acta
geologica
polonica

Vol. 47, No. 3-4, pp. 211-224 Warszawa 1997

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The micropolychaete *Josephella commensalis* sp.n. commensal to the scleractinian coral *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850) from the Korytnica Clays (Middle Miocene; Holy Cross Mountains, Central Poland)

ABSTRACT: Tiny calcareous tubes, observable under SEM-magnifications, settled within calyces of colonies of the scleractinian coral *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850) from the topmost part of the Korytnica Clays (Middle Miocene; Holy Cross Mountains, Central Poland), and ascribed to the life activity of micropolychaetes commensal to this coral, are accomodated into the extant genus *Josephella* CAULLERY & MESNIL, 1896, to represent a separate species, *Josephella commensalis* sp.n. A coat developed on some tubes, and structured like a dense felt composed of needle-shaped sclerites (presumably aragonitic) associated with a granular precipitate of calcite, is interpreted as having been produced by the infested scleractinian polyps which reacted against the intruders by an immense secretion of calcium carbonate. An abundant occurrence of *Josephella commensalis* sp.n. on local growth-discontinuity surfaces within the scleractinian colonies may suggest their formation just by temporary overpopulations of the micropolychaetes whose metabolism (? or exploitation) has become fatal to a part of the colony.

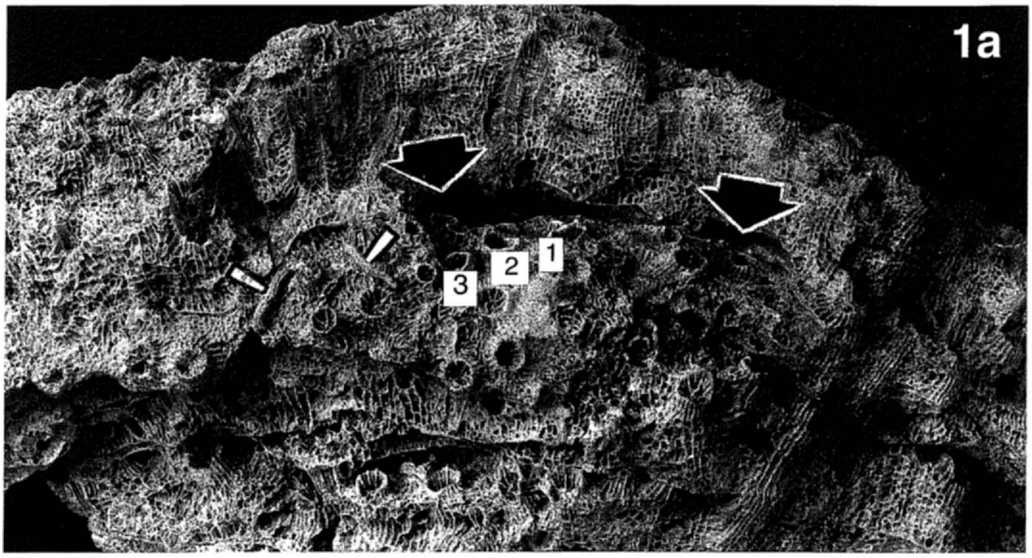
INTRODUCTION

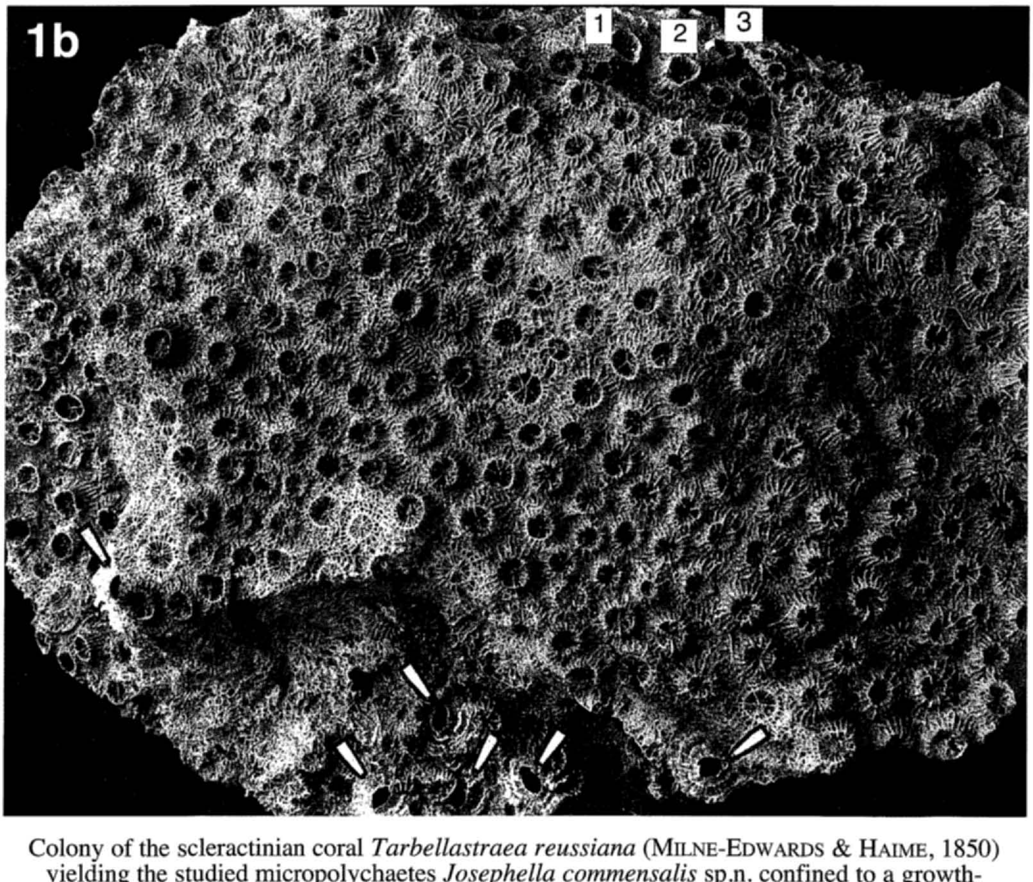
The aim of the present paper is to describe a very peculiar material of tiny calcareous tubes distributed within colonies of the scleractinian coral, *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850), from the Korytnica Clays filling up the Korytnica Basin on the southern slopes of the Holy Cross Mountains, Central Poland. The regional setting and a Middle Miocene age of the Korytnica sequence (Badenian stage, corresponding to the Langhian/Serravallian boundary interval) has recently been reviewed in former papers of the Authors (BAŁUK & RADWAŃSKI 1991, 1996, 1997).

The tiny loop-shaped tubes, invisible with naked eyes, are lining some calyces of corallites of *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850), always to the same tier of a given calyx. The SEM-studies have shown the microstructure of the tubes having been very close and/or indistinguishable from that of some smallest present-day polychaetes, precisely those of the genera *Josephella* CAULLERY & MESNIL, 1896, and *Rhodopsis* BUSH, 1905. On the other hand, the SEM-images demonstrated peculiar structures at the tube/corallite contact what involved a recognition of the biologic relationship between the polychaete and the coral. To the Authors' knowledge, neither present-day, nor ancient, biota have hitherto been shown to display such a relationship. Moreover, reaction of the coral against the tubes has realized in the secretion of sclerites to an extent also unknown as yet in any scleractinian corals. A presentation of these features, and an attempt to their biologic interpretation, are thus thought to make up the content of the present paper.

THE HABITAT OF THE POLYCHAETES

The studied polychaete tiny tubes have been recognized solely within some colonies of one scleractinian species, namely *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850), recently revised by BUDD & *al.* (1996), and whose occurrence within the Korytnica sequence is confined to the topmost part of the Korytnica Clays (*see* Community *III* of BAŁUK & RADWAŃSKI 1977, pp. 100-101 and Fig. 5). The majority of the *Tarbellastraea reussiana* colonies from this part of the sequence are inhabited (*see* Pls 1 and 11) by the creusioid barnacles *Creusia sanctacrucensis* BAŁUK & RADWAŃSKI, 1967, whose commensal relationship to the corals, as demonstrated in former papers (BAŁUK & RADWAŃSKI 1967, 1977, 1984), soon subjected to some comments and/or discussion in several monographs and textbooks (ROSS & NEWMAN 1973, p. 167; PATTON 1976, p. 31; NEWMAN & ROSS 1976, p. 59; GOULD 1977, p. 287; BOUCOT 1990, pp. 15-18: Figs 4-5).

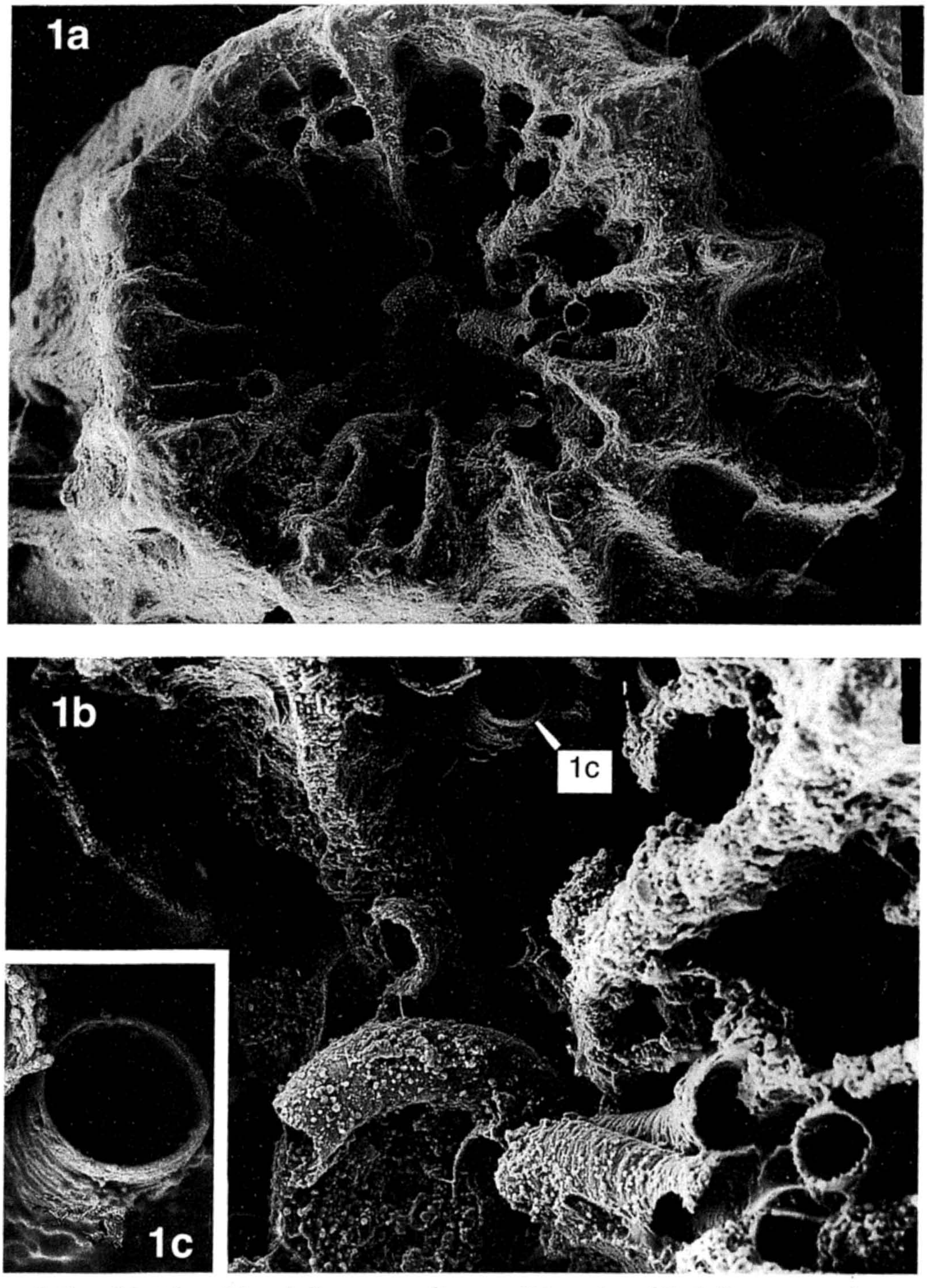




Colony of the scleractinian coral *Tarbellastraea reussiana* (Milne-Edwards & Haime, 1850) yielding the studied micropolychaetes *Josephella commensalis* sp.n. confined to a growth-discontinuity surface of the coral colony; both taken × 2

