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Description of *Saccocirrus goodrichi* sp. nov. (Annelida: Polychaeta: Saccocirridae), a new Mediterranean species and new data on the chaetae of *S. papillocercus* and *S. major*

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Abstract: A new species, *Saccocirrus goodrichi*, is described from *Amphioxus* sands of the Gulf of Naples. The species lives in sediments together with *S. papillocercus* and, for a long time, there has been a confusion between the two species. By the morphology of the chaetae, the presence of a pharyngeal bulb and the unilateral location of the ovaries, the new species belongs to the Indo-Pacific "*krusadensis* group", different from the "*papillocercus* group" that has a world wide distribution. On the other hand, scanning electron micrographs are given for the first time on the chaetae of *S. papillocercus* and *S. major,* two common Mediterranean species.

Résumé : *Description de* Saccocirrus goodrichi *sp. nov. (Annelida : Polychaeta : Saccocirridae), une nouvelle espèce méditerranéenne, et nouvelles données sur les soies de* S. papillocercus *et* S. major. Une nouvelle espèce, *Saccocirrus goodrichi,* est décrite des sables à *Amphioxus* du Golfe de Naples. Cette espèce coexiste avec *S. papillocercus* et il y a eu confusion entre ces deux espèces depuis de nombreuses années. Par la morphologie de ses soies, la présence d'un bulbe pharyngien, et la disposition unilatérale des ovaires, la nouvelle espèce appartient au "groupe *krusadensis*", groupe d'espèces indopacifiques différent du "groupe *papillocercus*" à répartition mondiale. D'autre part, des détails morphologiques, illustrés pour la première fois au microscope électronique à balayage, sont donnés sur les soies de *S. papillocercus* et *S. major,* deux espèces méditerranéennes communes.

Keywords: Polychaeta • *Saccocirrus* • New species • Marine meiofauna • Mediterranean Sea

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Introduction

Goodrich (1901) published an anatomical study of sexually mature specimens of *Saccocirrus papillocercus* Bobretzky, 1871, from sublittoral sediments at Naples (Italy) but in this study, he described at least one character of another species, i.e. the presence of a pharyngeal bulb, originally not mentioned in *S. papillocercus*.

Pierantoni (1907) pointed out that the specimens of *S. papillocercus* collected in the sands of the Gulf of Naples (3-6 m depth) have no pharyngeal bulb contrary to the description given by Goodrich (1901). On the other hand, he also reported that specimens of a large size, living in the pebbles of Mediterranean beaches and erroneously identified as *Saccocirrus papillocercus* by several authors belong to a new species, *S. major* Pierantoni, 1907, and he listed the distinctive features of the two species that are mainly: 1. the body size; 2. the shape of the chaetae; 3. the size of mature oocytes; 4. the reproductive season; 5. the habitat.

Fauvel (1927) used for *S. papillocercus* and *S. major*, the figures given by Pierantoni (1907) and Goodrich (1901) and thus, in his diagnosis of *S. papillocercus*, the presence of a pharyngeal bulb is erroneously mentioned.

During a stay at the Stazione Zoologica di Napoli in March 1967, one of us (CJT) collected two species of *Saccocirrus* occurring in the same sublittoral sediment, *S. papillocercus* without a pharyngeal bulb and another species with a pharyngeal bulb. This last species was previously identified (Jouin, 1971) as *Saccocirrus krusadensis* Alikunhi, 1942, a species from Krusadai (Gulf of Manaar, India), an identification that was later corrected after a comparison with specimens of *S. krusadensis* from Andaman and Laccadive Islands (Jouin, 1975). The specimens from the Gulf of Naples belong to a new species, *S. goodrichi* sp. nov., here described. In addition, in order to better characterize the morphology of their chaetae, SEM view of the chaetae of two common and widespread Mediterranean species, *S. papillocercus* and *S. major*, are given.

Material and methods

The specimens of *Saccocirrus goodrichi* sp. nov. were first collected in March 1967 (CJT) in a coarse sediment (Amphioxus sand) from the Gulf of Naples (Italy), at Cinito (5-8 m depth) and around the island of Ischia, at Casamicciola (8-10 m depth). New material was collected at Casamicciola in April 2007 by one of us (MCG) and a sexually mature female was found. In the samplings of 1967, the new species was associated, among other polychaetes, with *Saccocirrus papillocercus*, *Protodrilus purpureus* (Schneider, 1868), *P. hatscheki* Pierantoni, 1908, *P. oculifer* Pierantoni, 1908, *P. ciliatus* Jägersten, 1952, *P. hypoleucus* Armenante, 1903, *Mesonerilla intermedia* Wilke, 1953. All these species were sexually mature in March 1967, except *Saccocirrus goodrichi* sp. nov. More recent faunistic and ecological observations on the Amphioxus sands at Casamicciola are available in Gambi et al. (1997 & 2003).

Specimens of *S. goodrichi* sp. nov. from the Gulf of Naples, *S. papillocercus* from different localities (Roscoff, Brittany (France) and Gulf of Naples) as well as specimens of *S. major*, from pebbles at the shore of Antibes, Mediterranean Sea (France) were prepared for examination of parapodia and chaetae with SEM. Specimens fixed with 10% formalin were post-fixed with 1% OsO_4, for 1h, then rinsed, dehydrated in a graded ethanol series, dried by the critical point method, coated with gold palladium and examined with a Cameca 07 scanning electron microscope. A few specimens collected in April 2007 have also been used for SEM analysis, and were fixed in 2.5% glutaraldehyde, while other specimens for morphological analysis were fixed for collections with 7% formalin. SEM analysis in Naples was performed with a Jeol 6700F scanning electron microscope. Mature specimens of *S. major* were collected at the shore of Antibes in June 2007 and deposited at Muséum National d'Histoire Naturelle, Paris, MNHN PNT8 and PNT9.

