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New bioeroding sponges from Mingulay coldwater reefs, north-west Scotland

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The relatively shallow coldwater coral reefs growing off the eastern coast of Mingulay, north-west Scotland, are excavated by five sponge species, three of which, Alectona millari, Pione vastifica *and* Cliona lobata*, were known previously from Scottish waters. The other two species are new to Scotland and Great Britain. One species is here described as new to science:* Cliona caledoniae *sp. nov. The species shows a superficial resemblance in colour (orange) and spiculation (possession of tylostyles and knobby microscleres) to* Cliothosa hancocki *described disjunctly from the Pacific Ocean and the Mediterranean Sea, but it differs clearly in lacking the characteristic* Cliothosa *amphiasters with branching rays. The Scottish species only possesses peculiar thick-rayed streptasters, which at first glance appear rather similar to the second microsclere type reported for* Cliothosa hancocki*, knobby-rayed amphiasters. However, the majority of the microscleres in the Mingulay species appear to be genuine spirasters (not amphiasters), and exhaustive search for true amphiasters, branching or otherwise, was in vain. The new species is extensively illustrated. Furthermore, we also report the first occurrence in British waters of* Spiroxya levispira*, originally described from Azorean deep waters, and subsequently reported from Madeira and several Mediterranean localities. It was found to occur not uncommonly in the Mingulay reefs, and additionally also in reefs of the Rockall Bank, west of Ireland. The spicular characters generally match those of the southern locations. The newly recorded species is described and amply illustrated.*

Keywords: new bioeroding sponges, Mingulay cold water reefs, north-west Scotland

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INTRODUCTION

Coldwater reefs off the east coast of Mingulay Island, southern Hebrides, north-west Scotland (Figure 1), were investigated in July 2006 during a joint multidisciplinary effort of the Royal Netherlands Institute of Sea Research (NIOZ) and the Scottish Association of Marine Sciences (SAMS). Bottom samples were obtained by video-grabbing, boxcoring, and dredging, while side-scan and multibeam transects were made over the reefs (Maier, 2006). One of the projects concerned the species composition of sponges occurring in and near the reefs, as a continuation of a series of investigations made in coldwater reefs elsewhere in the north-east Atlantic (see e.g. Van Soest & Lavaleye, 2005; Van Soest *et al.*, 2007), forming a part of the Dutch funded BIOSYS 2005–2007 programme.

Excavating or 'boring' sponges play a distinct role in coldwater reef systems as major bioeroders (Beuck & Freiwald, 2005; Beuck *et al.*, 2007). Not unexpectedly they were found to be frequent dwellers in the Mingulay reefs, typically occupying recently dead coral branches, but they were not found in the living parts of the corals. However, recent sophisticated techniques applied by Beuck *et al.* (2007) demonstrated the cryptic presence of sponge borings infesting living parts of *Lophelia* in reefs on the Porcupine Seabight. Five species were encountered: *Alectona millari* Carter, 1879, *Pione vastifica* (Hancock, 1849), both quite common, *Cliona lobata* Hancock, 1849, which occurred only rarely, and two species not previously known from Scottish waters, a *Cliona* species that appeared to be undescribed, and a southern deep-water species *Spiroxya levispira* (Topsent, 1898). The former species was at first assigned to alpha forms of *Cliona* aff. *celata* Grant, 1826, because it seemed as if no microscleres were present, its colour is a distinct yellow or orange, and the papilla-size appears similar to that of *C. celata*. However, upon closer examination, not very numerous, thick spirasters were detected in some individuals. Subsequent studies demonstrated that the microscleres were confined to the papillar skeleton of all the alleged '*celata*' specimens. Below, the new species of *Cliona* and the newly recorded *Spiroxya levispira* are described and extensively illustrated.