1a — Side view of the colony: at the growth-discontinuity surface (*large arrows*) indicated are encrusting serpulids (*small leaders*) and some coral-calyces (numbered *1*, *2* and *3*) to make a reference to Fig. 1b

1b — Top view of the colony, to show the growth-discontinuity surface (*see* the referenced calyces *1*, *2* and *3* in Fig. 1a) inhabited by the creusioid barnacles (*small leaders* at the bottom of the photo), *Creusia sanctacrucensis* Bałuk & Radwański, 1967, and by the studied micropolychaetes *Josephella commensalis* sp.n. (*see* Pls 2-3)



Setting of the tubes of *Josephella commensalis* sp.n. within a calyx of *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850)

1a — Overall view of the calyx, to show the loop- or *U*-shaped tubes located at the bottom of the calyx, and between the septa; *SEM* × 45

1b — Close-up of the preceding (*see* center of Fig. 1a), to show the course of some tubes, the majority of which have their apertural parts broken-off; *SEM* × 135

1c — Close-up of the preceding (*see* Fig. 1b), to show the complete aperture of the tube with its final ring preserved; *SEM* × 285

To note, the discussed tiny loop-shaped polychaete tubes are totally absent from *Tarbellastraea reussiana* colonies from the deeper part of the Korytnica sequence (Community *II* of BAŁUK & RADWAŃSKI 1977), as well as from any other, not rarely occurring, scleractinian corals, either solitary (*see* STOLARSKI 1991) or colonial (*see* RONIEWICZ & STOLARSKI 1991).

From the aforegoing, inferred is a high host-specificity of the tiny polychaetes obligatorily confined to one scleractinian species, particularly its colonies inhabited by the indicated creusioid barnacles. The latter relation, typifying the topmost part of the Korytnica Clays and its Community *III*, was controlled by environmental conditions featured by extreme small depths, ranging finally from a few meters to almost nil at the demise of clay sedimentation in the Korytnica Basin (*see* BAŁUK & RADWAŃSKI 1977, pp. 100-101, and references therein).

When searching for the micropolychaete tubes, it appeared that they were domiciled preferentially in calyces distributed at more or less local growth-discontinuity surfaces of the coral colonies (Pl. 1, Figs 1a-1b). To these surfaces the above-indicated creusioid barnacles, *Creusia sanctacrucensis* BAŁUK & RADWAŃSKI, 1967, were commonly growing up and, moreover, the surfaces were encrusted by small epibionts, primarily serpulids (*see* Pl. 1, Fig. 1a) and various bryozoans (both cheilo- and ctenostomes). A space break above the discontinuity surfaces may reach even 2 mm; within a colony, several such surfaces may be recognized (*e.g.* four in the colony shown in a side-view in Pl. 1, Fig. 1a), and their area may either extend over a few calyces, or measure even a dozen or so square centimeters in larger colonies.

THE POLYCHAETE TAXONOMY

The studied tiny polychaetes are herein accomodated within the extant genus *Josephella* CAULLERY & MESNIL, 1896, to which they close by the size of their tubes, and by the microstructure of the latter, as revealed by the comparative present-day material (*see* Pls 12-13).

The indicated extant genus *Josephella* CAULLERY & MESNIL, 1896, as concerns the present-day taxa, has still remained monospecific (*see* BIANCHI 1981), with the type species *Josephella marenzelleri* CAULLERY & MESNIL, 1896, cosmopolitic, and commonly occurring at various depths, preferentially very shallow in the Mediterranean (*see* ZIBROWIUS 1968, BIANCHI 1981, BEN ELIAHU & TEN HOVE 1989, SANFILIPPO 1996). Its gregarious appearance is certainly involved by an ability to a very rapid asexual reproduction (*see* NISHI 1992).

Of the fossil taxa assigned to the genus *Josephella* by former authors (SCHMIDT 1951, 1955; R. JANSSEN 1972), and characterized generally by very small sizes, none can be precisely identified.

The four taxa from the Miocene of the Vienna Basin, established by SCHMIDT in an earlier paper (SCHMIDT 1951) and revised afterwards (SCHMIDT 1955, 1969), may be recognized to represent the subfamily Filograninae RIOJA, 1923, but with the exception of "*Josephella angulatella* W.J. SCHMIDT, 1951" which, as being adorned with a carina, should be placed in a genus of the subfamily Serpulinae MACLEAY, 1840.

A report on "*Josephella* sp." by R. JANSSEN (1972), from the Middle Miocene (Twistringen Schichten) of NW Germany, cannot be verified, as a schematic drawing and inserted scal bar (R. JANSSEN 1972, Fig. 15) are not compatible with the associated description.

As the studied Middle Miocene loop-shaped tubes cannot be identified either with any fossil taxa, or with the present-day species *Josephella marenzelleri* CAULLERY & MESNIL, 1896, diagnosed upon soft parts of its body, and whose tubes tend to be straightened (*see* BIANCHI 1981), they are herein classified as a separate species, *Josephella commensalis* sp.n.

Class **Polychaeta** GRUBE, 1850

Order **Sedentarida** LAMARCK, 1818

Family **Serpulidae** RAFINESQUE, 1815

Subfamily **Filograninae** RIOJA, 1923

Genus *Josephella* CAULLERY & MESNIL, 1896

Josephella commensalis sp.n.

(Plates 2-11)

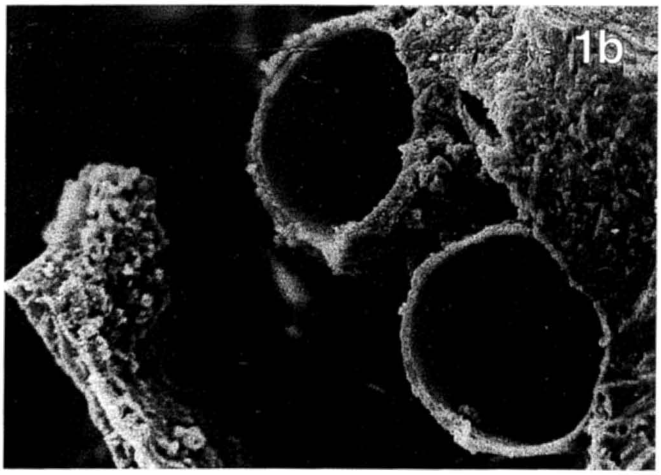
PLATE 3

General structure of the tubes of *Josephella commensalis* sp.n.

1a-1d — Apertural parts of the *U*-shaped tubes of *Josephella commensalis* sp.n. exposed within a calyx of *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850)

1a — Overall view of a part of the calyx, to show apertural parts of the *U*-shaped tubes located between the septa of the corallite; *SEM* × 120

1b-1d — Close-ups of the tube apertures (the final rings are broken-off); in Fig. 1b the loop arms do not adhere each other tightly; *SEM* × 400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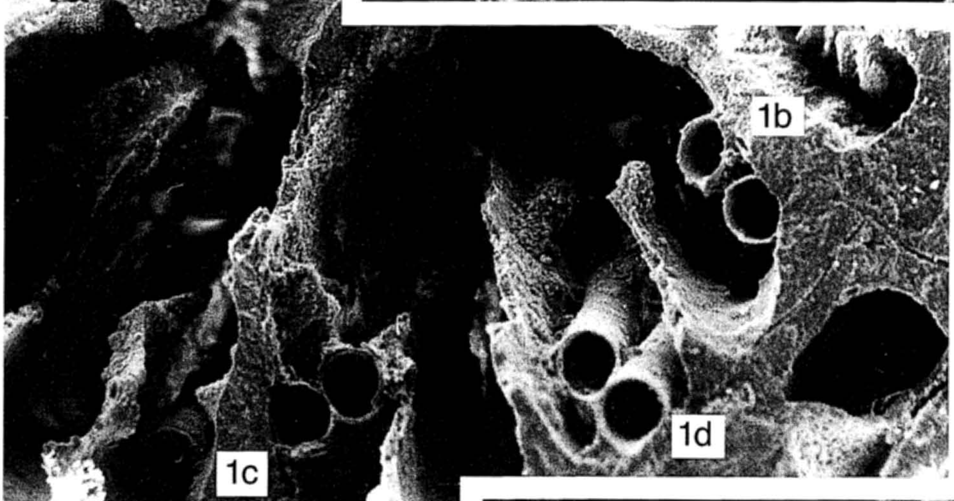
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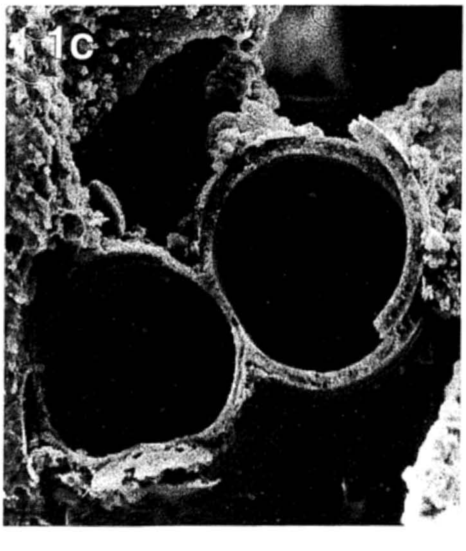
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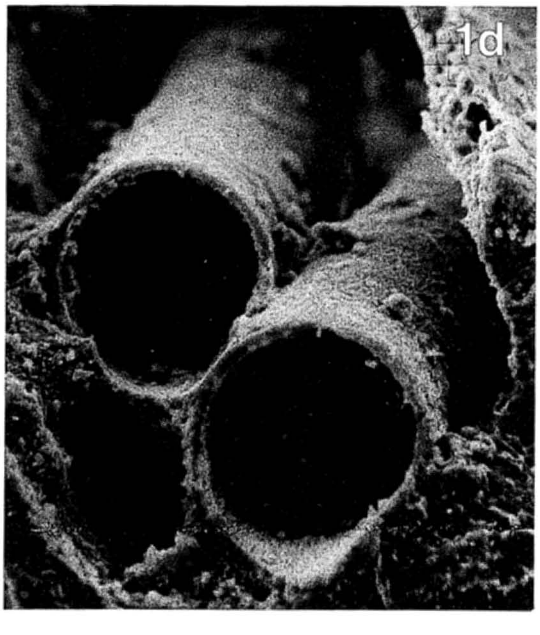

1d

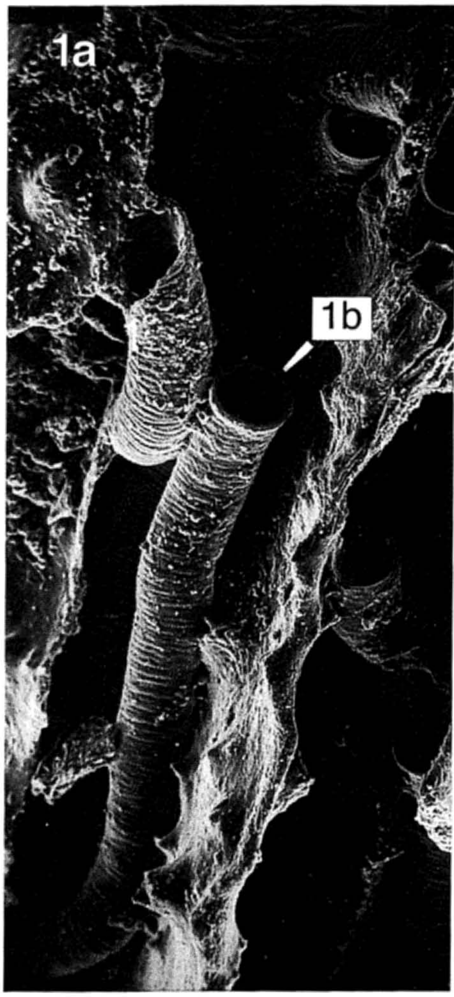
PLATE 4

Morphologic variability of the tubes of *Josephella commensalis* sp.n. within calyces of *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850)

