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## ON A NEW SPECIES OF *SALMACINA* CLAPARÈDE, 1870 (POLYCHAETA: SERPULIDAE) FROM SÃO PAULO STATE, BRAZIL

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### ABSTRACT

A new species of *Salmacina* Claparède, 1870, herein described, was found in dense aggregations on the coral *Mussismilia hispida* (Verrill, 1868). *Salmacina ceciliae* n. sp. is characterised by rounded enlarged cells located subdistally on the radioles, distally on the pinnulae, and, in most of the specimens, many eyespots are present in the distal third of radioles and pinnulae. Comparisons between *S. ceciliae* and the other species of the genus are provided.

### INTRODUCTION

The taxonomy of the similar genera *Filograna* Berkeley, 1835 and *Salmacina* Claparède, 1870 is difficult and confused. Traditionally, these nominal genera have been distinguished by the presence of a pair of opercula in *Filograna*, absent in *Salmacina*, although radiolar tips in *Salmacina* may be swollen (e.g., Fauvel, 1927). Some authors found operculate and non-operculate specimens within the same colony (McIntosh, 1919; Faulkner, 1929; Day, 1955) and stated that presence/absence of an operculum should be considered as an ecological adaptation, rather than as a taxonomic character of sufficient importance to distinguish between two genera. In consequence, the genera have been synonymized by several authors (McIntosh, 1919; Day, 1955, 1967;

Zibrowius, 1968, 1973; Uchida, 1978), even to the extent that some (e.g., McIntosh, 1923) recognised only a single species, '*Filograna implexa*'. This taxon has since been reported from all over the world, from shallow (e.g. Faulkner, 1929: 0-15 m) to considerable depths (e.g., Rosenfeldt, 1982b: 603 m). From both biogeographical and ecological points of view, it is hardly likely that a species inhabiting the boreal European shelf (type locality of *F. implexa*, Weymouth, U.K.) would occur in tropical regions, or in bathyal depths.

Contrary to McIntosh (1923), Fauvel (1927: 375-377) and Rioja (1931: 436-438) considered that three species could be distinguished in the Mediterranean/Atlantic, the operculate *Filograna implexa* Berkeley, 1835, and the non-operculate *Salmacina dysteri* (Huxley, 1855) and *S. incrustans* Claparède, 1870, the latter two taxa only distin-

guished by small differences in their collar chaetae. In a detailed study, Gee (1963) gave some consistent differences between operculate and non-operculate populations from the U.K., but placed both forms within the genus *Filograna*. In the last decades, sibling species were described in various polychaete genera. In this light, McIntosh (1919) observations on *Filograna* make worthwhile reading and even might suggest that a number of sibling species may be present. He was unable to find a consistent correlation between the presence of prostomial ocelli and operculum in this species complex. However, Ten Hove & Pantus (1985: 433) consistently found distinct ocelli in the prostomial area of operculate specimens (traditionally, '*Filograna implexa*') from Marseille, and no trace of prostomial pigment cells in non-operculate specimens, '*Salmacina incrustans*' from the same area (20 specimens in each group). Moreover, this character corresponded with small but consistent differences in collar chaetae, as claimed by Gee, 1963 (Ten Hove & Pantus, unpublished). Vannini (1975), studying asexual reproduction in two Mediterranean species of *Salmacina*, gave an indication that clonal differences may be present within that taxon, and showed a correlation between number of thoracic chaetigers of parent and offspring. Knight-Jones (1990) reported that in non-operculate forms (*Salmacina*) from the U.K. the rhachis of the radiole shows "paired scalloped 'ridges' with ca. 13 pairs of tightly packed lenticulate units", lacking in operculate forms (*Filograna*) from that area. It is not clear whether or not this is a constant character; review of material from Marseille was not conclusive, although some non-operculate specimens indeed showed lenticulate units. However, in an analysis of non-operculate eastern Mediterranean populations, Ben-Eliahu & Fiege (1996) reported lenticular radiolar ocelli present in most individuals as in Knight-Jones, 1990 (lacking in one of the six populations), all the specimens lacked traces of prostomial ocelli (as in Ten Hove & Pantus, 1985). Gee (1963) used small, but in his eyes characteristic differences in morphology of collar chaetae to distinguish between the operculate and non-operculate taxa. Nishi (1993) similarly utilized chaetal structure to discriminate between four taxa (in Japan): one species of '*Filograna*' with short teeth

on the fin of the collar chaetae, decreasing in size towards the base of the fin (i.e., increasing in size distally), and three species of '*Salmacina*' with coarser teeth distally, and shorter ones (denticles) proximally. However, all of Nishi's material was non-operculate, thus the nominal Japanese *Filograna implexa* is most probably not the same as the European form, if indeed differences in collar chaetae justify the distinction of two genera.

Other characters that have been used to separate the taxa are: (1) depth: *Salmacina* occurs littorally and *Filograna* sublittorally (Gee, 1963; Day, 1955); (2) reproduction: *Salmacina* is reported to be hermaphroditic and *Filograna* dioecious (Saint-Joseph, 1894; Fauvel, 1927); (3) radiolar tips: swollen in *Salmacina*, and gently tapering in *Filograna* (Gee, 1963); (4) shape of the colonies: encrusting (in *Salmacina dysteri*) versus woven, net-like masses (in *Filograna implexa*). However, most of these characters are not really reliable, as they may express ecological adaptations, regional variations, and may be an equivocal interpretation of data (Gee, 1963), or even may reflect seasonal changes.

A further reason to synonymize *Salmacina* with *Filograna* may have been that in some serpulid genera specimens may shed their opercula when killed (Schochet 1973; Ten Hove 1994), enfeebling the value of the character state 'operculate'. Presently, it is not known if *Filograna implexa* indeed sheds its opercula easily.

Operculate forms are further illustrated by Saint-Joseph (1894, fig. 367) from Dinard, N.W. France, by Wollebaek (1912, pl. XL) from various dredgings in Norway and by Bianchi (1981, fig. 51), from Italy. They have only rarely been reported from outside Europe, by Moore (1923, *Filograna tribranchiata* [S. California], however with swollen radiolar tips according to Berkeley & Berkeley, 1952, and placed in the genus *Salmacina* by Nishi, 1993); by Hartman (1944, pl. 54 fig. 7, New England, *F. implexa*), by Day (1955, 1967, fig. 38.7f, S. Africa, *F. implexa*), and by Rullier (1972, New Caledonia; *F. implexa*). Unfortunately, after McIntosh (1923) many authors did not even mention if their '*Filograna*' material was operculate or not, and if they did - e.g., a 'globular' operculum (Rullier, 1972)- it is questionable whether this is the obliquely funnel- to spoon-shaped operculum typical for *Filograna implexa* (the figures in Fauvel,

1927 and Rioja, 1931 are accurate), or whether it is simply a swollen radiolar tip often occurring in *Salmacina*.

