrustans* Boiko and *Neoguadalupia? norica* Senowbari-Daryan are synonyms. The dimensions of *N. incrustans* is variable and the range of variation in our Iranian specimens should be taken in consideration as characteristic of this sponge species.

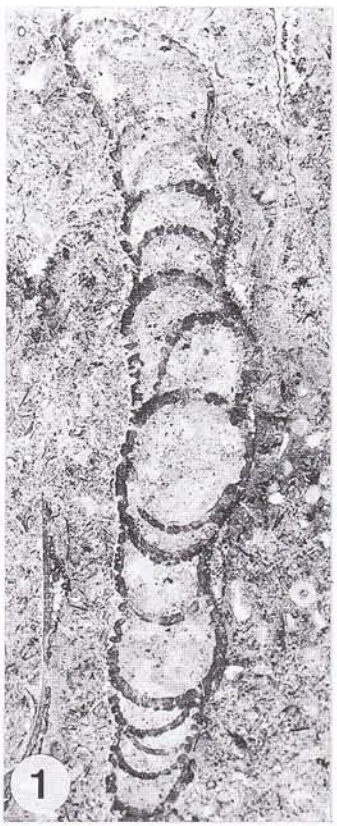
Recently Senowbari-Daryan & Stanley (1998) have described a new species as *N. oregonensis* from the Upper Triassic Martin Bridge Formation of northeastern Oregon. Additional collection from the same locality and further investigations have shown that the "segments" of this pseudofossil represent the nest-building activities of living bees (Stanley & Senowbari-Daryan, submitted).

Occurrence. *Neoguadalupia incrustans* Boiko is a relatively abundant thalamid sponge, both in the locality near the town of Wali-Abad, and in bioconstructions

PLATE 3

Fig. 1, 3-6 - *Neoguadalupia incrustans* Boiko. Fig. 1): Longitudinal section (section perpendicular to the plate) showing the globular initial chamber and the later chambers that are arranged on both sides of the initial chamber (the convex sides of the chambers are directed in the growth direction of the sponge). Some young chambers overlap the preceding chambers only in one side where the sponge segmentation is poorly visible. Polished slab. X2.6. Fig. 3) Section parallel to fig. 2 in pl. 2, at a distance of 1 cm, showing the initial part of sponge attached on three specimens(?) or a branched specimen of *Stylothalmia columnaris* (Le Maitre). The interior of the older chambers contain some filling structures. Interwalls of the chambers are thinner than the exowalls. Polished slab. X1.3. Fig. 4) Transverse section through the half sponge revealing the internal cavity (lower part), the thin interwalls, and the thick uniformly perforated exowals. X1. Fig. 5) Marginal transverse section showing the thick and well perforated exowalls and thin interwalls. Polished slab. X1. Fig. 6) Longitudinal section parallel to fig. 1 in pl. 2 showing the central cavity and chambers that have grown from the initial chamber on both sides (convex sides of chambers are oriented in the growth direction of sponge). The endowalls are thinner than the exowalls. Polished slab. X0.6.

Fig. 2 - General view of matrix around the sponge. A) bryozoan?, B) echinoderms, C) ostracode, D) nodosariid foraminifer, with some sponge spicules. Thin section W13/1. X20.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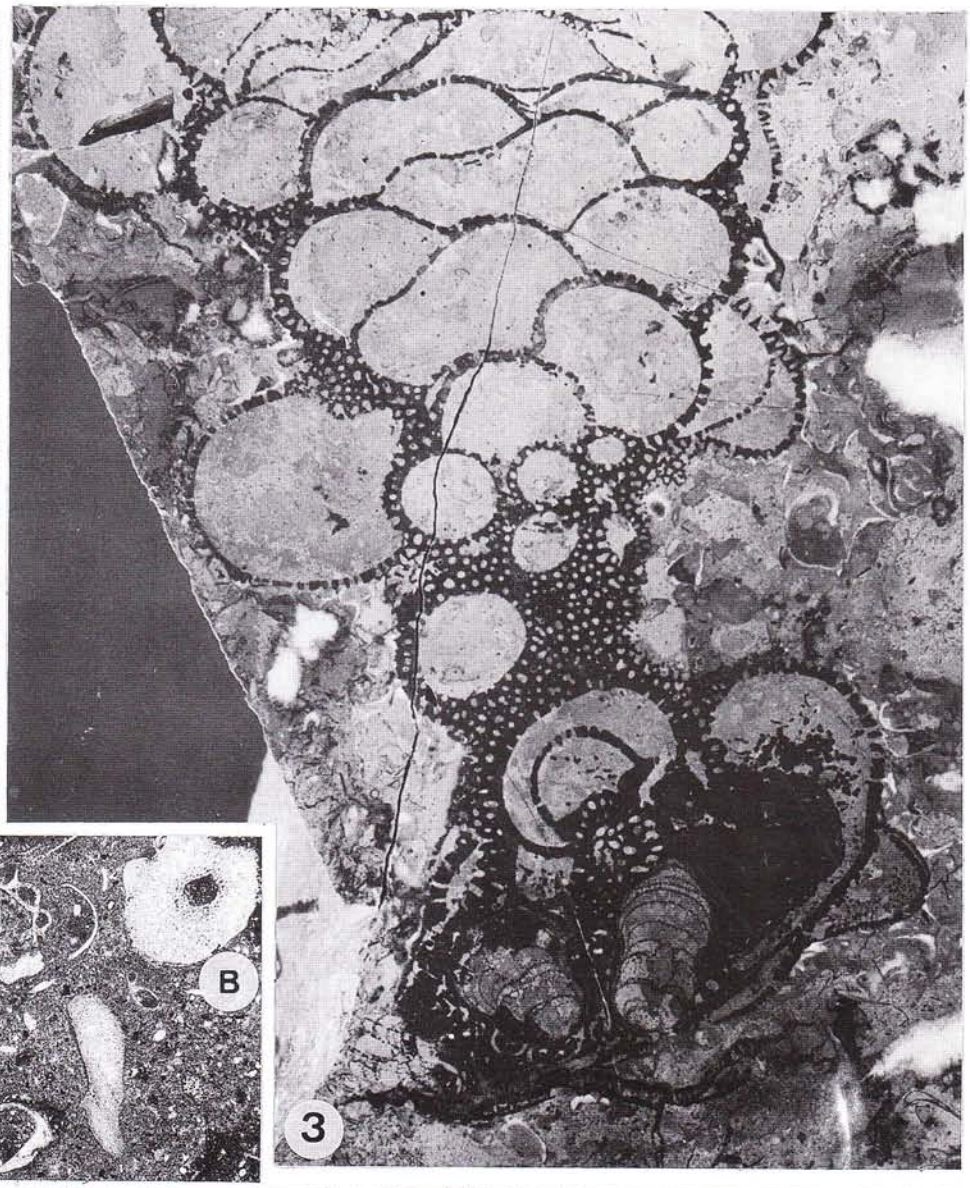
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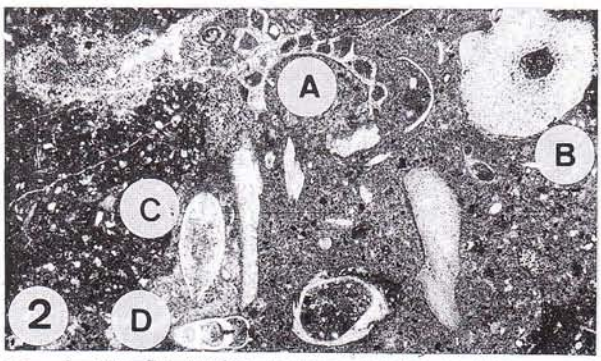
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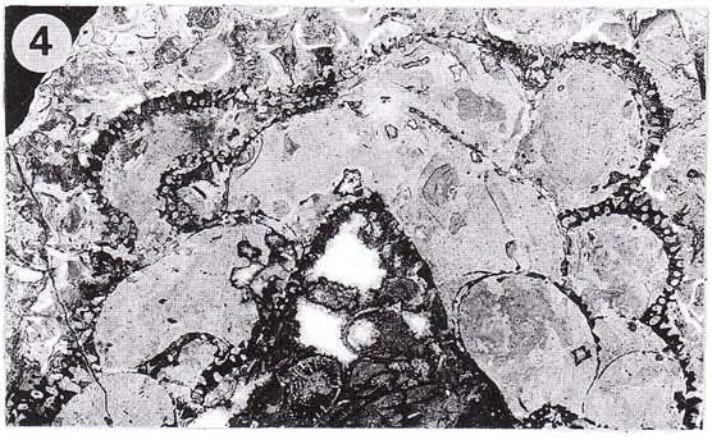
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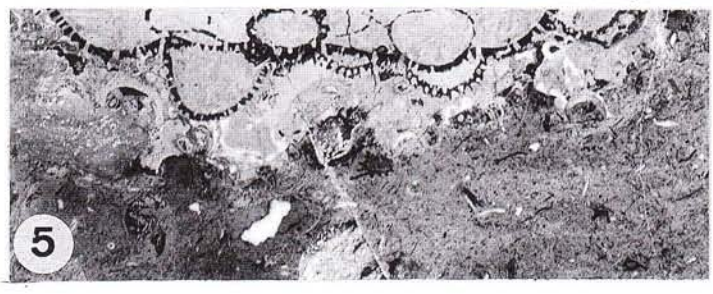
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within the Nayband Formation at other localities (e.g. in Khaneh-Khore reef in Abadeh area, reefs near the town of Marawand, NE of Esfahan). *N. incrustans* is a very abundant sponge in reefs located approximately 6.5 km west of the small town of Ali-Abad (N of Kuhe-Nayband, Tabas area). We found this sponge also in the Bulbullo section, south of Kerman, (see Huckriede at al., 1962).

