VOL. VI, FASC. 1 E 2, P. 3-33

SEA-HARES AND SIDE-GILLED SLUGS FROM BRAZIL

(RECEIVED JUL./28/55)

(With 8 plates)

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With the present paper we aim to settle the characters and the name of the common Sea-Hare of the coast of São Paulo, and to describe a new species of the Notaspidea that Dr. Peter Kaiser (Hamburg) collected at Cananéia, when he worked there as guest on the Research Laboratory of the Oceanographic Institute.

We add two other *Aplysia* from the coast of S.Paulo, and details of the hitherto hardly described reproductive organs of another Notaspidean slug, *Berthella agassizii* (MacFarland), a species known from Curaçao in the Caribbean Sea, from Alagoas, and from the coast of S.Paulo, where it lives under stones in the tidal zone (Marcus 1955).

Our thanks are due to our Colleagues which helped us with informations and separate copies of their papers, Mme. Alice Pruvot-Fol (Sceaux), Dr. Joyce K.Allan (Sydney), Dr. Nellie B.Eales (Reading), Dr. Kathleen M.White (Reading), and Messrs. R.Tucker Abbott (Washington), Kikutarô Baba (Osaka), Hjalmar Broch (Oslo), Hendrik Engel (Amsterdam), Iwao Hamatani (Osaka), N.T.Mattox (Los Angeles), Nils Hj.Odhner (Stockholm), Charles H.O'Donoghue (Reading), Jean Risbec (Bondy-Seine), Gunnar Thorson (Copenhagen) and Keizo Yasumatsu (Fukuoka).

between the light type with little pigment and the dark one with only few and very small light spots, so that a continuous series can be established. The pigmentation of some animals, f.ex., is irregularly dense and appears as multiform dark spots connected by a loose net. Some of the pigment-free meshes contain small round white dots, in groups or singly, that are lighter than even the lightest type of the ground colour. These dots are not visible in preserved specimens and are presumably contents of gland cells. Their amount is highly variable. In one living slug of 12cm length from Ubatuba they were confluent and covered nearly the entire outer surface of the parapodia, so that the animal appeared creamy white.

Neither the cephalic region nor the skin between the parapodia differ in colour from the rest of the body; only the former, as most contracted part, has the pigment more condensate and therefore appears darker in preserved animals. The tips of the tentacles and rhinophores are always light. Most slugs show a pattern of alternating dark and light areas along the inner border of the parapodia. The light fields are lighter than the ground colour; in one of 10 examined specimens the parapodial border itself was light so that the light areas appeared as inner continuations of the border. The pattern is more or less distinct, f.ex., the dark areas may be developed as narrow stripes, or the pattern may be wanting at all. The sharpness of the pattern is not correlated with the general pigmentation of the body. The colour of the sole is uniform and varies from light ground colour to dark brownish; the latter tinge occurs even in green slugs. The dorsal surface of the mantle is darker than the rest of the body in most animals and frequently shows light spots, the disposition of which is radiate or irregular. The ventral surface of the mantle is mostly lighter than the body. The basis of the anal funnel has the same colour as the upper surface of the mantle and its tip that of the body. The gill is generally pigmented, at least on its external surface, but the intensity of its colouring is independent of that of the body. All examined specimens have a dark spot around the genital aperture, though it is small in young slugs. The seminal groove may or may not differ in colour from the rest of the body; in the first case it is either lighter or darker.

The tentacles are considerably larger than the rhinophores and often hardly separated from the buccal veil. This is fleshy and slightly ruffled. The distance between the rhinophores is 5-10mm, that is 2-5% of the body length. The black eyes lie in unpigmented

patches, 3-7mm (1-4% of the body length) in front of the rhinophores, and farther to the sides, so that the distance between them is twice that between the rhinophores. The male aperture close to the base of the right tentacle is sometimes surrounded by a white spot. The gutter that separates the foot from the velum is 5-6mm deep, that is 3% of the body length. The anterior border of the foot is sometimes notched, also in living slugs. There is no transverse furrow in the sole, as occurs in some other species (Pruvot-Fol 1953, p. 34). The borders of the parapodia are thin and wavy. Posteriorly they are not fused but almost united at the root of the short tail.

