Mass occurrence of *Rossella nodastrella* Topsent on bathyal coral reefs of Rockall Bank, W of Ireland (Lyssacinosida, Hexactinellida)

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Abstract: We report on the mass occurrence of a hexactinellid species, *Rossella nodastrella* Topsent, 1915 in coldwater coral reefs W of Ireland. The species was until now known only from the holotype, a single small specimen collected off the Azores. In recent boxcore sampling at a reef mound situated in 580 m water at 55.4°N 15.7°W along the south-eastern slope of Rockall Bank numerous specimens of this species were collected, showing a range of morphologies from 1 cm high, spiny urn-shaped individuals to megabenthic cup-shaped forms of 30-40 cm high and wide. We provide an extensive redescription of the species including SEM images of all the microscleres. Underwater video transects showed this species to be densely concentrated, up to approx. 6 specimens per m², over a distance of more than 1 km. Presence of individuals was negatively correlated with live coral cover. This dense concentration was a local phenomenon, because the species was virtually absent in nearby similar habitats.

Keywords: bathyal, coral reefs, Hexactinellida, mass occurrence, North Atlantic

Introduction

Diversity of Hexactinellida in the North East Atlantic is limited to approx. 45 species (van Soest *et al.* 2006; http://www.marinespecies.org/porifera/), but this is compensated by reported mass occurrences of several of these species. This is especially documented for *Pheronema carpenteri* (Thompson, 1869) (see Rice *et al.* 1990, Barthel *et al.* 1996) and *Schaudinnia rosea* (Fristedt, 1887) (cf. Klitgard and Tendal 2004). These mass occurrences were reported from areas where also bathyal coral reefs have been sighted, but the general impression conveyed by various studies is that they are indeed neighbouring these reefs but usually downslope from them, for reasons as yet unexplained (Rice *et al.* 1990). In recent cruises with the Dutch research vessel ‘Pelagia’ in waters west of Ireland (Moundforce 2004, BIOSYS 2005) large build ups were encountered of an irregularly cup-shaped species initially thought to be *Asconema aff. setubalense* Kent, 1870 or *Asconema aff. foliata* Fristedt, 1887 (see van Soest and Lavaleye 2005). However, subsequent studies including exchange of specimens between us, made it clear that these large cups conformed in their skeletal characters to a ‘forgotten’ species described by Topsent (1915) from a single small urn-shaped specimen collected in bathyal depths off the Azores as *Rossella nodastrella*. The species can now be more completely described from a large series of specimens connecting tiny urn-shaped specimens to large cup-shaped specimens. It is the purpose of this paper to provide a re-description and quantitative information on its occurrence in the area W of Ireland.

Material and methods

Specimens were collected mainly by boxcoring. We used a boxcore of 50 cm diameter capable of bringing up 2000 cm² of ocean bottom, including reef corals. Additional samples were obtained in a few trawl attempts, which skirted a local reef.

*In situ* observations of larger *Rossella nodastrella* individuals were made from ‘Hopper’ camera transects. Images were obtained by an analogue video camera hung into a frame with two strong light strobos, which was lowered to just above the bottom and moved along it at a speed of 2 miles per hour for one hour. Position of the camera was monitored from the surface, thus the image field width varied over transects between approx. 1.2 m and several meters, depending of the vertical movement of the ship relative to the bottom. Due to this, densities of observed sponges could only be approximated.
Position and depth of all collecting attempts that contained *Rossella nodastrella* specimens are given in Table 1.

Specimens were preserved in 96% alcohol, with an occasional specimen kept dry. All specimens are incorporated in the collections of the Zoological Museum of the University of Amsterdam (ZMA).

Microscopic sections were made tangential and perpendicular to the surface to study *in situ* arrangement of the spicules using light microscopy. Spicule mounts for SEM and light microscopy were made by boiling fragments in concentrated HNO₃.

### Results

**Systematic description**

Class Hexactinellida Schmidt, 1870  
Subclass Hexasterophora Schulze, 1886  
Order Lyssacinosida Zittel, 1877  
Family Rossellidae Schulze, 1885  
Subfamily Rossellinae Schulze, 1885  
Genus *Rossella* Carter, 1872  

*Rossella nodastrella* Topsent, 1915  
Figs. 1A-N, 2A-I, 3A-H

*Rossella nodastrella* Topsent, 1915: 1, figs 1-5; Topsent, 1928: 76, pl. III fig. 22, pl. IV fig. 3.  
*Asconema* aff. *foliata*; van Soest and Lavaleye, 2005: figs 2A-B.

