REVISION OF THE GENUS *RENILLA* LAMARCK, 1816 (OCTOCORALLIA, PENNATULACEA), WITH DESCRIPTIONS OF TWO NEW SPECIES FROM THE SUB-ANTARCTIC REGION

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Revision of the genus Renilla *Lamarck, 1816 (Octocorallia, Pennatulacea), with descriptions of two new species from the Sub-Antarctic region.*– This study was made with samples from the SW Atlantic Ocean. *Renilla octodentata* n. sp. and *Renilla musaica* n. sp. are described. *R. octodentata* is characterized for the presence of eight calicinal teeth in its autozooids, the rhachis may be kidney-shaped or bilobulate-shaped and the length of the sclerites is uniform in the whole colony. *R. musaica* is characterized by the presence of five calicinal teeth in its autozooids, the rhachis may be horseshoe or kidney shaped, the medium dorsal tract free of zooids is lacking and the sclerites of the peduncle are short and wide while those of the rhachis are much longer and thinner. *Renilla muelleri* Kölliker, 1872 and *Renilla reniformis* (Pallas, 1766) are redescribed. The geographical and bathymetrical distribution of the studied species is given.

Key words: Pennatulacea, Renillidae, Taxonomy, Distribution.

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INTRODUCTION

There are only few studies on the order Pennatulacea in the SW Atlantic Ocean: JUNGERSEN (1904), BELEM & ALVARENGA (1973), CASTRO (1981), and ACUÑA & ZAMPONI (1992). These reports include the families Anthoptilidae Kölliker, 1880, Virgulariidae Verrill, 1868, and Pennatulidae Ehrenberg, 1834. The family Renillidae Gray, 1860 has not been studied in the Sub-Antarctic region, except for the *Renilla* collected during the campaign of the "Calypso" in the coast of South America (1961-1962) (TIXIER-DURIVAULT, 1969-1970); many collections of the Renillidae have been obtained during various campaigns. This work is based on them.

The genus of sea pens *Renilla* Lamarck, 1816 is analyzed and the results are compared with those of previous works such as KÜKENTHAL & BROCH (1911), KÜKENTHAL (1915), DEICHMANN (1936), BAYER (1959, 1961) and TIXIER-DURIVAULT (1969-1970).

MATERIAL AND METHODS

The material studied came from collections from the Museum of La Plata, the Museum of Natural Sciences "Bernardino Rivadavia" and also BIP Walter Hertwig /78 and BIP Oca Balda /88.

The material was kept in alcohol 96° and in a saline solution of neutralized formaldehyde 4%.

The morphological analysis was carried out with a stereoscopic microscope. The study of sclerites was made with an optic microscope after treatment in sodium hypochlorite for better visualization. An average of 30 sclerites both from the rhachis and the penduncle were measured. The length of rhachis and peduncle sclerites was compared with a Student's t test with a significance level of 5%.

The specimens examined are in the invertebrate collection of the Museum of Natural Science Bernardino Rivadavia and in the collection of coelenterates of the Marine Science Department (UNMdP).

RESULTS

1. Family Renillidae Gray, 1860

TIXIER-DURIVAULT (1987) mentions the presence of a medium dorsal area without any polyps in the description of the family Renillidae. This is not an exclusive characteristic of the whole family, except for *Renilla reniformis* (Pallas, 1766), *R. köllikeri* (Pfeffer, 1886) and *R. octodentata* n. sp. The rest of species such as *R. muelleri* Kölliker, 1872 and *R. musaica* n. sp., have all their dorsal area covered with polyps. It is thus necessary to include this new information in the diagnosis of this family.

Diagnosis

Sea pens with a sterile peduncle and a foliate dorsal-ventral rhachis bearing autozooids and siphonozooids in upper surface only. The siphonozooids are distributed in groups between autozooids. No axis. They may have on their dorsal rhachis face a tract free from polyps which continues the deep incision of

SHAPE / SPECIES	kidney	bilobulate	horseshoe	heart	round
Renilla muelleri	1	0	1	0	0
Renilla reniformis	1	0	0	1	1
Renilla octodentata	1	1	0	0	0
Renilla musaica	1	0	1	0	0

Fig. 1. Shapes of rhachis in the genus *Renilla*: 1. Presence; 0. Absence.

the peduncle. Sclerites of different forms, short and wide "twigs" or long and thin "nods", frequently three-flanged.

This family is monogeneric, endemic to America inhabiting both coasts of the continent. See KÜKENTHAL (1915, p. 21) and DEICHMANN (1936, p. 257).

