OPISTHOBRANCHIATE MOLLUSCA FROM GHANA: POLYCERIDAE

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Abstract *Descriptions are given of six species of Doridoidea belonging to the family Polyceridae from Ghana, West Africa.* Thecacera pennigera *and* Polycerella emertoni *have wide geographical ranges and may have travelled on boat bottoms from their original sites.* Kaloplocamus ramosus *also has a wide geographical range but there is little evidence of it travelling on boats. The remaining three species,* Limacia annulata, Polycera *sp. and* Paliolla templadoi, *are only known from West Africa and nearby islands. The species of* Polycera *probably belongs to a currently undescribed species.*

Key words *Atlantic nudibranchs, Polyceridae,* Kaloplocamus, Paliolla, Thecacera

INTRODUCTION

This is the fourth in a series of papers describing and reviewing the doridoid opisthobranchiate molluscan fauna of Ghana (Edmunds, 1981, 2007, 2009) collected by the author and colleagues in Ghana between 1963 and 1973. The purpose of this paper is to describe the species of Polyceridae *senso lato* from Ghana. The genus *Triopha* and its relatives are sometimes split off from Polyceridae as a separate family, the Triophidae (see Willan, 1989, and Rudman & Darvell, 1990), but there is no consensus on this among nudibranch specialists, and pending a detailed DNA profiling of representatives of the relevant genera I have retained all of them in the Polyceridae. Rudman's Sea Slug Forum (2008) recognises the Triophinae as a subfamily of the Polyceridae and places the genera *Kaloplocamus* and *Limacia* in the Triophinae.

MATERIAL AND METHODS

All of the material described here was collected near to Accra and Tema in Ghana, close to 0° W, 5.7° N. Collections were made by the author searching under stones etc. at low tide and by Mr Walter Pople either by SCUBA diving on the 9–12 m deep reef at Kpone Bay off Tema or dredging in Tema Bay at 20–40 m depth. Rocks and detritus obtained by diving or dredging were kept in aquaria for a few days to encourage the smaller animals to crawl out. Most of the animals were first described alive, then narcotised with magnesium chloride and fixed, usually in Bouin's fluid, before storage in 70% ethanol. Body measurements are for living animals unless otherwise stated. The buccal mass of some specimens was removed for examination of the radula. Muscle was softened in potassium hydroxide and the radula teased out before mounting in Gurr's 'Aquamount' for microscopical examination. Further details are given in Edmunds (2007).

The material is deposited in the Natural History Museum, London.

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SYSTEMATIC DESCRIPTIONS

Family POLYCERIDAE Alder & Hancock 1845
Genus *Polycerella* Verrill 1880

Type species *Polycerella emertoni* Verrill 1880 by monotypy

Polycerella emertoni Verrill 1880
Figs 1A–C, 2A–C

Polycerella emertoni Verrill 1880: 387
Polycerella davenportii Balch 1899: 150–151, Pl. 1, Figs 2–7
Polycerella conyna Marcus 1957: 429–432, Figs 104–110
Polycerella recondita Schmekel 1965: 226–232, Figs 1–8

Material examined On *Zoobotryon verticillatum* on boat in Tema Harbour: 1 spm 3 mm long, 27 December 1967; 5 spm up to 4 mm long, 10 March 1969; 13 spm 2 to 5 mm long, 18 June 1969; 1 spm 12 October 1969; 2 spm up to 5 mm long,

