

CATALOGUE OF THE WESTERN ATLANTIC WARM WATER OPISTHOBRANCHIA.
10. THE WESTERN ATLANTIC WARM WATER NOTASPIDEA (GASTROPODA,
OPISTHOBRANCHIA), PART 3, UMBRACULACEA

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(recebido em 15.V.1984)

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RESUMO - Os Umbraculacea do Atlântico Ocidental são *Umbraculum plicatulum* v. Martens, 1881, e *Tylodina americana* Dall, 1890. Recebi cinco exemplares do *Umbraculum*, dois da Flórida, um de Cayenne, e dois do Brasil, como também alguns exemplares de *Umbraculum mediterraneum* para comparação. De *Tylodina americana* tive três exemplares mais duas conchas.

ABSTRACT - The Western Atlantic Umbraculacea comprise *Umbraculum plicatulum* v. Martens, 1881, and *Tylodina americana* Dall, 1890. I have received five specimens of the *Umbraculum*, two from Florida, one from Cayenne and two from Brazil, as well as several specimens of *U. mediterraneum* for comparison. Of *Tylodina americana* I got three specimens and two shells.

INTRODUCTION

The Order Notaspidea or Pleurobranchomorpha, characterized by the gill under the right side of the mantle, is often placed in the Nudibranchia, though the Umbraculacea have an outer shell and the Pleurobranchacea and internal one or none, like the Ascoglossa. In Eliot's diagnosis (1910:60-61) the Nudibranchia are marine hermaphrodites without ctenidia and osphradia. Their vas deferens is always an internal tube, never an external groove as in the Notaspidea.

Characters that have been used for classification besides colours are size and pattern of shell, size and shape of tubercles on upper side of foot, jaw cuticle, and radula. The male organ is generally only drawn from the outer side. The foot gland depends upon the sexual state of the specimen and has no classification value. The inner reproductive organs have been studied (Moquin-Tandon, 1870; Vayssi re, 1885; MacFarland, 1966).

Pruvot-Fol (1960:190, note 1) supposed that the non-retractile organ in *Umbraculum* was not the proper penis but only a "feuille g nitale" as in other members of the group. From it should protrude a thin, thread-like organ, the perfectly retractile real penis.

Most descriptions, also the present one, are incomplete, and they contain quite different descriptions of the radula.

The number of denticles on the teeth might be a specific or even a generic character. However they are different in Vayssi re's figures of *Tylodina*, without denticles (1883, figs. 32, 33), with two or one on both sides in *Tylodina citrina* (1885, figs. 132, 133). These figures are not clear. The rachidian is given with 2-3 denticles on either side for *citrina* (p. 156-157). Mazzarelli's indication for *Tylodina nella trinchessii* (1897:600) is the same for the laterals, but the rachidian is without denticles. Thompson's *T. corticalis* (1970, fig. 2c) without denticles would belong to Vayssi re's not named species (1883, fig. 32). Pruvot-Fol & Fischer-Piette (1934:147-149, fig. 4, 5) also treated the radula of *T. citrina*, later synonymised (Pruvot-Fol, 1954:209, fig. 80c) to *T. perversa* (Gmelin, 1791). They described the teeth differently from Vayssi re, with only one outer lateral denticle, which fits into a groove of the neighbouring tooth, and no inner one, but their figures are not clear. Burn (1960:69) mentions articulation of the radular teeth as generic character of *Tylodina*. On p. 68, "the small denticle on the inner side articulates with the cusp of the next". His figure 9 does not show this. The present material of *Tylodina* has no denticles on the rachidian, and only one denticle on the inner side of the laterals (Fig. 25).

Odhner (1939:15, fig. 3) figured the teeth of the type specimen of *Tylodinella duebeni* (Lov n, 1846) and Bertsch (1980, fig. 3B) those of *Roya spongothearas* with 3-4 postero-lateral pectinate denticles, all in one line; both species are now named *Anidolyta* Willan, 1984.

In the present *Umbraculum plicatulum* the presence or absence of a rachidian tooth could not be recognized, as the transverse rows of the teeth are horizontal, not inclined towards the rachis, and folded longitudinally. Absence might be due to its easily falling away during preparation, as Willan observed in *Pleurobranchasa maculata* (1983:258).

Risbec (1934:151-154) complained of the descriptions of new species from a single specimen only for the length of its processes and other measurements, without figuring the whole animal, because the specimens of one population may vary considerably. All new species should have a total picture, "and who can not draw, should choose an other profession

than that of a describer"

I have too little material to treat the Umbraculacea completely. Of the large specimen from Florida I could only take out radula and central nervous system. Moquin-Tandon (1870:88-119, pls. 6-8) and Vayssière (1885:142-150, figs. 148, 149) studied the nervous system of *Umbraculum* and *Tylodina citrina* (Vayssière, p. 158-161, fig. 135), MacFarland (1966:67-68, pl. 12, fig. 11) that of *Tylodina fungina*, so thoroughly, that I will not repeat it with my few specimens.

