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Middle Triassic lyssacinosan sponges from Upper Silesia (southern Poland), and the history of hexactinosan and lychniscosan sponges

ABSTRACT: The allegedly hexactinosan sponges from the Anisian of the Polish part of the Middle Triassic (Muschelkalk) basin have been found to represent two new lyssacinosan genera and species: *Hexactinoderma trammeri* gen. et sp. n., and *Silesiaspongia rimosa* gen. et sp. n. It is suggested that the net-like or cubic organization of megascleres known from some Paleozoic forms (regarded as dictyid) are features only superficially resembling true dictyonal strands known in the Mesozoic and Recent hexactinosan sponges. The lychniscosan sponges are as yet unknown before the Jurassic.

INTRODUCTION

The hexactinellid sponges are rare and poorly known in the Triassic. The first records of bodily preserved specimens refer to the Middle Triassic of Upper Silesia (ECK 1865, RAUFF 1937), with "*Tremadictyon roemeri* RAUFF, 1937", being commonly regarded as the oldest hexactinosan sponge. Recently, a relatively well preserved fauna of the hexactinellid sponges (associated with lithistid and calcareous sponges) from the Carnian Cipit-Kalke of the southern Tirol has been described by KEUPP & *al.* (1989). So far the best preserved hexactinellid sponge has been described by RIGBY & GOSNEY (1981) from the Lower Triassic of Utah (USA). Exceptionally diversified siliceous sponge fauna from the Triassic of China, has also been recently reported, but the systematic position of some forms remains unclear (*see* WU XICHUN 1989a, b, 1990; WENDT & *al.* 1989; and the discussion below). Isolated spicules of hexactinellid sponges were described in some details by MOSTLER (1976, 1978).

The present paper deals with the material collected by the junior author (A. BODZIOCH) from the same stratigraphical levels and area as the sponges described by RAUFF (1937), and referred to in earlier papers (BODZIOCH 1990, 1991). Many specimens in this sponge fauna have the original siliceous spicules preserved and not calcified, as it is often the case.

The investigated material is housed in the Institute of Paleobiology, Polish Academy of Sciences (Warsaw), for which the abbreviation *ZPAL* is used.

GEOLOGIC SETTING

The sponges have been collected in the Karchowice Beds cropping out in the western part of Silesia, south-western Poland in such localities as Tarnów Opolski, Kamień Śląski, Szymiszów, Strzelce Opolskie, and Góra Świętej Anny (*see* Text-fig. 1). This is the uppermost horizon of the Lower Muschelkalk (*see* Text-fig. 2) of Anisian age (ASSMANN 1944, ZAWIDZKA 1975). According to BODZIOCH (1989, 1990), the occurrence of sponges is limited to the regressive episode, when extensive crinoidal-shell banks migrated across the present area of Upper Silesia. The sponges colonized top surfaces of the banks which were presumably established within the limits of storm wave base. Subsequent

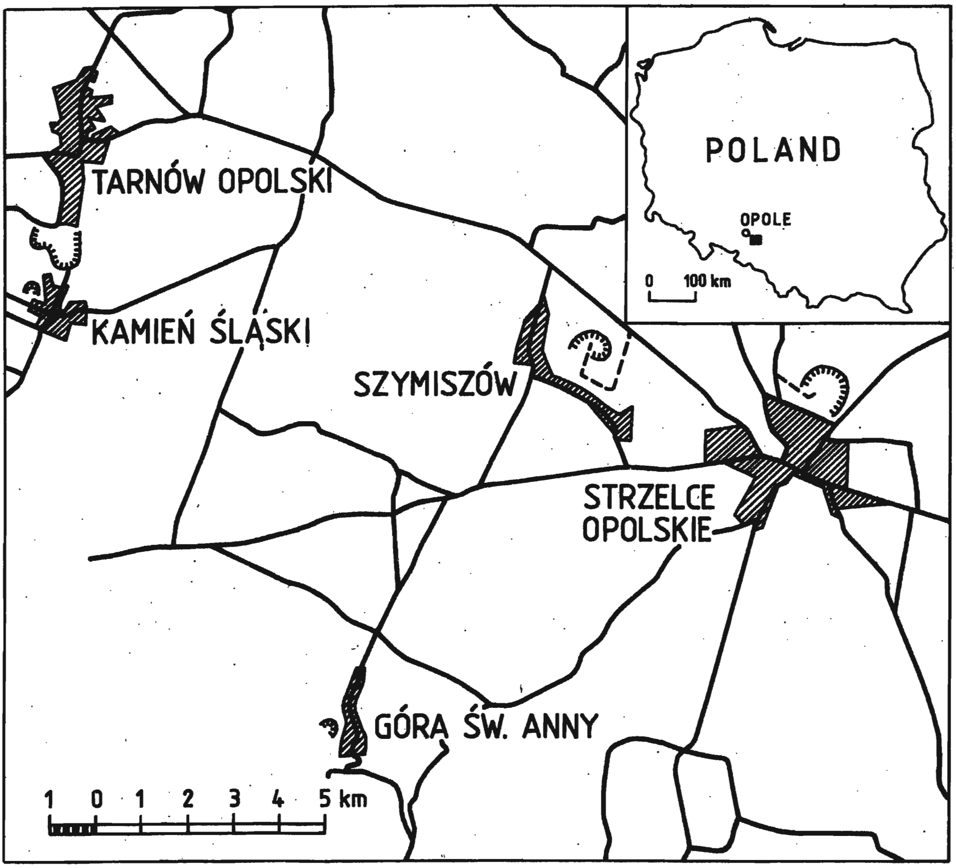


Fig. 1. Situation of the sponge-bearing localities in the western part of Upper Silesia

substitution of sponges with corals (*see* MORYCOWA 1988) is interpreted as an expression of a further shallowing of the basin.

PRESERVATION

The investigated material consists of a dozen whole specimens and wall fragments, as well as abundant isolated spicules (Pl. 3, Fig. 8), and smaller fragments of the main endosomal skeleton. Some specimens are preserved as "mummies" (Pl. 1, Figs 3a-3b) with entirely calcified spicules (Pl. 1.

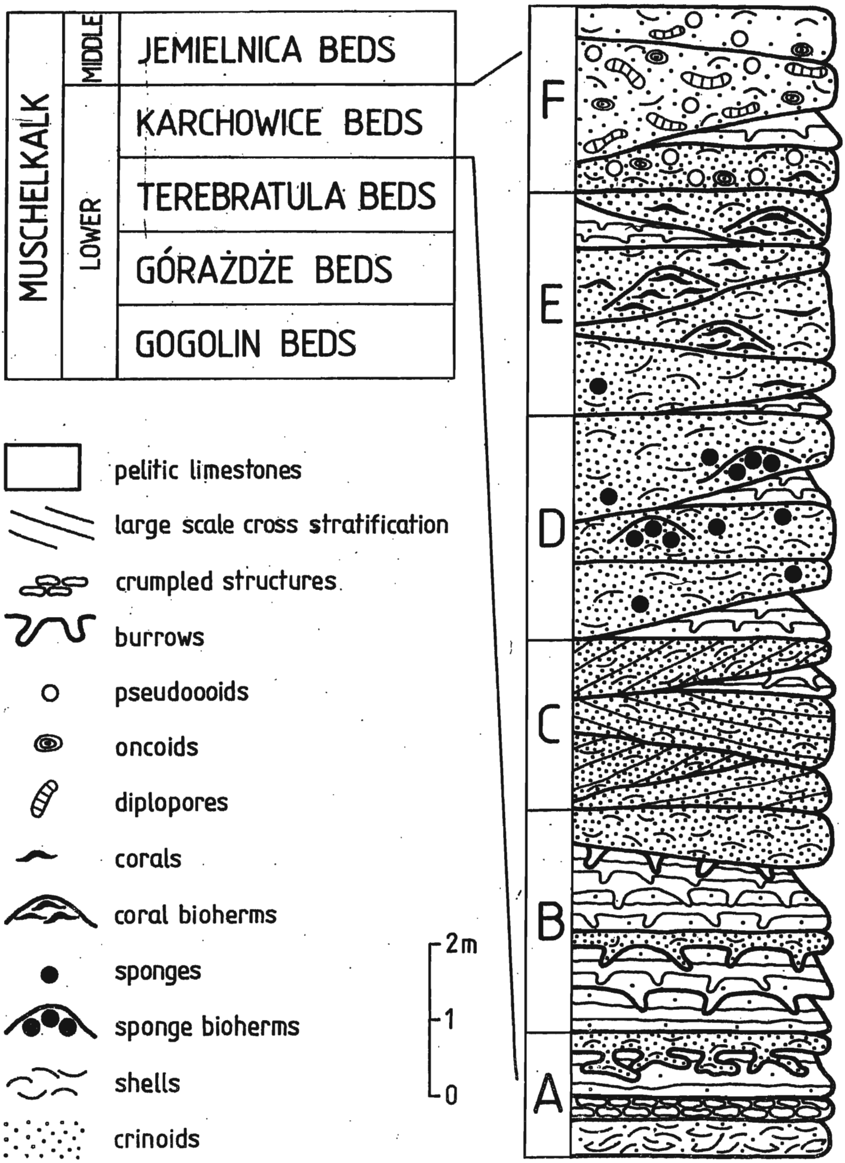


Fig. 2. Stratigraphical position and lithology of the Karchowice Beds

Figs 1–2). Most, however, have retained their original siliceous composition. It allowed to separate them from the rock by etching with acetic acid, and to study their three-dimensional spicular structure. Some details were also investigated in thin sections, prepared both from mummies and original siliceous skeletons. No microscleres have been found in the material under study.

SYSTEMATIC ACCOUNT

Class **Hexactinellida** SCHMIDT, 1897
Order **Lyssacinosa** ZITTEL, 1877
Superfamily **Euplectelloidea** FINKS, 1960

Family **Pileolitidae** FINKS, 1960

REMARKS: The material included here resembles in a character of endosomal megascleres the fossil sponges assigned to the Euplectellidae GRAY, 1867. However, Recent and also fossil euplectellids have no fused dermal (or gastral) layer of the type developed in the investigated material, and parietal gaps which are lacking in the material. Only the Permian genus *Pileolites* of FINKS (1960) has a single layer of similar specialized spicules, but these are more heavy and with thick nodes in the place of the reduced distal ray. The latter genus shows also some layering of the endosomal skeleton noted in the investigated material. Also the canal system seems to be similar. Thus, in the present authors opinion, the material under discussion is more close to *Pileolites* than to the Recent euplectellids, and as such should be included into the Pileolitidae FINKS, 1960. On the other hand, a relation of the Pileolitidae FINKS with the Euplectellidae GRAY seems doubtful, as *Pileolites* has different structure of the wall. It was compared with the Euplectellidae mainly because of having solid skeleton composed of fused spicules. In the present authors opinion, this cannot be sufficient for putting them together. Generally, the difficulties in classification of the material under study within the framework of Recent lyssacinosan families seem normal, because of evolutionary changes which one may expect since the Triassic.