N. incrustans was known previously from Nevada and the Pamir and is now known from Iran. No reports of this sponge are known from the western region of the Tethys. The age of all localities of *N. incrustans* is Norian-Rhaetian.

Family Stylothalamiidae Ott, 1967

Genus *Stylothalamia* Ott, 1967

Type species: *Stylothalamia dehmi* Ott, 1967.

Further species: All sponge species described in the literature as *Stylothalamia* up to 1990 were listed by Senowbari-Daryan (1990). Since then the following sponge species have been described as *Stylothalamia:*

- *Stylothalamia otti* Boiko (in Boiko et al., 1991) (Norian)
- *Stylothalamia polysiphonata* Senowbari-Daryan, 1994b (Norian).
- *Stylothalamia eleganta* Rigby et al., 1994 (Permian).

Discussion. Ott (1967, p. 44) established the genus *Stylothalamia* with the following diagnosis: "Porate Sphinctozoan mit trabeculären Stützgewebe aus entfernt stehenden, schlanken, oft röhrig ausgebildeten Pfeilern. Stämmchen asiphonat oder retrosiphonat". An emended diagosis was given by Rigby et al. (1994, p. 57): "Porate, single, branched sphinctozoans; central tube retrosiphonate or absent; chambers with trabecular filling structure. Pillars slender, may appear reedlike, vesiculae may occur in chambers, as well as in central tube".

Although the second diagnosis is more informative, both are very similar and both have taken only the morphological features of sponges into consideration. However, as mentioned by Senowbari-Daryan (1990) stylothalamid sponges, described as *Stylothalamia* by different authors from the Permian, Triassic, Liassic, and Cretaceous deposits, have different skeletal mineralogies: *Stylothalamia* from Ladinian? and Carnian reefs are composed of Mg-calcite (most probably High-Mg-calcite), but the sponges described as *"Stylothalamia"* from the Permian (Senowbari-Daryan, 1990; Rigby et al., 1994), Norian, (Senowbari-Daryan 1990, 1994b; Boiko: in Boiko et al., 1991), Liassic (*St. columnaris* = *Stromatomorpha californica* Smith var. *columnaris:* Le Maitre, 1935; *Pelleria bonomii* = *St. columnaris* Radoicic, 1966; Hillebrandt, 1971; 1981; Pallini & Schiavinotto, 1981; Schiavinotto, 1984; Schroeder; 1984; Beccarelli Bauck, 1986; Broglio Loriga et al., 1991; Senowbari-Daryan & Stanley; 1994), and from Cretaceous (*Verticillites budensis* = *St. budensis* Wells, 1934; Schroeder & Willems, 1983) had a primary aragonitic rigid skeleton (in most cases as neormorphic calcite). Stylothalamid sponges from the Triassic and Liassic were revised by Schroeder (1984). The author synonymized both species (*St. dehmi* Ott from Ladinian?-Carnian) and *Stylothalamia columnaris* (= *Stromatomorpha californica* Smith, var. *columaris* Le Maitre). However, Schroeder did not taken the skeletal mineralogy into consideration, which seems to be different in the two species. A carefully revision of stylothalamid sponges is in preparation (Senowbari-Daryan, in preparation). Until this revision is completed, we follow the previous systematic arrangement as given by Senowbari-Daryan (1990).

Thalamid sponges of stylothalamid construction (thin walled sponge with a spongocoel and pillar structure within the chambers) are not limited to the Upper Paleozoic and Mesozoic. Stylothalamid sponges have been described also from the Cambrian (e.g. *Tabulacyathellus*, see Zhuravlev, 1989).

Stylothalamia columnaris (Le Maitre, 1935)

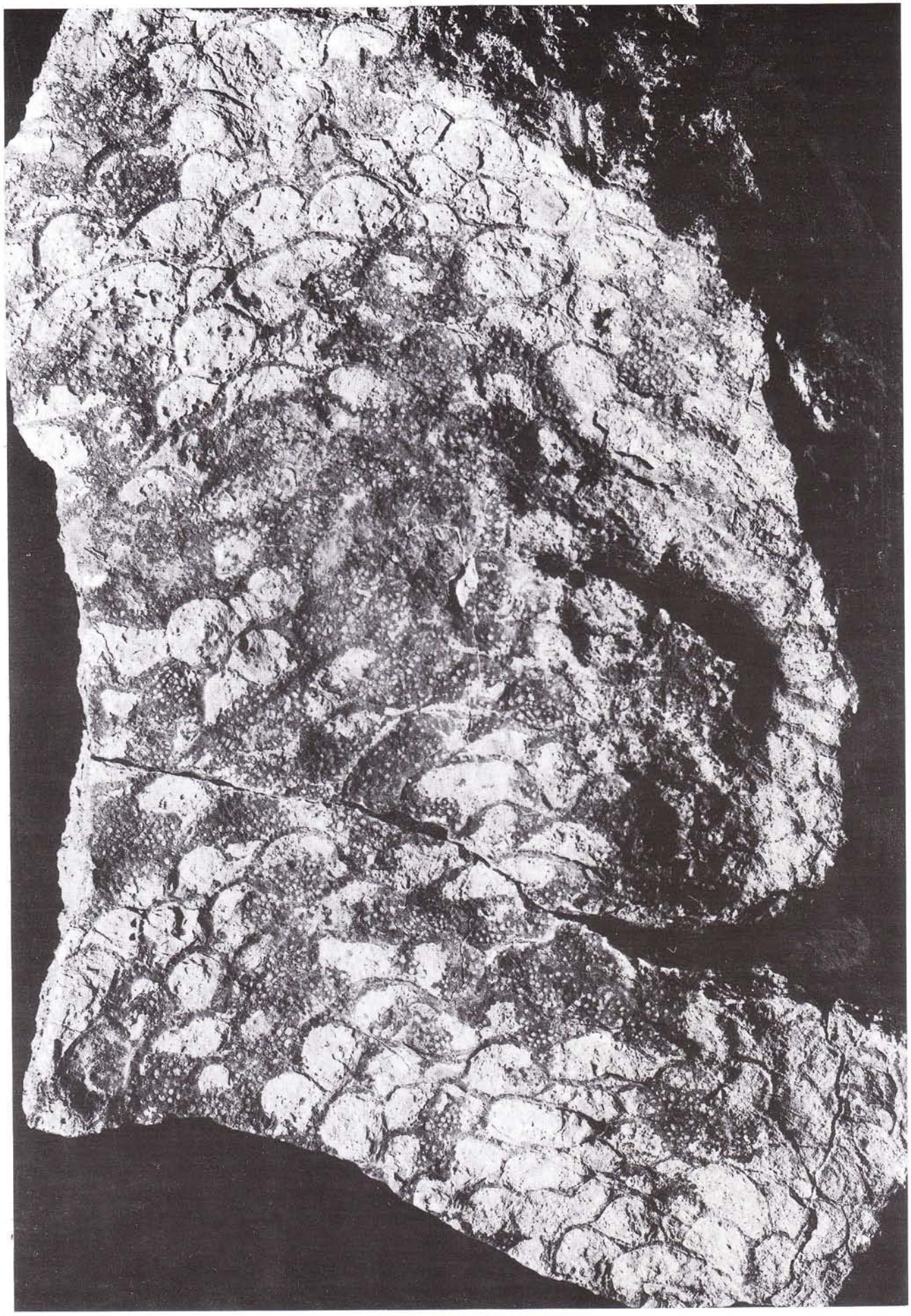
(Pl. 2, fig. 2/A; Pl. 3, fig. 3; Pl. 5, fig. 3? 4-5; Pl. 6, fig. 3)

