

North-eastern Atlantic and Mediterranean species of Cornulariidae Dana, 1846 (Anthozoa: Stolonifera) with the description of a new genus

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P.J. López-González; O. Ocaña; J.C. García-Gómez & J. Núñez. North-eastern Atlantic and Mediterranean species of Cornulariidae Dana, 1846 (Anthozoa: Stolonifera) with the description of a new genus. Zool. Med. Leiden 69 (20), 29.xii.1995: 261-272, figs 1-21.— ISSN 0024-0672.

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Key words: Anthozoa; Stolonifera; Cornulariidae; *Cervera* gen. nov.

The North-eastern Atlantic and Mediterranean species of the family Cornulariidae are re-examined and taxonomically revised. This family is mainly characterized by the absence of sclerites. Up to now, only one genus, *Cornularia* Lamarck, 1816, has been assigned to the family. Studies of the internal and external anatomy of the European species of Cornulariidae, carried out for the first time on a comparative basis, leads us to propose a new genus, *Cervera*. New combinations of the species included in the family are proposed. The main characters of *Cervera* gen. nov. are the presence of a fine chitinous periderm, various communication canals in the stolons and the absence of a additional chitinous layer that covers the periderm. *Cornularia atlantica* Johnson, 1861, is described for the first time subsequent to the original description, and is here designated as the type species of the new genus. The taxonomic significance of the anatomical and histological characters in the Cornulariidae are discussed and the systematic position of the species previously attributed to the genus *Cornularia* is reassessed.

Introduction

Several revisions of the stoloniferous octocorals have been carried out over the last century (e.g. Hickson, 1894, Gohar, 1940, Weinberg, 1978, and Bayer, 1981).

Only one genus, *Cornularia* Lamarck, 1816, has been included in the family Cornulariidae Dana, 1846. It has been described as lacking sclerites, and having separate polyps united by stolons. In the type species, *Cornularia cornucopiae* (Pallas, 1766), the stolons have only one canal, a thin periderm and a thick external chitinous cuticle covering the anthosteles and stolons (Benke and Hündgen, 1984). However, several authors (Light, 1915; Utinomi, 1950, 1955; Suzuki, 1971) also included species in the genus having stolons with more than one canal, and the diagnosis of the genus and family were therefore adapted to include these species.

In Europe the family Cornulariidae is represented by two species, *Cornularia cornucopiae* and *Cervera atlantica* (Johnson, 1861) **comb. nov.** *Cornularia cornucopiae* is widely distributed in the western Mediterranean and is also known from the Atlantic coasts of south-western Europe. *Cervera atlantica* was described from Madeira by Johnson (1861) as *Cornularia atlantica*, and had not been reported since its original description. This species is redescribed here and assigned to a new genus, together with other, Japanese species.

A comparative study of the anatomy of the two European species revealed useful characters for the classification of the family Cornulariidae.

Material and Methods

Colonies were collected from hard substrata by hand in the intertidal region, and by snorkeling or SCUBA diving in the upper infralittoral area. They were anaesthetised in a saturated solution of sea water and menthol, and preserved in 6-8% formalin.

A stereomicroscope was used for external anatomical studies. Histological sections, 8 µm thick, of dissected polyps and stolons were made using the classic method for topographical staining of Cajal (Gabe, 1968).

Specimens were deposited in the Nationaal Natuurhistorisch Museum, formerly Rijksmuseum van Natuurlijke Historie (RMNH) of Leiden, the Museo Nacional de Ciencias Naturales of Madrid (MNCN), Spain, and the Laboratorio de Biología Marina (LMB) of the University of Seville, Spain.

Descriptive part

Order Stolonifera Hickson, 1883

Family Cornulariidae Dana, 1846

Diagnosis.— Colonies small, without sclerites. Polyps not joined in a common coenenchymatous mass, but connected by stolons with one or several internal canals. Anthosteles and stolons covered by a periderm, and sometimes a thick additional cuticle.

Type genus: *Cornularia* Lamarck, 1816.

Cornularia Lamarck, 1816

Diagnosis.— Cornulariidae with polyps connected by stolons that are weakly attached to substratum, variable in length, circular in cross-section, and with one internal cavity. Stolons and anthosteles covered by a periderm and by a thick chitinous envelope, forming a kind of theca; anthocodiae retractable into the theca.

Type species: *Tubularia cornucopiae* Pallas, 1766, by monotypy.

Cornularia cornucopiae (Pallas, 1766)

(figs 1-9)

Tubularia cornucopiae Pallas, 1766: 80, fig. 37.

Cornularia rugosa Lamarck, 1816: 112.

