J. Mar. Biol. Ass. U.K. (2006), **86**, 691–698
Printed in the United Kingdom

A new Mediterranean 'lithistid' sponge, *Aciculites mediterranea* sp. nov. (Porifera: Demospongiae) from a dark marine cave in Sardinia

Renata Manconi*‡, Annalisa Serusi* and Andrzej Pisera†

*Dipartimento di Zoologia e Genetica Evoluzionistica, Università di Sassari, 07100 Sassari, Italy.
†Institute of Palaeobiology, Polish Academy of Sciences, Twarda 51/55, 00-818 Warszawa, Poland.
‡Corresponding author, e-mail: rmanconi@uniss.it

A first record of the genus *Aciculites* in the Mediterranean Sea and the description of *Aciculites mediterranea* sp. nov. are here presented from a faunistic survey in a dark shallow marine cave of the north-western Sardinian karstic area. The new species is characterized by a massive cerebellum-like growth form, and a peculiar distribution of inhalant and exhalant areas, respectively, in depressed and elevated portions of the sponge surface. Oscules show a long narrow atrial cavity. Ectosomal skeleton is made of tangential anisostrongyles on elevated areas, and more or less vertical tufts of anisostrongyles in depressed inhalant areas. Anisostrongyles are smooth or with tips ornated by irregular tubercles. Sigmaspire microscleres are lacking. Choanosomal skeleton with tubercled irregular rizhoclone desmas and few scattered and variably oriented anisostrongyles. A comparative analysis of *Aciculites mediterranea* sp. nov. versus morphological diagnostic traits, geographical range and habitat of the species hitherto ascribed to *Aciculites* confirms that the peculiar distribution of the genus supports its relic condition of an ancient Tethyan fauna in the Mediterranean Sea.

INTRODUCTION

The polyphyletic taxon 'Lithistids', previous order Lithistida (Schmidt, 1870), is a group of living and fossil Demospongiae comprising 13 recent families sharing the trait 'articulated skeleton of desmas megascleres' (Lévi, 1973; Pisera & Lévi, 2002; Pisera, 2002). This ancient group dates back to the Cambrian and their maxima of diversity were in the Ordovician, Late Jurassic and Late Cretaceous (Reid, 1967; Rigby, 1983, 1991; Wiedenmayer, 1994; Pisera, 1999; Finks et al., 2004). Recent lithistids are often considered living fossils belonging to a relict Tethyan fauna, and their geographical range is typically tropical–subtropical in deep water with enclaves in cryptic shallow water dark habitats such as crevices and caves (Reid, 1967; Wiedenmayer, 1994; Pisera & Lévi, 2002; Pisera, 2002).

'Lithistid' sponges are rare in the Mediterranean Sea with seven species belonging to seven genera so far reported (Topsent, 1893; Pouliquen, 1969, 1972; Vacelet, 1969; Pulitzer-Finali, 1972, 1983; Pansini, 1995; Magnino et al., 1999; Pisera & Lévi, 2002; Perez et al., 2004). *Desmanthus incrustans* (Topsent, 1889) (family Desmanthidae Topsent, 1893), was recorded first from Banyuls by Topsent (1893) and 80 years after from a superficial cave of Ischia in the central Tyrrhenian Sea by Pulitzer-Finali (1970). *Discodermia polydiscus* (Bowerbank, 1869) (family Theonellidae Lendenfeld, 1903), is known from the caves along the Marseille coast (Pouliquen, 1969, 1972). *Corallistes masoni* (Bowerbank, 1869) (family Corallistidae Sollas, 1888) was first recorded from submarine caves near Marseille (Pouliquen, 1969, 1972) and later from deep waters of the eastern-Ligurian and Tyrrhenian Seas (Magnino et al., 1999), together with *Leiodermatium lynceus* Schmidt, 1870 (family Azoricidae Sollas, 1888). Vacelet (1960, 1969) discovered *Siphonidium ramosum* (Schmidt, 1870) (family Siphonidiidae Lendenfeld, 1903) around Naples, Corsica and Marseille. Recently two new lithistid species *Gastrophanella phoeniciensis* Perez, Vacelet, Bitar & Zibrowius, 2004 (family Siphonidiidae Lendenfeld, 1903) and *Microscleroderma lamina* Perez, Vacelet, Bitar & Zibrowius, 2004 (family Scleritodermidae Sollas, 1888) were discovered in a shallow water cave in Lebanon. Only five species of 'Lithistids' were till now recorded from marine Mediterranean caves (Pulitzer-Finali, 1970; Pouliquen, 1971, 1972; Perez et al., 2004).

Although the first survey of north-western-Sardinian marine shallow-water caves highlighted the presence of a diversified assemblage of 'Lithistids', here we report only on the first record of the genus *Aciculites* (Schmidt, 1879) from the Mediterranean Sea with the description of a new species. The taxonomic position of the genus and its geographical range is also discussed together with a comparative analysis of its morphological diagnostic traits.

MATERIALS AND METHODS

The first and only specimen was collected by SCUBA diving at a depth of 7.5 m in the dark zone of the Grotta dei Laghi in the karstic promontory of Punta Giglio along the north-western-Sardinian coasts (Figure 1). Further surveys were carried out in seven other caves (Grotta dei Fantasmi, Grotta dei Cervi, Grotta del Teschio, Grotta del

Figure 1. Study area in north-western-Sardinia. The type locality of *Aciculites mediterranea* sp. nov. in the Grotta dei Laghi is indicated by a black circle.

Cabirol, Grotta di Nereo, Grotta della Galatea and Grotta della Madonnina) of the same study area but there are no other findings of the lithistid taxon here reported.

The sponge was fixed in formaldehyde 4% and then transferred in alcohol 70%. Macro-traits were observed under a stereo microscope and then the sponge was photographed and dissected to obtain representative fragments. Spicules and skeleton were prepared by boiling in nitric acid, following standard methods to prepare slides for light microscopy and stubs for scanning electron microscopy (SEM). The architecture of the ectosome, choanosome, inhalant and exhalant areas was studied by SEM to ascertain the topographical localization of spicular types. Diagnostic characters and spicular sizes of the species belonging to the genus *Aciculites* are listed in Tables 1 and 2. Type material is deposited in the Museo Civico di Storia Naturale 'G. Doria' di Genova (MSNG). Institutional acronyms as follows: Musée de Zoologie de l'Université de Strasbourg (MZUS), Zoölogisches Museum Universiteit van Amsterdam (ZMA), Muséum National d'Histoire Naturelle Paris (MNHN), Institute of Palaeobiology of the Polish Academy of Sciences Warzaw (ZPAL), Queensland Museum (QM).