Collection: 15 specimens in thin sections and on weathered rock surfaces.

Description. This slender, single or branched sponge is composed of numerous crescent-like ring chambers arranged catenulate around an axial spongocoel. Lengths of the sponges (at least 25 mm) can not be given exactly because the whole length is not seen in any of the specimens. Diameters of the sponges range between 5 and 9 mm. The largest specimens (single or branched?) served as a substrate for a specimen of *Neoguadalupia* (Pl. 3, fig. 3). The chambers are crescent-like, with the convex side toward the growth direction of the sponge. Chamber height varies insignificantly in the same specimen (see Tab. 1). Chamber interiors contain slender pillar structures that extend between the chamber roofs. The pillars are thinner in the middle part, becoming thicker in the direction of the rooves of the chamber. In cross section, the pillars are circular or oval. Occasionally,

PLATE 4

Neoguadalupia incrustans Boiko. Naturally weathered section, oriented parallel to the plate surface, showing the numerous chambers arranged one above the other. X1,5.



axial cavities of pillars, primary filled with organic material, were observed. Vesiculae do not occur either within chamber interiors or within the spongocoel.

Chamber walls, as well as the wall of the spongocoel are pierced by numerous circular or oval pores, that are the same size as the thickness of the wall between them (Pl. 5, fig. 4: upper part).

A relatively narrow axial spongocoel (diameter: 1.0-2.0 mm) of retrosiphonate type passes through the whole sponge (Pl. 5, fig. 5). The ratio of spongocoel diameter to the whole sponge diameter ranges between 14 and 22%.

The rigid skeleton of *St. columnaris* of Iran is composed of neomorphic calcite, like that of other Liassic sytlothalamid sponges; the primary skeleton was probably aragonite.

Discussion. A comparison of dimensions of specimens of the Iranian species with those of *St. columnaris* described from several localities in the world (see above) shows little difference in the sponge body and skeletal elements (see Schroeder, 1984; Beccarelli Bauck, 1986). Taking into consideration the range of variation and characteristics, the Iranian specimens are almost identical with features of *St. columnaris* (Le Maitre). Because of different skeletal mineralogy, a comparison of this species with Ladinian?-Carnian species, *St. dehmi* Ott, is out of the question.

D	d	d/D %	CH	TW	DPI	DPW
7	1.5	21.4	1.0-1.6	0.10-0.24	0.06-0.12	0.08-0.12
8	1.5	18.7	--	0.12-0.28	0.0.6-0.16	0.10-0.14
6	1.2	20.0	1.0-1.2	0.12-0.40	0.10-0.16	0.10-0.16
7	1.0	14.3	--	0.16-0.30	0.10-0.14	0.12-0.16
5	1.0	20.0	0.8-1.0	0.16-0.24	0.12-0.14	0.10-0.14
7.5	1.2	17.1	1.0-1.5	0.14-0.26	0.10-0.14	0.14-0.18
7	1.5	21.4	--	0.10-0.30	0.10-0.14	0.12-0.20
9	2.0	22.2	1.2-2,0	--	--	--

Tab. 1 - Measurements of *St. columnaris* from Hambast-Mts near Wali-Abad, Central Iran. D: diameter of sponge, d: diameter of spongocoel, d/D: ratio of spongocoel diameter/sponge diameter in percent, CH: chamber height, TW: thickness of the chamber walls, DPI: diameter of pillars, DPW: diameter of pores of the chamber walls and of the spongocoel wall (all data in mm).

Occurrence. *Stylothalamia columnaris* (Le Maitre) has been reported from numerous localities in the world (Peru: Hillebrandt, 1971; 1981; Senowbari-Daryan & Stanley, 1994; Morocco: Le Maitre, 1935; 1937; Schroeder, 1984; former Jugoslavia: Radoicic, 1966, Appennines: Pallini & Schiavinotto, 1981; Schiavinotto 1984, Southern Alps: Beccarelli Bauck, 1986; Broglio Loriga et al., 1991). The age of all these localities of *St. columnaris* is Liassic. The age of the Iranian *Stylothalamia*-bearing bed is discussed after the systematic description.

Stylothalamia hambastensis n. sp.

(Pl. 5, fig. 1-2; Pl. 6, fig. 4-5)

Collection: Four specimens. Two in thin section, two on natural weathered rock surfaces.

Derivation of name: From Hambast-Mountain, where the sponge was found.

Holotype: Pl. 6, fig. 4-5. From the holotype two parallel thin sections were made and the rest remains in the rock (1 piece).

Paratypes: Both specimens figured in Pl. 5, fig. 1-2.

Locus typicus: Locality near the town of Wali-Abad, south of Abadeh, Central Iran.

Stratum typicum: Upper Triassic, Rhaetian?

Diagnosis: Porate, cylindrical to conical, single thalamid sponge with several crescent-like low chambers; chamber interiors filled with pillar-like structures; outer segmentation indistinct; retrosiphonate central tube; vesiculae absent; primary skeletal mineralogy probably aragonite.

Description. This single, cylindrical to conical and unbranched species is composed of numerous crescent-like ring chambers arranged around a retrosiphonate spongocoel. The diameter of the sponge ranges between 24 and 30 mm (holotype), three time larger than that in *St. columnaris*, described above. A relatively wide spongocoel of 7-10 mm in diameter passes through the whole sponge. The ratio of spongocoel diameter/sponge diameter varies between 28 and 33%, distinctly larger than in *St. columnaris* (14-22%).

Chamber heights range between 2.5 mm and 5 mm. Pillar structures characterize the interior of the chambers. They are circular or oval in outline, having diameters of 0.16-0.24 mm. Chamber walls, as well as the wall of the spongocoel, are pierced by pores 0.2-0.6 mm in diameter having circular to oval outlines. Thicknesses of the chamber walls range between 0.2 mm and

PLATE 5

Fig. 1-2 - *Stylothalamia hambastensis* n. sp. Fig. 1) Oblique longitudinal section on natural weathered rock surface showing the ring chambers, spongocoel, clearly defined and equal perforated sponge walls, and the slender pillars within the chambers. X 2.2. Fig. 2) Marginal section through several chambers. X 2.