2. Emendation of gen. *Renilla* Lamarck, 1816

DEICHMANN (1936) states that the genus *Renilla* has autozooids with rudimentary calyces with three to seven calicinal teeth. In this study the species *R. octodentata* n. sp. has eight teeth, consequently the diagnosis has to be modified.

Diagnosis

Bilateral developed colonies. Rhachis with different shapes: kidney, heart, circular, bilobulate or horseshoe (fig. 1). Autozooids with rudimentary calyces with one to eight calicinal teeth. Sclerites deep violet to pale and white.

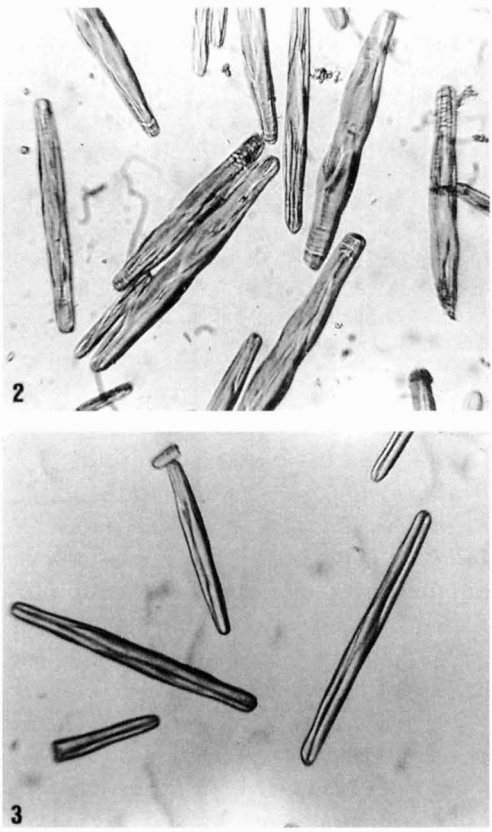
3. Redescription of known species

Characteristics such as the number of calicinal teeth and the absence of medium dorsal tract free of polyps, not mentioned in previous descriptions of the species but considered of important descriptive value, justify this redescription.

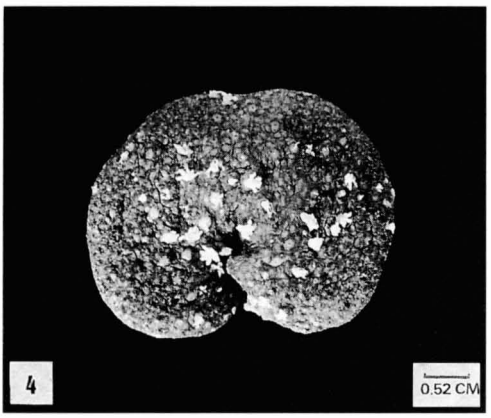
Renilla muelleri Kölliker, 1872 (figs. 4, 5)
Seechampignon Tilesius, 1812: 85.
Renilla muelleri Kölliker, 1872: 211; Kölliker, 1880: 31; Studer, 1878: 673; Balss, 1910: 78; Kükenthal & Broch, 1911: 211; Kükenthal, 1915: 22; Deichmann, 1936: 258 (synonymic list); Broch, 1958: 251; Bayer, 1959: 31; Bayer, 1961: 302; Spurlok & Cormier, 1975: 15.
Renilla amethystina Verrill, 1864: 29; Verrill, 1868: 378; Parker, 1919: 499; Parker, 1920: 343; Parker, 1920: 475; Hickson, 1930: 225; Buck, 1973: 19.
Renilla danae Verrill, 1864: 29; Kükenthal, 1915: 25.
Renilla patula Verrill, 1864: 29; Kükenthal, 1915: 25.
Renilla peltata Verrill, 1864: 29; Kükenthal, 1915: 25
Renilla chilensis Philippi, 1893: 3; Kükenthal, 1915: 26.
Renilla africana Kölliker, 1872: 283; Kükenthal, 1915: 25.
Renilla mollis Kölliker, 1872: 106; Kükenthal & Broch, 1911: 207; Kükenthal, 1915: 24.
? *Renilla inermis* Pfeffer, 1886: 60.
? *Renilla violacea* Quoy & Gaimard, 1826: 642.

Redescription

Horseshoe or kidney shaped (fig. 1).



Figs. 2, 3. *R. octodentata* n. sp. and *R. muelleri*: sclerites in the peduncle (2) as long as those of the rhachis (3). (500 x).



Figs. 4, 5. *R. muelleri:* 4. Dorsal view; 5. Ventral view.