Genus *Hexactinoderma* gen. n.
Type species: *Hexactinoderma trammeri* sp. n.

DERIVATION OF THE NAME: The name is referring to the type of spicules forming the dermal layer.

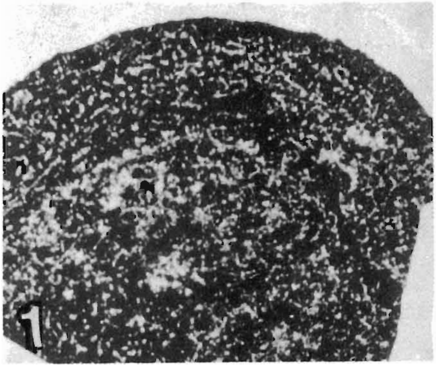
DIAGNOSIS: Thick-walled lyssacinosan sponges with clearly differentiated dermal and gastral layers of similar character, built of fused hexactines of various size and differentiated length of rays, which are covering entirely the openings leading to numerous canals perforating the wall radially; these canals can branch.

PLATE 1

1-2 — Thin sections of undeterminable mummified lyssacinosan sponges with totally calcified spicules; note some layering of the skeleton; Strzelce Opolskie; 1 — transverse section, ZPAL PfV/12, × 5; 2 — longitudinal section, ZPAL PfV/13, × 10

3 — Outer view of mummified lyssacinosan sponge resembling *"Tremadictyon" roemeri* RAUFF [the absence of well preserved skeleton precludes exact determination]; ZPAL PfV/14, × 1.2; Strzelce Opolskie; 3a — side view, 3b — top view

4 — *Silesiaspongia rimosa* gen. n., sp. n.; **holotype** (ZPAL PfV/21), × 1.4; Szymiszów; 4a — view of the interior, 4b — view of the outer surface of endosomal skeleton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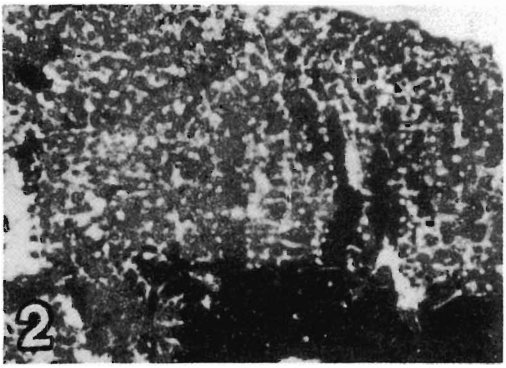
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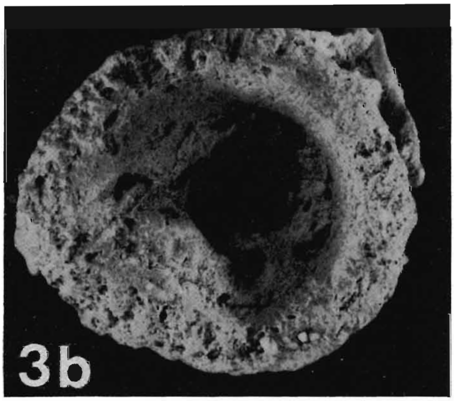
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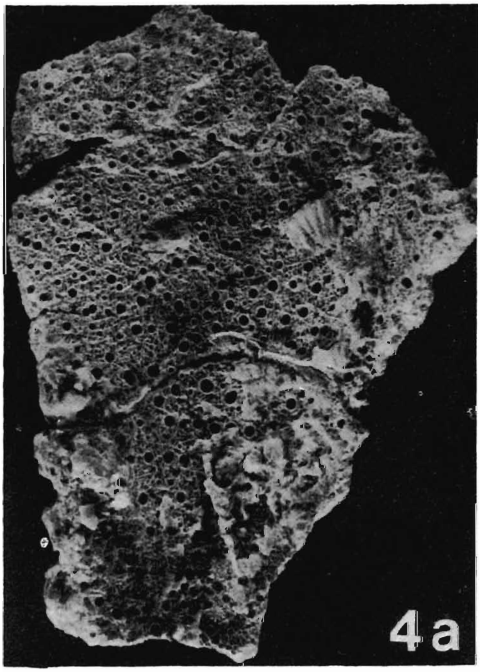
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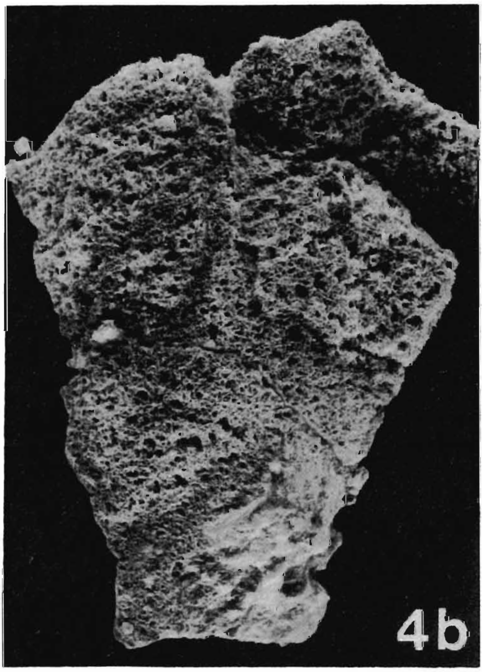
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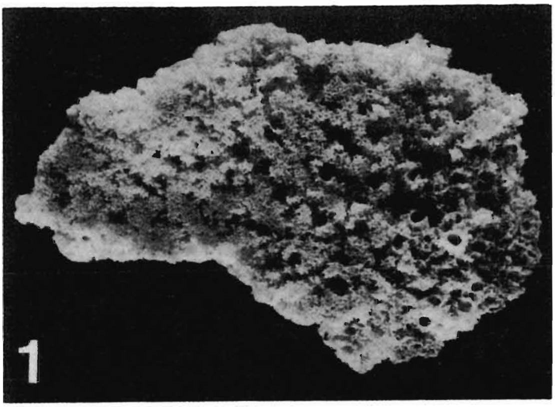
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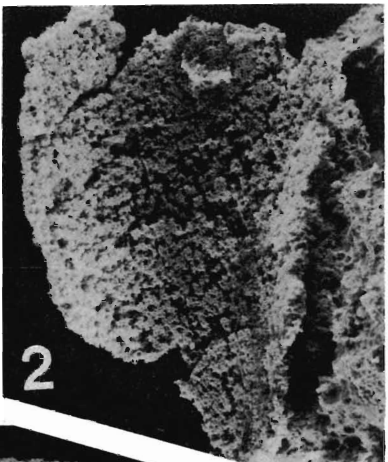
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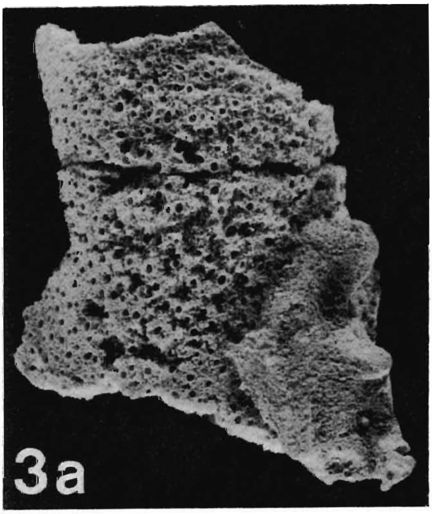
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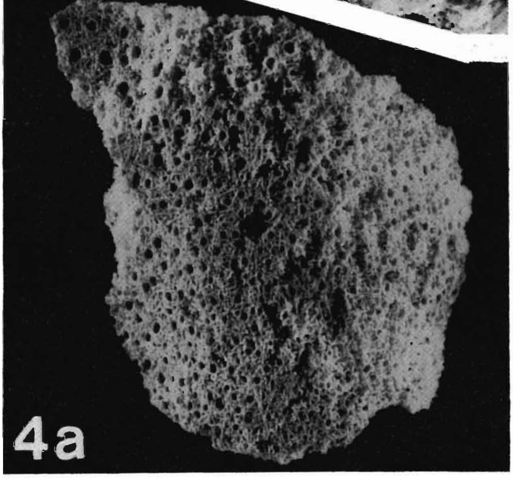
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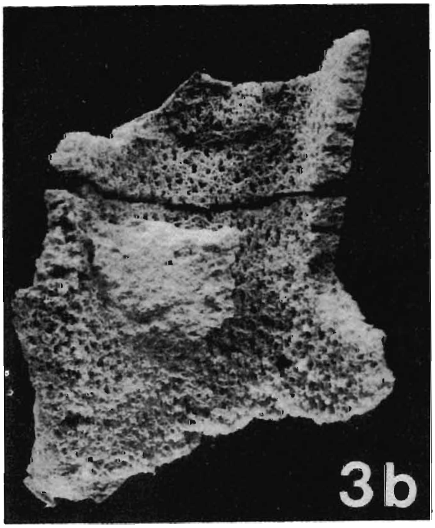
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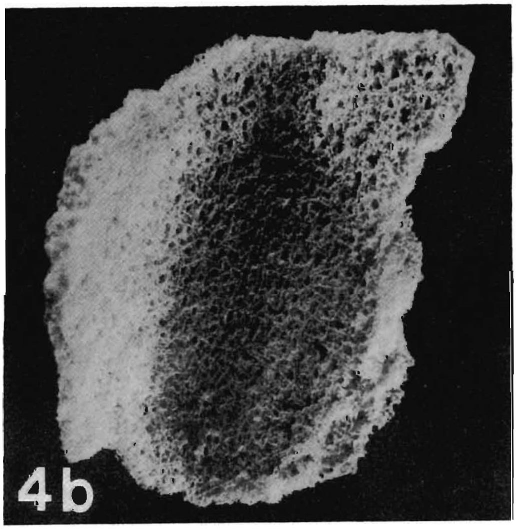
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REMARKS: Fused dermal layer (covering at least on the basal side canal openings) built of specialized hexactines is known in *Pileolites baccatus* FINKS. This latter species has also endosomal skeletal net very similar to the one observed in *Hexactinoderma*. The difference is in the shape of the sponge, which is encrusting and flat to shallow cone in the case of *Pileolites*, and deep cup or tube in the case of *Hexactinoderma*. What is more important, a dermal layer of *Hexactinoderma* has no spherical knobs in place of distal rays of these dermal specialized spicules. The new genus resembles also the genus *Cypellospongia*, described by RIGBY & GOSNEY (1981) from the Triassic of Utah. The fragments of the material indicate that *Hexactinoderma* differs in general shape, displaying similarities of spicular structure. The dermal layer, noted by RIGBY & GOSNEY (1981) in one specimen only, consists also of hexactines, being however very delicate and showing different organization and shape of hexactines. The openings in the wall of *Cypellospongia* were interpreted as parietal gaps, while in the investigated material they must be rather regarded as the openings of a true canal system which can branch inside the wall. Despite the presence of the fused dermal layer, RIGBY & GOSNEY (1981) included their new genus into the Euplectellidae.