Doubtless, part of the confusion is due to the worms' small size; and to the criteria used for identification being near the limits of the light-microscope. It emerges that many identifications in the literature cannot be trusted. In conclusion, the taxonomy of the group is very confused, although there is evidence that operculate and non-operculate forms belong to different taxa. Pending a full-scale revision, outside the scope of present paper, it may be wise to use local names (if available) for species of the *Filograna/Salmacina*-complex. In the present paper, '*Salmacina*' denotes non-operculate specimens.

In this paper, we describe a new species of *Salmacina* found in dense aggregations, laterally at the bases or in dead areas of colonies of the hemispheric stony coral *Mussismilia hispida* (Verrill, 1868) in two coastal islands of São Paulo State, Brazil. Since the purpose of the original study was an analysis of the polychaetes, including endolithic forms, associated with *Mussismilia*, samples were de-calcified and the resulting sediment filtered to obtain material; consequently there is no information on tubes or shape of the colonies.

## MATERIALS AND METHODS

The serpulids come from 12 coral heads (140-950 ml in size) of the massive hemispherical *Mussismilia hispida* (Verrill, 1868), collected at depths between three to ten metres on Laje de Santos (24°19'S 46°11'W) and Ilha dos Alcatrazes (26°06'S 45°42'W), São Paulo State (17 March, 1996 and 4 December, 1996, respectively). In both localities the rocky substrate is covered by *M. hispida*, along with large colonies of the zoantharians *Palythoa* and *Zoanthus*, and some algal tufts. Corals were fixed in formalin (4%) and later de-calcified entirely with formalin (5%)-formic acid (10%) solution; the resulting sediment was filtered and stored in 70% ethanol. Sorted polychaetes were mounted in glycerin. Observations and measurements were made using interference contrast optics (Nomarsky), and drawings with a 'camera lucida' (magnifications 200-1000x). Scanning electron micrographs (34 specimens) were made

at the Laboratório de Microscopia Eletrônica do Instituto de Biociências da Universidade de São Paulo (DSM 940; Figs. 2C and 2F), and Laboratório de Microscopia Eletrônica, Instituto de Biologia, Universidade Estadual de Campinas (JEOL 5800LV; Figs. 2D-E, 2G-H, and 3). Material was critical point dried, and covered with 25 nm gold. Types are deposited at Museu de História Natural, Instituto de Biologia, Universidade Estadual de Campinas (MHN-BPO 83/0-10) and the Zoological Museum Amsterdam (ZMA V. Pol. 4973).

## SYSTEMATICS

Genus *Salmacina* Claparède, 1870

***Salmacina ceciliae* n. sp.**

Figs. 1-3

**MATERIAL.** - Type series: Alcatrazes, colony nr. 8: holotype, MHN-BPO 83/0 (mounted); 15 paratypes: MHN-BPO 83/1-10 (five mounted, five in 70% ethanol), ZMA V. Pol. 4973 (five in ethanol). (About 150 more specimens were not studied in detail and not included in type series).

Other material: Alcatrazes (MHN, 100 specimens; ZMA V. Pol. 4975, three mounted); Laje de Santos: 64 specimens (61 MHN; three ZMA V. Pol. 4974.)

**DIAGNOSIS.** - Tube: unknown.

Branchial crown: without operculum. Four pairs of radioles, bearing several round enlarged cells subdistally, tips of radioles slender; pinnulae with enlarged cells positioned terminally (Figs. 1A-B, 2A-B). Ocelli on distal third of radiole and laterally disposed in two rows throughout length of pinnulae.

Collar and thoracic membranes: with two well-developed latero-dorsal lobes; medioventral lobe longer, tongue-like, blunt (Figs. 2C-D), 1/6 (holotype) to 1/4 of length of radioles. Thoracic membranes forming narrow apron across anterior abdomen (Fig. 2D).

Thorax: with six to nine chaetigers. Collar chaetae fin-and-blade and limbate. Fin-and-blade chaetae with denticulate blade well separated from fin, bearing many minute denticles proximally and larger teeth (at least eight) of different size and thickness, increasing in size distally (Figs. 1C; 2E-F). Second chaetiger with four limbate chaetae, subequal in size, like in collar bundle. Subsequent thoracic chaetigers with three types

