The genus *Acanthodendrilla* in the Mediterranean Sea with description of a new species

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ABSTRACT
Three specimens of a keratose sponge not ascribable to any known Mediterranean genus were collected by trawling off the continental shelf of the Blanes littoral (NE Spain, western Mediterranean). The sponge is foliose, erect, attached to the substratum by one or several short stalks. The stalks skeleton is formed by ascendant fascicled fibres, which repeatedly divide, anastomose, and reticulate in the foliose part, to form a dendro-reticulate network. The surface is conulose with long conules, up to 5 mm apart. Fibres have distinct pith filled with noticeable amounts of foreign debris, and a multi-stratified bark. The skeleton features do not match those of any genus known from the Mediterranean Sea but are similar to a new genus recently described from the Indo-Pacific: *Acanthodendrilla* Bergquist, which was represented up to now by the species *A. australis*. The Mediterranean species, here described as *Acanthodendrilla levii* n. sp., differs from *A. australis* in its dendro-reticulate skeleton (instead of that totally reticulated in the Pacific species), the way the sponge attaches to the substratum by means of one or several short stalks (which are absent from *A. australis*), and its foliose thin growth habit (instead of that massive and thicker in *A. australis*). The finding of a second species confirms the validity of the genus *Acanthodendrilla*. This is the first record of the genus outside the type locality, and the first time that a representative of the family Dictyodendrillidae has been reported in the Mediterranean Sea.

KEY WORDS
Porifera,
taxonomy,
keratose sponges,
Dendroceratida,
Dictyodendrillidae,
Acanthodendrilla,
spongin fibres,
Mediterranean Sea.

RÉSUMÉ

Le genre Acanthodendrilla *en Méditerranée, avec la description d'une nouvelle espèce.*

Trois échantillons d'une éponge cornée qui n'appartient à aucun genre connu jusqu'à présent en Méditerranée ont été récoltés par chalutage au large de Blanes (NE de l'Espagne, Méditerranée occidentale). L'éponge est foliacée, dressée, fixée au substratum par un ou plusieurs pédoncules. Les pédoncules sont formés de fibres fasciculées qui suivent une direction ascendante en se divisant et s'anastomosant plusieurs fois pour former un réseau dendro-réticulé. La surface est conuleuse avec de longs conules distants de 5 mm. Les fibres possèdent une moelle claire contenant des corps étrangers et une écorce multistratifiée. Les caractéristiques du squelette ne correspondent à aucun genre déjà connu en Méditerranée. L'espèce appartient sûrement au genre *Acanthodendrilla* Bergquist, qui était représenté jusqu'à présent par une seule espèce, *A. australis.* L'espèce méditerranéenne, décrite ici comme *Acanthodendrilla levii* n. sp., diffère de *A. australis* par son squelette dendro-réticulé (au lieu de complètement réticulé dans l'espèce du Pacifique), la façon dont l'éponge est attachée au substratum au moyen d'un ou plusieurs pédoncule(s) (absents chez *A. australis*) et la forme de croissance, mince et foliacée (au lieu de massive et plus épaisse chez *A. australis*). La signalisation d'une seconde espèce confirme la validité du genre *Acanthodendrilla*. C'est la première signalisation du genre *Acanthodendrilla* hors de la localité-type et aussi la première signalisation en Méditerranée d'un représentant de la famille Dictyodendrillidae.

MOTS CLÉS
Porifera, taxonomie, éponges cornées, Dendroceratida, Dictyodendrillidae, *Acanthodendrilla,* fibres de spongine, Méditerranée.

INTRODUCTION

The only genus of Dendroceratida with a clear erect habit in the western Mediterranean known to date is *Dendrilla* Lendenfeld, 1883 with the species *Dendrilla cirsioides* Topsent, 1893 and *Dendrilla acantha* Vacelet, 1958 as the only representatives. Although a dendritic arrangement of fibres was the main feature used (e.g. Vacelet 1959; Lévi 1973; Bergquist 1978) for the allocation of keratose sponges within the order Dendroceratida and still used as an informative characteristic, there are several examples of thick encrusting or massive dendroceratids in which reticulation of fibres occurs (Bergquist 1980, 1995, 1996). In fact, building a network of fibres, either by reticulation or anastomosis, appears to be the only way to acquire a massive or erect habit in keratose sponges. Bergquist (1980), in her comprehensive revision of this group, describes a new family to include those Dendroceratida with a completely reticulate skeleton: the family Dictyodendrillidae. However, a partial reticulation of fibres also occurs within the family Dendrillidae (Tsurnamal 1967; Maldonado & Uriz 1999).