Cornularia cornucopiae; Schweigger, 1820: 425; Hickson, 1894: 334.

Not *Cornularia cornucopiae*; Manuel, 1979: 393, 1981: 34.

For further references, see Weinberg, 1978: 141.

Material.— RMNH Coel. 23136 (Santa María del Mar. Cádiz, southern Spain, 36°11'N - 6°2'W, interti-

dal, 31.i.1990, 1 fragment); RMNH Coel. 23137 (El Chato, Cádiz, southern Spain, 36°31'N - 6°16'W, intertidal, 9.ii.1990, 1 colony); RMNH Coel. 23138 (Caños de Meca, Cádiz, southern Spain 36°11'N - 6°2'W, intertidal, 11.ii.1990, 1 colony); RMNH Coel. 23139 (Tarifa, Cádiz, southern Spain, 36°0'48"N - 5°36'W, 11 m, 9.vii.1990, 1 fragment); LBM (Pantalán de San Felipe, La Linea, Cádiz, southern Spain, 36°9'N - 5°22'W, 6 m, 26.vii.1990, 2 colonies); LBM (Punta Almina, Ceuta, Spanish city in North Africa, 35°54'N - 5°16'W, 25 m, 13.v.1988, 2 colonies).

Morphology (figs 1-2).— Colonies small; polyps connected by stolons of variable length. Stolons circular in cross-section, about 0.2 mm in diameter (range 0.12-0.25 mm), covered by a thick chitinous cuticle that does not strongly adhere to the substratum. Anthostele also covered by a thick envelope. In retracted polyps, the upper part of the thick chitinous cuticle appears to be separated from the polyp (fig. 2). In expanded polyps, the limit of the periderm is visible on the polyp body as a bottleneck (also reported by Benke and Hündgen, 1984) (see white arrows in fig. 1). Tentacles with 14-18 pinnules on each side.

Basal junctions of polyps and stolons narrow and of similar diameter as the stolons. Polyps translucently white and the chitinous envelope beige or brown. Distance between polyps variable (1.7-7 mm in the material examined). Height of expanded polyps 6.5-10 mm.

Anatomy (figs 3-4).— Retracted polyps elongated (fig. 3). Stolons circular in

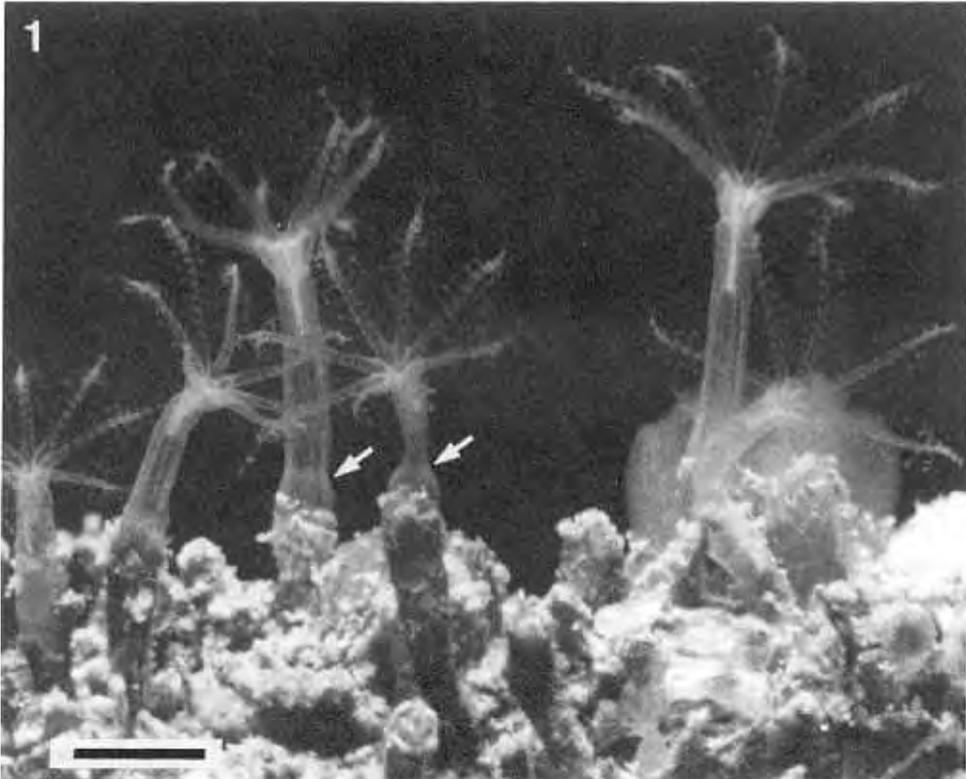


Fig. 1. *Cornularia cornucopiae*, general form. Aquarium photograph showing expanded polyps and the limit of the periderm (indicated by white arrows). Scale bar: 2 mm.