The Umbraculacea are divided into two families or subfamilies, Umbraculidae with the genus *Umbraculum* Schumacher, 1817, and *Tylodinidae* with two genera, *Tylodina* Rafinesque, 1814, and *Anidolyta* Willan, 1984, new name for *Tylodinella duebeni* (Lovén, 1846), as *Tylodinella trinchesei* Mazzarelli, 1897, is synonymous to *Tylodina perversa* (Gmelin, 1791) Bertsch (1980:234) replaced it by *Roya Iredale*, 1912, but the type species of the genus *Roya*, *R. kermadecensis* Iredale, 1912, was recognized as a Siphonariid, *Williamia radiata nutata* by Marshall (1981:488, fig. 1, 2), hence this generic name is also invalid. Willan substituted both names by *Anidolyta*, to which also *Roya spongothoras* Bertsch, 1980, must be transferred.

From the Western Atlantic only one species of *Umbraculum* and one of *Tylodina* are recorded. From other regions there are several species known, but their descriptions are often insufficient because of scarce material, and as the variability of the characters in one and same population is great, Burn (1959:21) proposed to synonymize all species of *Umbraculum* to the type species, *U. sinicum* (Gmelin, 1791) Thompson (1970:174) and Rehder (1980:104) consider *Umbraculum umbraculum* Lightfoot, 1786, as the type species. Thompson (1970:176) is ready to accept Burn's proposal, but distinguishes *U. mediterraneum*. He mentions the long processes of the mantle border (Vayssière, 1885, fig. 137) as distinct from his *sinicum* with inconspicuous ones (1970, fig. 1C). However, already Moquin-Tandon (1870:17, pl. 21, fig. 1, pl. 28, fig. 3) had shown quite different lengths. My Florida specimens of *U. plicatulum* have processes of various lengths, that from Cayenne has inconspicuous ones, and one from Bahia quite large ones (Fig. 3). Hence the marginal processes cannot serve as distinctive character.

I give a key of the Umbraculacean genera and restrict myself to a review of the Western Atlantic literature and my few own observations.

Key to the Western Atlantic Umbraculacea

- 1 Body much larger than shell; gill from under left rhinophore to last third of right side; central nervous system with two visceral ganglia; shell scar complete; gonopore over mouth. Umbraculidae - *Umbraculum*
- Shell covers almost whole body; gill only on right side; central nervous system with three visceral ganglia; gonopore on right side. Tylodinidae - 2

- 2 Intermediate muscle scar between shell muscle scars; radula with rachidian tooth; teeth unicuspid with one or two denticles... *Tylodina*
- No intermediate muscle scar; radula without rachidian tooth; teeth with several cusps. *Anidolyta* Willan, 1984, (for *Tylodinella* and *Roya*)

Umbraculacea

Umbraculidae Dall, 1889

Umbraculum plicatulum von Martens, 1881

Tylodinidae Gray, 1856

Tylodina americana Dall, 1890

Umbraculum Schumacher, 1817

Synonyms: *Operculatum* Linné, 1758

Patella, pars, Lightfoot, 1787

Acardo, pars, Lamarck, 1799

?*Parmophorus* Blainville, 1817

Gastroplax Blainville, 1819

Umbrella Lamarck, 1819

Ombrella Blainville, 1824

Umbella d'Orbigny, 1841

Type species *Patella umbraculum* Lightfoot, 1787

Umbraculum plicatulum (von Martens, 1881)

Figures 1-11

Umbrella plicatula von Martens, 1881:104, f. 1-3 (not seen); *Umbraculum plicatulum* Pilsbry 1896:178, pl. 72, f. 72-74; Sarasua, 1945:26, pl. 3; White 1952:106; Marcus 1967a:42, f. 51; 1967b:613, f. 39-41; 1970:939; Rios 1975 : 165, pl. 51.