The tiny mantle foramen lies on a small papilla. The free border of the mantle, the overhang, is about 5mm broad in 8-15cm long preserved specimens. Backwards it passes into the broad anal spout at the base of which lies the anal opening. The pigmented area around the folded slit-like common genital aperture extends backwards. The purple gland has numerous orifices, that discharge a magenta-red secretion. The opaline gland (gland of Bohadsch) with a single wide opening (Fig. 1) resembles that of *A. fasciata* (Blochmann 1884, t. 3, f. 7: *limacina*); it is a "sackartiges Gebilde" (Hoffmann 1934, p. 471) and belongs to the "grape-shaped" type (Eales 1921, p. 19). Its duct is not pigmented, the secretion greenish yellow, not foetid. The roomy pallial cavity contains the nearly circular ctenidium, anterior to the attachment of which the osphradium is recognizable as a yellow, 1,5mm long depression surrounded by some black pigment.

The biggest shell of our material is 52mm long and 44mm broad. Its sinus is 25mm long and the height, that is the depth of the ventral concavity, is 8mm. This shell belonged to a slug that was at most 150mm long alive. The shell of a 200mm long specimen was a little narrower, viz. 52 × 43mm. Although generally smaller animals have smaller shells, f.ex. a slug of 85mm body length had a shell of 30 × 20mm, the length of the shells in animals of similar size is more constant than their breadth. The longest sinus, of 28mm, was found in a shell of 52 × 38mm. The concentric lines of growth are 0,7-0,8mm distant from one another. One strong and one fine radial mark appear with certain frequency; further radial marks vary from one individual to the other. The posterior border is provided with an upward folded flap (Fig. 2). The not calcified border of the shell is about 5mm broad.

The jaws (Fig. 3) have the form of nearly right-angled triangles, the longest side (hypothenuse) of which is more or less convex.

This side is directed backwards and downwards in the natural position of the mandibles. The measurements of the jaws vary according to the body size; f.ex., the length (antero-posterior direction) from 3,5 to 11mm, the breadth (dextro-sinistral direction) of both from 6 to 14mm. The mandibular rodlets end with a bent plate bordered with denticles (Fig. 4). The palatal rods are pointed hooks (Fig. 5).

The dark orange radula has up to 70 rows of plates each with the formula: 35-43.1.35-43. In old animals the rhachidian plate (Fig. 6) is 0,3mm high. The proximal denticles of its cusp are bigger than the distal ones. The principal cusp of the pleural plates (Fig. 7, 8) lengthens in older animals. Of the two other species of *Aplysia* hitherto known from the brazilian coast *A. cervina* (Dall & Simps.) has shorter pleural cusps, while they are as long as in the present species in *A. dactylomela* Rang. The size of these cusps diminishes towards the border, and four or three marginal plates do not have any cusp at all.

The outer pharyngeal muscles correspond perfectly to Cuvier's figure (1803, t. 2, f. 5). The salivary glands are 3cm long in a 7cm long slug, and their hind end is fixed to the gizzard.

Further characters of the alimentary canal (Fig. 9) that might be of systematic value are the teeth of the gizzard and the caecum. Three groups of teeth can be distinguished. The anterior teeth form 3 rows increasing in size and decreasing in number. The bases of these teeth are rhombic and the anterior surface of their crowns is deeply concave. The second group is that of the big teeth (Fig. 10). They are disposed in three series of 4 teeth each. Their form resembles those of *A. cervina* (MacFarland 1909, p. 43, f. 20), but they are more distinct in their sculpture. Their shape might be described as a four sided pyramid ending in a spout; in our largest slug their grinding surface is rather worn. The third group of teeth are 60-70 curved spines (Fig. 11) on wider circular bases in the posterior portion of the gizzard. They are of very different sizes that are intermingled, and they do not form rows.

