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A new "deep-water" *Chaetetopsis* Species (*Chaetetopsis favositiformis* n. sp., Demospongiae) from the Plattenwald Bed (Mid-Cretaceous Garschella Formation, Vorarlberg, Austria)

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ABSTRACT

A phosphatized coralline sponge discovered in the Plattenwald Bed of the Mid-Cretaceous Garschella Formation in Vorarlberg (Austria) is distinguished from other coralline sponges by the presence of large calicles (mean diameter value = 1.5 mm) which increase in number during growth by the intercalation of basically v-shaped tubes. The calicles are divided by regularly spaced tabulae and the specimen resembles, therefore, the Paleozoic cnidarian taxon *Favosites.* It is described here as *Chaetetopsis favositiformis* sp. n.

In contrast to most known representatives of the coralline sponges, *Chaetetopsis favositiformis* sp. n. occurs in association with a non-reef-type open-marine fauna.

ZUSAMMENFASSUNG

In der vorliegenden Arbeit wird ein coralliner Schwamm beschrieben, welcher in einem Aufschluss der Plattenwald-Schicht (Garschella-Formation, mittlere Kreide) NW Mellau (Vorarlberg, Österreich) gefunden wurde. Das Exemplar unterscheidet sich von allen bekannten corallinen Schwämmen durch das Vorhandensein von breiten Tuben, welche sich durch Aufspaltung an der Basis vermehrt haben. Mit seinen regelmässig eingeschalteten Querböden erinnert das Stück an *Favosites,* ein Vertreter der paläozoischen Tabulata. Es wird deshalb als *Chaetetopsis favositiformis* sp. n. beschrieben.

Im Gegensatz zu den meisten bekannten Vertretern der Gattung *Chaetetopsis,* welche im Riffbereich angetroffen werden, ist *Chaetetopsis favositiformis* sp. n. ein Vertreter des offen-marinen Milieus.

Introduction

In the course of systematic field work on the Mid-Cretaceous Garschella Formation of the Helvetic Alps in Vorarlberg (western Austria), a representative collection of macrofossils was brought together for the purpose of biostratigraphical and paleoecological reconstructions (Sulser & Föllmi 1984; Föllmi 1986, 1989a, b, Föllmi & Ouwehand 1987). One enigmatic specimen in this collection is a calcareous, coralline sponge, which strongly resembles *Favosites,* a Mid-Paleozoic cnidarian taxon. Given the uniqueness of this occurrence in the investigated area, its location in a

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deeper water non-reef-type setting, and the lack of resemblance to other coralline sponges, we decided to subject the specimen to a more thorough examination and rank it as a new species *(Chaetetopsis favositiformis* n. sp.).

Geological Setting

Chaetetopsis favositiformis n. sp. was discovered in the vicinity of Mellau, south of the "Simonsbach" (Vorarlberg, Austria), in an outcrop of the Plattenwald Bed which is a highly condensed phosphatic bed of the Mid-Cretaceous Garschella Formation (Fig. 1; Föllmi & Ouwehand 1987). In this area, the Garschella Formation lies on top of a sequence of calcarenitic platform carbonates (Schrattenkalk Formation, Barremian) and is overlain by a thin cover of hemipelagic pebbly mud-flow deposits (Götzis Beds, Coniacian, Seewen Formation) and hemipelagic marls of the Amden Formation (Santonian). The Garschella Formation itself consists of (1) the Brisi Beds, a coarse-grained glauconitic sandstone (middle late Aptian), (2) the Klaus Beds, a heterogeneous mixture of reworked and transported glauconitic sands, fossil debris, and phosphatic nodules, and (3) the Plattenwald Bed, a highly condensed phosphatic bed including reworked lithoclasts of the subjacent Klaus Beds (Fig. 1; cf. Föllmi 1986, section HK, p. 337, Fig. 82; Föllmi 1989a, section 9 in Fig. 15, p. 31, section 13 in Fig. 19, p. 39). At this locality, the Plattenwald Bed includes phosphatized and non-phosphatized microbial mats ("stromatolites"), small phosphatized rhynchonellids, phosphatized inoceramids *(Birostrina* sp.), large quantities of belemnites *(Neohibolites* sp.), and phosphatized ammonoids [*Ptychoceras laeve laeve* Matheron, *Hypacanthoplites* cf. *inflatus* (Breistroffer) Sornay, *H. milletianus* (D'Orbigny), *H.* ex gr. *milletianus* (D'Orbigny) – *trivialis* (Breistroffer), *Beudanticeras (B.)* cf. *newtoni* Casey, *Leymeriella (L.)* sp.]. This phosphatized fauna indicates the early Albian (tardefurcata zone and early mammillatum zone). The non-phosphatized pelagic carbonatic matrix of the Plattenwald Bed includes globotruncanids of the early Turonian [*Helvetoglobotruncana praehelvetica* (Trujillo), *Dicarinella algeriana* (Caron), *D. imbricata* (Mornod), and *D. hagni* (Schreibnerova)], indicating a time span of approximately 22 million years included in the formation of the Plattenwald Bed. Based upon the biostratigraphical range of the phosphatized fossils, the time of phosphatization in the Plattenwald Bed of this area was determined to have lasted from the jacobi to the early mammillatum zone (latest Aptian-early Albian; Föllmi 1989a). *Chaetetopsis favositiformis* n. sp., being phosphatized, may, for this reason, stem from this time interval.

