On the phanerobranch dorids of Angola (Mollusca, Nudibranchia): a crossroads of temperate and tropical species

Yvonne VALLÈS
P.O. Box 15868, Petion Ville, W.I. (Haiti)
valles@acn2.net

Ángel VALDÉS
Department of Invertebrate Zoology and Geology, California Academy of Sciences
Golden Gate Park, San Francisco, CA 94118 (USA)
avaldes@calacademy.org

Jesús ORTEA
Departamento de Biología de Organismos y Sistemas, Laboratorio de Zoología
Universidad de Oviedo, 33071 Oviedo (Spain)
jortea@sci.cpd.uniovi.es

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ABSTRACT
This paper presents descriptions of a collection of phanerobranch dorids collected from Angola. The following species are reported for the first time in that area: *Okenia amoenula* (Bergh, 1907), *Okenia digitata* (Edmunds, 1966), *Polycera hedgpethi* Marcus, 1964, *Polycera aurantiomarginata* García-Gómez & Bobo, 1984, *Thecacera pennigera* (Montagu, 1815) and *Kaloplocamus ramosus* (Cantraine, 1835). Only three of them have been previously collected from the tropical west coast of Africa, *P. aurantiomarginata* in the Cape Verde Islands (under the junior name *Polycera xicoi* Ortea & Rolán, 1989), *T. pennigera* in Ghana, and *O. digitata* also in Ghana (as belonging to the genus *Teshia*, here synonymized with *Okenia*). In addition, the new species *Limacia annulata* is described. This species is characterized externally by having five branchial leaves, a red ring near the apex of the lateral papillae, and lacking tubercles on the dorsum. Internally, *L. annulata* has a rachian plate in the radula. The patterns of distribution of several species and the hypothesis that Angola is a transition area between western and southern Africa are discussed.

KEY WORDS
Mollusca,
Nudibranchia,
phanerobranch dorids,
systematics,
new species,
Angola,
biogeography.

RÉSUMÉ

Sur les doridiens phanérobranches d'Angola (Mollusca, Nudibranchia) : une rencontre des espèces des eaux tempérées et tropicales.

Ce travail contient une description des espèces de doridiens phanérobranches recueillies en Angola. Les espèces suivantes sont signalées pour la première fois dans ce secteur : *Okenia amoenula* (Bergh, 1907), *Okenia digitata* (Edmunds, 1966), *Polycera hedgpethi* Marcus, 1964, *Polycera aurantiomarginata* García-Gómez & Bobo, 1984, *Thecacera pennigera* (Montagu, 1815) et *Kaloplocamus ramosus* (Cantraine, 1835). Seules trois d'entre elles avaient déjà été recueillies en Afrique occidentale tropicale, *P. aurantiomarginata* aux îles du Cap-Vert (sous le nom *Polycera xicoi* Ortea & Rolán, 1989), *T. pennigera* au Ghana et *O. digitata* aussi au Ghana (comme appartenant au genre *Teshia* et que l'on synonymise ici avec *Okenia*). Une espèce nouvelle, *Limacia annulata,* est décrite. Cette espèce présente les caractéristiques externes suivantes : présence de cinq feuilles branchiales, un anneau rouge près de l'extrémité des papilles dorsales et absence de tubercules sur le dos. La radula de *L. anulata* possède une plaque rachidienne. Les modèles de distribution de plusieurs espèces sont discutés, ainsi que l'hypothèse selon laquelle l'Angola est une région de transition entre l'Afrique du Sud et l'Afrique occidentale.

MOTS CLÉS
Mollusca,
Nudibranchia,
dorides phanérobranches,
systématique,
espèces nouvelles,
Angola,
biogéographie.

INTRODUCTION

The phanerobranch dorids are a diverse group of nudibranchs that exhibit a large variability in shape and coloration. They are inhabitants of a variety of marine environments, and predators of bryozoans, ascidians, sponges, barnacles or other nudibranchs (see McDonald & Nybakken 1991). Similar to the other nudibranch groups, the phanerobranch dorid fauna of Angola still remains unknown.

This paper studies a collection of these animals made by Dr. Serge Gofas between the years 1982 and 1987, and deposited at the Muséum national d'Histoire naturelle of Paris (MNHN). All descriptions and drawings of the external morphology are based in the notes made by the collector.

SYSTEMATICS

Family GONIODORIDIDAE H. & A. Adams, 1859
Genus *Okenia* Menke, 1830

TYPE SPECIES. — *Idalia elegans* Leuckart, 1828

Okenia cf. ***amoenula*** (Bergh, 1907)
(Fig. 1)

Idaliella amoenula Bergh, 1907: 80-82, pl. 8, figs 6-11.

MATERIAL EXAMINED. — **Luanda Province.** Punta das Palmeirinhas, 9°09'S, 12°58'E, II.1987, 1 specimen 6 mm preserved length.

DISTRIBUTION. — *Okenia amoenula* has only been reported from South Africa (Gosliner 1987a). This paper is the first reference for this species to Angola.

DESCRIPTION

The background body colour is opaque white in the living animal. In the centre of the dorsum there are a few reddish spots and short lines of the same colour (Fig. 1). The oral tentacles are white and have four yellow tips each. The dorsum has, on each lateral margin, ten short papillae with yellow pigmentation on the apex. All over the dorsum there is a network of spicules. The rhinophores are white, non-retractile, and ringed with 18 lamellae. There are 11 unipinnate (the largest one is bipinnate) branchial leaves white in colour, having the rachis yellow (in the distal region edged with two red lines). The tail has a yellow line in the centre with few red spots.

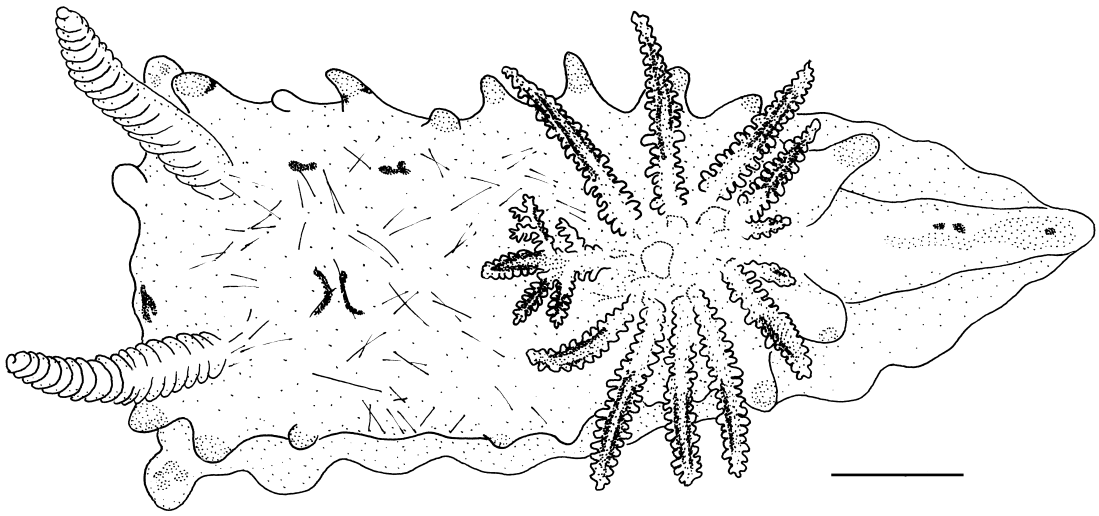

FIG. 1. — *Okenia* cf. *amoenula* (MNHN), dorsal view of the living animal. Scale bar: 1 mm.

REMARKS

The single specimen collected was badly preserved, making dissection and investigation of the internal anatomy impossible. In the process of removing the foregut the radula was lost. For that reason a positive identification of the specimen could not be done.