We describe here a new species belonging to a recently erected genus of Dictyodendrillidae from the Indo-Pacific: *Acanthodendrilla* Bergquist, presently known only from the species *A. australis* Bergquist, 1995.

MATERIAL AND METHODS

The material studied consists of three specimens collected by trawling from detritic and rocky bottoms at the Blanes (Spain, western Mediterranean) sublittoral, at depths of 100-130 m. For comparative purposes, we have also examined specimens of *Dendrilla cirsioides* Topsent, 1893 from the Banyuls and Blanes sponge collections,

the holotype of *Igernella vansoesti* Uriz & Maldonado (USNM 23395, as *Darwinella muelleri*) from the Smithsonian Institution, the holotype of *Igernella mirabilis* Lévi (ZMA POR9316), and specimens of *Igernella notabilis* (Duchassaing & Michelotti): ZMA POR3611 from the Zoologisch Museum of Amsterdam, and 2/5/86M ST32 and 27/4/86MM ST24 from the Station Marine d'Endoume, Marseille. Histological sections of preserved samples were made using a microtome Autocut 2040 (Reichert-Jung) after dehydratation and inclusion in parafin. Sections were stained using the Masson trichromic stain (Gabe 1968)

SYSTEMATICS

Order DENDROCERATIDA Minchin, 1900
Family DICTYODENDRILLIDAE Bergquist, 1980

Genus *Acanthodendrilla* Bergquist, 1995

TYPE SPECIES. — *A. australis* Bergquist, 1995 by monotypy.

DIAGNOSIS. — Reticulate fibrous skeleton with irregular mesh arrangement with all elements cored with detritus. Reticulation is more pronounced superficially, and ascending primary fibres project above the sponge surface. Absence of spongin spicules distinguishes the genus from *Igernella* and the irregular reticulum does it from *Dictyodendrilla* (from Bergquist 1995).

Acanthodendrilla levii n. sp.

HOLOTYPE. — Centre for Advanced Studies of Blanes, Spain, No. CEAB.POR.BIO.138

PARATYPES. — Centre for Advanced Studies of Blanes, Spain, No. CEAB.POR.BIO.137a and 137b).

ETYMOLOGY. — The species is dedicated to C. Lévi, who established the guidelines for the modern sponge systematics.

TYPE LOCALITY. — Blanes (Spain, western Mediterranean) sublittoral, at depths of 100-130 m.

DESCRIPTION

External features

Foliaceous to massive, erect sponge (Fig. 1). The holotype is a 9.5 cm high, 8 cm wide erect thin (0.2-0.3 cm in thickness) fan-like sheet, with some lateral projections perpendicular to the general sponge plane (Fig. 1C). One of the paratypes (CEAB.POR.BIO.137a) is a sheet 0.5 cm in thickness, which arises from the substrate by means of four stalks, 0.3-0.5 cm in diameter, and soon divides into several flat branches which often anastomose to produce an irregularly massive sponge (Fig. 1A, B). Paratype 2 exclusively consists of the skeleton, which shows a primarily dendritic, secondarily reticulate pattern (Fig. 1D).

The sponge surface is clean and smooth to the touch, conulose, with conules 1-3 mm high, 2-5 mm apart. The primary fibres protrude up to 2 mm from the conules but this might be the result of contraction after preservation in alcohol. Consistency soft in living specimens, somewhat coriaceous but easy to break in alcohol. The ectosome is firmly attached to the choanosome but can be separated with forceps in some places. Oscules, maximum width of 2 mm, are spread on the sponge top, either isolated or grouped in clusters of 3-4. Ostia are inconspicuous in preserved specimens. Living specimens were pinkish, cream after preservation in alcohol.

