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Notaspidean Opisthobranchiate Molluscs from Southern Africa.

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With 7 Text-figures.

THE order Notaspidea of the sub-class Opisthobranchia comprises two families, Umbraculidae and Pleurobranchidae ; and some would divide the former family into two separating the Tylodinidae. From southern Africa thirteen species of these families have been recorded and as a result of the present study seven are added of which three are described as new.

Of this order the following were recorded by Krauss (1848) :

Umbraculum sinicum as *Umbrella indica.*
Berthella granulata as *Pleurobranchus granulatus.*

Vayssière (1901) added

Pleurobranchaea capensis.

This species is also listed and described by Bergh (1907) and O'Donoghue (1929) ; it is an off-shore form trawled near the Cape Peninsula.

Bergh (1907) described

Pleurobranchaea melanopus.
Euselenops pleurobranchaeana as *Oscaniopsis.*
Pleurobranchus nigropunctatus as *Oscaniella.*

Of these the first was trawled off Cape Town, the second off the Tugela river mouth and the third was taken, presumably swimming in a tow net off Cape Infanta. Bergh also described as *Berthella granulata* Kr. a specimen which he himself stated was not identical with this species, and which was renamed *Pleurobranchus disceptus* by O'Donoghue (1929).

O'Donoghue (1929) gave full descriptions of *Umbraculum sinicum* from Inhaca, *Pleurobranchaea capensis* and *P. melanopus* presumably from the type locality and *Euselenops luniceps.* He described as new

Pleurobranchus sculptata.
— *papillosa.*
Pleurobranchoides gilchristi.

The first two were collected at Inhaca, the last was trawled. Although I collected many specimens of *Pleurobranchus* at Inhaca I have been unable to identify them with O'Donoghue's species. The description given of *P. papillosa* can be made to fit *P. peroni* and I suspect that these may be synonymous, and in fact *P. peroni* is abundant in the Bay of Lourenço Marques. *P. sculptata*

appears to resemble *P. inhacae* described below but this identity could only be proved by comparing specimens and O'Donoghue does not state where his specimens were deposited.

Turton (1932) described

Tylodina alfredensis.

So far as I am aware this species has not been found subsequently.

Family Umbraculidae.

Umbraculum sinicum (Gmelin).

For full synonymy see O'Donoghue, 1926, 36.

This common and widespread Indo-west-Pacific species is common on the sheltered shores of Inhaca island at the entrance to the Bay of Lourenço Marques.

During the day the animals lie half buried in the uppermost soft layers of the muddy substratum, with only the shell visible. When cleared of mud the sides of the foot are found to be more or less deep strawberry pink or pinkish-orange with large paler nodules scattered over the surface. The sole of the foot is usually a brilliant orange. When handled the animal gives off a characteristic scent slightly reminiscent of that of aplysiids. This scent may have some defensive function.

The length of the largest specimen examined is 95 mm., its breadth 80 and its height 38 mm. The ovoid cap-shaped shell is 80 mm. by 65 mm.

Family Pleurobranchidae.

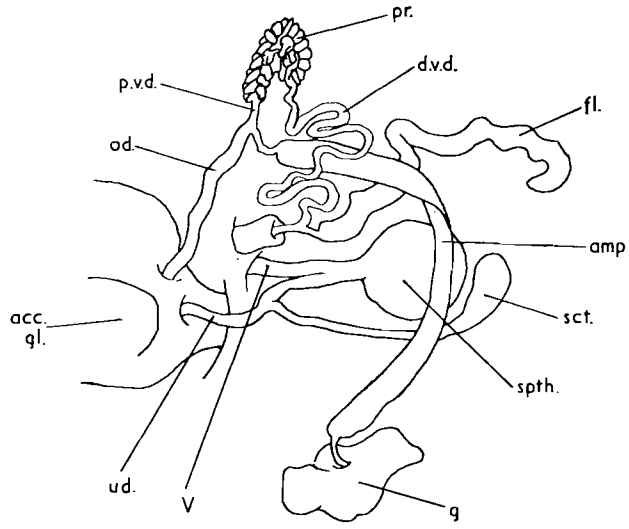
This family is widely distributed in the Indo-west-Pacific. On the southern shores of Moçambique and along the east and south coasts of the Union of South Africa species of five genera have been found. They may be distinguished on external characters by the following key :