Hexactinoderma trammeri sp. n.
(Text-figs 3A-3B; Pl. 2, Figs 1–2; Pl. 3, Figs 9–10; Pl. 7, Figs 1–5; Pl. 8, Figs 1–3)

HOLOTYPE: Specimen ZPAL PfV/20; figured in Pl. 2, Figs 1–2.
TYPE LOCALITY: Strzelce Opolskie, southern Poland.
TYPE HORIZON: Karchowice Beds, Middle Triassic (Anisian).
DERIVATION OF THE NAME: In honor of Dr. Jerzy TRAMMER (University of Warsaw), a prominent student of fossil sponges.

DIAGNOSIS: Thick-walled, cup-shaped lyssacinosan sponge with totally fused skeleton and with wall pierced by numerous canals. Dermal and gastral layers well developed (covering entirely also canal openings) and built of totally fused hexactine spicules with strongly reduced distal ray and strongly elongated proximal one; tangential rays of intermediate length; proximal ray penetrating deeply into endosomal skeleton.

MATERIAL: Two large fragments and numerous isolated small parts of dermal layer and endosomal skeleton.

DESCRIPTION: The exact shape of this sponge is unknown as studied were only fragments; they permit to suppose that it was cup-like (Pl. 2, Fig. 2) and had a relatively thick wall (up to 2 cm). The wall is pierced by numerous openings (Pl. 2, Fig. 1; Pl. 7, Figs 1a-1b; Pl. 8, Figs 1a-1b), covered by dermal layer of hexactine fused spicules, round in shape and measuring from 0.4 mm to 1.6 mm in diameters, usually 0.8 to 1.2 mm wide. These openings may be separated by a distance of up to 3 diameters, but are rather irregularly but evenly distributed over the whole surface (Pl. 8, Fig. 1a). The openings are present on both sides of the sponge and they lead to the canals piercing radially the wall (Pl. 8, Fig. 1c); some of them can branch. The outer layer of fused hexactines is present on both sides of the sponge (Pl. 2, Figs 1–2) and has there similar character. It consists of hexactines with the strongly elongated proximal ray (Pl. 7, Fig. 5) which penetrates deeply, more or less perpendicularly, the endosomal skeleton (Pl. 8, Fig. 1c). Distal rays are strongly reduced (Pl. 7, Figs 2, 5). Other rays

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PLATE 2

1-2 — *Hexactinoderma trammeri* gen. n., sp. n.; 1 — Outer view of a fragment of the wall with partly preserved dermal layer; ZPAL PfV/5, × 1.3; Góra Świętej Anny; 2 — View of the interior with preserved gastral layer, **holotype** (ZPAL PfV/20), × 0.87; Strzelce Opolskie

3-4 — Fragments of *Silesiaspongia rimosa* gen. n., sp. n.; ZPAL PfV/2, Strzelce Opolskie; 3a — outer view, 3b — view of the interior, × 1.4; 4a — exterior view, 4b — interior view, × 1.9

are oriented more or less tangentially in relation to the endosomal skeleton and have more or less equal length (Pl. 7, Figs 2, 5). The hexactines in the dermal layer are arranged without any pattern (Pl. 7, Figs 1b, 2; Pl. 8, Figs 1a–1b, 3) and fused at the points of contact forming a rigid layer which is also fused by the way of proximal rays with the main endosomal skeleton. This outer layer covers openings of the canal system (Pl. 7, Figs 1a-1b; Pl. 8, Fig. 1b). Endosomal skeleton composed of fused hexactines and their derivatives (Text-fig. 3; Pl. 8, Fig. 2), up to diactines, with rays of various length; sometimes in the interior slender hexactines with curved rays may be observed. Spicules of endosomal skeleton are irregularly organized, but in many places some traces of more or less vertical (*i.e.* perpendicular to the wall surface) orientation of many spicules or their longer rays are visible (Pl. 7, Fig. 1c). The skeleton is more dense and more tangentially organized near the surface (Pl. 7, Fig. 4) while in the interior is much looser so that individual spicules may be recognized (Pl. 8, Fig. 2). Sometimes two, or a bundle of diactine spicules running more or less parallel are united in several points by numerous synapticules forming thus a ladder-like structure (Pl. 3, Fig. 10; Pl. 7, Fig. 1c). Generally, however, the organization of the endosomal skeleton is the subject of strong variation and may differ strongly even in one specimen.

Family ?**Euplectellidae** GRAY, 1867

REMARKS: The sponges under discussion differ from typical euplectellid sponges in having a thick endosomal skeleton and true canalization system, and no parietal gaps which are known from the Recent *Euplectella.* Also the specialized layer of outer diactine spicules is different than known in the Recent species. On the other hand, loose spicules found in the same rock sample and interpreted here as dermal spicules belonging to that species are identical with those known in the Recent *Euplectella* species. Considered here sponges differ also from *Pileolites.*

Genus *Silesiaspongia* gen. n.

Type species: *Silesiaspongia rimosa* sp. n.

DERIVATION OF THE NAME: The name is referring to the region of Silesia, where the sponges were found.

DIAGNOSIS: Thin-walled, cup-shaped lyssacinosan sponge with an outer layer of the endosomal skeleton formed by long diactine spicules which do not cover canal openings.

Silesiaspongia rimosa sp. n.

(Pl. 1, Fig. 4; Pl. 2, Figs 3–4; Pl. 4, Figs 1–3)

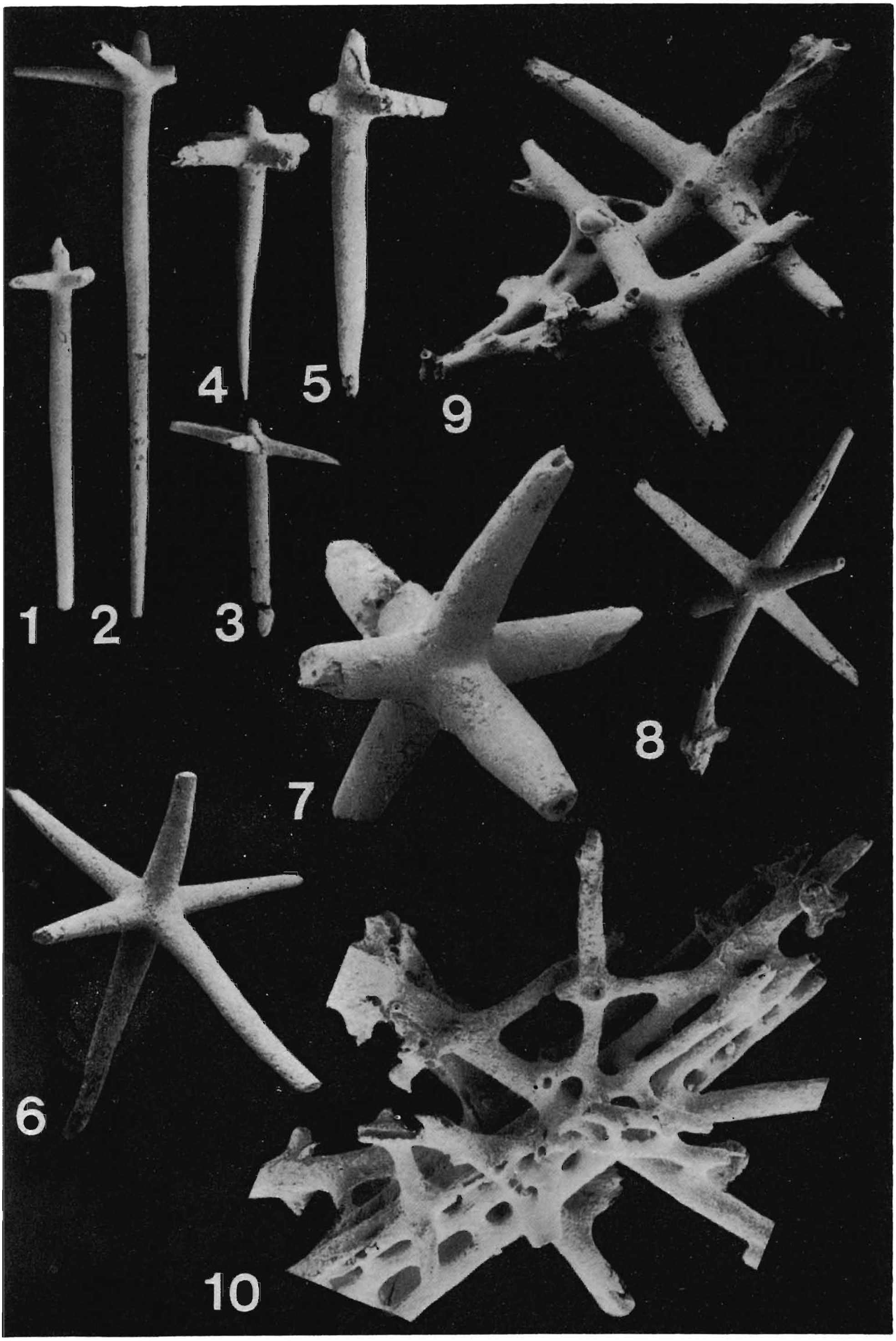
HOLOTYPE: Specimen ZPAL PfV/21; figured in Pl. 1, Figs 4a–4b.
TYPE LOCALITY: Szymiszów, southern Poland.
TYPE HORIZON: Karchowice Beds, Middle Triassic (Anisian).
DERIVATION OF THE NAME: The name is referring to the numerous holes perforating the sponge wall.