MATERIALS AND METHODS

Bottom samples containing dead and living reef corals, mostly *Lophelia pertusa* but occasionally also *Madrepora oculata*, were obtained by three sampling methods (Maier, 2006): video-grabbing (cf. Mortensen *et al.*, 2000 for an extensive description of this method), boxcoring using a 50 cm diameter cylinder, and trawling (10 minutes bottom time). Table 1 lists all the samples from which bioeroding sponges were obtained. Sponges were usually obtained from subsamples of coral branches assigned for sponge research. Occasionally the entire sample was made available for sponge studies. Sponges detected on board were pre-identified using crude

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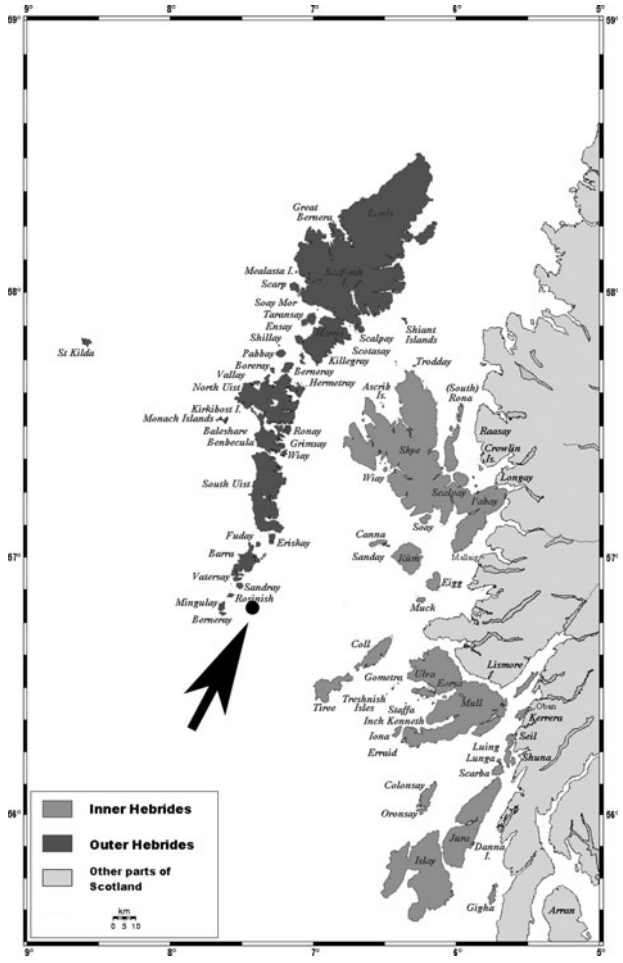


Fig. 1. Map of the Hebrides off the Scottish west coast showing the approximate location of the Mingulay reefs and the sampling stations (map obtained through Wikipedia from the internet source: www.aquarius.ifm-geomar.de, and was slightly modified).

slide preparations (cf. Van Soest & Lavaleye, 2005) and preserved in 96% ethanol. Unsorted trawl subsamples and boxcore subsamples were directly preserved in larger containers and analysed onshore in Amsterdam. Dead coral branches were examined using a low power microscope and opened up using hammer and chisel. Sponge identification was done from teased tissue preparations. Spicules were dissociated by boiling in concentrated nitric acid and the residue was washed five times in distilled water and mounted on slides and SEM stubs for examination at high magnification.

SYSTEMATIC DESCRIPTIONS

The classification used here follows the *Systema Porifera* (Hooper & van Soest, 2002):

Class DEMOSPONGIAE
Order HADROMERIDA
Family CLIONAIDAE
Genus *Cliona* Grant, 1826
Cliona caledoniae sp. nov.
Figure 2A–B, Figure 4A–D

TYPE MATERIAL

Holotype: ZMA Por. 20174, Mingulay, Station BX48/06, 56.8054°N 7.4419°W, 127 m, in *Lophelia pertusa*, 14/7/06.

Paratypes: ZMA Por. 20171C, same data as the holotype; ZMA Por. 20270 & 20271, Mingulay, Station BX127, 82 m, in *Lophelia pertusa*, 56.8033°N 7.4471°W, 20/7/06; ZMA Por. 20320, Station VG28/05, 131 m, in *Lophelia pertusa*, 56.8219°N 7.3964°W, 12/7/06.

DESCRIPTION

Excavating sponge, with exclusively alpha-habit (distinctly separate non-confluent papillae protruding from the corals). Papillae yellow, or orange-yellow, rather conspicuous, flush with the surface, often slightly elevated beyond the coral surface (Figure 4D), but in preserved material the papillae tend to be contracted below the substratum level (Figure 4C). The papillae turn brown in alcohol. Both optically 'closed' papillae, presumably exhalant, and optically perforated papillae, presumably oscular, occur. The holotype has only a single papilla (Figure 4A) hidden in the calyx of a dead coral polyp and sponge tissue has permeated and

Table 1. Locality data of studied samples.