1a — *U*-shaped tube with its arms adhering each other almost tightly; *SEM* × 140; **1b** — Close-up, to show the aperture undamaged, with the final ring preserved; *SEM* × 420

2 — Tubes shaped into broad loops, shown in an oblique view of the coral calyx; *SEM* × 170

3 — Loop-shaped tubes, tiering down to the bottom of the coral calyx; *SEM* × 100


1a
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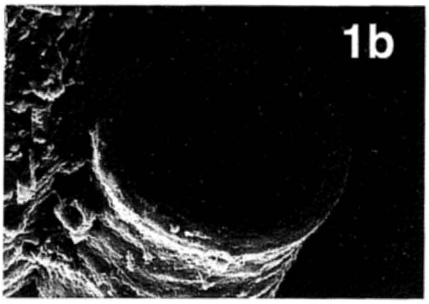
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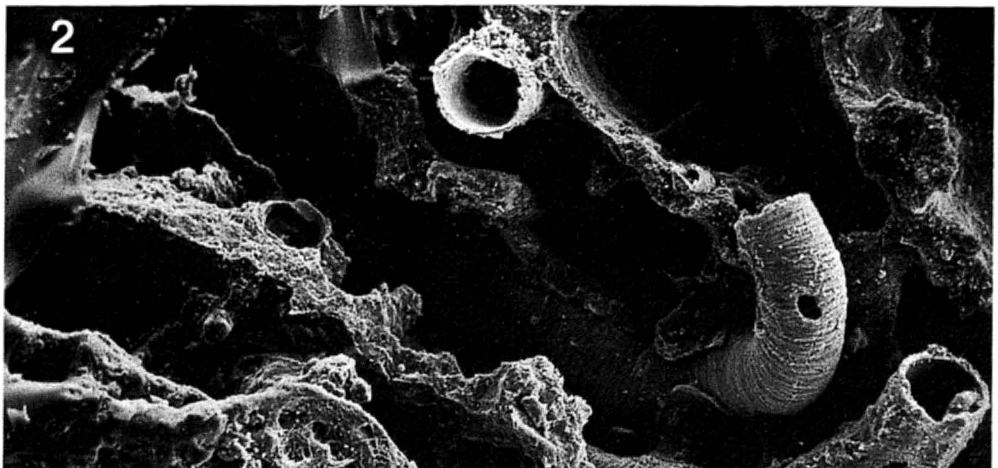
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PLATE 5

The **holotype** of *Josephella commensalis* sp.n.

An overall view of the *U*-shaped, tending to the loop-shaped, tube of *Josephella commensalis* sp.n. within a calyx of *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850), to show the loop-shaped part of the tube developing at the bottom of the coral calyx; *SEM* × 200

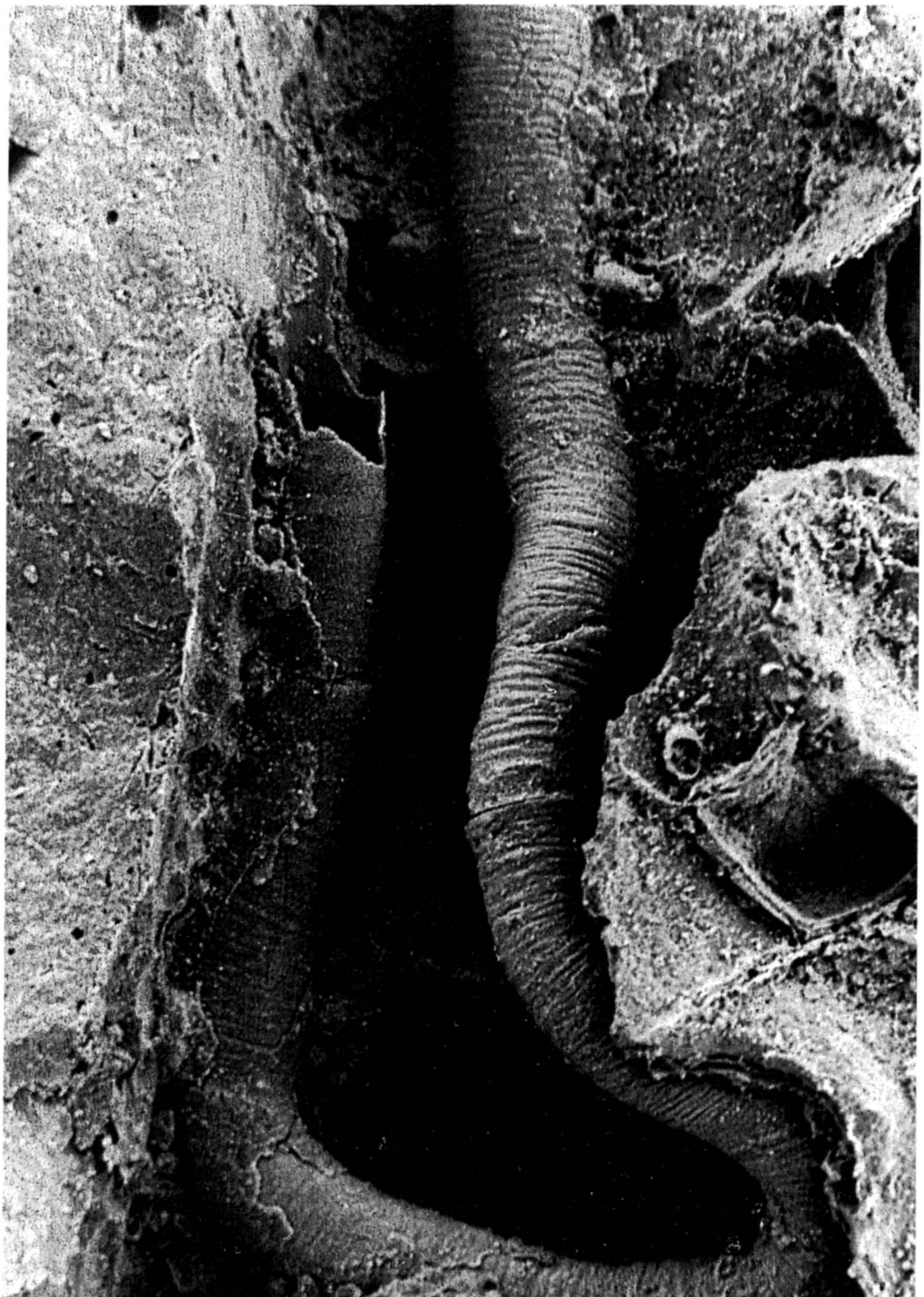
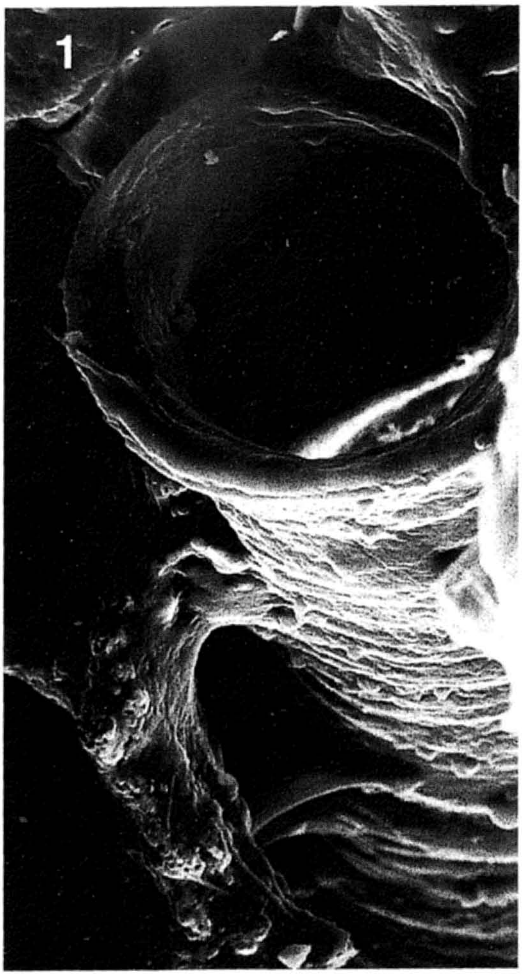


PLATE 6

Details of the tube structure of *Josephella commensalis* sp.n., to show its relationship to the scleractinian coral *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850)

1 — Apertural part of the tube, with fibers of the coral septa confluent with the polychaete annular bands; *SEM* × 1150; **2** — Close-up, to show details of the junction; *SEM* × 3500; **3** — Aperture of the tube, overgrown by the extrathecal dissepimenta of the coral; *SEM* × 1450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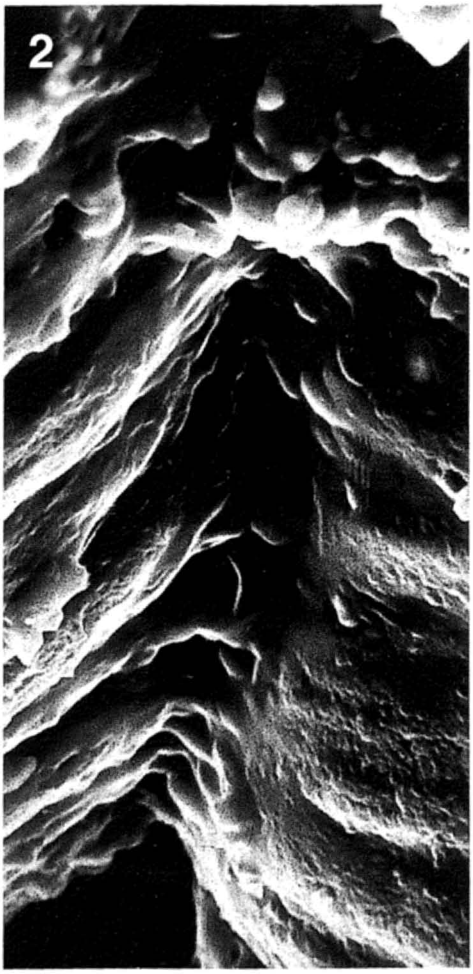
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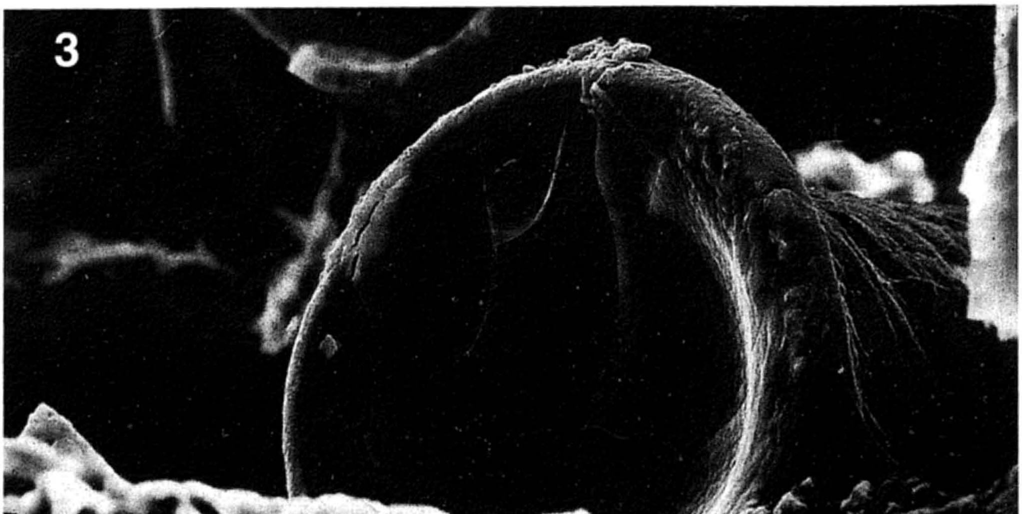
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PLATE 7

Structure of the coat of tubes of *Josephella commensalis* sp.n.