Systematics

Taxon **Demospongiae**
Taxon **Hadromerida**
Taxon **Suberitidae**

Introducing remarks. The classification of organisms with calcareous basal skeletons is generally based on preserved spicule remains and/or distinct skeletal features such as internal excurrent canal systems and certain skeletal microstructures (Reitner 1991a, b; Vacelet 1985; Wood 1987).

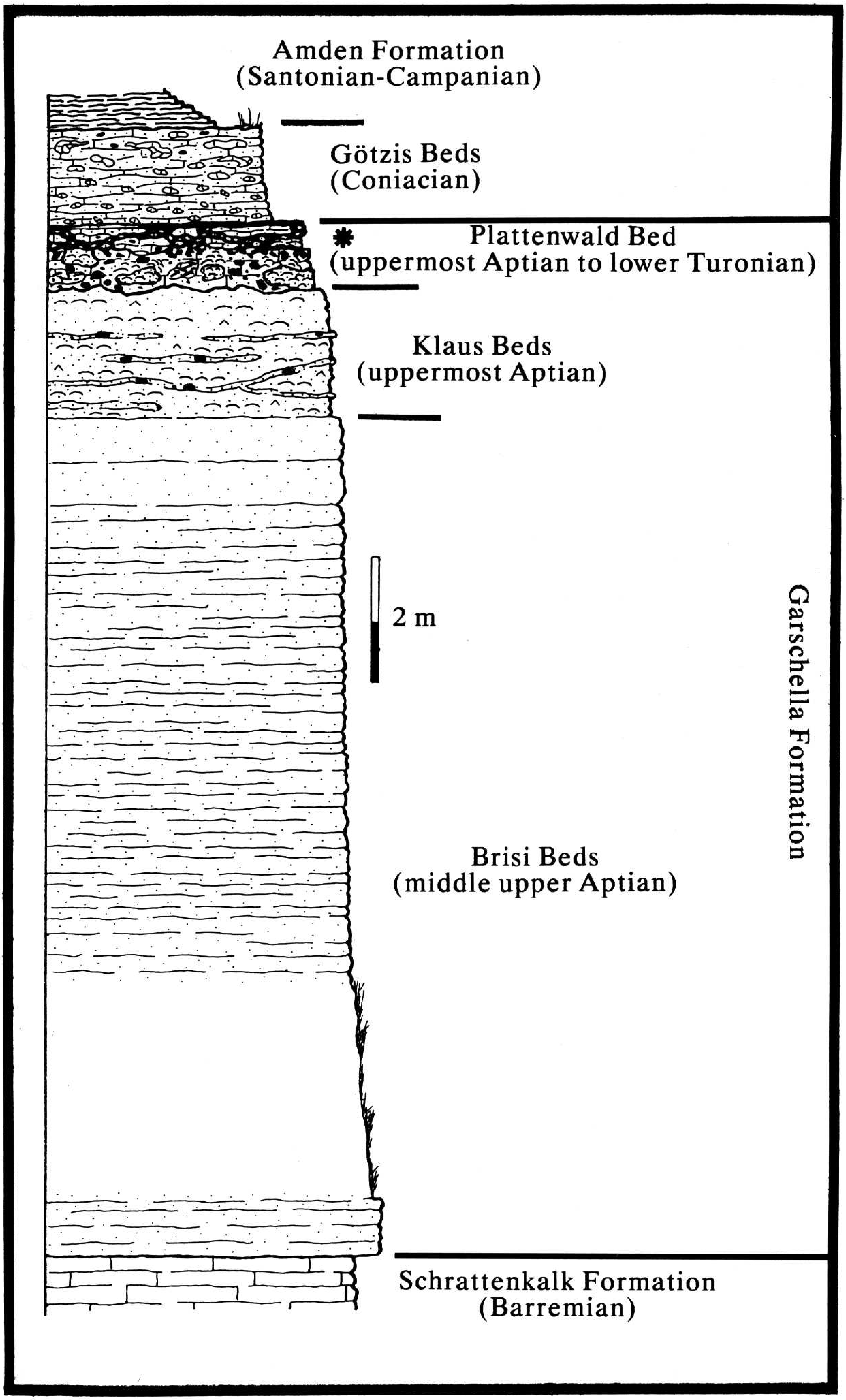

Fig. 1. Lithological section of the locality (Section HK in Föllmi 1986, p. 337, Fig. 82). Brisi, Klaus, and Plattenwald Beds all belong to the Garschella Formation; Götzis Beds is part of the Seewen Formation (Föllmi & Ouwehand 1987). Location of *Chaetetopsis favositiformis* n. sp. is indicated by star.