SYSTEMATICS

Class DEMOSPONGIAE Sollas, 1885
Family SCLERITODERMIDAE Sollas, 1888
Genus *Aciculites* (Schmidt, 1879)
[Type species *Aciculites higginsi* Schmidt, 1879]
Aciculites mediterranea sp. nov.
(Figures 1–6; Tables 1–3)

Aciculites spp.: Schmidt, 1879, 1880; Sollas, 1888; Lendenfeld, 1903; Dendy, 1905, 1924; Wilson, 1925; Vacelet & Vasseur, 1965, 1971; Bergquist, 1968; Vacelet et al., 1976;

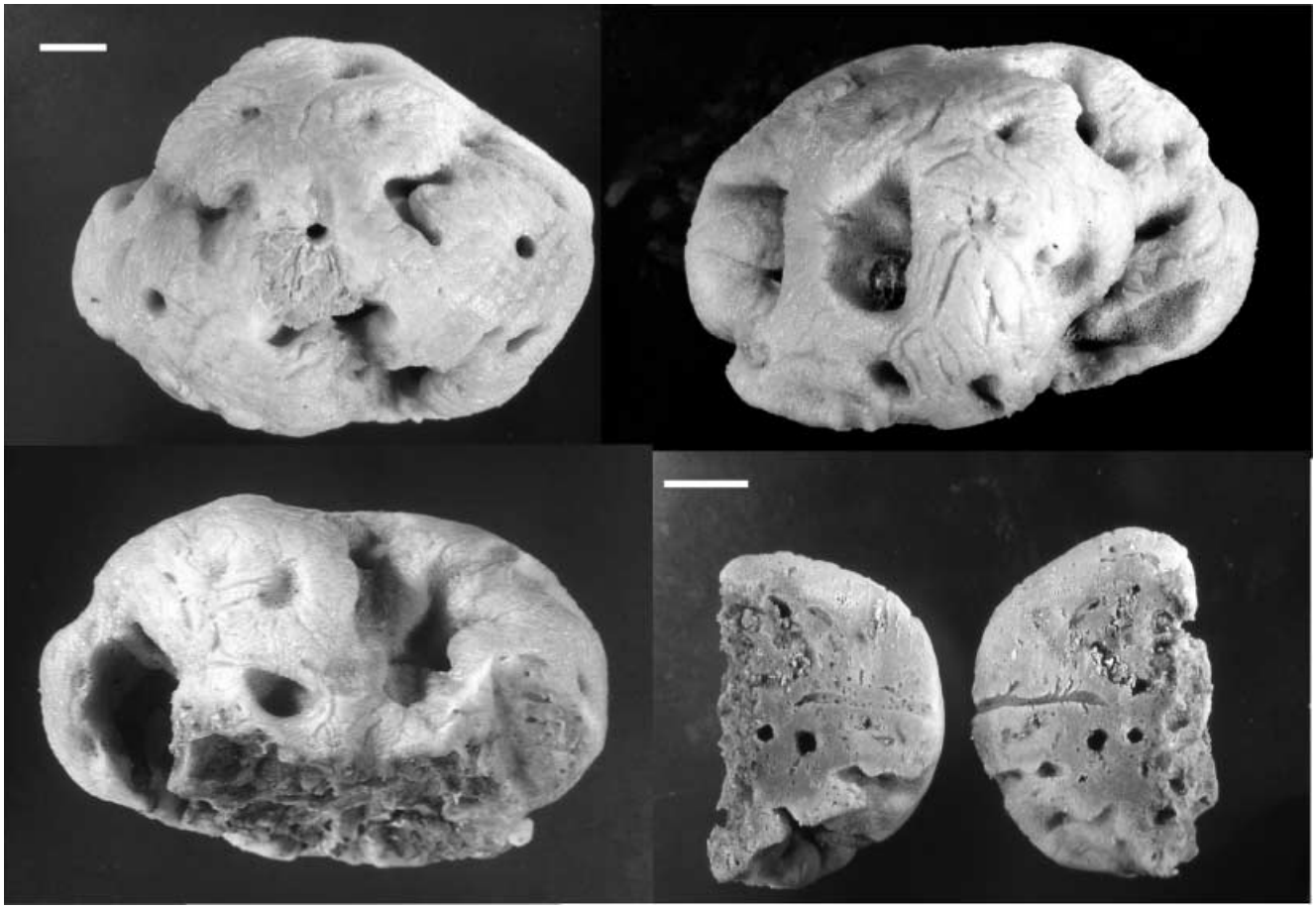

Figure 2. *Aciculites mediterranea* sp. nov., holotype MSNG 52268. From top left: upper view, lateral view, basal view, and cross section showing a well developed oscular canal. Scale bar: 5 mm.

https://doi.org/10.1017/S0025315406013580 Published online by Cambridge University Press

Table 1. *Spicular complement of the nine species hitherto ascribed to the genus* Aciculites. *Absence of a trait is indicated by '–' Measurements refer to the various authors as follows: Sollas, 1888 (*); Dendy, 1905 (#); Dendy, 1924 (◆); Bergquist, 1968 (**); Van Soest & Stentoft, 1988 (□); Lévi & Lévi, 1989 (■); Pisera & Lévi, 2002 (§); Schlacher-Hoenlinger et al., 2005(*).*