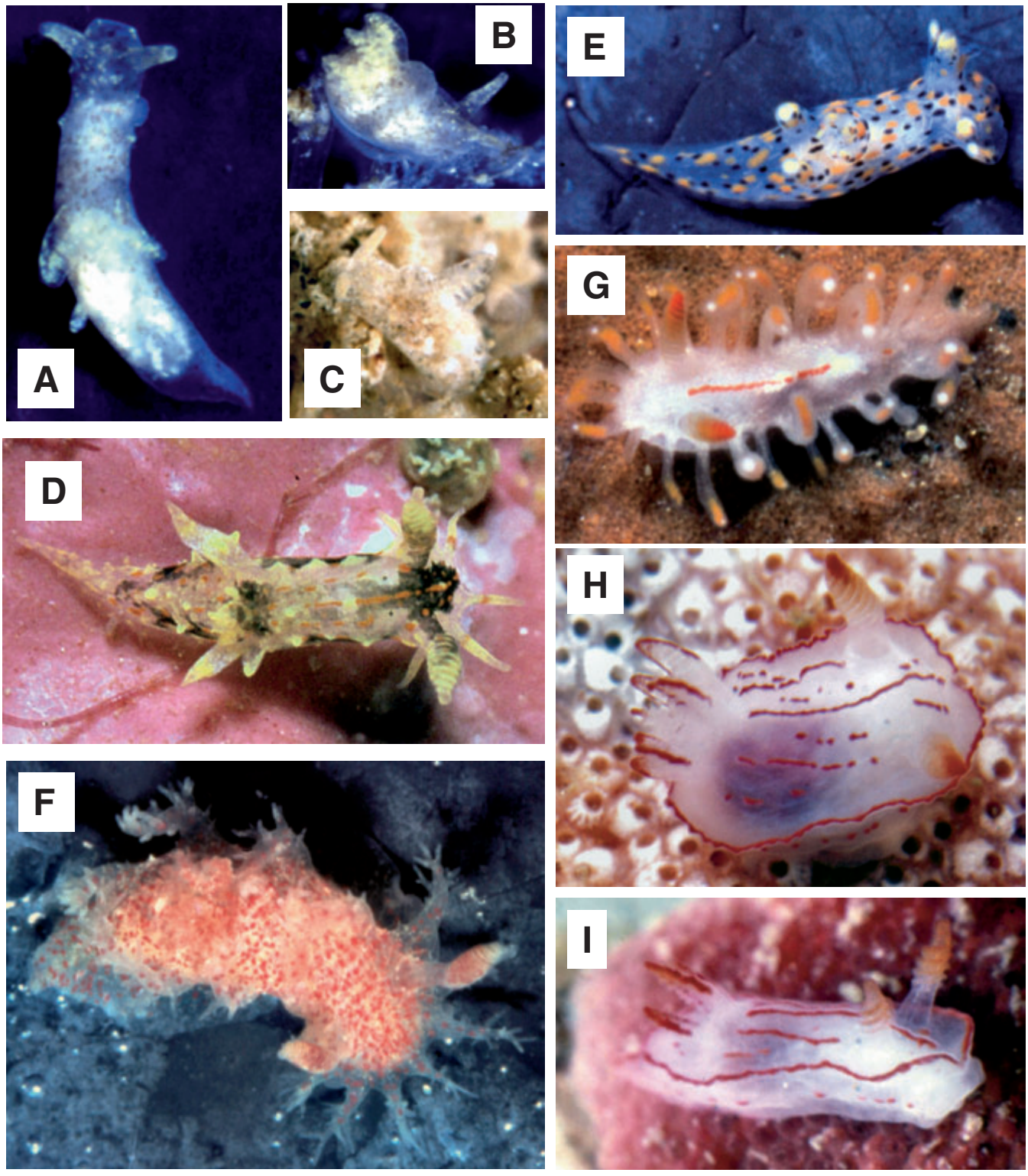

Figure 1 *Polycerella emertoni*: **A** 3 mm long, February 1969; **B** 4 mm long on *Zoobotryon verticillatum*, March 1969; **C** 3 mm long, April 1973. **D** *Polycera* sp.: 4.5 mm long, March 1970. **E** *Thecacera pennigera*: 7 mm long, February 1971. **F** *Kaloplocamus ramosus*: 10 mm long, November 1969. **G** *Limacia annulata*: 3.5 mm long, February 1970. **H** *Paliolla templadoi*: 3 mm long, feeding on *Trematoecia* aff. *magnifica*, March 1970; **I** 4 mm long, on *Alcyonidium* sp., February 1971.

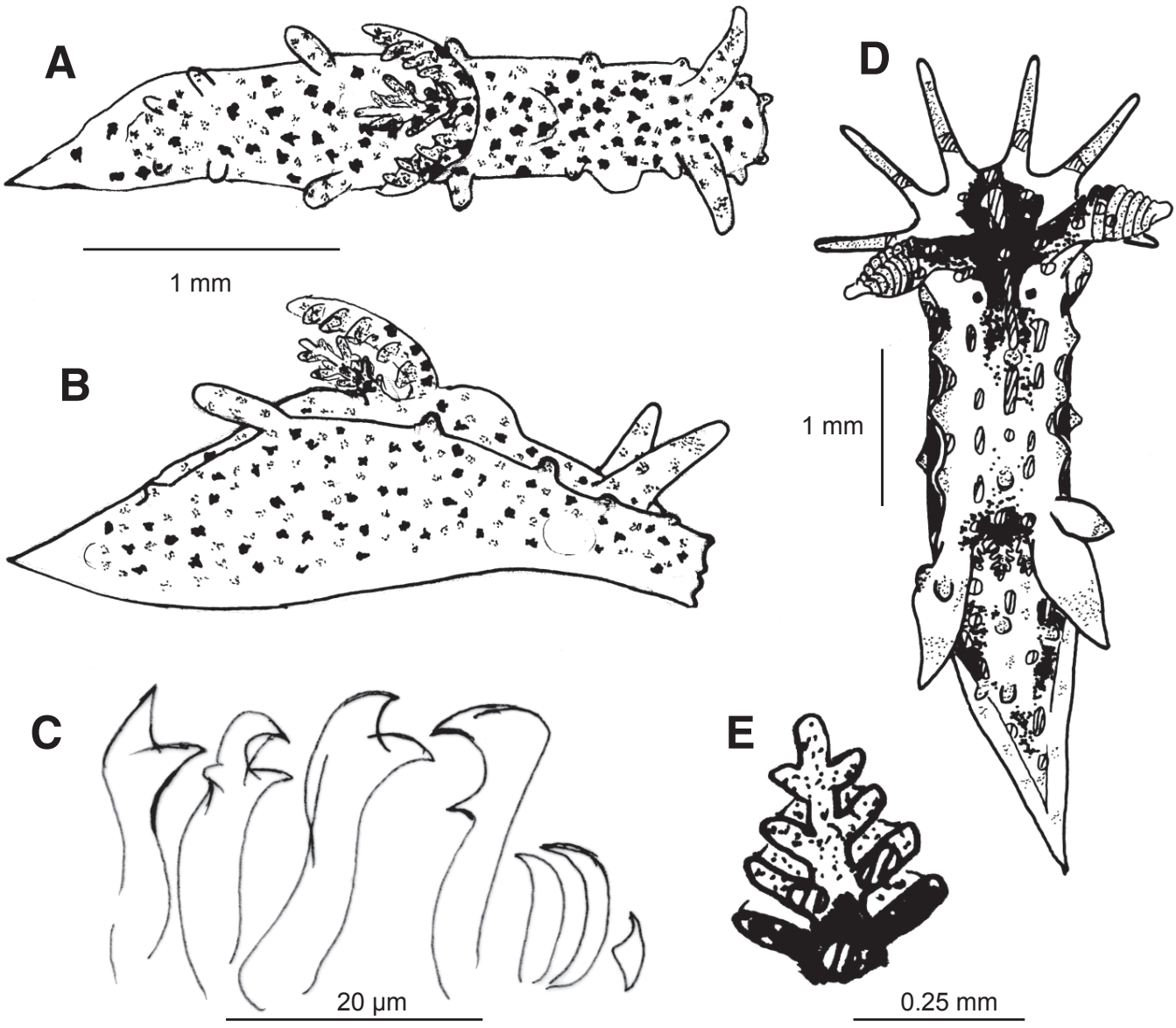

Figure 2 *Polycerella emertoni*: **A** dorsal view; **B** lateral view; **C** radula teeth: four lateral teeth, two inner marginals and one outer marginal to show their appearance at different angles of viewing. *Polycera* sp. March 1970: **D** dorsal view; **E** detail of gill. A, B, D & E are drawn from live animals. In A & B black is dark brown or maroon pigment, close stipple is cream spots; in D & E black is blackish pigment, diagonally hatched spots are orange pigment and stipple is cream pigment.