Systematics

Family SACCOCIRRIDAE Czerniavsky, 1881
Genus *Saccocirrus* Bobretzky, 1871

Saccocirrus goodrichi sp. nov.
(Figs 1-3)

Saccocirrus papillocercus (in Goodrich, 1901); *Saccocirrus papillocercus* (in Pierantoni, 1907)
Saccocirrus papillocercus (in Fauvel, 1927); *Saccocirrus krusadensis* (in Jouin, 1971); *Saccocirrus* sp. (in Jouin, 1975).
The species is named in honour to E.S. Goodrich who collected and studied this species for the first time at Naples, under the name *S. papillocercus*.

Type material

Holotype. A complete immature specimen, fixed with 10% formalin, coloured and mounted on a slide, collected in March 1967 from the Gulf of Naples at Cinito, 8 m depth, in coarse sand ("Amphioxus sand"), deposited at Muséum National d'Histoire Naturelle, Paris, MNHN TYPE 1484.

Paratypes. One female from Casamicciola fixed with 7% formalin, mounted on a slide MNHN TYPE 1485, collected

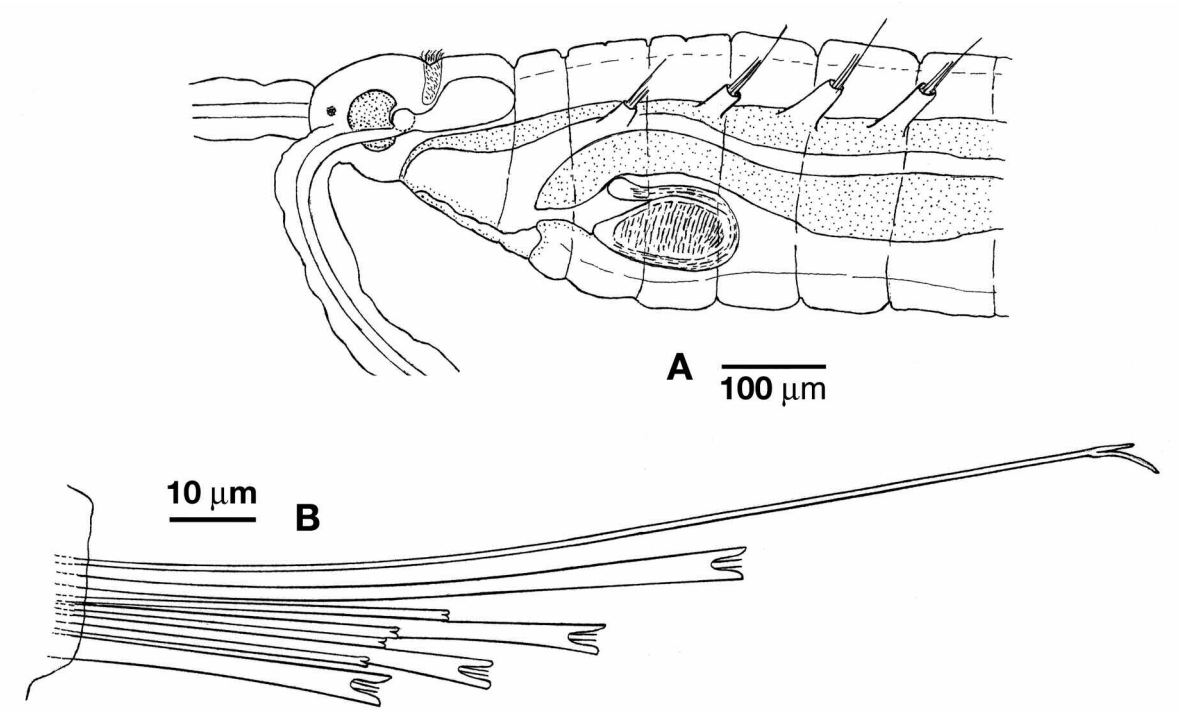


Figure 1. A. *Saccocirrus goodrichi* sp. nov. Lateral view (left side) of the head and four first chaetigers showing extension of the pharyngeal muscular bulb, ventral to oesophagus. **B.** Parapodium of *Saccocirrus goodrichi* sp. nov. with three types of chaetae.

Figure 1. A. *Saccocirrus goodrichi* sp. nov. Vue latérale gauche de la tête et des quatre premiers sétigères montrant l'extension du bulbe pharyngien, ventral à l'œsophage. **B.** Parapode de *Saccocirrus goodrichi* sp. nov. avec trois types of soies.

at Casamicciola in March 2007. Several other specimens from the same site in March - April 2007 MNHN TYPE 1488 and from the collection of March 1967 MNHN TYPE 1486 and 1487. Other fixed specimens from Casamicciola (March 2007) are in the personal collection of M.C. Gambi.