1a — Overall view of a tube fragment, displaying a relation of the coat to the tube; *SEM* × 850

1b-1d — Close-ups, to show the details; **1b** — Annular bands of the tube; *SEM* × 3650; **1c** — Margin of the coat; *SEM* × 570; **1d** — The coat composed of the calcareous micrite with larger, needle-shaped sclerites; *SEM* × 2100

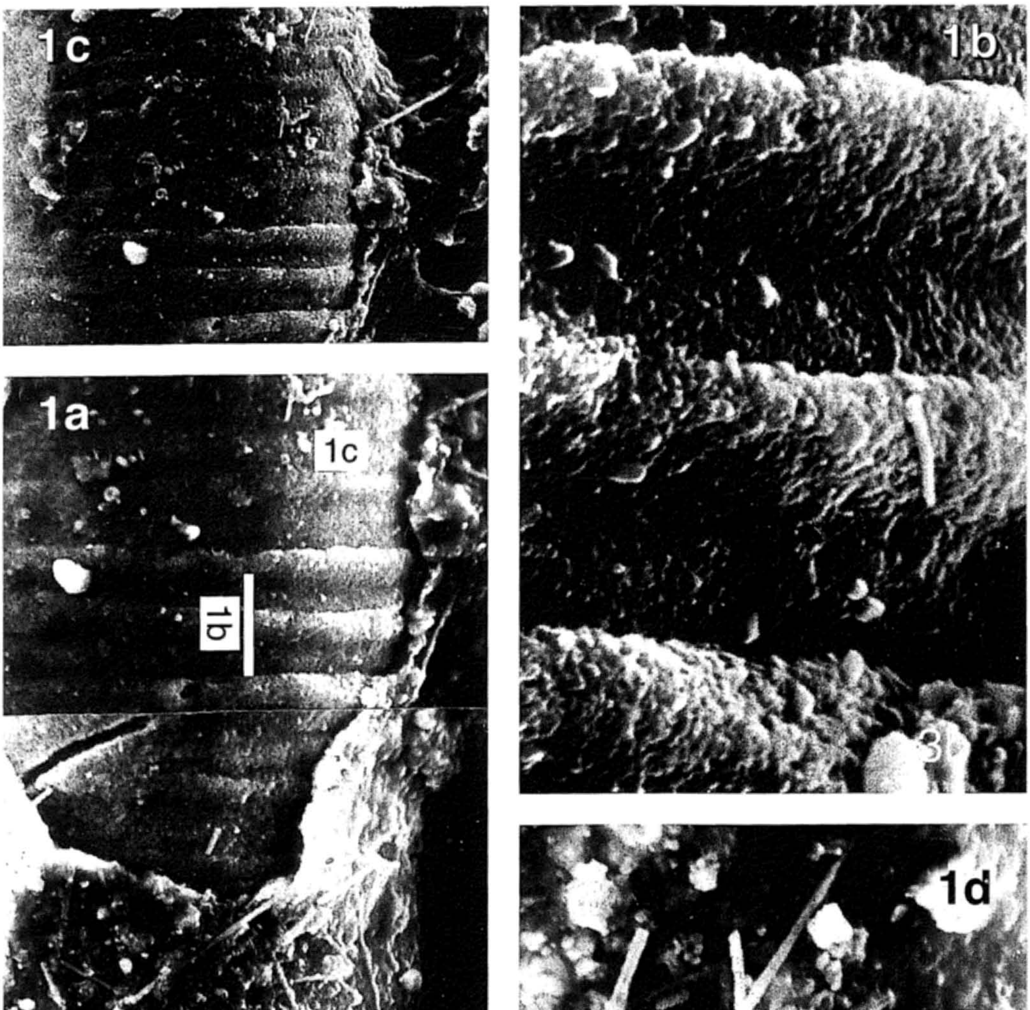
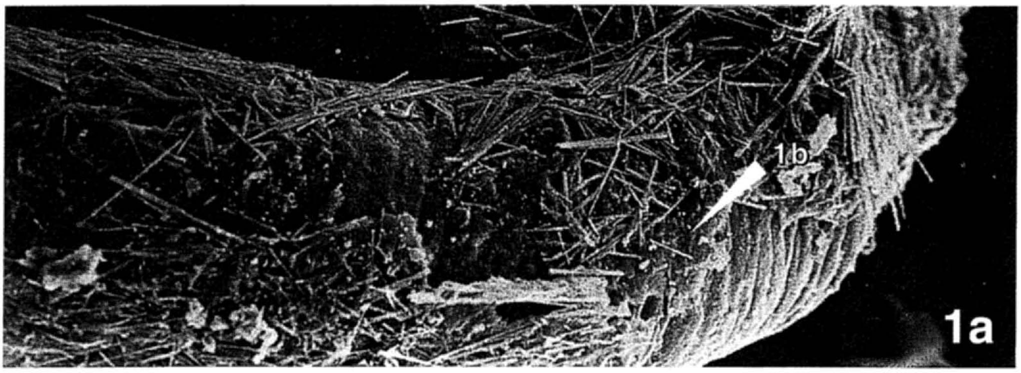

1c
1a
1c
1b
1d
1b
3
1d

PLATE 8

Details of the coat of tubes of *Josephella commensalis* sp.n.

1a — Overall view of the coated tube; *SEM* × 410; **1b** — Close-up, to show a dense felt of sclerites; *SEM* × 900; **1c** — Further close-up, to show the structure of sclerites; *SEM* × 4500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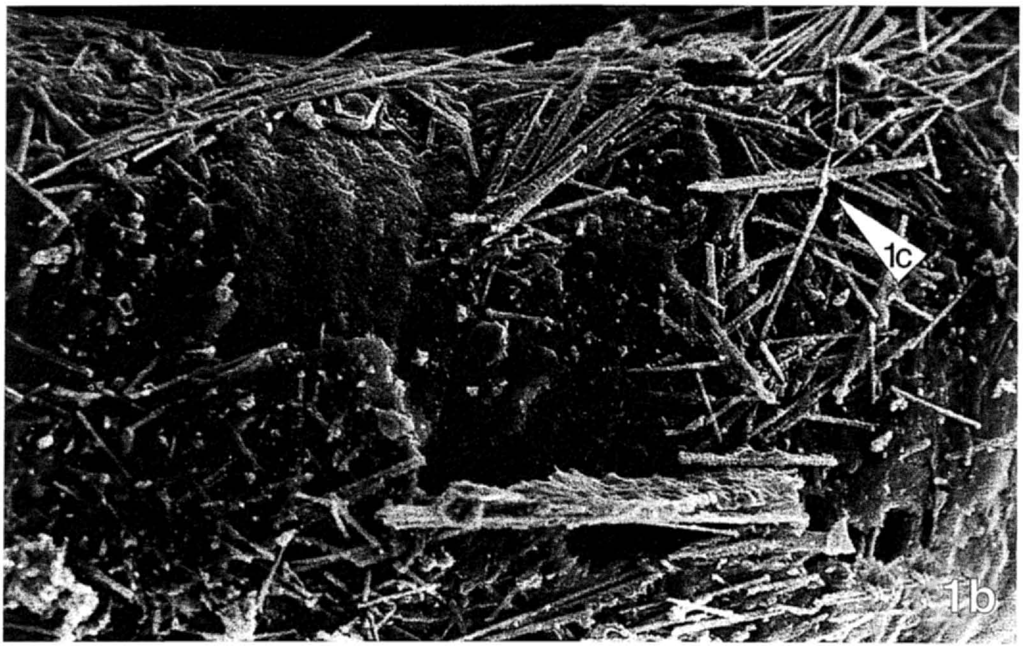
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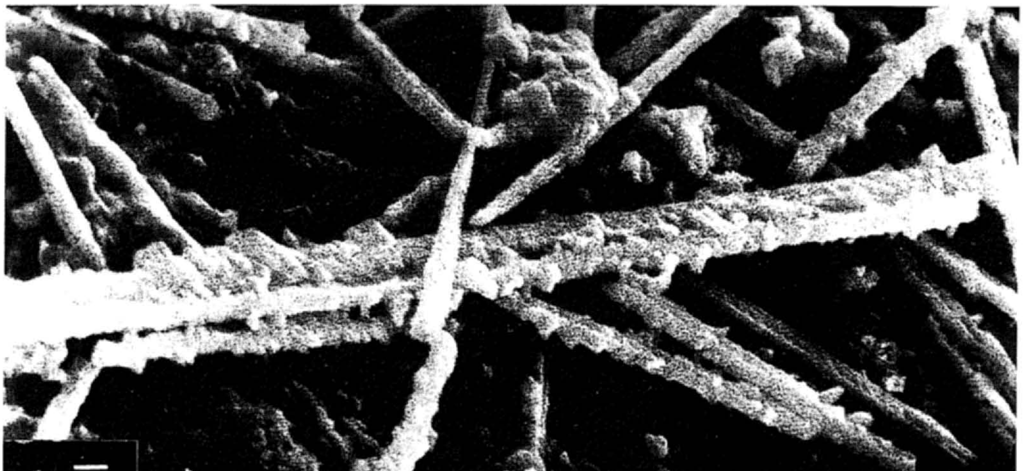
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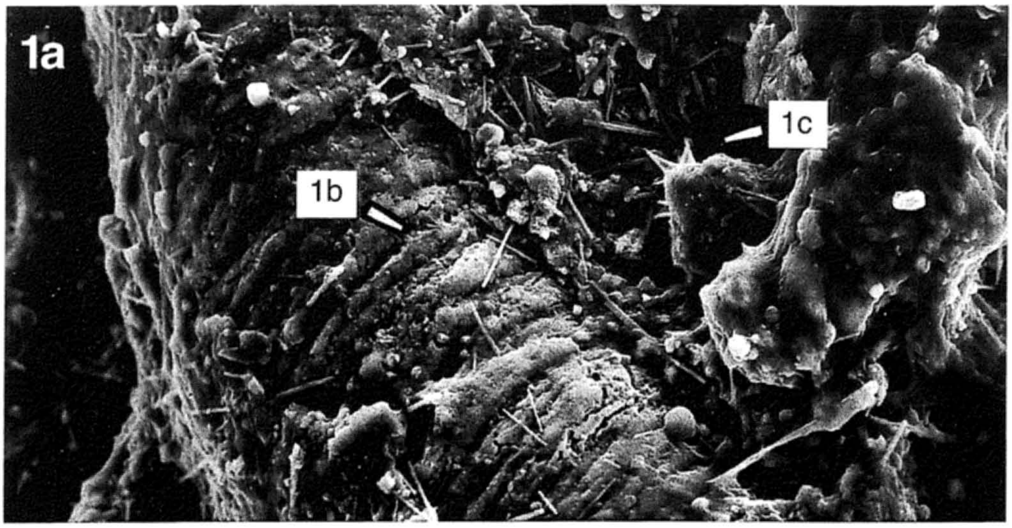
PLATE 9

Details of the coat of tubes of *Josephella commensalis* sp.n.