Fig. 3? 4-5 - *Stylothalamia columnaris* (Le Maitre). Fig. 3) Oblique transverse section through four chambers showing the pillars within the chambers and the perforated chamber walls. X5. Fig. 4) Longitudinal, obliqe and transverse sections through three specimens. X4. Fig. 5) Longitudinal section showing the crescent-like ring chambers, spongocoel and the pillar structure within the chambers. X 7.5.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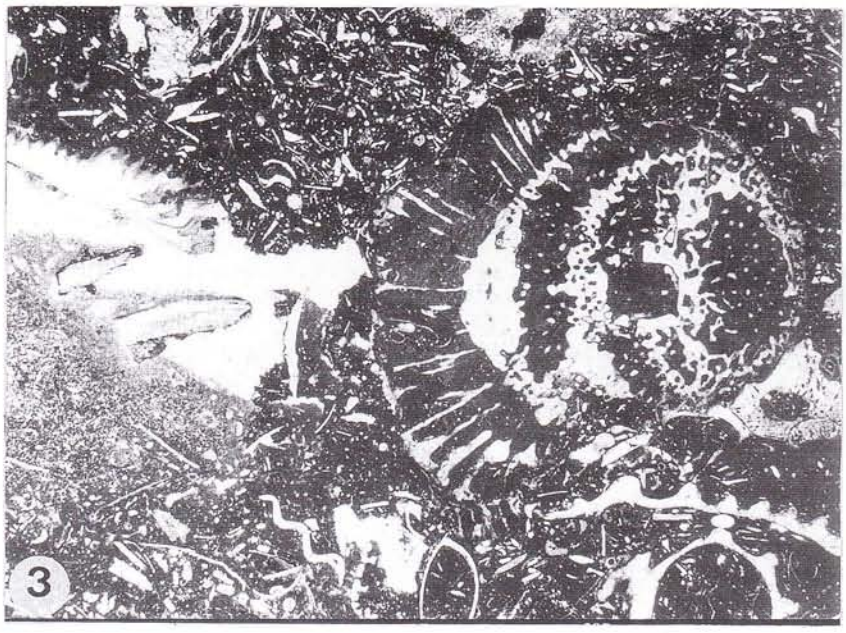
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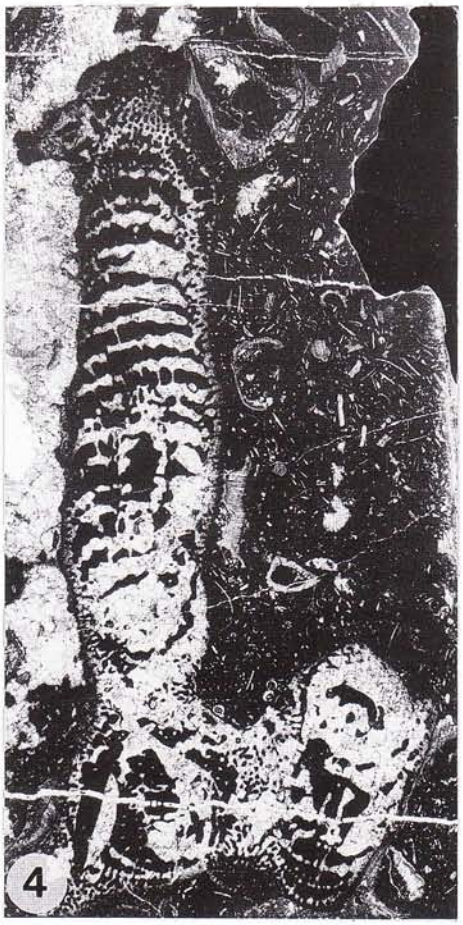
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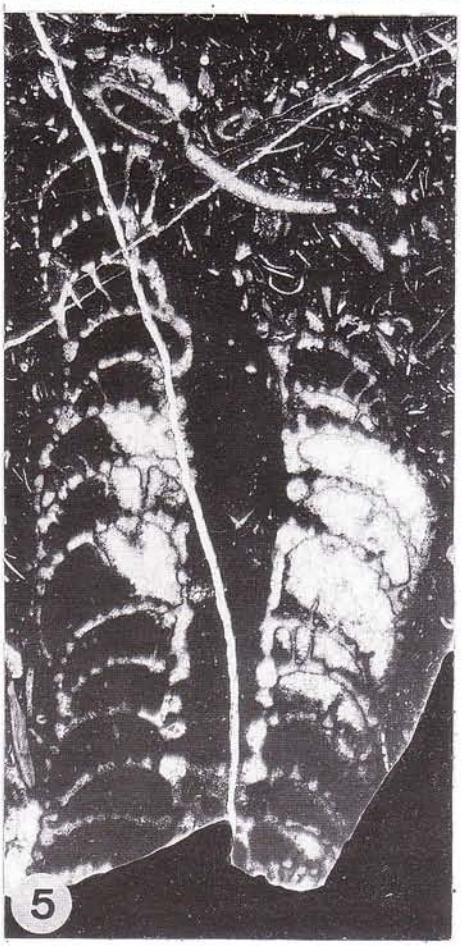
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0.7 mm. Vesiculae do not occur either in the chamber interiors or in the spongocoel.

The holotype was cut by chance in a rock specimen. Two parallel sections were made (Pl. 6, fig. 4-5). The holotype is conical in shape having a length of at least 33 mm, the top of the sponge is weathered away. The diameter of the sponge increase rapidly, reaching 32 mm in the upper part. At least two times in the younger part of sponge the younger chambers overlap three preceding chambers causing the disappearance of the older chambers in the exterior of the sponge. This characteristic was observed also in one paratype (Pl. 5, fig. 1). The diameter of the slender pillars in the interior of the chambers is 0.2 mm in the center reaching up to 0.4 mm near the chamber walls. The retrosiphonate axial spongocoel has a diameter of 10 mm in the upper part of the sponge.

Discussion. This species differs distinctly from *St. columnaris*, described above, by the large dimensions of the whole sponge skeleton and its skeletal elements. This species is differentiated from all other species described as *St. columnaris* from Morocco (Schroeder, 1984), *St.* cf. *columnaris* from Peru (Hillebrandt, 1971; Schroeder, 1884; Senowbari-Daryan, 1994a), *St.* cf. *columnaris* and *St.* cf. *budensis* from southern Alps (Beccarelli Bauck, 1986) and from the Cretaceous species, *St. budensis* (Wells, 1934) from Texas and Spain (Schroeder & Willems, 1983), by its large size, and in the height of chambers, which are 2-3 times higher than in all other species.

Hexactinellid sponges.

Different types of sponge spiculae are extremely abundant in micritic matrix (Pl. 1, fig. 1, 6). Fragments of hexactinellid, inozoid (Pl. 8, fig. 5) and chaetetid sponges also occur. Among the hexactinellid sponges both, segmented and non segmented types, occur (Pl. 1, fig. 7-8; Pl. 7, fig. 1-6).

Segmented hexactinellid sponges are known since Schmidel (1780) as *Spongia articulata*, and were placed to the genus *Casearia* by Quenstedt (1858). *Casearia articulata* is a relatively abundant sponge in Upper Jurassic of South Germany. Kolb (1910) has described another species as *Casearia depressa* also from the Upper Jurassic of Southern Germany. While Müller (1990) and Pisera (1997) plead *Casearia depressa* as a separate species, Mehl (1992) synonymied this species with *Casearia articulata* (Schmidel).