**Material examined:** All samples listed in Table 1 were examined.

**Additionally:** BIOSYS/HERMES Hopper Camera Transect Station 109 (08-07-2005).

### Description

**Shape and size:** Smaller specimens, from approx. 1 cm (Fig. 1C) to approx. 6 cm (Fig. 1K) are urn-shaped to tubular, with a spiny (Figs 1C, H, J-L, N) or occasionally smooth surface (Fig. 1M). They are thin-walled and have a large atrial cavity ending in a conspicuous oscule with fringeless rim, occupying approx. one third of the diameter of the sponge (Figs 1C, H, N). Occasionally, two oscules are found (Fig. 1K). Rarely, specimens were observed which appeared to be flabellate, i.e. their atrial cavity was exposed over the entire length of the individual (Fig. 1J); possibly these were damaged-and-repaired specimens. When reaching sizes over 6 cm in length, shape tends to alter into the *'Asconema'* type, i.e. tubular-trumpet-shaped, with a predominantly smooth surface, widely flaring vent and recurved rims (Figs 1B, E-G, I). With increasing length, also the diameter increases to wider-than-high cups (Figs 1E, G, I). Shape in larger specimens, which may grow to reach sizes of 30-40 cm high and in diameter, may be highly irregular and is often based on a prostrate anchoring plate or lobe (Figs 1B, F). Individuals may show more than one ‘vent’ and look distinctly mushroom-like (Fig. 1A). Detailed examination of a large number of adjacent specimens...
observed in a ‘Hopper Camera’ transect of ‘Haas’ Mound suggests that many of the smaller or prostrate specimens are fragmented off nearby larger individuals, indicating clonal processes might be common.

**Colour:** Greyish white.

**Consistency:** Of smaller specimens fragile but keeping their shape when lifted out of the water; larger individuals collapse when taken out of the water and tear very easily. Their consistency is best described as similar to a wet towel or a thick wad of wet paper.

**Skeleton (Figs 2A, B):** The dermal skeleton is built almost exclusively of spined stauractines (Fig. 2B) with rare spined pentactines mixed in. This beautiful network is carried by larger smooth hypodermal pentactines, with their long ray directed inward into the parenchyma. The parenchymal spicules making up most of the skeleton of the thin walls of the specimens are long smooth centrotylote diactines. Shorter diactines protrude up to approx. 1 mm from the dermal surface causing the spined surface which characterizes most of the younger/smaller specimens. The atrial skeleton consists entirely of spined hexactines. No special anchoring spicules are present. Microscleres are predominantly hemioxyhexasters, with the other hexaster-types only common in the smaller specimens, becoming rare in large specimens; the latter are positioned most commonly subatrially. Macrodiscasters/disasters and calycocomes are located mostly in the vicinity of atrial surface while microdiscohexasters are located close to the dermal surface. This is very unusual for Rossellidiae, as in all other genera of this family the situation is opposite.

**Spicules:**

Megascleres (Figs. 2C-I)

1. Dermalia are stauractines (Fig. 2D), entirely spined, with blunt ending rays, each ray 50-113.4 x 4.5-6.9 µm, and some pentactines (Fig. 2E), entirely spined, rays 117-150 x 6 µm. Stauractines may have a short rudimental tubercle.

2. Hypodermal pentactines (Figs. 2G,H), orthotropal, smooth, except for rugose apices; tangential rays 285-393.6 x 13-18.0 x 21 µm, proximal rays 480-634.1 x 17-19.2 x 22 µm.

3. Atrial hexactines (Fig. 2C), entirely spined, rays 108-133.7 x 6-6.3-7 µm. The proximal rays are usually slightly longer and more spined than the tangential and distal rays (see Table 2).

4. Short diactines (Fig. 2F), centrotylote, apically spined and somewhat swollen, 366-739.4 x 1520 x 6-7.4-9 µm.

5. Long diactines (Fig. 2A), centrotylote, smooth, 2,260-3,773.3 x 6,300 x 12-31.7 x 70 µm; rare truncated diactines may have a swollen spined end (Fig. 2I).