23 November 1970. On *Zoobotryon verticillatum* on wharf at Tema: 2 spm 3 & 2.5 mm long, 6 December 1968. On *Zoobotryon verticillatum* on buoy in Tema Harbour: 15 spm, 5 February 1970. On Tema Harbour: 33 spm up to 3 mm long, 15 February 1969; 5 spm, 17 February 1969. Under rocks low tide at Nungua: 1 spm, 29 January 1964. Rock pool at Teshie: 1 spm, 28 December 1970; 21 spm 2 to 3 mm long, 4 April 1973. On 10 m reef Kpone Bay: 1 spm 1.5 mm long, 10 April 1971.

External features (Figs 1A–C, 2A,B) Body elongate with blunt or shortly tapering tail, head lacking oral tentacles; mantle with inconspicuous dorso-lateral pallial ridge from which arise minute papillae, commonly two pairs on oral veil in front of rhinophores (sometimes reduced to angles), three pairs between rhinophores and gills, and two to three pairs (often asymmetrical) behind gills in animals more than 2.5 mm long, largest pair just behind the gills, papillae often with white glands; rhinophores tapering,

smooth; three irregularly bipinnate gills arising in arc, heart forming raised mound in front of gills; foot longitudinally grooved (best seen preserved) with minute antero-lateral projections. Overall appearance of animal creamy white; body translucent grey with brown spots and more numerous cream spots all over back, sides, rhinophores and gills, cream spots densest on rhinophores and gill lamellae; brown spots vary in hue from brown to maroon. Specimens from rock pools at Teshie (Fig. 1C) with blackish spots on body and gills and rhinophores tinged yellow. Preserved specimens have scattered blackish spots, not as numerous as the brown spots visible in life.

Internal morphology The radula plates are minute. The formula of one specimen is 33×2.1.0.1.2. The lateral teeth are bicuspid and sometimes have a smaller third cusp on the shaft. Marginal teeth are slender, hooked (Fig. 2C).

Geographical range This species is known under various names (see below) from west Atlantic coastal waters from Woods Hole (Massachusetts) to São Paulo (Brazil) and in the east Atlantic from the Gulf of Naples (Mediterranean) to the Atlantic coast of Spain and south to Ghana (Franz & Clark, 1972; Marcus, 1976; Schmekel & Portmann, 1982; García & Bobo, 1986, and this paper give principal references).

Ecology *Polycera emertoni* is a member of the marine fouling community where it feeds on bryozoans, typically *Bowerbankia* in north American temperate waters but on *Zoobotryon* in tropical east and west Atlantic waters and in the Mediterranean. It can therefore be readily transported on boat hulls where these encrusting organisms grow and so colonise buoys, harbours etc. throughout its geographical range. I consider it more likely that it crosses oceans on boats rather than on floating *Sargassum* because these particular bryozoans are more often found on boats than on seaweeds. The life cycle and development of *P. emertoni* have been described by Clark (1975) and Clark & Goetzfried (1978). Its occurrence in Ghana on *Zoobotryon* growing on wharves and buoys is in line with previously described habits, and it is probably widespread in similar habitats along the entire west African coast.

Remarks By 1965 four species of *Polycerella* had been described, *P. emertoni* Verrill 1880 from Massachusetts to Connecticut, *P. davenportii* Balch 1899 from Long Island, *P. conyna* Marcus 1957 from Brazil to Florida and *P. recondita* Schmekel 1965 from the Mediterranean. (A fifth species, *Polycerella zoobotryon* Smallwood 1910 from Bermuda, was shown by Clark, 1984 to be an *Okenia*, and has been discussed more recently by Edmunds, 2009.) The descriptions of *P. emertoni* and *P. davenportii* were not good enough for later workers to be certain whether or not their own material belonged to one of these species, so the Marcuses and Schmekel described their material (from tropical waters or a different continent respectively) as new species. Then Franz & Clark (1972) described the morphological variation within a population of *Polycerella* from Long Island, close to the type localities of both *P. emertoni* and *P. davenportii*. They found no consistent differences between their material and the descriptions of these two species which they therefore considered to be conspecific under the name *Polycerella emertoni*. They further suggested that *P. conyna* and *P. recondita* might also belong to the same species but they hesitated to synonymise them without examining material from the Caribbean and the Mediterranean. Eveline Marcus (1976) then examined further specimens from Brazil and from the Mediterranean and was convinced that there is just a single species of *Polycerella*. This conclusion has been accepted by subsequent authors (e.g. Schmekel & Portmann, 1982; García & Bobo, 1986). The species is characterised by variation in the number and size of small projections on the oral veil and pallial ridge; the number and size of papillae, typically one or two on each side behind the gills but sometimes with additional ones dorsally on the pericardial hump and dorsally or dorso-laterally on the tail; and the shape of the lateral radular teeth which typically have three cusps. Some of this radular variation is due to the angle of viewing of the teeth because the cusps are not all in the same plane, but some of the teeth appear to lack the third cusp (see the illustrations of Marcus, 1957, Figs 106, 107; Marcus & Marcus, 1960, Fig. 45; Marcus, 1972, Figs 1, 2; and García & Bobo, 1986, Figs 3 B, C). The lateral teeth of the present material show similar variation.

Did *P. emertoni* originate in the east or the west Atlantic? My guess is that it probably evolved

in west Atlantic waters because (a) this is the site of the earliest records (Verrill, 1880; Balch, 1899) and (b) the Mediterranean was at least as well studied by malacologists in the nineteenth and early twentieth centuries as North America yet the first record of this species from the east Atlantic (in the Mediterranean) was not until 1964 (Schmekel, 1965). *Polycerella glandulosa* Behrens & Gosliner (1988) from California is quite different in morphology from *P. emertoni*, so at present there are no records of *P. emertoni* from the Indo-Pacific although it may well spread there in the future.