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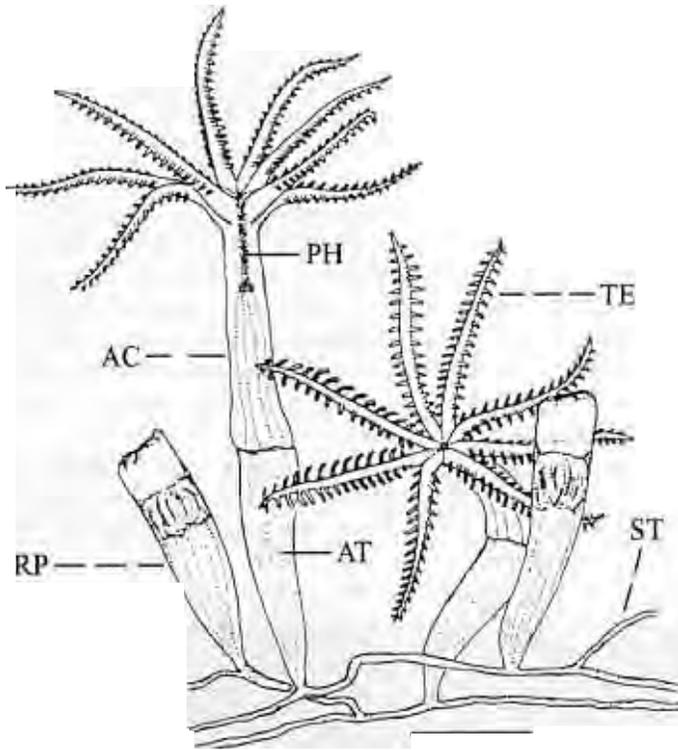


Fig. 2. *Cornularia cornucopiae*, general form. Habitus of expanded and retracted polyps and stolons. AC, anthocodia; AT, anthostele; PH, pharynx; RP retracted polyp; ST, stolon; TE, tentacle. Scale bar: 2 mm.

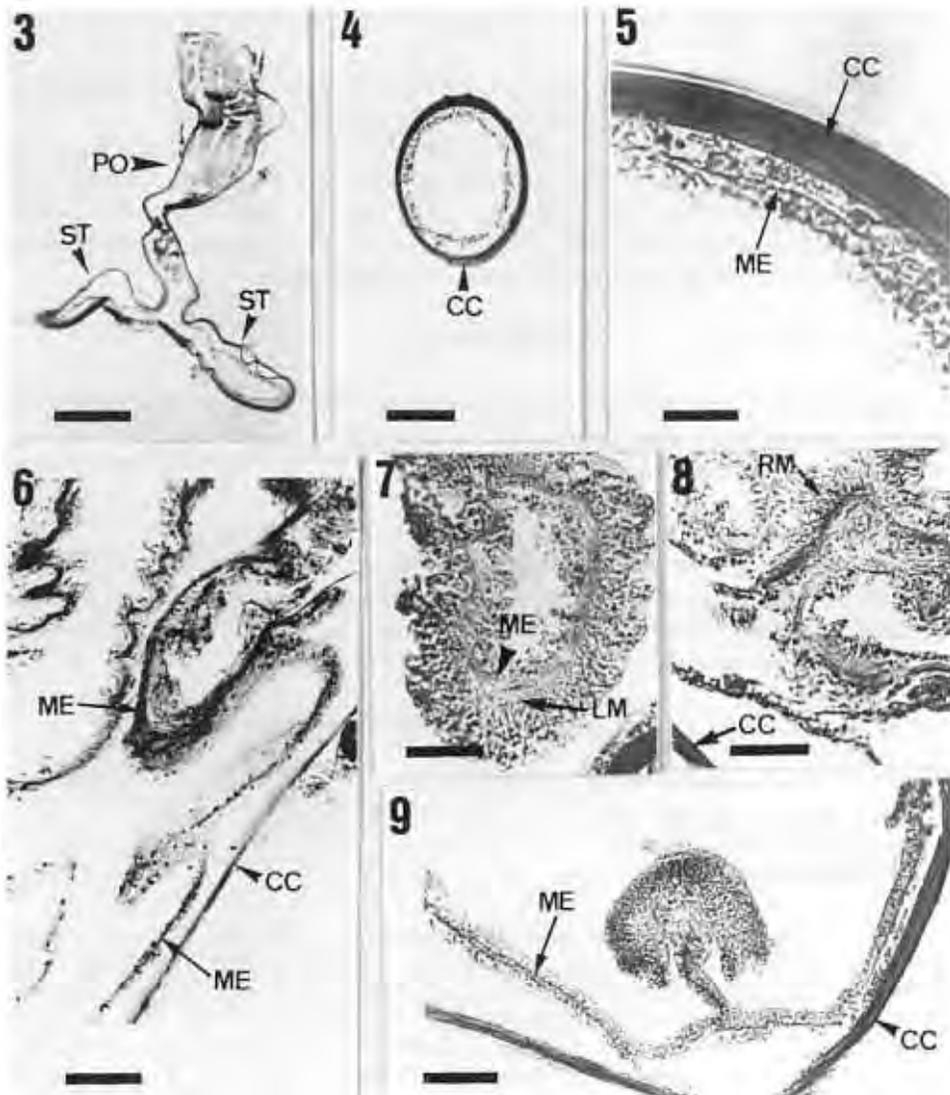
cross-section, with only one internal canal of 120-150 μm in diameter (fig. 4). External layer, with concentric grooves, 8-13 μm thick (fig. 5). Adherence of foreign particles to the exterior is minimal. Mesogloea reduced to less than 1 μm in thickness. General aspect and development of ectoderm and endoderm similar. Muscular processes were not observed.