PLATE 3

1-8 — Variously shaped loose hexactine spicules associated with the investigated lyssacinosan sponges, probably belonging to *Silesiaspongia rimosa* gen. n., sp. n.; ZPAL PfV/6, × 25; Strzelce Opolskie

9 — Fragment of dermal fused hexactines from *Hexactinoderma trammeri* gen. n., sp. n.; top view, ZPAL PfV/6, × 50; Strzelce Opolskie

10 — Fragment of the endosomal skeleton of *Hexactinoderma trammeri* gen. n., sp. n., with a hexactine (*top center*) and a bundle of diactines connected by synapticules forming ladder-like structure; ZPAL PfV/5, × 80; Góra Świętej Anny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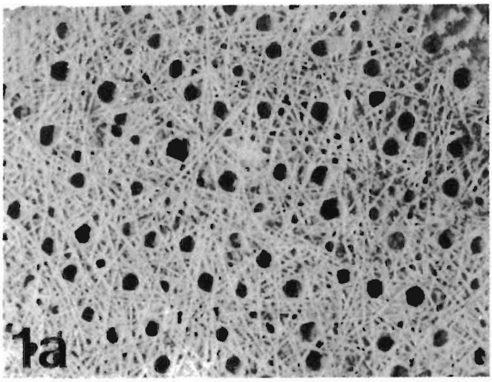
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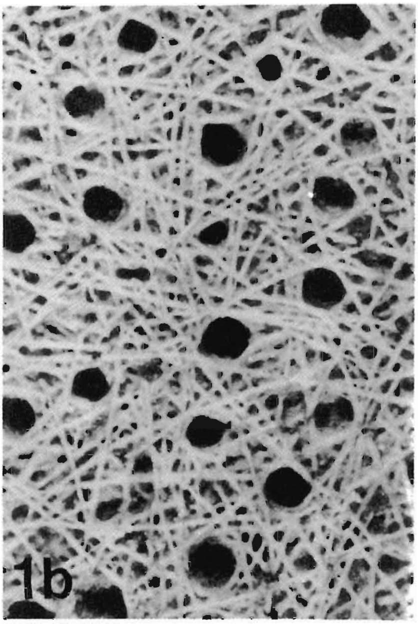
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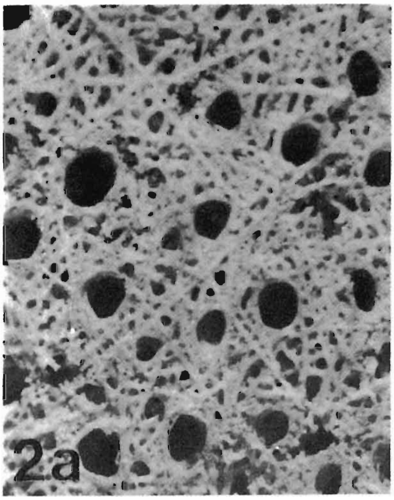
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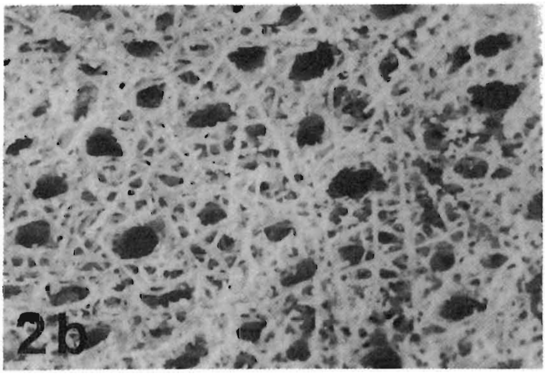
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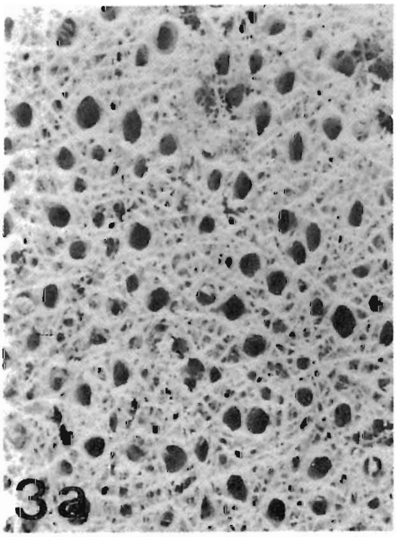
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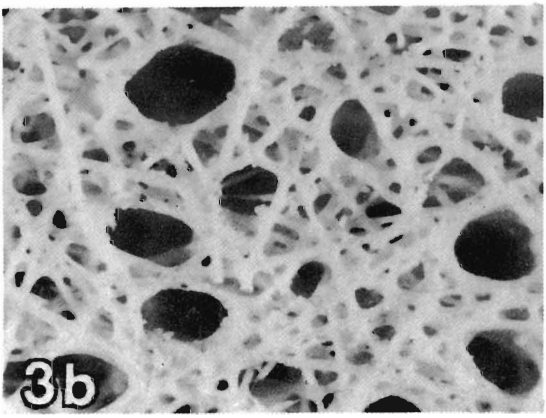
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DIAGNOSIS: Thin-walled, tubular to wide cup-shaped lyssacinosan sponge, often with strongly plicated wall and totally fused skeleton built of confused hexactines, and hexactine-derivative spicules (especially diactines). The wall pierced by numerous canals. External surfaces built of endosomal spicules mostly of diactine type organized tangentially to the surface and forming clearly differentiated outer layer which does not cover canal openings.

MATERIAL: Three large fragments and numerous small parts of endosomal skeleton.

DESCRIPTION: The exact shape of this sponge is unknown as only fragments are preserved, and thus the position of dermal and gastral layers is only inferred, One can guess, however, on this basis that the sponge was tubular to wide cup-shaped (Pl. 1, Figs 4a-4b; Pl. 2, Figs 3–4), rather large (not less than 7 cm high and with the diameter up to 5 cm). The wall was rather thin, usually 0.4 cm thick, often strongly plicated. Basal parts are rounded or node-like with spongocel penetrating into them. On the larger fragments, which belong to the upper portion and/or larger specimens, there are clearly two series of openings (Pl. 1, Fig. 4; Pl. 4, Figs 1a, 2a) leading to the canals penetrating the whole wall. Larger ones, circular to ellipsoidal with vertical elongation usually measure 1–1.25 mm across and are equally but irregularly distributed on the whole surface. They are usually 2 mm apart (but may be up to 3 mm apart), in some cases however, situated very closely. In smaller fragments which belong to smaller and/or lower part of the sponge these openings are also smaller and more densely and equally spaced, measuring usually 0.5–0.75 mm across. There is no clear differentiation of two series of openings differing in size. There is rather entire spectrum from small to large openings, but average ones dominate (Pl. 4, Fig. 3a; Pl. 5, Figs 1, 2a). The small openings, where existing, are irregularly dispersed among larger ones and measure on average 0.25 mm, but can be even 0.5 mm in diameter. Both series of canals are penetrating radially the whole wall without division, or are divided into 2 separate canals within the wall. It concerns mostly larger canals. At least some smaller canal openings are simply the openings of larger canal branches from the opposite side of the wall. On smaller specimens, and near the sponge base, the density of these openings is much higher. The canal walls are limited by spicules rays, sometimes thickened, thus limiting the size of skeletal meshes on the canal wall (Pl. 6, Figs 1, 3a–3b). The canals reappear on the opposite side of the wall as elliptical openings, usually with smaller diameter (Pl. 4, Fig. 3a), what is caused by a little diagonal orientation and division into branches.

The spicules which represent hexactines and their derivatives with various length of rays are totally fused and not oriented, and crossing at various angles (Pl. 5, Figs 2b, 3a–3b, 4; Pl. 6, Figs 2–5). They are more densely spaced near the wall margin and usually show there larger size, being more or less parallel to the surface. Spicules in the interior of the wall are more loosely spaced. It allows to recognize the presence of hexactines with equal and slender rays as well as such with some rays reduced, even diactines (Pl. 5, Fig. 4). Specialized external layer of endosomal skeleton exists on both sides and is composed of a very long (up to 2 cm) diactines organized tangentially to the surface (Pl. 4, Figs 1–3; Pl. 5, Fig. 2a). This layer does not cover, however, canal openings being the part of endosomal skeleton (Pl. 4, Figs 1a–1b, 2a).

PLATE 4

Silesiaspongia rimosa gen n., sp. n.

1 — View of endosomal skeleton displaying well developed outer (most probably gastral) tangential layer of long diactines and pierced by numerous canal openings of various size; note this layer does not cover canal openings; ZPAL PfV/1; Tarnów Opolski; 1a × 6; 1b × 16; **2-3** — Specimen ZPAL PfV/2, × 16; Strzelce Opolskie; 2a — exterior view; 2b — interior view; 3a — gastral surface showing canal openings (only some diactines from the tangential layer preserved), × 12; 3b – detail of 3a, × 40

REMARKS: Endosomal skeleton of this species is very variable and shows strong difference even in one specimen. Its appearance depends strongly on the preservation state and, of course, orientation of the section.

This species resembles mostly *Hexactinoderma trammeri* gen. n., sp. n. in the general character of endosomal skeleton which shows tendency to parallel (to the wall surface) organization of some parts of the skeleton, rather than perpendicular one, present sometimes in *Hexactinoderma trammeri* gen. n., sp. n. It differs in the absence of the fused outer layer of specialized hexactine spicules covering openings of the canal system.

ISOLATED SPICULES

Numerous loose single spicules in the residue after dissolving the sponge-bearing rock in acetic acid are invariably hexactines, but of a much variable morphology.

Some of them are slender with a very short distal ray and very long proximal one, while tangential rays are of intermediate length (Pl. 3, Figs 1–5). Other hexactines have approximately equal slender rays (Pl. 3, Figs 6–8), yet others being very stout (Pl. 3, Fig. 7). These spicules closely resemble loose dermal spicules in the Recent euplectellids (*see* SCHULZE 1887; *and* IJIMA 1927), thus they are herein interpreted as dermal spicules of one of the investigated forms, perhaps of the species *Silesiaspongia rimosa* gen. n., sp. n.

The very abundant, small fragments of endosomal skeleton, much different from those observed in larger fragments are not attributable to any of the investigated species. One type displays no individual spicules recognizable, and fused into a very dense skeletal net, most probably representing a basal (Pl. 8, Fig. 5) and a dermal (Text-fig. 3C) portion of the basal skeleton with the net reinforced by additional silica deposition. Others are more open textured with very delicate spicules (Text-fig. 3D; Pl. 8, Fig. 4) resembling closely *Proeuplectella* MORET, 1926, and which may belong to a young specimen, for example.