Diagnosis

Immature specimens about 12 mm long and 250-300 µm wide, with 130 chaetigerous segments, plus about nine small achaetous segments in the prepygidial area. Two small eyes on prostomium. Oral slit along the peristomium with posterior lip on a first achaetous segment. Tentacular ampullae short, extending in anterior part of peristomium. Pharyngeal bulb ventral to oesophagus, extending in chaetigers 1 and 2. Parapodia with 3 types of chaetae: 1 or 2 long and thin chaetae, unequally bifid at tip, 2-4 sturdy medium chaetae, with two equal-length prongs and two thin teeth inside the fork, 4-8 short and thin chaetae with a terminal notch. Two pygidial lobes, each with 6-7 ventral transverse adhesive ridges. Female with ovaries located on left side of digestive tract in chaetigers 26 to 61 (for a total number of 90 chaetigers). Only one or two large (130 µm in diameter) mature oocytes per segment. No spermathecae and no spermatozoa present in the coelomic cavities. Males still unknown.

Description of immature specimens (Figs 1-2)

Most of the collected specimens were immature in March and April.

Length 12 mm; width 250-300 µm. Number of chaetigerous segments 130 in the largest specimen collected, plus about nine small achaetous segments in prepygidial area.

Two small brown eyes anteriorly on dorso-lateral part of prostomium, diameter 7 µm each. Eyes may be absent on some specimens.

Two dorso-lateral ciliated nuchal organs at the limit between prostomium and peristomium and a small round medio-dorsal ciliated area, slightly behind nuchal organs.

Two long tentacles, 1.4 mm in length, reach when curved posteriorly the level of chaetigerous segment 11. Two round tentacular ampullae, rather short, extend in prebuccal region only in anterior part of peristomium, not in the first achaetous segment (i.e. posterior part of peristomium) (Fig. 1A).

Mouth bordered by two lateral lips and a posterior lip

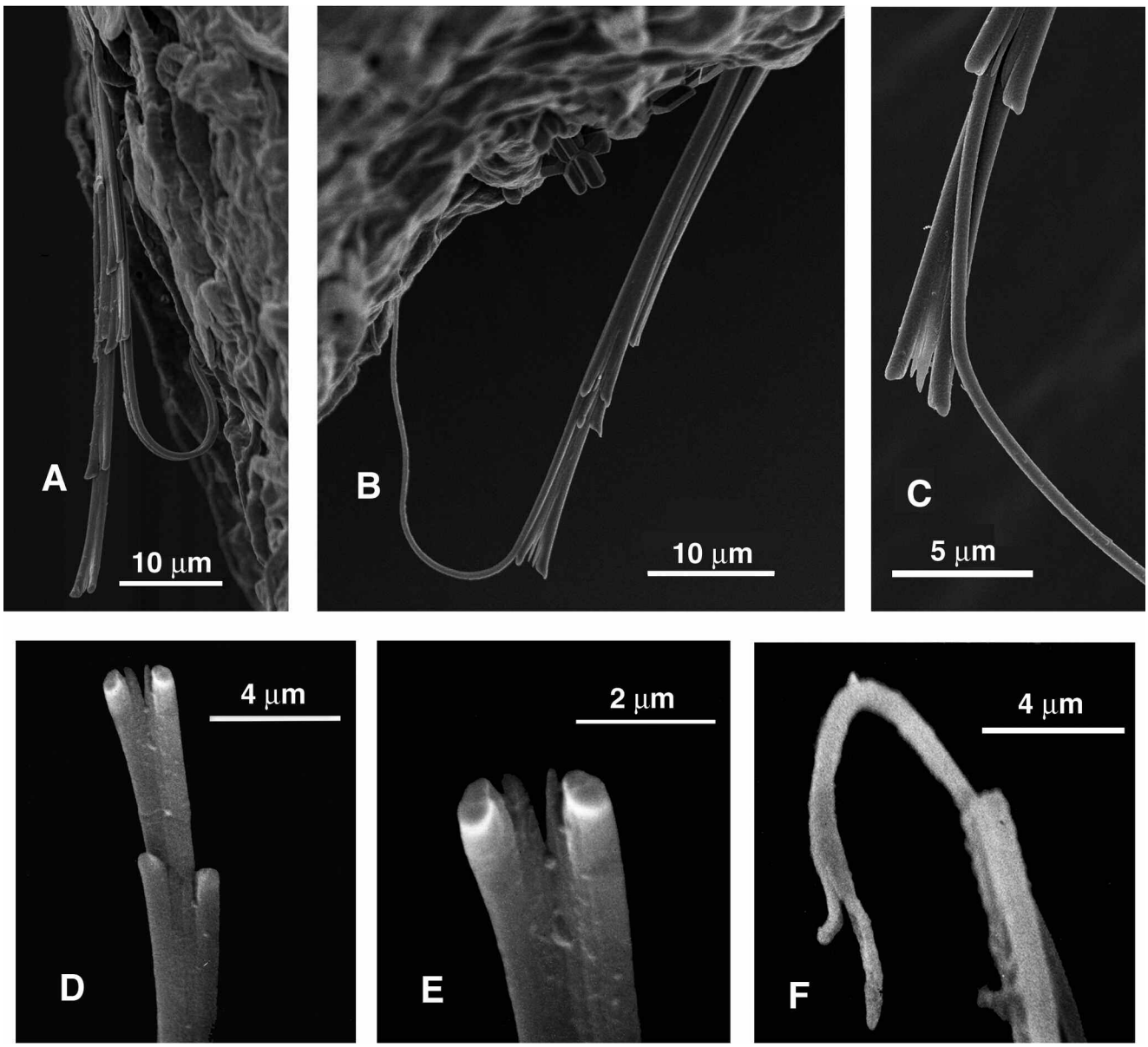


Figure 2. *Saccocirrus goodrichi* sp. nov. Parapodia and chaetae (SEM). **A- C.** Parapodia and chaetae from a single specimen collected in April 2007 with the long chaeta folded and partly hidden. **D-F.** specimen collected in March 1967. **D-E.** Apices of medium sized chaetae. **F.** Apex of a long chaeta.