Segmented hexactinellid sponges are poorly known from Triassic reefs of western Tethys (Keupp et al., 1989). However, such sponges seems to be abundant in the eastern part of the Tethyan realm. Boiko (1990) has described the genera *Caucasocoelia*, *Pseudoverticillites*, and *Innaecoelia*, which are placed to the new family and new order Innaecolidae and Innaecoelida by her. From the Carnian of Sichuan/China the genus *Dracolychnos* is reported by Wu & Xiao (1989) and *Monilispongia* by Wu (1990). The genera *Innaecoelia* is synonymied with *Casearia* by Mehl (1992) and *Monilispongia* as well as *Innaecoelia* by Rigby et al. (1998). These systematic revisions are followed in this paper.

The systematic position of *Casearia* is controversial. Laubenfels (1955: err. *Caesaria*)) placed *Casearia* in the family Pleurostomatidae, which was followed by e. g. Müller (1974). Pisera (1997, p. 55) considered *Casearia* as Haxactinosa incertae sedis. Rigby et al. (1998) placed *Casearia*, with questionmark, in the family Craticulariidae. In this study the following species of thalamid types were recognized.

Genus *Casearia* Quenstedt, 1858

Synonyms: *Monilispongia* Wu, 1990
Innaecoelia Boiko, 1990

Type species: *Spongia articulata* Schmidel, 1780

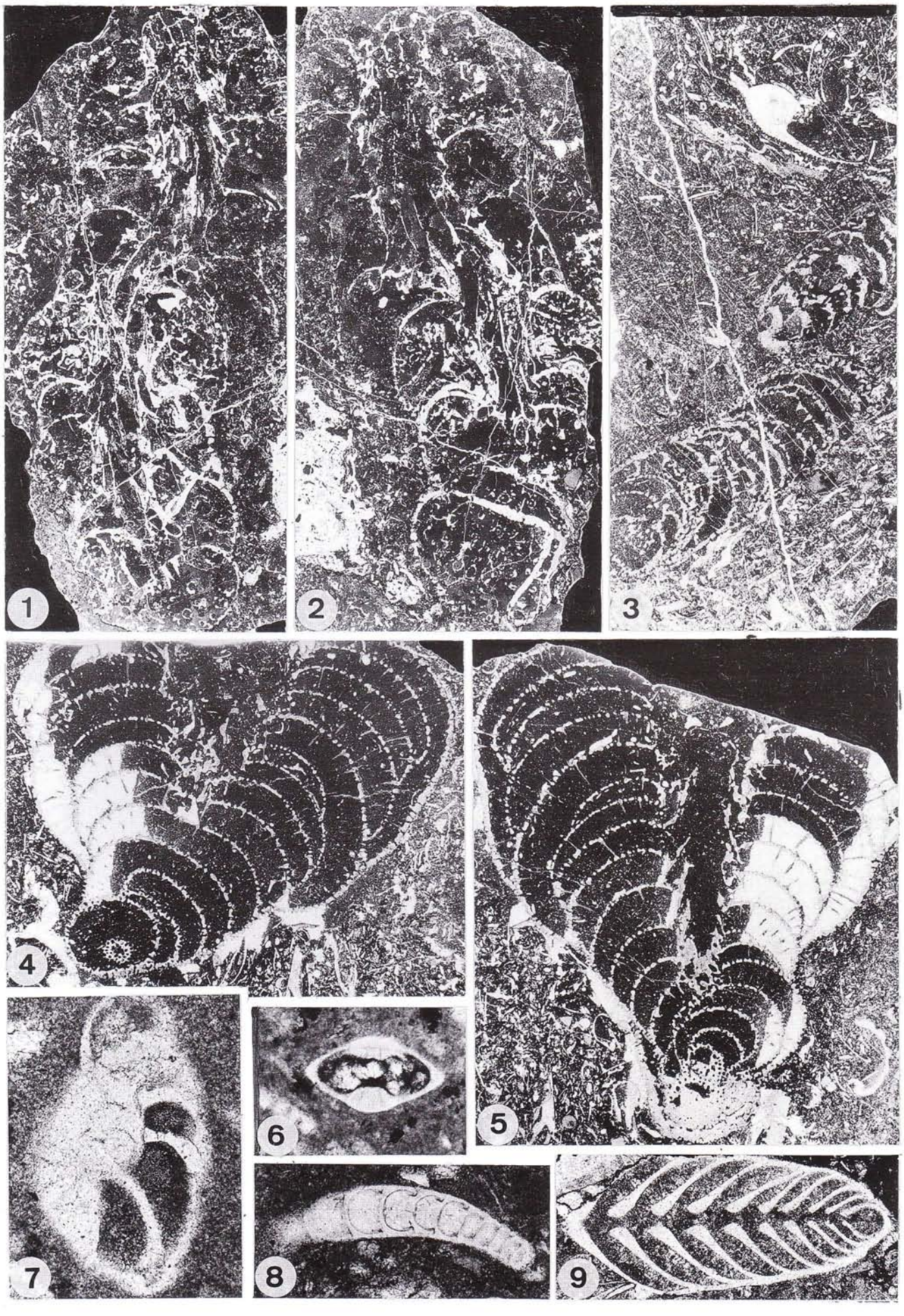
PLATE 6

Fig. 1-2 - *Nevadathalamia waliabadensis* n. sp. (Holotype). Fig. 1: Longitudinal section showing the axial bundle of tubes and the catenulate chambers with relatively thin chamber walls. The chamber interiors, especially the interior of the older chambers, are filled with a tubular structures. One chamber in the middle contains more filling structure indicating a break in growth. Exowalls of some chambers are broken away (compare Fig. 3).Thin section WA/H/1, X1,3. Fig. 2) Parallel section to fig. 1 showing the same characteristics as in fig. 1. Thin section WA/H/2, X1,3.

Fig. 3 - *Stylothalamia columnaris* Le Maitre. Oblique tranversal sections through two specimens imbedded in a bioclastic packstone with abundant fragments of brachiopod shells. Thin section WA5, X3,5.

Fig. 4-5 - *Stylothalamia hambastensis* n. sp. (Holotype). Fig. 4) Almost axial section parallel to fig. 5 revealing the crescent-like chambers arranged catenulate around a relatively wide axial spongocoel. Two times the young chambers overlap the preceding chambers. Easily recognized are the pillar structures within the chambers.Thin section WA/14/a, X2.5. Fig. 5) Longitudianal axial section parallel to fig. 5 showing the axial spongecoel extending the length of the whole sponge. At least three times the preceding chamber are overlapped by younger chambers causing the rapid increase of the sponge diameter. The sponge is imbedded in a bioclastic packstone with abundant fragments of brachiopod shells. Thin section WA/14/b, X2.5.

Fig. 6-9 - Typical nodosarid and lenticulinid (not determinated) foraminifeal assemblage associated with sponges, described in this paper. Fig. 6) Thin section WA/4, X100. Fig. 7) Thin section WA/3, X100. Fig. 8) Thin section WA/4, X65. Fig. 9) Thin section WA/3, X65.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Casearia articulata (Schmidel, 1780)

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

1780, *Spongia articulata* Schmidel, p. 19, pl. 4-5.
1858, *Casearia articulata* - Quenstedt, p. 680, pl. 82, fig. 9.
1974, *Casearia articulata* - Müller, p. 1-19, pl. 1-4.
1987, *Casearia articulata* - Ziegler, pl. 7, fig. 2.
1992, *Casearia articulata* - Mehl, p. 78, pl. 13, fig. 2 (cum syn.).
1997, *Casearia articulata* - Pisera, p. 55, pl. 11, fig. 3, pl. 35, fig. 6-9.
1998, *Casearia articulata* - Rigby, Wu & Fan, p. 134, pl. 5, fig. 5 (cum syn.).

Collection: Four specimens in two thin sections and a few fragments in other thin sections in our collection.