1.	Head not distinctly visible beneath mantle edge	2
—	Head projecting beyond mantle edge	3
2.	Gill rachis smooth	*Berthella*
—	Gill rachis tuberculated	*Pleurobranchus*
3.	Velum broad, gill rachis tuberculated	*Euselenops*
—	Velum narrow, gill rachis smooth	4
4.	Finger-like process on dorsal surface of tail	*Pleurobranchaea*
—	No finger-like process on tail	*Pleurobranchoides*

Several authors have used as taxonomic criteria features which have a dubious value. For example the presence of a metapodial gland, a prominent gland on the posterior end of the sole of the foot has been commonly used as a feature diagnostic of the genus *Pleurobranchus*. Thompson (1959) has shown that such a gland is not present in juveniles but only in older specimens. My own observations suggest that even in fully grown specimens it is not always present,

but only in those which are sexually active. Fully grown individuals which are not " in season " do not possess it.

The presence of a shell in all genera with tiny shells is also a criterion of doubtful value. Such a shell is always very small and frequently difficult to locate. In freshly collected specimens of both *P. peroni* and *P. inhacae* it is readily found in most cases but an occasional specimen may be found without a shell. So the presence and characters of the shell can be of only minor taxonomic importance.



TEXT-FIG. 1.

Basic plan of the genital organs of a generalized pleurobranchid. *acc. gl.*, accessory glands of the oviduct commonly known as the mucous and albumen glands ; *amp*, ampulla of hermaphrodite duct ; *dvd*, distal portion of vas deferens ; *fl*, flagellum of penis, a diverticulum of the vas close to the base of the penis ; *g*, gonad ; *od*, oviduct ; *p*, penis ; *pr*, prostate gland ; *pvd*, proximal vas deferens ; *sct*, spermatocyst ; *spth*, spermatheca ; *ud*, uterine duct ; *v*, vagina.

The extent of the mantle and velum seem to be of value in living specimens but are not so useful in preserved ones. The presence or absence of tubercles on the gill rachis has value as a generic character. In living specimens texture of the skin and its colour appear also to be constant within a species and are frequently of taxonomic use.

Of the internal organs the central nervous system and the gut follow a pattern highly characteristic for the family with some generic but few specific variations in the armature of the mandibles and radula. The anterior genital mass in this family is rather complex and follows a pattern highly diagnostic of the family. From species to species there is considerable variation in detail, particularly having regard to the male ducts and the vaginal communications both with the exterior and with the oviduct.

The basic pattern is shown in fig. 1, and specific variations from this basic plan are indicated in text-figs. 2–7. Normally there are three genital openings, that of the oviduct being posterior, the vaginal opening is central and the penial aperture is the most anterior. Sometime the two former open into the same depression, in which case the animal will appear to be diaulic. All of these openings lie close together and during copulation the entire area swells so that they come to lie at the summit of a papilla and are separated from one another by various frilly, leaf-like processes. The gonad lies on the surface of the digestive gland or is buried within it. The hermaphrodite duct is in three sections, the proximal portion is narrow, the median portion is swollen into an ampulla, functioning as a seminal vesicle, which may be coiled into a " spring " or may pass round the mass directly to the distal portion which is narrow and of variable length. It divides into the vas deferens and the oviduct. The oviduct passes very shortly into the glandular mass and thence to the oviducal opening. The vas is long and coiled, the proximal portion usually narrow and non-glandular, the distal portion usually wider and glandular. There is usually a prostate gland associated with the proximal portion. The penis is variable ; usually long, narrow and acrembolic, it may be short and thick. In some species of *Berthella*, there is a glandular diverticulum or flagellum on the distal vas deferens at the base of the penis. The vagina communicates directly with the spermatheca, and its length is normally similar to that of the penis of the same species. From the spermatheca a duct leads off to the spermatocyst, this duct often lies adherent to the vagina and diverges. The spermatocystic duct is continuous with the uterine duct which leads into the oviduct. In the more primitive members of the family this junction occurs before the oviduct passes into the glandular mass ; but in some species of the genera *Berthella* and *Pleurobranchus* the uterine duct passes parallel to the vagina right to the body wall then turns aside to enter the glandular mass and presumably joins with the oviduct within it. In most species of *Pleurobranchus* and of *Pleurobranchaea* the oviduct joins the vagina which in turn enters the oviduct close to its external opening.

Genus *Berthella* de Blainville.