	Desmas μm	Tylostyles/ styles μm	Strongyles/ anisostrongyles μm	Oxeas μm
A. ciliata	350×30	385–540×8–10		350–700×2–3
A. cribrophora	350–400×45–65□	–	150–320×6–12□	–
A. higginsi	65–84×26–39* (branch)	-	271–355×10*	–
	200×350§	188–350×8–11§	–	–
	250–370×30–38*	–	310–500×7.5–11*	–
A. orientalis	328◆	–	328×9*	–
	180–275×15–20■	130–180×5–8■	–	–
	–	240–463×8.8–14.6*	240–463×8.8–14.6*	–
A. papillata	270–280×40	–	180–340×8–12	–
A. pulchra	340#	–	340×12#	–
	300–387**	–	314–411×5.7–12.6**	510–663×23–30**
A. spinosa	30 (branch)	–	125-275×7-10	–
A. tulearensis	350	–	270–450×6–9	190–210×3
A. mediterranea sp. nov.	100–235	–	152–340×2.5–7.5	–

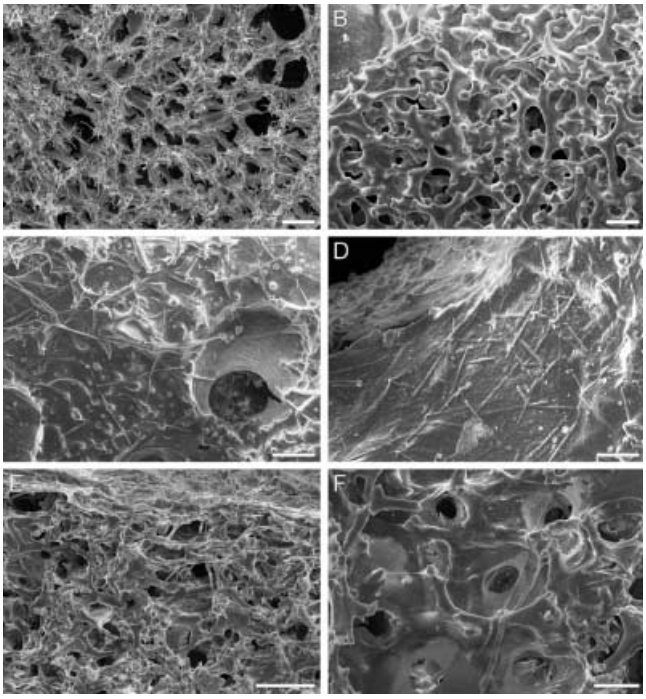

Figure 3. *Aciculites mediterranea* sp. nov., holotype MSNG 52268, photomicrographs of the ectosomal and choanosomal areas. (A) Inhalant area with more or less vertical anisostrongyles; (B) subectosomal area; (C) detail of the wall oscular canal; (D) transition area at the level of the dermal membrane between sponge surface with tangential anisostrongyles and the oscular canal (the oscular rim is not evident); (E) cross section of the ectosomal and subectosomal areas; and F, detail of the choanosome. Scale bars: A, 200 μm; B & F, 50 μm; C, D & E, 100 μm.

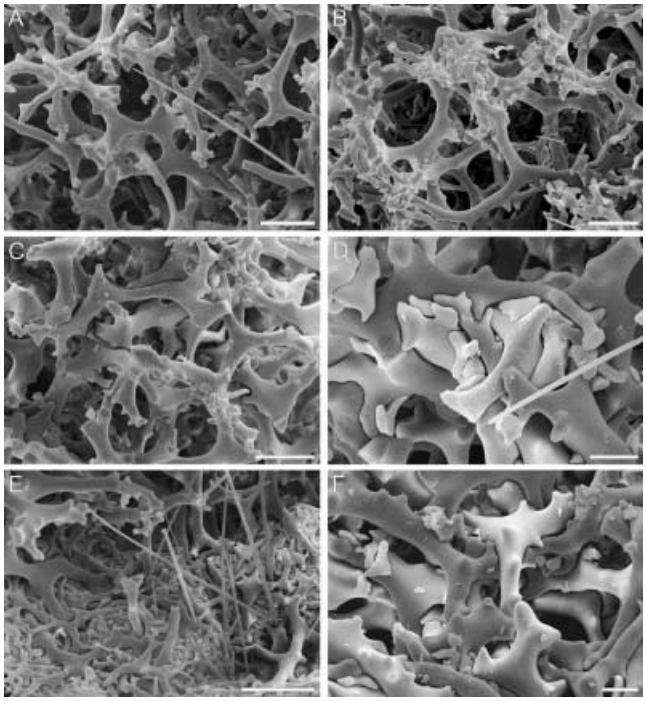

Figure 4. *Aciculites mediterranea* sp. nov., holotype MSNG 52268, photomicrographs of the skeletal architecture with desmas and anisostrongyles in the choanosome. (A–C) Network of articulated desmas; (D & F) detail of desmas at the level of articulation; and (E) network of desmas and anisostrongyles in a canal. Scale bars: A, B, C & E, 50 μm; D & F, 20 μm.

van Soest & Stentoft, 1988; Lévi & Lévi, 1989; Pulitzer-Finali, 1993; Pisera & Lévi, 2002; Perez et al., 2004. Not *A. oxytylota* Lévi & Lévi, 1983.

Type material

Holotype: MSNG 52268 (Grotta dei Laghi, 40°34′N 8°14′E, Punta Giglio Promontory, Alghero, north-western Sardinia), August 2000, R. Barbieri legit, by SCUBA diving. Schizoholotypes as fragments, slides, and SEM stubs are deposited in the collection of R. Manconi.

https://doi.org/10.1017/S0025315406013580 Published online by Cambridge University Press

Table 2. *Diagnostic traits of* Aciculites mediterranea *sp. nov. compared to the other species of the genus* Aciculites. *Presence (+), absence (—), dubious presence or not described (?).*