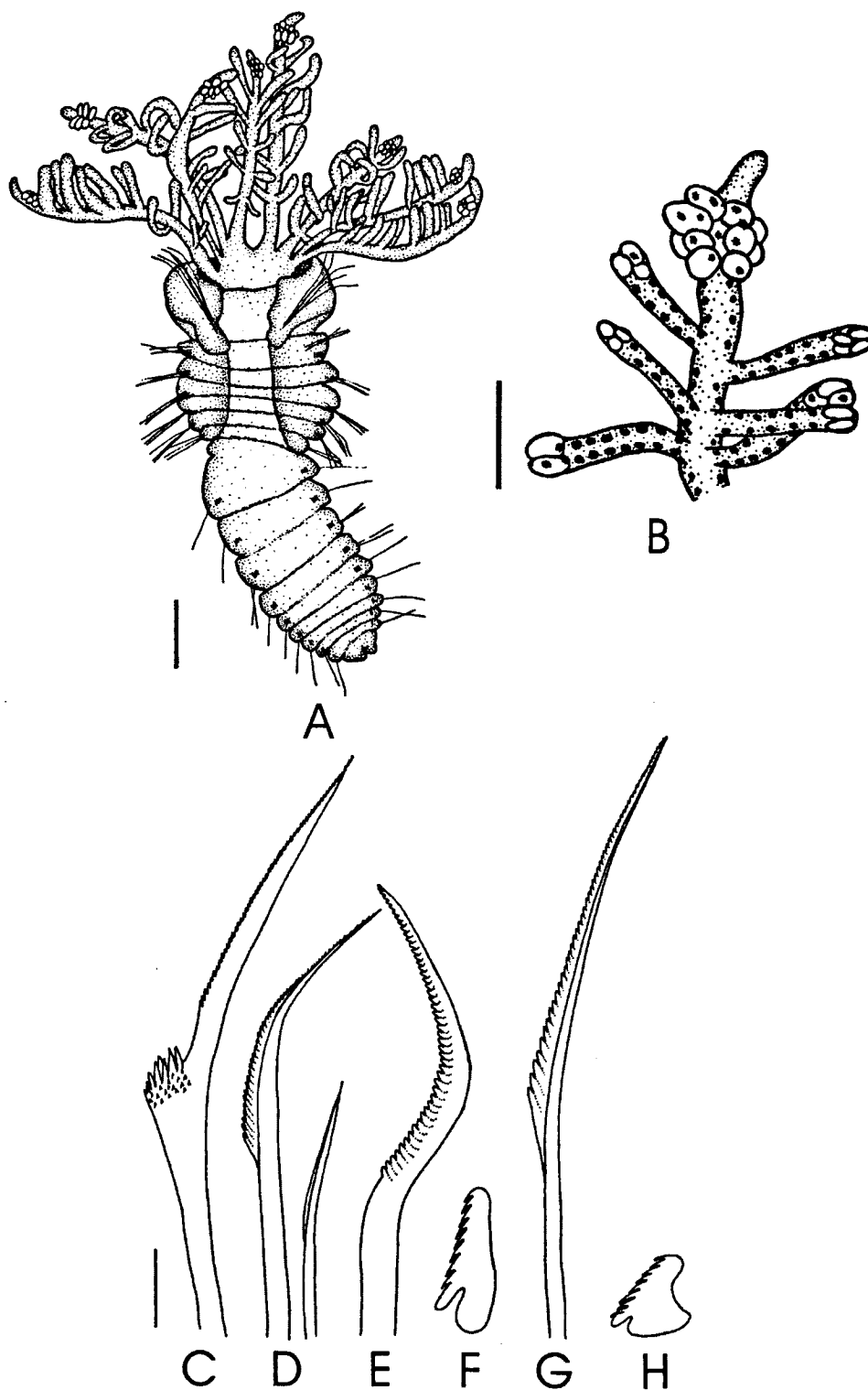


Fig. 1. *Salmacina ceciliae* n. sp. A, juvenile specimen, dorsal view. B, tip of radiole, showing subdistal enlarged cells on rhachis, located terminally on pinnulae; ocelli along rhachis and pinnulae. C, fin-and-blade chaeta. D, limbate chaetae. E, *Apomatus*-chaeta. F, thoracic uncinus. G, abdominal chaeta. H, abdominal uncinus (scale bars: A-B = 100 μm; C-H = 10 μm).

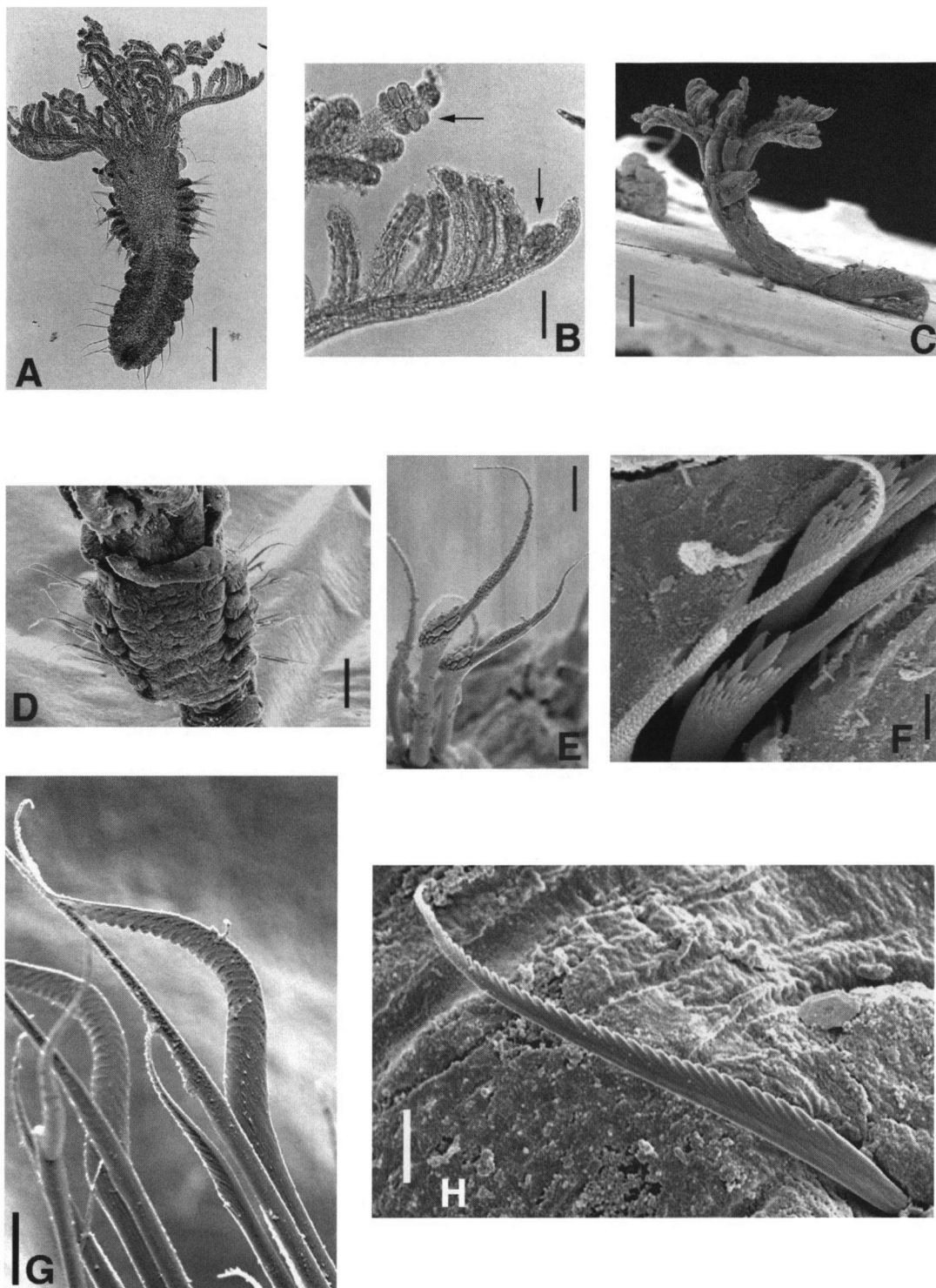


Fig. 2. *Salmacina ceciliae* n. sp. A, juvenile specimen. B, tip of radiole, arrows indicate subdistal enlarged cells. C, lateral view. D, thorax, ventral view. Note shape of collar, apron over anterior abdomen. E, collar chaetae. F, detail of collar bundle, capillary chaeta overlying the fin-and-blade chaetae. G, thoracic chaetae; chaetigers 6 and 7. H, abdominal neurochaeta. A and B: light microscope, C-H: SEM. All from type-locality, colony 8 (scale bars: A and C = 150  $\mu$ m; B = 70  $\mu$ m; C = 25  $\mu$ m; D = 10  $\mu$ m; E = 7.5  $\mu$ m; F = 4  $\mu$ m; G = 7  $\mu$ m; H = 5  $\mu$ m).