Relatively short peduncle. Peduncle sclerites of the same length as those of the rhachis (table 1, figs. 2, 3). Autozooids with five calicinal teeth. In the dorsal section, the rhachis is totally covered with zooids. Ventral part of the rhachis and peduncle of deep violet colour. Cnidocists found: microbasic amastigophore, holotrichous isorhiza, atrichous anisorhiza and macrobasic mastigophore (exclusive of Hydrozoa).

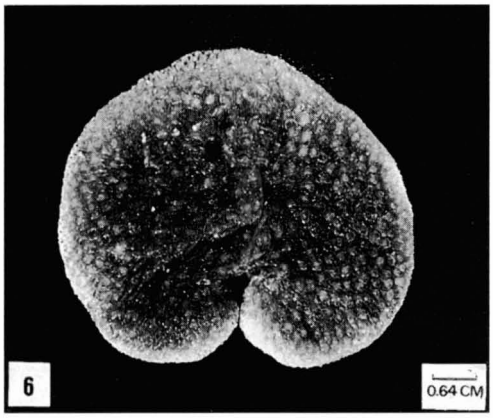
Material studied

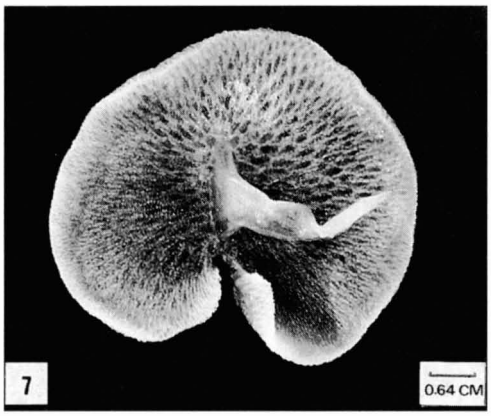
Four campaigns: Vessel "Comodoro Rivadavia", 1938, st. 15, 37°07'S 55°22'W, depth 23 m; st. 12, 33°52'S 52°26'W, depth 23 m. R.O.U. "Angélica", 1928, Uruguayan coast between Piriapolis and Maldonado. Vessel "Bahía Blanca" A.R.A., 1939, 36°21'S 56°33'W, depth 16 m., Juan M. Díaz de Astarloa col. Vessel "Undine", VI 1926, 35°08'S 52°35'W.

Renilla reniformis (Pallas, 1766) (figs. 3, 4)
Pennatula reniformis Pallas, 1766: 374.
Alcyonium agaricum Gmelin, 1788: 3811.
Renilla reniformis Agassiz, 1850: 10; Herklots, 1858: 28; Verrill, 1864: 26; Richiardi, 1870: 133; Kölliker, 1872: 98 (partim); Verrill, 1883: 533; Pfeffer, 1886: 60; May, 1899: 12; Wilson, 1883: 723; Torrey, 1901: 355; Moroff, 1902: 399; Balss, 1910: 78; Kükenthal & Broch, 1915: 297; Kükenthal, 1915: 22; Deichmann, 1936: 259; Waterman, 1950: 131; Bayer, 1961: 301; Tixier-Durivault, 1969-1970: 165; Dukelberger & Watabe, 1974: 573; Ivester, 1977: 238; Rittschof, Hooper & Costlew, 1986: 376; Tixier-Durivault, 1987: 18.
Renilla americana Lamarck, 1816: 428 (partim); Schweigger, 1819: 23; Blainville, 1834: 518; Ehrenberg, 1834: 65; Dana, 1846: 588 (partim); Milne-Edwards, 1857: 220.
Renilla edwardsii Kükenthal & Broch, 1911: 210; Kükenthal, 1915: 22.

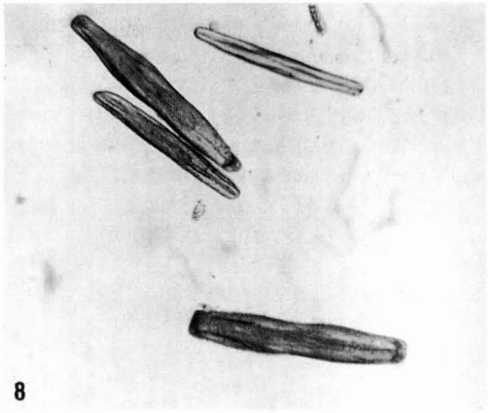
In the study of Alcyonaria of the Atlantic Ocean, DEICHMANN (1936) divides the *Renilla reniformis* species into the forms: *R. n. americana*, *R. n. typica* and *R. n. köllikeri*. This classification is based on the number of teeth and on the colour. According to DEICHMANN (1936), the *typica* and *americana* forms are violet and pale pink, respectively.

