Observations on the Jurassic Hexactinellid Sponge *Tremadictyon radicatum* (Quenstedt)

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Introduction

From an analysis of the fauna from an Oxfordian reef near Auerbach in Oberpfalz R. Meyer and L. Übelacker found a great number of irregularly shaped clumps (Meyer et al. 1987). These clumps were determined to be basal fragments of *Tremadictyon radicatum* (Fig. 1). This large siliceous sponge is the only described form from the Upper Jurassic which built root knots to anchor itself in soft sediment. This species may be one of the hypothetical "pioneer sponges" which contributed to the establishment of new reefs. The following description supports this supposition.

Systematics

Order: Dictyida (Zittel 1877)
Family: Staurodermatidae (Zittel 1877)
Genus: *Tremadictyon* (Zittel 1877)
Species typica: *T. reticulatum* (Goldfuss 1826), established by de Laubenfels (1955, p. 79).

Diagnosis of genus: (after Schrammen 1936, p. 22, varied). Tubular to funnel-shaped, large, relatively thin-walled sponge in which the oscula and postika are arranged in quincunx. The canals are corresponding to those of modification 4 after Rauff (1894, p. 129). The sponge body comprises a regular skeleton composed of hexactins with 0.3-mm-long rays. An overlying layer of stauractins exists which extends over the whole ostia with no discernible openings.

Tremadictyon radicatum (Quenstedt).
1858 *Spongites reticulatus* – Quenstedt, p. 694; Pl. 84, Fig. 2–3.
1877 *Scyphia reticulata* – Quenstedt, p. 29; Pl. 115, Fig. 3.
– *Scyphia reticulata radicata* – Quenstedt, p. 31; Pl. 115, Fig. 12.
– *Retispongia radicata* – Quenstedt, p. 34; Pl. 115, Fig. 20.
1880 *Tremadictyon reticulatum* Goldf. – Zittel, p. 175; Text-Fig. 89.
1910 *Tremadictyon radicatum* Quenst. sp. – Kolb, p. 155.
1937 *Tremadictyon radicatum* Quenst. sp. – Schrammen, p. 24, Pl. 3, Fig. 2 (Dictyonalia); Pl. 4, Fig. 1 (Inner surface of the skeleton).

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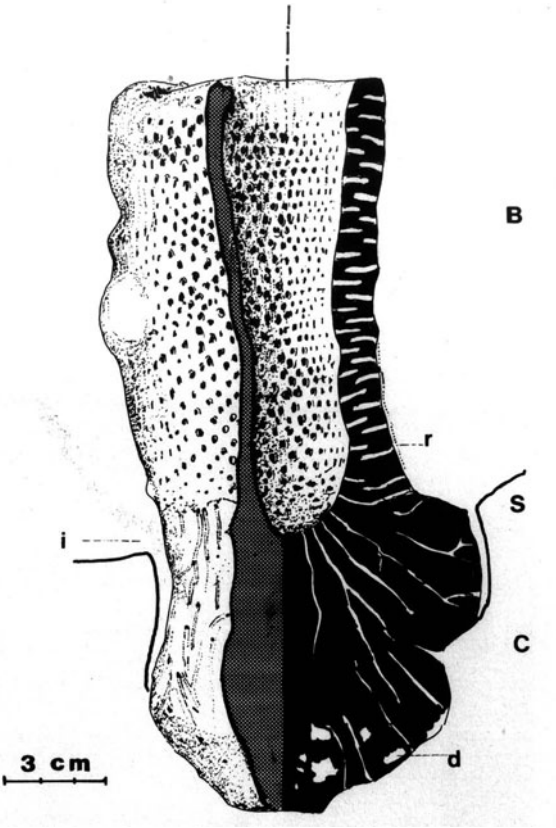

Fig. 1. *Tremadictyon radicatum* (Quenstedt). Vertical section, schematic. *B* Main sponge body; *S* surface of the sediment; *r* rests of the layer of stauractins; *d* debris collected from the sponge and built in into the root clod; *c* outer surface of the root clod showing the channels of the root system; *i* interstice between the sponge and the sediment. (Observed by Wiedenmayer 1978)

Lectotypus: Original from Quenstedt (1877, Pl. 115, Fig. 20; established here, deposited at Geolog. Paläontolog. Institute of University Tübingen.