The here described coralline sponge has strong similarities with the spicule-bearing *Chaetetopsis* taxa (Kazmierczak 1979; Reitner 1991a); however, it does not exhibit any spicule remains. This renders its classification to *Chaetetopsis* questionable, with the analogy to the basal skeleton of the spicule-bearing hadromerid taxon *Chaetetopsis* as the only justification.

Genus Chaetetopsis Neumayr 1890

Type species. Chaetetopsis crinata Neumayr 1890; Tithonian of Iwaso Konpira and Torino-Suyama (Japan). Revised diagnosis in Kazmierczak (1979). The entire taxon was revised by Fischer (1970).

Chaetetopsis favositiformis n. sp.

Fig. 2, Plates 1 and 2

Derivatio nominis. Name is based on the analogy with the outer morphology of the Mid-Paleozoic cnidarian taxon *Favosites.*

Holotype and repository. Illustrated in Figure 2, and Plates 1 and 2 and deposited in the Paleontological Institute and Museum of the University of Zürich (no. PIMUZ-6501).

Locus typicus. 1.5 km northwest Mellau, 1 km west-southwest Klaus, south of the "Simonsbach", Vorarlberg, Austria. Topographic map: "Hoher Freschen", 1:50,000, no. 228, edited by the Swiss Federal Topographic Survey, CH–3084 Wabern (coordinates: 783.750/248.400/780).

Stratum typicum. Plattenwald Bed, Garschella Formation.

Age. Latest Aptian or early Albian.

Material and methods. Only one specimen is available. From this specimen one oblique thin section was made and stained with potassium hexacyanoferrat III in order to distinguish different diagenetic events.

Diagnosis. Coralline sponge with a characteristic chaetetid basal skeleton. The microstructure of the presumably primarily aragonitic calicle wall is fascicular fibrous. Calicles are prominent and exhibit a large diameter. The specimen exhibits a very characteristic v-shape growing mode of the calicles. Sometimes the tubes are exhibiting longitudinal fission by pseudosepta. The distances of the tabulae are more or less constant and show a rather high frequency per measured unit (Plate 1). The tabulae are constructed of approximately parallel-orientated crystals (most likely aragonite) in close connection with organic lamellae. Spicules have not been observed.

Description

Outer morphology of the basal skeleton and the hostrock. The chaetetid exhibits a hemispherical shape (Fig. 2). The arrangement of calicles is radial and demonstrates a characteristic v-shaped intercalation of calicles caused through the enlargement of the specimen by growing (Plates 1–2). Occasionally, a longitudinal fission of the calicles by septa is observed.