REMARKS ON RELATED FOSSIL SPONGES

The sponges most similar to these described in the present paper are *Cypellospongia fimbriartis* of RIGBY & GOSNAY (1981) from the Triassic of Utah, and *Proeuplectella fragilis* of MORET (1926) from the Albian of France. However,

PLATE 5

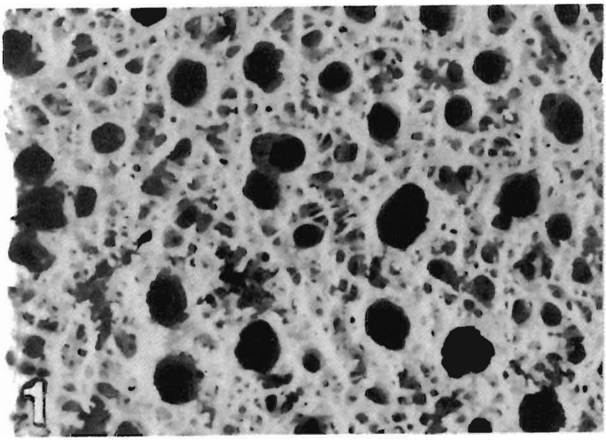
Silesiaspongia rimosa gen. n., sp. n.

1 — View of the endosomal skeleton with numerous variously sized canal openings (outer layer of oriented diactine spicules destroyed); ZPAL PfV/4, × 25; Szymiszów

2 — Specimen ZPAL PfV/4, × 12; Szymiszów; 2a — gastral surface showing canal openings and poorly preserved (?developed) outer layer of diactine spicules; 2b — transverse section of the wall, to show irregularly fused spicules forming endosomal skeleton

3 — Transverse sections of the wall showing spicular structure; note some parallel, to the wall surface, orientation of spicules; ZPAL PfV/3, Szymiszów; 3a × 33; 3b × 12

4 — Irregularly fused endosomal skeleton built mostly of hexactine spicules with rays of various length; note, however, long diactine spicule in the center; ZPAL PfV/31, × 24; Strzelce Opolskie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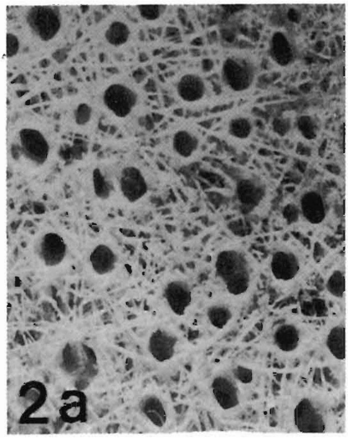
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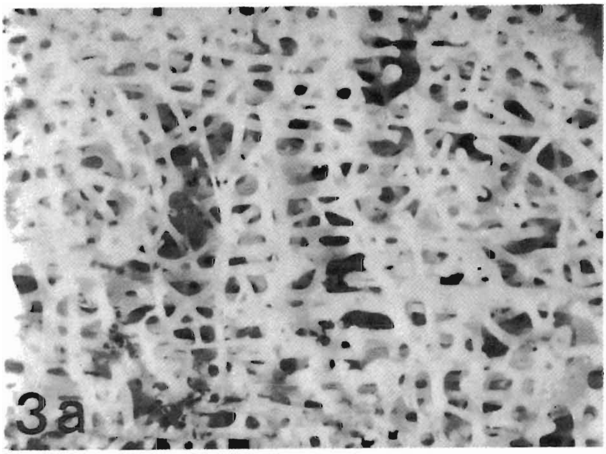
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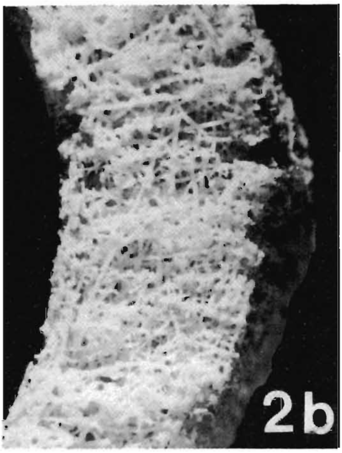
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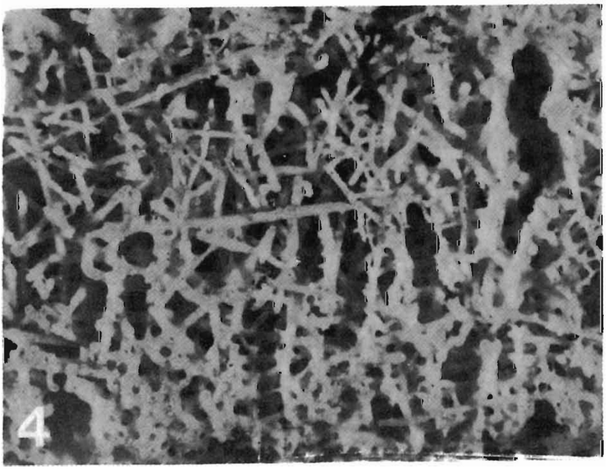
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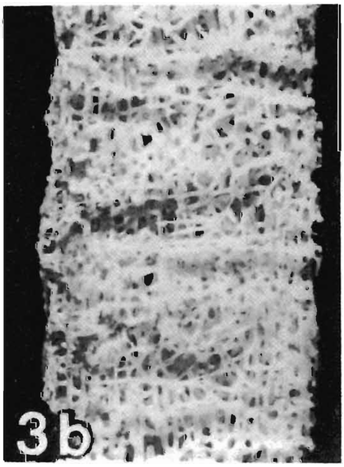
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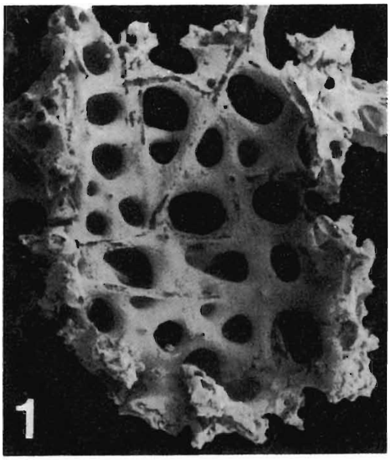
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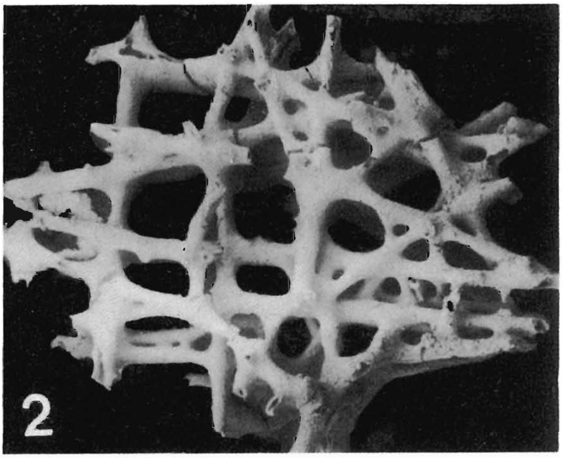
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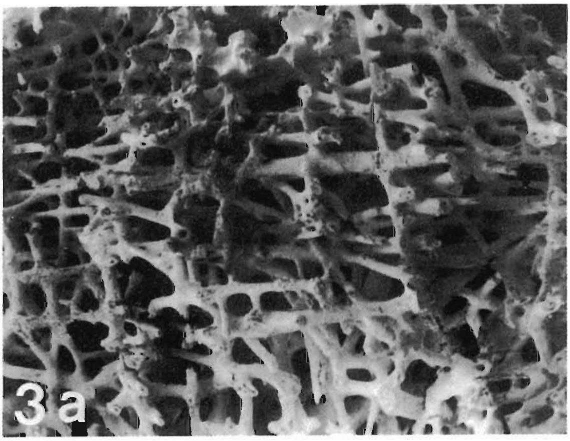
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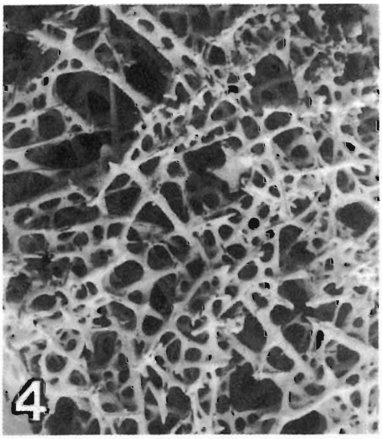
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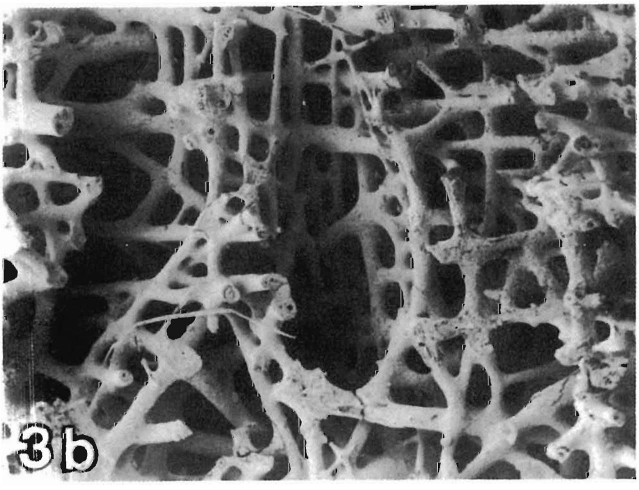
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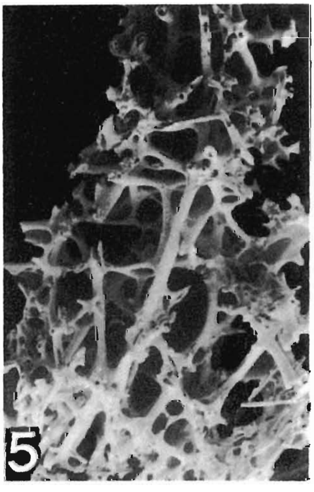
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comparison with this material is difficult because of a fragmentary nature of the material from the Cretaceous and doubts concerning its monospecifity following from observed differences in the wall structure of illustrated fragments (compare for instance: MORET 1926, Pl. 9 Fig. 1 and Pl. 23 Fig. 15 *left*, with his Pl. 23 Fig. 15 *right*). A rich fauna of lyssacinosan sponges from the Liassic deposits of Morocco has been described by DRESNAY & *al.* (1978). However, it is rather poorly preserved and was investigated in thin sections only, thus not allowing for exact determination or comparisons.

