Cymbastela hooperi sp. nov. (Halichondrida : Axinellidae) from the Great Barrier Reef, Australia

by Rob W.M. VAN SOEST, Ruth DESQUEYROUX-FAÜNDEZ, Anthony D. WRIGHT & Gabriele M. KÖNIG

Abstract

Cymbastela hooperi sp. nov. is described from the Great Barrier Reef, Australia. This species belongs to the recently erected genus of stalked sponges, Cymbastela HOOPER & BERGQUIST, 1992. The new species is the eighth member of this Australasian genus. Cymbastela hooperi sp. nov. is distinguished from other Cymbastela species, by its unique growth form (stalkless and flattened on substrate), its yellow to brown colour, its loose skeletal morphology, the often telescoped spicule shape and its chemistry. The new species produces a large number of structurally related diterpene isonitrile derivatives which demonstrate significant in vitro antimalarial activity. One of these compounds, di-isocyano-adociane, is also found in Amphimedon terpenensis FROMONT, 1993. In addition both species present similar skeletal characters and spicule size. Considering this, a new combination is proposed: Cymbastela terpenensis (from Amphimedon).

Keywords: Demospongiae, Halichondrida, diterpenes, isonitrile derivatives, secondary metabolites.

Introduction

The recently erected axinellid genus Cymbastela HOOPER & BERGQUIST, 1992 is endemic to Australia and New Caledonia. It presents a skeleton of exclusively small to medium sized oxeas that is reminiscent of a haplosclerid skeleton. However, a tangential surface skeleton is absent and in many species a more or less distinct axial and extra-axial skeletal differentiation is found. The chemistry of the secondary metabolites of one of the species of the genus, C. cantharella (LEVI, 1983) is similar to that known of Axinellidae (cf. DE NANTEUIL et al., 1985; AHOND et al., 1988; BRAEKMAN et al., 1992), not to that of Haplosclerida. The genus so far contains seven species differentiated principally by their skeletal reticulation, by the development of their axial skeleton and by the sizes of their oxeas. One species has a specialised ectosomal skeleton (HOOPER & BERGQUIST, 1992). We report here the existence of an eighth species: C. hooperi sp. nov. distinguished from the other Cymbastela species by its morphology and by the presence of secondary metabolites observed for the first time.

Material and methods

Studies of the new species and other comparative material were carried out from thick sections, light microscopy of spicule slides and SEM stubs mounted with fragments and spicules, prepared in the usual way (cf. HAIDU & DESQUEYROUX-FAÜNDEZ, 1994). The study of secondary metabolite chemistry of Cymbastela hooperi sp. nov. was performed from a dichloromethane soluble fraction obtained from sponge tissue that was subjected first to normal phase vacuum liquid column chromatography for pre-fractionation. Final purification step was performed by high pressure liquid chromatography (HPLC) (G. KÖNIG, unpubl.). Separations yielded 19 pure natural products, the structures of which will be published elsewhere.
Abbreviations for institutions cited in the text
BMNH : Natural History Museum, London.
JCU : James Cook University, Queensland.
MHNG : Muséum d’histoire naturelle, Geneva
QMA : Queensland Museum, South Brisbane.
ZMA : Zoölogisch Museum, Amsterdam.

Systematics

Order Halichondrida VOSMAER, 1887
Definition : Demospongiae with a plumoreticulate skeletal architecture built of interchangeable styles and oxeas and intermediate spicules of widely diverging sizes and not functionally localised (VAN SOEST et al., 1990).

Family Axinellidae RIDLEY & DENDY, 1887
Definition : Halichondrida with axially condensed and extra-axially plumoreticulate choanosomal skeletons (VAN SOEST et al., 1990).

Genus Cymbastela HOOPER & BERGQUIST, 1992
Type species : Pseudaxinyssa stipitata BERGQUIST & TIZARD, 1967, by original designation.
Diagnosis : Typically cup-shaped, lamellate sponges. With or without specialised surface skeleton of small oxea. Choanosomal axial skeleton compressed or not. Extra-axial skeleton radial, reticulate or plumose (modified from HOOPER & BERGQUIST, 1992).

Cymbastela hooperi sp. nov.

Material studied : Holotype MHNG 18990, schizotype fragment ZMA POR. 11008, field number CT293V, Kelso Reef Australia, Queensland (18°25'S 147°02'E), 03. 1993, G. A. D. WRIGHT, col., 6-9 m.

DESCRIPTION
Known from a single specimen (Figs 1, 2). Irregularly spreading over the substrate, stalkless, partly simulating an encrusting shape, but is in fact a modified cup-shaped, thickly lamellate sponge, with uneven, undulating incurved margins. Basal flattened part large, about 30 cm diameter. Thickness of the lamella about 10-30 mm.

Both surfaces are similar. They are rough, slightly micro-hispid, from single protruding terminal spicules. They bear characteristic rounded elevations, and are covered overall by a translucent collagenous membrane. Numerous and evenly distributed pores are visible on both surfaces. Oscules are small, 1.5 to 2.0 mm diameter, irregularly distributed, usually placed on the top of the rounded elevations or on surface ridges present on both surfaces of the sponge.

