GEOLOGICA CARPATHICA, DECEMBER 2006, 57, 6, 427–432

# Two Permian sphinctozoan sponges from the Shotori Mountains (eastern Iran)

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(Manuscript received November 7, 2005; accepted in revised form March 16, 2006)

**Abstract:** Two sphinctozoan sponge taxa, *Shotorithalamia tubulara* nov. gen., nov. sp. and *Amblysiphonella* cf. *A. vesiculosa vesiculosa* (de Koninck), are described from the Permian deposits of the Jamal Formation, exposed in Bagh-e Vang Mountain, and from a locality near the town of Deh-e Mohammad, both in the Shotori Mountains, north of Tabas, eastern Iran. The new genus *Shotorithalamia* is characterized by having ring-chambers — like *Amblysiphonella* — and also by possession of multibranched tubes that extended from the imperforate exo- and endowalls into the chamber interiors. The validity of families Amphorithalamiidae Senowbari-Daryan & Rigby and Girtyocoeliidae Finks & Rigby is discussed.

**Key words:** Permian, Iran, Shotori Mountains, Bagh-e Vang, Taxonomy, Porifera, Sphinctozoa.

## Introduction

The Permian deposits, called the Jamal Formation, crop out in several localities in the Shotori Mountains, in eastern, and also in central Iran (Stöckline et al. 1965). The section of the Jamal Formation crops out on the western flank of the Kuh-e Bagh-e Vang, located about 45 km NW of Tabas, approximately 5 km south of the town of Shirgesht (geol. map Shirgest, 1:100,000 by Ruttner et al. 1968, see Fig. 1). Here the Jamal Formation reaches thicknesses of 193 m (Ruttner et al. 1968) to 300 m (Leven & Vaziri Moghaddam 2004). The lower part (about 60 m thick) of the section is composed of differently coloured limestones and marls, with some olistoliths (up to 3 m in diameter). This part was identified as an independent formation by Partoazar (1995), who named it the Bagh-e Vang Member, of Bolorian age (for more information see Leven & Vaziri Moghaddam 2004; Senowbari-Daryan et al. 2005).

Sponges, described by Senowbari-Daryan et al. (2005) from the Bagh-e Vang locality, were collected mainly from reefal beds of the Bagh-e Vang Member. The following taxa have been described by the authors: **Sphinctozoa:** *Amblysiphonella rigbyi* Senowbari-Daryan, Rashidi & Hamedani, *Baghevangia minima* Senowbari-Daryan, Rashidi & Hamedani, *Shotorispongia permica* Senowbari-Daryan, Rashidi & Hamedani, *Shotorispongia biserialis* Senowbari-Daryan, Rashidi & Hamedani, *Thaumastocoelia*? cf. *Th. irregularis* Weidlich & Senowbari-Daryan, *Sollasia ostiolata* Steinmann, *Sollasia cylindrica* Senowbari-Daryan, Rashidi & Hamedani, *Girtyocoelia beedei* (Girty), and *Lemonea cylindrica* (Girty). **Inozoa:** *Preperonidella recta grossa* (Wu), *Bicoelia spinosa* Senowbari-Daryan, Rashidi & Hamedani, *Heptatubispongia symmetrica* Rigby & Senowbari-Daryan, *Maeandrostia kansasensis* Girty, *Maeandrostia radiata* Senowbari-Daryan, Rashidi & Hamedani, and *Solutosspongia tabasensis* Senowbari-Daryan, Rashidi & Hamedani.

*Shotorithalamia tubulara* nov. gen., nov. sp., described in this paper, was also collected from reefal beds of the Bagh-e Vang Member (Fig. 1, locality 1) by one of the authors (K. Rashidi).

*Amblysiphonella* cf. *A. vesiculosa vesiculosa* was found in an outcop (33° 59′ 46.6′′ N and 57° 01′ 46′′ E) located about 4 km northeast of the town of Deh-e Mohammad, approximately 68 km north of Tabas, and 23 km from the Bagh-e Vang locality (Fig. 1, locality 2). The age of the section, exposed in this locality corresponds to the Bagh-e Vang section (Lower Permian, Bolorian). The systematic classification, proposed by Finks & Rigby (in Finks et al. 2004) is used in this paper.