Bergh (1907) described *Okenia amoenula* (Bergh, 1907) in the binomen *Idaliella amoenula* Bergh, 1907, as being a white animal with three crimson lines on the dorsum, which joined together in the anterior part, and a crimson patch on the anal area. The dorsal papillae were reddish and yellow, the branchial leaves had a crimson colour, and the rhinophores were yellow. Our specimen, as well as Bergh's, has a white background colour, red and yellow pigmentation on the lateral papillae, and the branchial leaves are also reddish (with two red lines). However, our specimen shows a few differences in colour pattern from Bergh's material (white rhinophores instead of yellow, white branchial leaves instead of crimson), and with that described by Gosliner (1987a) from South Africa (dorsum with more red pigmentation in Gosliner's specimen and yellow lateral papillae, but also with red spots), which could be caused by differences in size. Otherwise they are identical.

Okenia amoenula has been considered by Schmekel (1979) as a synonym of *Okenia mediterranea* (Ihering, 1886). *Okenia mediterranea*, like our material of *O. amoenula*, has a yellow line in the centre of the tail with some red spots, and the rhinophores are white. However, our specimen lacks tubercles in the centre of the dorsum, which is a definitive character that separates the two species (Valdés & Ortea 1995).

Okenia amoenula is similar in colour to *Okenia hispanica* Valdés & Ortea, 1995. Both species have a white background colour, a white tail with a yellow line, and yellow pigmentation on the gill. However, they are clearly distinguishable by several external features. The dorsum of *O. hispanica* has two large pink patches, just behind each rhinophore, and another one on the anal area, the rhinophores are pink, and the oral tentacles are white, whereas in *O. amoenula* the dorsum is white with red spots or lines (lacking large patches), the rhinophores are white or yellow and the oral tentacles are white with four small yellow spots. Other differences include the absence of tubercles on the dorsum of *O. hispanica* and the radular morphology, already compared by Valdés & Ortea (1995).

Okenia digitata (Edmunds, 1966)
(Figs 2; 3D)

Teshia digitata Edmunds, 1966: 69-72, figs 1-10.

MATERIAL EXAMINED. — **Bengo Province.** Praia São Tiago, 08°35'S, 13°21'E, 1983, 1 specimen 6 mm preserved length; 1 specimen 5 mm preserved length; 1 specimen 3 mm preserved length. — Cacuaco, 08°47'S, 13°21'E, date unknown, 1 specimen 6 mm preserved length.

DISTRIBUTION. — The specimens from Angola represent the first reported occurrence of this species outside Ghana.

DESCRIPTION

The background body colour is white in the living animal. On its lateral border the dorsum has 16 tentacular papillae alternating between large and small ones (Fig. 2). Almost every lateral papilla has, at the same height, a yellow ring, and some black spots. The whole dorsum has small black spots that are more abundant in the centre of the dorsum, being dispersed in the sides. There are two oral tentacles, which are white and similar in form to the lateral papillae. The rhinophores are white as well, with very few black spots. The gill emerges from the body and divides into three branches. Each one has seven branchial leaves. The branchial leaves are unipinnate, white with very little black and have yellow spots dispersed all over. The tail is white with black spots. In each half-row of the radula there is one inner lateral and one outer lateral tooth. The inner lateral tooth (Fig. 3D) is flat and wide at the base. The large cusp on the inner side has ten strong denticles. The outer lateral tooth is thin and the apex is folded, being smaller than the inner lateral.

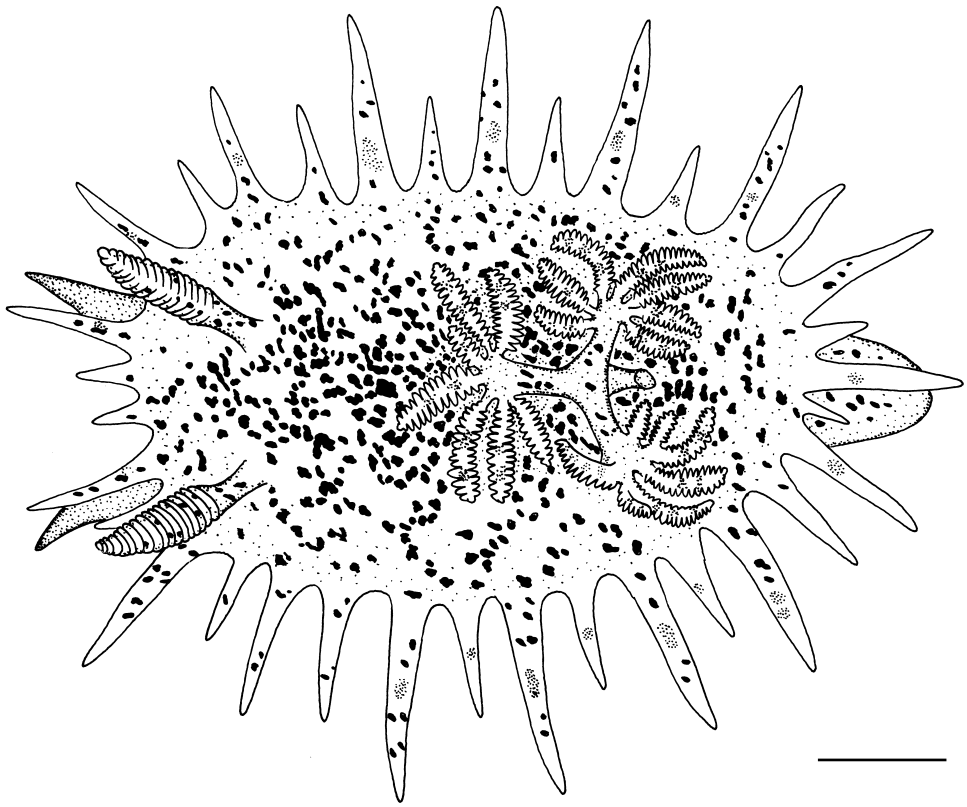

FIG. 2. — *Okenia digitata* (MNHN), dorsal view of the living animal. Scale bar: 1 mm.