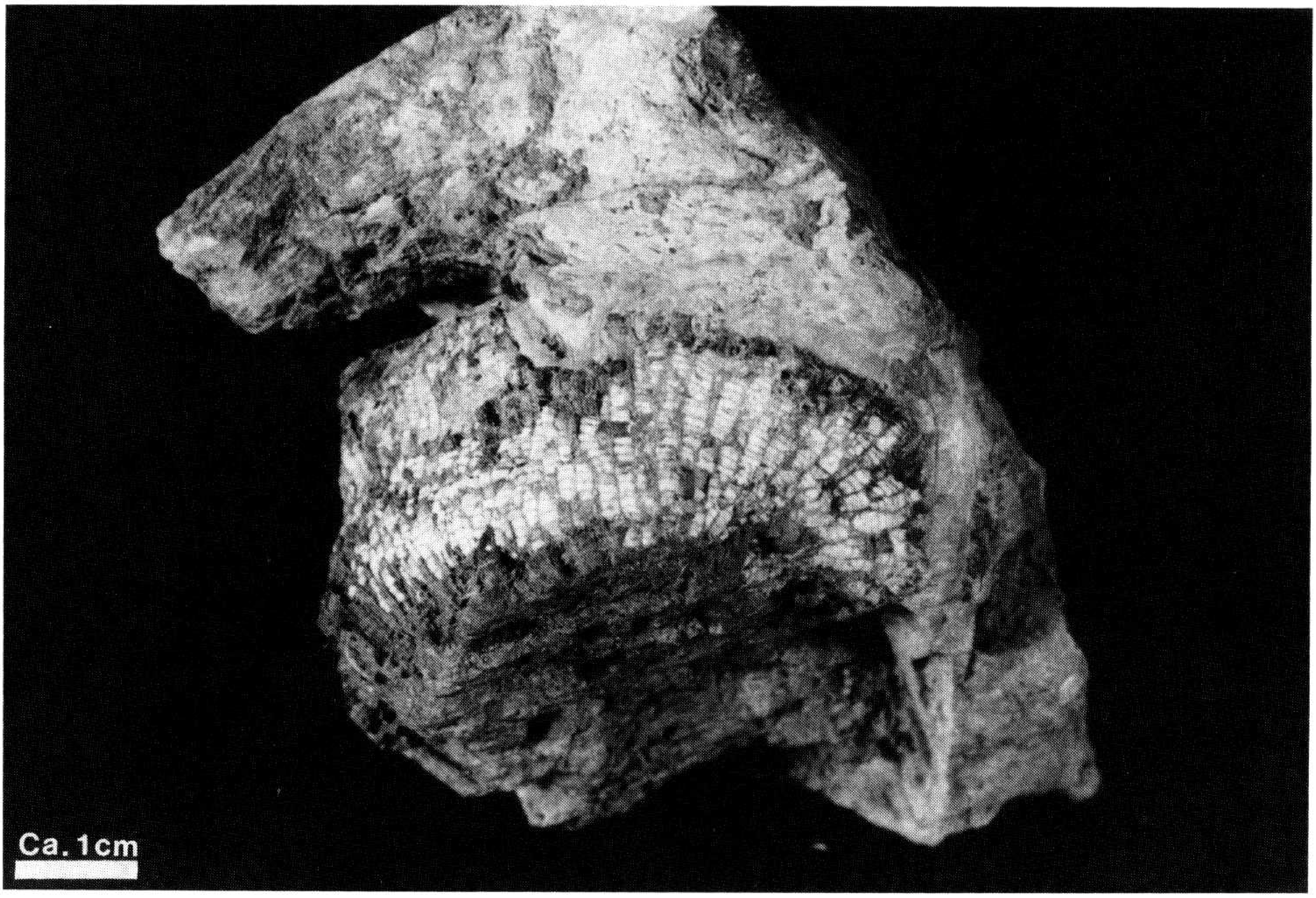

Fig. 2. Holotype of *Chaetetopsis favositiformis* n. sp.; external shape.

The specimen grew on a phosphatic rock surface, which may have been cemented in an early phase of diagenesis. The chaetetid basal skeleton is overgrown by prominent crudely laminated crusts, which are constructed of small phosphatic dome-shaped protuberances exhibiting a characteristic stromatolitic internal structure (Plate 2).

Measurements of the complete specimen. Length: 5.2 cm; maximum height: 2.5 cm; Diameter: minimal 6 cm (the skeleton is partly eroded).

Description of the internal skeletal structure. The specimen exhibits a very typical chaetetid architecture, i.e., a separation of calicle tubes by tabulae (Plate 1). Before replacement by phosphate, the calicle wall was constructed of a "water-jet"-type fascicular-fibrous skeletal material, most likely aragonite (see below). It exhibits irregular dome-shaped growing structures which are recognizable in the ontogenetic younger part of the skeleton (Plate 2). These structures are known from modern coralline sponges; this particular shape is even restricted to coralline sponges. The calicle wall is the primary part of the mineralized calcareous skeleton. It does not show perforations; however, in some parts internal pores have been observed (Plate 1, Fig. 2). It is unclear whether these pores are original or of diagenetic origin.

The tabulae represent secondary parts of the calcareous skeleton and define the space in which vital sponge tissue occupies the basal skeleton. The tabulae exhibit a relatively constant thickness; they are usually flat but may show convex and concave shapes due to diagenetic crystallisation-pressure changes. Besides the normal tabulae, secondary tabulae with a consistent irregular shape have been realized (Plate 2, Fig. 4). Important is that all tabulae are surrounded by distinguishable brownish layers which may represent remains of organic templates. These layers have also been observed in the outer primary calicle wall and are now transformed into calcium phosphate (Plate 2, Fig. 1).

In some parts on the inner roof of the tabulae, enigmatic grape-shaped phosphatized structures are visible. These structures may represent phosphatized microbes (Plate 2, Fig. 5).

Measurements. Thickness of the calicle wall: 200–320 µm (mean 265 µm); thickness of the tabulae: 40–80 µm (mean 60 µm); distances of the tabulae: 800–1,000 µm (mean 885 µm); diameter of the calicle tube: 1,200–1,800 µm (mean 1,500 µm); length of the fibrous crystals: ca. 50 µm.