Skeleton and characteristics of the soft tissue

Primary fibres strongly fasciculate and densely arranged at the sponge base (stalked zones) (Fig. 1D). They run parallel along the stalk and then spread divergently in a flabelliform pattern, branching and interlocking repeatedly (Figs 2A; 3A). They also appear secondarily reticulate by means of secondary fibres, which often form perforate spongin plates (Figs 2B; 3C). The reticulate pattern is much more evident at the sponge periphery, where a network is visible on the sponge surface.

Primary and secondary fibres have a strongly laminated bark (Figs 2D; 3B-D). Spongin layers appear to be breakable and of different thickness (Fig. 3B, C). A distinct pith is present in both the primary and secondary fibres (Fig. 2F). Primary fibres are heavily cored with foreign material (Figs 2A-E; 4A, B). Secondary fibres also include some debris. Sponge spicules are particularly abundant among the debris incorporated into the fibres (Fig. 4A-C), and are present not only within

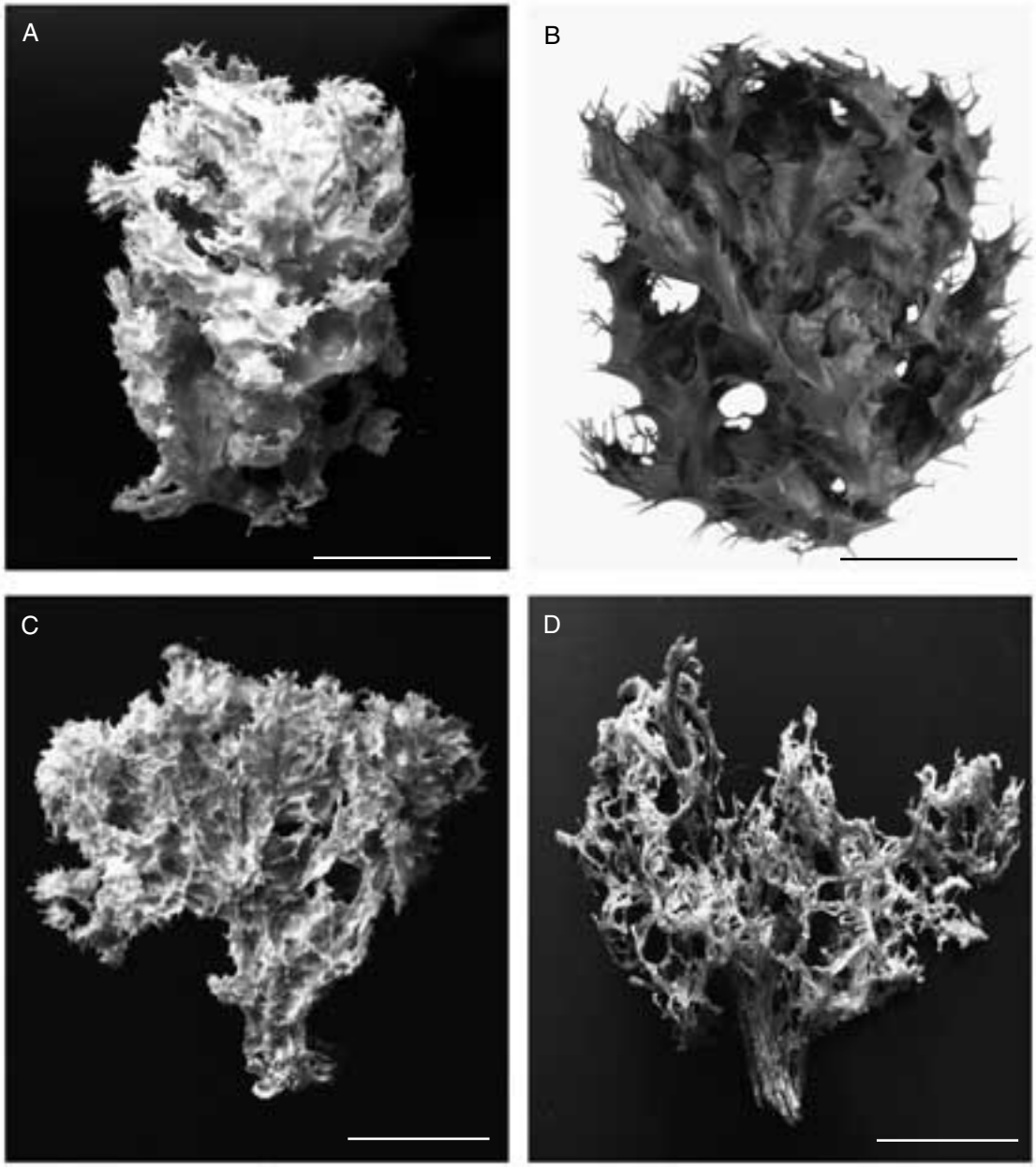

FIG. 1. — **A**, **B**, paratype 1; **C**, holotype; **D**, paratype 2, consisting of the sponge skeleton. Scale bars: A, B, 2.5 cm; C, D, 2 cm.

the pith but between contiguous spongin layers of the bark (Figs 2C, D; 4B, D). Some spicules completely traverse the fibre bark and the fibre surface thus appears perforated (Fig. 4D). Some foreign debris are present within the choanosome, outside the fibres.

Primary and secondary fibres are 230-400 µm and 20-150 µm thick, respectively. Fenestrate spongin plates are 400-1500 µm in diameter. The fascicled skeleton at the sponge stalks ranges between 3 mm and 10 mm in diameter.

Fibres are more or less dark brown but are never purple, red or black as described for other dictyodendrillid genera (Bergquist 1995).

The choanosome is well-developed with large aquiferous canals and reduced mesohyl. The choanocyte chambers are large (60-150 µm in diameter) and oval in a section with relatively large choanocytes (Fig. 5A). The ectosome is 100-200 µm thick and has two differentiated layers (Fig. 5B): the external layer, 50-60 µm thick, is rich in collagen; the inner layer, 100-130 µm thick, has abundant cells. Large subectosomal canals separate the ectosome from the choanosome.

Habitat and reproduction

The species dwells on detritic bottoms at a depth of 100-130 m. The specimen CEAB.POR.BIO. 137a (paratype) was reproducing in June. Embryos, 250 µm in diameter, were located in groups of two to three at the distal part of branches.

DISCUSSION