Characters	*A. mediterranea* sp. nov.	*A. ciliata*	*A. higginsi*	*A. orientalis*	*A. papillata*	*A. pulchra*	*A. spinosa*	*A. tulearensis*	*A. cribrophora*
Consistency stony	+	+	+	+	+	+	+	+	+
Growth form									
–cushion-shaped	—	—	+	+	—	—	+	—	—
–vase/cup-shaped	—	+	—	—	—	—	—	—	+
–cerebelliform	+	—	—	—	—	—	—	—	—
–lamellar	—	?	—	—	+	+	—	+	—
–pear-shaped	—	—	+	—	—	—	—	—	—
Basal portion									
–wide	+	—	+	+	—	—	+	—	—
–narrow	—	+	+	—	+	+	—	+	+
Surface									
–regular	—	+	?	—	—	+	+	—	+
–irregular (ridges, concavities)	+	—	+	+	—	—	—	—	—
–irregular ('papillae')	—	?	+	—	+	+	—	+	?
Subdermal canals									
–radial	?	+	+	—	?	—	?	—	?
–branched meandriform	?	—	—	+	?	+	?	+	?
Inhalant areas									
–scattered	—	?	—	+	+	+	—	+	+
–in concavities	+	?	+	—	—	—	—	—	—
–on one side (vase, lamella)	—	?	+	—	?	+	—	+	+
Oscules									
–on the top	+	?	+	+	?	+	—	+	+
–on one side (vase, lamella)	—	?	—	—	—	+	—	+	+
–also in other areas	—	?	—	+	?	—	—	—	—
–single	—	?	—	—	—	—	—	—	—
–several	+	?	+	+	+	+	—	+	+
–on elevations 'papillae'	—	?	+	—	+	+	—	+	—
–with atrial cavity	+	?	?	?	?	?	—	?	?
–diaphragm with strongyles	+	?	+	?	?	?	—	+	?
Ectosomal skeleton									
–tangential tylostyles/styles	—	+	+	—	—	—	—	—	—
–vertical tylostyles/styles	—	+	+	—	—	—	—	—	—
–tangential strongyles/ anisostrongyles	+	—	+	+	+	+	+	+	+
–vertical anisostrongyles	+	—	—	—	—	—	—	—	—
–oxeas	—	+	—	—	—	—	—	+	—
–microscleres	—	—	—	—	—	—	—	—	—
Choanosomal skeleton									
–rhizoclonal desmas	+	+	+	+	+	+	+	+	+
–desmas with spines/tubercles	+	+	+	+	+	+	+	+	+
–strongyles/anisostrongyles	+	—	+	+	+	+	+	—	+
–exotyles	—	—	—	—	—	—	—	—	—
–microscleres	—	—	—	—	—	—	—	—	—

Comparative material examined

Aciculites higginsi Schmidt, 1879, MZUS PO153 (Cuba), ZMA POR5249 and POR5250 (Barbados), MNHN DCL 1158 (Cuba), ZPAL Pf.15/2 (Barbados); *A. orientalis* Dendy, 1905, QM G318596 (Norfolk Ridge, south of New Caledonia); *Gastrophanella phoeniciensis* Perez et al., 2004 MNHN DJV73 (Lebanon).

Diagnosis

Aciculites mediterranea sp. nov. is a massive cerebellum-like lithistid with a peculiar distribution of inhalant and exhalant areas respectively in depressed and elevated areas. Dermal membrane is supported by tangentially arranged anisostrongyles on elevated areas, whereas the ectosomal skeleton in inhalant areas is represented by more or less vertical tufts of anisostrongyles. Oscules lead to long narrow atrial cavities which extend to the sponge base.

Etymology

The specific epithet refers to the first finding of the genus in the Mediterranean Sea.

Description

Sponge with a massive growth form, cerebellum-like, sub-oval (5×3.8 cm in width, 2.8 cm in height) (Figure 2)

https://doi.org/10.1017/S0025315406013580 Published online by Cambridge University Press

Table 3. *Bathymetric distribution, localities, and habitats of the nine species hitherto ascribed to the genus* Aciculites.

	Depth m		Habitat	References
A. ciliata	106	South-west Philippines 8°06′N 117°18′E	—	Wilson, 1925
A. cribrophora	—	—	Fossil barrier reef	Schmidt, 1880
	153–207	West Barbados 13°10′N 59°40′W		van Soest & Stentoft, 1988
A. higginsi	184–234	North-west Cuba	—	Schmidt, 1879
	108–198	West Barbados	Fossil barrier reef	van Soest & Stentoft, 1988
A. orientalis	–	Sri Lanka	—	Dendy, 1905
	186–189	Philippines	On calcareous debris	Lévi & Lévi, 1989
	568–589	New Caledonia	—	Schlacher-Hoenlinger et al., 2005
A. papillata	465–495	New Caledonia 22°16′S 167°17′E	Coral reef slope on calcareous debris	Lévi & Lévi, 1983
A. pulchra	126	Northern New Zealand	—	Dendy, 1924
	108	Northern New Zealand	—	Bergquist, 1968
A. spinosa	3	West Madagascar	Dark tunnels in barrier reefs	Vacelet & Vasseur, 1965
A. tulearensis	5	West Madagascar	Dark tunnels/cavities in barrier reefs	Vacelet & Vasseur, 1965, 1971
	55–230	North Kenya Banks	—	Pulitzer-Finali, 1993
A. mediterranea sp. nov.	7.5	Western Mediterranean 40°34′N 8°14′E	Dark karstic cave	Present paper

with a wide base adhering to the substrate and encrusted by some calcareous tubes of polychaetes. Colour in formaldehyde from whitish at the surface to light brown in inner areas. Consistency stony, gradually harder from the surface to the inner and basal parts of the sponge body. Surface smooth with a dense net of subdermal canals covered by a dermal membrane easily detachable. Inhalant areas irregularly scattered in notably depressed concavities of variable width; one specimen of *Sycon* sp. harboured in a concavity.

Oscules 1–2 mm in diameter, irregularly distributed on the upper part of the sponge, with a system of subdermal canals. The oscules bear a laminar diaphragm supported by few tangential anisostrongyles and lead to atrial cavities formed by narrow, long, vertical, widely perforated canals which extend to the sponge base. Visible apices of desmas support the dermal membrane along the atrial cavity.

The ectosomal skeleton on elevated areas and around the oscules is armed by anisostrongyle megascleres, with variable density, tangentially to partially embedded in the dermal membrane. Inhalant areas show an ectosomal skeleton of more or less vertical tufts of anisostrongyles with free distal ends surrounding the apertures.