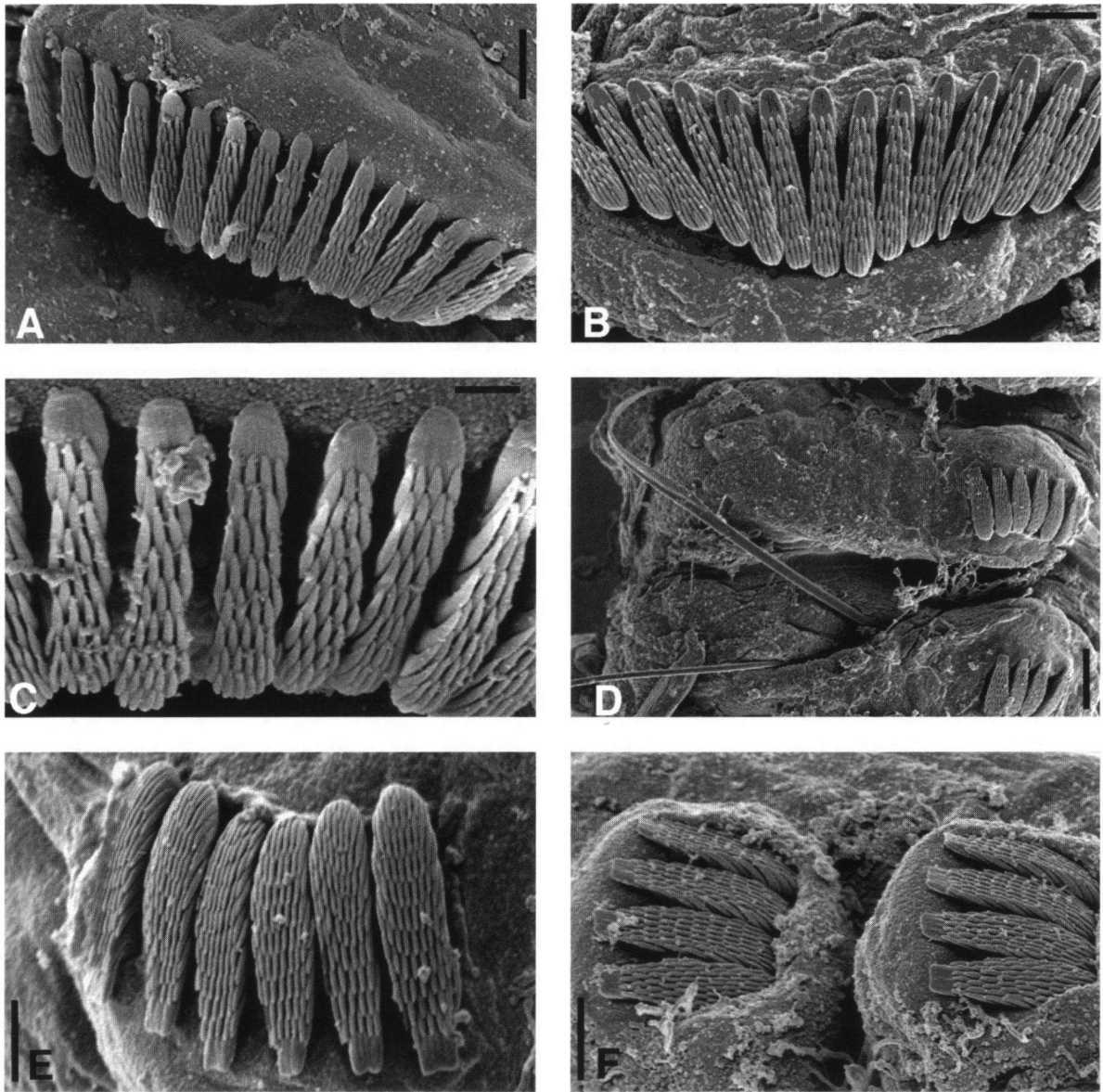


Fig. 3. *Salmacina ceciliae* n. sp. A, uncini, chaetiger 2. B, uncini, chaetiger 5. C, uncini, chaetiger 4. D, posterior abdominal parapodia. E, anterior abdominal uncini. F, posterior abdominal uncini. All from type-locality, colony 8 (scale bars: A = 6  $\mu$ m; B = 5  $\mu$ m; C = 2  $\mu$ m; D = 10  $\mu$ m; E = 3  $\mu$ m; F = 10  $\mu$ m).

of chaetae: long limbate (two to three), short limbate ('capillaries', one or two), and *Apomatus*-chaetae with blunt teeth along the blade (one or two) (Figs. 1D-E, 2G). Uncini present from chaetiger two, rasp-shaped, with eight to nine rows of teeth above thick, flat, rounded anterior peg; three to four teeth in row proximal to peg, increasing to five or six in middle row of uncinus (Figs. 1F, 3A-C).

Abdomen: with 7-26 segments. Anterior abdominal segments longer and inflated. One to two

capillary chaetae per torus, with narrow distal toothed zone (Figs. 1G, 2H, 3D; see discussion). Uncini shorter and broader than in thorax; about 10 rows of teeth above peg, five teeth in row proximal to peg, increasing to maximum of eight in middle row of uncinus (Figs. 1H, 2D-F).

Pygidium: rounded and bilobed (Figs. 1A, 2A).

Size: long and slender, 25-35 segments. Length 1-3.5 mm (including radioles, 0.3-0.7 mm); width about 0.2 mm (all specimens). Holotype 35 segments (including seven thoracic); length 3.0 mm

(radioles, 0.6 mm). Larger specimens incomplete.