Mineralogy and microstructure of the basal skeleton and main diagenetic structures. The entire specimen is strongly altered by diagenesis. The skeleton is partly transformed into a calcium phosphate (francolite). Except for small areas, the microstructure of the calicle wall is completely substituted by blocky ferroan calcite or francolite. In small relict areas, the original fascicular-fibrous microstructure of the skeleton is preserved, in a way described by Sandberg (1975). Originally, the fascicular-fibrous microstructures may have consisted of aragonite crystals, which presently are pseudomorph after calcite. Size and shape of these crystals are comparable to those observed in most modern coralline sponges (e.g., *Ceratoporella, Stromatospongia,* amongst others). For this reason, the primarily aragonite nature of these crystals is very likely.

The microstructures within the tabulae are poorly preserved and only in a few cases approximately parallel-orientated crystals have been observed. In most cases, the tabulae exhibit a secondary blocky calcite structure.

Differential diagnosis

The calicles of the basal skeleton of *Chaetetopsis favositiformis* n. sp. exhibit a larger diameter than those of all other known types of *Chaetetopsis.* In contrast to the type species *Chaetetopsis crinata* Neumayr, the basal skeleton of *Chaetetopsis favositiformis* n. sp. grew and increased through the intercalation of basically v-shaped tubes. An additional longitudinal fission of the calicles is rarely observed. In contrast to all other *Chaetetopsis* taxa, *Chaetetopsis favositiformis* n. sp. may have been adapted to an off-reef deeper-water environment.

With all similarities to the Mid-Paleozoic genus *Favosites,* the most obvious difference may lay in the lack of regular mural perforations.

Paleoecology and Relationships

In the palinspastic reconstruction, the location of *Chaetetopsis favositiformis* n. sp. is situated right at the distal, southern margin of the drowned Barremian Schrattenkalk carbonate platform. During the Aptian and Albian, the outer part of this platform area was transformed into a current-dominated bypass zone, in which sediments (mostly glauconitic sands) were transferred from more proximal areas to the outer-shelf area beyond the distally steepened platform margin. This distal zone experienced, therefore, a long phase of condensation and associated phosphogenesis (FÖLLMI 1989a).

Detailed stratigraphical, paleoecological, and sedimentological analyses imply that drowning of the Barremian carbonate platform occurred in two steps: a first and gradual phase during the early Aptian and a second and rapid phase during the latest Aptian. The first drowning phase may have been related to the combining effect of a sealevel rise, current-related erosion, and nutrient-poisoning through the establishment of an oxygen-minimum zone on the outer shelf. The second phase may have had an additional tectonic component, through which subsidence was reinforced (FÖLLMI 1989a). As a consequence, the greater water depth and the more fecund nutrient household induced the demise of the oligotrophic reef-type communities and their substitution by an open-marine biotic assemblage consisting of well-developed microbial mats, suspension feeders such as solitary corals, brachiopods, and crinoids, ubiquitous inoceramids, and abundant ammonoids and belemnites. By the extrapolation from nearby localities in which this assemblage was found in a condensed phosphatic bed of early to early late Aptian age (Luitere Bed; FÖLLMI 1989a), the transition into open-marine conditions at the site here described may have occurred in the early Aptian.

Reworking of *Chaetetopsis favositiformis* sp. n. from the Barremian Schrattenkalk carbonate platform cannot be fully excluded, because of the subjacent Klaus Beds bearing eroded lithoclasts of the Schrattenkalk Formation and the Plattenwald Bed bearing reworked lithoclasts of the Klaus Beds (FÖLLMI 1989a); it is, however, very unlikely, because (1) the Klaus Beds include only small-sized Schrattenkalk lithoclasts (maximum 2 cm), which indicate full lithification and cementation of the Schrattenkalk-paleosurface prior to erosion, rendering erosion and transport of this fragile form more than unlikely; and (2) *Chaetetopsis favositiformis* sp. n. is phosphatized like the associated early Albian fauna, which suggests that this specimen became fossilized during the early Albian. Cementation prior to phosphatization may be excluded, because of the relictic preservation of probably primarily aragonitic structures and the overall delicate preservation of the organism, typical for phosphatization in the earliest stages of diagenesis immediately after decease and burial of the organism (cf. FÖLLMI 1989a). We attribute, for these reasons, *Chaetetopsis favositiformis* sp. n. to a deeper-water, open-marine non-reef environment, with water depths probably around or even beyond 100 meters.

In contrast to *Chaetetopsis favositiformis* sp. n., most representatives of the taxon *Chaetetopsis* are encountered in shallow-marine carbonate-platform environments; for instance, within the Barremian to lower Aptian Schrattenkalk Formation of the Helvetic Alps (SALOMON 1989; REITNER 1989). Within this platform environments, the *Chaetetopsis* community is associated with scleractinians and other shallow-water organisms and do not demonstrate any cryptic or dim-light adaptations. In modern reefs as well as in most fossil reef environments, the majority of coralline sponges are restricted to cryptic niches (HARTMAN 1969; VACELET 1981; REITNER 1987, 1989).