Cover of the anthostele varying in thickness from its base (5 μm) to the distal edge of the theca, where it becomes reduced (1 μm) (fig. 6).

Ectoderm, mesogloea and endoderm of anthostele and stolon similar in appearance. In the anthocodia the thickness of these three layers is about 10 μm , in the anthostele and stolon about 2 μm . In the anthocodia the ectoderm and endoderm can be thicker than the mesogloea with ectodermal and endodermal muscle processes on mesogloea arcs. In the tentacles, the thickness of the mesogloea is rather uniform (4-5 μm) and the longitudinal musculature is better developed than the circular musculature (fig. 7).

Pharynx in cross-section irregular in outline. Its mesogloea less than 1 μm thick, its endoderm 20-40 μm thick. The single well-defined siphonoglyph appears midway, in the lower part of the pharynx.

Mesenteries short, with kidney-shaped filaments and weakly developed muscu-



Figs 3-9. *Cornularia cornucopiae*, anatomical and histological details. Fig. 3. Longitudinal section of a polyp and its stolon. Fig. 4. Cross-section of stolon. Fig. 5. Detail of wall of stolon. Fig. 6. Longitudinal section of a polyp, showing the difference in thickness of the mesogloea in anthostele (bottom) and anthocodia (top). Fig. 7. Cross-section of a tentacle. Fig. 8. Cross-section of a mesentery and retractor muscles. Fig. 9. Transverse section of a mesenteric filament.

CC, chitinous cuticle; LM, longitudinal musculature; ME, mesogloea; PO, polyp; RM, retractor musculature; ST, stolon. Scale bars: in fig. 3, 800 μm ; in fig. 4, 100 μm ; in fig. 5, 9 μm ; in fig. 6, 20 μm ; in fig. 7, 35 μm ; in fig. 8, 20 μm and in fig. 9, 40 μm .

lature (fig. 9). More distally, the longitudinal musculature of the mesenteries is diffuse (fig. 8).

Habitat.— *Cornularia cornucopiae* occurs in the intertidal and upper infralittoral areas, mainly on sponges, bryozoans, ascidians, hydrozoans and algae.

Distribution.— The species has been reported from the western Mediterranean (Stiasny, 1941; Pax & Müller, 1955, 1962; Weinberg, 1978; Bibiloni & Cornet, 1980; Ocharan & Anadón, 1981; Gili, 1982; Roca, 1986) and the Atlantic coasts of France (Teissier, 1965), Portugal (Saldanha, 1974), the Azores (Tixier-Durivault & d'Hondt, 1974) and Asturias (northern Spain) (Ocharan & Anadon, 1981).

Cervera gen. nov.

Diagnosis.— Cornulariidae with polyps connected by flattened stolons that are strongly attached to the substratum, variable in length, irregularly elongate in cross-section, and with several internal canals. Anthosteles and stolons covered by a weak periderm only.

Type species: *Cornularia atlantica* Johnson, 1861, designated herein.

Etymology.— The name *Cervera* has been adopted in honour of Mr Joaquin Cervera, recently deceased, who helped us in obtaining financial support and with the organization of marine biological expeditions around the Strait of Gibraltar. The gender of the name is feminine.

