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A rare new demosponge from the Solnhofen Lithographic Limestone (Upper Jurassic, Bavaria, Germany)

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Abstract

From the Lower Tithonian of the Eichstätt realm a new exceptional demosponge taxon is described. The new taxon *Hruodospongia lithographica* n. gen. n. sp. is related to the Halichrondrida/Axinellida based on the spicule arrangements and architecture. The sponge grew on a stem of unknown origin and was probably drifting for a while from a shallower, oxygen-rich environment before sinking down in the oxygen-depleted deeper water of the Eichstätter "Wanne" (lagoonal basin). Sponges are rare within the typical Plattenkalk facies, because the oxygen-poor benthic environments which did not allow the growth of sessile benthos which were transported from carbonate platforms nearby. Discussed is also the paleoecology and systematic relationship of further dubious demosponges found in the Plattenkalk facies.

Key words: Upper Jurassic, Tithonian, Porifera, demosponges, Solnhofen Lithographic Limestone, Bavaria, Germany

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Introduction

Sponges are usually very common in the upper Jurassic and often form a special reef-type facies (e.g. Leinfelder 1993). Normally most sponges prefer clear, oxygen-rich oligotrophic water which is characteristic for most reef facies. The Kimmeridgian and Tithonian sponge build-ups were dominated by lithistid demosponges cemented by microbial crusts. Within the older Oxfordian sponge reefs, hexactinellid sponges have often played the dominate role. The lower Tithonian Plattenkalk facies is a typical restricted lagoonal facies embedded between sponge and coral reefs of the vast reef belt of the northern margin of the alpine ocean system. The typical Tithonian Plattenkalk facies (Malm zeta 2b) exhibits only few occurrences of benthic organisms (ophiurids, polychaetes, bivales, etc.) and they are restricted to certain lagoons ("Wannen"), e.g. from Pfalzpaint, Zandt, and some others (Röper et al. 1999, 2001; Keupp & Schweigert 2012) which probably had short-time oxygen enriched water masses. The lagoonal basins of the southern Franconian Alb exhibit two major sedimentological-stratigraphic events, the so-called "Krumme Lagen", the lower "Trennende Krumme Lage" which separates the lowermost Tithonian (zeta 2a) from the central Plattenkalk series (zeta 2b) and the "Hangende Krumme Lage" from the "Mörnsheimer Schichten" (zeta 3) (Barthel 1978; Viohl 1998; Kölbl-Ebert et al. 2005). These up to meters thick layers were probably caused by earth quakes strongly synsedimentarily folded and sometimes bearing shallow water organisms like sponges from the surrounding reefs. These events could mixed up the stagnant lagoonal waters with oxygen. Sponges are very rare and only two taxa have up to now been described, the hexactinellid *Ammonella quadrata* Walter 1904 (Keupp & Mehl 1994) and the demosponge *Neochoiaella frattigianii* Keupp & Schweigert 2012. The autochthonous nature of these sponges is questionable, it is more convincing that they were transported from a shallower oxygenated environment.

Taxonomy and Systematics

The here presented taxonomic framework is based on "Systema Porifera" (Van Soest & Hooper 2002)

Phylum Porifera Grant, 1836
Class Demospongiae Sollas, 1875
Order Halichondrida/Axinellida

Genus: *Hruodospongia* n.gen.

Diagnosis: see diagnosis of the type species

Ethymology: The origin of the first part of the name is called after the old German word "Hruodo" for the modern name "Rolf". The literal meaning of "Hruodo" is glory and wulf. The second part is named after the Latin word *spongia* for sponge. The sponge is dedicated to PD Dr. Rolf Kohring, a deceased German palaeontologist.

Type species

Hruodospongia lithographica n.sp.

Holotype: Collection of the Geoscience Museum Göttingen GZG.INV. 78089

Fig.1-5

Diagnosis

Bowl-shaped demosponge with well developed plumose-like arranged dermal diactine spicules of some millimeters in length and reticulately arranged choanosomal diactine spicules. The dermal layer is prominently developed and gives the sponge the presented shape. The spicules of the dermal layer protrude outside the sponge body.

Ethymology:

after "Lithographic Limestone"

Material*, Locus typicus* and *stratum typicum:*

Only the holotype collected from the Wintershof quarry close to Eichstätt, Lower Tithonian (Malm zeta 2b).