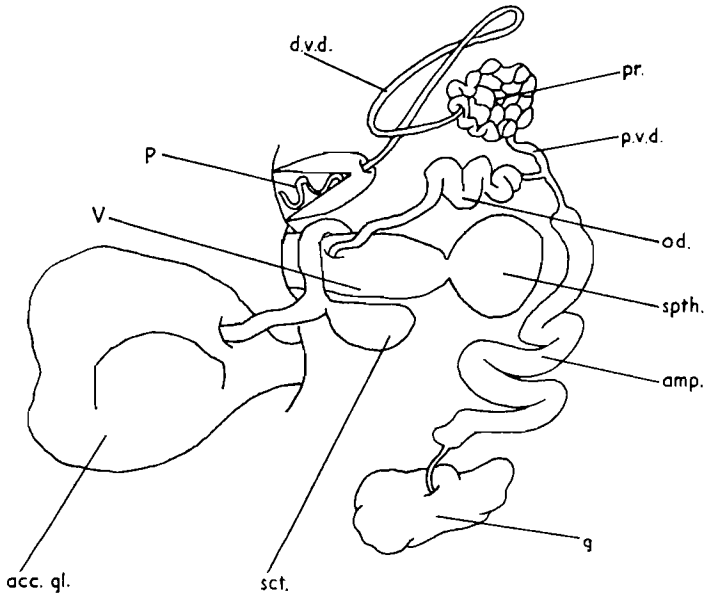
syn. *Bouvieria* Vayssière.
Berthellina Gardiner (non *Berthellinia* Mörch).

Gardiner (1936) established the genus *Berthellina* to include those species of *Berthella* with a shell, tiny in proportion to the animal and to the mantle cavity in which it lies. Apart from this distinction there is no significant distinction from the older genus. It is to be doubted if such a criterion is of more than sub-generic value, particularly when it is not supported by other distinguishing features. The name *Berthellina* is over-close to *Berthellinia* an older and valid generic name, for a bivalved Sacoglossan : confusion can only result from the use of such a name.

Berthella granulata (Krauss). Text-fig. 2.

Pleurobranchus granulatus Krauss, 1848, 61 ; *Berthella granulata* (Krauss) Vayssière, 1898, 268 ; pl. 16, 14–16 ; Bergh, 1907, 40 ; pl. 4, 27–28, pl. 5, 1–4.

Several specimens have been examined and found to agree with the descriptions given by Vayssière and Bergh. They agree in all respects with the descriptions and drawings published by Vayssière. But these descriptions and drawings deal only with external and skeletal features. Concerning the soft parts, the alimentary canal and the nervous system are as usual in the family Pleurobranchidae. The animals appear to be scavengers, partially digested shrimps were found in the stomachs of two individuals dissected—it is difficult to see how the " snails " could have caught these alive !



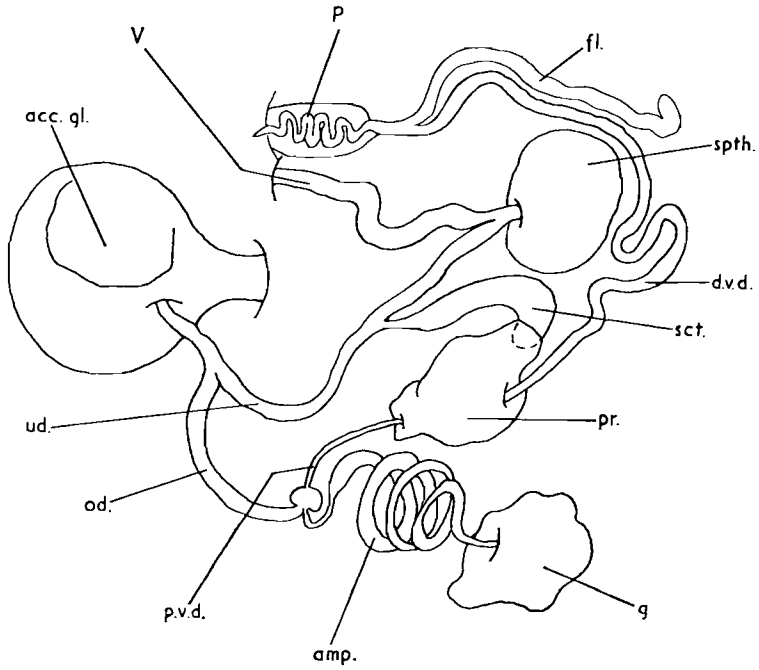
TEXT-FIG. 2.
Genital organs of *Berthella granulata* (Krauss).

The genital organs are of taxonomic value as may be seen from a comparison of figs. 2 and 3. Vayssière (1898) showed several diagrams of the genital organs of species of *Berthella* and Marcus (1957) has added another figure. This species differs from all of these in the following features : the penis is short and thick not long and slender as in most others, to accommodate it the vagina is very wide and comparable in length to the penis. The spermatocyst coils round the base of the vagina, its connection with the spermatheca running within the vaginal sheath and the uterine duct to the oviduct passes into and presumably through the glandular mass.