Figure 2. *Saccocirrus goodrichi* sp. nov. Parapodes et soies (SEM). **A-C.** Parapodes et soies d'un même spécimen récolté en Avril 2007, montrant la soie longue, repliée et en partie cachée. **D-F.** Spécimen récolté en Mars 1967. **D-E.** Apex de deux soies moyennes. **F.** Apex d'une soie longue.

located on the first achaetous segment (= posterior part of peristomium). Epidermal ventral ciliation on the peribuccal area could not be detected on fixed material.

Muscular pharyngeal bulb with length up to 170 µm and width 100 µm, posterior to mouth and ventral to oesophagus, extends in two first chaetigerous segments (Fig. 1A).

Oesophagus in 13 chaetigerous segments in the largest specimen examined. Alimentary canal containing some detritus and diatom frustules.

Pygidial adhesive lobes rather small with 6-7 ventral adhesive ridges each, sometimes with few adhesive ridges.

Uniramous parapodia present from first post-cephalic segment to end of body except in nine last achaetous prepygidial segments.

Three types of chaetae in each parapodium (Figs 1B & 2): 1 or 2 long and thin chaetae, with apex unequally bifid,

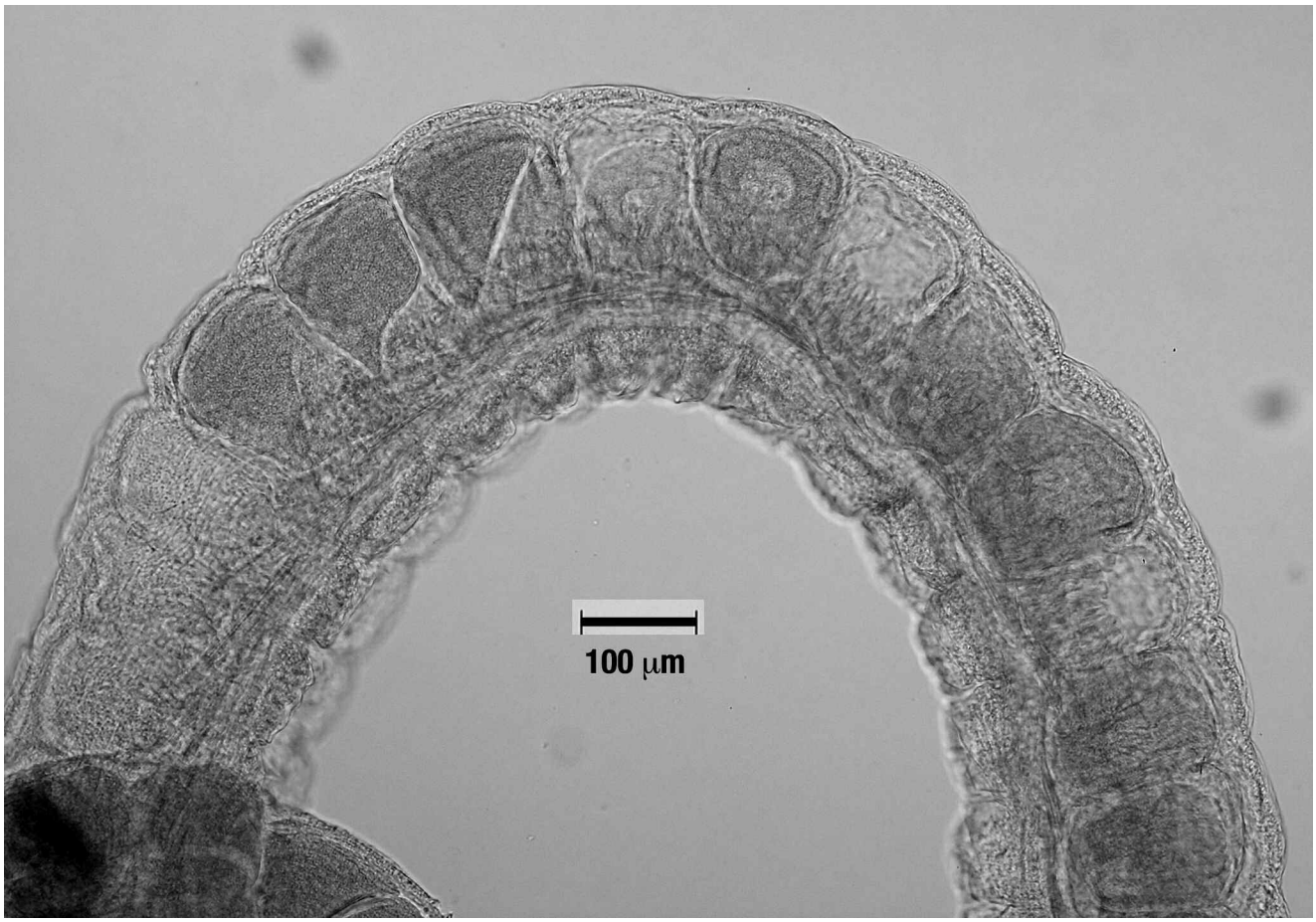


Figure 3. *Saccocirrus goodrichi* sp. nov. Segments 51-64 (from right to left) of a female specimen collected in March 2007, showing in each segment the small number (1-2) of large mature oocytes.