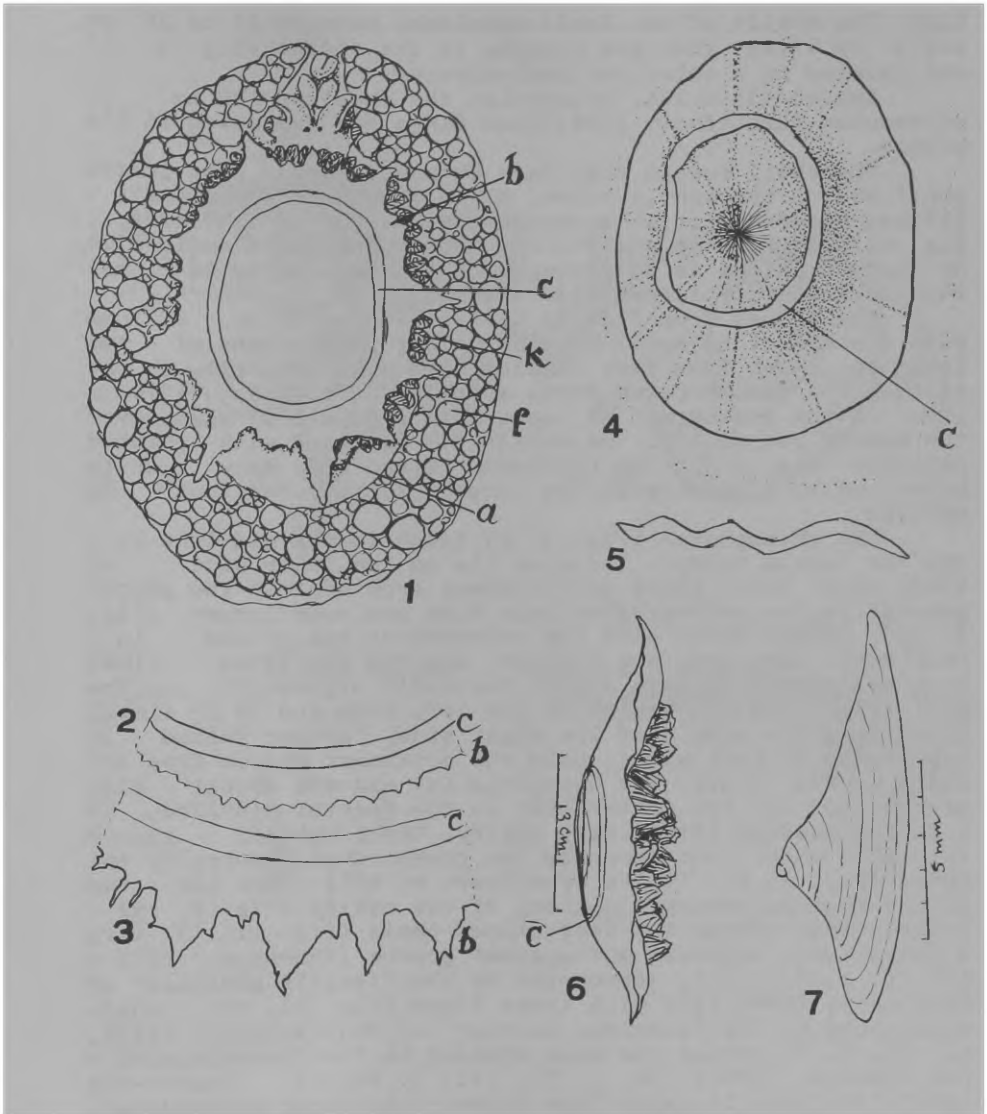
Material - Brazil, Barra Bahia, May 1983, 12 m depth, Eliezer Rios leg.; two specimens, strongly contracted, 85 and 75 mm long. - Pillsbury Expedition, 660, Cayenne, 06°07'N, 52°19'W, 84-110 m. 8.7.1968, one specimen, preserved 12 mm long. - Palm Beach, Florida, one specimen, preserved 95 mm long, from Robert Work.

Distribution - Florida; Dry Tortugas; Cuba, western Caribbean; Colombia; Brazil, south to Rio Grande do Sul.

For comparison, several specimens of *U. mediterraneum* (Figs. 12-17); from Naples, from Luise Schmekel; from Banyuls, from Philippe Bouchet.

Remark - My anatomical description refers also to the specimens from the Mediterranean (Figs. 12-17). The one from Naples was 50 by 42 mm; its shell measured 32 by 27 mm. The other animal was 90 mm long with a shell of 85 by 66 mm. Sarasua (1945:26) reported a living 88 mm long specimen of *plicatulum* from Havana. Its shell differs from the ones I have seen by a furrow in the anterior mid-line.

Description - The 12 mm long specimen (Fig. 7) is 8 mm broad and 6 mm high. Its shell measures 12 by 8.5 mm and is 4 mm



Figures 1-7: *Umbraculum plicatulum*. 1. Dorsal view of 85 mm specimen. 2. Mantle rim of 80 mm specimen from Bahia. 3. Mantle rim of 85 mm specimen from Bahia. 4. Ventral view of shell of same. The dotted line around the shell indicates the size of the preserved specimen. 5. Transverse aspect of same in middle of shell. 6. Lateral view of same. 7. Shell of 13 mm - specimen from Cayenne. a - anus. b - mantle rim. c - columellar muscle scar. f - upper side of foot. k - gill.

high. The shells of the Bahia specimens measure 80 by 56 mm and 77 by 59 mm; they are concave in the middle (Fig. 5, 6) and covered by a colorless periostracum.