Berthella punctata (Q. and G.). Text-fig. 3.

Pleurobranchus punctatus Quoy et Gaimard, 1832 ; Zool., **2**, 299, pl. 22, 15–19.
Berthella brocki Vayssière, 1898 ; 256, pl. 15, 1–13 and pl. 27, 180, 181.
Berthellina punctata (Q. and G.) Pruvot-Fol, 1934, 34.

Eighteen specimens have been examined. Ten were collected in September 1957 under coral debris on the west shore of Inhaca island. Eight specimens were found in similar situations on Nossi-bé, close to the northern tip of Madagascar in January 1959.



TEXT-FIG. 3.
Genital organs of *Berthella punctata* (Q. and G.).

The specimens varied in colour between orange and a rosy red. In size they ranged between 30 and 50 mm. in length. They agree in all respects with the descriptions and figures published by Vayssière, except that the spermatocyst (see fig. 3) does not connect up with the oviduct ; the uterine duct runs with the vagina in the same sheath and close to the body wall diverges and turns towards the glandular mass surrounding the oviduct which it enters, presumably to join up with the oviduct within the mass.

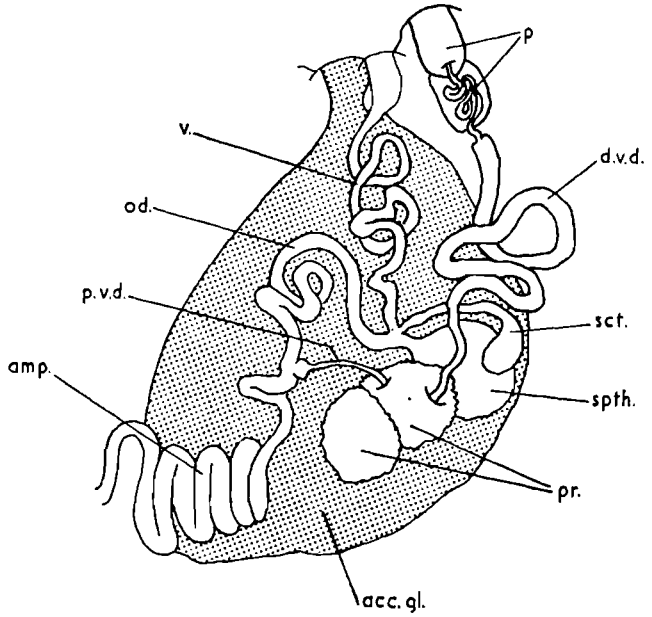
The distribution includes in addition to the above localities, Indonesia, West Australia and Mauritius.

Genus *Pleurobranchus* Cuvier.

Pleurobranchus peroni Cuvier. Text-fig. 4.

Pleurobranchus peroni Cuvier, 1805, 266, 275, pl. 18, 1–6 ; Quoy et Gaimard, 1832, Zool. 2, 296, pl. 22, 7–10 ; Deshayes, G. P., in Cuvier's Regne Animale moll., 88, pl. 32, 1, *a–i* ; Martens in Möbius, 1880, 309 ; Pilsbry, 1895–96, 207, pl. 74, 88–90 ; Vayssière, 1896, 124, pl. 5, 13–15 ; 1898, 308, pl. 13, 6, 7, pl. 21, 108–113.
Oscaniella purpurea Bergh, 1897, 95, pl. 8, 28–39 ; 1902, 375 ; 1905, 61, pl. 5, 4, pl. 11, 24–28.
? *Susania papillosa* O'Donoghue, 1929, 44, pl. IV, 45–51.

At Inhaca this species is numerous at all seasons. It may be found under stones and crawling among Cymodocea in the lower intertidal levels on the sheltered shores.



TEXT-FIGS. 4.
Genital organs of *Pleurobranchus peroni* Cuvier.

The colour of the animal is of the identical reddish purple shown in the illustrations by Vayssière (1898) and by Bergh (1905). The external features, appearance of the jaws and radula are as these authors have described them. The disposition of the nerve ring is typical of the genus and agrees with description given by both these authors.

The anterior genital mass (fig. 4) shows the facies typical for the genus.

In this species and in *P. inhacae* (see below) an interesting "sexual chase" has been noticed. Two or more individuals crawl in single file one immediately behind the other. Such individuals always have a large metapodial gland.