Figure 3. *Saccocirrus goodrichi* sp. nov. Segments 51-64 (de droite à gauche) d'un spécimen femelle récolté en mars 2007, montrant dans chaque segment le petit nombre (1-2) de gros ovocytes mûrs.

2-4 sturdy medium chaetae with a bifid apex divided in two equal–length prongs (about 3 µm long) plus two teeth inside the fork, slightly longer than prongs, 4-6 short and thin chaetae, with a notched apex. Long chaetae often twice longer than medium chaetae.

Remarks: these specimens, when stressed or disturbed, produce a strong smelling, similar to that produced also by specimens of *Protodrilus hypoleucus* Armenante, 1903 (see Jouin, 1970).

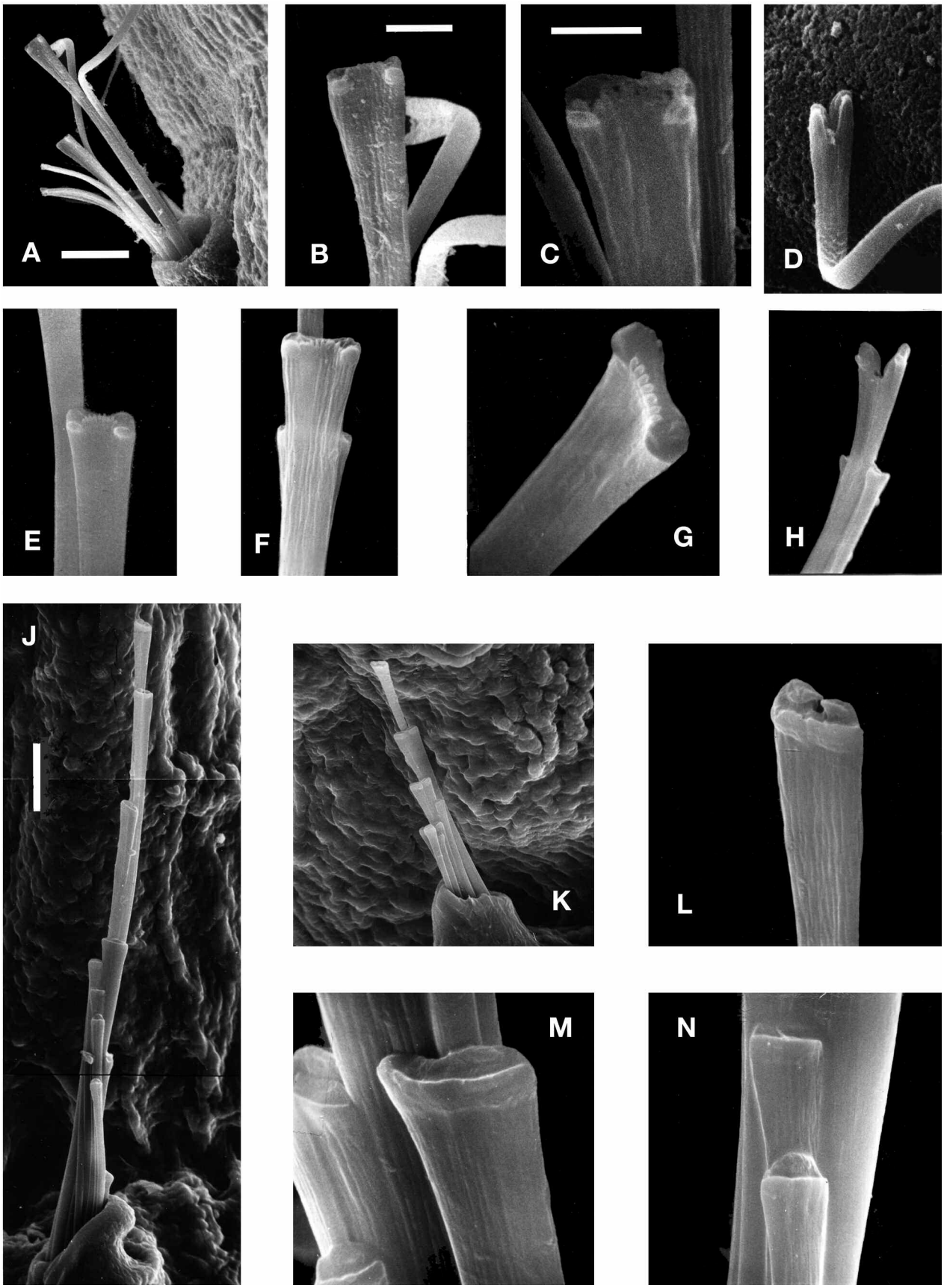
Sexually mature female (Fig. 3).

One female was collected in the Amphioxus sand at Casamicciola in March 2007 (Fig. 3). The fertile region extends in chaetigers 26 to 61 (total number of chaetigers 90, for a total length ca. 9 mm). The mature oocytes are located on the left side of the digestive tract and there is only one or two large, unfertilized, mature oocytes per segment, reaching, in the coelomic cavity, ca. 140 µm in diameter, with a large (ca. 40 µm) germinal vesicle. Mature oocytes are not present in each segment of the fertile region and, in this specimen, the total number of mature oocytes is only 30. We could not detect spermathecae nor spermatozoa in the coelomic cavities of this specimen.

On several specimens an accumulation of yellow-brown pigmented granules were present below the epidermis on left side of body, ventral to parapodia, in chaetigers 27 to 86, (total number of segments = 93 chaetigers + 8 achaetous). These granules suggest remains of genital tissues and could indicate that in March-April the reproductive period is terminating.