Description of the holotype

The bowl-shaped specimen has a maximum diameter of 14,4 cm in the longitudinal axis. Perpendicular to the longitudinal axis the specimen has a diameter of 11 cm. The sponge is grown on a stem of unknown origin. The stem has a length of 4 cm. The sponge lithified tissue has light brownish colour caused by iron hydroxides, probably oxidised very small pyrite crystals (fig.1). The central part of the sponge body exhibits star-shaped calcite cemented structures of ca. 1cm size. These features resemble *septaria*-like structures in carbonate concretions. The formation of

these calcite-cemented structures is probably related with synsedimentary shrinkage of hydrated taphonomically formed carbonate minerals (fig.3). Within the central part of the sponge no spicule remains are documented. The outer rim of the sponge is ca. 2 cm thick and exhibits the dermal spicule arrangements (fig.2-4). The former sponge tissue is partly preserved in small knobby calcite crystals and related with brownish iron hydroxide cover (fig.1). Also part of the spicular skeleton is preserved in irregular calcite rows (fig.3, 4). Spicules at the outer margin of the sponge are preserved in small granular brownish to black aggregates resembling small pyrite crystals (fig.2).
The dermal spicular skeleton is characterised by plumose-like arranged, slightly curved diactine spicules of a length of 3-4 mm with a thickness of 200 µm (fig.2). The preserved plumose bundles show 6 to 8 spicules. The choanosomal spicular skeleton is only fragmentarily preserved. Some remains show a reticulate arrangement (fig.5). The choanosomal spicules are also thin diactines with a length of ca. 2-3 mm. The dermal plumose spicule bundles and the reticulate spicule arrangements of the central choanosomal area resemble a typical halichondrid spicule arrangement.

Discussion

As already mentioned, sponges are rare in the Solnhofen Plattenkalk facies. Most sponges need a firm ground to settle down and only few modern type sponges are adapted to low oxygen conditions. The lagoonal Plattenkalk facies was therefore not an advantageous environment for sponges, however, the surrounding reefs were inhabited with abundant sponge communities. This is documented by sponge-rich mass flows which are common especially in the slightly younger Mörnsheimer Schichten (Malm zeta 3) and also in the "Krummen Lagen". Only few sponges have already been described *Ammonella quadrata* Walter 1904 (Keupp & Mehl 1994) and the demosponge *Neochoiaella frattigianii* Keupp & Schweigert 2012 and they were probably also drifting from the reef areas before sinking down in low oxygenated lagoonal waters. Their autochthonous character is in any case doubtful. The here described specimen was also floating. The sponge grew on a stick of unknown origin light enough to drift some time before sinking down.
There are further types of drifting/floating sponges, e.g. *"Phyllothallus" elongatus* (Sternberg 1833), which were primarily related to brown algae Rothpletz (1896) and relatively common (fig.6). However, the sponge nature of these fossils was already discussed by Goldfuß (1826-1833) and Schimper (1869), but they do not show any

evidence. Dietl & Schweigert (1999, 2001) classified these algae-like structures as "soft sponges", because they found rhax-like spicules, characteristic large microscleres of the tetractinellid taxon Geodiidae and also of the hadromerid *Placospongia* (e.g. Boury-Esnault 1973, Becking 2013). They oblige to use the still valid old name *Codites* established by Sternberg 1883. A detailed fresh look at some specimens has shown, that *"Phyllothallus elongatus"* is really a sponge with affinities to sterraster- and selenaster-bearing demosponges due to a dense cortex of these large dermal microscleres (100-150µm) and they also exhibit abundant oscular pores (250µm), a distinct sponge character (fig.7). However, no megascleres were found and therefore a clear taxonomic classification and relationship is difficult. The only known sponge taxon with exclusively large dermal microscleres is the hadromerid *Chondrilla grandistella* Thiele 1900 (Reitner 1992). However, the microscleres are large star-shaped euasters and not sterr- or selenasters (discussion in Reitner 1991, 1992). A detailed re-description of these sponges is in process. These types of demosponges are more common in Jurassic fossil record and they also represent an important parautochthonous faunal element within the Solnhofen Lithographic Limestone. The taxon *Rhaxella* (Hinde 1893) is common in Jurassic and Cretaceous shallow water environments (e.g. Reitner 1994, Helm & Schülke 1998, Helm et al. 2003, Delecat et al. 2001) and they also form types with a secondary calcareous basal skeleton (Reitner 1992).