From the marly sediments of the Barremian Drusberg Formation (Helvetic Alps), the Chaetetid taxon *Granatiparietes helveticus* was described by TURNSEK & HERB (1980). This taxon is associated with different oysters *(Lopha* sp., *Aetostreon* sp.) and may, therefore, not belong to a deeper-water community.

Deeper-water occurrences of modern coralline sponges are known from the area of New Caledonia (Vacelet 1988), from the Bahamas (Grammer, personal communication), and from Japan (Döderlein 1892, 1897). These coralline sponges appear in a depth between 40 and 100 m, as well as in shallow reef caves. In fore-reef zones of many Caribbean reefs, coralline sponges are the main reef constructors (Hartman & Goreau 1970). In the fossil record, deeper-water coralline sponges are known only from the Albian and Cenomanian of Spain (Reitner 1989). The best example of a deeper-water coralline sponge community beyond any reef influence is known from the lower to middle Cenomanian of Liencres (Santander, northern Spain; Reitner 1989). These sponges are growing on early diagenetically formed laminated ferroan hardgrounds, occasionally including stromatolitic structures comparable to those observed in *Chaetetopsis favositiformis* sp. n.

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Plate 1

Fig. 1. Oblique thin-section micrograph of the holotype exhibiting the growing mode of the chaetetid basal skeleton.

Fig. 2. Vertical thin-section micrograph of the chaetetid basal skeleton with regular tabulae and approximately regular tabulae distances within the calicles. Within the calicle wall, intramural pores are visible *(arrows)*.

Fig. 3. Oblique thin-section micrograph of the ontogenetic younger part of the basal skeleton.