1a — Overall view of the coated tube, *SEM* × 570; **1b** — Close-up, to show a scatter of isolated sclerites, *SEM* × 3300; **1c** — Another close-up, to show a part of the coat composed of isolated sclerites associated with granular (flat-truncated rhombohedrons) precipitate of calcite, *SEM* × 2700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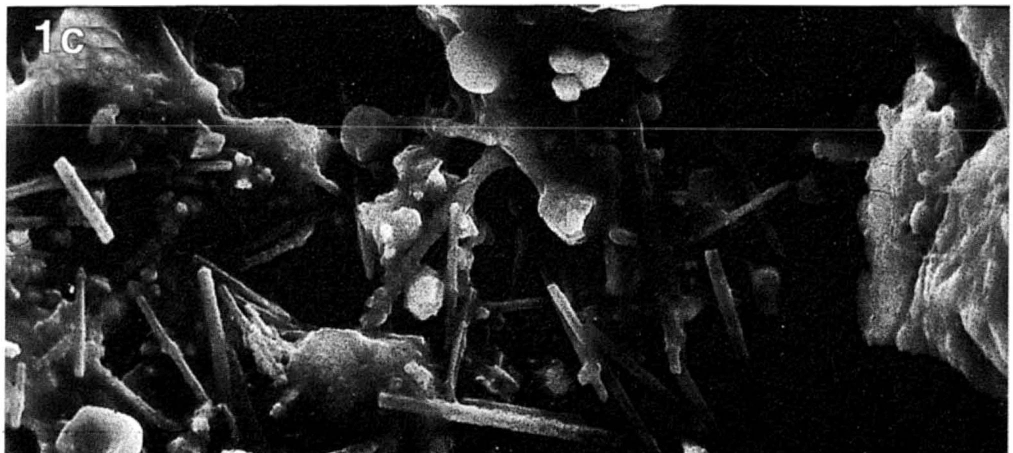
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PLATE 10

Details of the coat of tubes of *Josephella commensalis* sp.n.

1 — Common precipitates of granular calcite, *SEM* × 2100; **2** — Rare precipitates of granular calcite, *SEM* × 2000; **3** — Group of variably sized granular calcite, associated with a needle-shaped sclerite, *SEM* × 3200


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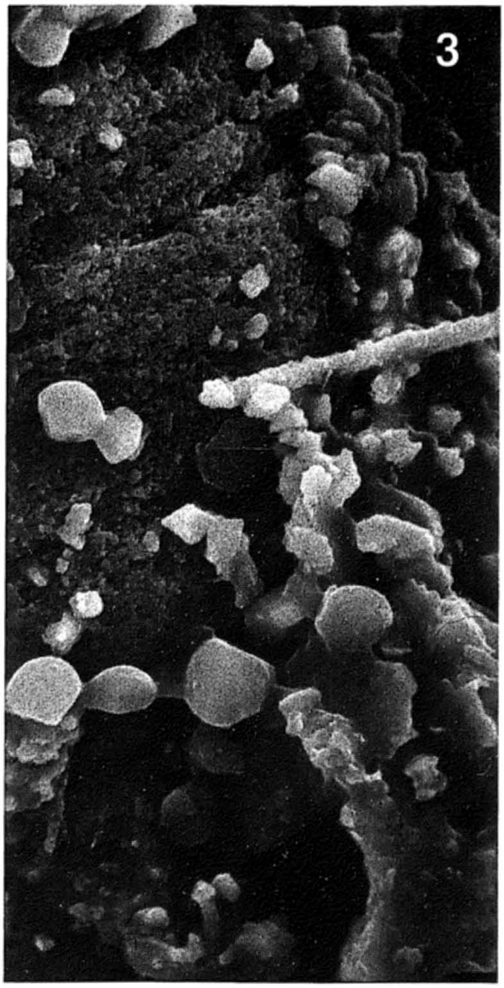
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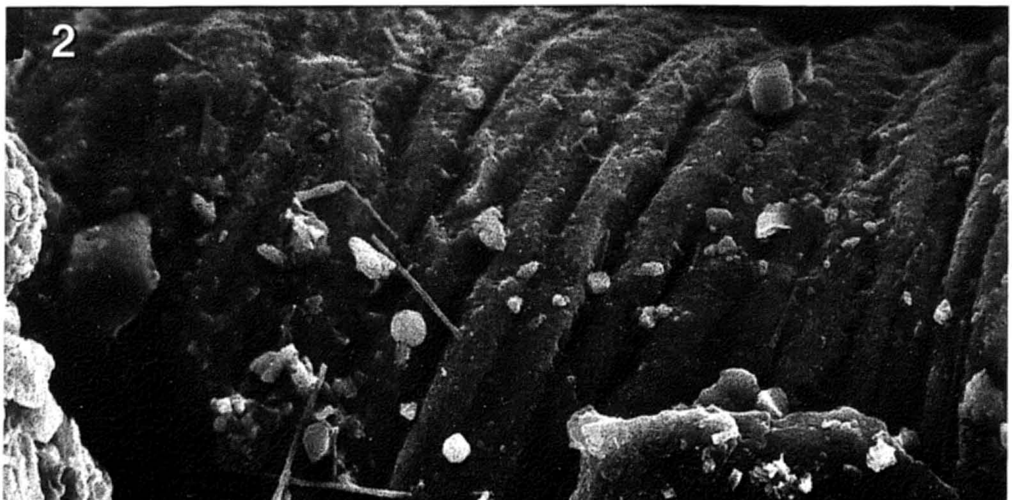
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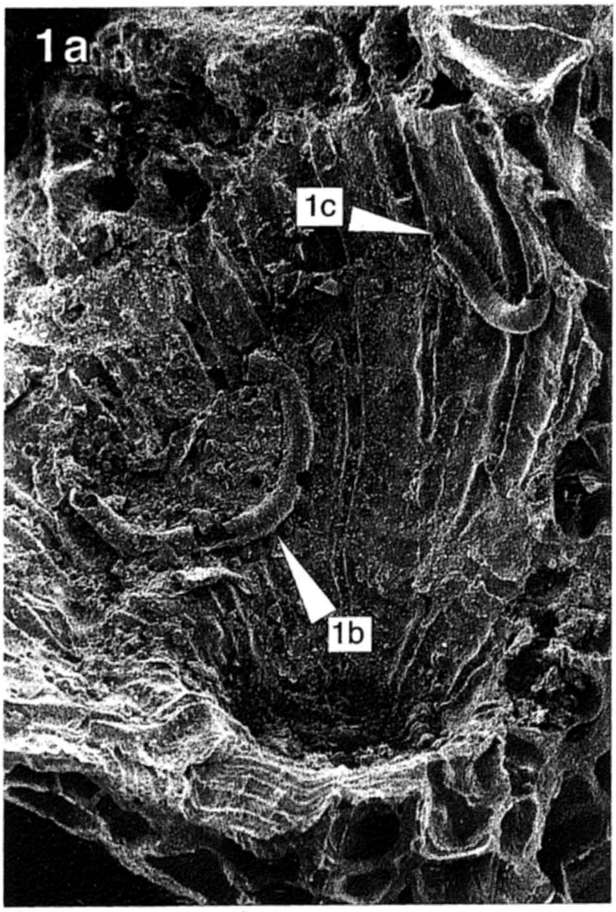
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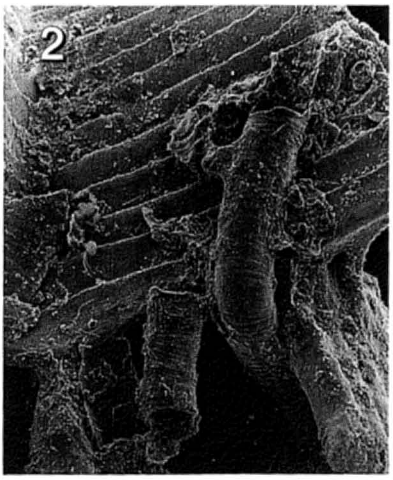
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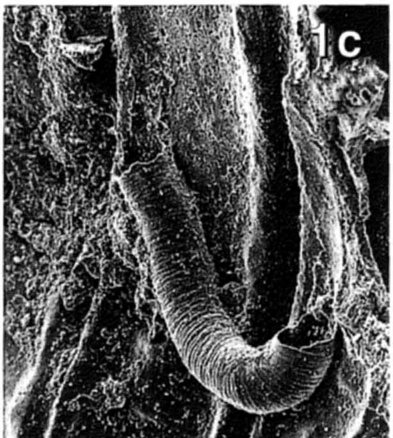
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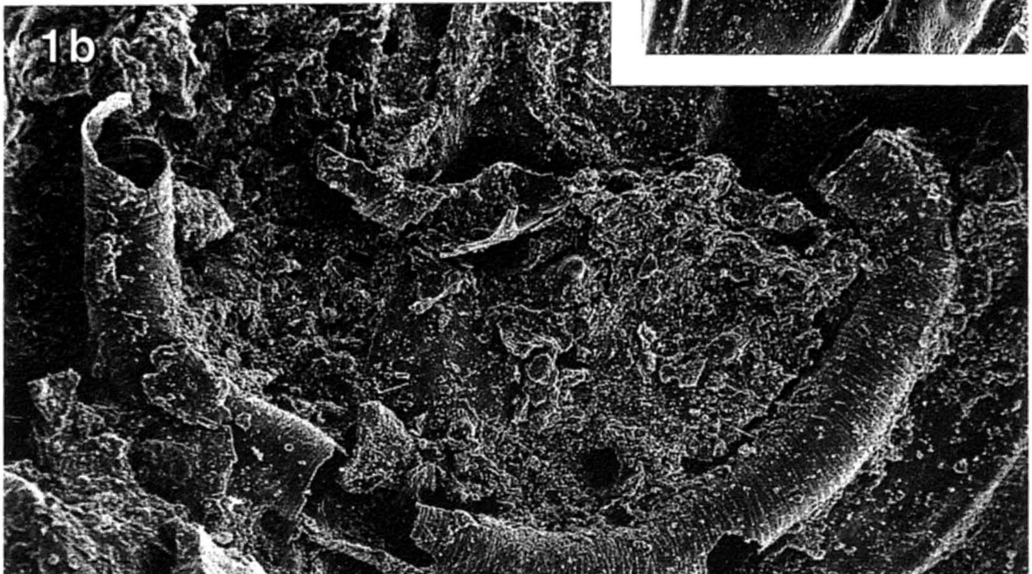

1b

HOLOTYPE: The specimen presented in Pl. 5.

PARATYPES: The specimens illustrated in Pls 2-4 and 6-11.

TYPE LOCALITY: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mountains, Central Poland.

TYPE HORIZON: Middle Miocene (Badenian corresponding to the Langhian/Serravallian boundary interval).

DIAGNOSIS: Tubes uniform in diameter, loop- to *U*-shaped, settled preferentially within calyces of the scleractinian coral *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850).

DERIVATION OF THE NAME: *commensalis* – in reference to the recognized mode of its life, commensal to the scleractinian coral *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850).

DESCRIPTION: As observed under low SEM-magnification (*see* Pls 2-5), the tubes in colonies of *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850) are placed preferentially inside the calyces of individual corallites. Exceptionally, single tubes appear amongst the extrathecal dissepimenta, and inside the shells of the above-indicated creusioid barnacles domiciled in the studied colonies.

In particular calyces of the coral colony, the tubes occur usually in groups of several up to ten specimens. The maximum number of tubes in a calyx is difficult to ascertain in SEM-images, since the tubes commonly acquire a loop-like shape, and the arms of the loops are often destroyed; thus, the maximum number of 28 is herein referred to the transverse sections visible in a calyx.

Within the coral calyces, the tubes are either scattered throughtout the whole space, both between the septa and the bottom of a calyx (Pl. 2, Figs 1a-1c), or placed interseptally at the calycal rim (Pl. 3, Figs 1a-1d). Particular tubes vary in shape, ranging from wiedely open, broad loops (Pl. 2, Fig. 1b and Pl. 4, Figs 2-3), through the intermediates (Pl. 3, Fig. 1b and Pl. 5), to the *U*-like forms with tightly adhering arms (Pl. 3, Figs 1a, 1c-1d and Pl. 4, Fig. 1a); one of such intermediate forms is chosen as the holotype of the species (Pl. 5).