## Systematic Paleontology

Phyllum: **Porifera** Grant, 1872
Class: **Demospongea** Sollas, 1875
Subclass: **Ceractinomorph**a Levi, 1973
Order: **Agelasida** Verrill, 1907
Family: **Sebargasiidae** Laubenfels, 1955
Subfamily: **Sebargasiinae** Senowbari-Daryan, 1990
Genus: *Amblysiphonella* Steinmann, 1882

*Amblysiphonella* cf. *vesiculosa vesiculosa* (de Koninck) 1863
(Fig. 2.4–5)

*1863 *Orthoceras vesiculosum* n. sp. — de Koninck, p. 15
1887 *Amblysiphonella vesiculosa* (de Koninck) — Waagen & Wentzel, p. 973–974, pl. CXXII, fig. 1
?1970 *Amblysiphonella vesiculosa* — Zhuravleva, fig. 3a–3b

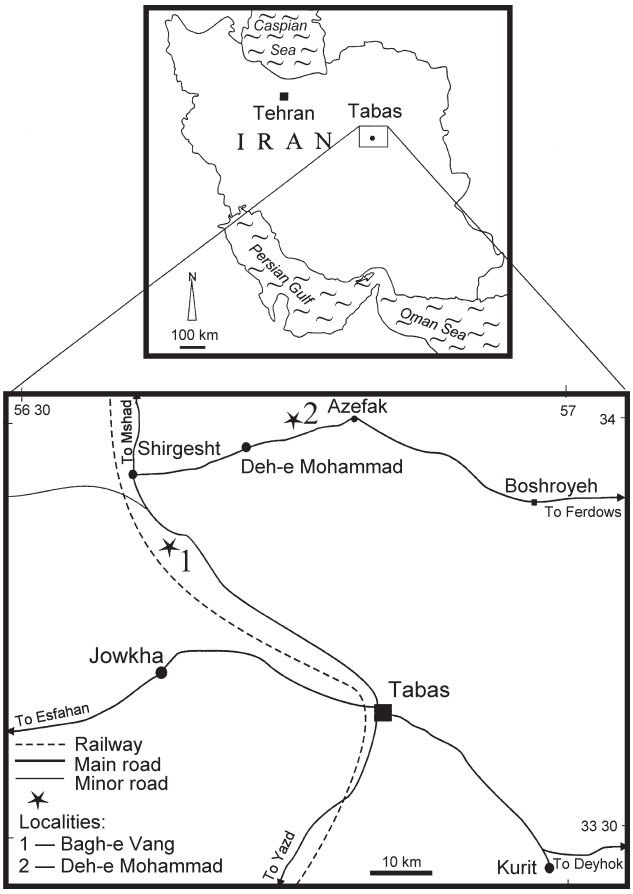


**Fig. 1.** Geographical position of the Kuh-e Bagh-e Vang (1) and Deh-e Mohammad (2) localities in eastern Iran.

**Material:** Only one specimen from the Lower Permian (Bolorian) Jamal Formation of Deh-e Mohammad locality (Fig. 1/2).

**Occurrence:** See synonymy.

**Description:** The available part of the broken sponge has a length of 50 mm. Its true length cannot be given, because only a portion is preserved. The sponge was cut in several pieces and later glued together. It has an outer diameter of 50 mm and is composed of several crescent-like ring-chambers. Because of the overlap of peripheral parts of preceding chambers by the younger chamber walls, outer segmentation is not recognizable from the exterior view, but internal chambered construction is clearly evident in sections of the specimen. The chambers reach heights of about 6–8 mm. The exowalls are doubled layered, reaching thicknesses of up to 3 mm, and the interwalls are about 1 mm thick. An axial spongocoel of retrosiphonate type is 10 mm in diameter. Chamber walls are pierced by numerous pores 0.3–0.4 mm in diameter. Chamber interiors are filled by vesiculae, which appear circular in longitudinal and tangential sections.