The caecum (Fig. 9, c) is straighter and longer than that of *A. cervina* (l.c., p. 45, f. 31, 32, h. coe.). Its shape suits better to the description of *A. dactylomela* (p. 23), but it is longer (more than 2cm) and wider (2mm). It reaches the posterior end of the liver, where its slightly curved hind end appears on the dorsal surface of the posterior visceral complex between liver and ovotestis. Fig. 9 also shows the stomach with its valves (v), the

openings of the caecum and the liver ducts and the intestine. As in *A. cervina* there are three principal hepatic ducts (MacFarland 1909, p. 44), in the slug of Fig. 9 two on the left, one on the right side. A caecal ridge (w) continues into the intestine. The two gastric valves of the present species are more like in *dactylomela* than in *cervina*.

Of the reproductive system the verge (Fig. 12) might be of taxonomic importance, though the references to european species are discordant (Vayssière 1885, p. 59; Mazzarelli 1889, p. 335; Eales 1921, p. 63 and 67). A 20cm long preserved slug of our material had a 3cm long copulatory organ, measured from the insertion of the two groups of retractors on the sheath to the outer opening. The pike--shaped penis itself was 24mm long. The diameter was 1,5mm at the base 1mm near the tip. The penis is covered with a ciliated epithelium, not chitinized. The sheath is provided with longitudinal folds, the ridges of which are pigmented. For comparison with Mac Farland's 4cm long preserved specimen of *A. cervina*, the penis of which is ca. 2,5mm long and 0,6mm in diameter at the base, a slug of equal length of our material was examined. Its penis was 5,4mm long and slightly thinner at the base, viz. 0,5mm.

The nervous system of *A. dactylomela* and *A. cervina* from the brazilian coast was completely described by MacFarland (1909), so that some comparative notes may be useful. Like in both there is no dorsal cerebral commissure in our species, because the cerebral ganglia are closely applied to each other. They are even completely fused together in the present species as in *A. cervina*. Like the latter also our species has a thin ventral commissure between the cerebral ganglia. This consists of several fine fibres that lie in a common sheath together with the pedal commissure. The buccal ganglia of the present species are farther separated from one another than in *A. cervina*, the buccal commissure of which is less than half as long as the width of each buccal ganglion, while it is a little longer (0,8mm) than the breadth of one ganglion (0,7mm) in our material. The uniting of the supra-intestinal (right) and the visceral (left) ganglion varies in different animals. Sometimes it likens that of *A. cervina*, where one right and one left confluent portion are recognizable (MacFarland 1909, p. 51). In other slugs it corresponds to Guiart's (1901, p. 119) fig. 70 B, where a short part of the visceral cord unites the separate right and left complex. The latter consists of an anterior part, after Guiart the parietal-subintestinal ganglion, and a posterior part, the abdominal or visceral ganglion.

OCCURRENCE OF *APLYSIA BRASILIANA*

The preceding description comprises 20 adult dissected specimens caught on the coast of the Island of São Sebastião (Lat. 23° 49' S- Long. 45° 20' W) and in the Bay of Santos. Numerous animals of different ages were observed at Ubatuba (December 1954). Their external characters were also used in the preceding diagnosis. The material from Ilha Grande (Lat. 23° 10' S - Long. 44° 15' W), to which Haas (1953, p. 205, note) referred, evidently belongs to the same species. Dr. H. Sick, who collected these slugs, courteously sent us a copy of the informations he had given to Dr. F. Haas - Chicago. We have seen a big, quite dark brown specimen of the present species from Rio de Janeiro (Niteroi) in the collection of the Oceanographic Institute, São Paulo, and registered living chocolate-brown slugs at Ubatuba and São Vicente. The collection of the former "Museu Paulista" contains specimens from the coast of São Paulo, Itanhaém, Island of São Sebastião, and the neighbouring Island of Victoria, and such from the coast of Sta. Catharina (Desterro, to-day Florianopolis) that we could not separate from our species. It is true that important criteria are wanting when one tries to classify more or less discoloured, in part entirely white, sea-hares that had been lying in alcohol for 40-60 years.