Genus *Polycera* Cuvier 1817
Type species *Doris quadrilineata* O. F. Müller 1776 by subsequent designation by J. E. Gray 1847

Polycera sp.
Figs 1D, 2D,E

Material examined 10 m reef in Kpone Bay: 1 spm 2.5 mm long, 2 October 1969; 1 spm 4.5 mm long, 2 March 1970.

External features (Figs 1D, 2D) Body elongate tapering behind gills to pointed tail, three pairs of digitiform papillae on oral veil, pallial ridge with 3 pairs of raised blunt knobs between rhinophores and gills, two knobs medially in front of gills and two or three pairs posterior to gills the largest almost papillate, one or two pairs of large papillae just behind gills (as in other species of *Polycera*) largest papillae with 0–3 lateral knobs; rhinophores with lamellae sloping back from anterior ridge, 9 in larger specimen, 5 in smaller one; three small unipinnate gills; foot with minute antero-lateral projections. Body grey with suffusion of darker grey mid-dorsally; black patches on oral veil, between rhinophores, in front of gills, and on flanks; orange streaks and spots forming three broken dorsal lines between rhinophores and gills, scattered streaks and spots elsewhere on head, tail and sides; minute cream dots scattered over body and forming several larger spots mid-dorsally on back, tail, sides and on projections to pallial ridge. Oral tentacles with pale grey base and tip, basal orange band followed by cream band; rhinophores with blackish basal half anteriorly, cream distally, tip clear and several orange spots on clavus; dorsal papillae with minute white spots becoming cream distally, knobs cream; gills with blackish base anteriorly and orange spots, cream distally (Fig. 2E).

Internal morphology Not examined.

Geographical range Known only from Ghana.

Remarks The colour pattern of these specimens is distinctive and quite different from any of the species illustrated in the Sea Slug Forum (2008) or by Debelius & Kuiter (2007). It is closest to *Polycera odhneri* Marcus 1955 illustrated by J. Hamann in Valdés, Hamann, Behrens & DuPont (2006) and in Debelius & Kuiter (2007). Like *Polycera odhneri* it has much black on the body with orange spots and stripes, as well as raised cream tubercles on the pallial ridge, back and flanks. However it has six oral tentacles with a basal orange band and large papillae beside the gills whereas *P. odhneri* usually has four oral tentacles (occasionally six) with a dark band and no papillae beside the gills (Marcus, 1955; Edmunds & Just, 1985). Other species of *Polycera* (including *P. hedgepethi* Marcus 1964 and *P. aurantiomarginata* García-Gómez & Bobo 1984 from Angola) differ in colour, lack of raised tubercles and different numbers of tentacles on oral veil (Vallès, Valdés & Ortea, 2000). The present specimens appear to belong to an undescribed species closely allied to *P. odhneri*. Unfortunately the larger specimen was lost and the smaller one dried up due to a defective vial stopper, so without a specimen to designate as a holotype this species remains unnamed.

Genus *Thecacera* Fleming 1828
Type species *Doris pennigera* Montagu 1815 by original designation

Thecacera pennigera (Montagu 1815)
Figs 1E, 3B

Doris pennigera Montagu 1815: 17–18, Pl. 4 Fig. 5
Thecacera pennigera – Fleming, 1828: 283
Thecacera maculata Eliot 1905: 241–243
Thecacera lamellata Barnard 1933: 294–295

Material examined 10 m reef Kpone Bay: 1 spm 2.5 mm long, 2 October 1969; 2 spm. 3.5 & 7 mm long, 22 February 1971. Teshie at low tide: 1 spm, 9 April 1970.

External features (Figs 1E, 3B) Body elongate with tapering pointed tail; oral tentacles and pallial ridge absent; one pair large papillae behind gills; rhinophores surrounded antero-laterally by broad sheath, with four to ten lamellae; one to six gills (depending on size of animal) in arc, largest bipinnate; foot with antero-lateral projections. Body grey covered with black spots and orange spots, spots increase in number but not in size as animals grow; rhinophores yellow with several black and orange spots, tip clear; rhinophore sheaths and dorsal papillae with orange and smaller black spots, large white defensive gland at bulbous tip; gills with orange and black spots on rhaches.

Internal morphology The animals were all young but so obviously closely similar to European *T. pennigera* that the radula and internal anatomy were not examined.

Geographical range Thecacera pennigera is a cosmopolitan species in warm temperate and tropical shallow seas but is absent from cold temperate and arctic/antarctic waters. There are records from the British Isles, the Netherlands and the Atlantic coast of Europe (Thompson & Brown, 1984; Cervera & García, 1986), the Mediterranean (Vayssière, 1913; Cervera *et al.*, 2006), Canary and Madeira Islands (Cervera *et al*., 2006), Senegal (Rudman, 1998–2005: Poddubetskaia, Mar 8, 2004), Ghana (this paper), Angola (Vallès *et al*., 2000), South Africa (Macnae, 1958; Gosliner, 1987), Pakistan (Eliot, 1905), Japan (Baba, 1960), Australia (Burn, 1978), New Zealand (Willan, 1976) and Brazil (Marcus, 1957).

Remarks Willan (1976) synonymised *Thecacera maculata* Eliot 1905 and *T. lamellata* Barnard 1933 from the Indo-Pacific with *T. pennigera* from the Atlantic Ocean. Like *Polycerella emertoni*, this is a tramp species which now occurs throughout the world in temperate and tropical waters where it feeds on species of the bryozoan genus *Bugula* (Willan, 1976; Thompson & Brown, 1984). Gosliner (1987) found a colony of this species in South Africa several hundred kilometres from ports frequented by shipping so he suggested that it may be a long-term resident here. Marcus (1957) also found it well established in the intertidal zone away from harbours in Brazil. The Ghanaian specimens were from the intertidal zone or a shallow reef but only a few kilometres from Tema harbour, so it is likely that this species can travel widely on boats and then spread into neighbouring environments where there is suitable bryozoan food.