This species represents the first record of a genus of the family Dictyodendrillidae in the Mediterranean. The genus *Acanthodendrilla* was only known from New Caledonia. The new species is very close to *A. australis* in both external features and skeletal characteristics. The resemblance of fibres concurs accurately with the photographs included in the description of the type by Bergquist (1995).

Although the differences between *A. australis* and *A. levii* are not great, they cannot be ascribed exclusively to environmental causes due to the long distance between the respective type localities and the low capacity for dispersal of sponges (Boury-Esnault *et al.* 1993; Uriz *et al*. 1998). Several characteristics, which are present in the three specimens of *A. levii*, and absent from *A. australis*, allow us to distinguish these two species: a dendro-reticulate skeleton instead of the completely reticulate one in *A. australis*, the presence of fascicles of fibres running parallel at the sponge stalks, and the foliaceous growth habit of the Mediterranean species as compared to the clearly massive and thicker habit of *A. australis*. Moreover, *A. levii* has fenestrate spongin plates formed by the fusion of secondary fibres. These are not mentioned for the New Caledonian species (Bergquist 1995).

The colour of living specimens of *A. levii* was pink while it is unknown for *A. australis*. It is biscuit and cream in preserved specimens of *A. australis* and *A. levii,* respectively.

The presence of fibres with a strongly laminated bark and a pith cored by foreign debris, and the dendro-reticulate skeleton might suggest, at first sight, some resemblance between the new species and *Pleraplysilla reticulata* Maldonado & Uriz (1999). However, there are strong differences in the skeletal patterns between the genera *Pleraplysilla* and *Acanthodendrilla* despite the reticulation found in *P. reticulata*. The latter species is clearly a *Pleraplysilla*. Its fibres are inserted on the substratum by individual spongin plates, and, although they can divide several times, branching never reaches that of *Acanthodendrilla* species. As for the growth habit, *A. levii* is more similar to a *Dendrilla* species, particularly to *D. acantha* from the Mediterranean or to *Dendrilla rosea* from the Indo-Pacific, which have flat branches (Vacelet 1958). As in *Dendrilla*, *A. levii* is attached to the substrate by thick stalks made of parallel but anastomosed laminated fibres. However, two main characters present in *Acanthodendrilla* and absent from *Dendrilla* separate these two genera: the presence of foreign debris in the fibres and a secondary reticulation. These two characters justify placing these two genera in different families (Darwinellidae and Dictyodendrillidae), according to Bergquist (1995).