PLATE 11

Tubes of the micropolychaete *Josephella commensalis* sp.n. within the shell of the creusioid barnacle, *Creusia sanctacrucensis* BAŁUK & RADWAŃSKI, 1967, domiciled in the coral colony of *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850)

1a — Overall view of the shell interior of *Creusia sanctacrucensis* BAŁUK & RADWAŃSKI, 1967: tubes of *Josephella commensalis* sp.n. are adhered to the inner side of the basal plate of barnacle shell, *SEM* × 45

1b-1c — Close-ups, to show the structure of the loop-shaped tubes; Fig. 1b *SEM* × 160, Fig. 1c *SEM* × 95

2 — Tube of *Josephella commensalis* sp.n. adhered to the inner side of the barnacle sheath at the carinal plate, *SEM* × 95

All the tubes extend from the calycal margin down into the calyx, to an almost identical depth of 2.5 mm, interpreted as the calyx bottom (Pl. 4, Figs 2-3 and Pl. 5). In deeper parts of the corallites the tubes never occur.

Throughout the whole length, attaining up to 5-6mm alongwith the loop, the tubes display a uniform annular structure with more or less continuous bands, slightly variable in thickness (*see* Pl. 5), and distinctly swollen at one end, interpreted as the final, that is apertural, ring (*see* Pl. 2, Fig. 1c and Pl. 4, Fig. 1b; *also* Pl. 6, Figs 1 and 3).

The tubes are equisized along the whole length, to measure almost ideally 0.1mm in diameter.

Under higher SEM-magnification (*see* Pls 6-10), it is visible that the annular bands are confluent with the fibers projecting from the coral septa (Pl. 6, Figs 1-2), and that some of the tube apertures are overgrown by extrathecal dissepimenta of the coral (Pl. 6, Fig. 3).

Moreover, under still higher SEM-magnification, it appears that many of the tubes are furnished with a coat, composed of calcareous, needle-shaped, more or less tattered sclerites (presumably aragonitic), and /or calcareous micrite, presumably calcitic (*see* Pls 7-10). The coat makes up commonly a distinct layer, structured like a dense felt, that slightly stretches out of the tube (Pl. 7, Figs 1a and 1c; Pl. 9, Fig. 1a). Around some tubes the coat becomes not very dense, and partly formed by single sclerites associated with granular precipitate of calcite (flat-truncated rhombohedrons; *see* Pl. 9, Figs 1a-1c). Finally, in some other tubes, the coat is composed of granular precipitate of calcite, locally with isolated needle-shaped sclerites (Pl. 10, Figs 1-3).

BIOLOGIC INTERPRETATION: The recognized confluence of the tubes with the coral septa, as well as an overgrowth of coral dissepimenta upon the tubes (*see* Pl. 6, Figs 1-3), clearly indicates that the tubes were secreted by the polychaete simultaneously with the growth of the coral which was able to biomurate the tubes. If to interpret that one partner, the polychaete, gains by having a space, and the second, that is the coral, is not harmed, thus the relationship should be – in terms classified by AGER (1963) – regarded as the commensalism.

Neverthless, some individuals of the polychaetes could develop outside the coral calyces, that is between the corallites and, accidentally, in shells of the creusioid barnacles commensal to the corals. In the latter case (*see* Pl. 11, Figs 1a-1c and 2), if the settlement and orientation of the tubes are taken into account, it is inferred that the polychaete grew in the alive cirripede, to the aperture of which all the tubes were oriented (!).

The coat of the polychaete tubes, composed of sclerites produced by polyps of the scleractinian coral, is interpreted to have acquired variable structures (*see* Pls 7-10) dependently on the intensity of calcareous secretion by the infested coral; consequently, it is regarded as not being an obligatory feature of the studied tubes.

To note, a similar mechanism of calcerous deposition by the polyp to form almost regular tubes was suggested by OLIVER (1983, p. 265) for Devonian rugose corals reacting to the presence of their tubular symbiont. Surprisingly, an almost identical reaction has recently been recognized by URIZ & *al.* (1992) in the present-day horny sponges (Demospongiae) producing a sclerite felt around the commensal scyphozoan *Nausitoë punctata* KÖLLIKER, 1853.

An immense secretion of calcium carbonate by some polyps of the scleractinian colony may indicate a serious reaction against the above-interpreted commensal micropolychaete, *Josephella commensalis* sp.n. If so, it may also be inferred that the presence of this very commensal could become harmful for the coral. It is thus suggestable that an over-population of the micropolychaetes *Josephella commensalis* sp.n. in some coral colonies could be fatal to, at least, a part of the colony of *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850) which then died, and what manifested by the growth-discontinuity surface to which the more abundant micropolychaetes are confined (*see* Pl. 1, Figs 1a-1b).

THE COMPARATIVE PRESENT-DAY MATERIAL

The comparative present-day material of *Josephella marenzelleri* CAULLERY & MESNIL, 1896, from the Mediterranean (Pls 12-13) displays some features in common with the studied Middle Miocene forms, although it is evidently epibiontic, encrusting either an opercular cap of the macropolychaete (Pl. 12), or the Precious Coral (Pl. 13). In both cases the tubes are much variable in their general course, especially those encrusting the Precious Coral, upon which they are either more or less straight, or they form broadly opened loops (*see* Pl. 13, Fig. 1). Their microstructure, both as concerns the annulation and possessing the apertural ring, is almost identical, although the annular bands seem to be less uniform (*see* Pl. 12, Fig. 1c *and* Pl. 13, Figs 5-6). In the present state of recognition, it cannot be assumed whether such differences are of individual variability, or are either habitat-controlled or species dependant. Neverthless, noteworthy is the confluence of the tube annulation with the substratal skeleton (another polychaete; *see* Pl. 12, Figs 2a-2b), whose owner was certainly alive when the specimen of *Josephella marenzelleri* was growing upon, similarly as in the studied fossil material (*compare* Pl. 6, Figs 1-2).

To note, the herein presented comparative material of *Josephella marenzelleri* CAULLERY & MESNIL, 1896, is not compatible with that recently illustrated in SEM-photos by SANFILIPPO (1996, Pl. 1, Figs 1-4), whose specimens differ in details of annular bands, much thicker apertural ring, and by the presence of funnel-shaped former apertures. Moreover, SANFILIPPO (1996, p. 211) stated that the SEM-microstucture studied by her is similar to that in *Rhodopsis pusilla* BUSH, 1905, recognized by BEN ELIAHU & TEN HOVE (1989, Fig. 10*i-k*).

From the aforegoing, it is to conclude that the hitherto recognized SEM-microstructure of some polychaete tubes (*e.g.* ZIBROWIUS & TEN HOVE 1987, BEN ELIAHU & TEN HOVE 1989, NISHI 1993, WEEDON 1994, ALIANI & *al.* 1995, SANFILIPPO 1996) does not clearly evidence its taxonomic significance.

Moreover, as concerns the smallest, tiny micropolychaetes, to which the studied Middle Miocene forms are classified, the best recognized present-day species, *Josephella marenzelleri* CAULLERY & MESNIL, 1896, does often occur together (*see* BEN ELIAHU & TEN HOVE 1989, p. 381) with *Rhodopsis pusilla* BUSH, 1905 [with which it was indicated as similar and/or confused (BUSH 1905; BEN ELIAHU & TEN HOVE 1989, p. 382; NISHI 1993; SANFILIPPO 1996)], to form common "colonies" of intertangled tubes (NISHI & YAMASU 1992, p. 98). Quite serious disopportunities thus appear for further research when having at the disposal solely the tube material, and no control of the soft parts of polychaete bodies.

PLATE 12

Comparative material of the present-day micropolychaete *Josephella marenzelleri* CAULLERY & MESNIL, 1896, encrusting an opercular cap (calotta) of the macropolychaete *Vermiliopsis labiata* (O.G. COSTA, 1861) from the Mediterranean (specimen kindly supplied by Dr. H. ZIBROWIUS; the same as illustrated by RADWAŃSKA 1994, Pl. 3, Fig. 3)

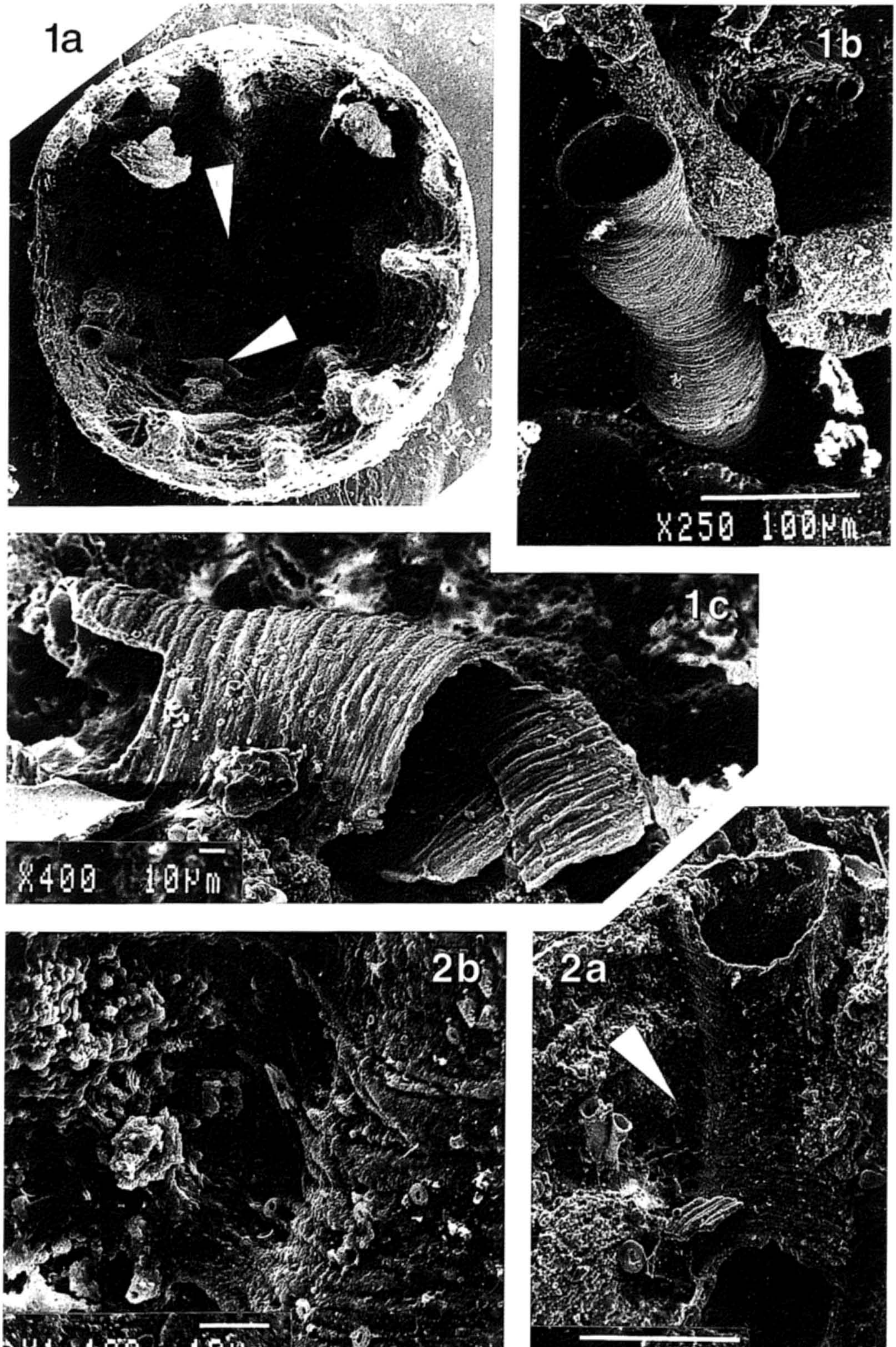
1a — Overall view of the calotta, taken × 50; arrowed are parts magnified in Figs 1b and 1c of this Plate