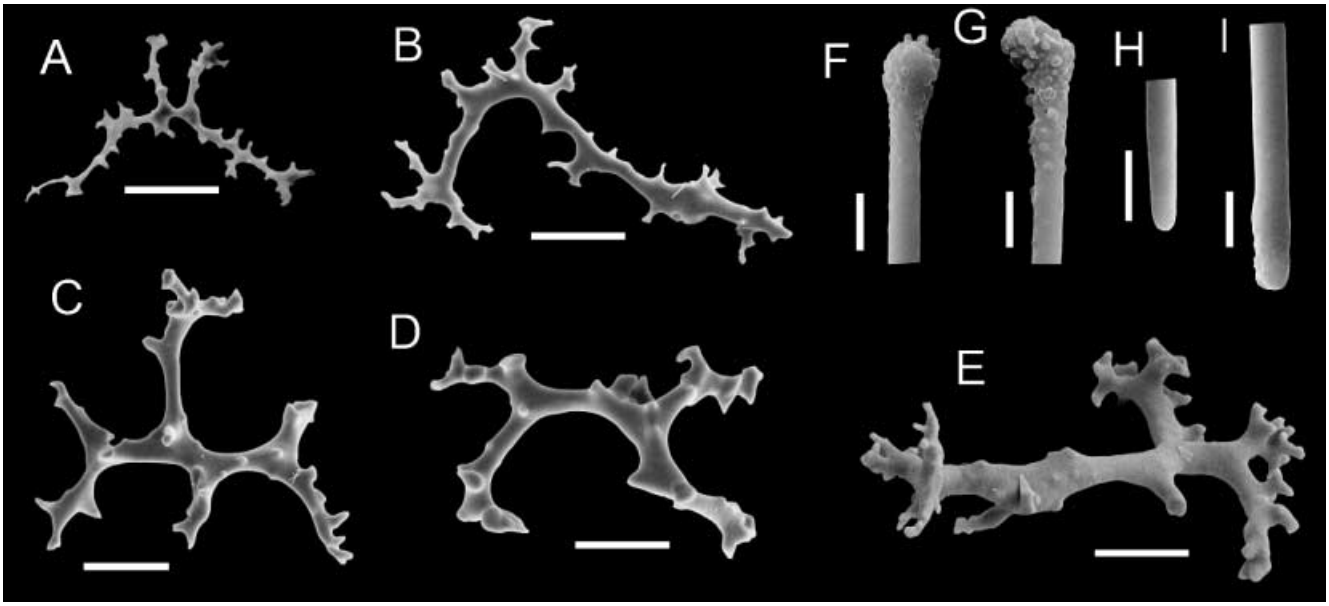

Figure 5. *Aciculites mediterranea* sp. nov., holotype MSNG 52268, photomicrographs of the spicular complement. (A–E) Desmas; (F–I) details of anisostrongyles tips. Scale bars: A–E, 50 μm, F–I, 5 μm.

https://doi.org/10.1017/S0025315406013580 Published online by Cambridge University Press

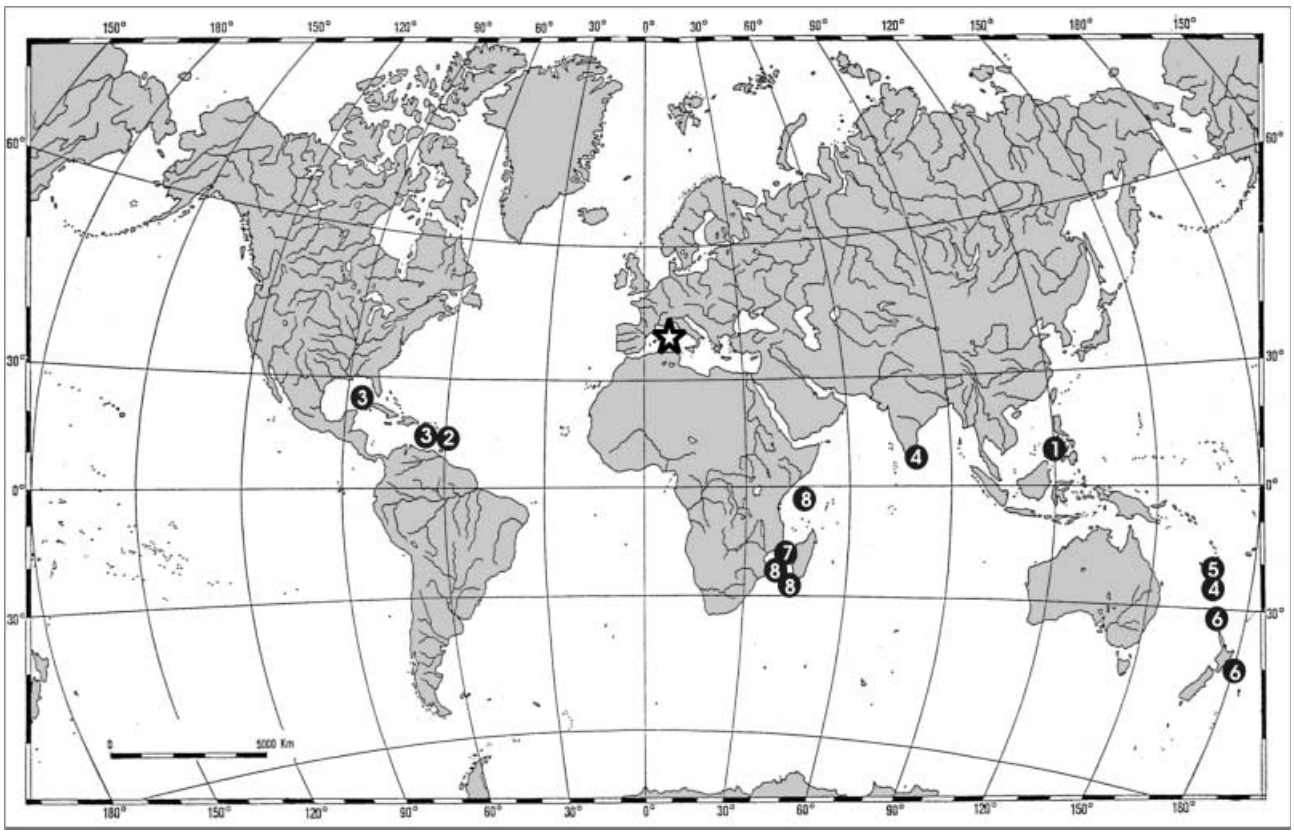

Figure 6. Circumtropical-subtropical geographical range of the genus *Aciculites* with occurrence of the known species. The type locality of *A. mediterranea* sp. nov. is indicated by a star. 1, *A. ciliata*; 2, *A. cribrophora*; 3, *A. higginsi*; 4, *A. orientalis*; 5, *A. papillata*; 6, *A. pulchra*; 7, *A. spinosa*; 8, *A. tulearensis*.