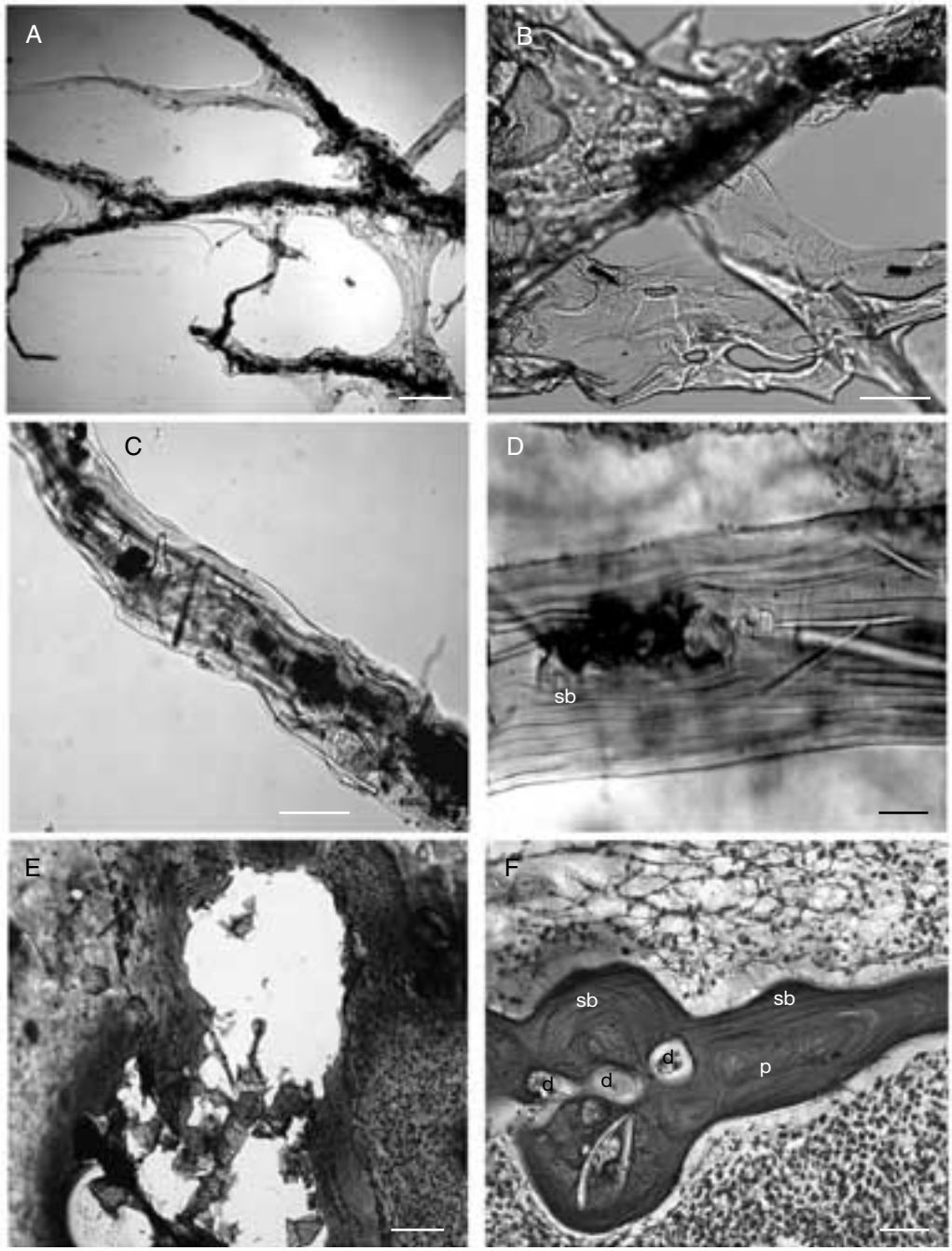

Fig. 2. — Light microscope views of different aspects of the sponge skeleton; **A**, distal part of the skeleton with terminal primary fibres heavily cored with foreign debris, secondary fibres slightly cored; **B**, perforate plate formed by secondary fibres; **C**, detail of a primary fibre (distal zone) showing large amounts of foreign materials; **D**, detail of a primary fibre with the stratified bark (sb) and the pith masked by some foreign material; **E,** primary and secondary fibres showing reticulation; **F**, histological section showing the insertion of a secondary fibre (without inclusions) in a primary fibre (with inclusions): **p**, pith; **sb**, stratified bark; **d**, foreign debris. Scale bars: A, E, 500 µm; B, C, 200 µm; D, F, 100 µm.