Cervera atlantica (Johnson, 1861) comb. nov. (figs 10-21)

Cornularia atlantica Johnson, 1861: 298.

?*Anthelia inermis* Berenguier, 1954: 61.

?*Cornularia inermis*; Roca, 1986: 540.

Material.— MNCN 02.04/0003 (Isla de Tarifa, Cádiz, southern Spain, 36°0'48"N - 5°36'W, 2 m, ii.1991, 1 colony); RMNH Coel. 23140 (Santa María del Mar, Cádiz, southern Spain, 36°31'N - 6°17'W, intertidal, 30.ii.1990, some fragments); RMNH Coel. 23141 (Isla de Tarifa, Cádiz southern Spain, 36°0'48"N - 5°36'W, 2 m, 6.ii.1991, 1 colony + 3 fragments); RMNH Coel. 23142 (Ceuta, Spanish city in North Africa, 35°53'N - 5°16'W, 3-5 m, 15.viii.1991, 3 fragments); RMNH Coel. 23143 (idem, 9-12 m, 17.viii.1991, 1 colony); RMNH Coel. 23144 (idem, 1 m, 20.viii.1991, 1 fragment); RMNH Coel. 23158 (Candelaria, Tenerife, Canary Islands, 28°34'30"N - 16°20'W, 3 m, 4.ii.1989, 2 colonies); RMNH Coel. 23159 (Punta Hidalgo, Tenerife, Canary Islands, 28°21'N - 16°22'W, 1 m, 9.iii.1990, 2 colonies); RMNH Coel. 23160 (Montaña Roja, La Tejita, Tenerife, Canary Islands, 28°30'N - 16°33'W, intertidal, under stones, 20.i.1990, 2 colonies).

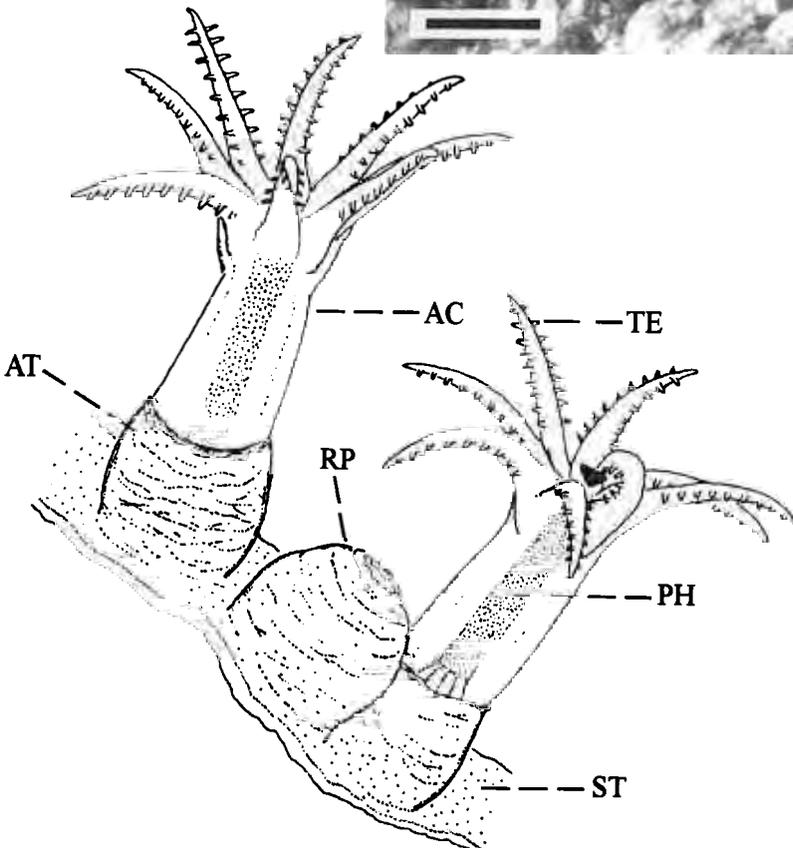
Morphology (figs 10-11).— Colonies small; polyps up to 1 cm in height, connected by flattened stolons of variable length, and maximally 2-3 mm in width. Polyps translucently orange. Anthosteles (represented by the basalmost 2-3 mm of the polyps) and stolons covered by a thin brownish periderm. Junctions of polyps and stolons wide. Tentacles with 12-14 pinnules on each side.