Anisostrongyles (160–340×4–7.5 μm) with a straight to slightly bent smooth shaft bearing both ends notably variable in shape and size. They may be ornated by irregular tubercles, resembling tylotes (Figure 5F,G). Few smooth oxeas (215–430×7 μm) are also present in the slides but we consider them allochtonous. No sigmaspire microscleres were found.

The choanosome shows variably oriented canals, some filled with sediment. The architecture of the choanosomal skeleton is a dense network of articulated desmas, forming meshes with variable size and density in the different portions of the sponge. Young desmas almost free in the subectosomal area, in different growth phases, are flattened with irregular clones armed by spines and tubercles. Mature rizhoclone desmas irregular in shape due to their variable number of branches. Surface is ornated with few scattered tubercles with button-shaped apices. Silica appears sublaminar in desmas. The size-range of desmas is 100–235 μm. Few scattered and variably oriented monaxial megascleres anisostrongyles grading to strongyles (152–335×2.5–5 μm) are also present decreasing in density towards the central area of the sponge body.

Habitat

The habitat of *Aciculites mediterranea* sp. nov. is the dark zone of the cave on a bare surface of the carbonate rock wall. Associated fauna represented by few tubicolous polychaetes and one specimen of *Sycon* sp.

Distribution

Known exclusively from the type locality in the Sardinian Grotta dei Laghi.

DISCUSSION

The body shape of sponges belonging to the genus *Aciculites* ranges from thin cushion, lamella, cup or vase to massive cushion and pear-shape (Table 2). The peculiar cerebellum-like growth form of *Aciculites mediterranea* sp. nov. diverges notably from the lamellar-cup-vase group of *A. ciliata*, *A. cribrophora*, *A. papillata*, *A. pulchra* and *A. tulearensis* (Schmidt, 1879; Dendy, 1924; Wilson, 1925; Vacelet & Vasseur, 1965; Lévi & Lévi, 1983). The most similar body shape is that of the type species *A. higginsi* Schmidt, displaying concavities and elevated areas on the surface (van Soest & Stentoft, 1988; Pisera & Lévi, 2002).

The new species matches the trait of the genus with a 'differential topographical distribution of inhalant and exhalant areas', resembling the type species with pores grouped in concavities and oscules scattered on the top. In *A. mediterranea* oscular areas are supported by anisostrongyles also in the diaphragm, but not in a dense radiating pattern as described by Sollas (1888) for *A. higginsi*. The new species diverges from *A. papillata*, *A. pulchra* and *A. tulearensis* with the absence of oscules on elevations ('papillae'). Another species with papillae *A. oxytylota* Lévi & Lévi, 1983, was recently removed from

https://doi.org/10.1017/S0025315406013580 Published online by Cambridge University Press

this genus because of its long papillae resembling *Siphonidium*, and tylostyles with microspined heads arranged perpendicularly to the surface and attributed to *Siphonidium* Schmidt, 1879 (Muricy & Minervino, 2000). Inhalant apertures of *A. mediterranea*, bearing more or less vertical tufts of anisostrongyles, differ from the other species, even if vertical tylostyles/styles in some areas of the ectosomal skeleton are reported also for *A. higginsi* and *A. ciliata* (Table 2).

The architecture of the ectosomal skeleton with tangential anisostrongyles is shared by most *Aciculites* species except *A. ciliata* and *A. higginsi* bearing tylostyles/styles. Moreover the latter spicular trait of *A. higginsi* is not reported in the description by van Soest & Stentoft (1988) that recorded an ectosomal skeleton of tangential anisostrongyles (Table 2).

The comparative analysis of the skeleton of *A. mediterranea* sp. nov. versus the eight other species of *Aciculites* shows that the new species displays most spicular traits of the genus as rizhoclones desmas, absence of ectosomal microscleres, and dermal membrane supported by an ectosomal skeleton of tangential monaxial megascleres (Table 2). The few smooth oxeas present in slides of *A. mediterranea* to be considered allochtonous, because they were not found in the skeleton samples observed by SEM. *Aciculites mediterranea* sp. nov. is characterized mainly by the peculiar cerebellum-like growth form, the differential topographical distribution of inhalant/exhalant apertures and the architecture of the ectosomal skeleton with tangential to vertically arranged anisostrongyles in the dermal membrane. Spicule measurements of *A. mediterranea* sp. nov. match those reported for the other species (Table 1).

The absence of sigmaspire microscleres in the new species and in all the other species of the genus (Table 2) suggests that the taxonomic status of *Aciculites* needs to be emended. Sollas (1888), Lendenfeld (1903), Wilson (1925), Lévi & Lévi (1983), and Pisera & Lévi (2002) ascribed the genus to the family Scleritodermidae. All these authors inferred that the absence of microscleres was the result of the loss of this trait during the natural history of the genus. Dendy (1905), however, considered *Aciculites* as belonging to the family Leiodermatidae. At the same time, the ectosomal spicules of *Aciculites* differ from the typical acanthorhabds of *Scleritoderma*; in addition no styles and/or tylostyles are known to occur in other Scleritodermidae. These data strongly suggest that the taxonomic status of the genus should be revised because it does not match very well with other Scleritodermidae. On the other hand, the absence of microscleres and the characteristics of the ectosomal spicules place *Aciculites* close to *Gastrophanella* Schmidt, 1879. This similarity is especially well visible in the case of the species *Gastrophanella phoenicensis* from Lebanon, which displays traits very similar to *Aciculites* such as depressed inhalant areas and styles to tylostyles as ectosomal spicules, either tangential or perpendicular to the sponge surface. One may even speculate, but this must be investigated by detailed studies of type material before final conclusions are made, that *G. phoeniciensis* belong in fact to the genus *Aciculites*, but both genera are closely related and could be placed together in the Siphonidiidae.