One wonders if this gland lays a trail which attracts the others to follow in its train.

This species is widespread in the Indo-west-Pacific.

Pleurobranchus perrieri Vayssière, 1896.

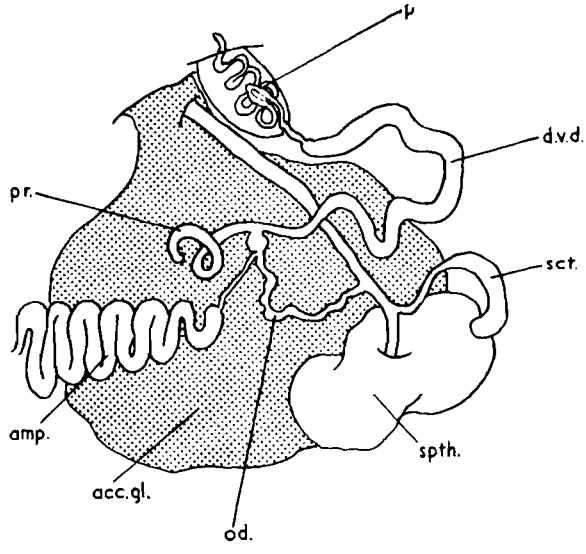
P. perrieri Vayssière, 1896, 126, pl. 4, 2–4 ; 1898, 321, pl. 13, 9, pl. 23, 127–134, pl. 26, 178.

Several specimens of this beautiful dark purple and white lined species were found in the northern bay of Inhaca island during July 1958. In appearance they agree well with Vayssière's description and with his coloured illustration. The anatomy of two specimens dissected also agreed with his descriptions and figures.

Distribution : Philippines, Indonesia, Tahiti.

Pleurobranchus inhacae n. sp. Text-fig. 5.

In appearance this species is a typical *Pleurobranchus*. The type specimen when alive was 10 cm. in length and 6 cm. in breadth. The colour of the sides



TEXT-FIG. 5.
Genital system of *P. inhacae* n. sp.

and the dorsal surface of the foot was beautiful deep orange ; on the tuberculated back the colour was deeper and darker at the bases of the tubercles. The sole of the foot was almost reddish.

The mantle is large and tuberculated with the anterior notch wide but shallow. The velum is well developed and the rhinophores almost tubular,

short and united close to their bases. The foot is long and its rounded posterior end projects beyond the mantle and extends outside its postero-lateral margins. The metapodial gland is large and conspicuous. The gill is tripinnate, the rachis of the gill and of the primary pinnae each have a double row of nodules. The gill extends almost to the posterior end of the mantle.

The genital openings lie close together just in front of the insertion of the gill. The opening of the prebranchial gland, or renal organ of Bojanus is just dorsal to the hindmost genital opening at the base of the gill. The male opening is provided with dorsal and ventral lappets, the ventral being largest and roughly spoon shaped. The copulatory opening and the oviducal orifice are joined and protected by lappets, less large and less conspicuous than those round the male opening.

The buccal mass is capable of being pushed out quite a long way in front (up to 1 cm.). The mandibles are large with just over 70 rows of about 44 teeth. Each tooth has three or four small lateral denticles but there is some variation. The radula is large with many rows of teeth, each row varying around 150–0–150. Each tooth is hook-like, those towards the centre being the biggest. Both mandibles and radula are very pale and do not show the high degree of tanning characteristic of those of *P. peroni*.

The shell has no trace of calcification. It is small, yellowish rectangular ovoid with faint growth lines. The surrounding cuticle is clear and hyaline and quite narrow. The shell lines in front of the mantle cavity and to the right—it is 9 mm. long and 2·5 mm. wide. It is absent from some specimens.

The nerve ring has the same form as that of *P. membranaceus* illustrated by Vayssière (1898) and the gut the same pattern as shown for this species by Thompson (1959).

The facies of the genital organs (fig. 5) is that characteristic of the genus. The type specimen and one other were dissected and found to be identical. The organs of both were well developed, and both were collected in the act of egg laying. The gonad lies towards the right on the dorsal surface of the digestive gland. The hermaphrodite duct is long, coiled and possesses thick glandular walls ; when it reaches the level of the genital openings it narrows and divides. The male portion immediately swells and the vas deferens becomes glandular, a tubular caecum represents the prostate gland. The prostate is large and well marked in other species of *Pleurobranchus* and its reduction to an insignificant caecum of the vas deferens would appear to be a feature diagostic of this species. Just before entering the penis the vas narrows and becomes a much convoluted narrow tube in a sheath at the base of the penis. The oviduct passes to the base of the spermatheca where it joins the duct from the copulatory aperture. A small spermatocyst opens at a level almost opposite the entrance of the oviduct.