TRIASSIC HEXACTINELLID SPONGES AND THE HISTORY OF HEXACTINOSA AND LYCHNISCOSA

For a long time *Scyphia roemeri* ECK, 1865, and *Tremadictyon roemeri* RAUFF, 1937 (commonly regarded as conspecific; *see* discussion hereafter), together with *Casearia* sp. from the Middle Triassic of Germany (FREYBERG 1928), and *Triadocoelia magyara* VINASSA from the Middle Triassic of Hungary (VINASSA 1911) were regarded as the oldest known, respectively, hexactinosan (hexactinellids with hexactines fused into dictyonal strands — *see* REID 1963, 1964), and lychniscosan (hexactinellids with hexactines bearing octahedral nodes) sponges. However, this specimen of *Casearia* sp. is poorly preserved and no spiculation is known, while its morphology is very similar to that of calcareous sponges. Thus, an attribution of that specimen to the Hexactinosa rests doubtful. Evaluation of illustration by VINASSA (1911), of his supposedly lychniscosan sponge reveals a poorly preserved skeleton which displays rather lyssacinosan structure (*i.e.* without dictyonal strands). The only supposed lychnisc node represents in fact a cross section of the hexactine spicule with an axial canal in the central part, displaying no trace of lychnisc (*see also* MOSTLER 1990). Also, the recently reported (WU XICHUN 1990) Late Triassic sponges from China show no octahedral nodes, and so they cannot represent the Lychniscosa.

PLATE 6

Silesiaspongia rimosa gen. n., sp. n.

1 — Fragment of endosomal skeleton showing the canal wall; note narrowing of the meshes by secondary silica deposition; ZPAL PfV/2, × 40; Strzelce Opolskie

2 — Nonoriented fragment of endosomal skeleton; ZPAL PfV/2, × 40; Strzelce Opolskie

3 — Section of endosomal skeleton perpendicular to the wall; surface; ZPAL PfV/3, Szymiszów; 3a — note parallel-like horizontal organization of many rays, × 24; 3b — detail of the preceding figure, to show spicule arrangement around canal, × 37

4 — Section of the endosomal skeleton in a view parallel to the surface wall; note the presence of the ladder-like structure (*top center*); ZPAL PfV/2, × 24; Strzelce Opolskie

5 — Nonoriented section of endosomal skeleton; ZPAL PfV/2, × 30; Strzelce Opolskie

There are also many questions concerning the position and relations between the sponges described by ECK (1865) and RAUFF (1937).

The Jurassic genus *Tremadictyon* ZITTEL, 1877, was established on a material from Germany (*see* ZITTEL 1877, SCHRAMMEN 1937). RAUFF (1937), redescribing ECK's material, and describing the new one had to base his comparisons on rather general morphological characters and measurements of hexactine size. These are unreliable features, and thus many Jurassic genera and species can conform such description. The original material was not available for the study, but even examining the illustration leaves no doubt that the forms described as "*T. roemeri* sp. n." by RAUFF (1937) in fact do not represent hexactinosan ("dictyid") sponges but rather a lyssacinosan one. There is a high probability that under discussion is one of the species here described which come from the same stratigraphical level and area as one of the specimens illustrated by RAUFF (1937, Pl. 1, Figs 1–12). Unfortunately, the features preserved and illustrated by RAUFF (1937) do not allow for precise attribution, except the assignment to Lyssacinosa. It cannot be determined even to the genus level with certainty. Similar shape and thickness of the wall suggest relation with the specimens described here as *Hexactinoderma trammeri* gen. n., sp. n.

On the other hand, the form described as "*Scyphia (?Tremadictyon) roemeri* ECK" by RAUFF (1937), which was never synonymized by RAUFF with his new species *T. roemeri* (he had only written that it probably also represents the genus *Tremadictyon*), has no spicules preserved at all, and differs considerably in shape from "*T. roemeri* RAUFF, 1937". In this situation, "*Scyphia (?Tremadictyon) roemeri* ECK" can be classified only as an undetermined sponge, without more precise attribution, but clearly different from "*Tremadictyon roemeri* RAUFF".

The well preserved specimen from the Triassic (Anisian) of the Alps (TICHY 1975) attributed to the genus *Tremadictyon* represents, as revealed during reexamination of the type material, a lyssacinosan sponge (PISERA, *in prep.*). Recently, KEUPP & *al.* (1989) reported the supposedly *Tremadictyon* (and other hexactinosan sponges) from the Carnian of Southern Tirol. They were observed

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PLATE 7

Hexactinoderma trammeri gen. n., sp. n.

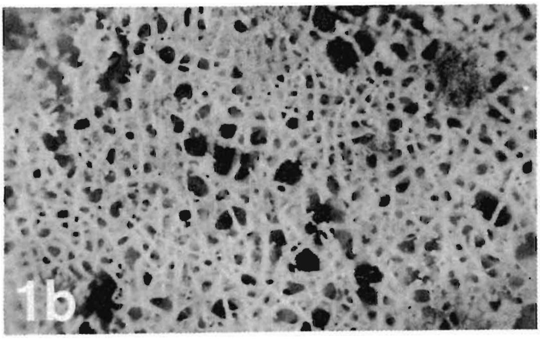
1 — Specimen ZPAL PfV/5, Góra Świętej Anny; 1a — view of the dermal layer; × 6; 1b — detail of 1a, random orientation of dermal spicules is visible, × 16; 1c — section perpendicular to the wall, visible are canals and irregular organization of the spicules, × 12

2 — Top view of the dermal layer spicules; ZPAL PfV/6, × 32; Strzelce Opolskie

3 — Nonoriented section of the endosomal skeleton (no individual spicules can be discerned), ZPAL PfV/5, × 40; Góra Świętej Anny

4 — Section of the sponge perpendicular to the wall surface, outer margin at the top; ZPAL PfV/5, × 24; Góra Świętej Anny