ZMA registration number	Species	Reef site	Sample number	Depth (m)	Latitude	Longitude	Date
20174	*Cliona caledoniae* sp. nov.	Mingulay	BX48/06	127	56.8054	−7.4419	14/7/06
20171C	*Cliona caledoniae* sp. nov.	Mingulay	BX48/05	127	56.8054	−7.4419	14/7/06
20270	*Cliona caledoniae* sp. nov.	Mingulay	BX127	82	56.8033	−7.4471	20/7/06
20271	*Cliona caledoniae* sp. nov.	Mingulay	BX127	82	56.8033	−7.4471	20/7/06
20320	*Cliona caledoniae* sp. nov.	Mingulay	VG28/05	131	56.8219	−7.3964	12/7/06
20210A	*Spiroxya levispira*	Mingulay	BX123	162	56.8059	−7.429	19/7/06
20255A	*Spiroxya levispira*	Mingulay	BX180	144	56.8034	−7.4467	22/7/06
20269A	*Spiroxya levispira*	Mingulay	BX127	82	56.8033	−7.4471	20/7/06
20274	*Spiroxya levispira*	Mingulay	BX127	82	56.8033	−7.4471	20/7/06
20280B	*Spiroxya levispira*	Mingulay	BX127	82	56.8033	−7.4471	20/7/06
20350A	*Spiroxya levispira*	Mingulay	VG49	168	56.8071	−7.4303	14/7/06
20418A	*Spiroxya levispira*	Mingulay	DR182	128	56.8243	−7.3686	22/7/06
20611	*Spiroxya levispira*	Rockall Bank	BX72	762	55.44437	−16.07597	4/7/05
20612	*Spiroxya levispira*	Rockall Bank	BX168	691	55.44432	−16.07457	12/7/05

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replaced most of the limestone skeleton (Figure 4B), leaving only a thin-walled coral. Papilla size variable, 1–4 mm diameter. Papillae unevenly distributed over the coral surface (Figure 4C–D). Excavations are extensive chambers, up to 5 mm or more in diameter, filled with soft tissue of a pale brown or off-white colour. The branching corals and coral polyps are hollowed out to leave only a thin limestone wall.

SKELETON

The papillae are provided with the usual dense palisade of tylostyles, points outward, with intermingled microscleres in a moderate density. The intra-coral tissue contains scattered loose tylostyles, and microscleres are absent.

SPICULES

Tylostyle megascleres and spiraster microscleres. Tylostyles (Figure 2A), robust, with usually slightly subterminal tyle, 246–360.9–426 × 8–9.8–12 μm (N = 25); tyles 11–12.3–15 μm diameter.

Spirasters (Figure 2B), thick, blunt-rayed, with short axis, occasionally almost straight and with the rays concentrated at the extremities. Length: 19–24.3–31 × 5–6.8–9 μm (N = 25), excluding rays which are 3–5.1–7 μm; number of rays 10–11.8–17.

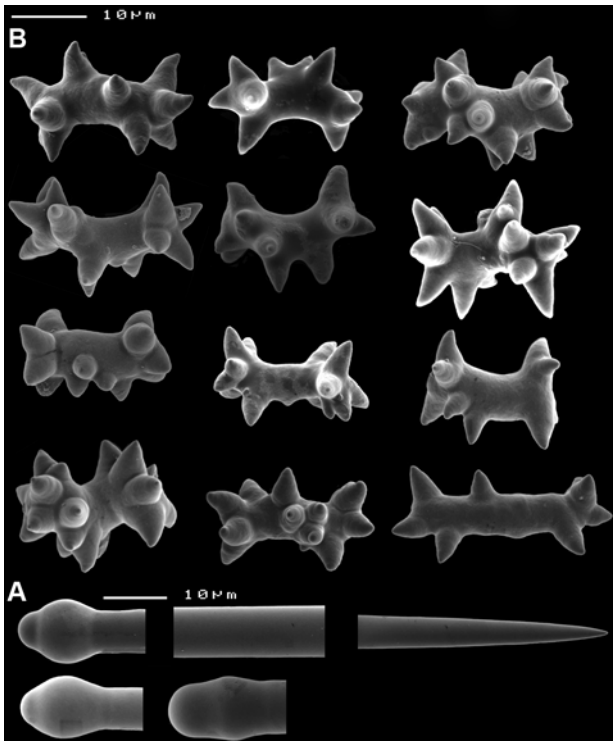


Fig. 2. *Cliona caledoniae* sp. nov., scanning electron microscopy images of spicules. (A) Tylostyle and variations of tyles; (B) spirasters, showing from upper left to lower right spicules with spiral turns and conical rays spread randomly to amphiaster-like forms with straight rhabd and apically concentrated rays.