Consistency
Hard, stiff, not flexible.

Colour
Alive colour was yellowish to brown. Beige in alcohol.

Substrate
Dead coral rock, 6-9 m.

Skeleton
The skeletal structure is different from most other Cymbastela species in being predominantly loose. There is an extensive system of aquiferous canals in the centre of the lamella.

Ectosomal skeleton : no specialised surface skeleton, but terminal oxeas from the principal skeleton protrude through the surface membrane (Figs 3, 4), isolated or in divergent, close-set terminal bundles (Fig. 5).

Choanosomal skeleton : Axial skeleton slightly compressed into axial tracts or bundles, longitudinally distributed. Tracts are wavy, vaguely plumose, of irregular width. In cross section 6 to 8 spicules are visible in strongly developed fibers (Fig. 6), which have a thickness of about 80 µm. Distance between tracts 400 µm. Interconnecting tracts are weak, uni or paucispicular (1 - 3 spicules) and 1 or 2 spicules long (Fig. 7). Interstitial free oxeas are very abundant (Fig. 8). Aquiferous canals in the centre of the fan have a diameter of 600 - 700 µm.

Spicules (Table 1)
Oxeas are long, curved at the central part or straight, often with telescoped ends (Figs 9, 10), or with one of the apices blunt (Fig. 11) and sometimes a mucron. Many of them present a wide axial canal.

Ecology and distribution
Known only from the type locality, a shallow-water reef habitat, in the middle section of the Great Barrier Reef.


Scale bars : Figs 1 & 2 = 0.5 cm; Figs 3, 4 & 7 = 50 µm; Fig. 5 = 100 µm; Fig. 6 = 20 µm; Fig. 8 = 200 µm; Figs 9 & 11 = 5 µm; Fig. 10 = 2 µm.
Table 1.

<table>
<thead>
<tr>
<th>Species</th>
<th>Length</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>C. cantharella</em></td>
<td>187 - 215.5 - 232</td>
<td>4.1 - 8.1 - 10.0</td>
</tr>
<tr>
<td><em>C. cantharella</em></td>
<td>200 - 250</td>
<td>8.0 - 10.0</td>
</tr>
<tr>
<td><em>C. concentrica</em></td>
<td>172 - 239.6 - 305</td>
<td>2.5 - 9.5 - 16.0</td>
</tr>
<tr>
<td><em>C. coralliophila</em></td>
<td>236 - 318.8 - 357</td>
<td>6.5 - 14.4 - 21.7</td>
</tr>
<tr>
<td><em>C. marshae</em></td>
<td>124 - 156.8 - 192</td>
<td>2.0 - 5.4 - 9.0</td>
</tr>
<tr>
<td><em>C. notaiina</em></td>
<td>49 - 77.7 - 98</td>
<td>1.5 - 3.2 - 4.5</td>
</tr>
<tr>
<td><em>C. stipitata</em></td>
<td>155 - 259.1 - 344</td>
<td>2.7 - 8.6 - 16.0</td>
</tr>
<tr>
<td><em>C. vespertina</em></td>
<td>167 - 252.2 - 270</td>
<td>5.2 - 11.9 - 15.0</td>
</tr>
<tr>
<td><strong>&quot;A&quot;. terpenensis</strong></td>
<td>223 - 256 - 292</td>
<td>4.7 - 6.1 - 7.7</td>
</tr>
<tr>
<td><em>C. hooperi</em> sp. nov.</td>
<td>163 - 232 - 269</td>
<td>3 - 6.4 - 10.0</td>
</tr>
</tbody>
</table>

**Chemistry**

The new species produces a large number of secondary metabolites which are either sesqui- or diterpenes. Almost all of the diterpenes were distinguished by being isonitrile derivatives. The most abundant compound, present as 0.33% of the dry sponge tissue, was the known compound di-isonitrile-adociane (Fig. 12). This particular compound is identical to the major compound isolated from "Amphimedon" terpenensis by GARSON (1986).

**Etymology**

We dedicate this species to John N.A. HOOPER in recognition of his admirable efforts to bridge the enormous gap between existing and described Australian sponge biodiversity.

**COMPARISON WITH OTHER CYMBASTELA SPECIES**

We compared the new species with a member of the genus *Cymbastela*, viz. *C. vespertina* (specimens ZMA POR. 11006, from a coral reef, 10 m, East Point, Darwin, Northern Territory, Australia, collected & donated by J.N.A. HOOPER, 29.02.1987). Comparison of the new species with this material and with the descriptions and figures provided by HOOPER & BERGQUIST (1992) suggested its affinity to *Cymbastela* because it shares lamellate shape, tough consistency, differentiation into axial and extra-axial skeleton, spicule type, size and telescoped endings, with most *Cymbastela* species. The definition of the genus needs to be widened only slightly to include forms that are not precisely cup-shaped but more generally lamellate. Differences and similarities with various species of *Cymbastela* are the following:

**Growth form**

The new species differs from all other *Cymbastela* species in the lamellate-flattened-encrusting habit. Also the oscules on elevations are unique. Spicule lengths are similar to those of most other *Cymbastela* species, excepting *C. marshae* and *C. notaiina* which have much smaller oxeas (HOOPER & BERGQUIST, 1992). The thickness of the oxeas is relatively low, lower than most *Cymbastela* species, and close to that of *C. marshae*. Like most *Cymbastela*, excepting *C. coralliophila*, there is only a single oxea size category.