Locus typicus: Oberdigisheim near Balingen, Baden-Württemberg, West Germany.

Stratum typicum: Upper Jurassic, Kimmeridgian, (Weißjura Beta/ Gamma).

Diagnosis: Large, tubular to funnel-shaped representatives of the genus, able to produce a shapeless root clod for to anchoring itself in soft mud. The construction of the skeleton is different in both main body and root clod. The boundary between is uneven but clear.

Description of the figured specimen (Fig. 2 Staatl. Museum f. Naturkde. Stuttgart Inv. Nr. 21877): The silicified sponge was dissolved out of the Malm limestone with HCl so that, with the exception of the paragaster all details of the skeleton and canal systems were exposed.

Fig. 2. *Tremadictyon radicatum* (Quenstedt), habitus. Upper Kimmeridgian (Weissjura Epsilon/Zeta). Sontheim, West Germany. Staatl. Museum f. Naturkde. Stuttgart, Inv. Nr. 21877. For details see text

The sponge is altogether 190 mm high with 70 mm of it composed of the root system. The cross-section is circular with an average diameter of 70 mm for the main sponge body, 60 mm at the boundary between the body and the root system, and 90 mm at the root system. The wall is 8–10 mm thick.

The root clod is lumpy, shapeless with short rounded protrusions. In certain places foreign material appears to be included in the clod. The boundary between

the main sponge body and the root system is uneven, but sharp. The paragaster is as in other examples tubular and ends up in the form of a hollow half-ball.

The canal system of the sponge body and the root system differ from each other (Fig. 3). The outer surface of the sponge body contains ostia which occur at distances of ca 2 mm in oblique rows (9 ostia cm^{-2}). The ostia near the root system are round, but become elongated toward the top of the sponge body. The canal system is composed of these 2-mm-wide pores belonging to short epirhysis which enter horizontally into the wall and finally end. Epirhysis and ostia are lined by a smooth siliceous "skin" which is penetrated by diminutive pores and is built of crooked flattened hexactins.

In contrast, the root system is composed of many fine 0.5 mm wide channels, which penetrate the clod upwards in unorganized manner ending with round postika in the bottom of the paragaster (Fig. 4). These channels appear as fine troughs on the outer surface and may show starlike figures. Evidently the channels of the root had function other than that in the main sponge body.

The skeletal components of the root system are also different than that in the main sponge body. Hexactins are found within both skeletons, which combine to form a fixed structure. However, in the root system the structure is entirely irregular and narrow meshed. In the main sponge body the dictyonal skeleton is regularly right-angled coarsely meshed. An overlying layer of stauractins is here and there preserved. The stauractins covered the entire sponge body and seemingly covered all ostia-like openings at a distance of 1 mm from the body. Thus, between the sponge and the outer layer a narrow empty space existed which can compared to the "vestibule" in Recent sponges.

The flanks of the figured specimen were colonized after death by a few placunopsids, as well as a small serpulid. The root system is, however, like all other examined root systems, free from colonizers.

Occurrence: *Tremadictyon radicatum* is ascribed from the Oxfordian/Kimmeridgian boundary to the beginning Tithonian by Schrammen (1937, p. 25). With his report from the lower Oxfordian, the form occurs within the entire Upper Jurassic of southern Germany.

Samples: 16 root clods: Private collection Übelacker, Bachetsfeld: two whole specimens and six fragments: Staatl. Museum f. Naturkunde in Stuttgart.

Taxonomic note: *Tremadictyon radicatum* and *Tremadictyon reticulatum* differ only by possession of a root clod. Perhaps both species should be united. In this case *Tremadictyon radicatum* would receive the status of a younger synonym.