ECOLOGY

Excavating dead *Lophelia* and *Madrepora* corals at 82–131 m depth.

ETYMOLOGY

Named after Caledonia, the Roman name for Scotland.

REMARKS

The new species is distinguished from the known north-east Atlantic Clionaidae species by its combination of commonplace tylostyles and a single category of thick-rayed amphiaster-like spirasters. *Cliona lobata* is the only species in the area with similar overall spiculation of tylostyles and spirasters, but it has two categories of spirasters the larger of which are longer and thinner (up to 65 μm), with up to 9 spiral curves (Topsent, 1900) and its papillae are usually not larger than 0.5 mm in diameter. *Cliona celata* has similar papilla size as the new species but these are usually much closer together, and the species lacks microscleres entirely (Rützler, 2002a). Excavations in the alpha-form of this species usually are thin, branching corridors and small galleries, not large chambers entirely filled with tissues as described above. No specimens of *Cliona celata* were encountered in the Mingulay reefs, although initially the present species was mistaken for it. *Pione vastifica*, very common in the Mingulay reefs, possesses next to tylostyles and thin microrhabds also rugose microxeas, usually in two size-classes. Macroscopically, *Pione vastifica* and *Cliona caledoniae* sp. nov. are similar and microscopic examination is necessary to identify either with certainty.

Other excavating sponges in the Mingulay reefs (*Spiroxya levispira*, cf. below, and *Alectona millari*) belong to a different family, Alectonidae, and are clearly distinct in spiculation from the Clionaidae. Further excavating species, e.g. *Aka infesta* (Johnson, 1899), *A. nodosa* (Johnson, 1899) and *A. insidiosa* (Johnson, 1899), found in North Atlantic cold-water reefs (see e.g. Van Soest & Lavaleye, 2005 and Schönberg & Beuck, 2007), but so far not found in the Mingulay reefs, differ in lacking microscleres and having only oxeas as spicules.

Elsewhere in European waters, several additional *Cliona* species are reported (Topsent, 1888, 1900; Rützler, 1973; Rosell & Uriz, 2002). *Cliona janitrix* Topsent, 1932 and *C. amplicavata* Rützler, 1974 do not have spirasters. *Cliona viridis* (Schmidt, 1862) has two categories of spirasters, long thin ones with 2–5 bends, 10–53 μm and short straight ones with long spines, 13–30 μm. The short spirasters have the spines much sharper and subdivided compared with those of *C. caledoniae* sp. nov. It occurs predominantly in shallow waters in the Mediterranean–Atlantic area. *Cliona schmidti* (Ridley, 1881) likewise has two categories of spirasters, longer/thinner (25–90 μm) and shorter/thicker (35–62 μm). The shorter/thicker spirasters are not unlike those of *C. caledoniae* sp. nov. in shape but are longer and thicker, neatly separated in size. The colour of *C. schmidti* is characteristically dark purple, which is retained in alcohol-preserved specimens. Similar spiculation is found in *Cliona carteri sensu* Rützler, 1973 (probably not Ridley, 1881) and *C. rhodensis* Rützler & Bromley, 1981 from Tunisia, with

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small spirasters resembling those of *C. caledoniae* sp. nov. but possessing an additional long type with several bends.

Thick knobby spirasters occur in *Cliona thoosina* Topsent, 1888 described from several localities in the Mediterranean, and this species shares the yellow colour and tylostyle size with the new species, but the spirasters occur in three size-categories, up to 65 μm in length. Addtional similar species are the Mediterranean *Cliona cretensis* Pulitzer-Finali (1983), but this has the typical thin spirasters of the majority of *Cliona* species, and *C. tremitensis* Sarà, 1961, which has a complement of oxea megascleres (which may mean it is not a *Cliona* but a *Volzia*) and microscleres longer and slimmer than but not unlike those of *C. caledoniae* sp. nov.