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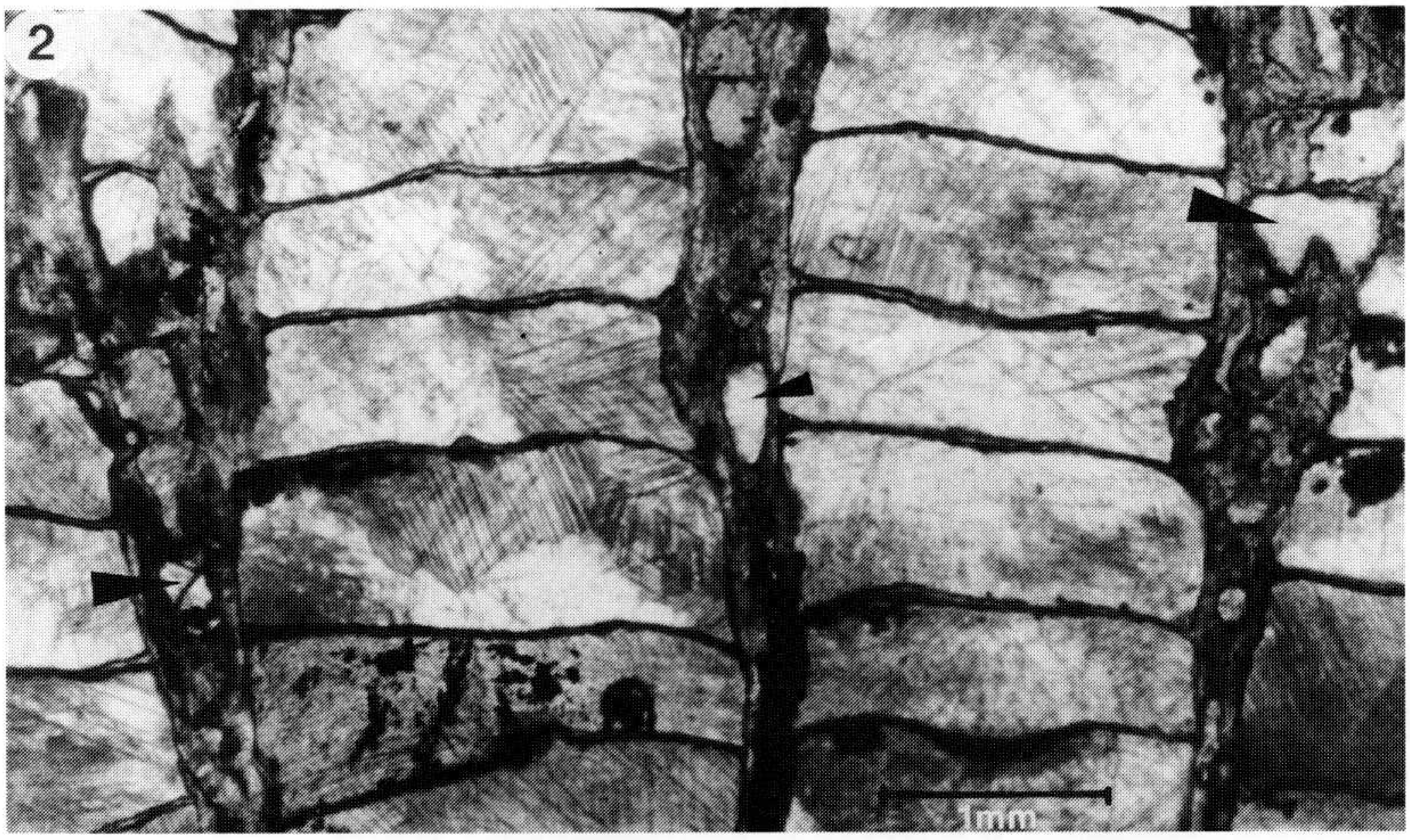
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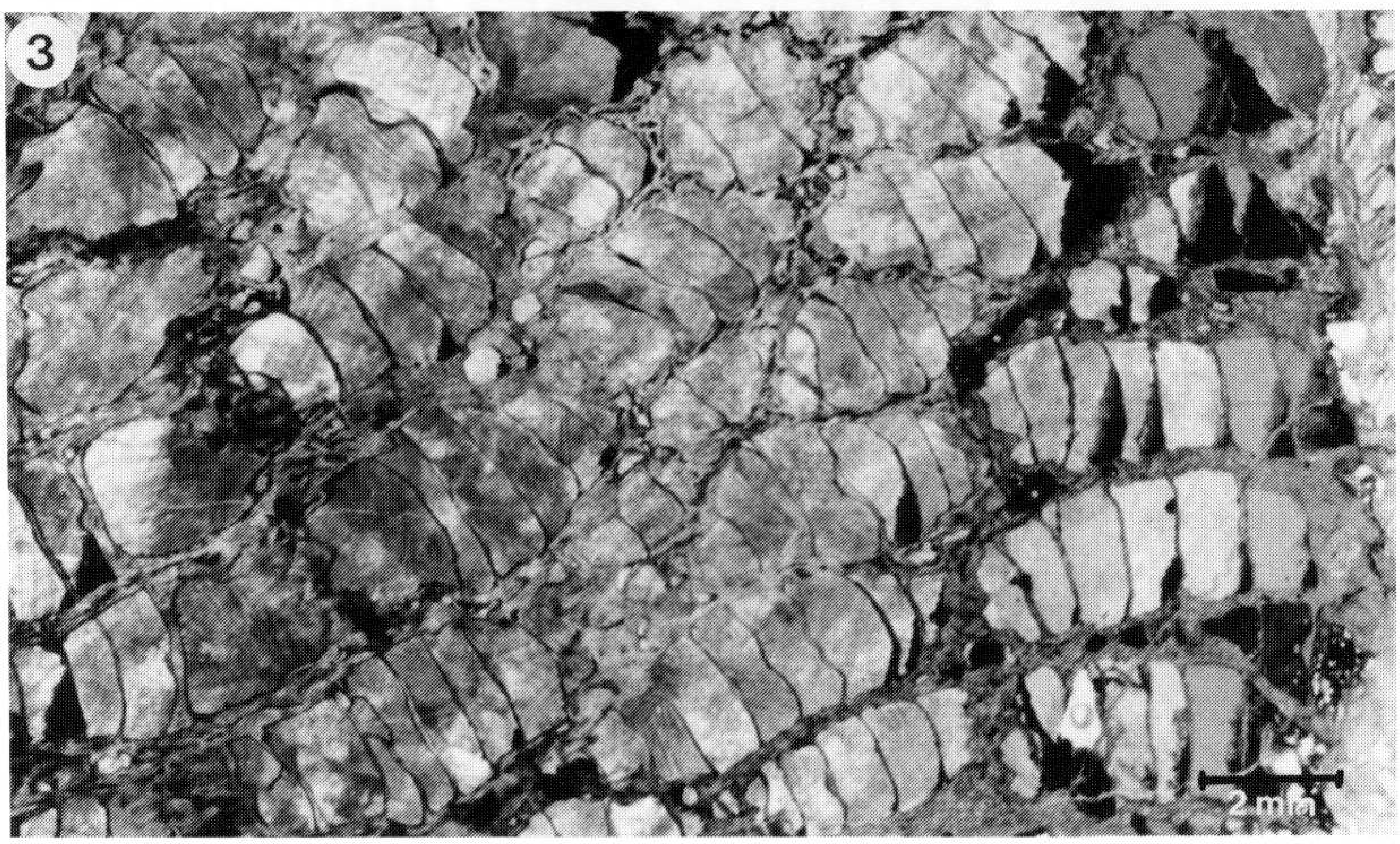
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Plate 2

Fig. 1. Microstructure of a calicle wall with remains of the fascicular-fibrous primary structure and tabulae/calicle wall boundary structures.