Observations on the chaetae of Saccocirrus papillocercus *and* S. major *(Fig. 4)*

SEM illustrations of the chaetae of these two species are given here for the first time in order to clarify the confusion concerning their morphology reported in the literature


A
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(Goodrich, 1901; Pierantoni, 1907; Fauvel, 1927)

S. papillocercus has a wide ditribution and the three types of chaetae (long, medium and short) are similar in size and shape in the Mediterranean specimens (Fig. 4A-D) and in those from the coast of Brittany (Fig. 4E-H). The longest chaetae are thin and terminate with a tip (width ca. 2 µm) divided in two short prongs. The medium chaetae terminate with an oar shaped apex (apical width about 3.5 µm) provided on one side with several (about 7) minute teeth. The short chaetae have smooth tips.

Specimens of *S. major,* collected under the pebbles of the beach at Antibes (Mediterranean Sea, France) are much larger than *S. papillocercus* and the chaetae are also larger, having widths at least twice those of *S. papillocercus* (Fig. 4J-N). The long chaetae (Fig. 4J-L) terminate with a tip (width about 4.3 µm) divided in two short equal prongs, the medium chaetae (Fig. 4J, K & M) (apical width about 7 µm) terminate with a smooth tip, without minute teeth and the short chaetae have smooth tips (Fig. 4J, N). The shape of the medium chaetae with three apical prongs, illustrated in Pierantoni (1907), Fauvel (1927) and Sasaki (1981), was not observed. The species was sexually mature in June and we could confirm and complete the data given by Pierantoni (see Table 1). Sexually mature males and females were deposited at MNHN PNT8 and PNT9.

Discussion

Immature specimens of *Saccocirrus goodrichi* were first collected in March 1967 from infralittoral sediments (Amphioxus sands) of the Gulf of Naples, together with mature specimens of *S. papillocercus*. The two species, occurring in the same spot and sediment type, have a comparable size and habit and so the confusion between them is very easy. Although Pierantoni (1907) mentioned that the reproductive period is winter for *S. papillocercus* at Naples, we found sexually mature males and females in March, probably at the end of the reproductive period.

It is likely that Goodrich (1901) collected in winter, at Naples, these two species: undoubtedly the anterior region of the *Saccocirrus* specimen provided with a pharyngeal bulb, illustrated in his Figures 1 and 2, does not represent *S. papillocercus*, a species devoid of a pharyngeal bulb (Bobretzky, 1871; Marion & Bobretzky, 1875; Pierantoni, 1907) but most probably *S. goodrichi*. The author mentions (p. 415) that this muscular sac is "absent in two out of a dozen series of sections", a remark which indicates that two different species were present in his material. On the other hand, Goodrich (1901), could give a detailed description of the bilaterally arranged gonads and genital organs of males and females of *S. papillocercus*, a species that reproduce in winter and has bilateral gonads (Pierantoni, 1907). The shape of the medium chaetae (Fig. 9, in Goodrich, 1901) may correspond to that of *S. papillocercus*, but the tips of the longest chaetae with three sharp prongs according to Goodrich (1901), do not correspond to our observations neither on *S. papillocercus* nor on *S. goodrichi*

Pierantoni (1907) also collected probably these two species at Naples, in sublittoral sediments (2-6 m depth) under the name *S. papillocercus*. The long and medium chaetae he describes (page 3 and Fig. 4, Table 8) are similar to those of *S. goodrichi* not to those of *S. papillocercus*, while the bilateral arrangement of the genital organs is a character of *S. papillocercus* and *S. major*. The aim of Pierantoni in this paper was to clearly distinguish the new species *S. major,* with a large size, living under the pebbles at the water edge of Mediterranean beaches and sexually mature during spring and summer, from *S. papillocercus* of smaller size, from sublittoral sediments and sexually mature during winter.

Figure 4. Parapodia and chaetae (SEM) of *Saccocirrus papillocercus* (A-H) and *S. major* (J-N).
Saccocirrus papillocercus. **A-D.** Specimens from Casamicciola (Naples). **E-H.** Specimens from Roscoff. **A.** Parapodium. **B.** Medium and long chaetae of the same parapodium as in A. **C.** Apex of a medium chaeta. **D.** Apex of a long chaeta. **E.** Apex of a medium chaeta. **F.** Apices of two medium chaetae. **G.** Apex of a medium chaeta. **H.** Apices of a long and a medium chaetae.
Saccocirrus major (specimens from Antibes). **J.** Parapodium. **K.** Parapodium partly retracted of a younger specimen. **L.** Apex of a long chaeta. **M.** Apex of a medium chaeta. **N.** Apex of a short chaeta and a young medium chaeta. Scale bars: A = 10 µm. B = 3 µm, the same scale for D, E, F, H, L, M, N. C and G = 2 µm. J and K = 15 µm.

Figure 4. Parapodes et soies (MEB) de *Saccocirrus papillocercus* (A-H) et *S. major* (J-N).
Saccocirrus papillocercus. **A-D.** Spécimens de Casamicciola (Naples). **E-H.** Spécimens de Roscoff. **A.** Parapode. **B.** Soies moyenne et longue du même parapode qu'en A. **C.** Apex d'une soie moyenne. **D.** Apex d'une soie longue. **E.** Apex d'une soie moyenne. **F.** Apex de deux soies moyennes. **G.** Apex d'une soie moyenne. **H.** Apex d'une soie longue et d'une soie moyenne.
Saccocirrus major (spécimens d'Antibes). **J.** Parapode. **K.** Parapode en partie rétracté d'un spécimen jeune. **L.** Apex d'une soie longue. **M.** Apex d'une soie moyenne. **N.** Apex d'une soie courte et d'une jeune soie moyenne. Echelles: A = 10 µm. B = 3 µm, même échelle pour D, E, F, H, L, M, N. C et G = 2 µm. J et K = 15 µm.