T. pennigera usually has black and orange spots all over the body but there is some variation in the disposition of colours: in both British and Ghanaian specimens the ground colour of the rhinophores is yellow while in the specimen from Angola it is white. There is considerably more colour variation in specimens from Australia and Japan, and this has led Rudman (1998–2005: Mar 26, 1998, Jun 20, 2005) to suggest that the species may have originated in the Indo-Pacific, and that the forms which were transported to the Atlantic were much less variable in colouration. However, the diversity of colouration shown by specimens from different parts of the world (well illustrated by Debelius & Kuiter, 2007) suggests that *Thecacera pennigera* may conceal several closely related but distinct species. A careful examination including DNA profiling of populations from Japan, Australia and the Atlantic could resolve this problem.

Genus *Kaloplocamus* Bergh 1892

Type species *Euplocamus croceus* Philippi 1836 by monotypy

Kaloplocamus ramosus (Cantraine 1835)

Figs 1F, 3A

Doris ramosa Cantraine 1835: 383
Euplocamus croceus Philippi 1836: 103, Pl. 7 Fig. 1
Euplocamus frondosus Philippi 1839: 114, Pl. 3 Fig. 1
Euplocamus ramosus – Cantraine, 1840: 54
Idalia ramosa – Philippi, 1844: 76, Pl. 19
Euplocamus japonicus Bergh 1880: 636–639, pl. 13 Fig. 17, Pl. 14 Figs 3–10
Caloplocamus ramosus – Baba, 1937: 293
Kaloplocamus ramosus – Baba, 1949: 42–43, 136, Fig. 40, Pl. 13 Figs 46–47
Kaloplocamus filosus Cattaneo-Vietti & Sordi 1988: 50–55, Figs 1–12

Material examined Dredged in Tema Bay: 35 m depth, 1 spm 4 mm long, 9 October 1968; 40 m depth, 1 spm 8 mm long, 14 November 1968; 40 m depth, 1 spm 10 mm long, 28 November 1969; 30–32 m depth, 1 spm 10 mm long, 8 May 1970.

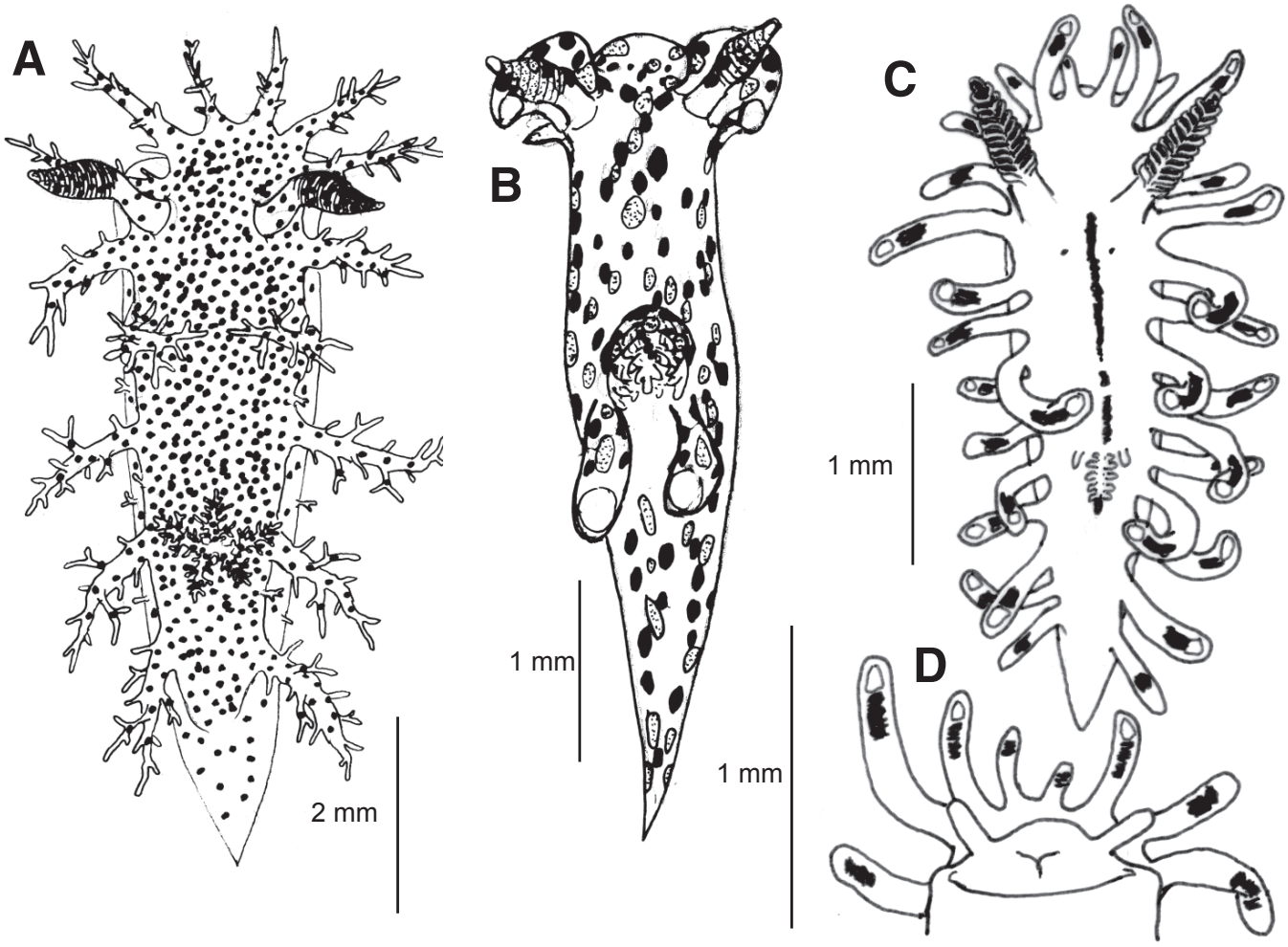

Figure 3 *Kaloplocamus ramosus*: **A** dorsal view. *Thecacera pennigera*: **B** dorsal view. *Limacia annulata*: **C** dorsal view; **D** ventral view of head. All are of live animals. In A & C black is orange pigment; in B black is black pigment, stipple is orange pigment; circles at tips of rhinophore sheaths and dorsal papillae in B and in papillae in C and D are white glands.