Our biological notes are preliminary. Frequently we observed adult animals from early spring to summer, viz. September to February, but dozens of them had been left stranded by the low tide also in June 1952, and living adult slugs were seen in April, July, September and December 1954. Very different months of winter (November, January, February), spring (April) and summer (July, August) were indicated for the appearance of *A. californica* Cooper by MacGinitie (1935, p. 737). Like in *A. punctata* Cuv. (Eales 1921, p. 8) the appearance of our species "is often sporadic and whereas it may be very abundant in a certain year at a definite spot, the same place may not yield a single specimen when searched again the following year". We noted the egg-strings that are excellently compared with a tangled bunch of yellow wool yarn by MacGinitie (1934, p. 302) at the end of August and beginning of September as well as in the last week of November and the first fortnight of December, but can not state that spawning does not take place also in other months.

ON THE POST-LARVAL DEVELOPMENT OF *APLYSIA BRASILIANA*

Our collection contains six juvenile specimens that were obtained among algae in the eulittoral of the Island of S. Sebastião.

I. Living 0,9, preserved 0,5mm long (Fig. 13, 14); shell 0,45mm long, 0,32mm broad. (10.IV.1954). To judge from the shell of A. californica Cooper (MacGinitie 1934, p. 303) stage I is newly settled from the plankton.

II. Living 2mm, preserved 1mm. Shell 0,9mm long (10.IV.1954) (Fig. 15, 16). Sectioned (Fig. 23).

III. Living 2,5mm, preserved 1,5mm (Fig. 17). Shell about 1,5mm long (19.IV.1954). Sectioned. This was the youngest animal seen to secrete purple dye.

IV. Preserved 2,1mm (Fig. 18). Shell 1,3mm long, 0,72mm broad (17.IV.1954).

V. Alive about 4mm (Fig. 19), preserved 2,5mm. Shell 1,8mm long (1.XII.1953).

VI. Living nearly 8mm, preserved 4,5mm. Shell 2mm long (8.VI. 1953).

The youngest slug (I) was uncoloured, II-IV reddish, V and VI brownish. A few dark red dots were noted in III, and VI is speckled with red. Slug V had a brilliant green lateral line from each tentacle to the parapodium and some light green spots on the sides of the parapodia, probably the first of the white dots of the adults.

While eyes are not yet developed in the newly hatched Veliger-larvae of *A. punctata* Cuv. (Thorson 1946, p. 263, f. 155), they are already present in our youngest metamorphosized stage (I). The eyes are 50 micra in diameter in the sections of stage III. Slug I has also tentacles that were alive pointed (Fig. 13) and are preserved roundish, located near the anterior end. Rhinophores were not recognizable in I. These begin to appear as round knobs in II and III (Fig. 17, u); the slightly longer IV (Fig. 18) does not have them yet. Animal V has distinct rhinophores (Fig. 19). The rhinophore buds of II and III were sectioned. They are not innervated, while the tentacles of the same stages are supplied with mighty, 40 micra thick nerves. Pruvot-Fol (1931, p. 526, f. 1 B; 1953, t. 3, f. 42) and Engel & Hummelinck (1936, p. 29, f. 15) figure young stages of *Aplysia* with incipient rhinophores.

Though stage I was relatively long while creeping, it is nearly covered by the shell when contracted (Fig. 14). This is no longer the case with our further young animals. A narrow stripe of the adult shell (d) exists beyond the brown border (j) of the larval shell (e) in I. The latter has about 3 whorls like the metamorphosizing Cephalaspidea *Diaphana hyalina* (Thorson 1946, p. 251, f. 147 D) and *Philine aperta* (ibid., f. 150 K), and as in these species it turns to the ventral side when the shell grows out to the right side. This ventral position is attained in stage II, where the shell sinus leaves a space for the already salient cloacal sipho (Fig. 17). The anterior border of the mantle lies under the shell in I-IV; the mantle begins to grow over the shell in V. Also in VI it is not much farther developed, so that a large area of the shell is still uncovered. The parapodia involve half the shell in the living slug I, less after preservation. In IV the parapodia meet over the shell.