Description. The specimens of this cylindrical and internally well segmented sponge have a maximal length of 60 mm and a diameter between 20 mm and 23 mm. The sponge composed of numerous chambers of relatively constant height 3 mm. A retrosiphonate axial tube of 10 mm in diameter passes through the whole sponge (Pl. 7, fig. 1-2). The spongocoel is slightly wider in the upper part of the sponge.

Chamber walls as well as the wall of spongocoel are equal in thickness, measuring 0.3-0.4 mm. Chamber walls are pierced by numerous inhalant pores of 0.2-0.4 mm. Exhalant pores of the spongocoel wall are slightly larger having a diameter of 0.3-0.5 mm. The hexactinellid lattice is easily recognizable in the sponge walls. Numerous long rays, of up to 1 mm in length of the hexactines lattice extend from the chamber roof or chamber bottom into the chamber interior, but never into the interior of the spongocoel (Pl. 7, fig. 3-4).

Within the chambers of all specimens some spicules of hexactine type where observed, which probably belong to the sponge. In addition numerous small tubes with micritic walls (serpulids?) occur within the chambers.

Discussion. *Casearia articulata* (Schmidel), a typical sponge of the Upper Jurassic, was for a long time the only representative of segmented hexactinellid sponges. However, Boiko (in Boiko 1990), Wu & Xiao (1989) and Rigby et al. (1998) have described other segmented hexactinellid taxa including species of *Casearia* (Schmidel), *Innaecoelia* Boiko (= *Casearia*), *Caucasocoelia* Boiko, *Pseudoverticillites* Boiko, *Dracolychnos* Wu & Xiao, from the Upper Triassic deposits of Pamir range or Sichuan/China. Following Rigby et al. (1998), the Upper Triassic cylindrical and chambered hexactinellid sponge is included in the type species, *Casearia articulata* (Schmidel, 1780), based on its general morphology, but without a clear identification of the internal skeletal and canal pattern as documented by Müller (1974).

Occurrence. *Casearia. articulata* (Schmidel) seems to be a relatively abundant sponge within the Nayband Formation in the Abadeh area. We found this sponge also in the northern area of Esfahen, south of the town of Delijan (see Senowbari-Daryan, et al. 1997) together with other hexactinellid and coralline sponges. *Casearia articulata* was not found in the type locality of the Nayband Formation (Tabas area, NE Iran).

Casearia seems to be relatively abundant segmented hexactinellid sponge in the Upper Triassic in central and eastern Tethyan realm (Carnian/China: Wu, 1990; Wu & Xiao, 1989; Rigby et al., 1998; Pamir Range: Boiko, in Boiko et al., 1991, Iran: this paper). The occurrence of *Casearia* in the Triassic deposits in western Tethys, as reported from the Middle Triassic of Sondershausen/Germany by Freyberg (1928) and by Keupp et al. (1989) from Carnian Cassian Formation of southern Alps/Italy is uncertain (compare Pisera, 1997). Also, there is no record of *Casearia* from the Lower and Middle Jurassic.

Microfacies, organism association and paleoenvironment.

The sponges, described here, and other organisms from the locality near Wali-Abad occur in isolated boulders at the bottom of section. However, *Neoguadalupia*, *Stylothalamia*, and *Casearia* were found in place associated with *Oxycolpella* in the "Oxycolpos-limestone" beds (Kristan-Tollmann et al., 1979) (see Fig. 1) and crinoidal limestones. The carbonates are mainly a wackestone, although partly a packstone.

PLATE 7

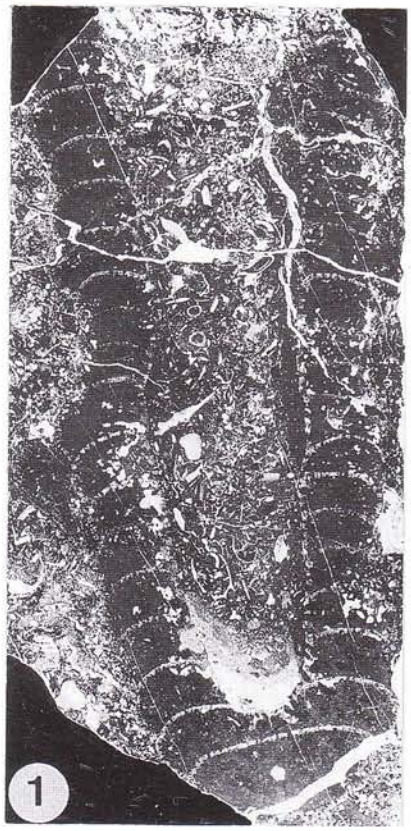
Fig. 1-4 - *Casearia articulata* (Schmidel). Fig. 1): Axial lontigudinal section through a specimen with numerous ring-like chambers. The chamber walls are thin and pierced by numerous pores. The relatively wide spongocoel is filled with matrix. Thin section WA30, X2. Fig. 2) Section similar to fig. 1. The specimen branches (right in picture) or a second specimen is growing on the first one. Thin section WA36, X2. Fig. 3) Magnification of the chamber wall of specimen in fig. 2 showing the hexactine latitude with some long rays extending into the chambers. Two pores of the chamber wall are cut. Thin section WA36, X40. Fig. 4) Similar to to fig. 3. Thin section WA36, X62.

Fig. 5 - Undeterminated segmented (left in picture) hexactinellid sponge similar to *Caucasocoelia* Boiko and nonsegmented hexactinellid with large inhalant canals (right in picture). The chamber interiors of the segmented haxactinellid is filled with spicules from the skeleton. Thin section WA3, X3.

Fig. 6 - Two species of undeterminated segmented hexactinellid sponges. WA/? X4.5.

Fig. 7 - *Amblysiphonella* cf. *Steinmanni* (Hass) on a natural weathered rock surface showing the relatively low chambers. X2.