Microscleres (Fig. 3A-G)

1. Oxyoidal microscleres: oxyhexasters, hemioxyhexasters (Fig. 3B) and oxyhexactines. The hexasters invariably have two secondary rays (not three as Topsent described for the type), rays rugose or finely spined; rarely rays have a claw-like termination (Fig. 3C) and these may be considered hemioxyhexasters; malformed smaller thick-centred forms are not uncommon (Fig. 3D). Diameter: 48-67.9 µm, with primary ray length: 2-4 µm, secondary ray length: 23-30.4-38 µm, diameter of primary rosette: 7-19 µm.

2. Macrodiscasters (Fig. 3E), with smooth centre and approx. 20 spined rays, ends provided with toothed discs. Diameter: 56-95.9-120 µm, ray length 28-43.6-54 µm, diameter of primary rosette 10-30 µm.

3. Calycocomes (Figs. 3A, F, G), with smooth primary rays, crowned with 6-12 densely spined secondary rays each ending with (larger, Fig. 3G) or without (smaller, Fig. 3F) toothed discs. Diameter: 48-83.7-126 µm, primary ray length: 3-6 µm, secondary ray length: 18-31.2-39 µm, diameter of primary rosette: 6-30 µm.

4. Microdiscohexaster (Figs. 3A, H), with smooth primary rays, crowned with 12-20 sparingly spined small thin rays each ending in toothed discs (barely visible in light microscopy, so measurements were done in SEM preparations). Diameter: 14-32 µm, primary ray length: 2 µm, secondary ray length: 4-6 µm, diameter of primary rosette: 8-12 µm.

**Distribution and ecology:** The type specimen was collected on August 18, 1911, at station 3140 of the cruises of the Prince of Monaco, close to Sao Miguel, Azores, 37°38’N 26°01’W, at a depth of 1378 m; it was fixed on the dead skeleton of another hexactinellid, Hertoiswiga falcifera Schmidt, 1880. The Rockall Bank specimens were collected on or at the fringe of reef mounds found at the SE slopes of Rockall Bank, 55.4-55.5°N 15.6-16.1°W, at depths of 524-857 m. Most often they were growing on dead coral branches adjacent to or in the midst of live corals of both species Lophelia pertusa (L., 1758) and Madrepora oculata L., 1758.

**Remarks:** The smaller specimens reported here resemble Topsent’s (1915) drawing of the type and all spicule types reported by Topsent were found in our specimens, although presence of microscleres varied considerably among individuals. Nevertheless, some clear discrepancies in spicule sizes were found with data reported by Topsent from the type specimen (see Table 2):

- proximal rays of the hypodermal pentactines are only 755 µm in maximum length, compared to 2,000 µm in the type
- short diactines are up to 2-3 x larger in the type
- long diactines are 2 x larger in the type
- hexasters have two secondary rays, not three
- the five hexaster types are all distinctly smaller than in the type.

In spite of these differences, we refrain here from erecting a new (sub-)species, as the variation over geographic distance is not properly known. Topsent’s material consisted only of a single individual. In the absence of measurements of further specimens from other localities, the observed differences are here explained as individual variation caused by geographic separation.

Our Rockall Bank individuals all originate from a small reef mound area of approx. 15 km² in size, and it is conceivable that many were propagated by fragmentation (see below), which would explain the narrow range of variation of the spicule sizes (Table 2). The different branching condition of the hexasters should be verified in the type, because the drawing of Topsent shows only four in stead of six primary.
rays and the number of secondary rays visible in the drawing exactly matches the twelve secondary rays in the Rockall Bank hexaster. In the 1928 repetition of the description of the type, Topsent admits that there are also hexasters with two secondary rays, although the majority were still considered having three secondary rays. It is possible that Topsent’s drawing is not accurate and in fact shows a hexaster with two secondary rays.

Should future material obtained from the Azores and elsewhere show consistent differences in spicule measurements with our material, then recognition of the Rockall Bank population at the subspecific level is probably warranted. Until then, we maintain the name *Rossella nodastrella* for it.

A second North Atlantic species of *Rossella*, *Rossella mortenseni* Burton, 1928 was reassigned to *Mellonympha* by Koltun, 1967, as a junior synonym of *M. velata* (Thomson), but is considered a valid species of *Mellonympha* by Tabachnick (2002) (here confirmed), among other things because the type specimen lacks calycocomes, which are characteristic for *Rossella*. No other *Rossella* species are known to occur in the North Atlantic; the genus has a predominantly Antarctic-Southern Ocean distribution.