**ETYMOLOGY.** - The specific name *ceciliae* is given in honour of Dr. Cecilia Amaral, a Brazilian polychaetologist.

**REMARKS.** - Variation: enlarged cells: the presence and number of enlarged cells on the pinnulae may be an ontogenetic character. Younger, shorter specimens have none or few enlarged cells; the character apparently becomes more evident with increasing size.

Ocelli: the presence of branchial ocelli is a variable character, probably ontogenetic as well. Although ocelli were found in most of the adults, and their development can be followed (as with the enlarged cells on the pinnulae), several adults without ocelli have been observed.

Uncini: the number of uncini per torus varies from one chaetiger to another. The length of uncini increases progressively towards the middle of the tori, however, the numbers of rows of teeth, and of teeth in each row are almost constant (Figs. 3A-C).

Anterior abdominal segments: the longer and more inflated anterior abdominal segments may be due to storage of gametes.

**TERMINOLOGY.** - Traditionally, the abdominal chaetae have been called 'geniculate' (e.g., Fauvel, 1927: 377; Rosenfeldt, 1979: 90). However, Rosenfeldt's figures of *Filograna implexa* and *Salmacina dysteri* clearly show these chaetae to be almost straight capillaries, with a distal zone of fairly coarse rounded teeth (Rosenfeldt, 1979, figs. 47c, g; 1982a, fig. 6e), as in the present material (Fig. 2H).

## DISCUSSION

To obtain an overview of characters in the taxa *Filograna* and *Salmacina*, we analysed descriptions of the nominal species listed in Table 1. Some of these taxa are considered to be synonymous (denoted by the symbol †). More available names may be 'hidden' as synonyms or under other generic names in older literature. Data are taken at face value from the literature, in taxa marked with an asterisk they are based upon observations by one of us (HAtH) and/or by

Plaia and Perkins (pers. comm.). 'Differences' in collar chaetae are given, even though they may reflect different observation techniques (even from a single person over the years), a different angle of viewing, or even a different quality of microscope (for instance, Grube, 1872 only had an available magnification of 300 x); see also accompanying notes to Table 1. The literature contains contradictory statements: Fauvel (1927) attributes many small denticles to the basal fin in *Filograna implexa* and *S. dysteri*, but four to six coarse teeth in *S. incrustans*. However, Gee (1963) agrees on uniform denticles in *S. dysteri*, but attributes larger and smaller fin teeth to *Filograna*. The structure of chaetae should be evaluated using scanning electron micrography.

## CONCLUSION

Table 2 and our comments once again illustrate the confused state of the taxonomy in *Salmacina*. Tabulated like this, it at once becomes apparent that *S. chilensis* is widely apart from all other nominal *Salmacina* in its high number of radioles. A closer look at the figure of its collar chaetae shows an arrangement of teeth and denticles in the fin, which is rather more reminiscent of *Protis* or *Chitinopoma*, than of *Salmacina*. The collar chaetae of the taxon *falklandica* also need closer examination.

Between us we have seen material from NW Europe, the Atlantic, Mediterranean, Florida, Caribbean, Brazil, Seychelles, Indonesia and Australia. Although we did not study most material in detail, we never noticed specimens with subdistal enlarged cells; generally these are to be found distally (see also Huxley, 1885, fig. 5; Saint-Joseph, 1894, fig. 376; Fauvel, 1927, fig. 129d; Faulkner, 1929, fig. 1A; Gee, 1963, fig. 1c; Ten Hove & Wolf, 1984, fig. 55-2a) or not present at all (Haswell, 1885, Pl. 33 fig. 7).

In comparison with previously described species, *Salmacina ceciliae* n. sp. is well characterised by the presence of round enlarged cells subdistally on radioles, and distally on pinnulae, together with numerous eyespots along the distal third of radioles and pinnulae, in most of the specimens. Remaining characters seem not too much different from the other nominal species reported from the tropical W. Atlantic, *S. amph-*



Table 1. Taxa analysed. First locality is type-locality. Taxa considered to be synonyms are denoted by ‡.

Taxon	Description	Localities and attributions
‡ <i>Filograna berkeleyi</i> † <sup>1</sup>	Quatrefages, 1866	St. Vaast, Atlantic France; see <i>F. implexa</i>
<i>Filograna implexa</i> <sup>2</sup>	M. Berkeley, 1835	Weymouth; cold temperate-subtropical Atlantic, Mediterranean
‡ <i>Filograna schleideni</i> † <sup>3</sup>	E.O. Schmidt, 1848	Faroe Islands; see <i>F. implexa</i>
‡ <i>Salmacina aedificatrix</i> † <sup>4</sup>	Claparède, 1870	Naples, Italy; Black Sea, Madeira, Amboina; see <i>S. dysteri</i>
<i>Salmacina amphidentata</i> <sup>5</sup>	Jones, 1962	Port Royal, Jamaica; Caribbean; ? S.China, Japan
<i>Salmacina australis</i>	Haswell, 1885	Port Jackson; temperate-cold S part of Australia, New Zealand
<i>Salmacina chilensis</i>	Gallardo, 1969	off Punta Patache, N. Chile; bathyal
<i>Salmacina dysteri</i>	(Huxley, 1855)	Tenby, Scotland; 'worldwide', probably complex of species
<i>Salmacina dysteri falklandica</i> <sup>6</sup>	Monro, 1930	East Falkland Island
<i>Salmacina huxleyi</i> <sup>7</sup>	(Ehlers, 1887)	Tortugas, Loggerhead Key, Florida; West Indies
<i>Salmacina incrustans</i>	Claparède, 1870	Naples, Italy; 'worldwide', probably complex of species
<i>Salmacina piranga</i> <sup>8</sup>	(Grube, 1872)	Estreite, Desterro, Brazil
<i>Salmacina setosa</i> <sup>9</sup>	Langerhans, 1884	Madeira; W. off England, bathyal
<i>Salmacina?</i> <i>tribranchiata</i> <sup>10</sup>	(Moore, 1923)	Santa Rosa Island, S. California; British Colombia, ?Japan

Notes on Table 1.