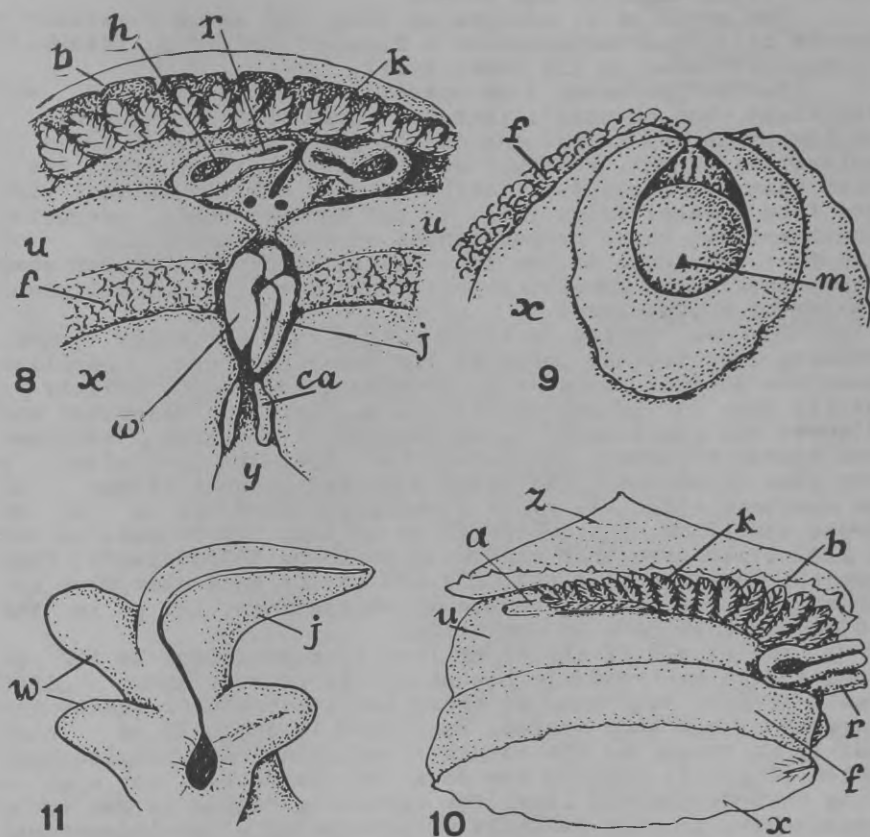
Rehder (1980:105) found also the shell of 120 mm *U. umbraculum* (Lightfoot, 1786) from Hanga Roa depressed in the middle.

The shell muscle scar is a complete narrow ring in the shell and on the mantle below. Already Moquin-Tandon (1870 : 22) had described it as a narrow muscle. Morton (1972:346 , fig. 6d) figures the shell attachment muscle as a solid disc. My largest animal is so strongly contracted (85 by 62 mm) that it is hardly larger than the shell.

The animal from Florida (1967a:42) was 95 by 83 mm with a shell of 66 by 51 mm. The colour photographs of two large specimens from West Florida have a white shell, in one of them the periostracum forms a "beard" (Thompson, 1970 : 175) In the photograph it looks like a girdle of algae over the narrow red mantle. The mantle rim is beset with pointed papillae (Fig. 1-3). The hyponotum is red with many white knobs, up to 6 mm wide in the large specimen. The foot is whitish.

The rhinophores (Fig. 8, r) touch in the mid-line under the mantle border. The eyes lie on the inner side of their base. Their shape is different from that in the photographs: in the preserved animals they are much larger (Fig. 8, 10). On the outer side the rhinophores are rolled in , near their base they are widened and the cavity is lined with transverse sensory folds, Hancock's organs (h). The gill (Fig. 1, 8, k) begins on the left side and is simply pinnate to the middle of the right side. Farther behind it has pinnae on both sides. Only the outermost end is free and has a smooth rachis. The hyponotum (u) and the dorsal side of the foot (f) are interrupted in the frontal mid line by a furrow leading into a deep cavity, the propodial groove (y), into which open dorsally the gonopore and ventrally the mouth (Fig. 9, m) In the upper part of this sinus lie two ridges that accompany the sides of the cavity (Fig. 8, ca) . Between them arises the leaf-shaped penis (Fig. 11, j) with a conspicuous external autospermal groove (Thompson, 1970 : 176, f. 1, d). It is surrounded by the "feuille g nitale" of Pruvot-Fol (1960:190) with three flaps (Fig. 11, w), which correspond to the "mamelons buccaux" of Moquin-Tandon (1870, pl. 21, f. 2) around the male opening in the Pleurobranchinae (Marcus, 1984:f. 56, I, II, III, f. 60, n). Pruvot-Fol (1960:190, note 1) said: "one thread-like organ protruding , the true penis, fully retractile, while at the base of the "feuille" an orifice is the opening of the oviduct" In the specimen from Naples I dissected the outermost part of the inner genital duct. It contained a white fold firmly attached to the wall, but looking like a round tube. This might be what Pruvot-Fol considered to be the "true penis"