All known sponge specimens from the Solnhofen Lithographic Limestone are parautochthonous and probably drifting from surrounding reefs. The good preservation of the specimens is related to oxygen-depleted deep basin water of the Plattenkalk lagoons. The taphonomy of the tissue and also of the spicules was related with strong microbial sulphate reduction, proofed by abundant iron hydroxides which are oxidised small pyrite crystals.

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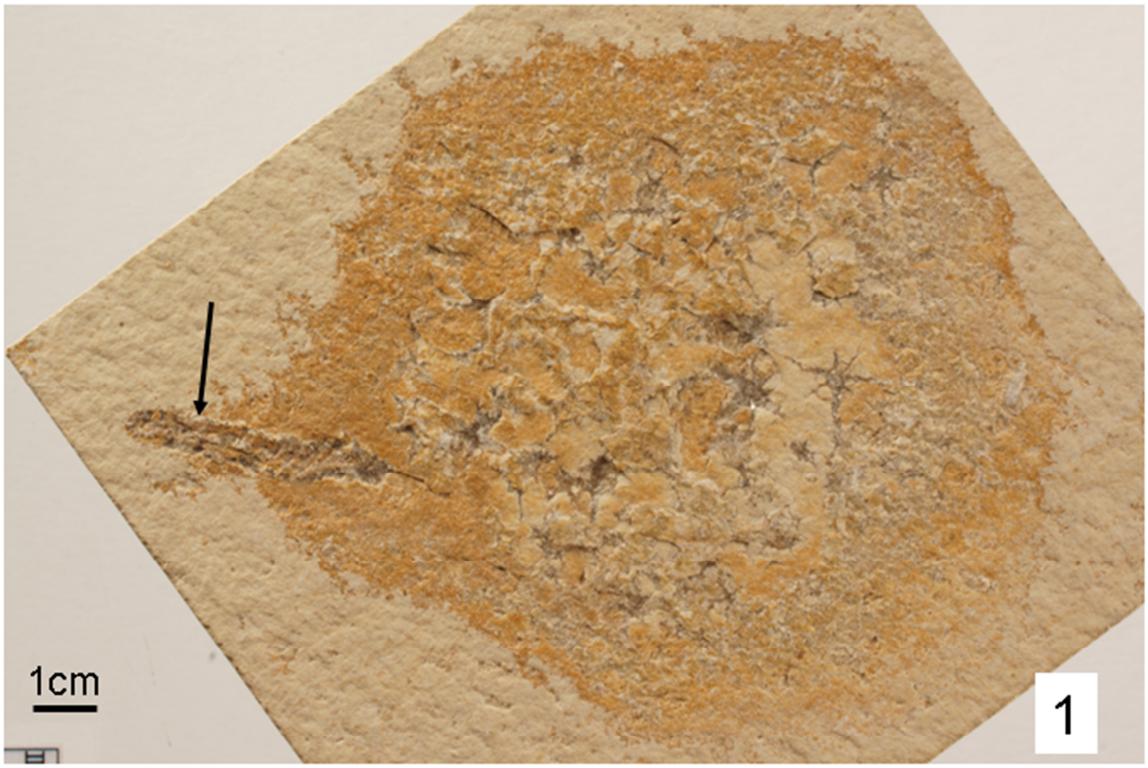
Figures

Fig.1 Holotype of *Hruodospongia lithographica* n.gen. n.sp.
Collection of the Geoscience Museum Göttingen GZG.INV. 78089
Arrow shows stick of unknown origin on which the sponge was grown.