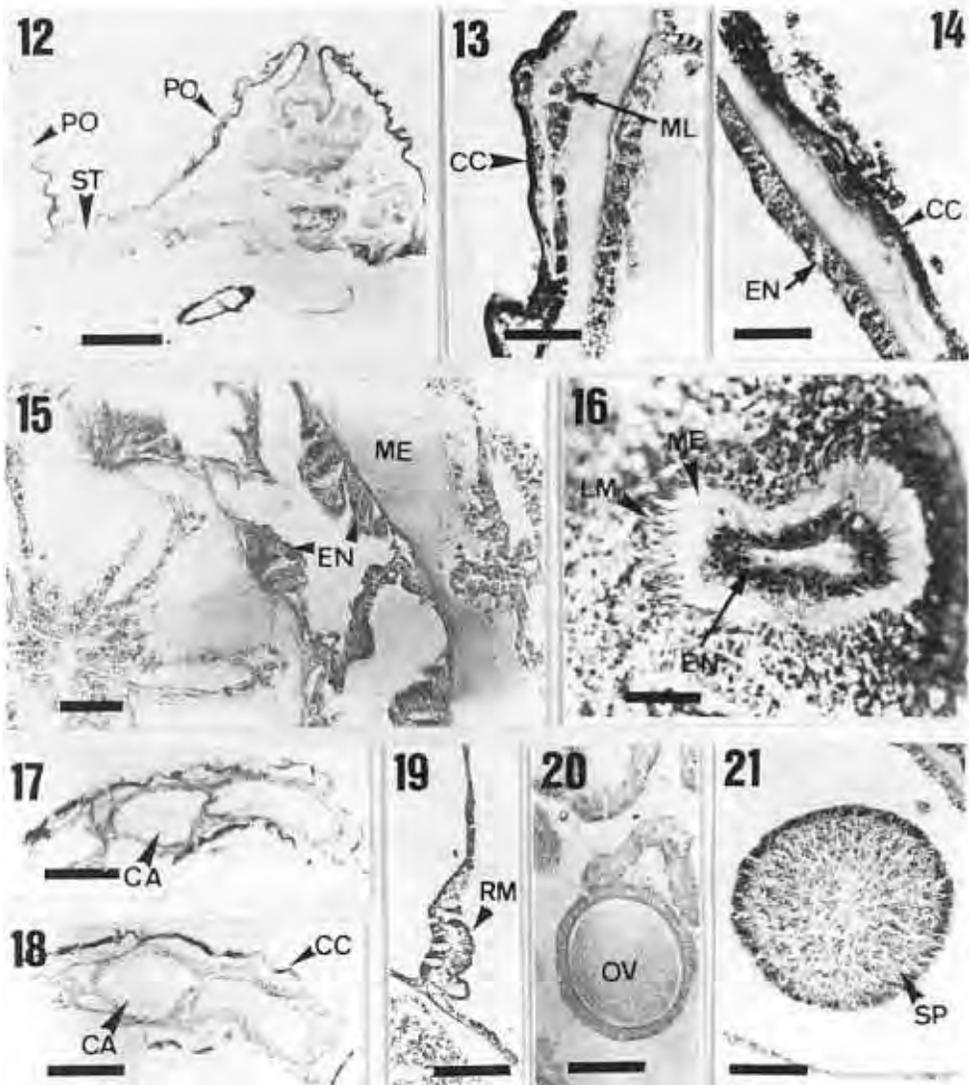
Anatomy (figs 12-21).— Retracted polyps conical or spherical (fig. 12). Outline of stolons irregularly elongate in cross-section. Each stolon containing 3-5 principal canals and others smaller in size (fig. 17-18). Foreign particles adhering to external

Figs 10-11. *Cervera atlantica*, general form. Fig. 10. Aquarium photograph showing an expanded polyp. Fig. 11. Habitus of expanded and retracted polyps and stolons. AC, anthocodia; AT, anthostele; PH, pharynx; RP, retracted polyp; ST, stolon; TE, tentacle. Scale bars: 2 mm.



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Figs. 12-21. *Cervera atlantica*, anatomical and histological details. Fig. 12. Longitudinal section of a retracted polyp and its stolon. Figs 13-14. Details of wall of polyp, showing the mesogleal lacunae and the weak chitinous cuticle. Fig. 15. Transverse section of anthocodia, showing the well-developed endoderm. Fig. 16. Detail of transverse section of a tentacle, displaying a thick mesogloea and the longitudinal musculature. Fig. 17-18. Cross-section of stolon, showing the mesogleal canals. Fig. 19. Transverse section through a mesentery. Fig. 20. Oocyte. Fig. 21. Packet of spermatogonia. CA, canal; CC, chitinous cuticle; EN, endoderm; LM, longitudinal musculature; ME, mesogloea; ML, mesogleal lacunae; OV, oocyte; PO, polyp; RM, retractor muscle; SP, packet of spermatogonia; ST, stolon. Scale bars: in fig. 12, 1 mm; in figs 13-14, 25 μm; in fig. 15, 37 μm; in fig. 16, 15 μm; in figs 17-18, 360 μm; in fig. 19, 50 μm; in fig. 20, 35 μm and in fig. 21, 65 μm.

surface of periderm. Ectoderm scarcely developed. Mesogloea with a complex system of lacunae, lined with thin (5 µm) endoderm.