- Filograna berkeleyi* was figured with two club-shaped opercula, in the same position as the two spoon-shaped and very thin-walled opercula of *F. implexa*. Disregarding this ostensible difference, the first taxon generally is regarded to be a synonym of the latter (e.g. Fauvel, 1927).
- The type-locality of *F. implexa* is Weymouth, United Kingdom. The taxon shows two spoon-shaped opercula. Such material has been reported only from the cold-temperate to warm-temperate Atlantic and Mediterranean. Other records, in our opinion, are doubtful.
- F. schleideni* is described as non-operculate and operculate. This may be a correct observation, due to stage of development after division, but it is possible that Schmidt overlooked the very thin and transparent opercula in his fresh material. Also, he may have been dealing with a mixed sample. Generally the taxon has been synonymized with *F. implexa* (e.g., Saint-Joseph, 1894).
- S. aedificatrix* usually has been synonymised with *S. dysteri* (e.g., Fauvel, 1909).
- G. Plaia (pers. comm.) compared the type material of *S. amphidentata* (American Museum Natural History 3615, 3616) with that of *S. huxleyi*, and considers both taxa to be the same, apart from a slight difference in size. These observations have not been published, thus, we treat both taxa separately.
- According to Monro (1930: 213), this taxon agrees with the common *S. dysteri*, except in the collar chaetae, which do not show the typical gap. Monro's description is lacking detail.
- Described as *Filograna huxleyi*, this taxon is non-operculate, thus transferred to *Salmacina* (Types, Museum of Comparative Zoology, Harvard 739).
- Salmacina setosa* was reported from "corals from greater depths" (Types, Natural History Museum, Vienna 3813).
- In 1872, Grube described a new species of *Protula*, *P. piranga*, which to our knowledge went unnoticed in the subsequent literature. Therefore we give a fairly literal translation of the relevant text :  
(: 51) "The *Protula* (*Pr. piranga*), whose tubes form large cushions [clumps] in the vicinity of Estreite near Desterro, is very small and of blood-red coloration, [the worm] however, has green blood. The length of the spirit-specimens does not surpass 3 mm, of which with small variations one third is made up by the branchiae, one third by the anterior body half –by two outstanding skinfolds [of] winged [appearance]– and one third by the posterior body half. The skinfolds [=thoracic membranes] are not so large, that they, folded over the back, cover each other. The branchial (: 52) leaves are very short and bear both four with about 10 blunt short thick radii feathered equally long radioles with short thick apex. [The branchial bases are very short and both have four feathered radioles of equal length, each with about 10 blunt thick spinules, and with a short thick tip]. In the anterior half of the body lie at both sides eight bundles of chaetae, the first with about four oblique-chisel-shaped, geniculate chaetae; the subsequent [bundles] have about five straight, not limbate [chaetae]. In the abdomen can be counted at most 27 pairs far-extending even finer chaetae, in bundles of two to four. The uncini, in rows of about 30 each, are so small, that with a 300fold magnification one can just see, that they are comb-shaped and have about 8 small teeth (at least in the thoracic ones). The extraordinary narrow –not even with a lumen of 1/2 mm– tubes build an accumulation of partially single, partially and mostly bundle-like arranged, interwoven [tubes]; the single tubes, which can be trailed for a length of at most 7 mm, are very fragile and have smooth stretches, as well as densely annulated stretches." A study of the type material (Zoologisches Museum Berlin Q5356), by HAtH and by Gayle Plaia, indicates that the taxon should be placed in the genus *Salmacina*, but *S. piranga* seems to be different from *S. huxleyi* by its narrower radiole tips.
- Originally described as *Filograna tribranchiata*, the single spoon-shaped operculum mentioned by Moore (1923) might just be the same spoon-shaped tip with inflated cells figured by Ehlers (1887, pl. 56 fig. 5) for *S. huxleyi*, and thus completely different from the typical *Filograna* opercula. This hypothesis seems to be corroborated by Berkeley & Berkeley (1952), who mention bare swollen tips for the taxon; thus, we tentatively transferred it to *Salmacina*. The types are in the United States National Museum (17298) and Academy of Natural Sciences, Philadelphia (3309), fide Loi (1980).



Table 2. Tabulation of *Salmacina* characters; \* denotes taxa of which topotypical material has been studied. Thor. = thoracic. Pros. = prostomial.

Nominal taxon	Pairs of radioles	Radiole tip <sup>1</sup>	Pinnules with enlarged cells?	Teeth in basal fin of collar chaetae <sup>2</sup>	Gap	Thor. uncini	Pros. eyes	No. of abd.
* <i>S. amphidentata</i>	4	slightly inflated distally		regularly increasing in size distally <sup>4</sup>	+	8 rows, 4 teeth (3-5) <sup>5</sup>		17(-33) <sup>6</sup>
* <i>S. australis</i>	4	not inflated		small denticles only	-?		-	19
<i>S. chilensis</i>	10	not inflated		4-5 large teeth and many small denticles	+	8 rows, 2 teeth		36
* <i>S. dysteri</i>	4	inflated distally	? proximally	many small denticles	+	7 rows, 2-3 teeth	+	27-50 <sup>7</sup>
<i>S. d. falklandica</i>	4			?regularly decreasing in size distally? <sup>8</sup>	-			
* <i>S. huxleyi</i>	4	inflated distally		regularly increasing in size distally	+?	? 9 rows	-	20
* <i>S. incrustans</i>	4	inflated distally	proximally	4-6 large teeth	+?	many teeth	+	40
* <i>S. piranga</i>	4	hardly inflated distally		6 large teeth and many small denticles to regularly increasing distally	+	9 rows, 3-5 teeth		27
* <i>S. setosa</i>	4	? inflated distally		7 large teeth?	+ <sup>9</sup>	6-7 rows, 1-3 teeth <sup>10</sup>	+	20(-34) <sup>11</sup>
<i>S. tribranchiata</i>	3	inflated distally		"coarsely toothed"	+	8-9 rows, 3-4 teeth		26
* <i>S. ceciliae</i> n.sp.	4	inflated subdistally	distally	8 large teeth and many small denticles	+	8-9 rows, 3-4(6) teeth		28

Notes on table 2.

1. Over the years, one of us (HAtH) has seen a number of specimens from the Gulf of California, Florida, the Netherlands Antilles, Puerto Rico, the Seychelles, Indonesia and Australia. All were non-operculate. Although not studied in detail, distally inflated tips do not seem to be a very robust character because in some specimens inflated tips may occur next to not inflated radioles. In a population of *Salmacina* spec. from Florida, G. Plaia (pers. comm.) found both subdistally and distally inflated radiole tips. However, the inflated cells are not nearly as large as in *S. ceciliae*. It seems unlikely that such large cells would have escaped attention of all previous authors.