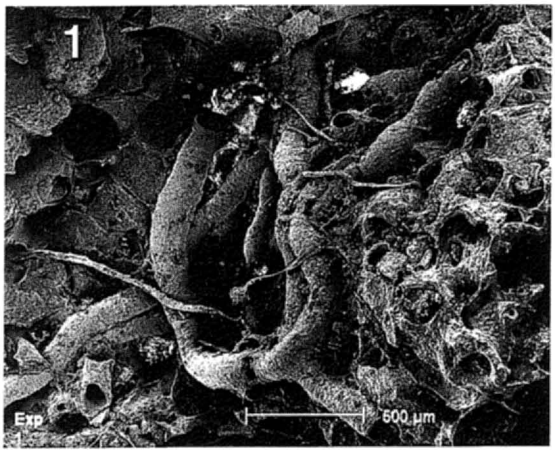
1b — Close-up, to show the apertural part of the tube of *Josephella marenzelleri* CAULLERY & MESNIL, 1896; *SEM* × 250

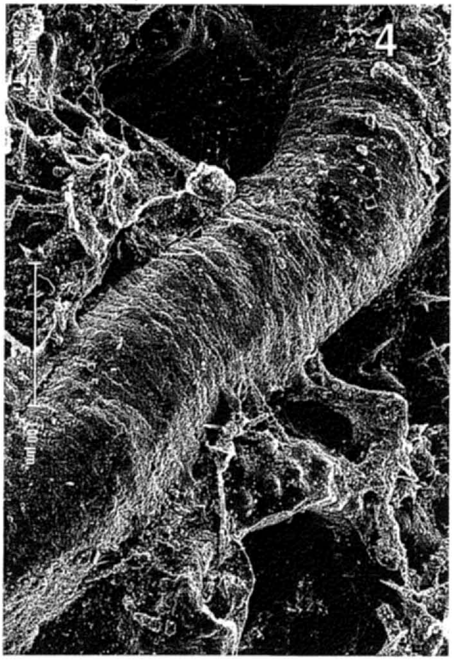
1c — Another close-up, to show the annular structure of the tube of *Josephella marenzelleri* CAULLERY & MESNIL, 1896; *SEM* × 400

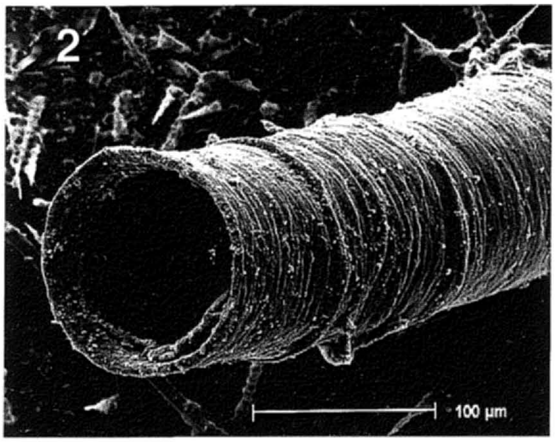
2a — Another tube of *Josephella marenzelleri* CAULLERY & MESNIL, 1896, from the same calotta (its deeper part, shadowed in Fig. 1a), to show the tube tightly adhered to the calotta wall (arrowed is a part magnified in Fig. 2b); at left margin two (?) folliculinid infusorians are visible (*cf.* MULISCH 1985, Fig. 1a-1b); *SEM* × 250

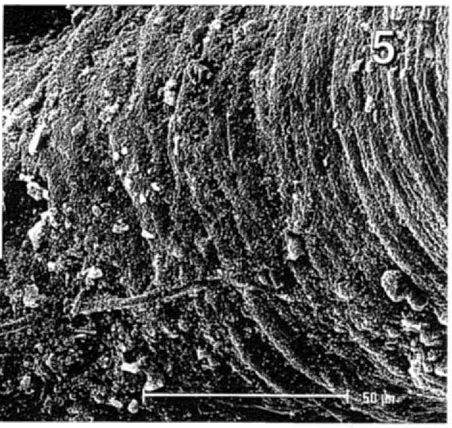
2b — Close-up, to show the tube annulation confluent with the calotta wall, to the extent similar to that of the studied fossil specimens from the Korytnica Clays (*compare* Pl. 6, Figs 1-2); *SEM* × 1100

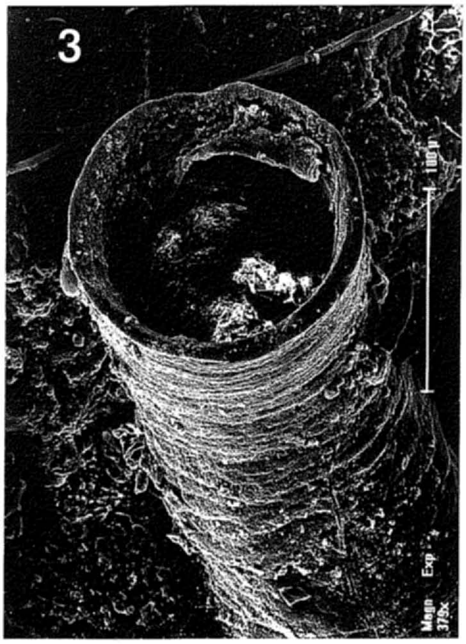

1a
1b
X250 100μm
1c
X400 10μm
2b
X1,100 10μm
2a
X250 100μm

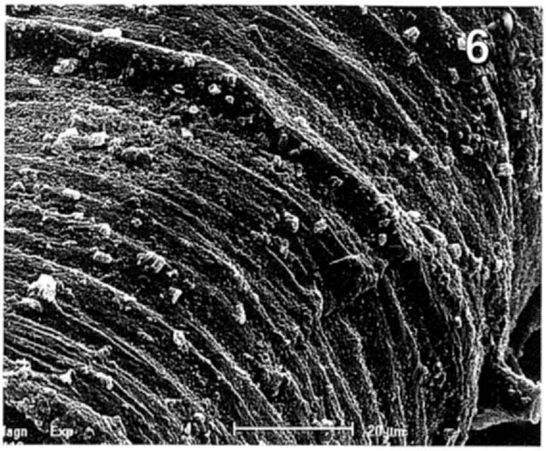

1
Exp
500 µm


4


2
100 µm


5
Magn
750x
Exp
50 µm


3
100 µ
Magn
375x
Exp


6
Magn
Exp
20 µm

REMARKS ON THE MICROPOLYCHAETE/CORAL RELATIONSHIP

The biologic relationship between the studied micropolychaete *Josephellà commensalis* sp.n. and the scleractinian coral *Tarbellastraea reussiana* (MILNE-EDWARDS & HAIME, 1850), as discussed above, is interpreted generally as commensal. Moreover, the studied micropolychaete is postulated to have acquired a high host-specificity to that very coral species.

The recognized extreme cases of local destruction of the coral colony by the presence of *Josephella commensalis* sp.n. indicate, however, that the nature of the biologic relationship between these two biota may locally change in time of the association being. Moreover, when voting for the commensalism in the studied association, it must be kept in mind that the mode of interaction between the micropolychaete and the coral cannot be precisely recognized. The micropolychaetes *Josephella commensalis* sp.n. could only get a space for their dwelling to benefit from the food either discarded by the coral, or supplied by the water motion involved by the polyps but, on the other side, they could also penetrate into the gastric cavity of the polyps to feed upon their diet. Such a food competition could result in the exploitation of the host, and the polychaete metabolism could accelerate polyp's harm, and cause its death. This interpretation is consistent with the spectrum of interactions between the corals and their inhabitans recognized both in present-day (*see* comprehensive review by PATTON 1976) and in fossil situations (*see* discussion by OLIVER 1983).

To the Authors' knowledge, no associations accurately comparable to that one studied have hitherto been presented in the literature.

PLATE 13

Comparative material of the present-day micropolychaete *Josephella marenzelleri* CAULLERY & MESNIL, 1896, encrusting a piece of Precious Coral from the Mediterranean (specimen kindly supplied by Dr. H. ZIBROWIUS)

1 — Overall view, to show the tubes encrusting gregariously the Precious Coral; *SEM* × 30

2-3 — Close-ups, to show the apertures of various tubes; *SEM* × 250 *and* 380, respectively

4 — Close-up, to show a median part of the tube; *SEM* × 200

5-6 — Close-ups, to show the annular structure of the tubes; *SEM* × 550, *and* 800, respectively

Surprisingly, of the numerous associates of the present-day corals (*see* PATTON 1976), various crustaceans were the most detaily investigated, and supplied an extensive bibliography (*see also* TÜRKAY & SCHUHMACHER 1985, ZIBROWIUS & GRYGIER 1985, KROPP & MANNING 1987, SIEG & ZIBROWIUS 1989, DENHARTOG & TÜRKAY 1991, GRYGIER & NOJIMA 1995, GRYGIER & CAIRNS 1996) with a separate file that on the creusioid barnacles (*see* BAŁUK & RADWAŃSKI 1967, 1984; ROSS & NEWMAN 1973; NEWMAN & ROSS 1976; OGAWA & MATSUZAKI 1992), while every little attention has been paid to the polychaetes, sometimes only mentioned to be ubiquitous on modern corals, especially reef corals.

Moreover, as concerns the fossil examples, in which usually the voids are left after the tubes being dissolved during diagenesis, the associates may often be referred only to as "worms" or worm-like invertebrates. Of such worm-like creatures, the commensal (or even mutualistic) sipunculans have been the best recognized since their discovery by BOUVIER in 1895 (*see* SCHINDEWOLF 1959, 1960; RICE 1976; BRETT & COTTRELL 1982). Not discussed are herein diverse tubular structures or voids (some of them corkscrew-like; *see* PLUSQUELLEC 1968, OEKENTORP 1969) in Paleozoic favositids, ascribed to such worm-like invertebrates, possibly polychaetes, partly at least (*see* bibliography *in*: OLIVER 1983); not commented is also a similar corkscrew-like structure in a mid-Cretaceous scleractinian colonial coral reported by VOIGT & LAFRENZ (1973).

From the present-day environments very few reports have been devoted precisely to the polychaetes commensal to various corals (VOIGT & LAFRENZ 1973, Figs 7-8; ZIBROWIUS & *al.* 1975; RANDALL & ELDREDGE 1976; TEN HOVE 1989; BAYER 1992), of which none corresponds to the studied example from the Korytnica Clays.

A case of the fossil relationship comparable, to some extent, is only that revealed in a Devonian rugose solitary coral, described by OLIVER (1983, Fig. 5), who interpreted it as parasitic. To the truth, many biologic relationships still remain difficult to be interpreted unequivocally, not only under ancient, but also under present-day conditions, and as evidenced not only by the corals and their associates, but also by other hosts and their intruders *vel* guests (*see* MORTON 1989, URIZ & *al.* 1992, GRYGIER & CAIRNS 1996).

Acknowledgements

The Authors offer their most sincere thanks to Dr. Helmut ZIBROWIUS, *Station Marine d'Endoume, Université d'Aix-Marseille II* (France), for his help and advice during the research progress, particularly for a kind delivery of the comparative present-day material. The same generosity the Authors owe to Dr. Harry A. TEN HOVE, *Instituut voor Systematiek en Populatiebiologie, Universiteit van Amsterdam* (The Netherlands), and to Dr. Eijiroh NISHI, *Natural History Museum and Institute, Chiba; Aoba-cho, Chuo-ku, Chiba* (Japan). Last but not least thanks are also to Dr. Ulla RADWAŃSKA, of the Authors' institution, for her continuous help of various kind during the polychaete research and preparation of the present report.

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REFERENCES

AGER, D.V. 1963. Principles of paleoecology, pp. 1-371. *McGraw – Hill*; New York.

ALIANI, S., BIANCHI, C.N., DEASMUNDIS, C. & MELONI, R. 1995. Scanning electron microscope observations on the tube of the reef-forming serpulid *Ficopomatus enigmaticus* (FAUVEL) (Annelida, Polychaeta). *Boll. Zool.*, **62**, 363-367.

BAŁUK, W. & RADWAŃSKI, A. 1967. Miocene cirripeds domiciled in corals. *Acta Palaeont. Polon.*, **12** (4), 457-513. Warszawa.

— & — 1977. Organic communities and facies development of the Korytnica Basin (Middle Miocene; Holy Cross Mountains, Central Poland). *Acta Geol. Polon.*, **27** (2), 85-123. Warszawa.