Interestingly, the microscleres of *C. caledoniae* sp. nov. are reminiscent of the knobby amphiasters described for several *Cliothosa hancocki* (Topsent, 1888) individuals from widely disparate areas (Rützler, 2002a). Like the thick spirasters of *C. caledoniae* sp. nov., these knobby amphiasters of *C. hancocki* are concentrated in the papillae. Also the excavations of the new species are similar to those of *C. hancocki* (cf. also Calcinai *et al.*, 2005). The resemblance is superficial, but needs further comment. *Cliothosa hancocki* was originally described from various Pacific and Indian Ocean localities (Topsent, 1888, 1905; Lindgren, 1898; Annandale, 1915; Schönberg, 2000; Calcinai *et al.*, 2005) but subsequently from the Mediterranean (Adriatic, Tunisia) (Lendenfeld, 1897 (as *Vioa ramosa*); Topsent, 1928; Rützler, 1973). The closest locality to Mingulay from which this species was recorded is the Adriatic (Lendenfeld, 1897; see also Topsent, 1932), so occurrence in Mingulay is not unimaginable. The nodulous amphiasters of *Cliothosa hancocki* are characterized by blunt cone-shaped rays and a very short axis, making them similar to thick spirasters. The difference between *Cliona* and *Cliothosa* is that the latter has only amphiasters, while the former has spirasters sometimes combined with amphiaster-like microscleres. *Cliothosa* typically has thin-rayed amphiasters with branched rays as the major synapomorphy for the genus, while the nodulous amphiasters are apparently rare or absent. In theory, the thin-rayed amphiasters of *Cliothosa* could also be rare in some individuals (cf. Topsent, 1932), and then such *Cliothosa* individuals would resemble *Cliona* species with thick, blunt-rayed spirasters such as the present new species. Further similarities with *Cliothosa hancocki* are the exclusively alpha-stage, the colour and the size of papillae and galleries. However, we do not think the specimens of our new species are deficient *Cliothosa* specimens, because: (1) exhaustive search did not reveal the presence of thin-rayed amphiasters with branching rays; (2) the axis of most microscleres is curved; (3) the rays are distributed all over the axis and do not appear to be concentrated at both ends so technically they are not amphiasters; and (4) length of the microscleres (19–31 μm) is clearly greater than that of reported nodulous amphiaster sizes in *Cliothosa hancocki* (10.5–25 μm)

Family ALECTONIDAE
Genus *Spiroxya* Topsent, 1896
Spiroxya levispira (Topsent, 1898)
Figures 3A–D, 4E

Cliona levispira Topsent, 1898: 235, figure 2; Topsent, 1904: 105, pl. XII figure 1; Pouliquen, 1972: 751, pl. 9 figure 4; Boury-Esnault, 1994: 61, figure 37.

Scantilla spiralis Johnson, 1899: 462, figure 5.