The habitat of *A. mediterranea* sp. nov., dwelling in dark karstic shallow water caves, matches well the dark zone of tunnels and cavities in the barrier reefs of Tulear and Songoritelo along the western coast of Madagascar from where *A. tulearensis* and *A. spinosa* (Vacelet & Vasseur, 1965) have been recorded (Table 3). The really skiophilous behaviour of the species of *Aciculites* and their preferential habitat in calm waters is also suggested by their quite deep bathymetric range (55–589 m) (Table 3). This distribution and the preferential habitat of the species belonging to the *Aciculites* allow us to hypothesize that the colonization of shallow water caves and tunnels of coral reefs occurred by larval dispersal from deeper water populations. Unfortunately no data exist on the reproduction of lithistid sponges and larvae were never recorded. Cave habitats characterized by extremely harsh environmental conditions for most organisms, represent an empty space with very low competition. Caves could have played a key role, as a refuge, in the survival colonization strategies of these sponges.

Aciculites mediterranea sp. nov. represents the first record of the genus from the Mediterranean Sea and the eastern Atlantic Ocean. The eight species hitherto ascribed to the genus are *A. higginsi* Schmidt, 1879, *A. ciliata* Wilson, 1925, *A. cribrophora* Schmidt, 1880, *A. orientalis* Dendy, 1905, *A. papillata* Lévi & Lévi, 1989, *A. pulchra* Dendy, 1924, *A. spinosa* Vacelet & Vasseur, 1971, *A. tulearensis* Vacelet & Vasseur, 1965 (Schmidt, 1879, 1880; Sollas, 1888; Dendy, 1905, 1924; Wilson, 1925; Vacelet & Vasseur, 1965, 1971; Bergquist, 1968; Vacelet et al., 1976; Lévi & Lévi, 1983, 1989; van Soest & Stentoft, 1988; Pulitzer-Finali, 1993; Schlacher-Hoenlinger et al., 2005).

The new finding in the Mediterranean Sea fills a gap in the disjunct geographical range of the genus *Aciculites* known worldwide from rare, scattered, spot-like findings, often referred to a single specimen or fragments, in the western Atlantic, central-western Indian Ocean, and western Pacific with a latitudinal range typically circumtropical/subtropical (Figure 6). This geographical range is shared with several other genera of lithistids and implies relicts of an ancient abundance and a large-scale distribution related to the geological and climatic history of the Tethys Sea, and in the particular case of *A. mediterranea* to the vicissitudes of the Mediterranean basin.

This paper is dedicated to the memory of Professor Rupert Riedl, the pioneer of marine biospeleology. Funds for R. Manconi and A. Serusi were provided by the European program Interreg Sardinia–Corsica–Tuscany and the Università di Sassari. A. Pisera was supported in part by the grant no. PO4 D03924 of the Polish Ministry of Science and Information Society Technologies. Investigations by SEM were funded by the Italian Ministero dell'Università e della Ricerca Scientifica e Tecnologica (MIUR-PRIN 2004057217 'Zoogeography of Mediterranean–southern African disjunct distributions by a multimethod approach'). We are grateful to Roberto Barbieri for his help in sponge collection, and to Giuseppe Delitala for photographs of the holotype.

REFERENCES

Bergquist, P., 1968. The marine fauna of New Zealand: Porifera, Demospongiae, Part 1. (Tetractinomorpha and Lithistida). *New Zealand Department of Scientific and Industrial Research Bulletin* (*New Zealand Oceanographic Institute Memoir* 37), **188**, 1–105.

Dendy, A., 1905. Report on the sponges collected by professor Herdman at Ceylon in 1902. In *Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar* (ed. W.A. Herdman), *Royal Society London*, **18**, Suppl. 3, 57–246.

Dendy, A., 1924. Porifera. Part I. Non Antarctic sponges. Natural History Report. *British Antarctic ('Terra Nova') Expedition, 1910 (Zoology)*, **6**, 269–392.

Finks, R.M., Reid, R.E.H. & Rigby, J.K., 2004. Porifera. In *Treatise on Invertebrate Paleontology* (ed. R.L. Kaesler). Part E. *The Geological Society of America & The University of Kansas, Boulder, Colorado, and Lawrence, Kansas*, **3**, 1–872.

Lendenfeld, R. von, 1903. Porifera. Tetraxonia. In *Das Tierreich* (ed. F.E. Schulze), **19**, 1–168, Berlin: Friedländer.

Lévi, C., 1973. Systématique de la classe des Demospongiaria (Demosponges). In *Traité de Zoologie. Anatomie, Systématique, Biologie. Spongiaires*, 3(1), 577–631. Paris: Masson & Cie.

Lévi, C. & Lévi, P., 1983. Éponges Tétractinellides et Lithistides bathyales de Nouvelle-Calédonie. *Bulletin du Muséum National d'Histoire Naturelle Paris*, IV Ser., **5**A, 101–168.

Lévi, C. & Lévi P., 1989. Spongiaires (MUSORSTOM 1 and 2). In *Resultats des Campagnes MUSORSTOM*, vol. 4, (ed. J. Forest). *Bulletin du Muséum National d'Histoire Naturelle Paris, (A Zoologie)*, **143**, 25–103.

Magnino, G., Gravina, M.F., Righini, P., Serena, F. & Pansini, M., 1999. Due demosponge Lithistidi nuove per i mari italiani. *Biologia Marina Mediterranea*, **6**, 391–393.

Muricy, G. & Minervino, J.V., 2000. A new species of *Gastrophanella* from central western Atlantic, with a discussion of the family Siphonidiidae (Demospongiae: Lithistida). *Journal of the Marine Biological Association of the United Kingdom*, **80**, 599–605.

Pansini, M., 1995. Porifera. In *Checklist delle specie della fauna italiana* (ed. A. Minelli et al.), pp. 1–23. Bologna: Calderini.