Fig.2 Bundles of diactine spicules (arrow) of the dermal layer. Former siliceous spicules are preserved either in oxidized pyrite crystals (brown dark spots) or in calcite.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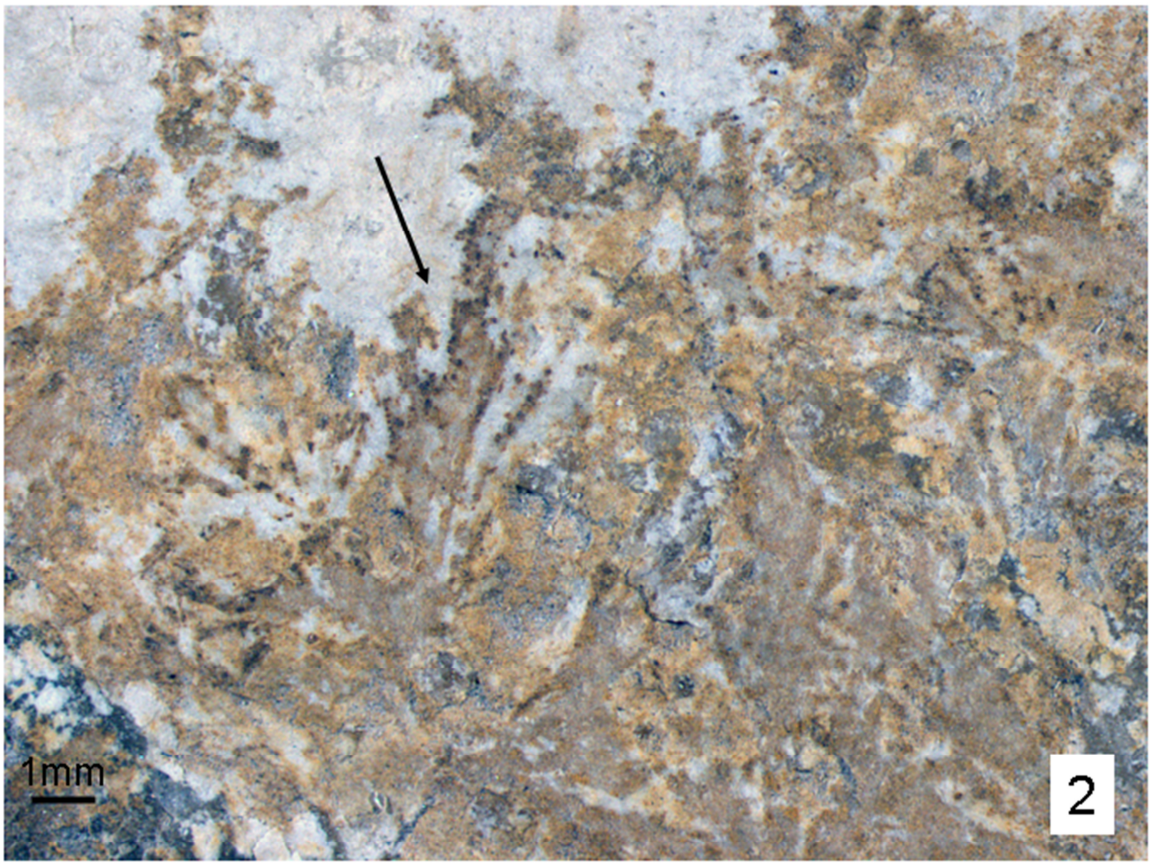
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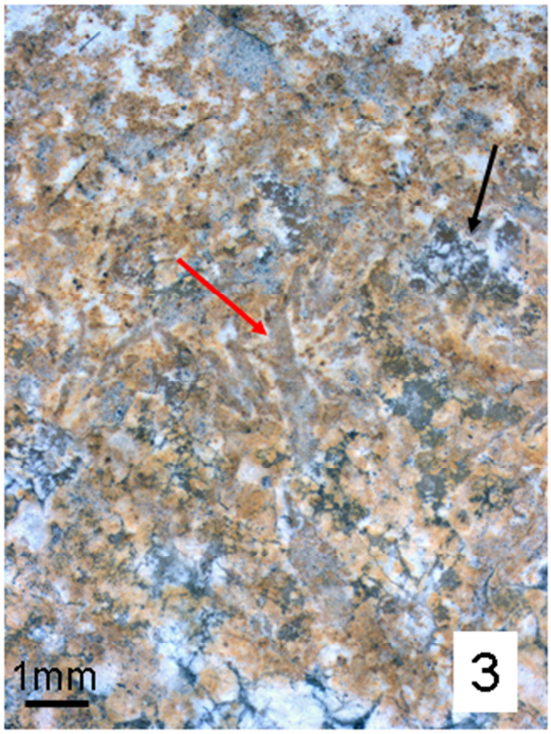
2

Fig.3 Thick dermal spicule layer with abundant spicules preserved in knobby calcite (red arrow). Within the former sponge tissue abundant star-shaped calcite crystal aggregates are shown, probably an early diagenetic phase of tissue preservation (black arrow).

Fig.4 Same as Fig.3 with clear plumose-like arranged dermal spicules preserved in calcite.