Fig. 8 - *Amblysiphonella* cf. *tubifera* Senowbari-Daryan. Specimen on a natural weathered surface showing the chambers and the axial tube-bundle. X2,5.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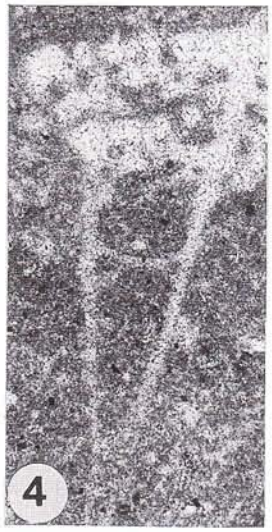
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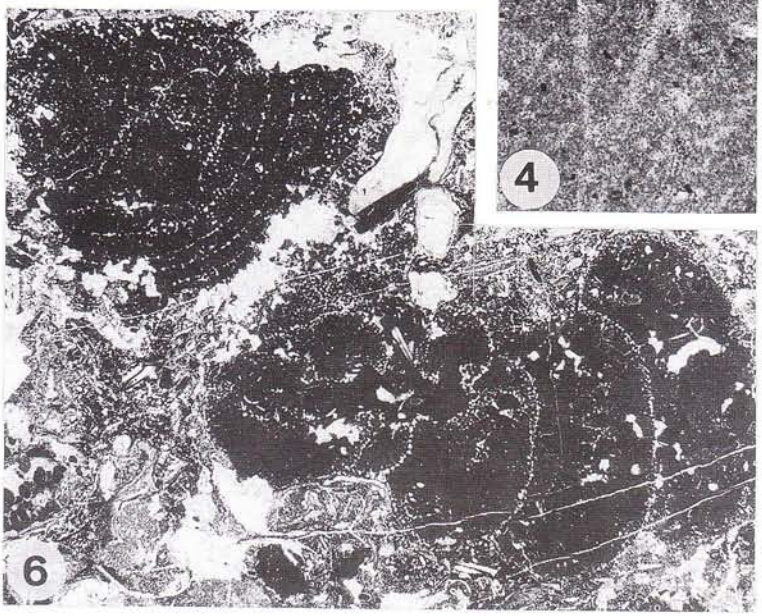
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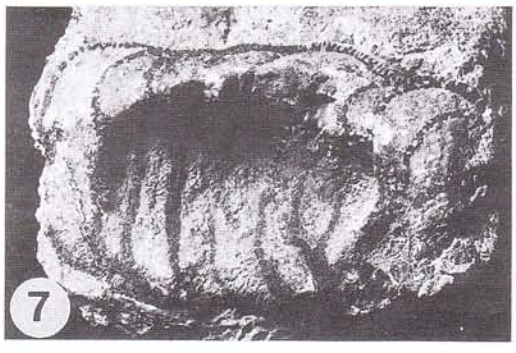
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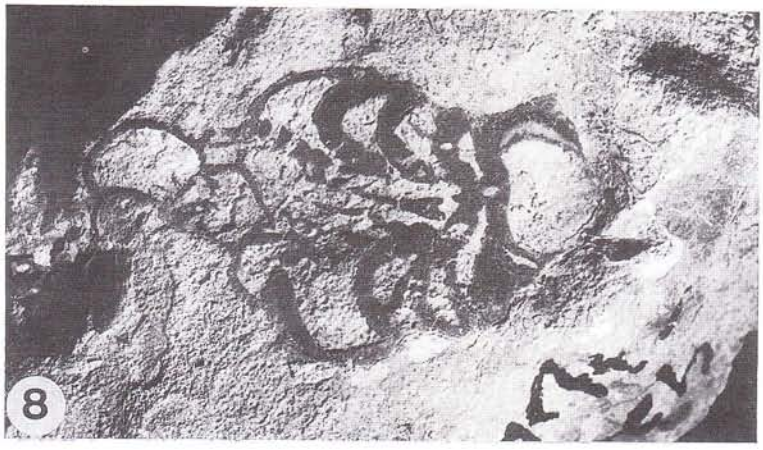
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In addition to thalamid sponges, a few fragments of inozoids (Pl. 8, fig. 5) and chaetetids and relatively abundant hexactinellids and extremely abundant sponge spicules and abundant brachiopod shell fragments were found in the micritic matrix. Presence of the following organisms was determinated in the field or from thin sections: solitary, dendroid and cerioid corals (not associated with sponges), bryozoans, some spongiomorphids, extremely abundant brachiopods as epifauna on sponges and corals or as fragments, abundant worm tubes and echinoderms (crinoids and echinoids), ostracodes, foraminifers (abundant lagenid and lenticulinid types: Pl. 3, fig. 2; Pl. 6, fig. 6-9; Pl. 8, fig 6, *Semininvoluta?* sp., *Trocholina* sp., *Bullopora?* sp., but never miliolid types) and algae (some solenoporacean and halimedacean types, Pl. 8, fig. 4). The problematic organism, *Radiomura cautica* Senowbari-Daryan & Schäfer (1979) also occurs. Brachiopods and worm tubes are the most important epifaunal elements on sponges or corals. The micritic crusts usually abundant in Triassic reefs were not found in the collection investigated here. Activities of boring organisms are documented in corals and spongiomorphids, but rarely in sponges.

The occurrence of hexactinellid spicules and parts of hexactinellid lattices in the micritic matrix, and the presence of small nodosariid and lenticulinid foraminifers, as well as the preservation of muddy matrix indicates a depositional environment below storm wave base. The most abundant brachiopod genus *Oxycolpella*, occurs in numerous localities in Tethys: Alps, Turkey, Himalaya, China, New Caledonia, New Zealand, Iran and Oman (Kristan-Tollmann, 1987; Senowbari-Daryan et al., submitted) and suggest a depth of about 100 m (*Oxycolpella*-biofacies: Golebiowski, 1991). *Oxycolpella* occurs also in crinoidal limestone in Oman (Senowbari-Daryan et al., submitted), similar to that in the Hambast-Mts., suggesting a water depth below 100 m or even more than 300 m according to Blendinger (1991). Similar recent brachiopods, like *Oxycolpella* live also in deeper water in warmer climate regions (Bitner, 1996).

Abundant brachiopod shell fragments (Pl. 6, fig. 3-6; Pl. 8, fig. 1) and fragments of algae suggest water currents in the depositional enviroment. Therefore the process of redeposition can not be excluded. The occurrence of algae suggests a depositional enviroment within the photic zone, but their fragmented occurrence indicate allochtonous deposition.

Discussion.

The sponge association, described in this paper from the Hambast-Mts. near the town of Wali-Abad (Abadeh region, S Esfahan), is composed of thalamid types including *Amblysiphonella*, *Nevadathalamia*, *Neoguadalupia*, *Stylothalamia*, the hexactinellid genus *Casearia*, and some indeterminable other hexactinellids, chaetetids, and inozoid types.

Amblysiphonella is an abundant sponge in Permian and Triassic shallow-water carbonates (see Senowbari-Daryan, 1990). With regard to Triassic occurrences, *Amblysiphonella* is known from the Ladinian to the Rhaetian. There are no reports of the occurrence of *Amblysiphonella* in Anisian or in Liassic deposits, respectively.

In the Hambast-Mts. *Amblysiphonella* is not an abundant sponge. It is represented by two species, differentiated by a single spongocoel or by a bundle of tubes as an axial spongocoel, respectively. *Amblysiphonella* occurs also in other localities of the Nayband Formation in central Iran.

Nevadathalamia is known from several localities on the Northern American continent (Nevada: Seilacher, 1962; Kristan-Tollmann & Tollmann, 1983; Senowbari-Daryan & Stanley, 1992; Yukon/Canada: Senowbari-Daryan & Reid, 1986; Sonora/Mexico: Senowbari-Daryan, in Stanley et al., 1994) and from Alps (Wurm, 1982; Senowbari-Daryan, 1990). The genus and the new species *N. waliabadensis* is reported here for the first time from Iran. *Neoguadalupia* also occurs in reefs within the Nayband Formation at other localities in central Iran.

Neoguadalupia was described first from the Permian of China (Zhang, 1987). Occurrence of this sponge from other Permian localities was unreported until now. With regard to the Triassic occurrences, *Neoguadalupia* or *Neoguadalupia*-type thalamid sponges are

PLATE 8

Fig. 1 - The sponge bearing limestone classified as a bioclastic packstone with abundant brachiopod shell fragments. In the center is a section of a punctate brachiopod shell. Thin section WA11, X5.

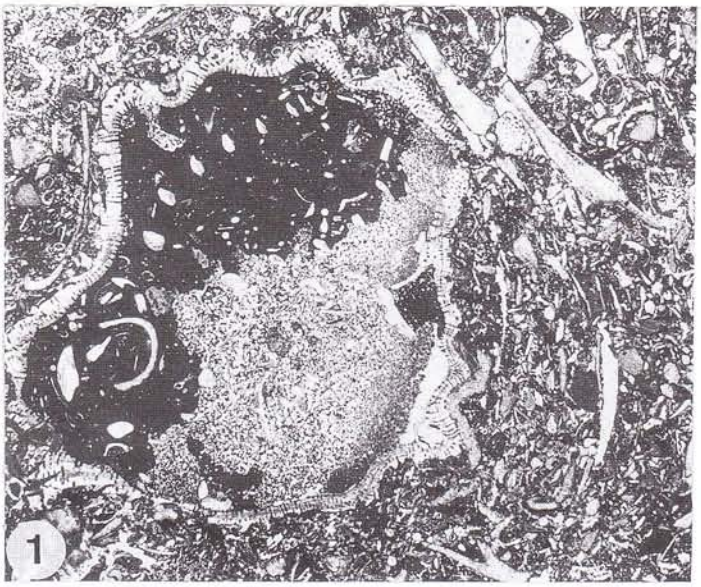
Fig. 2 - *Amblysiphonella* cf. *tubifera* Senowbari-Daryan. Oblique section through four or five chambers and the axial tube. Thin section WA2, X3.5.