2. As stated above, 'differences' in collar chaetae may reflect different observation techniques. Moreover, the variability of the character may be larger than sometimes assumed. Intraspecific variability has not been documented well. One of the paratypes of *Salmacina amphidentata* had both collar chaetae with four to six distinctly larger teeth, and all teeth gradually increasing in size! (G. Plaia, pers. comm.). The same holds for *Salmacina piranga* (T. Perkins, unpublished drawings). Based upon observations on the morphology of six to ten collar chaetae per taxon, Nishi (1993) made a case for the existence of four different taxa in Japan. However, Nishi's (1993) identifications may be debatable since he did not compare his material with types nor with topotypical material. One of us (HAtH), when presented with 20 unlabelled slides of collar chaetae, successfully attributed all to their correct taxon (operculate *F. implexa* versus non-operculate *S. incrustans*).

3. SEM observations by one of us (HAtH) on *Salmacina incrustans* from the Costa Brava (Spain) indicate that there may be some variability in uncini along the thorax: 2nd chaetiger with five rows of three to four teeth; 4th chaetiger with five to six rows of three to four teeth; last chaetiger (7th or 8th) with seven rows of three to four teeth. On the other hand, the operculate *Filograna implexa* (Orkney Islands) showed consistently seven to eight rows of two to three teeth along the entire thorax.

4. Jones (1962) mentions three types of collar chaetae: fin-and-blade, limbate, and almost capillary with a short proximal limba. To our knowledge, this is the only time that three types of chaetae have been mentioned; he may have observed a not yet fully formed chaeta, as supposed by Uchida (1978: 13) as well. This character should be checked with SEM.

5. SEM photographs by B. Pernet (pers. comm.) from Fort Pierce, Florida show eight to nine rows of three to five teeth.

6. The original description of *S. amphidentata* noted 17 abdominal chaetigers, but B. Pernet (in litt.) mentions 33.

7. The original description of *S. dysteri* shows about 43 abdominal chaetigers, Fauvel (1927) mentions 50, Gee (1963) 27.

8. Collar chaetae of *S. dysteri falklandica* were figured as having a fin with a range of teeth decreasing in size distally, merging with blade without a gap. This is unlike any other known arrangement in *Salmacina*.

9. Collar chaetae in *S. setosa* figured by Langerhans as without gap between fin-and-blade, but a gap is present in topotypical material if Ten Hove & Aarts' unpublished identification is correct.

10. The thoracic uncini in *S. setosa* showed an unusual variability in number of rows of teeth; it is possible to find in the same torus next to each other a tooth formula 1111111P and 323322P or 123222P (P symbolizing the anterior peg; Ten Hove & Aarts, unpublished).

11. Original description of *S. setosa* mentions 20 abdominal chaetigers (three achaetigerous), topotypical material showed 34.

*dentata*, *huxleyi* and *piranga*. With its description as a new species, we hope to stimulate others to actually look at material again, and search for new and better characters.

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## REFERENCES

- BEN-ELIAHU, M.N., & D. FIEGE, 1996. Serpulid tube-worms (Annelida: Polychaeta) of the central and eastern Mediterranean with particular attention to the Levant Basin. *Senckenberg. marit.* **28** (1/3): 1-51.
- BERKELEY, E. & C. BERKELEY, 1952. Polychaeta Sedentaria. *Can. Pacif. Fauna* **9**, Annelida **9b** (2) Toronto: 1-139.
- BERKELEY, M.J., 1835. Observations upon the *Dentalium subulatum* of Deshayes. *Zool. J. Lond.* **5** (20): 424-427.
- BIANCHI, C. N., 1981. Policheti serpuloidi. Guide per il riconoscimento delle specie animali delle acque lagunari e costiere italiane. C.N.R., AQ/1/96, **5**: 1-187.
- CLAPARÈDE, E., 1870. Les annélides chétopodes du Golfe de Naples. Seconde partie. *Mém. Soc. phys. Hist. nat. Genève* **20** (1): 1-225.
- DAY, J. H., 1955. The Polychaeta of South Africa. 3. Sedentary species from Cape shores and estuaries. *J. Linn. Soc., Zoology* **42**: 407-452.
- DAY, J. H., 1967. A monograph on the Polychaeta of southern Africa. Part 2. Sedentaria. London, Brit. Mus. nat. Hist.: 459-878.
- EHLERS, E., 1887. Report on the Annelids. Reports on the results of dredging, under the direction of L.F. Pourtalès, during the years 1868-1870, and of Alexander Agassiz, in the Gulf of Mexico, and in the Caribbean Sea, in the U.S. Coast Survey Steamer 'Blake'. *Mem. Mus. comp. Zool. Harv.* **15**: 1-335.
- FAULKNER, G. H., 1929. The anatomy and the histology of bud-formation in the serpulid *Filograna implexa*, together with some cytological observations on the nuclei of the neoblasts. *J. Linn. Soc., Zoology* **37**: 109-189.
- FAUVEL, P., 1909. Deuxième note préliminaire sur les Polychètes provenant des campagnes de l'Hirondelle et de la Princesse-Alice, ou déposées dans le Musée Océanographique de Monaco. *Bull. Inst. océanogr. Monaco* **142**: 1-76.
- FAUVEL, P., 1927. Polychètes Sédentaires. Addenda aux Errantes, Archiannélides, Myzostomaires. *Faune de France* **16**. Paris, Le Chevalier: 1-494.
- GALLARDO, V. A., 1969. Description of *Salmacina chilensis* n. sp. (Polychaeta, Serpulidae) from northern Chile. *Boln. Soc. Biol. Concepción* **41**: 9-12.
- GEE, J. M., 1963. On the taxonomy and distribution in South Wales of *Filograna*, *Hydroides* and *Mercierella* (Polychaeta: Serpulidae). *Ann. Mag. nat. Hist. (13)* **6**: 705-715.
- GRUBE, A.E., 1872. Zur kritischen Übersicht der bisher beschriebenen Terebellen und über *Terebellides anguicomus* und einige Serpulaceen. *Jber. Schles. Ges. vaterl. Cultur* **49**: 48-53.
- HARTMAN, O., 1944. New England Annelida. Part 2. Including the unpublished plates by Verrill with reconstructed captions. *Bull. Am. Mus. nat. Hist.* **82**: 327-344.
- HASWELL, W.A., 1885. The marine annelides of the order Serpulea. Some observations on their anatomy, with the characteristics of the Australian species. *Proc. Linn. Soc. N.S.W.* **9** (3) [1884]: 649-675.
- HOVE, H.A. TEN, 1994. The dualistic relation between molluscs and serpulid tube-worms. In: COOMANS-EUSTATIA, M., R. MOOLENBEEK, W. LOS & P. PRINS (eds). *De horen en zijn echo*. Stichting Libri Antilliani, Zool. Mus. Amsterdam: 65-70.
- HOVE, H. A. TEN, & F.J. A. PANTUS, 1985. Distinguishing the genera *Apomatus* Philippi, 1844 and *Protula* Risso, 1826 (Polychaeta: Serpulidae), a further plea for a methodological approach to serpulid taxonomy. *Zool. Meded. Leiden* **59** (32): 419-437.
- HOVE, H. A. TEN, & P. S. WOLF, 1984. Family Serpulidae Johnston, 1865. In: UEBELACKER, J.M. & P. G. JOHNSON (eds). *Taxonomic Guide to the Polychaetes of the Northern Gulf of Mexico*. Final Report to the Minerals Management Service, contract 14-12-001-29091 Barry A. Vittor & Associates, Inc., Mobile, Alabama **7**, 55: 1-33.
- HUXLEY, T. A., 1855. On a hermaphrodite and fissiparous species of tubicolar annelid. *Edinb. New phil. J., n.s.* **1** (1): 113-129.