— & — 1984. Creusioid cirripedes from the Korytnica Clays (Middle Miocene; Holy Cross Mountains, Central Poland). *Acta Geol. Polon.*, **34** (3/4), 271-279. Warszawa.

— & — 1991. A new occurrence of fossil acrothoracican cirripedes: *Trypetesa polonica* sp.n. in hermitted gastropod shells from the Korytnica Basin (Middle Miocene; Holy Cross Mountains, Central Poland), and its bearing on behavioral evolution of the genus *Trypetesa*. *Acta Geol. Polon.*, **41** (1/2), 1-36. Warszawa.

— & — 1996. Stomatopod predation upon gastropods from the Korytnica Basin, and from other classical Miocene localities in Europe. *Acta Geol. Polon.*, **46** (3/4), 279-304. Warszawa.

— & — 1997. A biogenic paradigm of shells of the clavatulid gastropods: the trace fossil *Clavatulicola evaephilus* ichnogen. et ichnosp.n. from the Middle Miocene localities Korytnica (Holy Cross Mountains, Poland) and Grund (Vienna Basin, Austria). *Acta Geol. Polon.*, **47** (3/4), 199-210. Warszawa.

BAYER, F.M. 1992. The helioporacean octocoral *Epiphaxum*, recent and fossil: A monographic iconography. *Studies in Tropical Oceanography*, **15**. *University of Miami*; Miami, Florida.

BEN-ELIAHU, M.N. & TEN HOVE, H.A. 1989. Redescription of *Rhodopsis pusilla* BUSH, a little known but widely distributed species of Serpulidae (Polychaeta). *Zool. Scripta*, **18** (3), 381-395. Oxford.

BIANCHI, C.N. 1981. Policheti Serpuloidei. *Consiglio Nazionale delle Ricerche*; *Guide per il riconoscimento delle specie animali delle acque lagunari e costiere italiane*, **5**, 1-187. Genova.

BRETT, C.E. & COTTRELL, J.H. 1982. Substrate specificity in the Devonian tabulate coral *Pleurodictyum*. *Lethaia*, **15** (3), 247-262. Oslo.

BOUCOT, A.J. 1990. Evolutionary paleobiology of behavior and coevolution, pp. 1-725. *Elsevier*; Amsterdam.

BUDD, A.F., BOSELLINI, F. & STEMANN, T.A. 1996. Systematics of the Oligocene to Miocene reef coral *Tarbellastraea* in the northern Mediterranean. *Palaeontology*, **39** (3), 515-560. London.

BUSH, K.J. 1905. Tubicolous annelids of the tribes Sabellides and Serpulides from the Pacific Ocean. *Harriman Alaska Exped.*, **12**, 169-355.

DEN HARTOG, J.C. & TÜRKAY, M. 1991. *Platypodiella georgei* spec. nov. (Brachyura: Xanthidae), a new crab from the island of St. Helena, South Atlantic Ocean, with notes on the genus *Platypodiella* GUINOT, 1967. *Zool. Med. Leiden*, **65** (15), 209-220. Leiden.

GOULD, S.J. 1977. Ontogeny and phylogeny, pp. 1-501. *The Belknap Press of Harvard University Press*; Cambridge, Massachusetts – London, England.

GRYGIER, M.J. & CAIRNS, S.D. 1996. Suspected neoplasms in deep-sea corals (Scleractinia: Oculinidae: *Madrepora* spp.) reinterpreted as galls caused by *Petrarca madreporae* n.sp. (Crustacea: Ascothoracida: Petrarcidae). *Diseases of Aquatic Organisms*, **24**, 61-69.

GRYGIER, M.J. & NOJIMA, S. 1995. Petrarcid galls and Petrarcidae (Crustacea: Ascothoracida) in some scleractinian corals from Japan. *Galaxea*, **12**, 83-101. Nishihara, Okinawa.

JANSSEN, R. 1972. Beiträge zur Kenntnis der Bryozoa, Vermes, Crustacea und Echinodermata aus dem nordwestdeutschen Mittel- und Obermiozän. *Veröff. Überseemus. Bremen, Reihe A*, **4** (11), 71-108. Bremen.

KROPP, R.K. & MANNING, R.B. 1987. The Atlantic gall crabs, family Cryptochiridae (Crustacea: Decapoda: Brachyura). *Smithsonian Contr. Zool.*, **462**, 1-21. Washington, D.C.

MORTON, B. 1989. Partnerships in the sea: Hong Kong's marine symbioses, pp. 1-124. *Hong Kong University Press*; Hong Kong.

MULISCH, M. 1985. Die Flaschentierchen (Folliculiniden): Interessante Bewohner des Meeres. *Mikrokosmos*, **2**, 39-44. Stuttgart.

NEWMAN, W.A. & ROSS, A. 1976. Revision of the balanomorph barnacles; including a catalog of the species. *Mem. San Diego Soc. Nat. History*, **9**, 1-108. San Diego.

NISHI, E. 1992. Asexual reproduction in the serpulid tube worm, *Josephella marenzelleri* CAULLERY & MESNIL (Polychaeta, Sedentaria). *Nanki-Seibutu, Nanki Biol. Soc.*, **34** (2), 109-111.

— 1993. On the internal structure of calcified tube walls in Serpulidae and Spirorbidae (Annelida, Polychaeta). *Marine Fouling*, **10** (1), 17-20.

— & YAMASU, T. 1992. Brooding and development of *Rhodopsis pusilla* BUSH (Serpulidae, Polychaeta). *Bull. College Sci., University of the Ryukyus*, **54**, 93-100.

OEKENTORP, K. 1969. Kommensalismus bei Favositiden. *Münster. Forsch. Geol. Paläont.*, **12**, 165-217. Münster.

OGAWA, K. & MATSUZAKI, K. 1992. An essay on host specificity, systematic taxonomy, and evolution of the coral-barnacles. *Bull. Biogeograph. Soc. Japan*, **47** (10), 87-101.

OLIVER, W.A., Jr. 1983. Symbioses of Devonian rugose corals. *Mem. Ass. Australas. Palaeontols*, **1**, 261-274.

PATTON, W.K. 1976. Animal associates of living reef colonies. *In*: O.A. JONES & R. ENDEAN (*Eds*), Biology and geology of coral reefs, pp. 1-36. *Academic Press*; New York – San Francisco – London.

PLUSQUELLEC, Y. 1968. De quelques commensaux de Coelentérés paléozoïques. *Ann. Soc. Géol. du Nord*, **86**, 163-172. Lille.

RADWAŃSKA, U. 1994. A new group of microfossils: Middle Miocene (Badenian) opercular caps (*calottae*) of the tube-dwelling polychaetes *Vermiliopsis* SAINT-JOSEPH, 1894. *Acta Geol. Polon.*, **44** (1/2), 83-96. Warszawa.

RANDALL, R.H. & ELDREDGE, L.G. 1976. Skeletal modification by a polychaete annelid in some scleractinian corals. *In*: G.O. MACKIE (*Ed.*), Coelenterate ecology and behavior, pp. 453-465. *Plenum Press*; New York – London.

RICE, M.E. 1976. Sipunculans associated with coral communities. *Micronesica*, **12** (1), 119-132.

RONIEWICZ, E. & STOLARSKI, J. 1991. Miocene Scleractinia from the Holy Cross Mountains, Poland; Part *2* – Archaeocoeniina, Astraeina, and Fungiina. *Acta Geol. Polon.*, **41** (1/2), 69-83. Warszawa.

ROSS, A. & NEWMAN, W.A. 1973. Revision of the coral-inhabiting barnacles (Cirripedia: Balanidae). *Trans. San Diego Soc. Nat. History*, **17** (12), 137-173. San Diego.

SANFILIPPO, R. 1996. Micromorphology, microstructure and functional morphology of the *Josephella marenzelleri* (Polychaeta Serpulidae) tube. *In*: A. CHERCHI (*Ed.*), Autecology of selected fossil organisms: Achievements and problems. *Boll. Soc. Paleont. Ital., Spec. Vol.*, **3**, 205-211. Modena.

SCHINDEWOLF, O.H. 1959. Würmer und Korallen als Synöken. *Akad. der Wiss. u.d. Lit. in Mainz, Abhandl. d. Math.-Naturwiss. Kl., Jg. 1958*, **6**, 259-327. Wiesbaden.

— 1960. Über Lebensgemeinschaften von Würmern und Korallen. *Natur und Volk*, **90** (1), 1-10. Frankfurt a.M.

SCHMIDT, W.J. 1951. Neue Serpulidae aus dem tertiären Wiener Becken. *Ann. Naturhist. Mus. Wien*, **58**, 77-84. Wien.

— 1955. Die tertiären Würmer Österreichs. *Denkschr. Österr. Akad. Wiss., Math.-Naturwiss. Kl.*, **109** (7), 1-121. Wien.

— 1969. Vermes. *In*: Catalogus Fossilium Austriae, Heft **Va**, 1-56. Wien.

SIEG, J. & ZIBROWIUS, H. 1989. Association of a tube inhabiting tanaidacean, *Bifidia scleractinicola* gen.nov., sp.nov., with bathyal scleractinians off New Caledonia (Crustacea Tanaidacea – Cnidaria Scleractinia). *Mésogée 1988*, **48**, 189-199.

STOLARSKI, J. 1991. Miocene Scleractinia from the Holy Cross Mountains, Poland; Part *1* – Caryophyllidae, Flabellidae, Dendrophylliidae, and Micrabaciidae. *Acta Geol. Polon.*, **41** (1/2), 37-67. Warszawa.

TEN HOVE, H.A. 1989. Serpulinae (Polychaeta) from the Caribbean: IV – *Pseudovermilia madracicola* sp.n., a symbiont of corals. *Studies in honour of Dr. Pieter Wagenaar Hummelinck; Foundation for Scientific Research in Surinam and the Netherlands Antilles*, **123**, 135-144. Amsterdam.

TÜRKAY, M. & SCHUHMACHER, H. 1985. *Latopilumnus tubicolus* n.gen.n.sp., eine neue korallenassoziierte Krabbe, die die Bildung einer Wohnhöhle induziert. *Senckenberg. Marit.*, **17** (1-3), 55-63. Frankfurt a.M.

URIZ, M.-J., ROSELL, D. & MALDONADO, M. 1992. Parasitism, commensalism or mutualism? The case of Scyphozoa (Coronatae) and horny sponges. *Marine Ecol. Progress Series*, **81**, 247-255.

VOIGT, E. & LAFRENZ, H.R. 1979. Serpuliden (?) als Kommensalen in einer Stockkoralle aus dem englishen Ober-Albien. *N.Jb. Geol. Paläont. Mh.*, **8**, 501-511. Stuttgart.

WEEDON, M.J. 1994. Tube microstructure of Recent and Jurassic serpulid polychaetes and the question of the Palaeozoic 'spirorbids'. *Acta Palaeont. Polon.*, **39** (1), 1-15. Warszawa.

ZIBROWIUS, H. 1968. Étude morphologique, systématique et écologique, des Serpulidae (Annelida Polychaeta) de la région de Marseille. *Rec. Trav. Station Mar. Endoume, Bull.*, **43** (59), 81-253. Marseille.

— & GRYGIER, M.J. 1985. Diversity and range of scleractinian coral hosts of Ascothoracida (Crustacea: Maxillipoda). *Ann. l'Inst. Océanogr., N. Sér.*, **61** (2), 115-138. Paris.

—, SOUTHWARD, E.C. & DAY, J.H. 1975. New observations on a little-known species of *Lumbrinereis* (Polychaeta) living on various cnidarians, with notes on its recent and fossil scleractinian hosts. *J. Mar. Biol. Ass. U.K.*, **55**, 83-108.

— & TEN HOVE, H.A. 1987. *Neovermilia falcigera* (ROULE, 1898): a deep- and cold-water serpulid polychaete common in the Mediterranean Plio-Pleistocene. *Bull. Biol. Soc. Washington*, **7**, 259-271. Washington, D.C.