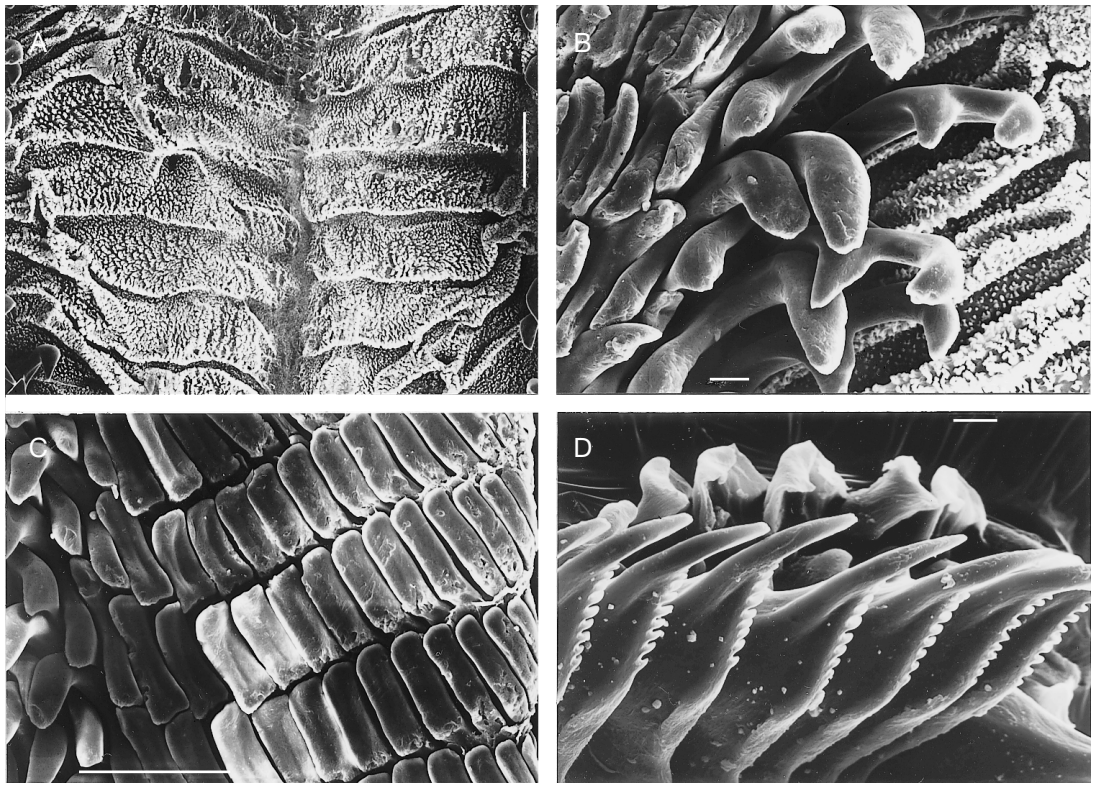

FIG. 3. — **A**, *Kaloplocamus ramosus* (MNHN), rachis of the radula; **B**, *Kaloplocamus ramosus* (MNHN), inner lateral teeth; **C**, *Kaloplocamus ramosus* (MNHN), outer lateral teeth; **D**, *Okenia digitata* (MNHN), radular teeth morphology. Scale bars: A, C, 100 µm; B, 20 µm; D, 10 µm.

REMARKS

The genus *Teshia* Edmunds, 1966, was introduced by Edmunds (1966) for *Teshia digitata* Edmunds, 1966, as different from *Okenia* Menke, 1830. The main characteristic used by Edmunds to separate both genera was that *Teshia* had three sets of branchial leaves whereas *Okenia* just had one, all other features of *Teshia* being identical to those of *Okenia*. In our opinion, this difference is not enough to separate a different genus and therefore both genera are here regarded as synonyms, with *Okenia* Menke,1830, having priority.

The specimens from Ghana and Angola are very similar in their colour pattern, however they show some differences. Edmunds (1966) described his single specimen as being grey with dark maroon spots on the dorsal and lateral areas of the body, and pale yellow spots on the flanks. The long rhinophores were grey on the stalk and maroon on the club. Gill and rhinophores were both scattered by maroon spots and small white dots. On the contrary, our specimens are white instead of grey, and have black small spots instead of maroon. The rhinophores of our specimens are white and the gill is yellow. The radula appears to be similar between the material of Ghana and Angola. Both have an outer lateral tooth, folded on the apex, much smaller than the innermost one, which has a strong cusp with eight to ten wide denticles in the inner side.

Edmunds (1966) described the gill of *O. digitata* as having three different sets of branchial leaves that emerge from three different points of the body. Instead, we observed that our specimens have three different sets emerging from a single point. The collector observed this character on the living animals, which after preservation cannot be

properly observed. On preserved animals the gill seems to be just as Edmunds' description except for the presence of a triangular area differently pigmented that joins the three sets of gills. We consider that the gills in both animals are similar and that Edmunds' description could be based on preserved animals, for this reason the true nature of the gills could have been misinterpreted.

Family POLYCERATIDAE Alder & Hancock, 1845
Genus *Limacia* Müller, 1781

TYPE SPECIES. — *Doris clavigera* Müller, 1776

REMARKS

MacFarland (1905) introduced the genus *Laila* MacFarland, 1905, based on *Laila cockerelli* MacFarland, 1905, as an "allied" to the genera *Triopha* Johnston, 1838 and *Issa* Bergh, 1880, but he did not refer to the genus *Limacia* Müller, 1781. The description of *L. cockerelli* was later completed with drawings of the radula and the animal in the living form (MacFarland 1966). *Laila janssi* Bertsch & Ferreira, 1974, presents similar morphological characteristics as *L. cockerelli*, differing on the colour pattern and in some radular features such as a smaller number of teeth rows, a rougher rachidian plate texture and some variations on the shape of the outer lateral teeth (Bertsch & Ferreira 1974).

The genus *Laila* has the same morphological characteristics as the genus *Limacia*: pallial margin with numerous club-shaped papillae; presence of tubercles on the notum; veil appendages canaliculated; retractile rhinophores; branchial leaves non retractile; two inner lateral teeth hook-shaped, the innermost being thinner and longer than the outermost, and many outer lateral teeth quadrangular-shaped. *Laila* and *Limacia* only differ in the fact that *Limacia clavigera* Müller, 1776, lacks a rachidian plate in the radula, which is present in both *L. cockerelli* and *L. janssi*. Since most of the morphological features of *Laila* and *Limacia* are very similar, just the presence of rachidian plate in the radula of *Laila* does not seem to be enough to consider *Laila* as a different genus. Therefore both genera are here regarded as synonyms, with *Limacia* Müller, 1781 having priority. This idea was already proposed by Ortea *et al.* (1989).

Limacia annulata n. sp.
(Figs 4; 5)

TYPE MATERIAL. — Holotype and one paratype (MNHN).

MATERIAL EXAMINED. — **Bengo Province.** Praia São Tiago, 08°35'S, 13°21'E, 6.I.1985, 1 specimen 6 mm preserved length (holotype); 1 specimen 9 mm preserved length (paratype).

ETYMOLOGY. — We named this species *annulata* based on the distinctive red rings present near the apex of each lateral papilla.

DISTRIBUTION. — So far *Limacia annulata* has only been collected from Angola.

DESCRIPTION

The background body colour is opaque white in the living animal, with a few red spots dispersed over the whole dorsum. The mantle does not cover the foot and it can be seen on the sides and the posterior part of the body. The laterals of the dorsum bear 26 club-shaped papillae of different sizes on each side (Fig. 4). All of them are white and have a large red ring near the apex, where a rounded opaque white body is arranged. Ventrally to the lateral papillae one tubular oral tentacle emerges at each side of the head of the animal. The rhinophores are retractile and have the same colour as the lateral papillae, but the red ring is open on the posterior side of the rhinophore. There are five white bipinnate branchial leaves that may have red spots.

The radular formula is 53 × (11.1.1.1.1.1.11) for the 9 mm specimen. The innermost lateral tooth is much thinner than the second lateral being also a little longer (Fig. 5B). The second lateral tooth has a small pointed denticle on the inner side and a basal irregular cusp on the outer side. Both lateral teeth have a hook-shaped form. The rachidian plate consists of a rudimentary, thin and long plate that goes all long the radula and contains many small papillations. There are 11 outer lateral teeth, which are approximately quadrangular in shape (Fig. 5A). All of them have almost the same size except for the innermost one, which is shorter, and the outermost one, which is thinner.

REMARKS

Limacia annulata n. sp. is different from all other species of the genus *Limacia* already described.