- JONES, M. L., 1962. On some polychaetous annelids from Jamaica, the West Indies. *Bull. Am. Mus. nat. Hist.* **124** (5): 169-212.
- KNIGHT-JONES, P., 1990. Serpulidae. In: HAYWARD, P.J. & J.S. RYLAND (eds). The marine fauna of the British Isles and North-West Europe. I. Introduction and Protozoans to Arthropods. Clarendon Press, Oxford: 280-286.
- LANGERHANS, P., 1884. Die Wurmfauna von Madeira. Pt. 3. *Z. wiss. Zool.* **40** (2): 247-285.
- LOI, T.-N., 1980. Catalogue of the types of polychaete species erected by J. Percy Moore. *Proc. Acad. nat. Sci. Philad.* **132**: 121-149.
- MCINTOSH, W.C., 1919. Notes from the Gatty Marine Laboratory, St. Andrews. No. XLII. 1. Preliminary studies on *Filograna*: a, historical; b, faunistic; c, structural; d, general. 2. On *Harmothoe watsoni*, M'I., and var. *H. marphysae*, M'I. *Ann. Mag. nat. Hist.* (9) **3**: 125-164.
- MCINTOSH, W.C., 1923. A monograph of the British marine annelids. 4, 2. Polychaeta - Sabellidae to Serpulidae. London, Ray Society: 251-538.
- MONRO, C.C.A., 1930. Polychaete worms. 'Discovery' Rep. Cambridge **2**: 1-222.
- MOORE, J.P., 1923. The polychaetous annelids dredged by the U.S.S. Albatros off the coast of southern California in 1904. Spionidae to Sabellariidae. *Proc. Acad. nat. Sci. Philad.* **75**: 179-259.
- NISHI, E., 1993. Notes on reproductive biology of some serpulid polychaetes at Sesoko Island, Okinawa, with brief accounts of setal morphology of three species of *Salmacina* and *Filograna implexa*. *Mar. Foul.* **10** (1): 11-16.
- RIOJA, E., 1931. Estudio de los poliquetos de la Peninsula Iberica. *Mems Acad. Cienc. exact. fis.-quím. nat. Zaragoza* **2**: 1-472.
- ROSENFELDT, P., 1979. Zur Ultrastruktur der Borsten und Haken von Polychaeten und ihre taxonomische Bedeutung. Thesis, Univ. Hamburg: 1-118 [mimeogr.]
- ROSENFELDT, P., 1982a. Zur Ultrastruktur und taxonomischer Bedeutung der Borsten (Setae) und Haken (Uncini) von Polychaeten. *Zool. Jb. Syst.* **109**: 268-289.
- ROSENFELDT, P., 1982b. Die Polychaeten der Fahrt 44 (1977) von F.S. 'Meteor' in das Auftriebsgebiet vor Nordwest-Afrika. *Meteor Forsch. Ergebn. D.* **35**: 43-53.
- RULLIER, F., 1972. Annélides Polychètes de Nouvelle Calédonie recueillies par Y. Plessis et B. Salvat. *Expéd. Franç. Récifs Corall. Nouv.-Caléd.* **6**: 1-169.
- SAINT-JOSEPH, A. DE, 1894.- Les annélides polychètes des côtes de Dinard. III. *Annls Sci. nat. (7, Zool.)* **17**: 1-395.
- SCHOCHET, J., 1973. Opercular regulation in the polychaete *Hydroides dianthus* (Verrill, 1873). I. Opercular ontogeny, distribution and flux. *Biol. Bull.* **144**: 400-420.
- SCHMIDT, E.O., 1848. Neue Beiträge zur Naturgeschichte der Würmer gesammelt auf einer Reise nach den Färör im Frühjahr 1848. Jena: 1-44.
- UCHIDA, H., 1978. Serpulid tube worms (Polychaeta. Sedentaria) from Japan with the systematic review of the group. *Bull. mar. Park Res. Stns* **2**: 1-98.
- VANNINI, E., 1975. Cicli riproduttivi nei policheti *Salmacina dysteri* e *Salmacina incrustans*. VIII European Mar. Biol. Symp. Sorrento (Naples) 1973. *Pubbl. Staz. zool. Napoli* **39**, Suppl.: 335-346.
- VERRILL, A. E., 1868. Notice on the corals and echinoderms collected by Prof. C. F. Hartt at the Abrolhos reefs, Province of Bahia, Brazil, 1867. *Trans. Conn. Acad. Arts Sci.* **1** (2): 351-364.
- WOLLEBAEK, A., 1912. Nordeuropaeiske Annulata polychaeta. 1. Ammocharidae, Amphictenidae, Ampharetidae, Terebellidae og Serpulidae. *Skr. VidenskSelsk Christiania 1 (math.-nat.)* **18**: 1-144.
- ZIBROWIUS, H., 1968. Étude morphologique, systématique et écologique des Serpulidae (Annelida Polychaeta) de la région de Marseille. *Recl Trav. Stn. mar. Endoume, Bull.* **43** (59): 81-252.
- ZIBROWIUS, H., 1973. Serpulidae (Annelida Polychaeta) des côtes ouest de l'Afrique et des archipels voisins. *Annls Mus. r. Afr. cent. Tervuren, Sér. 8°, Sci. zool.* **207**: 1-93.

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