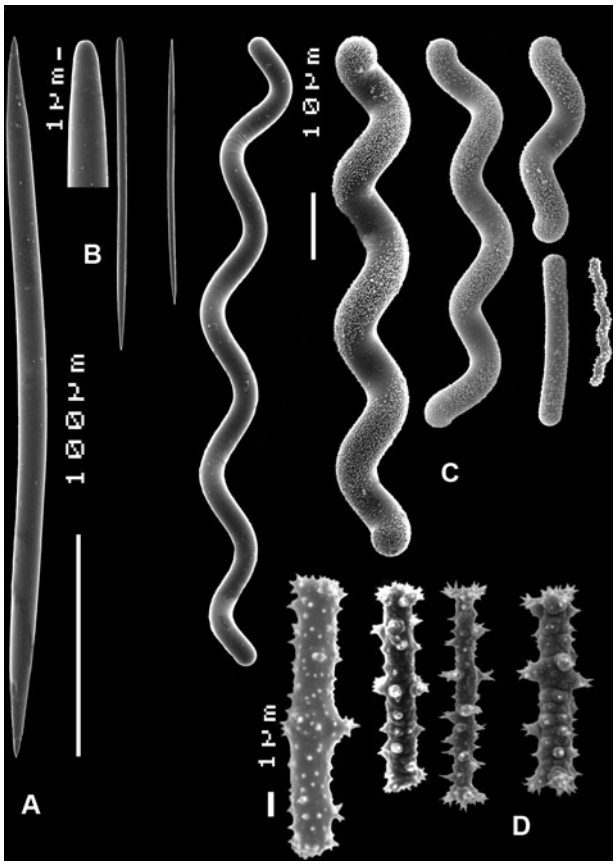


Fig. 3. *Spiroxya levispira* (Topsent, 1898), scanning electron microscopy images of spicules. (A) Large oxea; (B) smaller anisoxeas with magnified bluntly rounded end; (C) various sizes and forms of spiral strongyles; (D) spined microrhabds.

Scantiletta levispira; Rosell & Uriz, 1997: 361; Rosell & Uriz, 2002: 60, figure 3.

Spiroxya levispira; Rützler, 2002b: 289, figure 10D–E; Longo *et al.*, 2005: Table 2; Van Soest *et al.*, 2007: Table 2.

MATERIAL EXAMINED

ZMA Por. 20210A, Mingulay, Station BX123, 162 m, 56.8059°N 7.429°W, 19/7/06; ZMA Por. 20255A, Mingulay, Station BX180, 144 m, 56.8034°N 7.4467°W, 22/7/06; ZMA Por. 20269A & 20274 & 20280B, Mingulay, Station BX127, 82 m, 56.8033°N 7.4471°W, 20/7/06; ZMA Por. 20350A, Mingulay, Station VG49, 168 m, 56.8071°N 7.4303°W, 14/7/06; ZMA Por. 20418A, Mingulay, Station DR182, 128 m, 56.8243°N 7.3686°W, 22/7/06; ZMA Por. 20611, Rockall Bank, Station BX72, 762 m, 55.44437°N 16.07597°W, 4/7/05; ZMA Por. 20612, Rockall Bank, Station BX168, 691 m, 55.44432°N 16.07457°W, 12/7/05.

DESCRIPTION

Excavating sponge, with exclusively alpha-habit, papillae inconspicuous, flush with the surface, 2–4 mm in diameter, giving access to relatively large ellipsoid cavities (Figure 4E), up to approximately 10 mm diameter, filled with pale-coloured, off-white or beige, soft tissue.

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Table 2. Spicule measurements and characteristics of all European *Spiroxya levispira* records.

Spicule type	Rockall	Mingulay	Azores	Madeira	Morocco	Mediterranean
Source	**Present paper**	**Present paper**	**Topsent, 1898, 1904**	**Johnson, 1899**	**Boury-Esnault *et al.*, 1994**	**Pouliquen, 1972; Rosell & Uriz, 2002**
Oxeas	360–450	186–330	350–410	Unknown	355–461	180–450
	10–15	9–12	15	Unknown	8–13	8–27
Anisoxeas	129–232	126–198	200	180	106–265	70–215
	3–5	4	3–4	5	2.5–5	1–8
Microstrongyles	24–156	15–138	15–150	60	26–120	15–82
	3–6	6	4–8	3	2.5–5	1–7
	Spined	Spined	Smooth?	Smooth?	Smooth?	Smooth and spined
Acanthomicrorhabds	8–12	9–15	7–10	Unknown	Present	5–12
	Microspined	Microspined	Microspined	Unknown	Microspined	Long-spined

SKELETON

Radiate arrangement of megascleres at the surface of papillae, with tracts of oxeas lining the cavities and with confused arrangement of spicules in the soft interior mass. Smaller oxeas are concentrated in the surface, larger oxeas in the cavities.

SPICULES

Two size-classes of oxeas, spiral microstrongyles and acanthomicrorhabds. Oxeas I: fusiform, sharply pointed, 186–280.3–330 × 9–12 μm (N = 25); oxeas II, anisoxeote, with one end usually rounded or blunt, the other end sharply pointed, 126–169.0–198 × 4–5 μm (N = 25); spiral microstrongyles, large size variation, 15–138 × 5–6 μm (N = 50); acanthomicrorhabds, straight, amphiaster-like, usually centrotylote or spined most prominently in the middle, 9–11.9–15 × 1–1.2–2 μm (N = 25).