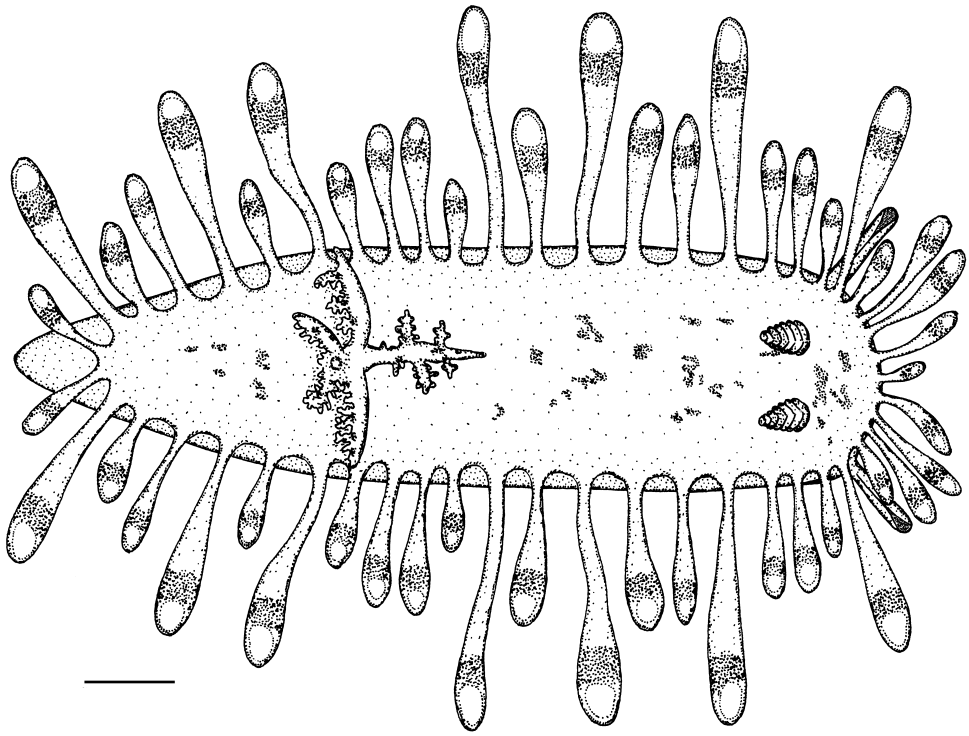

FIG. 4. — *Limacia annulata* n. sp., paratype (MNHN), dorsal view of the living animal. Scale bar: 1 mm.

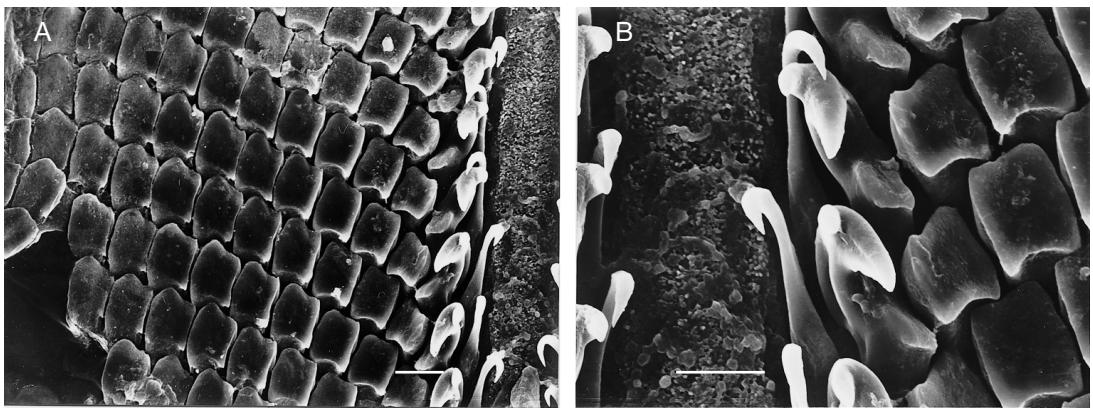

FIG. 5. — *Limacia annulata* n. sp., paratype (MNHN); **A**, radular teeth; **B**, detail of the rachis and lateral teeth morphology. Scale bars: A, 20 µm; B, 10 µm.

Following Ortea *et al.* (1989), the European and African species *Limacia clavigera* seems to be the one that differs most from *L. annulata*. Both species have a white background colour and both of them have spots on the dorsum, lateral papillae, gill and rhinophores. However, *L. annulata* has no tubercles on the dorsum nor spherical yellow bodies on the apex of the dorsal papillae (as in *L. clavigera*), but a red ring near the apex of the papillae and a spherical opaque white body on

the apex itself (absent in *L. clavigera*). The number of lateral papillae is much higher in *L. annulata* (26 on each side) than in *L. clavigera* (9-10 on each side), and the former has a red ring on the rhinophores absent in *L. clavigera*. One of the most conspicuous differences between these two species is the branchial leaves, which are three in number in *L. clavigera* and five in *L. annulata*. On the other hand, *L. clavigera* lacks a radular rachidian plate, which is present in *L. annulata*.

Limacia lucida (Stimpson, 1855), described from South Africa, has an external morphology very close to *L. clavigera*, and it has been considered a junior synonym of the latter (Bergh 1907; Macnae 1958; Gosliner 1987a). Regardless, this species differs from *L. annulata* in having dorsal tubercles, and spherical red bodies in the apex of the lateral papillae as does *L. clavigera*.

Another species of the genus *Limacia* is *Limacia janssi* (Bertsch & Ferreira, 1974), originally described from the Pacific coast of Central America. *Limacia janssi* has an orange background colour instead of white, as in *L. annulata*, and the colour of the spots is not red but orange. Both species have many lateral papillae, but *L. janssi* has two different forms of them (the largest ones being fewer in number than the smaller ones), whereas *L. annulata* has only one club-shaped papillar type. On the dorsum, *L. janssi* has many tubercles forming rows, a character that does not appear in *L. annulata*. The rhinophores of *L. janssi* are orange as the rest of the body, while they are white with a red ring in *L. annulata*.

Limacia cockerelli (MacFarland, 1905), originally described from the Pacific coast of North America (MacFarland 1905), seems to be the most similar species to *L. annulata*. Both have a distinct rachidian plate of the radula (MacFarland 1966), white background colour and five bipinnate branchial leaves. Even if both species have numerous white lateral papillae, *L. cockerelli* has them in a much higher number, more than 60 on each side, whereas in *L. annulata* there are only 26 on each side. Also there is a red-orange body at the apex of the lateral papillae in *L. cockerelli*, while in *L. annulata* the apex is white. *Limacia cockerelli*, as well as *L. janssi*, differs from *L. annulata* by the presence of two different lateral papillae forms. In these two species the larger papillae are fewer in number than the thinner ones. The absence of tubercles on the dorsum of *L. annulata* is another difference with *L. cockerelli*.

Genus *Polycera* Cuvier, 1817

TYPE SPECIES. — *Doris quadrilineata* Müller, 1776

Polycera hedgpethi Er. Marcus, 1964
(Figs 6; 7A)

Polycera hedgpethi Er. Marcus, 1964: 128-131, figs 1-4.

MATERIAL EXAMINED. — **Luanda Province.** Corimba, 08°49'S, 13°13'E, 26.VI.1983, 1 specimen 7 mm preserved length; 2 specimens 9 mm preserved length.

DISTRIBUTION. — This species has been reported from California, South Africa, New South Wales, Victoria and New Zealand, and more recently from Baja California, Mexico (see Behrens 1991) and Italy (see Cervera *et al.* 1988). These specimens are the first record from Angola.

DESCRIPTION

The background body colour is white in the living animal, covered of black points that give it a dark appearance (Fig. 6). The oral veil digitations are white with a yellow ring in the middle area. Black spots are present over the entire lateral papillae except the apices, which are white. The rhinophores are white with numerous small black spots and have two yellow rings (one at the apex and another near the base). The oral tentacles are white with small yellow spots. There are eight white branchial leaves with numerous black spots, except for the rachis, and yellow spots on the borders. There is one extrabranchial process on each side of the gill, which is white with black and yellow spots. A small tubercle is present on each side, just anterior to the extrabranchial processes. On the left side of one animal the extrabranchial process has a malformation on its posterior part. The side of the animal is translucent white. The dorsum is covered with conical tubercles, some of them with yellow tips. A white line edges the mantle margin on each side of the dorsum, joining together in a single line behind the gill. This line continues to the posterior end

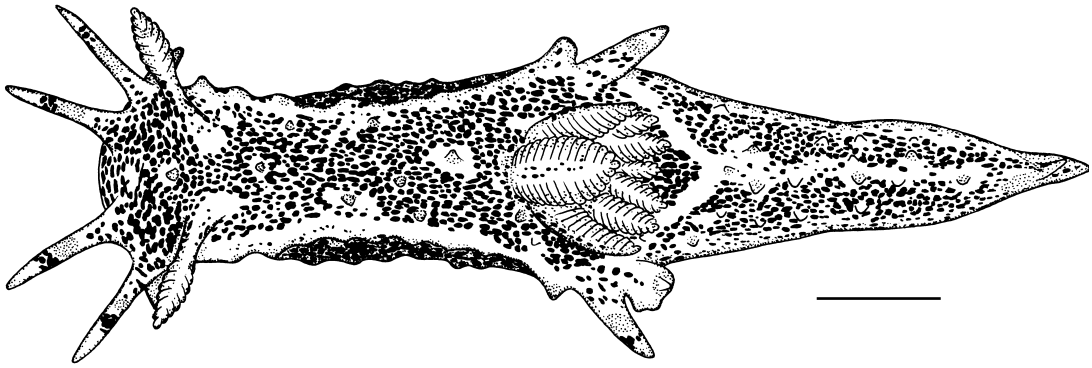

FIG. 6. — *Polycera hedgpethi* (MNHN), dorsal view of the living animal. Scale bar: 1 mm.