Already Vayssi re (1885:134, f. 141) had shown a longitudinal ciliated fold in the pallial oviduct of *Umbraculum mediterraeum* separating male and female duct, which was confirmed by our transverse sections of *Umbraculum* (Marcus ,



Figures 8-11: *Umbraculum plicatulum*. 8. Frontal view of 13 mm-specimen from Cayenne. 9. Under side of same. 10. Lateral view of same. 11. Genital aperture and penis of 80 mm-specimen from Bahia. a - anus. b - mantle rim. ca - mouth tentacles. f - upper side of foot. h - Hancock's organ. j - penis. k - gill. m - mouth. r - rhinopore. u - hyponotum. w - genital fold. x - sole. y - propodial groove. z - shell.

1967b: fig. 40) and MacFarland's of *Tylodina fungina* (1966, fig. 2-5) From the monaulic genital aperture a ciliated sperm groove runs forward to a non-protrusible penis, as Gosliner (1981, fig. 3B) has shown.

The penis of *U. plicatulum* (Fig. 11) and *U. mediterraneum* differs from Vayssi re's figure (1885, fig. 146) which is not mentioned in his text, p.142.

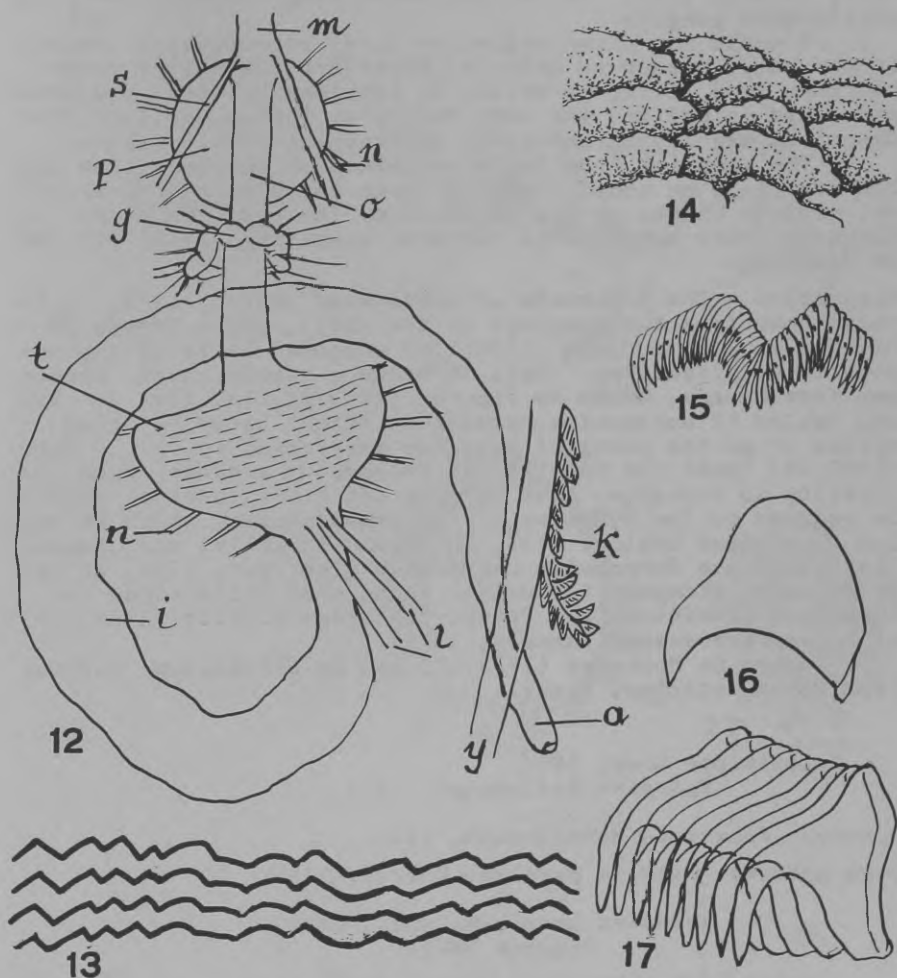
In our preserved 8 mm specimen (1967b:613, f 40, 41) the flaps were so small, that I figured them as the penis; in the preserved animal one cannot judge whether an organ is retractile or not. Possibly we have dealt with an other species than *U. plicatulum*. Farther behind the two lateral ridges form several folds (Fig. 8, ca) between the retracted mouth and two large protuberances of the anterior part of the foot. The sole of the foot (x) is smooth except for some folds around the frontal notch. I did not find a pedal gland in any of my specimens.