**Remarks:** *Amblysiphonella* is a long-lasting genus occurring from the Ordovician and Carboniferous to the Late Triassic. To date, the genus has not been reported from the Silurian and Devonian. More than 60 species are known (Senowbari-Daryan & Garcia-Bellido 2002). The majority of these have been described from Permian deposits.

According to the sponge diameter, the Iranian species is comparable with *A. vesiculosa vesiculosa*, erroneously described as a cephalopod *Orthoceras vesiculosum* by de Koninck (1863), and later redescribed by Waagen & Wentzel (1887) as a sponge from the Permian of the Salt Range (Pakistan). Later, the species was described by Zhuravleva (1970) from the former Soviet Union without giving the exact stratigraphic level and locality of the occurrence. The Iranian specimen differs from other known specimens described by de Koninck and by Zhuravleva (diameter smaller than 30 mm) by having a larger diameter (50 mm) and by different shapes of the chambers. Chambers of the Iranian specimen, however, have almost the same height as in *A. vesiculosa minima* described by Zhang (1983), and Fan & Zhang (1985) from the Late Permian of Lichuan, West Hubei, China. We are not sure about the assignment of the Iranian specimen to the species from Pakistan or from China, and have thus described it as *A.* cf. *vesiculosa vesiculosa* (de Koninck).

*Amblysiphonella* is an abundant sponge genus in Permian deposits in eastern and central Iran. The species *A. iranica* was described from the Permian at a locality near the La Kaftari Mountain (south of Bagher-Abad, north of Esfahan by Senowbari-Daryan & Hamedani 2002). Other sponges from this locality were reported by Rigby, Senowbari-Daryan & Hamedani (2005).

*A. rigbyi* Senowbari-Daryan, Rashidi & Hamedani (2005) is the most abundant sphinctozoan sponge in the Permian Jamal Formation of the Bagh-e Vang locality. *A.* cf. *vesiculosa vesiculosa*, described in this paper, is the third species of the genus *Amblysiphonella* occurring in Permian deposits in Iran, along with *A. iranica* and *A. rigbyi*.

## Discussion about the validity of the families Amphorithalamiidae and Girtyocoeliidae

Finks & Rigby (in Finks et al. 2004: p. 658) established the new family Girtyocoeliidae designating *Girtyocoelia* as the type genus of the family. Additional genera, including *Amphorithalamia* Senowbari-Daryan & Rigby (1988), *Calymenospongia* Elliott (1963), *Enoplocoelia* Steinmann (1882), *Henricellum* Wilckens (1937), *Phraethalamia* Senowbari-Daryan & Ingavat-Helmcke (1994), *Polyedra* Termier & Termier (1955), *Sollasia* Steinmann (1882), and finally, with question-mark *Solenocoelia* Cuif (1973), were attributed to the Girtyocoeliidae. Later, an additional Ordovician genus, *Girtyocoeliana* Rigby, Karl, Blodgett & Baichtal (2005) was added to this family.

*Amphorithalamia* was designated as the type genus of the family Amphorithalamiidae by Senowbari-Daryan & Rigby (1988). According to the "International Code of Zoological Nomenclature (ICZN)", published in its German version by Kraus (2000), it is incorrect to move *Amphorithalamia* to another family established later than the first establishment of its family ("Priority Principle"). Amphorithalamiidae has priority. It would be correct to leave

*Amphorithalamia* within the originally established family of Amphorithalamiidae. The same is also true for the genus *Polyedra*, which was attributed to the family Polyedridae Termier & Termier (in Termier et al. 1977).

Finks & Rigby (in Finks et al. 2004) have attributed to the family Girtyocoeliidae genera with totally different diagnostic characteristics. For example, the genera *Girtyocoelia*, *Enoplocoelia*, *Phraethalamia* or *Polyedra* are characterized by possession of one or more axial canals, but *Sollasia* or *Henricellum* are asiphonate genera. The "interior of each chamber" of *Amphorithalamia* (an asiphonate sponge) is "filled with a fine, meandriform, trabecular net that outlines anostomosing, tubular spaces" (Finks & Rigby: in Finks et al. 2004: p. 658). The filling skeleton, vesiculae excepted, is lacking in all other mentioned genera. Because of the rule of priority (ICZN), the family names Amphorithalamiidae and Polyedridae cannot be replaced by Girtyocoeliidae, or any other new family.