After the literature a pallial caecum occurs only in the Cephalaspidea (Guiart 1901, p. 70, 74; Hoffmann 1933, p. 298, 307-8) not in the Anaspidea. So much the more astonishing are a dorsal and a ventral patch of long cilia in the hinder part of the mantle cavity of our stages II and III. We consider these ciliated areas (Fig. 23, y) as homologous with the ciliary stripes of the pallial caecum of the Cephalaspidea that we have seen in *Chelidonura evelinae* Marcus (1955). In *Aplysia* they lie in front of the anus; also in the Cephalaspidea they may extend from the pallial caecum forward into the mantle cavity and even reach the mantle border. The cilia of our *Aplysia* are 40 micra long in II, 50 micra in III, and the patches are broader (120, 170 micra) than long (90, 100 micra).

The osphradium of the sectioned stages II and III is very large, 80 micra in diameter in the older, 0,75mm broad slug. The opaline gland is insunk already in stage II and contains intra-cellular pear-shaped, 80 micra long (in III: 140 micra) erythrophilous masses of secretion.

The jaws of slug I have ca. 11 transverse rows of about 15 denticulate platelets each. In the following stages these platelets are in the central part of the mandible lifted from their bases by the outgrowing rodlets. In stage VI (Fig. 4) the rodlets already liken those of adult slugs, in which however the denticles are generally worn. Each rodlet is formed by one cell.

The radula of stage I consists of 11 series with the formula 2.1.1.1.2. The rhachidian plate (Fig. 20) in the oldest row is 33 micra broad and has a median and on each side 4 lateral den-

ticles. The pleural plates are hook-shaped with two or more points. The marginal plates are simple longish thickenings of the sub--radular membrane. The radula of stage IV (Fig. 21) has 18 rows, the oldest of which corresponds to the youngest of stage I. It has a 60 micra broad rhachidian plate with a median notch in the anterior border, one pleural hook with 5 denticles and two simple marginal plates. In the youngest rows with the formula 3.3.1.3.3 the median cusp of the rhachidian plate is denticulate. Also the shape of the pleural plates approaches that of adult animals. The specimen of *Aplysia parva* Pruvot-Fol (1953, p. 38) corresponds approximately to our stage IV, but has a straight, not notched, anterior border of the rhachidian plate. Slug VI has 22 series, the youngest of which are yellow. The formula is 3.6.1.6.3, and the shape of the plates (Fig. 22) is nearly definitive.

In slug II the gizzard has no teeth yet, while in III their multicellular primordia, about 40 micra in diameter, have a cap of cuticular substance. In this stage there is already on the right side of the pharynx a hollow penial sheath without opening. Living 2-3cm long animals have the external seminal groove and a dark spot around the common genital aperture. Also the penis is already developed but there is not the slightest trace of inner generative organs. The same holds true for slugs 4-5cm long alive. A specimen that was preserved about 4,5cm long showed a string of undifferentiated tissue from the gonopore inwards. Animals of 7-8cm length (preserved) have complete gonads over the liver.

DISCUSSION OF *APLYSIA BRASILIANA*

Of the genus *Aplysia* (name see Engel 1936) the first species from the coast of southern middle Brazil (Rio de Janeiro) is *A. brasiliana* Rang (1828, p. 55, t. 8, f. 1-3). The description and the figures "are evidently from alcoholic specimens" (Pilsbry 1895, p. 82), and already Griffith (1834, p. 44) observed the often unsatisfactory state of preserved sea-hares for systematic purposes. Notwithstanding Rang's characterization is even now very useful, and we think that the modern Brazilian (Oliveira 1950, p. 372) and North American publications (Haas 1953, p. 205, note) are right to call the common sea-slug from Rio *A. brasiliana* Rang, 1828.

D'Orbigny (1837, p. 206, t. 18, f. 3-5) studied great numbers of living *Aplysia* in Rio de Janeiro and called them *A. livida*, or *A. lurida* on the plate. He emphasized the differences from *brasiliana*, the colour, the rather elongated posterior end, and "beaucoup d'autres dissemblances".