The oral cavity is lined with a thin cuticular ring, forming longitudinal folds in its outer part and papillae near the pharynx, like in *T. fungina* (MacFarland, 1966:62, pl.11, fig. 2). Vayssi re (1885:138, fig. 136) described and figured the papillae of *T. citrina* which are much stronger and closer together. He stated that they are lost after a few days in alcohol. The large muscular pharynx of the 50 mm specimen (Fig. 11, p) is globular. Its radula is 20 mm broad and 17 mm high in the 50 mm animal; its formula is 150 x 1100.0.1100, so that the total would be 330000 teeth. They are all unciform (Fig. 16, 17) and of the same size from side to side, 80 μ m high in the 21 mm specimen, 110 μ m in the 50 mm one. They have no denticles.

The radula of the 95 mm long Florida animal is 25 mm long and 25 mm broad. It has about 360 rows of about 1200 teeth to each half-row, so there are about 800000 teeth, the largest number ever stated. Each tooth is about 70 μ m high and 10 μ m broad. As the radula is wrinkled in longitudinal folds (Fig. 13, 15) and the rows are transverse, not slanting towards the mid line, the rachidian region is not recognizable, so that presence or absence of a rachidian tooth cannot be seen in the present specimens, and the number is only approximate. There is no gizzard.

The stomach (Fig. 12, t) lies ventral to the intestinal gland. It appears flat and is lined with transverse, cuticular ridges. Its sides are connected to the inner wall of the body cavity by muscle strands (n) which Moquin-Tandon thought to be liver ducts. However, the two liver ducts (l) enter the intestinal tube (i) where it leaves the stomach. The intestine has a longitudinally folded epithelium. It runs backward, curves forward and back again (Fig. 12) and opens on an anal papilla (Fig. 1, 10, 12, a) on the right side, just behind the tip of the gill. The contents of the stomach could not be defined from the present specimens; they might be remains of ascidians.

The ovotestes lie intermingled with the intestinal gland. Their follicles contain sperm and ovocytes together.



Figures 12-17: *Umbraculum mediterraneum*. 12. Diagram of in - testinal tract. 13. Transverse rows of teeth. 14 - Cuticular ridges of stomach, dry. 15. Details of transverse row of teeth. 16. Tooth. 17 Part of row of teeth. a - anus. g - ce rebral ganglion. i - intestine. k - gill. l - liver ducts. m - mouth cavity. n - muscle strands. o - esophagus. p - pha - rynx. s - salivary ducts. t - stomach. y - body wall.

As Vayssi re described and figured in detail (1885:142-147, f. 148, 149), the central nerve ring contains two pleuro-visceral ganglia.

I could not disentangle the inner reproductive organs in the hard, preserved animals. Vayssi re (1885:138) prepared them from living material. In sections I found oocytes and sperm in one and the same follicle. Thelma Hartley (1964) described egg laying and early development of *U. sinicum*.

The material from Bahia contained an egg mass. The ribbon was 15-20 mm broad, forming large folds on the outside, closely united at the substratum. The eggs, 80 micra in diameter, were numerous in capsules measuring 0.4 to 0.6 mm in diameter.

Discussion - The "*Operculatum bermudense*" M rch, 1875, is only known from two drawings of the shell, which Forbes published in 1758. Pilsbry (1896:178) supposed it to be synonymous to *U. plicatulum*. Dall obtained a single, dead specimen from Havana, which he figured (1889:pl. 14, fig. 9, 10) and called it *Umbraculum bermudense* M rch? Later he classified it as the young of *Tylodina americana*, sp. n. Burn (1959:29) found the material of *Umbraculum sinicum* from one locality so variable, that he says all other species should be reduced to the synonymy of the type species, which he called *U. sinicum* Gmelin, 1791. Thompson (1970:174) and Rehder (1980:104) use *Umbraculum umbraculum* Lightfoot, 1786, as type species. Thompson (1970:176) found some differences between his *U. sinicum* and Pruvot-Fol's description (1954:211) of *U. mediterraneum* (Lamarck, 1812).