In external features this species differs from *P. peroni* only in the orange colour and in the greater conspicuousness of the metapodial gland. Internally

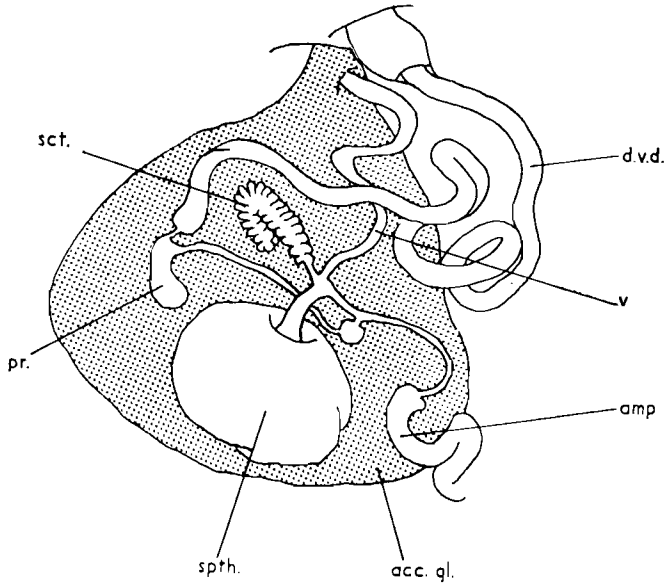
the most noteworthy difference is the absence of a massive prostate gland, this being represented by an insignificant caecum hidden between the coils of the adjacent genital ducts.

Several specimens were laying eggs—whitish in massive colourless curtain-like lamina of jelly-like material. The " curtains " were attached along one edge and were around 20 mm. in width. The eggs are small with very little, yolk.

Twenty-four specimens have been examined. All were collected in meadows of " sea-grasses " on the northern shores of Inhaca island off Lourenço Marques.

Pleurobranchus xhosa n. sp. Text-fig. 6.

The form of the body is typical of the genus. The mantle is large and covers the entire body ; it is slightly emarginated in front above the head



TEXT-FIG. 6.
Genital organs of *P. xhosa* n. sp.

which projects a little while the animal is moving. The rhinophores lie close together in the mid line just beneath the emargination of the mantle. The eyes lie just lateral of their bases. The velum is broad and quadrangular.

The colour of the entire body is a dark purplish red, paler on the sides beneath the mantle edge, and almost reddish on the sole of the foot.

The gill is long, about half the body length, and bipinnate. It is attached for about two-thirds of its length. The rachis has a double row of alternating tubercles. The anus lies just above the posterior end of the attached part of

the gill. The prebranchial gland is on the base of the gill rachis. The genital apertures are surrounded by a simple fringe ; the penis is subconical, elongated and unarmed.

The foot is large and strong but there is no metapodial gland. Whether this is a seasonal lack or whether it is a permanent lack is not known.

The buccal mass is large and strongly muscular. The buccal tube is lined by a thin almost colourless " chitin " which bears two large strong mandibles, each golden brown in colour. Each plate is made up of about 35 rows of imbricating plates, about 30 plates in each row. The dentate tip of the tooth is slightly wider than the body ; and there are five denticles on either side of the central one. The radula bears many rows of about 150–0–150 teeth. Each tooth is simply hooked ; the innermost have a broad base and a short blunt hook ; around numbers 50–70 the hook lengthens but remains blunt and the base becomes smaller and long rather than broad ; from numbers 130–150 each tooth is awl-like with a tiny base. The teeth are all simple and bear no denticulations. The remainder of the alimentary system follows the typical family pattern.

The mantle cavity is quite extensive but no shell was found within it.

The nerve ring also follows the pattern characteristic of the family.

The genital organs (fig. 6) show the usual complex interconnections. On leaving the gonad the hermaphrodite duct swells and the glandular portion is coiled like a cylindrical spring of some six turns. It then narrows abruptly and divides. The vas deferens passes alongside the spermatheca, gradually widens and becomes glandular, a short diverticulum is given off and this lies closely attached to the spermatheca. There is no distinct prostate. The oviduct passes to the spermathecal duct or vagina which it joins close to the spermatheca, a large very thin-walled spherical sac. Directly opposite there is a connection, narrow at first and very short, to a lobulated spermatocyst, bent once on itself, of which the walls appear to be glandular. The mucous albumen glands associated with the oviduct are as usual.