*Calymenospongia kudistanensis*, a minor chambered fossil described from the Kolosh Formation (Paleocene) of northern Iraq by Elliott (1963), is another genus, attributed to the Family Girtyocoeliidae by Finks & Rigby (in Finks et al. 2004). The construction of this microfossil is similar to *Sollasia*, as noted by Elliott. However, the very small dimensions, which according to Elliott are: maximum diameter of 0.72 mm, chamber heights of 0.42 mm, and a wall thickness of the chambers of 0.03 mm, differs from all other sphinctozoan sponges. The wall structure is also different from other sphinctozoan sponges. The systematic position of *Calymenospongia* is uncertain, and an attribution to foraminifers is not be excluded.

Cuif (1973) described the genera *Solenocoelia* and *Reticulocoelia* without placing them in a higher taxonomic category. He illustrated both genera only by tangential sections, which unfortunately do not show the sphinctozoan construction. Also the species name "*cylindrica*" does not reflect the sphinctozoan construction of this sponge. *Solenocoelia,* attributed, althought with some doubt, to the family Girtyocoeliidae by Finks & Rigby (in Finks et al. 2004), shows a wall with well-preserved spherulitic microstructure, without pores or ostia (Cuif, pl. 9, figs. 3–4, pl. 10, fig. 4). The systematic position of this fossil as either a segmented sphinctozoan or an unsegmented inozoa is uncertain. Also the systematic position of *Reticulocoelia arborescens* Cuif (1973), attributed to the Virgulidae — a family of inozoid sponges — by Finks & Rigby (2004: p. 598), is uncertain.

In our opinion establishment of a new family Girtyocoeliidae, and separation of the genera included there from the rest of the genera of the family Thaumastocoeliidae seems superfluous and not necessary. We use in this paper the "classic" classification (Senowbari-Daryan 1990, Senowbari-Daryan & Garcia-Bellido 2002) of the sphinctozoan sponges to classify the new genus *Shotorithalamia*.

Concerning the above problem, J.K. Rigby (Provo, Utah) concurs with our opinion and states (pers. com. Rigby, 11th February 2005): "You are right, as you have interpreted the International Rules of Nomenclature. I think that the Amphorithalamiidae should be separated out, like we did (Senowbari-Daryan & Rigby 1988). I would encourage you to publish basically what you have written to me, that the Amphorithalamiidae is a valid and useful family, separate from the Girtyocoeliidae, and that it ought to be maintained because of differences, but also because of the rules and priority".

Family: **Thaumastocoeliidae** Ott, 1967
Subfamily: **Enoplocoeliinae** Senowbari-Daryan, 1990

*Shotorithalamia* nov. gen.

**Derivatio nominis:** From the Shotori Mountains, and *thalamos* (Greek) = chamber.

**Diagnonis:** Aporate sphinctozoan sponge with ring-chambers arranged around an axial spongocoel of ambisiphonate type. The exo- and endowalls are pierced by ostia extended inwards by multibranched tubes with perforated walls. The openings of exowall are rimmed. Vesiculae and other internal structures are lacking.

**Type species:** *Shotorithalamia tubulara* nov. sp.

**Discussion:** Because of its imperforate chamber walls, *Shotorithalamia* nov. gen. is attributed to the family Thaumastocoeliidae Ott. Further placement of the genus within the sphinctozoan sponges is discussed above.

In general, *Shotorithalamia* is similar to the genus *Girtyocoelia* Cossmann (1909), an abundant sponge in Carboniferous and Permian deposits, but differs from it by having tubes extended from the exo- and endowalls into the chamber interior. In *Girtyocoelia* the tubes may extend from the exowalls to the outside (see Senowbari-Daryan 1990, pl. 45, figs. 5–6, text-fig. 48, reillustrated in Finks et al. 2004: fig. 434/1d–1e) but not into the chamber interiors, where the chamber interiors are hollow. The structure of the spongocoel (*Girtyocoelia* is also prosiphonate, while *Shotorithalamia* is ambisiphonate) and the perforation types of both genera are totally different.