Table 1. Data on some characters of females in 14 species of *Saccocirrus.* (**) indicates bilateral ovaries, (*) unilateral ovaries, (§) this paper.

Tableau 1. Données sur les caractères des femelles de 14 espèces de *Saccocirrus.* (**) indique la disposition bilatérale des ovaires, (*) la disposition unilatérale, (§) cet article.

Saccocirrus species	Length (mm)	Width (mm)	Number of segments	Number of fertile segments	Size of mature oocyte (µm)	Number of mature oocytes /segment	Reference
papillocercus Bobretzky, 1871	25-30	0.40	100-150	120 (**)	90	6-10 (§)	Pierantoni, 1907 and this paper
major Pierantoni, 1907	60-70	1	150-200	175 (**)	50-65	30-40 (§)	Pierantoni, 1907 and this paper
minor Aiyar & Alikunhi, 1944	10-15	0.20	70-100	40 (**)	45	2-4	Jouin & Rao, 1987
pussicus Marcus, 1948	30	0.40	120	20-36 (**)	60-80	4-5	Marcus, 1948
heterochaetus Jouin, 1975	5-9	0.30	60-74	20 (**)	80	2-4	Jouin, 1975
krusadensis Alikunhi, 1942	20-25	0.40	100-150	80 (*)	70	10	Sasaki & Brown, 1983
gabriellae Marcus, 1946	30	0.40	160	100 (*)	65-85	15-20	Marcus, 1946
eroticus Gray, 1969	22	0.30	125	110 (*)	90	8-11	Gray, 1969
labilis Yamanishi, 1973	14	0.25	94-133	100 (*)	60	5-8	Yamanishi, 1973
sonomacus Martin, 1977	20-25	0.33	125	55 (*)	60	7-24	Martin, 1977
jouinae Brown, 1981	20	0.55	100-120	(*)	85	3-5	Brown, 1981
tridentiger Brown, 1981	20	0.60	100	(*)	95	4-10	Brown, 1981
uchidai Sasaki, 1981	15-20	0.35	66-146	100 (*)	65	30-50	Sasaki, 1981
goodrichi Jouin-Toulmond & Gambi 2007	10-15	0.30	90-130	35 (*)	130	1-2	This paper

The reproductive period of *S. goodrichi* is most probably winter, since only one female was collected in April 2007. Moreover the accumulation of yellow-brown granules on the left side in the posterior part of body, observed on several specimens, suggests remains of genital tissues indicating that in April the reproductive period of the species is over. Similar brown granules are mentioned in the wall of spermathecae in *S. papillocercus* (Goodrich, 1901) in *S. jouinae* Brown, 1981 and in the males of *S. uchidai* Sasaki, 1981.

The female of *S. goodrichi* has a small number of large mature oocytes, up to 130 µm in diameter, located on the left side of the digestive tract. This oocyte size is the largest recorded in the genus *Saccocirrus* (Table 1). The small size of the coelomic cavities of *S. goodrichi* allows the development of a reduced number (1-2 per segment) of large mature oocytes. By contrast, larger coelomic cavities in larger species (cf. *S. major*) allow the development of numerous smaller (50-65 µm) mature oocytes (Table 1). The absence of spermathecae could also be related in *S. goodrichi* to the small body width, as in *S. heterochaetus* (with bilateral gonads) (Jouin, 1975), but it has to be noted that the same feature also occurs in a larger species *S. pussicus* Marcus, 1948.

S. goodrichi with a unilateral position of the ovaries, in accordance with the presence of a muscular pharyngeal organ and with a peculiar morphology of the chaetae presents features that are characteristics of the "*krusadensis* group" of *Saccocirrus*.

Two groups of species have been identified in the genus *Saccocirrus* by several authors (Wu & Yang, 1962; Jouin, 1971; Martin, 1977; Brown, 1981; Sasaki, 1981; Sasaki & Brown, 1983; Jouin & Rao, 1987; Purschke & Jouin, 1988; Bailey-Brock et al., 2003).

The "*papillocercus* group" (see Jouin & Rao, 1987) has bilateral gonads, no muscular pharyngeal organ, no ventral ciliation, longest chaetae with short prongs, medium chaetae with an oar shaped tip, is probably carnivorous and has a world wide distribution; this group comprises at present 10 species (we include *S. cirratus* Aiyar & Alikunhi, 1944, considering the presence of a pharyngeal organ as doubtful, but not *S. archboldi* Kirsteur, 1967 that has a typical pharyngeal organ).

The "*krusadensis* group" possesses unilateral gonads, a pharyngeal muscular organ, an anterior ventral ciliation, longest chaetae deeply bifid at tip, medium chaetae with a deep median notch at tip, is detritivorous, bacteria-diatom browser and has an Indo-Pacific distribution; this group comprises at present 12 species, including *S. archboldi* and *S. goodrichi*

Sasaki & Brown (1983) have described interesting differences in the morphology of the trochophores of these two groups: in *S. papillocercus*, the trochophores have pseudochaetae and lack oral processes, while trochophores of several species in the "*krusadensis* group" are provided with extensible oral processes and lack pseudochaetae. Such extensible oral processes are also a typical and constant larval character of the swimming trochophores for all the species of *Protodrilus*, a genus also provided with a muscular pharyngeal organ. Ultrastructural studies on adult muscular pharyngeal organs of *Saccocirrus*, *Protodrilus* and *Protodriloides* showed that a pharyngeal organ must have been present in the stem species of these different genera of Protodrilida; so this organ has to be considered, in *Saccocirrus*, as a plesiomorphous character and its loss as a derived character (Purschke & Jouin, 1988).