External features (Figs 1F, 3A) Body elongate but broad, tapering abruptly to pointed tail; eight pairs of elongate irregularly branched papillae arising from oral veil and mantle edge; larger specimens with several minute papillae on flanks and sides of foot; oral tentacles short, rounded; up to 18 lamellae on rhinophores meeting on frontal ridge; five or six bipinnate gills in larger specimens, three unipinnate gills in smallest specimen; foot broader than body, rounded anteriorly without projecting corners. Body pale grey with cream viscera visible through body wall, small orange-red spots evenly distributed over dorsal and lateral surfaces but fewer on foot edge, minute inconspicuous white dots also scattered over body; rhinophores grey, sometimes cream distally and as frontal line on club with orange spots on club and stalk; papillae pale grey with orange spots; gills grey with orange spots on rhaches and larger pinnae.

Internal morphology Not examined as the species is readily identified from external features.

Behaviour When at rest or crawling the papillae are normally held spreading horizontally apart from the fifth pair which arch over the back. The smaller branches of the papillae twitch or retract and extend slightly even when the animal is resting. The function of this twitching is not clear; it could facilitate gaseous exchange, although since the animal also has typical dorid gills this seems unlikely. Alternatively it could possibly be a warning that the animal is unpalatable: when the animal is disturbed or prodded with forceps the papillae are extended up to 5 mm in length

and waved towards the point of stimulation. They then twitch and secrete a viscous white fluid which is presumably defensive in function, but it is not acidic (tested with BDH wide range indicator paper).

Geographical range Mediterranean (Schmekel & Portmann, 1982; Cervera *et al*., 2006), Canary Islands, Madeira and the Azores (Cervera *et al*., 2006; Malaquias *et al.,* 2008), Ghana (this paper), Angola (Vallès *et al*., 2000), South Africa (Gosliner, 1987), Japan (Baba, 1949, 1989), Hong Kong and Australia (Rudman & Darvell, 1990).

Remarks Although originally described from the Mediterranean, this species has also been reported from South Africa, Japan and Australia. Dorid nudibranchs with such a wide geographical range are often ones that can find food and hence transport on boat hulls (e.g. *Thecacera pennigera*), but it is not known if species of *Kaloplocamus* together with their foods can survive on boat hulls and so travel around the world in this way.

Kaloplocamus ramosus exhibits considerable variation in both inter- and intra-population colouration. Pruvot-Fol (1951) illustrates two colour forms from the Mediterranean of which her Plate 2 Fig. 3 is similar to the specimens from Ghana. Baba (1989) describes a uniformly orange form and an orange spotted form on a white or orange-yellow body from Japan, but with no clear differences between them in external or internal morphology. These have been illustrated in colour by Baba (1949) of which Fig. 47 is similar to the present material while Fig. 46 is different. A similar range of colour variation occurs in Australian specimens (Rudman & Darvell, 1990) such that it is possible that not all belong to the same species. Many of these colour forms can be seen on the Internet in *Sea Slug Forum* (2008) and in Debelius & Kuiter (2007). Specimens from Angola are pale orange with bright yellow spots (Vallès *et al*., 2000). Variation in colour of the body and internal organs may be caused by differences in diet, but presence or absence of orange spotting implies either that the species is polymorphic or that more than one species is present. It is unlikely that the juveniles are spotted and the adults uniformly orange: although Pruvot-Fol's spotted form was only 2 mm long and the largest of my specimens was 10 mm, Baba records spotted forms from 10 to 55 mm in length and orange specimens from 20 to 65 mm, Schmekel & Portmann (1982) report a yellow specimen of 14 mm, and Ortea, Moro & Caballer (2001) report very small specimens some of which were spotted and others not.

For the present I consider that all of the animals described in the references cited here belong to a single species, although there does appear to be morphological as well as chromatic variation in some of the specimens illustrated in Sea Slug Forum (2008). Three studies would help to resolve the question of whether there is one or several species confused under the name *Kaloplocamus ramosus*: first, experiments to determine if colouration varies with diet; second, a study of a polymorphic population to determine if different colour forms mate with one another; and third DNA profiling of specimens with different colours and from different localities.

Genus *Limacia* O. F. Müller 1781
Type species *Doris clavigera* O. F. Müller 1776 by monotypy

Limacia annulata Vallès, Valdés & Ortea 2000
Figs 1G, 3C,D

Limacia annulata Vallès, Valdés & Ortea 2000: 20–22, Figs 4–5

Material examined Dredged from 40 m south of Tema: 1 spm 3.5 mm long, 10 February1970.

External features (Figs 1G, 3C,D) Body broadly oval with short tapering tail, foot almost as broad as body; 15 papillae on each side arising from edge of mantle, of variable length, all with spicules in basal half; oral tentacles short, rhinophores with short stalk and 11 lamellae meeting in a posterior groove, single unipinnate gill with one minute papilla on each side of it which could be smaller gills lacking pinnae or processes similar to the lateral papillae. Colour semi-transparent grey, mid-dorsal orange stripe from between rhinophores to gill, longer papillae with orange stripe distally and conspicuous white gland between orange and tip, shorter papillae lacking white gland; rhinophores with colourless base, then yellow and distal half orange; gill with yellow stripe on rhachis and tip.

Internal morphology The animal was not dissected to preserve the single specimen intact.

Geographical range Known only from Angola (Vallès *et al*., 2000) and Ghana (this paper).