Because of the tubes within the chamber interiors, *Shotorithalamia* resembles *Praethalamia* described by Senowbari-Daryan & Ingavat-Helmcke (1994) from Upper Permian strata of Phrae province, Thailand. *Shotorithalamia*, however, differs from *Phraethalamia* by having only one spongocoel and the latter genus by having two or more axial spongocoels. In addition, tubes in *Phaerethalamia* extend only from the endowall into the chamber interiors. Tubes like these, extending from the exowall into the chamber interiors, as in *Shotorithalamia*, are absent in *Phraethalamia*.

Tubes that extend from the endowall into the chamber interiors are also developed in the Permian genus *Pseudoamblysiphonella* (Demospongea?) described by Senowbari-Daryan & Rigby (1988) from Upper Permian reefs of Djebel Tebaga of southern Tunisia and they also occur in the species *Barroisia lehmani* (Calcispongea), described by Hillmer & Senowbari-Daryan (1986) from the Cretaceous strata of northern Germany. Tubes that extend from the exowall into the chamber interior, as developed in *Shotorithalamia,* are absent in both of the forementioned genera. In addition, *Pseudoamblysiphonella* and *Barroisia* have perforated chamber walls and are attributed to the group of Porata of Seilacher (1962).

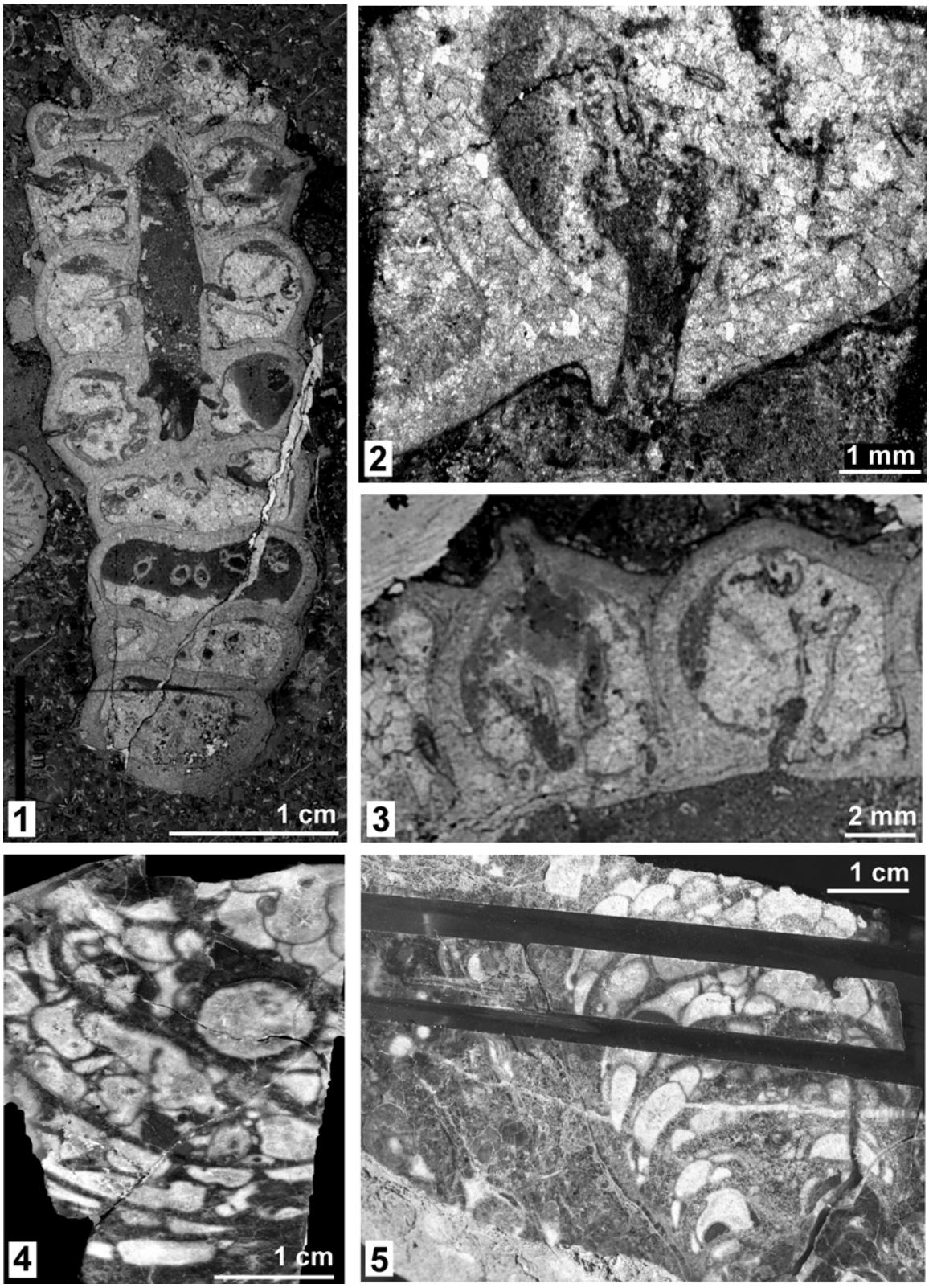


**Fig. 2. 1–3** — *Shotorithalamia tubulara* nov. gen., nov. sp. 1 — Holotype. Marginal axial longitudinal section show the ring-chambers, spongocoel and the rimmed ostia on the exowalls. In the third chamber from the bottom the tubes extended from the exo- and endowalls appear as circles. 2 — Magnification from Fig. 1 exhibits one rimmed ostium of the exowall. 3 — Magnification from Fig. 1 shows two chambers with a rimmed ostium of the exowall and the tubes extended from the ostia into the chamber interiors. **4–5** — *Amblysiphonella* cf. *vesiculosa vesiculosa* de Koninck. 