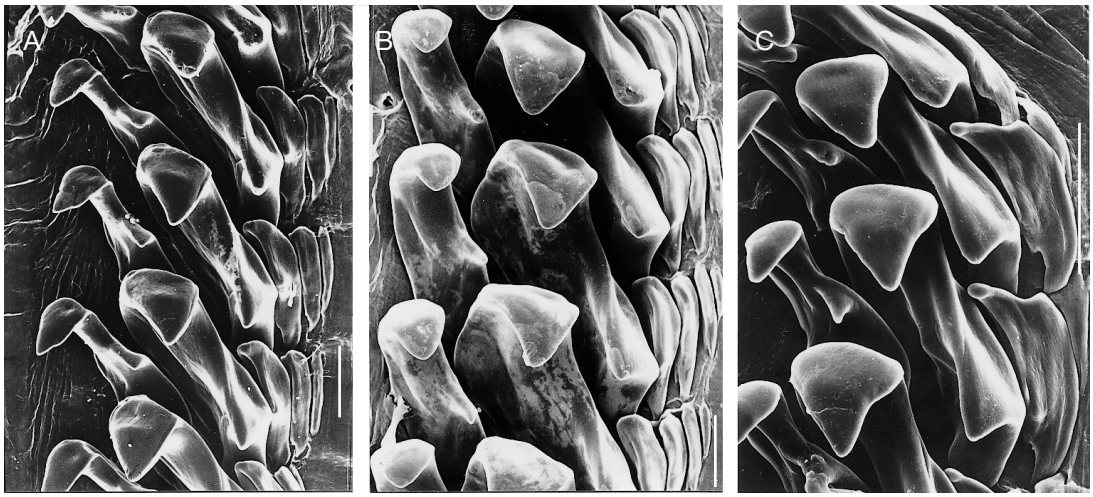

FIG. 7. — Radular teeth morphology; **A**, *Polycera hedgpethi* (MNHN); **B**, *Polycera aurantiomarginata* (MNHN); **C**, *Thecacera pennigera* (MNHN). Scale bar: 100 µm.

of the foot, which is yellow with some black spots and a large conical tubercle near the tip.

The radular formula is 11 × (3.2.0.2.3) in a 9 mm specimen. The innermost lateral tooth is smaller than the second, having both a rectangular peak shape (Fig. 7A). The innermost lateral tooth is narrow at the base, and has a bulge in the middle. There are three outer lateral rectangular teeth, which decrease in size from the inner to the outermost.

REMARKS

Marcus (1964) described *Polycera hedgpethi* Marcus, 1964 as being a "grey color background animal with small black dots, with yellow-orange marks on the rhinophores, corners of the foot, and on the velar and extrabranchial appendages; streaks of the same color are seen on the pallial ridge, caudal crest, and upper border of the foot, and yellow orange spots are present on the widely spaced tubercles all over the body".

Our specimen from Angola has a white background body colour that may appear grey (as Marcus observed in his specimen) due to presence of small black dots on the whole body. As mentioned before, our specimen has small yellow spots on the rhinophores, corners of the foot, on the velar appendages and on the lateral papillae. However, like Gosliner's (1987a) specimen of *P. hedgpethi* from South Africa, our material from Angola has no orange spots. The tail has yellow pigmentation, and the tubercles are pigmented with yellow. The branchial leaves in the African material have a yellow pigmentation on their border, differing from Marcus' material which have the same colour as the rest of the body. On the other hand, the radular teeth morphology is very similar between Marcus' and our material, and we consider that the differences in coloration mentioned above could be due to differences in size (Marcus' specimens reached 16-20 mm preserved length, and our specimens are 7-9 mm preserved length).

Polycera aurantiomarginata
García-Gómez & Bobo, 1984
(Figs 7B; 8)

Polycera aurantiomarginata García-Gómez & Bobo, 1984: 362-372, figs 1-8, pls 1-4.
Polycera xicoi Ortea & Rolán, 1989: 23-28, pl. 1.

MATERIAL EXAMINED. — **Luanda Province.** Corimba, 08°49'S, 13°13'E, date unknown, 1 specimen 9 mm preserved length; 4 specimens 11 mm preserved length; 2 specimens 12 mm preserved length; 4 specimens 13 mm preserved length; 2 specimens 14 mm preserved length; 3 specimens 15 mm preserved length; 1 specimen 16 mm preserved length; 1 specimen 17 mm preserved length. — Ilha de Luanda, 08°48'S, 13°15'E, 12.X.1985, 1 specimen 9 mm preserved length.
Namibe Province. Praia Amelia, 15°01'S, 12°08'E, 3.VIII.1985, 1 specimen 5 mm preserved length; VIII.1985, 1 specimen 7 mm preserved length.
We have also examined the holotype of *Polycera aurantiomarginata* García-Gómez & Bobo, 1984, deposited at the Museo Nacional de Ciencias Naturales, Madrid (MNCN 15.05/1001).

DISTRIBUTION. — Previously, this species was known from the South of Spain (García-Gómez & Bobo 1984) and Cape Verde Islands (Ortea & Rolán 1989). This paper is the first record from Angola, a significant southern range extension.

DESCRIPTION
The background body colour is whitish in the living animal. The dorsum and sides are longitudinally crossed by orange and yellow alternating lines (Fig. 8A). The orange lines are mostly present on the side of the animals and in the anterior part of the dorsum, whereas the yellow lines are more abundant on the dorsum and in the posterior areas of the body. Some specimens have a greyish pigmentation on the dorsum, which may cover the whole body or just part of it. However, the cephalic area is always white with three orange lines between the rhinophores, which may have a grey area around them. Some specimens have a greyish colour only in the centre of the dorsum that is absent on the tail. The velum bears six appendages that are yellow with a white base. Some specimens have also a white apex. The rhinophores may be white or yellow and have a black ring near the apex, which is always white. At the base of the rhinophores (always white) there are orange and yellow spots. One of the specimens has black rhinophores. There are between eight and eleven unipinnate branchial leaves, white with small orange and yellow spots on the rachis. Some specimens have a black ring near the apex of the leaves. The specimen with black rhinophores has a black gill as well, with an orange rachis. Each animal has a white extrabranchial process on either side of the gill, which has yellow lines arranged just at the apex or almost all over the appendage.
The dorsum is covered with numerous, minute spicules, 10 µm long or smaller. The majority are oval (Fig. 8D). There are also a few large and scattered spicules bigger than 200 µm, being elongated with tubercles or cusps in their centre (Fig. 8C).
The radular formula is 8-13 × (4.2.0.2.4) for specimens between 5-15 mm preserved length. The radula has two inner lateral teeth, the innermost being smaller than the second (Fig. 7B). Both have a rectangular peak. There are four rectangular-shaped outer lateral teeth, which decrease in size towards the outer edge. The oesophagus is straight. The intestine emerges from the left side of the animal, surrounds the digestive gland anteriorly and descends to the right side to the anus. The irregularly circular-