Remarks *Limacia annulata* was described from Angola on the basis of two specimens 6 and 9 mm long preserved (Vallès *et al*., 2000), characterised by 26 pairs of lateral papillae each with a red ring and a white spot near the tip, and with a few red spots on the notum. The present specimen was only 3.5 mm long alive so it is not surprising that it has fewer papillae. It resembles the Angolan material in having a large white spot distally on the larger papillae and below this a brightly coloured region, but this is not really a ring and is reddish orange rather than red. A ring of colour implies superficial pigment in the epidermis, but in the present specimen it is a cylinder in the central core of the papilla that is coloured with the epidermis transparent and uncoloured. There are two possibly significant differences between the Ghanaian and the Angolan specimens: in the Ghanaian specimen there is a mid-dorsal stripe on the back instead of a few scattered red spots; and Angolan material had five white gills with a few red spots while the Ghanaian specimen has just a single gill with a yellow stripe. This difference could be a matter of age as the Ghanaian animal had a minute projection on either side of the gill which could be an early stage in the development of further gills as the animal grows. Thus while it is possible that the Ghanaian specimen is a hitherto undescribed species, I consider it more likely that it is conspecific with Angolan specimens of *L. annulata*, and that there is some variation in the disposition and hue of the red or orange colour. The white spot at the tips of the larger papillae appears to be diagnostic: it is probably a defensive gland which has not been described in other species of the genus reviewed by Vallès *et al*. (2000) and by Rudman (in Sea Slug Forum, 2008).

The colour of the best known species of the genus, *Limacia clavigera* (O. F. Müller 1776), varies: it is usually yellow in British and north-western European specimens but orange in those from the Mediterranean, although in some individuals the hue is almost red (Schmekel & Portmann, 1982). *Limacia lucida* (Stimpson 1855) from South Africa has been illustrated by Gosliner (1987) who considered it to be synonymous with *L. clavigera*: it is bright orange with the same colour pattern as European specimens and it lacks the white glands of *L. annulata*. It has a disjunct distribution with records from northern Europe to the Mediterranean, the Canary Islands and the Azores (Cervera *et al*., 2006), and also on the southern coast of South Africa (Gosliner, 1987). It may therefore be present but unrecorded on the coast of West Africa. Alternatively it may be more of a cool water species since it occurs in the Faroes and northern Norway (Platts, 1985) as well as in the warmer waters of the Mediterranean and the Canaries, in which case it may be replaced by *L. annulata* in West Africa. If this is the situation then the South African population could have been founded by immigrants on boats. It feeds on *Electra pilosa* and other bryozoans in Europe (Thompson & Brown, 1984) and on *Membranipora* in South Africa (Gosliner, 1987), so, like *Thecacera pennigera*, it may be able to live on bryozoans growing on boat hulls.

Genus *Paliolla* Burn 1958
Type species *Polycera cooki* Angas 1864 by original designation

Paliolla templadoi (Ortea 1989)
Figs 1H–I, 4A–H

Esuriospinax templadoi Ortea 1989: 23–25, Fig. 7
Paliolla templadoi – Ortea, Rolan & Valdés, 1992: 103–107

Material examined 10 m reef Kpone Bay: 2 spm, 8 March 1970; 1 spm, 10 February 1971; 1 spm, 11 March 1971. All about 3–4 mm long.

External features (Figs 1H–I, 4A–F) Body elongate oval with tail projecting at rear, edge of mantle finely corrugate/serrulate; oral tentacles short, broadly linear in one specimen (Fig. 4C) blunt and rounded in a second one and when preserved (Fig. 4B); rhinophores with up to eight lamellae sloping down from front to rear; up to eight unipinnate gills each with up to nine pinnae. Colour semi-transparent whitish grey with five bright longitudinal orange stripes dorsally, lateral ones incomplete, orange submarginal band round mantle edge (Fig. 4A inset), up to 15 orange spots on each side most in a single row, orange line (in one specimen) or spots on tail; oral tentacles (when present) tipped