Discussion: Most of the siliceous sponges of the Upper Jurassic required a hard surface on which to attach as shown by Müller (1978). The sponges colonized already calcified fossil sponges or algal crusts. They would have had difficulty in anchoring themselves in soft muddy sediment. This is documented by the almost complete absence of sponges in the muddy Dogger, except in association with hard surfaces such as oyster banks. How, then, did sponge reefs establish themselves in the marls of the Lower Oxfordian?

Gaillard (1983, p. 139) hypothesized the existence of a "pioneer sponge" but had no organic evidence.

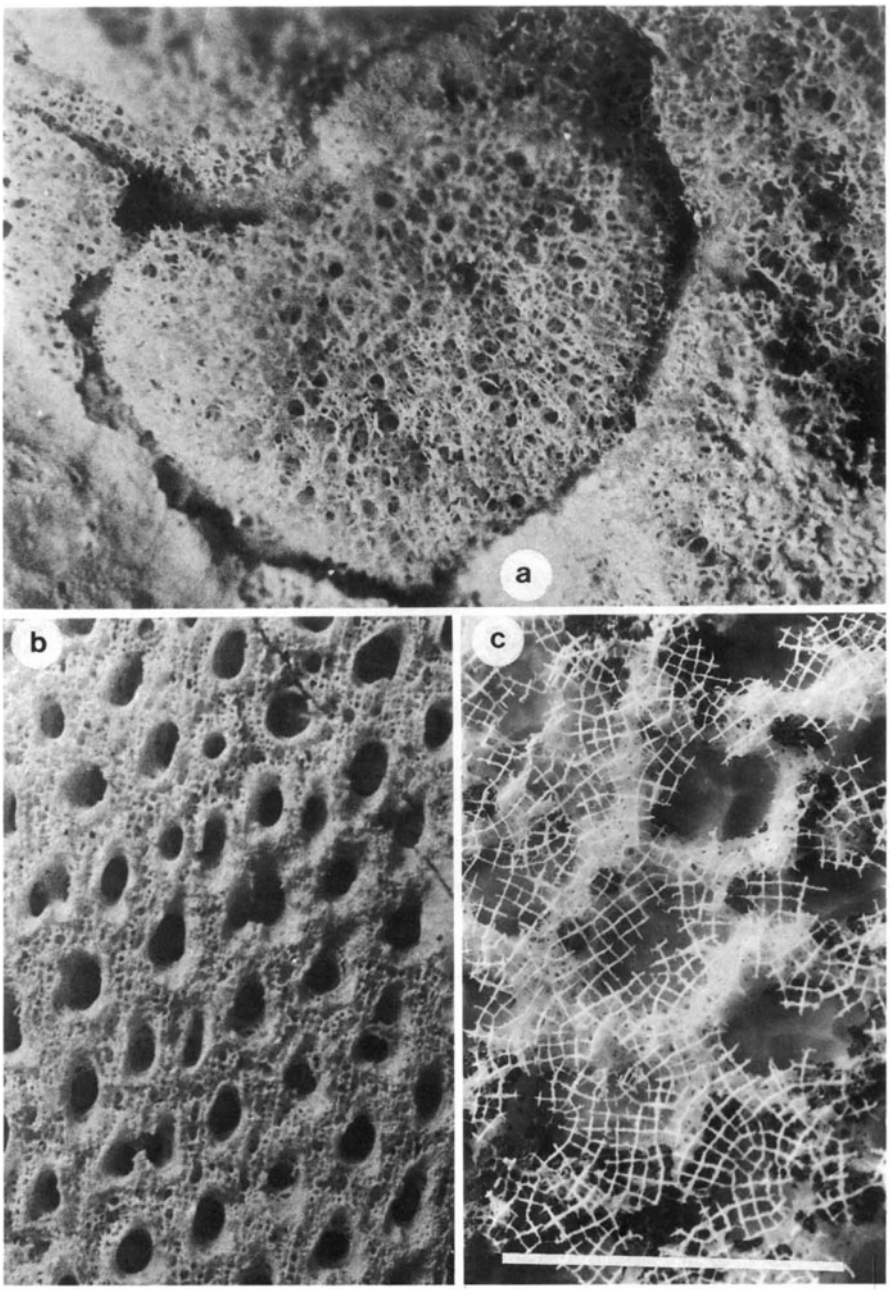

Fig. 3. **a** *Tremadictyon radicatum*. The same specimen as Fig. 2. View of the top of a root system; the outside a fine-meshed skeleton with numerous fine channels. **b** *Tremadictyon radicatum*. The same specimen as Fig. 2. Ostia occurring in oblique rows on the outer surface of the main sponge body. **c** *Tremadictyon* sp. Kimmeridgian (Weissjura Gamma). Erkenbrechtsweiler Steige. A delicate layer of stauractins covering the entire sponge body. Scale = 1 cm

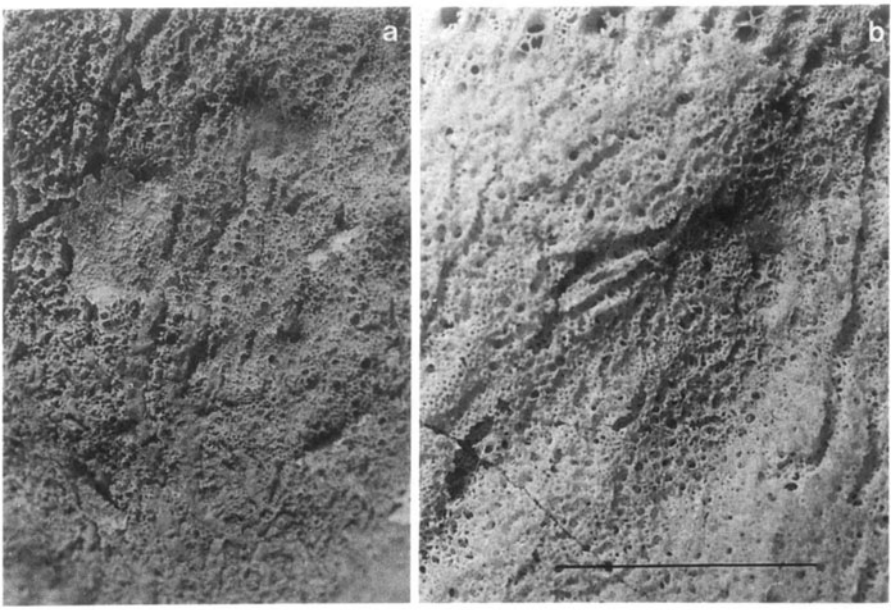

Fig. 4. *Tremadictyon radicatum* (Quenstedt), the same specimen as Fig. 2. Two different views (**a,b**) on the outer side of the root clod showing the complex intake system with irregular throughs and fine pores. Scale = 1 cm