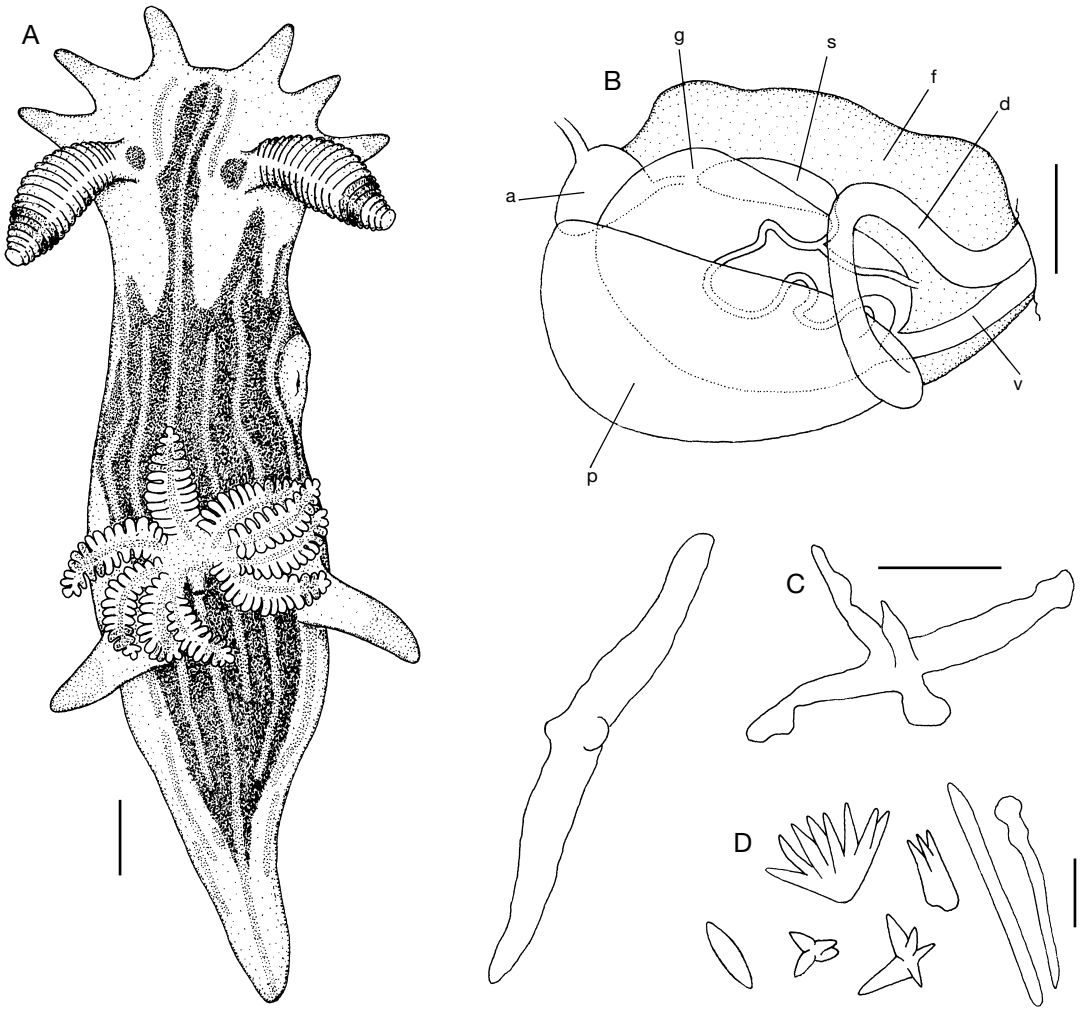

FIG. 8. — *Polycera aurantiomarginata* (MNHN); **A**, dorsal view of a dark coloured specimen alive); **B**, reproductive system; **C**, larger intergumentary spicules; **D**, smaller intergumentary spicules. Abbreviations: **a**, ampulla; **d**, deferent duct; **f**, female gland; **g**, gametolytic gland; **p**, prostate; **s**, seminal receptacle; **v**, vagina. Scale bars: A, 1 mm; B, 0.5 mm; C, 100 µm; D, 8 µm.

shaped heart is connected by the aorta to the blood gland, situated near the oesophagus.

The reproductive system has a prostate one half as long as wide (Fig. 8B). The deferent duct has three folds and is two times longer than the vagina. The vagina is short, has no folds and is connected to the gametolytic gland. The gametolytic gland is almost as long as wide. It is also connected in the distal region to the seminal receptacle by a narrow and convoluted duct. The seminal receptacle is one sixth times the size of the gametolytic gland and it is connected to the female gland by a narrow and short duct. The ampulla is almost as long as wide and it has no folds.

Spawn

The egg mass is spirally coiled, 0.6 mm in height. There are about 24 embryos occupying the whole height of the egg ribbon. The cream-coloured embryos are enclosed in a much larger capsule. There is only a single embryo per capsule. Capsule measured: 124-148 µm (mean: 136 µm).

REMARKS

García-Gómez & Bobo (1984) described *Polycera aurantiomarginata* García-Gómez & Bobo, 1984 from the South of Spain, as having a black or dark grey background colour, less pigmented in the cephalic area. Yellow lines and yellow spots are present on the dorsum and on the sides. The spots close to the foot are orange to reddish. The veil has six appendages; frequently the two central appendages are orange and the rest is yellow. The basal and apical regions of the rhinophores are translucent whitish, exhibiting less coloration than the rest of the body. There is a black ring near the apex of the rhinophore. The branchial leaves are pigmented like the rhinophores except for the rachis that is yellow. The extrabranchial processes are hyaline white at the basal area, and vary from yellow to orange nearer the apex.

The darkest specimens from Angola have the same colour pattern as the European animals. However, specimens from Angola show a great variability in the size and distribution of the patches of grey colour, which is entirely absent in several specimens.

On the other hand, both European and African specimens have numerous spicules that are identical in shape, but the spicules described by García-Gómez & Bobo (1984) were 150 µm long rather than 10 µm long as in specimens from Angola. We have examined the holotype of *P. aurantiomarginata* which has spicules with the same shape and size as the material from Angola (10 µm long or smaller). There is another type of spicules that García-Gómez and Bobo did not describe. These are fewer in number but have a much larger size (up to 200 µm) and less variability in form. They are present in the holotype and in our material from Angola. The radular formula is similar between European and African specimens, as is the radular teeth morphology. We observed no differences between the reproductive systems of García-Gómez & Bobo's (1989) original description and our material from Angola.

Polycera xicoi Ortea & Rolán, 1989 was described by Ortea & Rolán (1989) from the Cape Verde Islands. The radular morphology, external shape and coloration of this species are identical to that of *P. aurantiomarginata*, including our material from Angola. Consequently, we think that this species must be considered as a synonym of *P. aurantiomarginata.*

Genus *Thecacera* Fleming, 1828

TYPE SPECIES. — *Doris pennigera* Montagu, 1815

Thecacera pennigera (Montagu, 1815) (Figs 7C; 9)

Doris pennigera Montagu, 1815: 17, pl. 4, fig. 5.
Thecacera maculata Eliot, 1905: 241-243.
Thecacera lamellata Barnard, 1933: 294-295, fig. 1.

MATERIAL EXAMINED. — **Namibe Province.** Praia Amelia, 15°01'S, 12°08'E, 3.VIII.1985, 1 specimen 6 mm preserved length.

DISTRIBUTION. — *Thecacera pennigera* has been collected from Britain, the Netherlands, France, Sicily, South Africa, Pakistan, Japan, Australia, New Zealand and Brazil (see Willan 1976). Our data represents the first report of this species in Angola.

DESCRIPTION

The background colour is white in the living animal. The whole body is covered by orange, yellow and black spots (Fig. 9). The velum has two lateral prolongations. The rhinophores, the rhinophoral sheath, the gill (with five bipinnate branchial leaves) and the two extrabranchial processes (very long) are covered with orange, yellow and black spots as well.