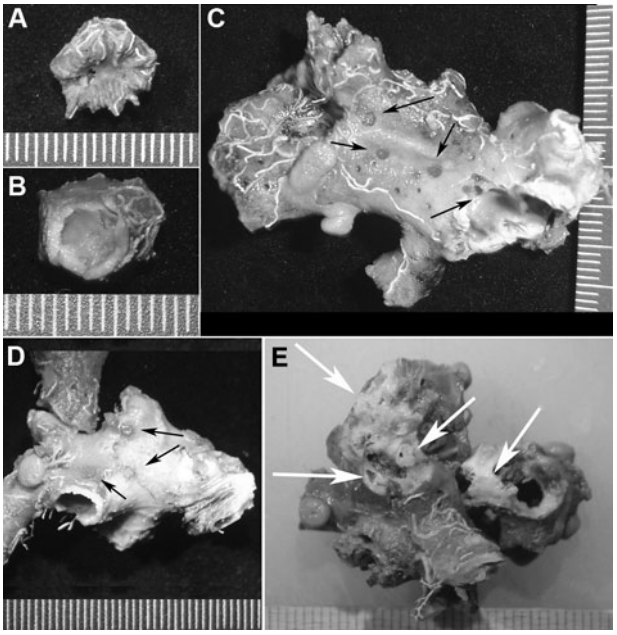


Fig. 4. Habitus images of *Cliona caledoniae* sp. nov. (A–D) and *Spiroxya levispira* (Topsent, 1898) (E). (A–B) Holotype of *C. caledoniae* sp. nov. infesting dead *Lophelia* corallite; (C–D) papillae (arrows) of paratypes of *C. caledoniae* sp. nov.; (C: ZMA 20271, D: 20270); (E) *S. levispira* excavations (arrows) (ZMA Por. 20418A).

ECOLOGY

Excavating dead *Lophelia* and *Madrepora* corals at 82–762 m depth (present study); elsewhere 5–2165 m. The shallow record is from Mediterranean cave habitats (Pouliquen, 1972), which are known to contain a deepwater fauna.

REMARKS

The present record is the most northern location known for the species and the first report of it from the waters of the British Isles. The species is predominantly reported from southern European localities, Azores, Madeira, Morocco and the western Mediterranean (Topsent, 1898, 1904; Johnson, 1899; Boury-Esnault *et al.*, 1994; Pouliquen, 1972; Rosell & Uriz, 2002; Longo *et al.*, 2005). The species was recently reported from Rockall Bank deepwater coral reefs, in the ocean west of Ireland (Van Soest *et al.*, 2007). Together with the Mingulay specimens these recent records comprise a considerable range extension. Most of the reported specimens show closely similar spicular characters (see Table 2). Compared to the description of the holotype from deep water off the Azores, the oxeas I of the Mingulay specimens are notably shorter and do not appear to overlap in length. The Madeira specimen of Johnson (1899 as *Scantilla spiralis*) was not fully described, but the figures provided by this author make it likely that they concern the same species.

A second species of *Spiroxya*, *S. heteroclita* Topsent, 1896 is recorded from *Lophelia* reefs west and south of Ireland (Stephens, 1915; Beuck *et al.*, 2007). This species differs clearly from *S. levispira* in possessing spirally spined straight strongyles, lacking acanthomicrorhabds, and having oxeas up to 900 μm (Rützler, 2002b).

The acanthomicrorhabds are named amphiasters by most past authors (e.g. Rosell & Uriz, 2002), but microstructure of the Mingulay and Rockall microscleres does not justify the name amphiaster as there are no proper rays, merely spines and clusters of spines (cf. Figure 3D). Calcinai *et al.* (2002) called the microscleres of their species *Scantiletta (=Spiroxya) corallophila* spiny microrhabds and we fully agree with that and recommend naming them

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acanthomicrorhabds in the definition of the genus *Spiroxya*. These microrhabds appear to be the only spicule type with some morphological diversification over the range of *Spiroxya levispira*, as the microrhabds shown by Rosell & Uriz, 2002 have a different appearance with fewer much more prominent spines and less microspination. Further studies along the lines of Picton & Goodwin (2007), who looked at differences of local sponge populations in a restricted area, are needed to establish whether such subtle but apparently consistent differences in microstructures of spicules and relatively small size differences are of taxonomic importance.

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