5 — Two hexactines from the dermal layer in natural relations; ZPAL PfV/6, × 32; Strzelce Opolskie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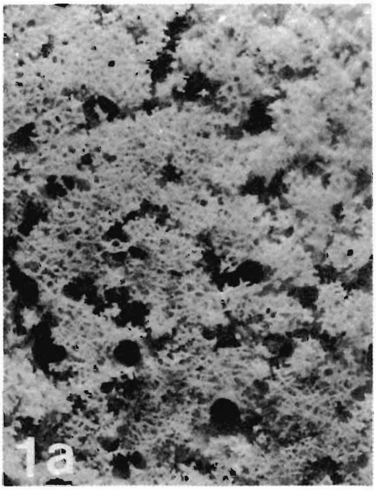
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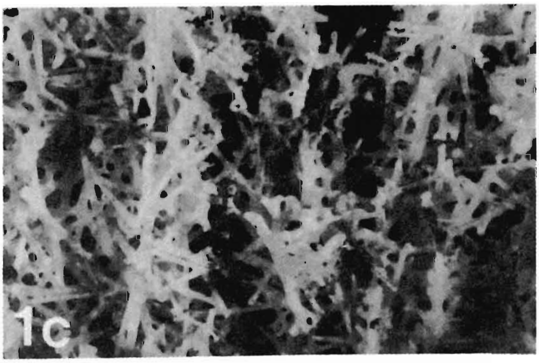
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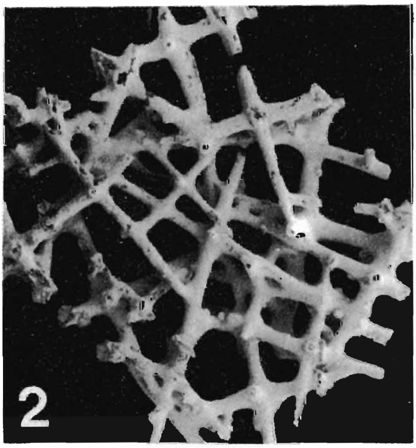
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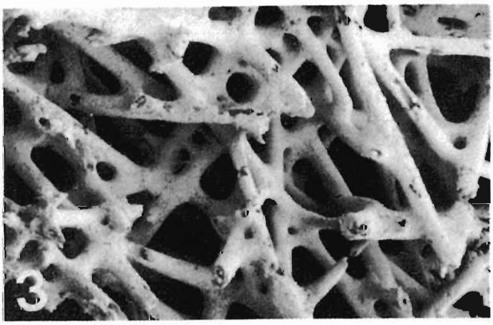
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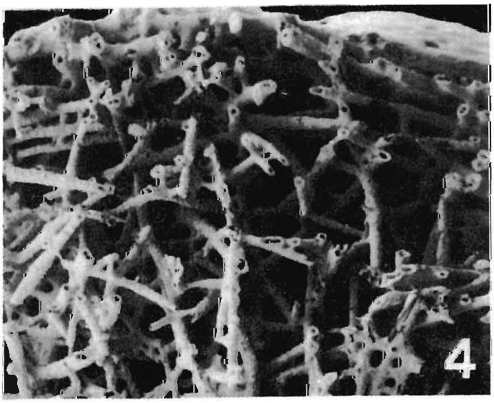
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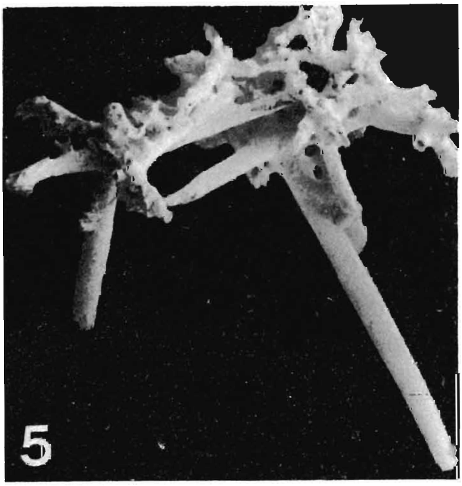
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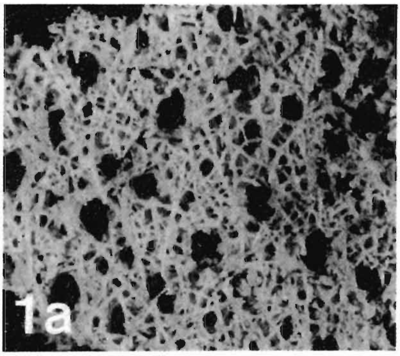
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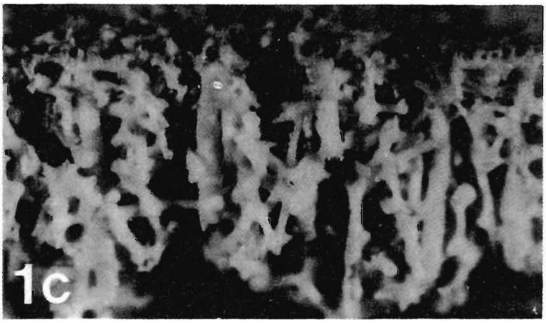
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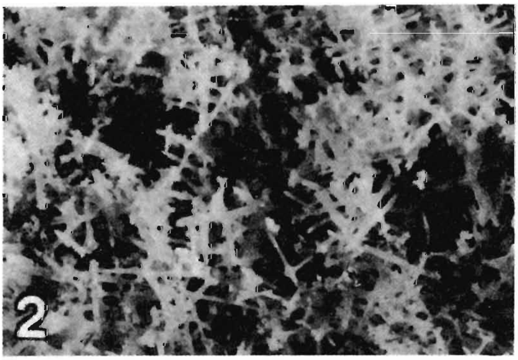
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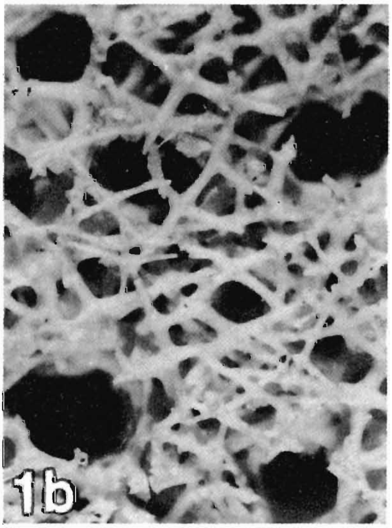
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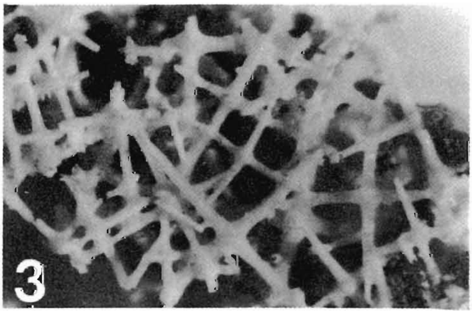
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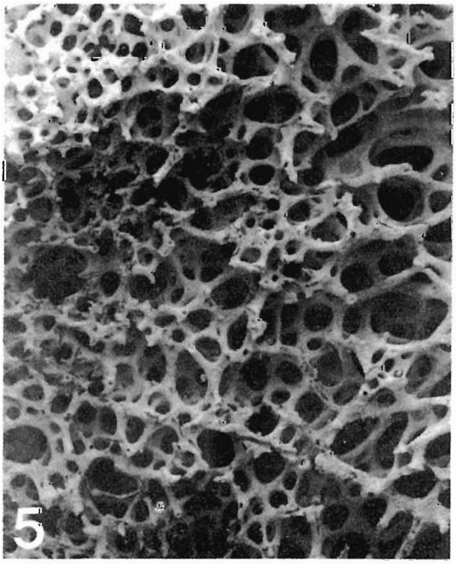
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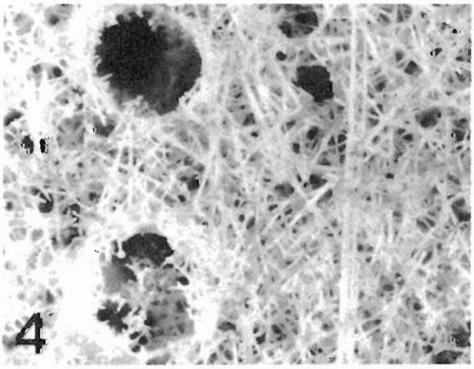
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only in thin sections in which they display undoubtful hexactines organized in dictyonal strands, and as such cannot be conspecific with the forms called *T. roemeri.* On the other hand, KEUPP's & *al.* (1989) material displays no characteristic features allowing for a precise generic and specific attribution. Those described and illustrated conform with many genera, and attribution to the genus *Tremadictyon* seems in fact, the most improbable. Also, the small size of these specimens makes any attribution very difficult. On the other hand, Late Triassic (Carnian) sponges from China attributed to the Lychniscosa (WU XICHUN 1990) show very regular skeleton of fused hexactines without lychnisc nodes, and most probably belong to the Hexactinosa; this diversified fauna is rather advanced evolutionary and it morphologically resembles Upper Jurassic one.

In summary, none of the so far described Triassic species can be assigned to the genus *Tremadictyon.* The specimens described by ECK (1865) can be classified only as undeterminable sponges, and those described by RAUFF (1937) and TICHY (1975) are the lyssacinosan sponges with skeleton composed of fused hexactine and hexactine derivative (diactine) spicules, but without dictyonal strands. Thus, most probably the oldest hexactinosan sponges are those of Late Triassic age described by KEUPP & *al.* (1989), WENDT & *al.* (1989), and WU XICHUN (1990).

Isolated spicules and fragments of endosomal skeleton of the hexactinosan sponges have also been described earlier by MOSTLER (1976, 1978). The most recent reports by this author (MOSTLER 1986, 1990) extend the hexactinosan history deeply into the Paleozoic. The reasoning remains not clear, however, as MOSTLER (1990) refers only to microscleres in his paper, while generally accepted definition of the Hexactinosa describes them as hexasterophoran sponges with fused skeleton built of dictyonal strands (*see* FINKS 1983, HARTMAN 1983). Thus,

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PLATE 8

1-3 — *Hexactinoderma trammeri* gen. n., sp. n.

1 — Specimen ZPAL PfV/20, Strzelce Opolskie; 1a — view of the gastral surface showing canal openings and partly preserved gastral layer of specialized hexactines, × 15; 1b — detail of 1a, showing hexactines in the gastral layer, × 32; 1c — section of the wall (gastral surface at the top) showing long distal rays of hexactines from the gastral layer penetrating deeply into endosomal skeleton, × 24

2 — Interior of the endosomal skeleton (nonoriented section) where spicules are less tightly distributed thus allowing for recognition of individual hexactines; ZPAL PfV/5, × 12; Góra Świętej Anny

3 — Fragment of the gastral layer showing well developed hexactines randomly fused; ZPAL PfV/6, × 35; Strzelce Opolskie

4 — Undeterminable fragment of a very delicate endosomal skeleton resembling *Proeuplectella*; ZPAL PfV/6, × 24; Strzelce Opolskie

5 — Undeterminable, dense irregular endosomal skeleton, probably from the sponge base; ZPAL PfV/6, × 32; Strzelce Opolskie

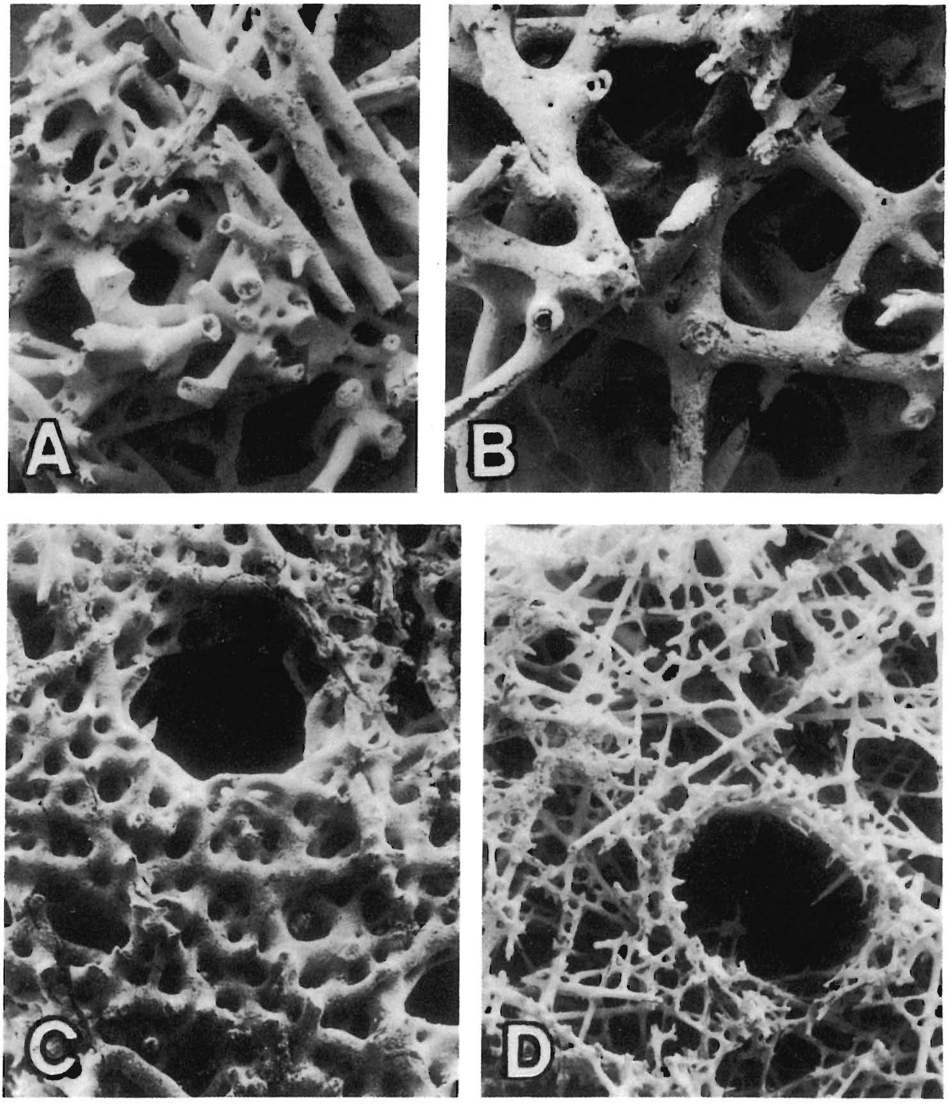
the presence of hexasters cannot be used as the evidence for a long Paleozoic history of the Hexactinosa.