The radular formula is 8 × (2.2.0.2.2). The innermost lateral tooth is smaller than the second. Both of them have a peaked hook shape (Fig. 7C). The base of the inner lateral is larger than the peak. The two outer lateral teeth are smaller than the inner laterals. The outermost lateral is smaller than the innermost. Both outer laterals are rectangular in shape.

REMARKS

As in our specimen, Thompson & Brown (1984) described specimens of *Thecacera pennigera* (Montagu, 1815) as being white with numerous irregular-shaped orange areas and black and yellow spots. However, the rhinophores described by Thompson and Brown had a yellow upper part with black speckling, while the whole rhinophore of our specimen is white with black, yellow and orange speckling. The branchial leaves are also similar, but our specimen has not only black and orange, but also yellow spots.

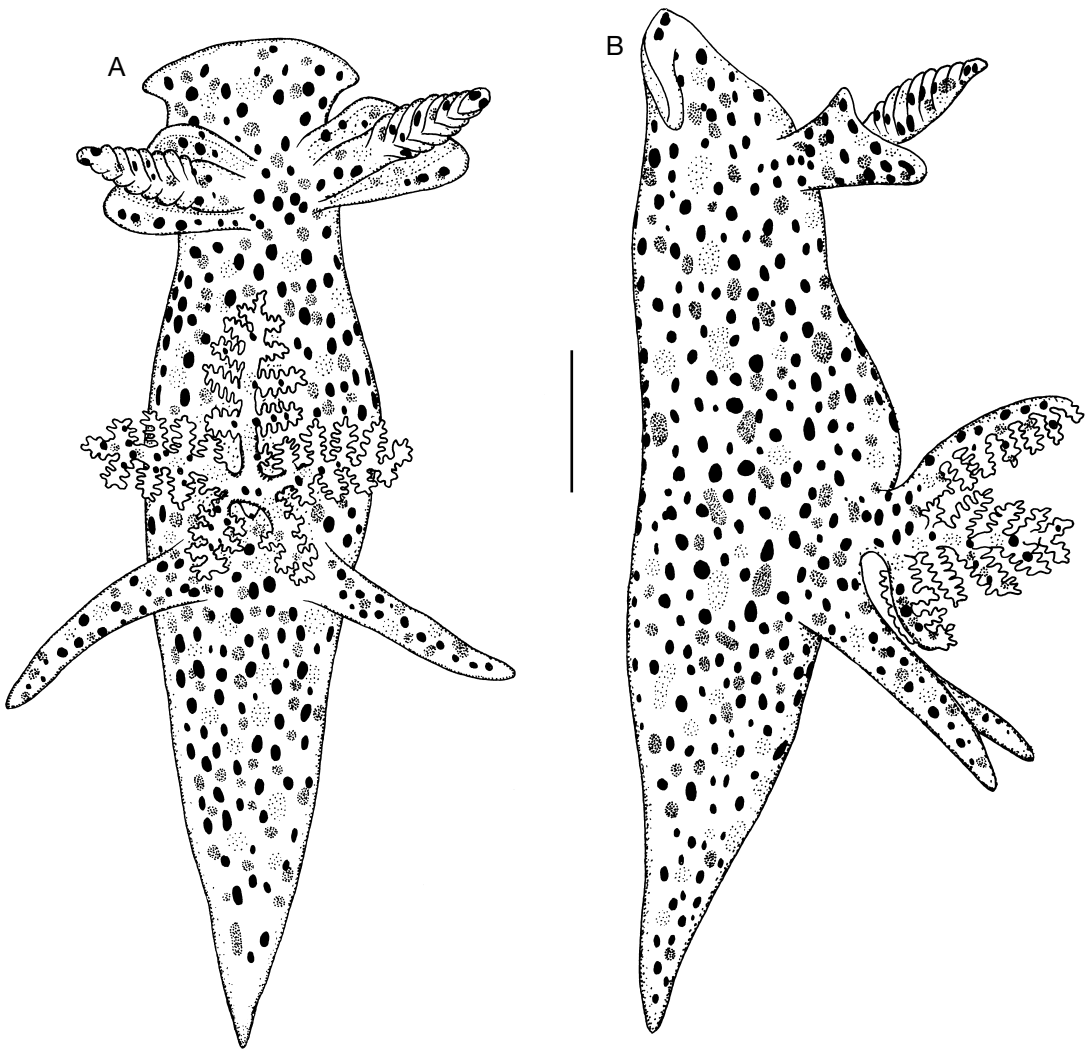

FIG. 9. — *Thecacera pennigera* (MNHN); **A**, dorsal view of the living animal; **B**, lateral view of the living animal. Scale bar: 1 mm.

Genus *Kaloplocamus* Bergh, 1892

TYPE SPECIES. — *Euplocamus croceus* Philippi, 1836

Kaloplocamus ramosus (Cantraine, 1835) (Figs 3A-C; 10)

Doris ramosa Cantraine, 1835: 383.
Kaloplocamus filosus Cattaneo-Vietti & Sordi, 1988: 50-55, figs 1-12.

MATERIAL EXAMINED. — **Luanda Province.** Ilha de Luanda, 08°48'S, 13°15'E, date unknown, 1 specimen 17 mm preserved length. — Corimba, 08°49'S, 13°13'E, IV.1982, 5 specimens 9-14 mm preserved length.

DISTRIBUTION. — This species has been reported from South Africa, Mediterranean Sea, Australia and Japan (Gosliner 1987a). This is the first report of this species in Angola.

DESCRIPTION

The background body colour is pale orange in the living animal, with bright yellow spots scattered over the entire body. The foot is pale yellow.

The dorsum has eight tripinnate bright red lateral papillae on each side, with pale orange tips on the branchial leaves (Fig. 10A). The rhinophores are uniformly orange, with a paler apex. The whole rhinophore is covered with bright yellow dots. There are five bipinnate branchial leaves that are orange with orange dots on the rachis.
The radular formula is 28 × (14.3.2.3.14) in an 11 mm specimen. The radula has a broad rachidian plate, which is traversed by a strong furrow and divided into several elongate tuberculate plates (Fig. 3A). The three inner lateral teeth are hook-shaped having a secondary cusp, and are similar in length (Fig. 3B). The 15 outer lateral teeth are rectangular and decrease in size towards the margin of the radula (Fig. 3C).
The reproductive system (Fig. 10B, C) has a prostate that is not differentiated from the deferent duct. There is a laminar mucus gland, which is three times larger than the albumen gland. The vagina is half as long as the deferent duct, but is almost the same width. The ampulla is twice as wide as the deferent duct and one half its length. The gametolytic gland is nine times larger than the seminal receptacle. They are joined together by a long thin and almost straight duct.

REMARKS

Five species of the genus *Kaloplocamus* Bergh, 1892, have been described in the Atlantic Ocean and the Mediterranean Sea: *Kaloplocamus ramosus* (Cantraine, 1835), *Kaloplocamus atlanticus* (Bergh, 1892), *Kaloplocamus aureus* Odhner, 1932, *Kaloplocamus gulo* (Marcus, 1979) and *Kaloplocamus filosus* Cattaneo-Vietti & Sordi, 1988.
Kaloplocamus atlanticus from the Azores is easily differentiated from *K. ramosus* and the other species of the genus in having a dorsal keel (Bergh 1892) on the foot, which is typical of the genus *Plocamopherus* Leuckart, 1828, and three branchial leaves, whereas *K. ramosus* lacks the dorsal keel and has five branchial leaves. Following Bergh (1892), the radular formula for an 11 mm preserved long *K. atlanticus* is 29 × (19-20.9.0.9.19-20) whereas it is 28 × (14.3.2.3.14) in a same size specimen of *K. ramosus*.
Kaloplocamus gulo has been described from Brazil based on a single specimen 11 mm long with a radular formula 21 × (17-18.3.0.3.17-18), which alive was light brown and very transparent (Marcus 1979). This species differs from *K. ramosus* in apparently lacking red pigmentation on the lateral papillae, having small bosses and tiny pointed papillae on the sides, and 17-18 outer lateral radular teeth on 21 rows, instead of 14 outer lateral teeth on 28 rows for a same size specimen of *K. ramosus.*
Kaloplocamus filosus was described as a different species from *K. ramosus* based on few morphological differences, such as the presence of small tubercles and longer tape-shaped lateral appendages (Cattaneo-Vietti & Sordi 1988). However, since the radula, and other external characteristics (arborescent lateral appendages, reduced mantle margin and pigmentation) of *K. filosus* are identical to those of *K. ramosus*, we suggest that both species should be regarded as synonyms.
The external appearance and radular morphology of our specimens from Angola are identical to those of *K. ramosus* described by Cattaneo-Vietti & Sordi (1988) from the Mediterranean Sea, except for the red pigmentation, which is present only in the lateral appendages of the specimens from Angola.