Fig.5 Reticulately arranged choanosomal diactines (arrows) preserved in iron hydroxides, probably oxidized pyrite.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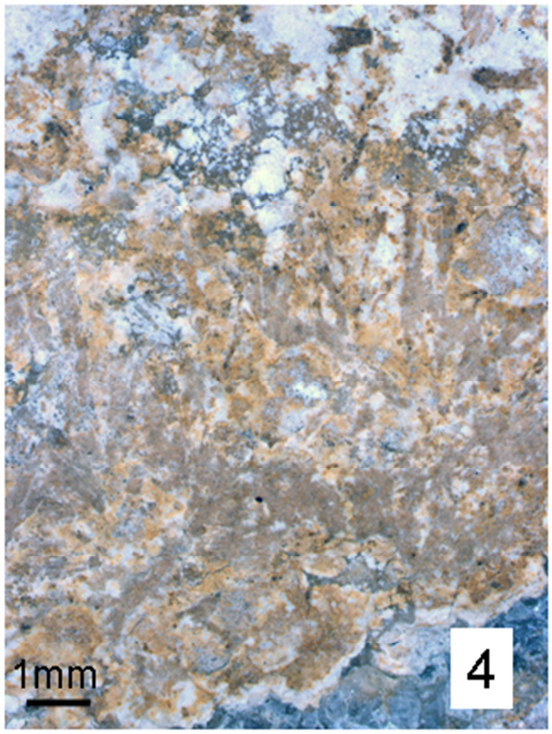
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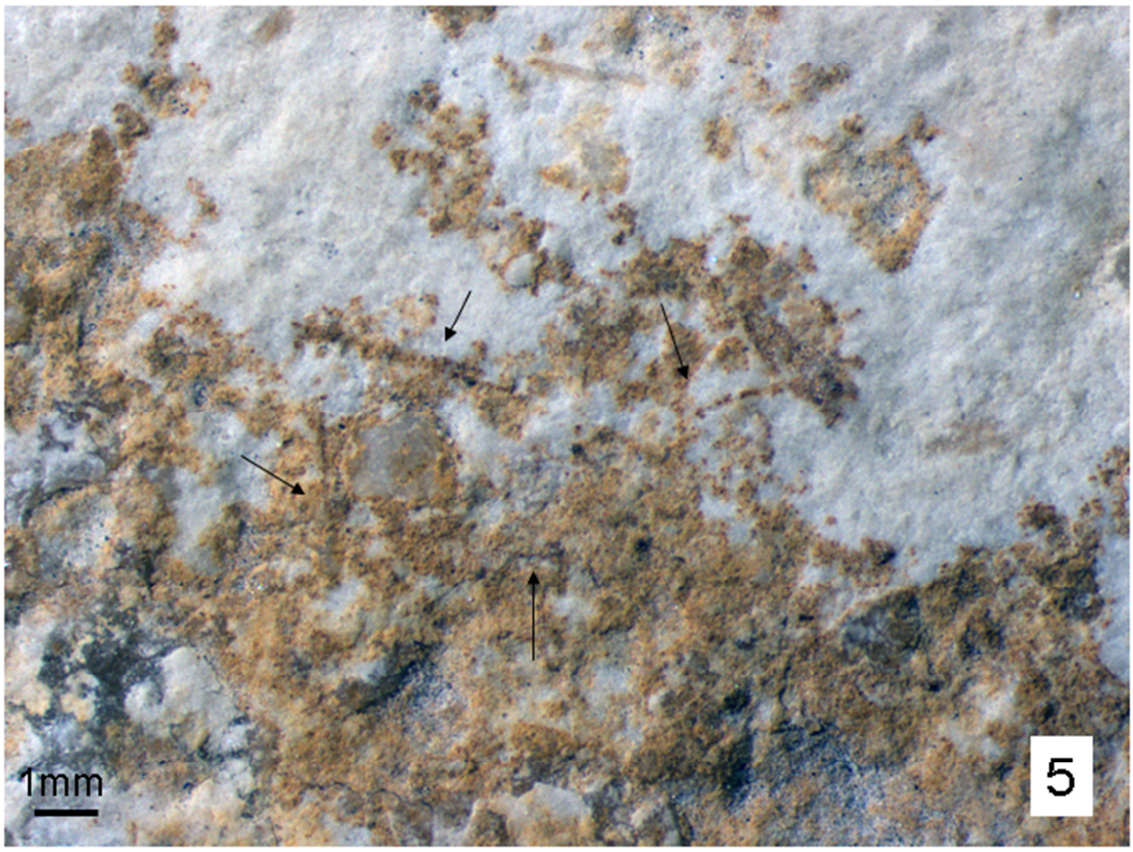
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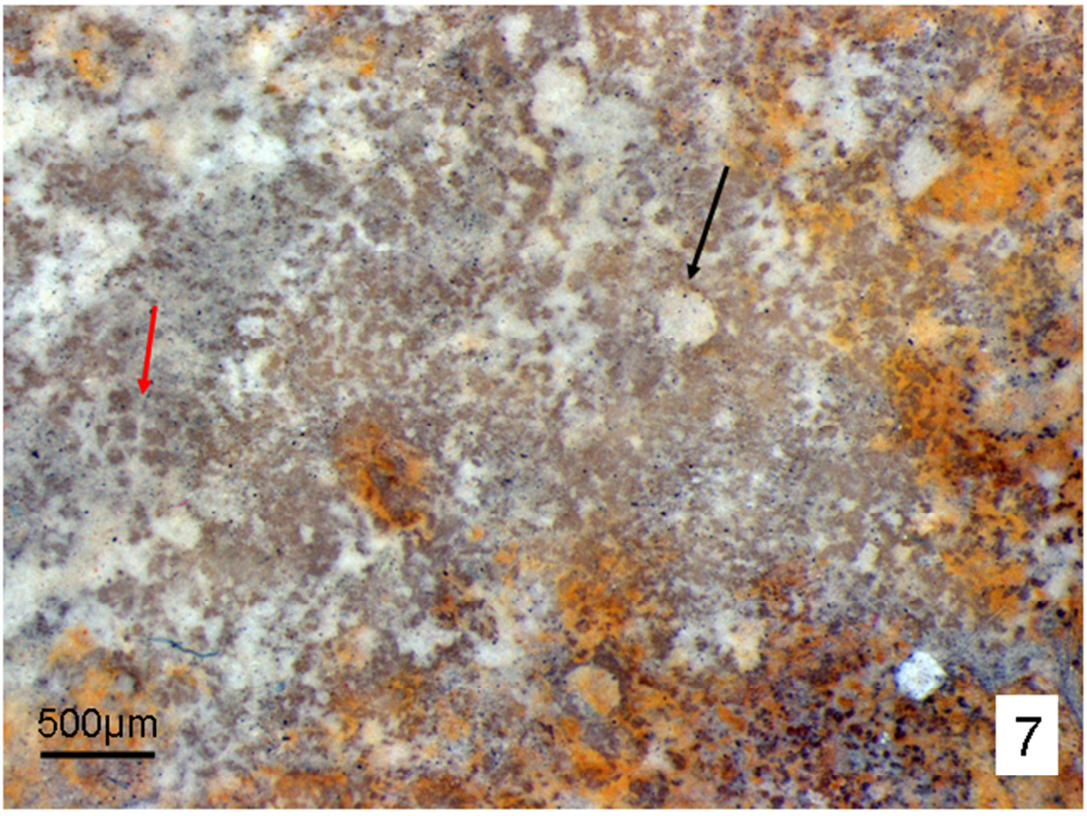
Fig. 6 *Codites ("Phyllothallus") elongatus* Sternberg 1833. These types of fossils are relatively common and traditionally interpreted as brown algae. Dietl & Schweigert (1999, 2001) re-interpreted these fossils as "Weichschämme- soft sponges" because they detected large kidney-shaped microscleres (rhax, sterraster, selenaster). "Weichschwämme" is definitely not a good description of this sponge type. The strong dermal layer caused by a dense crust of microscleres gave the sponges a hard and stable character, as known from modern relatives. The term "soft sponges" is often used for non-spiculated keratose-type sponges and should be restricted to them. The taxonomic position is unclear, since different taxa of demosponges bear these types of microscleres and megascleres are also not known. Anatomically best coincidences are seen with the taxon *Chondrilla grandistellata* Thiele 1900, a hadromerid sponge with a prominent dermal layer of large euasters. However, the kidney-shaped microscleres of *Codites ("Phyllothallus") elongatus* resemble more the selenasters of the hadromerid *Placospongia*.

Fig.7 Detailed view of the dermal layer of *Codites ("Phyllothallus") elongatus* exhibiting abundant large kidney-shaped microscleres (red arrow) and abundant oscula pores (black arrow), which finally prove the sponge nature of these fossils.


2cm
6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7