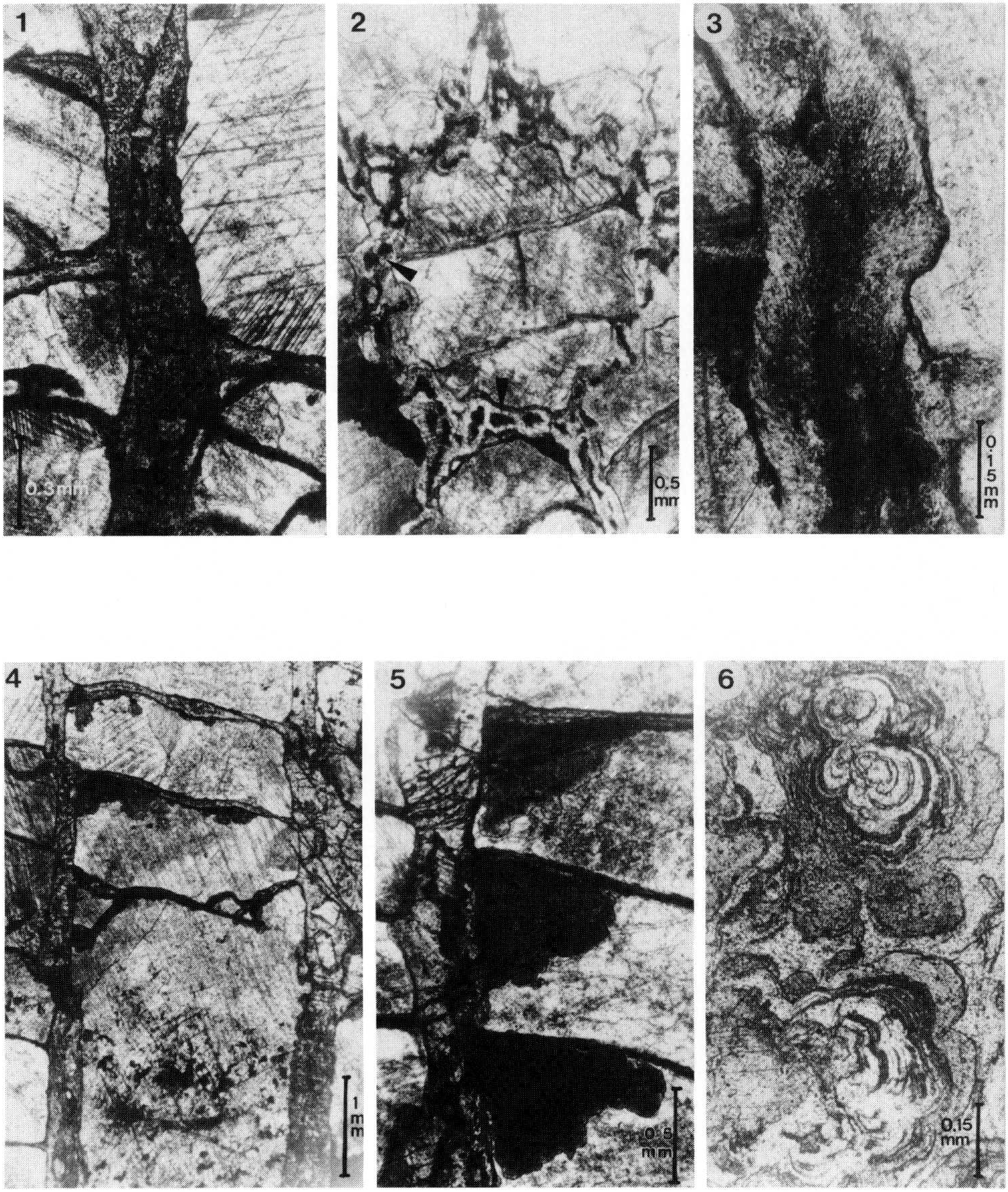
Fig. 2. Oblique-horizontal section of a calicle tube with remains of the internal wall structure *(arrow)*.

Fig. 3. Relict fascicular-fibrous microstructure ("water jet") of the primarily aragonitic wall structure.

Fig. 4. Calicle tube with irregular tabulae.

Fig. 5. Phosphatized remains of probably microbial colonies on the inner roof of a tabulae.

Fig. 6. Stromatolitic structures within the host rock. Dark layers are phosphatized, whereas the light layers consist of ferroan calcite.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