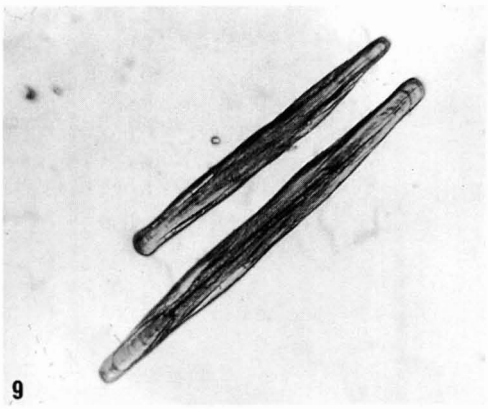
Several reasons can cause the difference in colours such as protection or warning (WALTON, 1911). If both forms have the same structural characteristics, eg. seven calicinal teeth, the colour has systematic importance in the description. For that reason, the criterion supported by DEICHMANN





Figs. 6, 7. *R. reniformis:* 6. Dorsal view; 7. Ventral view.





Figs. 8, 9. *R. reniformis* and *R. musaica* n. sp.: 8. Sclerites of the peduncle are short and wide; 9. Sclerites of the rhachis are long and thin. (500 x).

(1936) have been unified, gathering the *typica* and *americana* forms in only one taxon. According to BAYER (1961) "these color forms seem to be inconsistent, since specimens from the Antilles may be either uniformly dark purple, or pale (yellowish or purplish white) with a deep purple stalk, and retention of names for them seems to serve no useful purpose". According to WATERMAN (1950) the *köllikeri* form becomes *R. köllikeri* (Pfeffer,1886) since this species has five calicinal teeth.

Redescription

Round, kidney or heart shaped (fig. 1). Relatively long peduncle with very few sclerites. Peduncle sclerites short and wide and rhachis sclerites long and thin (table 2, figs. 8-9). Autozooids with seven calicinal teeth. Medium dorsal tract free of polyps. Ventral section of rhachis and peduncle white or pale pink. Sclerites are of various colours: intense violet, yellow, pale pink or white. Cnidocists found: atrichous isorhiza.

Table 1. Comparison between sclerite lengths of rhachis and peduncle of *Renilla muelleri*: BCR. Vessel Comodoro Rivadavia; BA. Vessel Angélica; BOB. Vessel Oca Balda; BBB. Vessel Bahía Blanca; BU. Vessel Undine; t. Student's t test values. All values non significant.

Samples		Sclerite length (mm) Peduncle	Rhachis	t
BCR	$\bar{x}$	0,262	0,268	
	s.d.	0,036	0,049	0,529
	n	30	30	
BA	$\bar{x}$	0,234	0,256	
	s.d.	0,052	0,064	1,479
	n	30	30	
BOB	$\bar{x}$	0,348	0,306	
	s.d.	0,318	0,061	0,699
	n	30	30	
BBB	$\bar{x}$	0,282	0,283	
	s.d.	0,055	0,090	0,032
	n	30	26	
BU	$\bar{x}$	0,262	0,256	
	s.d.	0,036	0,064	0,440
	n	30	30	

Table 2. Comparison between sclerite lengths of rhachis and peduncle of *R. reniformis*: CCR. Campaing Comodoro Rivadavia; BWH. Vessel Walter Hertwig; t. Student's t test values. All values significant.

Samples		Sclerite length (mm) Peduncle	Rhachis	t
CCR	$\bar{x}$	0,336	0,376	
	s.d.	0,053	0,055	6,667
	n	30	30	
CCR	$\bar{x}$	0,273	0,412	
	s.d.	0,051	0,061	9,115
	n	27	30	
BWH	$\bar{x}$	0,261	0,356	
	s.d.	0,088	0,096	2,690
	n	10	30	

Table 3. Comparison between sclerite lengths of rhachis and peduncle of *R. octodentata* n. sp.: CCR. Campaign Comodoro Rivadavia; BOB. Vessel Oca Balda; t. Student's t test values. All values non significant.

Samples		Sclerite length (mm) Peduncle	Rhachis	t
CCR	$\bar{x}$	0,266	0,252	
	s.d.	0,009	0,042	0,210
	n	30	30	
BOB	$\bar{x}$	0,296	0,294	
	s.d.	0,044	0,039	0,737
	n	31	20	

Table 4. Comparison between sclerite lengths of rhachis and peduncle of *R. musaica*: BPM. Vessel Presidente Mitre; BU. Vessel Undine; BBB. Vessel Bahía Blanca; t. Student's t test values. All values significant.