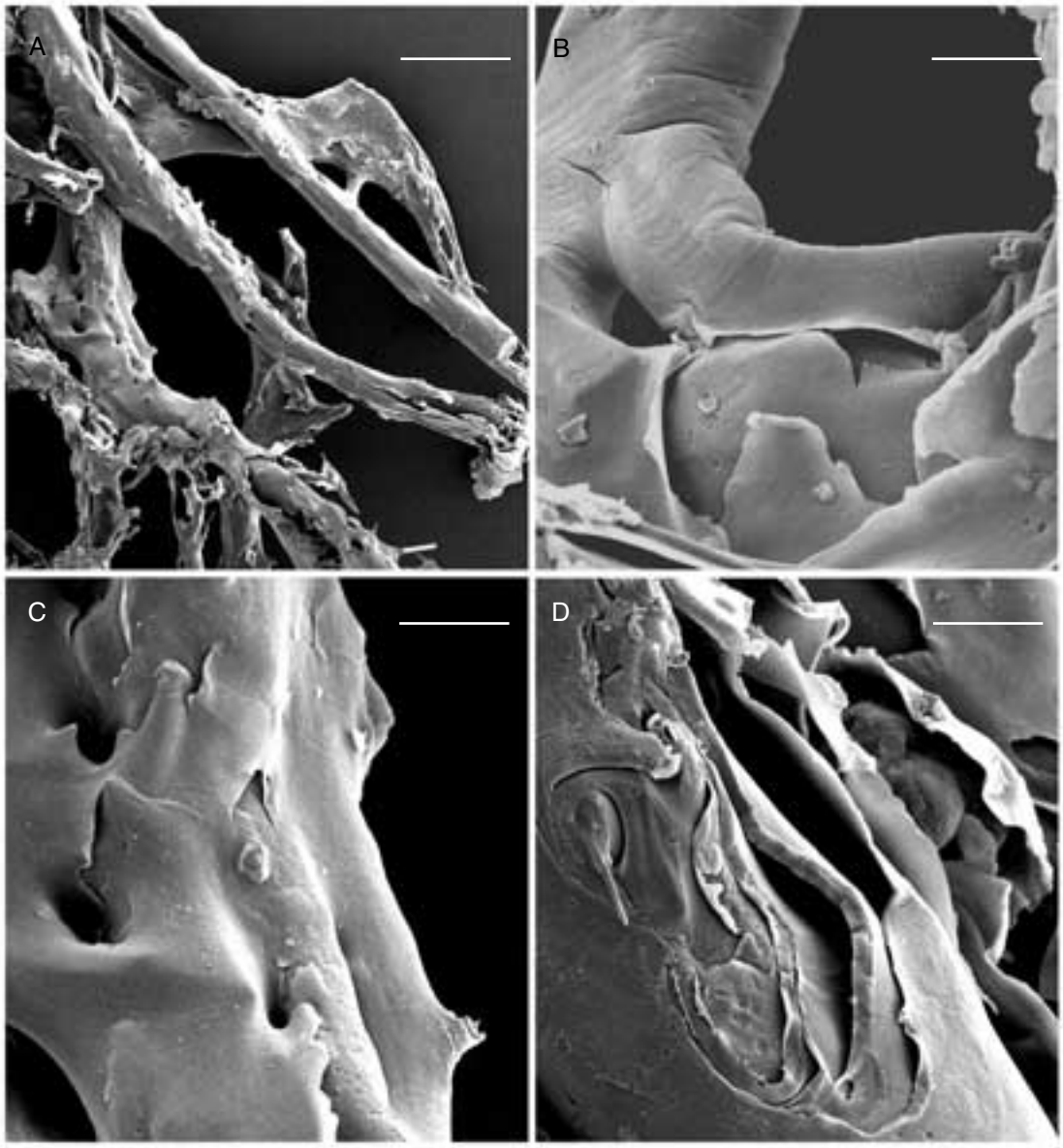

FIG. 3. — SEM views of spongin fibres; **A**, view of several fibres; **B**, external aspect of a ramified secondary fibre; **C**, perforate plate; **D**, broken fibre showing the different layers of the stratified bark. Scale bars: A, 500 µm; B, D, 50 µm; C, 100 µm.