4 — Transverse oblique section shows the axial spongocoel and a few chambers filled with vesiculae. 5 — Longitudinal oblique section shows the crescent-like chamber filled with vesicular skeleton.

*Shotorithlamia* nov. gen. differs from *Girytyocoeliana*, another genus of the family, described by Rigby, Karl, Blodgett & Baichtal (2005) by possessing of the internal tubes and by the lack of "rimmed to tubular interpores in irregular rings around central tube" (Rigby et al. 2005: p. 867).

Multiple tubes, as tubular filling skeleton, fills chamber interiors of representatives attributed to the family Polytholosiidae Seilacher (1962). The kind of filling skeleton and the perforated chamber walls distinguish *Shotorithalamia* from the taxa attributed to the family Polytholosiidae. No other sphinctozoan genera are comparable with *Shotorithalamia* nov. gen.

*Shotorithalamia tubulara* nov. sp.
(Figs. 2.1–3, 3, 4)

**Derivatio nominis:** Named from the occurrence of the tubes extending from the endo- and exowalls into the chamber interiors.

**Holotype:** Fig. 2.1 (magnifications of holotype are illustrated in Figs. 2.2–3).

**Locus typicus:** Kuh-e Bagh-e Vang, about 45 km NW of Tabas (see Fig. 1, locality 1).

**Stratum typicum:** Lower Permian, most probably Bolorian.

**Diagnosis:** See diagnosis of the genus.

**Material:** One specimen (holotype) only.

**Depository:** The material is filled together with sponge material described by Senowbari-Daryan et al. (2005) in the collection of the Institute of Paleontology, University of Erlangen-Nürnberg (Material: Senowbari-Daryan, Permian, Bagh-e Vang, thin section BVA/1 and a rock piece with the other half of the sponge).

**Description:** Because there is only one available specimen of the species the description of holotype corresponds to the description of the species.