As indicated in the preceding description, the colour is composed of various elements, as f.ex. pigments and contents of skin glands. With the preponderance of one or the other of these components the general aspect varies from dark brown to creamy white. The length of the tail differs already in d'Orbigny's figures 3 and 4. Resting slugs have a shorter tail than those gliding or swimming, and in big old animals the tail is not as long in relation to the total length as in younger, smaller ones. The length of the tail of living slugs that d'Orbigny described is not comparable with that of Rang's preserved animals.

The fluid of the purple gland of *livida* is pale rose coloured "ou mieux couleur de lie de vin". Our slugs have magenta-red secretion that changes to bluish in sea water. Dr. H.Sick, who's notes were decisive for Haas' classification (1953), wrote in a letter (12.I.1954) "Tinte dunkel lila gefärbt". We have hardly noticed the musky odour of the secretion that d'Orbigny mentioned for *livida*. Neither the diversity by degree of the colour of the dye (see Eales 1921, p. 23) nor its more or less perceptible smell are specific characters. Perhaps the latter depends on the intensity of irritation to which the slugs are exposed by the collector. *Aplysia juliana* that fixes itself to the substratum and must be removed from it with some violence has a strongly smelling secretion.

On the whole the diagnoses of Rang and d'Orbigny are not easy to compare, because one describes other details than the other. Rang, f.ex., does not mention the pattern of alternating dark and light areas along the inner border of the parapodia, emphasized for *livida*. Therefore Ihering (1915, p. 135) considered the absence of this pattern as a character of *brasiliana* and erroneously also of *A. cervina* (Dall & Simpson 1901, p. 365), a well-known species (MacFarland 1909, p. 38; Engel & Hummelinck 1936, p. 13). The absence of the pattern in a slug in the former Museu Paulista is without significance, as the animal was preserved in 1893. We have seen living slugs without the pattern, and in alcohol the colours, also the black pigment, fade (MacFarland 1909, p. 39). A slug from São Sebastião in the mentioned collection caught in 1896 still shows traces of the pattern; it is labelled *A. brasiliana*. We do not see

the reason, why other sea-hares from Sta. Catharina (Desterro, to-day Florianopolis) and the coast of São Paulo (Itanhaém) were determined as *livida* by Ihering. Probably the breadth of the shell (Ihering 1915, p. 136) was decisive for the classification, but Engel & Hummelinck (1936, table 3 on p. 11) showed the broad variation of this character when an ample material is examined.

Resuming we consider *Aplysia brasiliana* Rang, 1828 and *A. livida* d'Orbigny, 1837 as synonyms. The distribution comprises the brazilian coast from Rio de Janeiro to Sta. Catharina; the classification of material from Bahia (Ihering 1915, p. 135) is uncertain.

Aplysia dactylomela Rang, 1828

This species first described from the Cape Verde Islands (Rang 1828, p. 56) is also widely distributed on the coast of Brazil. Bergh's material from Rio de Janeiro (Selenka leg., July 1877), that he with some doubt called *A. protea* Rang (Bergh 1908, p. 150, t. 12, f. 1-7), belongs, together with the latter, to *A. dactylomela* (Engel 1927, p. 85, 90). The coast of the State of São Paulo too is inhabited by *A. dactylomela*. We have, f.ex., found a young slug of 10mm length creeping among algae near the low water-line at Ilhabela, and seen two adult specimens from the Island of Victoria, near the Island of São Sebastião, in the collection of the former Section of Zoology of the "Museu Paulista" (Cat.no. 10325). Bahia (Ihering 1915, p. 139), Alagoas, and Pernambuco (MacFarland 1909, p. 14) are further brazilian records for *A. dactylomela*; from the latter locality Dr. Sebastian Gerlach (Kiel) brought us 2 well preserved slugs.

The black or sepia brown rings are specially characteristic for this species (Engel & Hummelinck 1936, p. 13).