Samples		Sclerite length (mm) Peduncle	Rhachis	t
BPM	$\bar{x}$	0,156	0,352	
	s.d.	0,022	0,045	20,923
	n	30	30	
BU	$\bar{x}$	0,286	0,401	
	s.d.	0,059	0,089	5,780
	n	30	30	
BBB	$\bar{x}$	0,259	0,362	
	s.d.	0,071	0,052	6,350
	n	30	30	

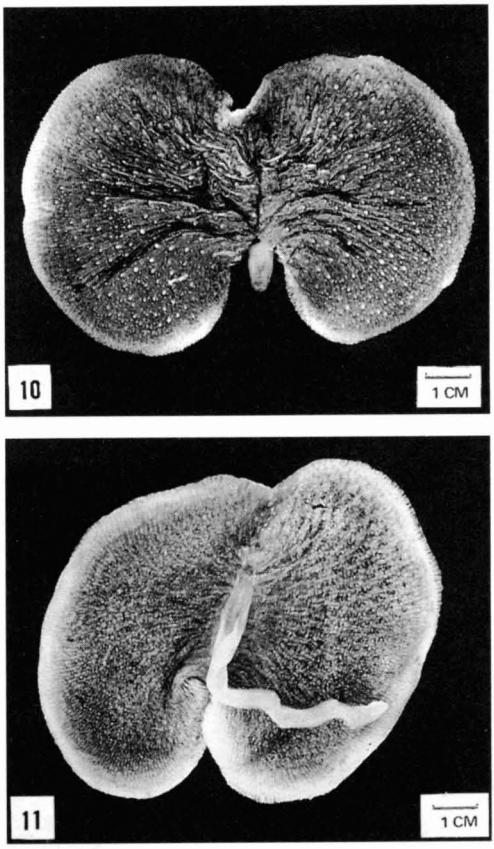
Material studied
Three campaigns: BIP "Walter Hertwig", 1978, est. 506, 41°35'S 57°53'W, depth 91-92 m; st. 531, 45°59'S 59°57'W, depth 580-540 m; st. 533, 45°54'S 59°43'W, depth 900 m; st. 540, 45°46'S 65°34'S, depth 80-82 m; st. 560, 50°42'S 67°54'W, depth 82-85 m; st. 575, 50°46'S 56°01'W, depth 770 m; st. 584, 54°18'S 56°10'W, depth 450-560 m; st. 592, 54°34'S 61°59'W, depth 440 m; st. 595, 53°26'S 61°33'W, depth 620 m; Mauricio 0. Zamponi col. Campaign to Comodoro Rivadavia (Chubut, Argentine), 1938, Biraben col. Campaign to Comodoro Rivadavia (Chubut, Argentine), 1941, R. Obusbky col.

4. Description of the new species

Renilla octodentata n. sp. (figs. 10, 11)

Diagnosis
Kidney-shaped or bilobulate-shaped. Rhachis with two commissures, one typical of the genus related to the origin of the peduncle and the other placed in the opposite end (fig. 1). Relatively short peduncle which does not reach the edge of the rhachis. The autozooids and siphonozooids are placed, as in all the genus, on the dorsal part of the rhachis although it presents a dorsal tract lacking polyps. The autozooids have eight calicinal teeth and the siphonozooids are grouped between the autozooids in numbers from five, six or seven zooids. Length of the sclerites uniform in the whole colony (table 3; figs. 2, 3). Sclerites are violet on the upper surface of the rhachis and white in the ventral part and in the peduncle. Cnidocists found: holotrichous isorhiza.

Etymology
The epithet of the species makes reference to the existence of eight calicinal teeth in each autozooids.



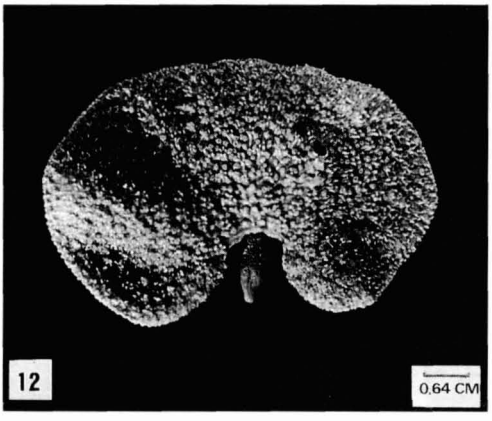
Figs. 10, 11. *R. octodentata* n. sp.: 10. Dorsal view; 11. Ventral view.