Perez, T., Vacelet, J., Bitar, G. & Zibrowius, H., 2004. Two new lithistids (Porifera: Demospongiae) from a shallow eastern Mediterranean cave (Lebanon). *Journal of the Marine Biological Association of the United Kingdom*, **84**, 15–24.

Pisera, A., 1999. PostPaleozoic history of the siliceous sponges with rigid skeleton. *Memories of the Queensland Museum*, **44**, 463–472.

Pisera, A., 2002. Fossil 'Lithistid': an overview. In *Systema Porifera. A guide to the classification of sponges*, vol. 1 (ed. J.H. Hooper and R.V.M. van Soest), pp. 388–402. New York: Kluwer Academic/Plenum Publisher.

Pisera, A. & Lévi, C., 2002. 'Lithistid' Demospongiae. In *Systema Porifera. A guide to the classification of sponges*, vol. 1 (ed. J.H. Hooper and R.V.M. van Soest), pp. 299–383. New York: Kluwer Academic/Plenum Publisher.

Pouliquen, L., 1969. Remarques sur la présence d'Eponges de l'étage bathyal dans les grottes sous-marines obscures en Méditerranée. *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, **268**, 1324–1326.

Pouliquen, L., 1972. Les Spongiaires des grottes sous-marines de la région de Marseille. Ecologie et systématique. *Téthys*, **3**, 717–758.

Pulitzer-Finali, G., 1970. Report on a collection of sponges from the Bay of Naples. I. Sclerospongiae, Lithistida, Tetractinellida, Epipolasida. *Pubblicazioni della Stazione Zoologica di Napoli*, **38**, 328–354.

Pulitzer-Finali, G., 1983. A collection of Mediterranean Demospongiae (Porifera) with, in appendix, a list of the Demospongiae hitherto recorded from the Mediterranean Sea. *Annali del Museo Civico di Storia Naturale "Giacomo Doria"*, **84**, 445–621.

Pulitzer-Finali, G., 1993. A collection of marine sponges from East Africa. *Annali del Museo Civico di Storia Naturale "Giacomo Doria"*, **99**, 247–350.

Reid, R.E.H., 1967. Tethys and the zoogeography of some modern and Mesozoic Porifera. In *Aspects of Tethyan biogeography* (ed. C.G. Adams and D.V. Ager). *Systematic Association Publication*, **7**, 171–181.

Rigby, J.K., 1983. Fossil Demospongiae. In *Sponges and spongiomorphs* (ed J.K. Rigby and C.W. Stearn), *Studies in Geology*, **7**, 12–39. Notes for a Short Course.

Rigby, J.K., 1991. Evolution of Paleozoic heteractinid calcareous sponges and demosponges. Patterns and records. In *Fossil and recent sponges* (ed J. Reitner and H. Keupp), pp. 83–101. Berlin & Heidelberg: Springer Verlag.

Schlacher-Hoenlinger, M.A., Pisera, A. & Hooper, J.N.A., 2005. Deep-sea 'Lithistid' assemblages from the Norfolk Ridge (New Caledonia), with descriptions of seven new species and a new genus (Porifera: Demospongiae). *Zoosystema*, **27**, 649–698.

Schmidt, O., 1879. Die spongien des Meerbusens von Mexico. I. Lithistiden. In *Reports on the dredging under the supervision of Alexander Agassiz in the Gulf of Mexico by the USCSS 'Blake'*, pp. 1–32. Jena: Gustav Fischer.

Schmidt, O., 1880. *Die spongien des Meerbusens von Mexico un des Caraibischen meeres. II. Hexactinelliden, III. Tetractinelliden, Monactinelliden und Anhang*, pp. 35–90, Jena: Gustav Fischer.

Soest, R.W.M. van & Stentoft, N., 1988. Barbados deep-water sponges. In *Uitgaven van de Natuurwetenschappelijke studiekring vor Suriname an de Nederlandse Antillen* (ed. P.W. Hummelink and L.J. van der Steen), no. 122, **70**(215), 1–175.

Sollas, W.J., 1888. Report on the Tetractinellida collected by H.M.S. "Challenger" during the years 1873–1876. *Challenger Reports, Zoology*, **25**, 8–458.

Topsent, E., 1893. Nouvelle série de diagnoses d'éponges de Roscoff et de Banyuls. *Archives de Zoologie Expérimentale et Générale*, (3), **1**, 33–43.

Vacelet, J., 1960. Eponges de la Méditerranée nord-occidentale récoltées par le 'Président Théodore Tissier' (1958). *Revue des Travaux de l'Institut des Pêches Maritimes*, **24**, 257–272.

Vacelet, J., 1969. Eponges de la roche du large et de l'ètage bathyal de Méditerranée (Récoltes de la soucoupe plongeante Cousteau et dragages). *Mémoires du Muséum National d'Histoire Naturelle, (A, Zoologie)*, **59**, 145–219.

Vacelet, J. & Vasseur, P., 1965. Spongiaires de grottes et surplombs des récifs de Tuléar (Madagascar). *Recueil des Travaux de la Station Marine d'Endoume*, **4**, 71–123.

Vacelet, J. & Vasseur, P., 1971. Eponges des récifs coralliens de Tuléar (Madagascar). *Téthys*, **1**, 51–126.

Vacelet, J., Vasseur, P. & Lévi, C., 1976. Spongiaires de la pente externe des récifs coralliens de Tulear (Sud-Ouest de Madagascar). *Mémoires du Muséum National d'Histoire Naturelle, (A Zoologie)*, **159**, 1–116.

Wiedenmayer, F., 1994. Contribution to the knowledge of post-Palaeozoic neritic and archibental sponges (Porifera). The stratigraphic record, ecology, and global distribution of intermediate and higher taxa. *Schweizerische Paläontologische Abhandlungen*, **116**, 1–147.

Wilson, H.V., 1925. Silicious and horny sponges collected by the U.S. fisheries steamer 'Albatross' during the Philippine Expedition 1907–1910. In *Contribution to the biology of the Philippine Archipelago and adjacent regions. Bulletin of the United States National Museum*, Smithsonian Institution Press, **100** (2, part 4), 273–532.

Submitted 29 June 2005. Accepted 13 April 2006.