Periderm of anthosteles similar to that of stolons. Ectoderm scarcely developed. Mesogloea well-defined, reaching its maximal thickness in the anthostele. Large lacunae filled with cells present in mesogloea of both anthosteles and stolons (figs 13-14). Endoderm of anthosteles weakly developed, reaching its maximal development distally in the anthocodia (fig. 15).

Ectoderm of tentacles and pinnules well developed, 10-12 µm thick; longitudinal musculature strong, supported by mesogloea processes, up to 10 µm thick in the pinnules and axis of the tentacles. Circular musculature present but not well marked. Endoderm well developed, 4-5 µm thick (fig. 16).

Mesenteries with a thin mesogloea and weak musculature (fig. 19).

The colony fragments from Santa María del Mar (Cádiz) (RMNH Coel. 23140) collected in February 1990, contain oocytes up to 69 µm in diameter (fig. 20). The colony from Tarifa (MNCN 02.04/0003) collected in February 1991, contains well developed packets of spermatogonia, up to 205 µm in diameter (fig. 21).

In the pharynx, the mesogloea is reduced in thickness to 5 µm. Ectoderm well-developed, about 45 µm thick. Siphonoglyph distinct, with mesogloea lacunae at its more proximal level; its cilia moderately long.

Habitat.— The specimens were collected under stones, in rock fissures and caves in intertidal and upper infralittoral areas.

Distribution.— So far, *Cervera atlantica* had only been reported from Madeira (Johnson, 1861). The present records extend the area of distribution to Tenerife (Canary Islands) and the Strait of Gibraltar.

Discussion

Three species to be accommodated in Cornulariidae have been reported from European waters, including the Azores, Canary Islands and Madeira, viz., *Cornularia cornucopiae* (Pallas, 1766), *Cervera atlantica* (Johnson, 1861) and "*Anthelia*" *inermis* Berenguier, 1954. The last-named species is still insufficiently described and a careful anatomical study is in fact necessary to establish whether it is different from *Cervera atlantica* (see below).

Cornularia cornucopiae is a well known European species (see distribution) and needs no further discussion by itself.

Cervera atlantica (Johnson, 1861) was originally described from Madeira as *Cornularia atlantica*. Johnson's brief description of this species reads as follows: "Basal band narrow, [...], destitute of spicula, but invested by a thin epidermis containing particles of sand; when retracted, forming a fleshy hemispherical button". The characters mentioned in this description justify its inclusion in Cornulariidae, but do not match *Cornularia cornucopiae*. In *Cornularia cornucopiae*, the thicker translucent chitinous envelope of the anthostele forms a theca. In fully retracted polyps the distal part of this theca is empty (fig. 2), an aspect well illustrated by Weinberg (1978). This theca is absent in *Cervera*. Another difference exists in the junction of polyp and stolon. In *Cornularia cornucopiae* this junction is narrow, while it is wide in *Cervera atlantica*. The last-named species had not been reported again since its original description. Our

specimens from Tenerife (Canary Islands), Santa María del Mar, Tarifa and Ceuta (all Strait of Gibraltar) match Johnson's account of the species. Unfortunately Johnson's type material from Funchal, Madeira, may be assumed to be no longer extant; Dr. R. B. Williams, Tring, England, kindly informed us that the material is neither present in the British Museum (Natural History) nor in the museum in Funchal, and that it was also not found among some material of Johnson recently traced by him in the Botanical Garden of Funchal.

Anthelia inermis Berenguiet (1954) was insufficiently described on the basis of material collected near the Marine Biology Research Station at Endoume, under rocks at a depth of 0.5 m. It might be identical with *Cervera atlantica*, but Berenguiet did not compare it with that species. Weinberg (1986) cited the possible rediscovery of Berenguiet's species near Benidorm (Spain) basing himself on a personal communication of Dr. R. B. Williams, and tentatively classified it in the family Clavulariidae, as *Clavularia* ("*Anthelia*") *inermis*. Unfortunately the depository of Berenguiet's type material is not known (cf. Weinberg, 1978: 166). Therefore, a study of topotypical material of this species is necessary to establish its identity.