The 50 mm long sponge with a diameter of 18 mm is composed of 9 spherical to rectangular ring-like chambers arranged around an axial spongocoel (Fig. 2.1). The last two chambers are incompletely developed or broken. Chamber height varies between 5 and 7 mm. The chamber walls (exo-, inter- and endowalls) have the same thickness of 0.8–1.0 mm. Because of the thickening of chamber roofs by doubling of the walls (especially at the peripheral part) these may appear thicker than 1 mm. An axial spongocoel of ambisiphonate type, 4 mm in diameter, passes through the whole sponge length. The exowalls are pierced by rimmed ostia of about 0.6 mm (Figs. 2.2–3). The most characteristic features of the sponge are the branched tubes extended from the ostia and those from the endowall into the chamber interiors (Figs. 2.3, 3–4). The tubes are multibranched and pierced by numerous pores connecting the tubes interior with the chambers (Fig. 3). The tubes from exowalls and those from endowalls are not connected with others. Tubes in oblique sections through the chambers appear as circles (Fig. 2.1, in lower chambers, compare with Fig. 3). The openings of the endowall and the tubes have the same diameter as the ostia on the exowalls. Skeletal mineralogy, microstructure and spi-

**Fig. 3.** *Shotorithalamia tubulara* nov. gen., nov. sp. (holotype, counterpart to Fig. 2.1). Drawn from thin section. Scale bar = 1 cm.

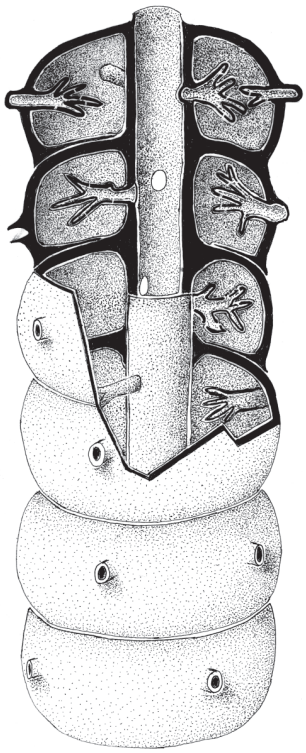

**Fig. 4.** Reconstruction of *Shotorithalamia tubulara* nov. gen., nov. sp., showing the ring-like chambers around the axial spongocoel, tubes within the chamber interiors, and the rimmed ostia within the exowalls. Schematic (not to scale).

cules are unknown. A reconstruction of *Shotorithalamia tubulara* showing the chambers, tubes within the interior of the chambers and the rimmed ostia is given in Fig. 4.

## Discussion

A total number of 12 sponge genera and 15 species, including sphinctozoans (7 genera and 9 species) and inozoid (5 genera and 6 species), were described by Senowbari-Daryan et al. (2005) from the reefal limestone of the Permian Jamal Formation exposed in Kuh-e Bahg-e Vang. With documentation of *Shotorithalamia tubulara* the number of sponge taxa in this locality is raised to 13 genera and 17 spieces, including *Amblysiphonella* cf. *vesiculosa*. The reefal limestones of the Jamal Formation exposed in Kuh-e Bagh-e Vang should be classified as sponge-*Tubiphytes-Archaeolothoporella*-boundstones (Senowbari-Daryan et al. 2005).

As discussed by Senowbari-Daryan et al. (2005), the sponge association of the Permian Jamal Formation in Kuh-e Bagh-e Vang shows considerable similarity to the sponge association known from the Lower Permian reef boulders imbedded within the Lercara Formation, western Sicily (Senowbari-Daryan & Di Stefano 1988).

**Aknowledgments:** The investigations were carried out within the framework of Project Se 416/11, supported by the Deutsch Forschungsgemeinschaft (DFG). The authors thank the University of Esfahan for logistic support of our field work. Our special thanks are addressed to Prof. Dr. J. Keith Rigby (Provo, Utah) for the improvement of the first draft of the manuscript. The authors express their gratitude to Diego C. Garcia-Bellido (Madrid), Jozef Michalík (Bratislava), and Oliver Weidlich (Berlin) for their fair and constructive comments as reviewers.

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