Lange de Morretes (1953:57) had an *Umbraculum* species from Santa Catarina, Brazil.

Tylodinidae Gray, 1856

Tylodina Rafinesque, 1819

Synonym: *Joannisia* Monterosato, 1884.

Type species: *Patella perversa* Gmelin, 1790

Tylodina americana Dall, 1890

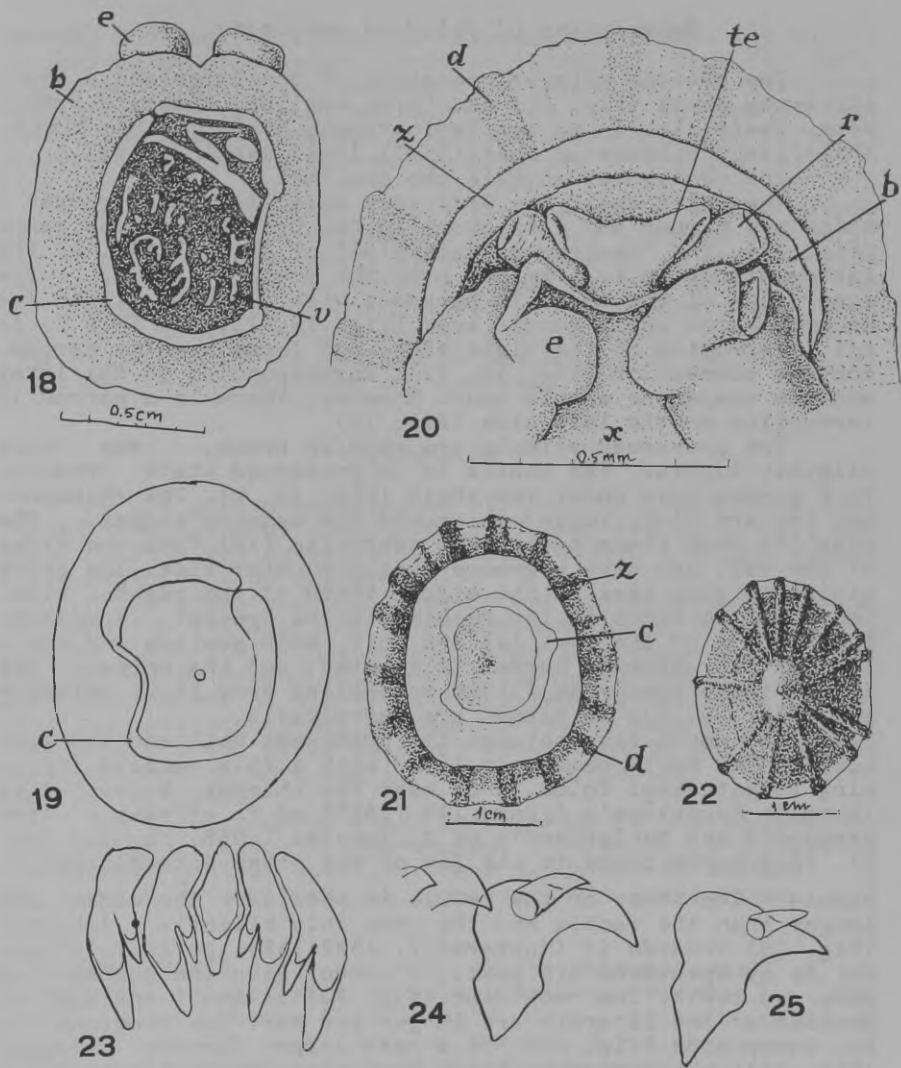
Figures 18-25

Umbraculum bermudense M rch? Dall, 1889, p.60, pl. 14, figs. 9, 10.

Tylodina americana Dall, 1890:121, Pilsbry, 1896:188, pl.50, fig. 47, 48; Gosliner, 1981:220, fig. 3B (reproductive system).

Material - Florida, Fort Pierce, 3 animals and 2 empty shells, collected by Larry Harris and given to me by Terrence Gosliner.

Distribution - From Dry Tortugas, Florida, to northern Gulf of Mexico.



Figures 18-25: *Tylodina americana*. 18. Dorsal view of 21 mm specimen without shell. 19. Under side of shell of same. 20. Ventral view of anterior part of same. 21. Under side of 34 mm shell. 22. Upper side of 21 mm specimen. 23. Radula, middle of row. 24. Teeth from middle of row. 25. Tooth from middle of half row. b - mantle rim. c - columellar muscle scar. d - periostracum. e - anterior foot corners. r - rhinophore. te - tentacle on side of veil. v - ovotestis. z - shell.