This specimens appears to be very similar to *P. forskali* Rüppel, a species common in the Red Sea and on the coast India. It differs in the absence of a distinct prostate, this being represented by the caecum already mentioned and by the lack of any vestige of a shell.

P. xhosa is based on three specimens collected, one at Port St. Johns and the other two at Port Alfred. The name refers to the tribe of African natives which inhabits the district between these two small ports.

Pleurobranchus möbii Vayssière.

Two immature specimens, of length 14 mm. and 28 mm., probably of this species have been examined. The form of the shell, radula and jaws agree with Vayssière's (1898) description.

Genus *Euselenops* Pilsbry.

Euselenops luniceps (Cuvier).

For full synonymy see O'Donoghue, 1929.

A single specimen of this well-known species was collected from a shallow burrow in sand between tidemarks near Ponta Torres, Inhaca island, in July 1958. It is in every way typical of the species.

This species has already been recorded from Southern Africa by O'Donoghue (1929). It is distributed throughout the Indo-west-Pacific region.

Genus *Pleurobranchaea* Leue.

Two species of this genus, *P. capensis* and *P. melanopus* have been recorded from the trawling grounds off the Cape of Good Hope (Cape Point) and off Cape Hangklip at the opposite side of False Bay. Neither of these appears to enter the intertidal areas. From the intertidal of the Indo-west-Pacific three species were recorded by Vayssière (1900). *P. novae-zealandiae* from New Zealand and more recently from Australia (Burn, 1957) and Japan (Baba, 1949); *P. maculata* from South Australia and New Zealand; and *P. brocki* from Indonesia. All species are very closely similar one to the other. From collections sent from the University of Cape Town's Ecological Survey *P. brocki* has been identified from Durban Bay. From Inhaca island come two specimens which must be considered to belong to a new species.

Pleurobranchaea brocki Bergh.

Pleurobranchaea brocki Bergh, 1897, 41, pl. 4, 8–17; Vayssière, 1900, 62, pl. 6, 255–260.

This species, which is characterized by a mamelonated mantle, a median radula tooth and a lobulated spermatocyst adjacent to the spermathea, was found in Durban Bay in January 1951.

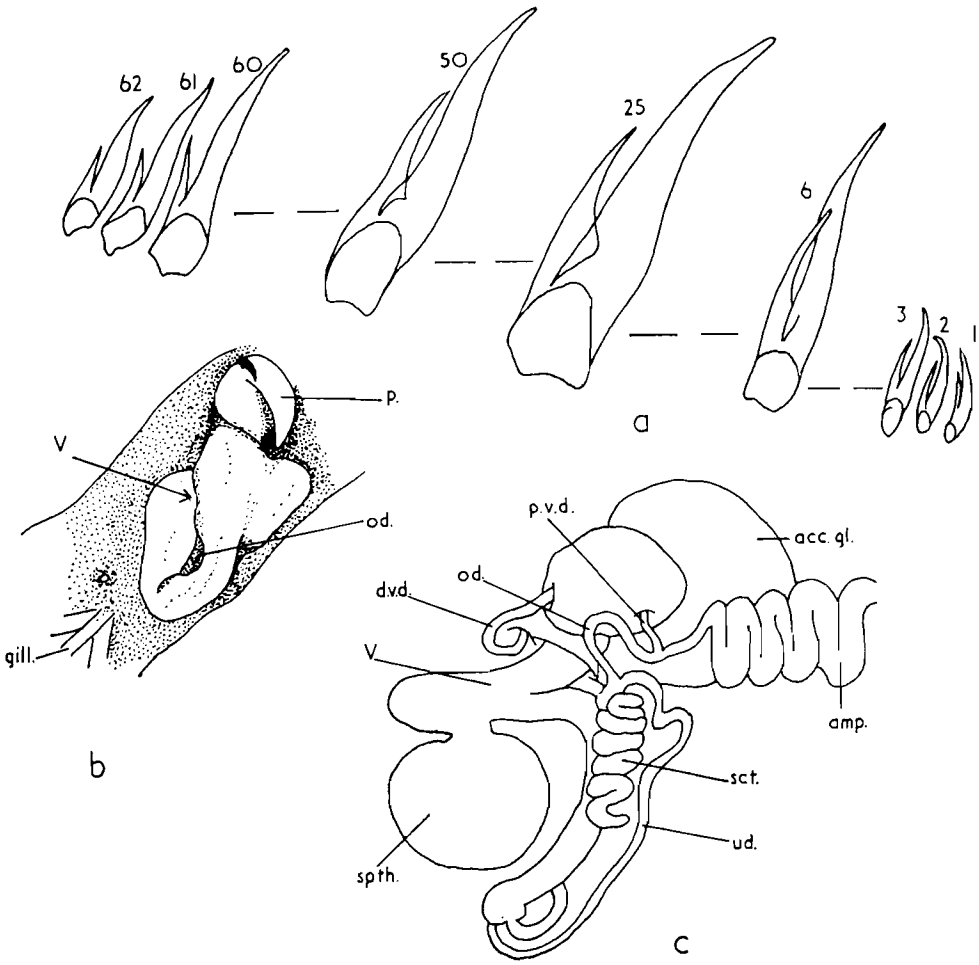
It is to be noted that the median teeth on the radula are very deciduous and all had fallen off from the broad fragile rachis, they were found in the debris at the bottom of the watch glasses used in dehydrating the radula.