DISCUSSION

Gosliner (1987b) described the opisthobranch fauna from southern Africa as being very rich, with a high degree of endemic species. He suggested that vicariant events caused the distributional patterns of many endemic species of this area, with sister species in the North Atlantic and Indo-Pacific faunas.
On the contrary, the situation in Angola seems to be very different. In light of the species composition and geographical range of phanerobranch dorids, Angola appears to be a transitional area between the cold waters of the Atlantic coast of South Africa and Namibia, and the warm waters of the tropical coast of West Africa. Tropical and subtropical species such as *Okenia digitata*, originally described from Ghana, and *Polycera aurantiomarginata*, previously known from Gibraltar Straits and Cape Verde Islands, have been collected

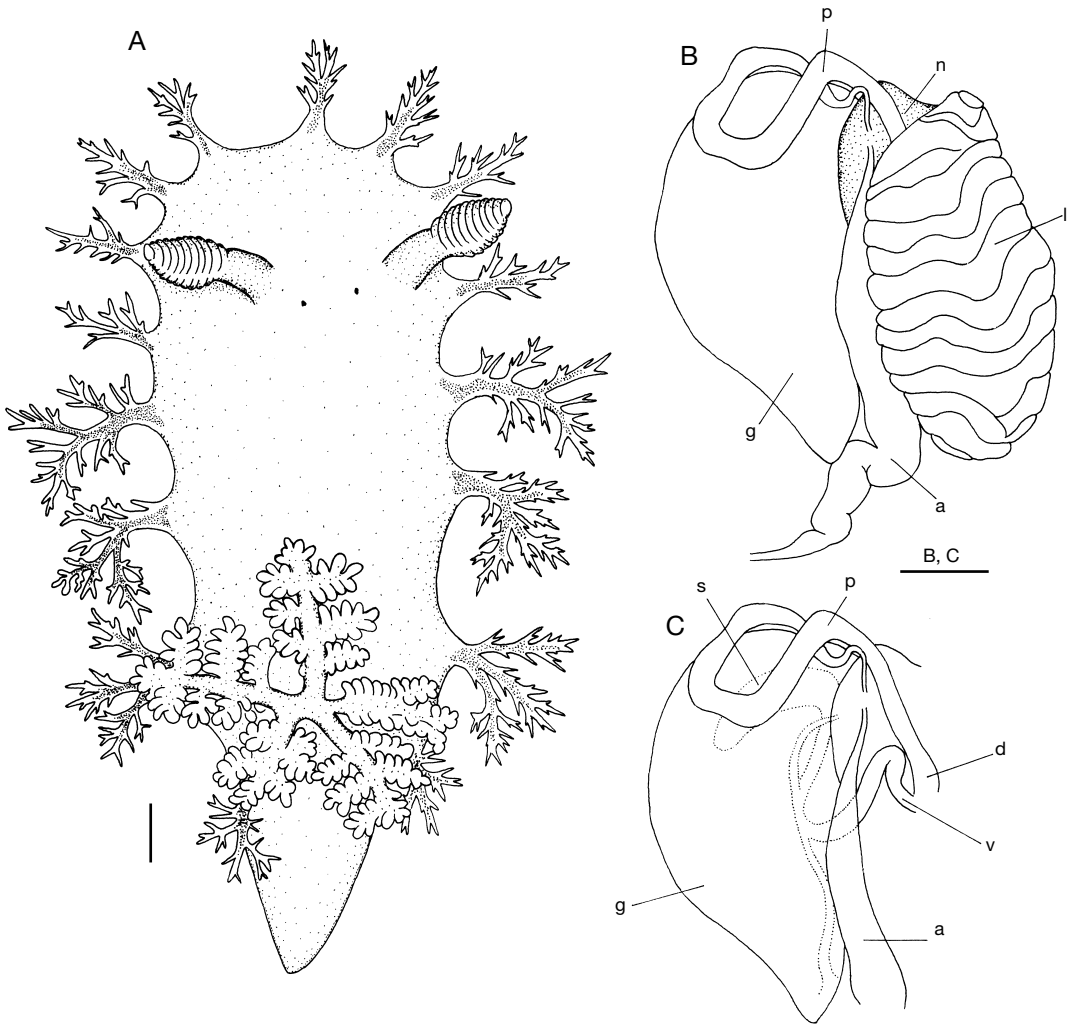

FIG. 10. — *Kaloplocamus ramosus* (MNHN); **A**, dorsal view of the living animal; **B**, reproductive system; **C**, detail of the reproductive organs hidden under the mucus and gametolytic glands. Abbreviations: **a**, ampulla; **d**, deferent duct; **g**, gametolytic gland; **l**, mucus gland; **n**, albumen gland; **p**, prostate; **s**, seminal receptacle; **v**, vagina. Scale bars: A, 1 mm; B, C, 0.5 mm.

in the northern coast of Angola. *Polycera aurantiomarginata* has also been rarely found in the southern coast, near the border with Namibia. In both cases this seems to be the southern boundary of its distributional range. On the other hand, the species *Okenia amoenula*, previously considered endemic to the Atlantic coast of South Africa, is here reported for the first time from northern Angola.

Other species, characterized by their large and discontinuous geographic ranges, such as *Kaloplocamus ramosus*, *Thecacera pennigera* and *Polycera hedgpethi*, have also been found in Angola. *Kaloplocamus ramosus* and *T. pennigera* have been mainly reported from the eastern Atlantic coast, from Europe to South Africa, but they have also been cited from other isolated points: Australia and Japan (the former) and

Brazil, Japan, Australia and New Zealand (the latter). *Polycera hedgpethi* has been recorded from California, the Pacific coast of Mexico, Australia, New Zealand, South Africa and the Mediterranean Sea. The dispersal ability of *T. pennigera* and *P. hedgpethi* has been the subject of controversy. Willan (1976) suggested that this species owes much of its distribution to transport by shipping. However, Gosliner (1987b) considered that it does not seem reasonable to ascribe the presence of these species in South Africa solely to human introduction. He remarked that introduced species retain limited ranges (generally restricted to harbours), for extensive periods of time, whereas both *T. pennigera* and *P. hedgpethi* are usually collected in localities far away of the main South African harbours. In Angola these species were only collected in the vicinity of the harbours of Moçamedes (Namibe) and Luanda, which support international shipping traffic. In this case, an artificial introduction cannot be discarded.

The last species, *Limacia annulata*, has only been recorded from Angola, and should be provisionally considered endemic to this area. Apparently, this species inhabits a gap in the range of the related *Limacia clavigera*. The latter is a common species in the European coast, Canary Islands and South Africa, but has not been recorded from the tropical west coast of Africa. However, *L. annulata* appears to be more closely related to the American Pacific species *Limacia cockerelli* (see above), which seems to be its sister species. The distributional patterns of this species could be caused by vicariant events, as Gosliner (1987b) suggested for several species from southern Africa, but a phylogenetic analysis is necessary to confirm this hypothesis.

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