Description of *Tylodina americana*

The present material consists of one large and a smaller empty shell (Fig. 21) and three smaller, complete specimens. Their size in mm is: Periostracum 34x29, 22x19, 21x17, 15x14, 12x10 calcareous shell 24x21, 15x12, 14x11, 7x6, 8x7

The contracted animals are smaller.

The white shell has 9-20 very delicate radial ridges, which are higher and dark brown in the brown periostracum (Fig. 22), the "membranous extension" of Dall (1889). The latter stands up to 5 mm out over the shell (Fig. 20). The inner side of the shell is nacreous with a bright silver zone around the shell muscle scar (Fig. 19, 21, c). This is not interrupted on the right side, but forms a quite narrow, concave connection (Fig. 18, 21), corresponding to the intermediate suspensor muscle scar. However, there is a narrow interruption on the left side (Fig. 19).

The preserved animals are reddish brown, the sole slightly lighter. The mantle is in preserved state reduced to a narrow fold under the shell (Fig. 20, b). The rhinophores (r) are flat, rolled in around the sensory ridges. The eyes lie near their bases. The tentacles (te) form the sides of the veil and have a groove on their outer side. The short bipinnate gill lies in the middle third of the right side. There are no knobs on the rachis. In the present specimens the borders of the foot (x) are soft, much swollen and rolled in. Its anterior border is grooved, and the corners are in all three specimens folded resembling very large rhinophores (Fig. 20, c). No glands are perceivable.

The mouth lies between the prominent veil and the foot border. The mouth cavity is lined with a thin cuticle forming longitudinal folds, and, near the pharynx, knobs like those in Vayssi re's figure 136 (1885) of *T. citrina* (now *perversa*) and MacFarland's of *T. fungina* (1966, pl. 11, fig. 2). This corresponds to the jaw of the other Notaspideans.

Radula - The shape of the radula is peculiar: the sides are longer than the rachis and the rows only slightly inclined (Fig. 23) towards it (Mazzarelli, 1897:148), as in *T. citrina*. As my specimens are small, I cannot give the number of rows and teeth. The rachidian (Fig. 23) is small and has no denticles. The laterals are larger and have one denticle on the inner side (Fig. 25). This gets larger farther outwards (Fig. 24); the outermost teeth have none. MacFarland's figures 1-9 (1966, pl. 12) of *T. fungina* are exactly like the present ones, except for fig. 6, which shows a malformation with two denticles.

The gizzard, stomach and intestine were not observed. The anal opening lies on the tip of a papilla over the end of the gill. The nervous system of *T. citrina* has been described and figured by Vayssi re (1885:158-161, fig. 135).

MacFarland (1966:66, pl. 16, f. 1, 8) found the palial oviduct with the dividing ridge and the monaulic opening in *T. fungina*, like already Vayssi re (1885:142, f.147) had seen it in *Umbraculum mediterraneum*. From the gonopore a ciliated groove runs along the inner side of the median

curved, non-protrusible penis (Marcus, 1967b:614, fig.40,41) in *Umbraculum plicatulum*. Gosliner (1981:220, fig. 3B) described and figured the reproductive organs of *T. americana* and showed the ciliated sperm duct and the non-protrusible penis. The present specimens are too small and too strongly contracted to permit for recognizing any of the genital organs and pore.

On the two largest shells there are the remains of barnacles, fixed to the calcareous shell and piercing the periostracum. Some quite small barnacles seem to be under the periostracum without an outer opening; as they are close to the protoconch that is not covered by the periostracum, they might have crawled in between it and the shell. Others farther outward may have settled on the border of the shell at the time the periostracum was secreted.

DISCUSSION

As the genera and species of the Tylodinidae were discussed thoroughly by Pruvot-Fol & Fischer-Piette (1934), and their opinion was accepted by Willan (1984), I do not repeat their discussion of the genera.

My material and bibliography are not sufficient for me to judge the value of the different species of *Tylodina*. Pruvot-Fol (1954:208) and Thompson (1970:170) suppose that all species may be merged into one, *T. perversa* (Gmelin, 1790). The descriptions of the teeth are extremely different, so that synonymising is not recommendable, as long as re-examination of the old types does not prove them to be wrong. There might even be more species for the differently described ones of *T. citrina*.

The uninterrupted shell muscle scar in the present species brings it close to *Umbraculum*, from which it differs by the lateral genital aperture. From *Anidolyta* it differs by the rachidian tooth and the complete shell muscle scar.

ACKNOWLEDGEMENTS - For material of the Umbraculacea I am very grateful to Frederick M. Bayer, Philippe Bouchet, Larry Harris, Harold Harry, Eliezer de C. Rios, Luise Schmekel, Robert Work and the South African Museum; for encouragement, to Terrence Gosliner, Richard Willan and others.

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