Roca (1986) collected some colonies of a species of Stolonifera lacking sclerites on rhizomes of *Posidonia*, which he identified as *Cornularia inermis* (Berenguiet, 1954) on the basis of external appearance.

The British specimens collected by Manuel (1979; 1981) in Portland Harbour and identified by him as *Cornularia cornucopiae* do not show the ridged chitinous "theca" characteristic of that species. Manuel's specimens reach about 2 cm in full expansion, much superior to those of *C. cornucopiae*, and the junction of polyps and stolons is quite different. The shape of the polyps is similar to those of *Cervera atlantica*. Unlike in *C. cornucopiae* the stolons of Manuel's specimens are cylindrical and relatively fine compared to the size of the polyps. Although belonging to the family Cornulariidae, these specimens are different from *C. cornucopiae*. They probably belong to *Cervera*. An anatomical study is needed to determine their true identity.

Classification of the family Cornulariidae.— The characters used in the taxonomy of the Cornulariidae are few. In other groups of Octocorallia, the sclerites are useful to establish generic and specific differences.

Recognizing two genera, we suggest the following tentative classification of the family Cornulariidae:

Family Cornulariidae Dana, 1846

Genus *Cornularia* Lamarck, 1816 (type species: *Tubularia cornucopiae* Pallas, 1766).

Cornularia cornucopiae (Pallas, 1766) (type depository unknown).

?*Cornularia australis* Busk, 1867 (type depository unknown).

Genus *Cervera*, gen. nov. (type species: *Cornularia atlantica* Johnson, 1861)

Cervera atlantica (Johnson, 1861) comb. nov. (type no longer extant; see discussion).

Cervera minuta (Light, 1915) comb. nov. (*Cornularia minuta* Light, 1915; holotype: University of the Philippines no. C.2457, Legaspi Bay, Albay Province, Luzon, P. I.; January).

?*Cervera inermis* (Berenguiet, 1954) comb. nov. (*Anthelia inermis* Berenguiet, 1954; type depository unknown).

Cervera komaii (Utinomi, 1950) comb. nov. (*Cornularia komaii* Utinomi, 1950; type depository unknown)

?*Cervera sagamiensis* (Utinomi, 1955) comb. nov. (*Cornularia sagamiensis* Utinomi, 1955; Type

material: Biological Laboratory of the Imperial Household, Japan, no Coel. 342, Koiso in Hayama, shore, 18.ii.1949))

Cervera aggregata (Utinomi, 1955) comb. nov. (*Cornularia aggregata* Utinomi, 1955; type material: Biological Laboratory of the Imperial Household, Japan, no Coel. 390, off Moroiso, 22 fms, 1.i.1951)

?*Cornularia australis* Busk, 1867, is currently included in the genus *Cornularia*, but a reexamination on the basis of new collections is desirable to establish with certainty its generic affinities.

Cornularia aurantiaca Stimpson, 1855, cannot be attributed to the Cornulariidae because it contains sclerites, as mentioned by its author in the short original description.

Cornularia sagamiensis Utinomi, 1955, was originally described as not having sclerites, but Suzuki (1971) redescribed this species on the basis of new collections from the upper intertidal zone near Manazaru Marine Biological Laboratory (Japan) and reported the presence of some sclerites characteristic of the genus *Clavularia* Blainville, 1830, in the proximal portion of the anthocodia, the distal portion of the anthostele and in the stolon. A re-examination of the type material is therefore necessary to establish whether it belongs in *Clavularia* or in *Cervera*.

Acknowledgements

Dr R.B. Williams (Tring, England) is gratefully acknowledged for information on the type material of *Cornularia atlantica* Johnson. Our thanks are also due to Dr G.C. Williams (California Academy of Sciences, San Francisco) for reviewing the first draft of this paper, and to Dr J.M. Gili (Instituto de Ciencias del Mar, C.S.I.C., Barcelona) and Dr Marie José d'Hondt (Musée National d'Histoire Naturelle, Paris) for providing us with literature. We extend our acknowledgements to Dr A. Brito (University of La Laguna, Tenerife, Canary Islands) for his valuable suggestions, and to the Departamento de Biología Celular (Citología) of the University of La Laguna for providing facilities. Diane A. Gwynne and Dr C. Finlayson helped with word processing.

The present study was financially supported by CEPSA, Fundación Sevillana de Electricidad, Excmo. Ayuntamiento de los Barrios, Mancomunidad de Municipios del Campo de Gibraltar and Agencia de Medio Ambiente (Junta de Andalucía).

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Received: 13.xii.1994

Accepted: 18.ix.1995, after revision

Edited: J.C. den Hartog