In other recent report of Triassic sponges from China, WU XICHUN (1989) refers to the exceptionally rich and diversified material of siliceous sponges. However, in the text either the material is attributed to the Lyssacinosa and "Lithistida" (WU XICHUN, p. 172), or as consisting of the Lychniscosa and Lyssacinosa (p. 180). The illustrations show only a general sponge morphology, and the illustrated spicules (WU XICHUN 1989, Pl. 40, Figs 2–4) can be ascribed neither to the Lychniscosa nor Hexactinosa. Also WENDT & *al.* (1989) mentioned the sponges from the same formation; illustrated is an undoubtful hexactinosan skeleton (WENDT & *al.* 1989, Fig. 6), which only in caption is misnamed as a lychniscosan sponge (in the text, it is referred to *Casearia* which is a hexactinosan sponge, so that there is a contradiction).

Recently, there also appeared two reports on the presence of dictyid (= hexactinosan) sponges in the Upper Devonian of Poland (RIGBY & *al.* 1981, HURCEWICZ 1985). However, there are also earlier papers (FRAIPONT 1911, TERMIER & *al.* 1981) reporting of the occurrence of hexactinellid sponges with a net-like fused skeleton in the Devonian. This extends evolutionary history of this group deep into the Paleozoic, or one must suppose independent origin of dictyonal strands in the Paleozoic and Mesozoic forms. As it is a rather important subject, it would be discussed in more details.

The present authors were not able to reexaminate the material described in RIGBY & *al.* (1981), but a close examination of their illustrations arose some doubts. One illustration presents so poorly preserved material (thin section of a sponge, RIGBY & *al.* 1981, Fig. 5) that it cannot be decided if there are any dictyonal strands; all what can be said it is that spicules are hexactine based and regularly arranged. On the other hand, very well preserved skeletal net shown by RIGBY & *al.* (1981, Pl. 4, Figs 1–2) displaying five or six rays meeting in one spicular node in most cases, is not deciding and can be not hexactine based. It can be also interpreted as a eutaxicladine or anthaspidellid type of the skeleton (*compare* FINKS 1960, Pl. 10, Fig. 1; PICKETT & RIGBY 1983, Fig. 3; RIGBY & WEBBY 1988, Pl. 10, Fig. 8 and Pl. 11, Fig. 9). The same remarks apply to the material described in FRAIPONT (1911) and TERMIER & *al.* (1981).

A newly collected Devonian material, from the same outcrop as RIGBY's & *al.* (1981), however, delivered some support for RIGBY & *al.* (1981) opinion. The present authors have found, in thin section, a very regular, grid-like structure of the skeletal net (Text-fig. 4) built of spicules which can be interpreted as hexactine based. This finding needs further investigations of three-dimensional spicular structure, but it seems that the Mesozoic "dictyid" (hexactinosan) structure can be of independent origin of earlier net-like fused skeleton of the Devonian sponges. This is suggested by the fact of the absence of such spicular net organization in sponges of Carboniferous and Permian age, which are relatively well known. Also an extreme regularity of the Devonian dictyid-like organization is rather specific; Mesozoic hexactinosan sponges display not

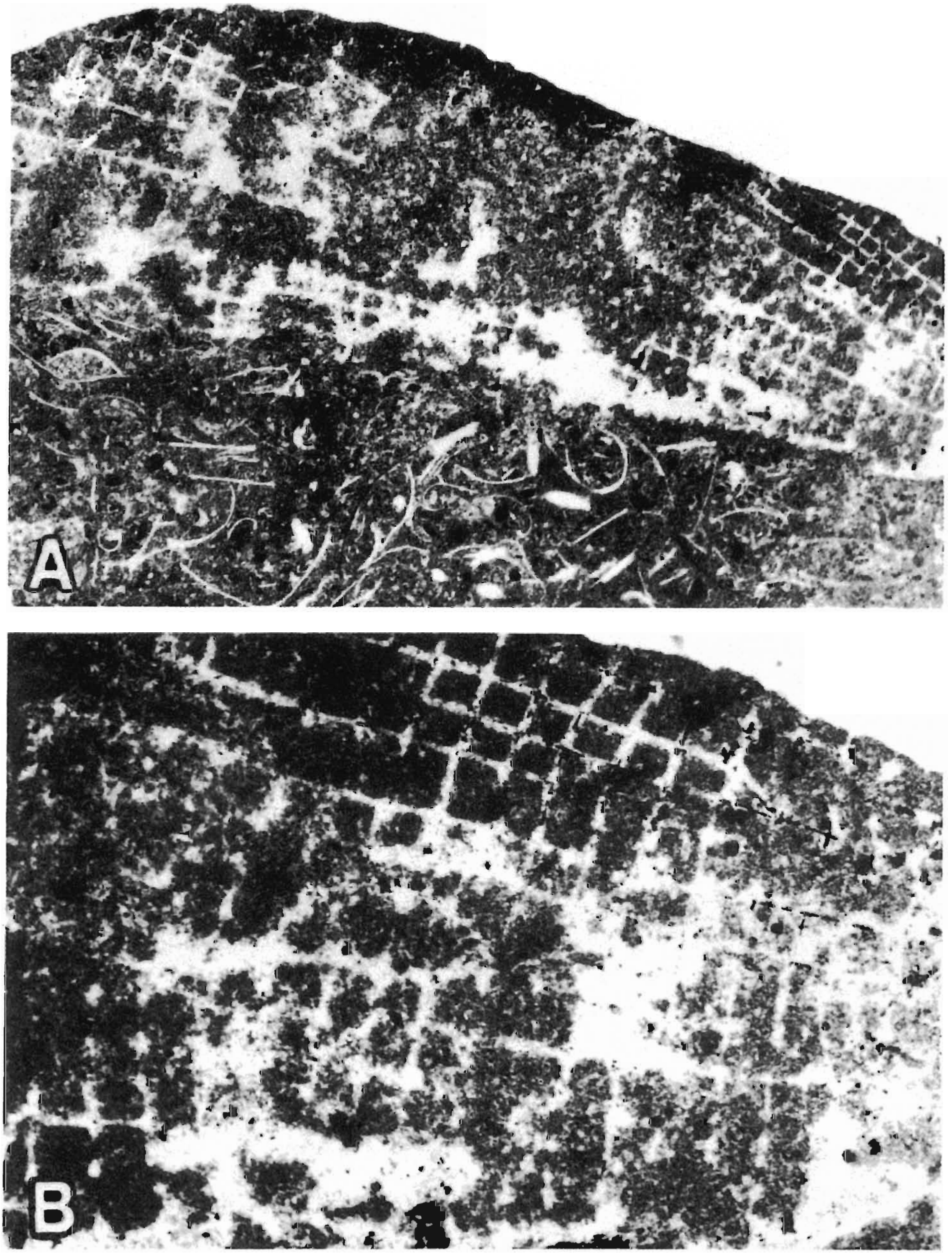


A — Details of endosomal skeleton of *Hexactinoderma trammeri* gen. n., sp. n.; note totally irregular, arrangement of spicules (most probably diactines); ZPAL PfV/5, SEM × 30; Góra Świętej Anny

B — Regular hexactine spicule among irregular (?diactine) fused spicules of endosomal skeleton of *Hexactinoderma trammeri* gen. n., sp. n.; ZPAL PfV/5, SEM × 45; Góra Świętej Anny

C — Dense irregular skeleton from the surface of undetermined lyssacinosan sponge; note thickening of spicules caused by additional silica deposition at the points of spicules contact, SEM × 40; Strzelce Opolskie

D — Open-textured endosomal skeleton of undetermined lyssacinosan sponge: note slender and thin spicules, SEM × 30, Strzelce Opolskie



A-B — Devonian (Frasnian) cup-shaped sponge showing very regular, hexactinosan-like arrangement of spicules (calcified); longitudinal thin section (*A* taken × 6.5; *B* close-up, × 15); Jaźwica Quarry, Holy Cross Mts a grid-like organization but development of dictyonal strands, which do not usually produce cubic framework. Thus, one should be very careful with interpretation as dictyonal the skeleton with fused (even hexactine based) spicular net displaying grid-like or reticulate structure (*see also* REID 1963).

On the other hand, reexamination of the material described by HURCEWICZ (1985) has shown that it is so poorly preserved that all sponges described by her as hexactionosan sponges with the "dictyid" type of skeletal net can be easily interpreted as eutaxicladine or anthaspidellid sponges as well, but in fact nothing precise, except that the skeleton is fused, can be said about this material. It is worth of mention that all specimens described by HURCEWICZ (1985, Pl. 2) as *Reniera* (3 new species), the genus which belongs to the Recent haplosclerid sponges, are in fact remains of receptaculitids [sic!].

The present authors do not also agree with a suggestion of a new interpretation of *Pileolites*, from the Permian of North America by FINKS (1983), as representing probably a dictyonal pattern of fused hexactins. Its structure is clearly irregular (however, some layering of endosomal skeleton is observed) and strictly resembling the structure encountered by the herein investigated, undoubtful lyssacinosan material.

Taking all the presented facts into consideration one should regard Triassic hexactinosan sponges, known from China and Europe, as the oldest undoubtful representatives of the Hexactinosa, while the first record of Lychniscosa comes not from the Triassic but only from the Jurassic deposits (as it was already noted by MOSTLER 1986). Some Paleozoic (Devonian) forms show hexactinosan-like pattern of skeletal net organization, but their attribution rests unsure and needs further investigation. It may be suggested that origin of the Mesozoic dictyonal strand can be an independent feature based on different principle.

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ŚRODKOWOTRIASOWE GĄBKI LYSSACINOSA Z GÓRNEGO ŚLĄSKA

(Streszczenie)

Środkowotriasowe gąbki z wapienia muszlowego (anizyk) Górnego Śląska (*patrz* fig. 1–3 oraz pl. 1–8), uważane dotąd (ECK 1865, RAUFF 1937, BODZIOCH 1991) za przedstawicieli rzędu Hexactinosa, zostały opisane jako dwa nowe gatunki należące do rzędu Lyssacinosa: *Hexactinoderma trammeri* gen. et sp. n. oraz *Silesiaspongia rimosa* gen. et sp. n. Rozpoznanie struktury szkieletu tych gąbek pozwoliło przedyskutować historię geologiczną rzędów Hexactinosa i Lychniscosa. Wydaje się, iż regularny szkielet przypisywany niektórym gąbkom dewońskim, w tym także z franu Gór Świętokrzyskich (*patrz* fig. 4; *oraz* RIGBY & *al.* 1981) tylko zewnętrznie przypomina typ organizacji spikul w formie "*dictyonal strands*" znany u mezozoicznych i późniejszych Hexactinosa.