S. goodrichi sp. nov. described from the Gulf of Naples is the first species recorded in Mediterranean and in European Seas, sharing features with the Indo-Pacific group of *Saccocirrus* species.

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References

Alikunhi K.H. 1942. Note on the occurrence of Archiannelida at Krusadai together with a description of an undescribed species of *Saccocirrus*. *Proceedings of the 29th Indian Scientific Congress*, Baroda, part III, section VII Zoology: 149.

Bailey-Brock J.H., Dreyer J. & Brock R.E. 2003. Three new species of *Saccocirrus* (Polychaeta: Saccocirridae) from Hawai'i. *Pacific Science,* **57**: 463-478.

Bobretzky N. 1871. *Saccocirrus papillocercus* gen. nov. sp. nov. (in Russian). *Mémoires de la Société des Naturalistes de Kiev*, **2**: 211-259.

Brown R. 1981. Saccocirridae (Annelida: Archiannelida) from the Central Coast of New South Wales. *Australian Journal of Marine and Freshwater Research*, **32**: 439-456.

Fauvel P. 1927. Faune de France **16**. Polychètes sédentaires. P. Lechevallier, Paris : 494 pp.

Gambi M.C., Ramella L., Sella G., Protto P. & Aldieri E. 1997. Variation in genome size in benthic polychaetes: systematic and ecological relationships. *Journal of the Marine Biological Association of the United Kingdom*, **77**: 1045-1057.

Gambi M.C., Dappiano M., Lanera P. 2003. I popolamenti bentonici di alcuni fondi mobili selezionati dell'isola d'Ischia. *Accademia Scienze Lettere ed Arti, Napoli Memorie Società Scienze Fisiche e Matematiche*, **5**: 187-200.

Goodrich E.S. 1901. On the structure and affinities of *Saccocirrus*. *Quarterly Journal of Microscopical Sciences,* **44**: 413-428.

Gray J. 1969. A new species of *Saccocirrus* from the west coast of North America. *Pacific Science*, **23**: 238-251.

Jouin C. 1970. Recherches sur les Protodrilidae (Archiannélides). I. Etude morphologique et systématique du genre *Protodrilus*. *Cahiers de Biologie Marine*, **11**: 367-434.

Jouin C. 1971. Status of the knowledge of the systematics and ecology of Archiannelida. *Proceedings of the First International Conference on meiofauna. (*N.C. Hulings ed.). *Smithsonian Contribution to Zoology,* **76**: 47-56.

Jouin C. 1975. Etude de quelques Archiannélides des côtes d'Afrique du Sud ; description de *Saccocirrus heterochaetus* sp. nov. (Archiannélide : Saccocirridae). *Cahiers de Biologie Marine,* **16**: 97-110.

Jouin C. & Rao G.C. 1987. Morphological studies on some Polygordiidae and Saccocirridae (Polychaeta) from the Indian Ocean. *Cahiers de Biologie Marine,* **28**: 389-402.

Marcus E. du B.-R. 1946. On a new archiannelid *Saccocirrus gabriellae* from Brazil. *Comunicaciones Zoologicas del Museo de Historia Natural de Montevideo*, **2**: 1-6, (2 plates).

Marcus E. du B.-R. 1948. Further archiannelids from Brazil. *Comunicaciones Zoologicas del Museo de Historia Natural de Montevideo*, **2**: 69-83, (3 plates).

Marion A.F. & Bobretzky N. 1875. Annélides du Golfe de Marseille. *Annales des Sciences Naturelles Zoologie*, **2**: 1-106.

Martin G.G. 1977. *Saccocirrus sonomacus* sp. nov., a new archiannelid from California. *Transactions of the American Microscopical Society*, **96**: 97-103.

Pierantoni U. 1907. Il genere *Saccocirrus* Bobretzky e le sue specie. *Annuario del Museo Zoologico della Regia Università di Napoli,* **2**: 1-11.

Purschke G. & Jouin C. 1988. Anatomy and ultrastructure of the ventral pharyngeal organ of *Saccocirrus* (Saccocirridae) and *Protodriloides* (Protodriloidae fam. nov.) with remarks on the phylogenetic relationships within the Protodrilida (Annelida: Polychaeta*). Journal of Zoology London*, **215**: 405-432.

Sazaki S. 1981. A new species of the genus *Saccocirrus* (Archiannelida) from Hokkaido, Northern Japan. *Annotationes Zoologicae Japonenses,* **54**: 259-266.

Sazaki S. & Brown R. 1983. Larval development of *Saccocirrus uchidai* from Hokkaido, Japan, and *Saccocirrus krusadensis* from New south Wales, Australia (Archiannelida, Saccocirridae). *Annotationes Zoologicae Japonenses,* **56**: 299-313.

Wu B.L. & Yang D.J. 1962. The taxonomy and Distribution of the genus *Saccocirrus* Bobretzky (Archiannelida). (Russian abstract). *Oceanologica and Limnologia Sinica,* **4**: 169-179.

Yamanishi R. 1973. A new species of *Saccocirrus* (Archiannelida) in Japan. *Publications of the Seto Marine Biological Laboratory*, **21**: 73-76.