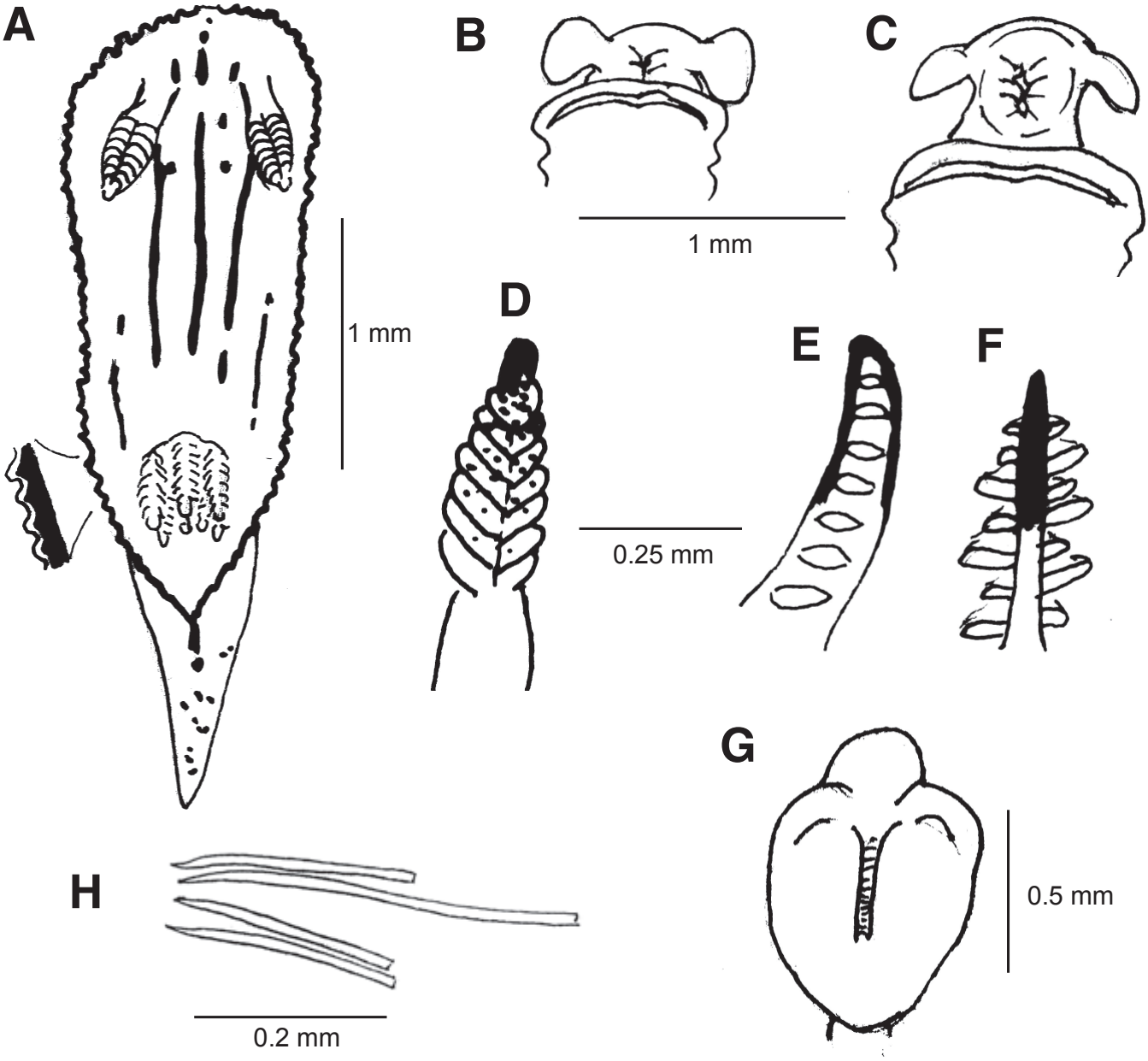

Figure 4 *Paliolla templadoi*: **A** dorsal view; **B**, **C** ventral view of head of two preserved specimens; **D** rhinophore, posterior view; **E** gill in side view; **F** gill in frontal view; **G** buccal mass; **H** radular teeth. A, D, E & F are drawn from live animals; black is orange pigment, small dots in D are yellow suffusion.

orange; rhinophores colourless below, then yellow rings merging to orange tip; gills colourless with orange stripe distally at front and rear.

Internal morphology The buccal mass is spherical (Fig. 4G) and the radula unusual among doridacean nudibranchs in that it is composed of a bunch of unusually long needle-like teeth (Fig. 4H).

Geographical range Cape Verde Islands (Ortea, 1989), São Tomé (Ortea *et al*. 1992) and Ghana.

Ecology Two of the four animals were found on the cheilostomatous bryozoan *Trematoecia turrita* (Hastings). One rested on the edge of the bryozoan and its buccal mass was observed jerking up and down every few seconds. Because it has needle-shaped radular teeth I conclude that it was piercing the *Trematoecia*. After two hours all of the opercula near the animal had been opened and the lophophore and soft tissues of the zooids removed, presumably sucked up. Later one of these animals was observed feeding on *Trematoecia* aff. *magnifica* (Osborn) leaving

several zooids opened and the orange cuticle stripped off. A third specimen was feeding on a bryozoan which was identified as close to *Reptadeonella*. The animals were also kept with four other bryozoans, *Metarabdotos unguiculatum cooki*, *Steganoporella magnilabris*, *Stylopoma duboisii* and *Alcyonidium* sp., but they did not feed on any of these.

Remarks The genus *Paliolla* Burn 1958, was established for *Polycera cooki* Angas 1864, because this species has needle-like radular teeth bound together in bundles. Burn (1975) later gave a more thorough description of its internal anatomy and considered that its discrete reproductive organs lying on top of the digestive gland justify its placement in the Gymnodorididae. Unaware of these papers, Ortea (1989) proposed a new genus, *Esuriospinax*, for his new species with similar radular teeth which he placed in the Polyceridae Gymnodoridinae. Later Ortea *et al*. (1992) realised that *Esuriospinax* was unnecessary and that *Esuriospinax templadoi* should be transferred to *Paliolla*, which they placed in the Goniodorididae. Burn (1975) had earlier pointed out that *Paliolla* is probably closely related to the genus *Lecithophorus* Macnae 1958 from South Africa which completely lacks a radula (see also Rudman, 2007). Rudman (2001), however, places *Paliolla* in the Polyceridae while retaining *Lecithophorus* in the Gymnodorididae. For convenience rather than as a result of a detailed comparative study I place *Paliolla* in the Polyceridae.

The present specimens are similar in colouration, external morphology and radula to material of *P. templadoi* from the Cape Verde Islands and from São Tomé so I have no hesitation in considering them to belong to the same species.

Discussion

Of the six species of Polyceridae described in this paper *Thecacera pennigera* is cosmopolitan, *Kaloplocamus ramosus* also occurs world-wide but only in warm waters, and *Polycerella emertoni* occurs on both sides of the Atlantic in both temperate and warm waters. *Thecacera pennigera* and *Polycerella emertoni* both feed on bryozoans that thrive on boat hulls and so can travel widely across oceans. However, although *Polycerella emertoni* can live in temperate waters of the north Atlantic it seems not to have crept round southern Africa or Chile to colonise the Indian and Pacific Oceans. The wide geographical ranges of these two species may be a recent phenomenon due to their ability to feed and reproduce on boat hulls and then to colonise buoys and other structures associated with shipping harbours. This may also apply to *Kaloplocamus ramosus* but I am not aware of any evidence of it being found on boats or on man-made structures in harbours.

The other three species, *Limacia annulata*, *Polycera* sp. and *Paliolla templadoi*, are restricted to West Africa and also (in the case of *Paliolla templadoi*) the warm water Atlantic islands. These species appear to be more specialised in their ecological requirements than the first three species, possibly because they have a more restricted range of bryozoan foods that do not thrive on boats.

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