Fig. 3 - Crinoidal limestone which overlies the *Oxycolpella*- and sponge-bearing beds in the section studied. Almost all components represent echinoderms embedded in a micritic matrix. Thin section A2, X4.

Fig. 4 - Udoteacean alga (Boueina sp.) are very abundant in ochre colored limestones (see Fig. 2). Thin section Tol, X2.5.

Fig. 5 - Half of a large inozoid sponge of the *Peronidella*-type. The upper left corner of the picture represents the spongocoel of the sponge. Thin section WA11, X4.

Fig. 6 - The sponge bearing limestones are developed as bioclastic packstone. In pictures are some nodosariid foraminiferes, sponge spicules, echinoderms, and a small gastropod. WA/?, X32.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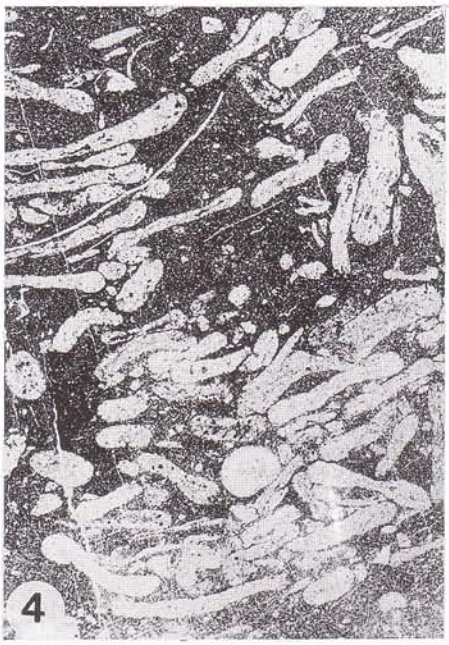
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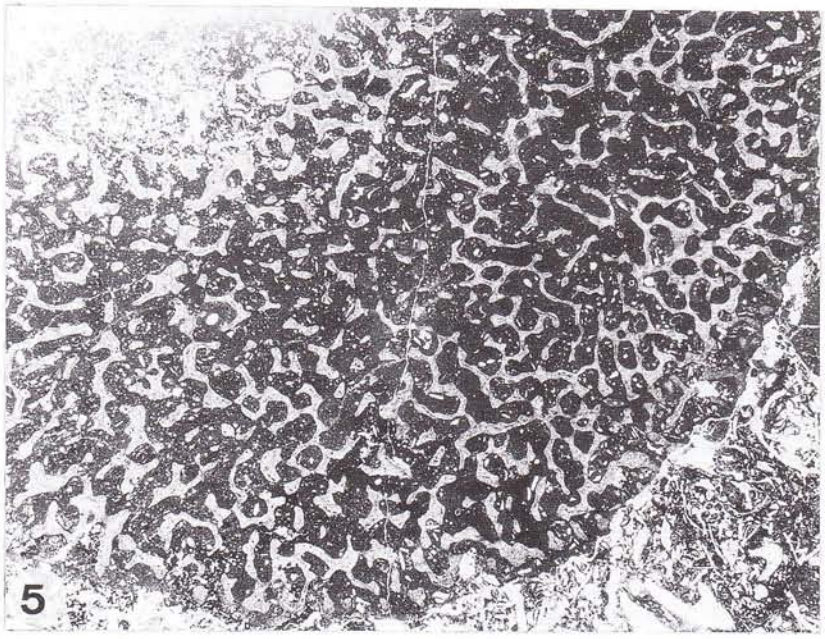
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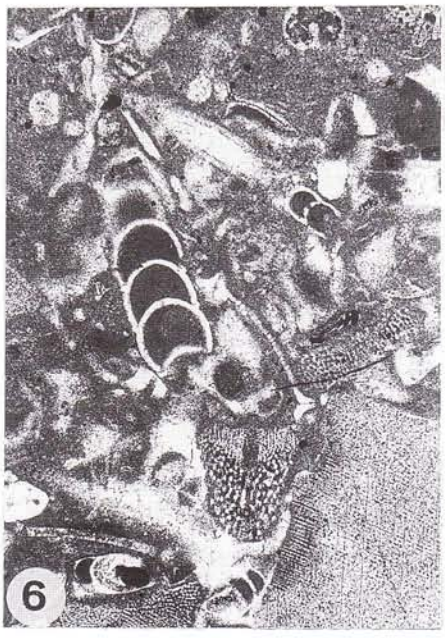
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known only from the Norian of USA (Nevada: Senowbari-Daryan & Stanley, 1992) and from the Pamir Range (Boiko, in Boiko et al., 1991). *Neoguadalupia incrustans* Boiko is the most abundant sponge in Norian-Rhaetian deposits in the Hambast-Mts.

Stylothalamia or stylothalamid sponges are known from Permian, Triassic, Liassic and Cretaceous shallow water carbonates. However, *Stylothalamia columnaris* (Le Maitre) is limited to Liassic deposits and there are no reports of its occurrence in the Norian-Rhaetian. We do not think *St. dehmi* Ott and *St. columnaris* represent the same species as thought by Schroeder (1984). *St. dehmi* is limited to the Ladinian?-Carnian and no reports of its occurrence in the Norian-Rhaetian are known.

The genus *Stylothalamia* and both species, *Stylothalamia columnaris* (Le Maitre) and the new species *Stylothalamia hambastensis*, are reported here for the first time from the Triassic of Iran. The genus seems to be limited to the Abadeh-area and has not been found in other localities of Nayband Formation in central Iran.

The hexactinellid thalamid sponge *Casearia* is not known from the Norian-Rhaetian deposits either in the western Tethys or on the American continent. The occurrence of *Casearia* in the Middle Triassic (Freyberg, 1928) and in the Carnian (Keupp et al., 1989) is uncertain. *Casearia* seems to be abundant in the central and western parts of the Tethys and is known from the Pamir Range (Boiko, 1990) as well as from China (Wu, 1990; Ribgy et al., 1998). The sponge association of our locality near the town of Wali-Abad holds an exceptional position, unknown from other localities in the world. Here, a thalamid sponge assemblage of Norian-Rhaetian and Liassic elements is associated. All three genera, *Amblysiphonella*, *Nevadathalamia*, *Neoguadalupia* and hexactinellids including *Casearia* occur in the bioconstructions within the Nayband Formation in other localities in Iran, but nowhere else does this association contain *Stylothalamia columnaris*, up to now reported only from Liassic deposits.

Not only is the sponge association different but the foraminiferal association is also different from other localities of the Nayband Foramation in central Iran. Further differences between exposures of the Nayband Formation in Iran also exists, as shown by the absence of *Heterastridium* and by the presence of halimedacean (udateacean) algae, found in this locality and in other localities in the Abadeh area (Senowbari-Daryan & Hamadani, in press). The occurrence of the brachiopod genus *Oxycolpella* and some ostracodes, reported by Kristan-Tollmann et al. (1979) are further differences between the organism association of the Nayband Formation in the Abadeh area when compared with other localities of the Nayband Formation in Central Iran. We agree with Kristan-Tollmann et al. (1979) that these differences justify use of the term "Abadeh Fazies Region" for the Nayband Formation in this area.

According to Kristan-Tollmann et al. (1979) the sponge-bearing carbonate bed is Rhaetian in age. Krystyn (pers. comm. University of Vienna) has found Norian conodonts and ammonites below the sponge-bearing level. Some small foraminifers, found in two thin sections, suggest a possible Liassic age for the sponge-bearing carbonate beds and crinoidal limestones of the uppermost part in our section. The exact age of these sponge-bearing carbonate beds remain uncertain. We will further investigate this problem in the future.

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