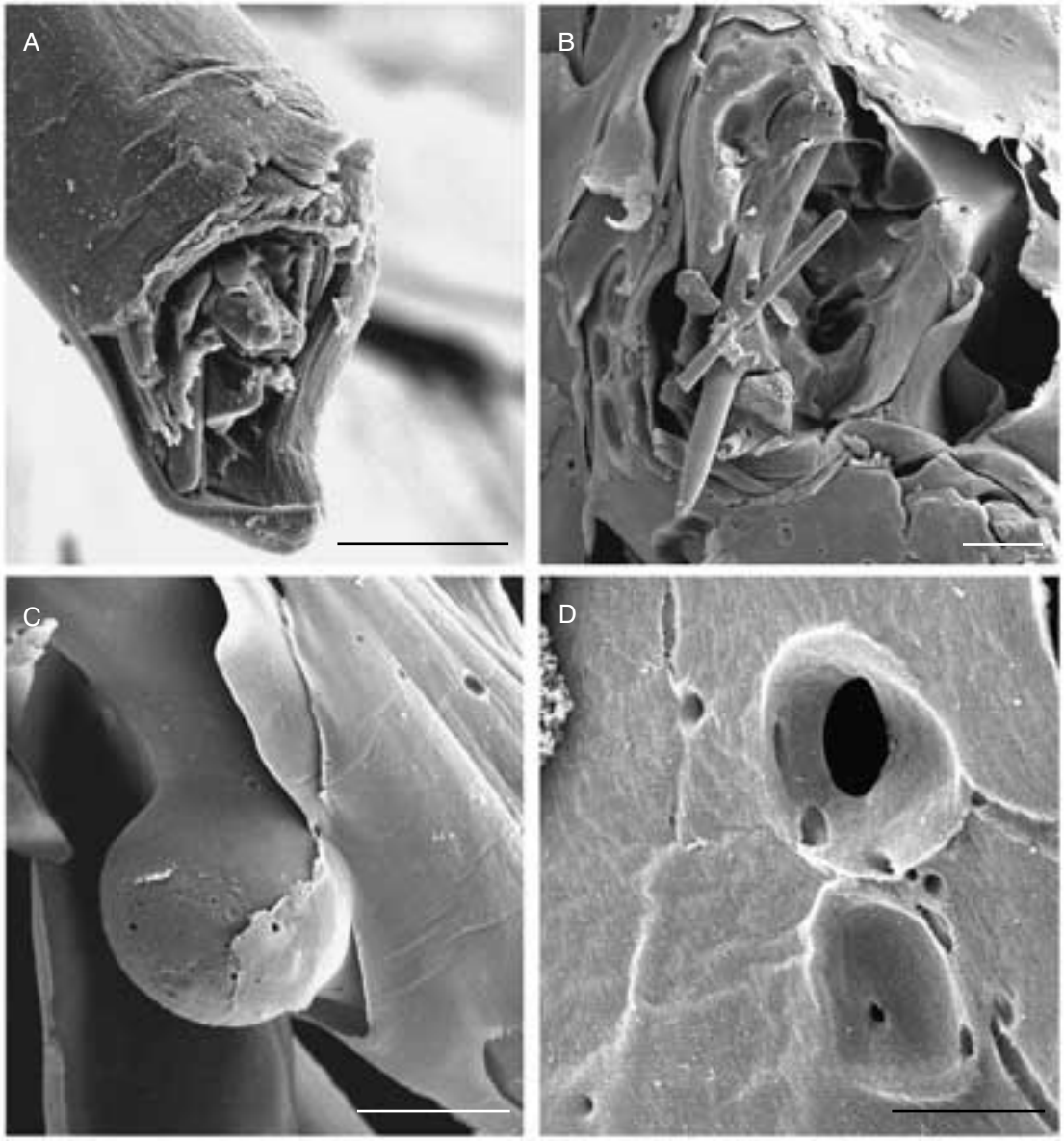

FIG. 4. — SEM views of fibre details; **A**, section of a secondary fibre showing abundant inclusions; **B**, broken fibre with sponge spicules among the foreign inclusions; **C**, tylostyle head protruding the fibre surface; **D**, orifices and other tracks in the fibre surface produced by detached materials previously incorporated to the fibre. Scale bars: A, 25 µm; B, 50 µm; C, 60 µm; D, 6 µm.

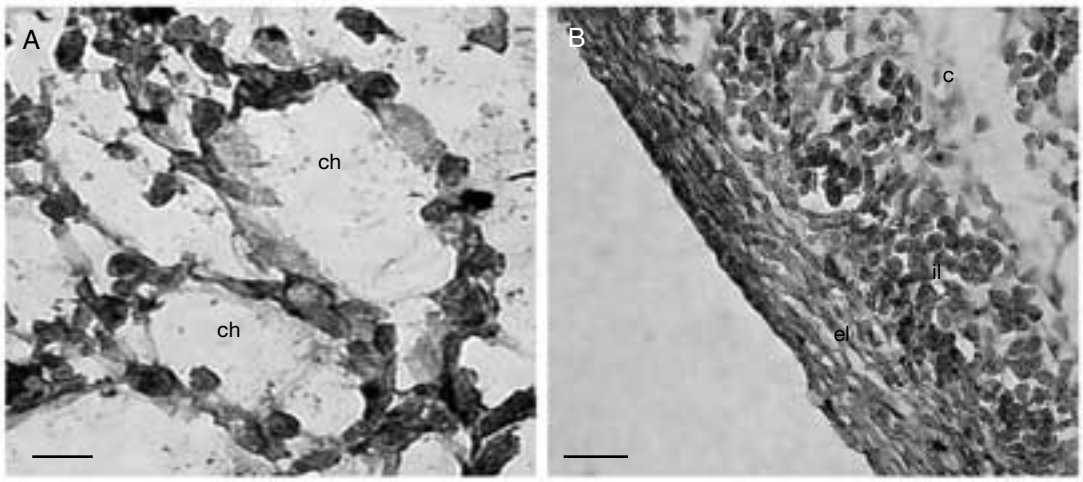

FIG. 5. — Light microscope images of sponge sections; **A**, choanosome: **ch**, choanocyte chamber; **B**, ectosome: **el**, external layer; **il**, internal layer; **c**, subectosomal canal. Scale bars: A, 15 µm; B, 40 µm.

The soft tissue organization matches, in general, that of Dendroceratida (Vacelet *et al.* 1989; Bergquist 1996) and particularly that described for *A. australis* (Bergquist 1995). Nevertheless, it is also close to that of *Dysidea avara* (Dictyoceratida) with large, oval and eurypylous chambers, and a loose mesohyl (e.g. Uriz *et al*. 1996; Turon *et al*. 1997).

The record of this second species reinforces the validity of the genus *Acanthodendrilla*. It highlights the utility of erecting new genera even on the basis of a sole known species as this facilitates later allocation of new related species. This is the first record of the genus *Acanthodendrilla* outside of the type locality and the first time that a representative of the family Dictyodendrillidae is found in the Mediterranean Sea.

The distribution of the genus *Acanthodendrilla* extends to the Pacific and the Mediterranean. The presence of this genus in the Mediterranean brings the number of dendroceratid genera known in this sea to seven (*Spongionella* Bowerbank, 1862; *Hexadella* Topsent, 1896; *Pleraplysilla* Topsent, 1905; *Aplysilla* Schulze, 1878; *Darwinella* Müller, 1865; *Dendrilla* Lendenfeld, 1883 and *Acanthodendrilla* Bergquist, 1995) and supports arguments for the subtropical affinities of the Mediterranean keratose sponges, as previously indicated (Uriz 1984).

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