**Skeletal structure**

*C. hooperi* sp. nov. differs from most other *Cymbastela* species in having a relatively loose skeleton and an extensive system of aquiferous canals. The distance of the fibers exceeds that of all other *Cymbastela* species, with the possible exception of *C. cantharella*. Interconnecting tracts relatively weak.
Cymbastela hooperi sp. nov. from the Great Barrier Reef, Australia

Fig. 12. - Natural products from Cymbastela hooperi sp. nov. - 1. Di-isocyane-adociane. - 2 & 3. are new products. - 4 & 5. known products.

COMPARISON WITH AMPHIMEDON TERPENENSIS

The skeletal similarity of certain axinellid genera such as Cymbastela with Haplosclerida, especially family Niphatidae, noted by HOOPER & BERGQUIST (1992) is indeed striking and has probably led to at least one misjudged ordinal assignment.

FROMONT (1993) employed the definition of the niphatic genus Amphimedon (by VAN SOEST, 1980) loosely to include at least one species without a proper euctosomal tangential reticulation. Her drawings and photos do not show evidence of an euctosomal tangential skeleton, and the specimen she very kindly sent us (ZMA POR. 10896, from John Brewer Reef, Great Barrier Reef, Queensland, Australia, collected & donated by J. FROMONT, 29.08.1986; this specimen does not belong to the type, but was collected at the same area and is, in all respects, similar to the type) also did not reveal a surface reticulation. The type species of Amphimedon and other close related Amphimedon species all have a clearly developed tangential surface reticulation.

The skeletal structure of "A". terpenensis is very loose and irregular, not at all as in true Amphimedon, nor, it must be conceded, true Cymbastela. However, the relatively loose structure described above for C. hooperi n.sp. connects these extreme skeletal developments.

Spicule sizes (210 - 335 x 5.9 - 12.6 μm) are similar to those of most Cymbastela and considerably longer than true Amphimedon species (70 - 180 x 1-12 μm).

The shape of "A". terpenensis is thickly, irregularly lamellate. Consistency is elastic (FROMONT, 1993), rather easily compressible (ZMA POR 10896), a clear difference with most Cymbastela, caused no doubt by the loose skeletal arrangement. Colour is red-brown, partly caused by a cyanobacterial symbiont, which is a common feature of Cymbastela (cf. HOOPER & BERGQUIST, 1992).

Apart from "Amphimedon" terpenensis no other Haplosclerid is recorded as a source of isonitriles. The fact that the largest secondary metabolite fractions of "A", terpenensis and C. hooperi n.sp. have identical chemical structure is strong evidence for close phylogenetic relationship. Other isonitrile derivatives are exclusively produced by axinellid (Axinella, Acanthella) and halichondrid (Hymeniacidon, Ciocalypta) sponges (BRAEKMAN et al., 1992).

Further evidence that "A." terpenensis does not belong in Amphimedon are chemical studies made of the fatty acids of "A." terpenensis. They are qualified as widely different from those of true Amphimedon such as A. compressa (type species of Amphimedon) and A. complanata (GARSON et al., 1994). In view of this and of the close similarity in skeleton structure and size and form of the spicules we introduce here the new combination: Cymbastela terpenensis (from Amphimedon).

However, its specific characters make it likely that it occupies an isolated position among the known species of Cymbastela.

The occurrence in a single genus of two unrelated structural chemical types, viz. isonitriles ("A". terpenensis, cf. GARSON, 1986; C. hooperi, cf. present study) and pyrrole-derivatives (C. cantharella cf. DENANTEUIL et al., 1985; AHOND et al., 1988) is perhaps odd. However, it is not unprecedented, because isonitriles are found in the Mediterranean Axinella cannabina (cf. e.g. ADINOLFI et al., 1977), while former compounds are recorded from the Mediterranean Axinella verrucosa (cf. CIMINO et al., 1982). These compounds form part of a more extensive problem of distribution of these chemical types over Axinellidae and Halichondriidae, already
outlined in BRAEKMAN et al. (1992). Although the chemical types have a limited distribution (isocyanates: Axinellidae, Halichondridae; pyrrole-derivatives: Agelasidae, Axinellidae, Halichondridae) their precise significance for chemotaxonomy is still not clear.

**GEOGRAPHIC DISTRIBUTION OF C YMBASTE LA**

C. hoopen sp. nov. and C. terpenemis are recorded from lat 14°-18°S, long 145-147°E. Thus, their sympatric distributions are added to the two overlapping sympatric species C. coralliophila and C. concentrica found on the Great Barrier Reef between 11°S and 22°S. Other species of Cymbastela occur allopatrically or only slightly overlapping in Western and Southern Australia, and in New Caledonia (HOOPER & BERGQUIST, 1992). All Cymbastela species are reef sponges occurring from the intertidal to 30 m.

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**References**