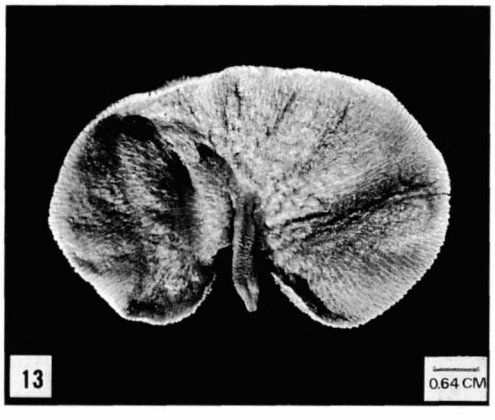
Material studied
Two campaigns: 44°48'S 65°30'W, depth 65 m; Holotype, V. 1988, BIP "Oca Balda", st. 37, Genzano col., Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" nº 25397; Paratype, V. 1988, BIP "Oca Balda", Genzano col., (Universidad Nacional de Mar del Plata, nº CP2); BIP "Oca Balda", V. 1988, st. 38, 44°48'S 65°33'W, depth 44 m; st. 42, 46°39'S 66°00'W; st. 43, 46°43'S 66°12'W, depth 79 m; st. 44, 46°51'S 66°25'W, depth 48 m; st. 48, 46°39'S 66°37'W, depth 85 m; st. 59, 46°10'S 66°39'W, depth 91 m. Campaign to Comodoro Rivadavia, 1984, 46°00'S 67°00'W, depth 25 m.

Renilla musaica n. sp. (figs. 12, 13)

Diagnosis

The rhachis is kidney-shaped or horseshoe-shaped, the latter with an extremely wide hilum (fig. 1). Relatively short peduncle. Autozooids and siphonozooids placed on the whole dorsal region of the rhachis. The medium dorsal tract free of zooids is lacking. Autozooids with five calicinal teeth. Sclerites of the peduncle short and wide, those of the rhachis much longer and thin (table 4, figs. 8, 9). Sclerites of intense violet colour. Cnidoscists found: holotrichous macrobasic eurytele (exclusive of Hydrozoa) and microbasic amastigophore.





Figs. 12, 13. *R. musaica* n. sp.: 12. Dorsal view; 13. Ventral view.

Etymology

The epithet of the species derives from Greek and means "inherent to the muses". It is an obsolete adjective of the word "mosaic" and it is applied to works incrusted with stones or glass of different colours and types. This species has a combination of characteristics of the other species of the genus *Renilla*, which is reflected on the epithet.

Material studied

Three campaigns: 39°59'S, 56°16'W, depth 100-200 m, Holotype, II. 1955, Vessel "Presidente Mitre", Caride col. Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" nº 8528; Paratype, II. 1955, Vessel "Presidente Mitre", Caride col. (Universidad Nacional de Mar del Plata, nº CP3). Vessel "Undine", VII. 1925, 35°08'S 52°35'W, Cap. C. Alexanderson col. Vessel "Bahía Blanca", VIII. 1965, 34°57'S 54°33'W, A. Nani col.

5. Recognition key to species of genus *Renilla*

1. With dorsal tract almost free of polyps 2
- Without dorsal tract almost free of polyps . . .3
2. Autozooids with seven calicinal teeth . . . . . *R. reniformis*
- Autozooids with five calicinal teeth . . . . . *R. köllikeri*
- Autozooids with eight calicinal teeth . . . . . *R. octodentata* n. sp.
3. Sclerites short and wide in the peduncle and long and thin in the rhachis . . . . . *R. musaica* n. sp.
- Sclerites as long in the peduncle as in the rhachis . . . . . *R. muelleri*

6. Different shapes of rhachis of the genus *Renilla*

The shape of the rhachis of the species of the genus *Renilla* is variable; nevertheless, there are certain ones which may facilitate the identification of more than one taxa. For example, bilobulate-shape is exclusive of *R.*

octodentata, or heart-shape of *R. reniformis*.

Figure 1 shows all shapes present in the genus and specifies which species present it.

7. Geographic and bathymetric distribution

According to DEICHMANN (1936), the genus RENILLA is endemic to America and it is distributed on both coasts of the continent. In the Sub-Antarctic region, four species of different bathymetric distribution have been found. Bearing in mind the classification made by ZAMPONI & ACUÑA (1991) of actiniarians of the Magellanic province, it is convenient to group the species by depth: a. Circalittoral species (*Renilla muelleri*, *R. octodentata* and *R. musaica*); b. Circalittoral-bathyal species (*R. reniformis*).

Once they are grouped (fig. 14), it is necessary to analyze each species separately because their bathymetry varies considerably.

R. muelleri has a littoral distribution that extends from 9 to 150 m of depth. It can generally be found in the external sector of the Río de la Plata estuary (KÖLLIKER, 1880) (fig. 15) which indicates that it is eurihaline. This agrees with Urien (1972 in COUSSEAU, 1985), which indicates that this zone is influenced by the flow of fresh water coming from the middle and internal sectors of the river and by marine water coming from the maritime front (fig. 16).