Pleutobranchaea gemini n. sp. Text-fig. 7.

Three specimens were collected in the northern bay at Inhaca during July 1958. Two were together creeping actively one just behind the other in " sexual chase " as noted above under *Pleurobranchus peroni*.

The ground colour of all three was a dull creamy white with scattered patches of chocolate and dark brown along the sides of the mantle and on the veil. They were similar in size, 11 cm. long, 7 cm. broad and 5 cm. high.

The form of the body is typical of the genus. The mantle and veil are united and slightly narrower than the foot. The veil is provided with a number of short arborescent papillae in front. The rhinophores are far apart



TEXT-FIG. 7.

Pleurobranchaea gemini n. sp. (*a*) representative radula teeth ; (*b*) penis and genital apertures ; (*c*) genital organs.

between the veil and the mantle. The foot is long, broad and rounded behind with a prominent metapodial gland and a little " horn " on the dorsal surface. The gill is bipinnate and extends beyond the mantle. The genital apertures lie close together just in front of the root of the gill ; the prebranchial gland opens just behind and above the genital openings.

The buccal mass is protruded after death.

The mandibles are very large, sub-rectangular, fragile, made up of many polygonal prisms, each without any dentation. The radula (fig. 7) is large

and made up of some thirty rows of 62–0–62 teeth in each row. The teeth are long and uncinate, each with a slender denticle on the outer edge but without the basal prominence on the inner edge characteristic of *P. brocki* Bergh.

The nerve ring has the form characteristic of the genus described by Vayssière (1901).

The anterior genital mass (fig. 7) is tightly bound up in muscles and connective tissue. The gonad lies on the right on the antero-dorsal surface of the digestive gland. The hermaphrodite duct is wide and glandular and passes towards the genital opening at the level of which it divides. The vas deferens dives into the massive prostate, from whence it emerges to pass to the penis. The vas deferens is therefore quite short. The acrembolic penis is long and worm-like. The oviduct swells becomes glandular and shortly gives of a lobulated cæcum of some five spirally wound coils, and with glandular walls. The oviduct now narrows and proceeds as a slender tube for some distance, then swells to about thrice its diameter and passes towards the genital opening. Just before reaching this, however, it gives off another caecum to one side of which is attached the thin-walled large spermatheca. Close to the aperture the glandular mass formed by the mucous and albumen glands communicates with the oviduct. The female genital aperture is provided with two leaf-like flaps above and below.

In the form of the genital mass this species comes close to *P. brocki* Bergh. Together with *P. brocki* it possesses a lobulated caecum at the proximal end of the oviduct and this feature distinguishes these two from other species of *Pleurobranchaea*. The complete lack of a median tooth on the radula, the difference in the form of the teeth described above and the smooth, not mamillated surface are distinguishing features separating *P. gemini* from *P. brocki*.

The name given is from my twin sons who were responsible for finding the first specimen for me.

The type specimens of new species described here will be deposited in the British Museum (Natural History) and paratypes (where several are available) will be sent to the U.S. National Museum, Washington, and the Academy of Natural Sciences, Philadelphia.

Addendum

During September, 1961, specimens of two additional species were found.

The occurrence of *Pleurobranchus möbii* Vayssière (1898, p. 327 pl. 21 figs. 103-107) was confirmed. The colour, hitherto unknown, is pinkish with the pigment in discrete spots on a cream background. These spots follow the network characteristic of members of this genus.

Pleurobranchus mammillatus Q. & G. was found for the first time; the two specimens agreed with both the original and Vayssière's (1898) description.

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