**In situ observations of the Rockall Bank populations**

Of the 107 samples taken in the Rockall Bank area during Moundforce 2004 and BIOSYS/HERMES 2005 19 contained one or more specimens of *Rossella nodastrella*. The samples were taken at two locations approx. 15 km apart, dubbed ‘HAAS’ and ‘CLAN’ Mounds. Of 44 stations made at ‘CLAN’ Mound only two contained a small individual each, whereas at 64 stations made at ‘HAAS’ Mound 43 individuals were obtained divided over 17 stations.

The dominant occurrence at ‘HAAS’ mound was confirmed by *in situ* observations made from ‘Hopper’ video camera transects. One particular transect at ‘HAAS’ mound (Station 109) going uphill from approx. 55°29.572 N / 15°47.213 W, depth 728 m, to approx. 55°29.739 N / 15°48.149 W, depth 529 m, showed extremely high densities of *Rossella nodastrella* in the upper half. Between 552 and 529 m, over a
**Fig. 3:** *Rossella nodastrella* Topsent, 1915, microscleres. A. overview of various hexasters. B. dominant oxyhexaster. C. rare claw-ending hemionychexaster. D. rare thick-centred, malformed oxyhexaster. E. macrodiscaster. F. calycocome with rounded ray apices. G. calycocome with disc-ended rays. H. microdiscohexaster.

**Table 2:** Spicule dimensions (µm) reported by Topsent (1915, 1928) from the Azores type specimen and the Rockall Bank specimens.

<table>
<thead>
<tr>
<th>Spicule Type</th>
<th>Azores</th>
<th>Rockall Bank</th>
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<tbody>
<tr>
<td>Stauractines, rays</td>
<td>160 x 8</td>
<td>50-147 x 4-9</td>
</tr>
<tr>
<td>Dermal pentactines, rays</td>
<td>present</td>
<td>117-150 x 6</td>
</tr>
<tr>
<td>Hypodermal pentactines, tangential</td>
<td>270 x 9-27</td>
<td>285-520 x 13-21</td>
</tr>
<tr>
<td>Hypodermal pentactines, proximal</td>
<td>up to 2,000</td>
<td>480-755 x 17-22</td>
</tr>
<tr>
<td>Hexactines, rays</td>
<td>200 x 11</td>
<td>108-150 x 6-7</td>
</tr>
<tr>
<td>Short diactines</td>
<td>900-4,000 x 4-20</td>
<td>366-1,520 x 6-9</td>
</tr>
<tr>
<td>Long diactines</td>
<td>12,000 x 100</td>
<td>2,260-6,300 x 12-70</td>
</tr>
<tr>
<td>Oxyhexasters</td>
<td>100-120</td>
<td>53-78</td>
</tr>
<tr>
<td>Macrodiscasters</td>
<td>170</td>
<td>84-120</td>
</tr>
<tr>
<td>Calycocomes</td>
<td>175</td>
<td>48-93</td>
</tr>
<tr>
<td>Microdiscohexasters</td>
<td>27-37</td>
<td>16-32</td>
</tr>
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distance of approx. 1350 m a total of 1387 individuals could be counted. Since image field width varied considerably, only an approximation of the observed bottom surface area can be given: we estimate this to be around 2100 m², thus an average of 0.66 individuals per m² were present over the second half of the transect. Locally, densities were as high as 6 large individuals per m². The percentage living corals and the presence of *Rossella nodastrella* were negatively correlated: averaging 19% live coral in the presence of *Rossella nodastrella* vs. 42% live coral cover in its absence (see Fig. 4).

The irregular shapes of the observed sponges and the frequent occurrence of larger individuals surrounded by a number of smaller individuals gives the strong impression that processes of propagation by fragmentation and regeneration of partly dead or damaged individuals could be a part of the life strategy this species. Crabs (*Paramola cuvieri* (Risso, 1816)) were observed carrying fragments of *Rossella* cups around as camouflage, a further indication that fragments may easily become isolated from the parent individuals. This
would also explain why the species has such an extremely patchy distribution. However, the capability for regeneration of fragments has never been demonstrated in hexactinellid sponges in general, and in rossellid sponges in particular, so the remarks made here remain hypothetical.

Other species recognizable in the video transect, *Mellonympha velata* (Thomson, 1873) (153 individuals) and *Geodia macandrewi* Bowerbank, 1858 (13 individuals) had a much lower density and were more evenly spread over the transect.

**Acknowledgements**

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