R. octodentata is a littoral species (depth 25-91 m) but limited to the marine environment (fig. 15) and found in the Gulf of San Jorge, Camarones Bay and Port Deseado.

R. musaica is a littoral species which extends up to the continental slope (depth 200 m). It is not restricted to the marine environment since it has been found on maritime front of La Plata River, where there is a strong influence of the river. For this reason it could be an eurihaline species (fig. 16).

R. reniformis has a wide distribution which extends from the littoral (80-82 m) up to 900 m of depth (fig. 15).

In the Sub-Antarctic region, the species of the genus *Renilla* are distributed in the biogeographic Bonaerense or Argentine province and Magellanic or Patagonian province. The first one includes *R. muelleri* and *R. musaica*, while the Magellanic province has all the species studied. *R. reniformis* has an oceanic distribution as well and is found in external sectors of the continental shelf.

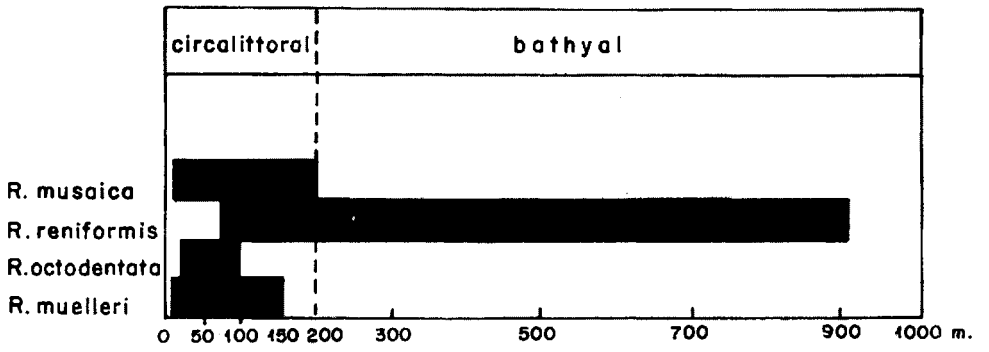


Fig. 14. Bathymetrical distribution of the species belonging to the genus *Renilla* from SW Atlantic Ocean.

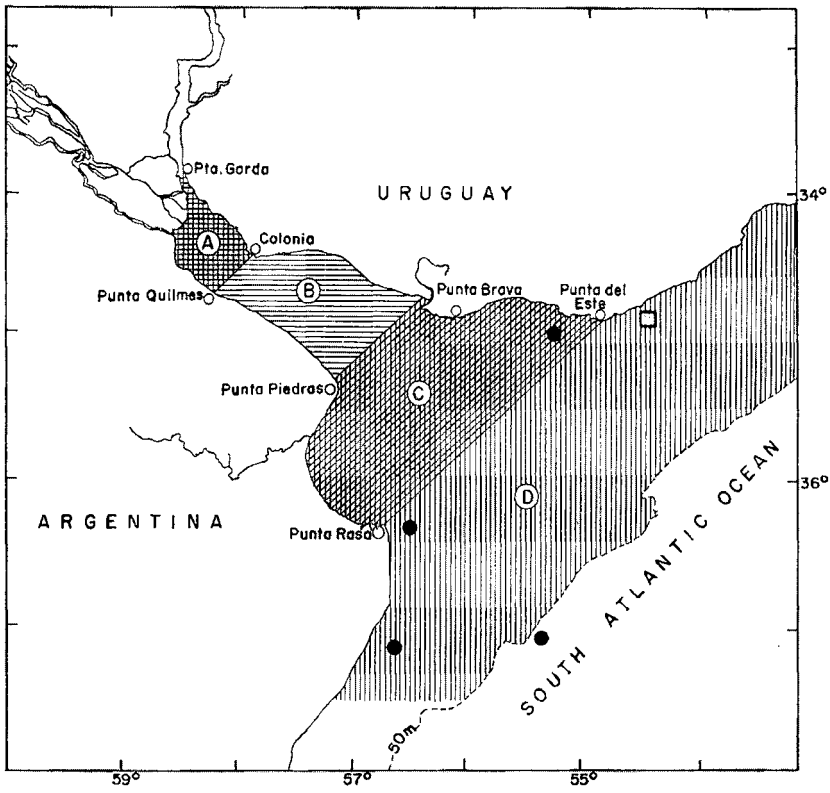


Fig. 15. Distribution of the genus *Renilla* in the external sector and in the maritime front of Río de la Plata estuary. ● *R. muelleri*; □ *R. musaica*. A. Internal sector; B. Middle sector; C. external sector; D. Maritime front. (Drawn from COUSSEAU, 1985).