Förster and Schairer (1987) dug out an entire Oxfordian reef near Biburg (Frankenalb) and found that, directly below the bioherme, isolated rests of great plate-shaped sponges occur. Hence, they are of the opinion that the growth of the bioherme, or its lateral expansion, began with the colonization by a few plate-shaped sponges, for example *Stauroderma* or *Tyroidium*. However, neither genus possesses any organs qualified to settle in a soft sediment, added to which, *Tremadictyon* and *Stauroderma*, when badly preserved, cannot be differentiated.

Very important are the reports from Wiedenmayer (1978) concerning the examination of living sponge reefs of the Great Bahama Bank: "Some species of sponges, chiefly Hauromenids, are believed to be responsible for early lithifications" (Müller: penetrating the sediment with its base) "*Spheciospongia vesparium* (Lamarck) is by far the most important of these species."

In a comparison with the exact information of Wiedenmayer (1978), the sponge *Tremadictyon* described here shows some correspondence:

Spheciospongia as well as *Tremadictyon* are able to anchor themselves in soft sediment. Both sponges built debris into its base. Both sponges have developed two different mechanisms for water intake into the base or into the main sponge body. Both sponges were able to found new reefs. Therefore *Tremadictyon radicatum* may be a "pioneer sponge". But further investigations are necessary.

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