DISCUSSION

The genus *Renilla* includes *Renilla muelleri* Kölliker, 1872; *R. reniformis* (Pallas, 1766); *R. köllikeri* (Pfeffer, 1886); *R. octodentata* n. sp. and *R. musaica* n. sp.

The analysis of the constitution of the cnidae, introduces new data in all species. The cnidocists which have been found are microbasic amastigophore, holotrichous isorhiza, atrichous isorhiza and holotrichous macrobasic eurytele. Their existence is controversial because it has always been held that Pennatulacea had monocnidae (atrichous isorhiza) (WATERMAN, 1950; MARISCAL, 1974; IVESTER, 1977). Later on, MARISCAL (1979), FAUTIN & MARISCAL (1991) sustained that the Octocorallia had more than one type of nematocist and, in coincidence, it was verified the existence of more than one type of cnidocist in genus *Renilla*. This verification is sustained by the finding of cnidocist microbasic mastigophore in *Pennatula argentina* by ACUÑA & ZAMPONI (1992).

Contrary to MARISCAL (1974), the existence of cnidocists such as macrobasic mastigophore and holotrichous macrobasic eurytele in the genus *Renilla* show that they are not exclusive to the Hydrozoa class. The presence of cnidocists has not diagnostic

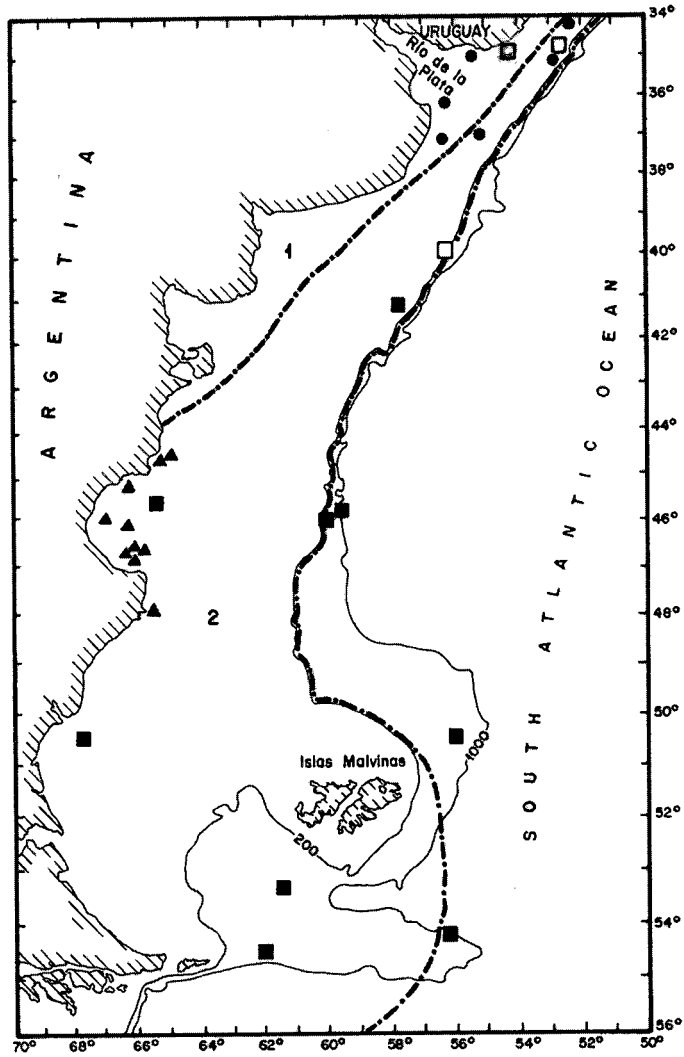


Fig. 16. Distribution of the genus *Renilla* in SW Atlantic Ocean: ● *R. muelleri*; □ *R. musaica*; ▲ *R. octodentata*; ■ *R. reniformis*. 1. Biogeographic Bonaerense or Argentine province; 2. Biogeographic Magellanic or Patagonian province. (Drawn from BOSCHI, 1976).

value because they are small and not important in number.

This study allows some considerations on the distribution of the genus *Renilla*. This genus does not include only littoral forms as stated by DEICHMANN (1936) and TIXIER-DURIVAULT (1987) since specimens of *R. reniformis* have been found at 900 m of depth, forming a circalittoral-bathyal species.

The findings of *Renilla* specimens in the Sub-Antarctic region proves that the distribution suggested by BROCH (1958) is a continuous one along the coasts of South-America, supporting the criterion that the genus *Renilla* is endemic to America.

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