As far as the synonymy is certain, the distribution of typical *A. dactylomela* comprehends the Atlantic, approximately between Lat. 35° N and 35° S. Pruvot-Fol (1953, p. 33) classified a slug from the Morocco coast as *A. dactylomela*, and this locality, together with the Islands of Bermuda, seems to be the northern limit of *dactylomela*. Its southern extent on the American coast, the coast of São Paulo, is certainly only a temporary limit due to the present state of knowledge. This can be concluded from its distribution on the African coast, where the species goes around the Cape of Good Hope.

Engel (1929; Engel & Hummelinck 1936, p. 5-6) also includes Indo-pacific species in the synonymy of *A. dactylomela*. Following this authority recent publications on Japanese and Pacific sea-hares apply this name, f.ex., Baba (1936, p. 7; 1949, p. 124), Baba & Hamatani (1952, p. 2), and Pruvot-Fol (1954, p. 6). The specific separation of the eastern specimens (Eales 1944, p. 4) as *Aplysia fimbriata* Adams & Reeve, 1848 was substituted by giving them the rank of a subspecies (Macnae 1955, p. 231) or variety (Letter of Dr. Eales from May 9, 1956). The typical form and var. *fimbriata* overlap on the southern coasts of South Africa, and intermediate specimens between the two forms occur (Macnae, l.c.).

Aplysia juliana Quoy & Gaimard, 1832

(Fig. 24–37)

For bibliography and synonymy see Macnae 1955, p. 237.

The living slugs (Fig. 24) are smooth and round; preserved their skin resembles peccary leather. The greatest breadth lies behind the middle of the body; the cephalic region (head and neck) is about one third of the total length. Our biggest slugs measured up to 70mm alive and creeping, but the hermaphroditic gland is not developed yet. The preserved animals vary from 4 to 40mm, the greatest breadth is 21, the maximum height 20mm. Smaller specimens are f.ex. 13mm long, 8mm broad, and 6mm high.

The colour is dark green, brownish or reddish yellow, with small light dots; light stripes run from the tentacles or eyes to the parapodia. The ground colour may be covered by a net of black pigment, the meshes of which are of variable size. Sometimes alternating light and dark blotches occur along the inner border of the parapodia.

The sole is smooth, dark grayish green, and, when contracted, nearly black in front and behind. The breadth of the foot varies according to its contraction, its rounded hind end stands out over the body in most cases. The foot is as broad as the body or half as broad. The lateral pedal borders are sharp, the anterior margin is subdivided by a notch separating two rounded and highly contractile lobes that are less sticky than the posterior "disc". The middle part of the sole is soft and thin, the posterior end, when contracted, a kind of solid disc that adheres tightly to the substratum.

Histologically the adhesive areas are not differentiated from the rest of the sole. Pilsbry (1951, p. 3, f. 4) described them as adhesive discs that are sharply limited against the sole, though they do not appear darker.

The concentrated foot glands correspond to Eales' description (1921, p. 22): one anterior, one suprapedal, and a paired posterior gland (Fig. 37). The posterior glands were only seen in serial sections of a 4mm long slug, and the same holds true for *A. brasiliana*, of which a 1 and a 1,7mm long slug were sectioned.

The four cephalic appendages have either light or dark tips. The broad labial expansions are prolonged into the tentacles that have outer grooves and are larger than the rhinophores. The length of the rhinophorial slits varies very much and may even differ considerably on the right and left side of one individual.

The parapodia are fused high up behind, and their rather smooth borders lie close together in front, so that the dorsal slit is narrow. The mantle is pigmented, with inconspicuous overhang. The mantle aperture (w) is wide in all specimens. It has about half the dimensions of the shell, f.ex., 6mm length and 4mm breadth in a 40mm long preserved slug, the shell of which measures 12,5 × 8mm. Also the under side of the mantle is pigmented with exception of the purple glands (t) that have a whitish secretion. The anal spout (siphon, x) is folded, and the anus has a radiate appearance (Eales 1921, p. 17).

The pallial cavity is rather small. The upper side of the gill is striped with pigment, the rest colourless. The gray opaline glands (u) discharge a strong-smelling, viscous fluid by numerous small orifices. In preserved slugs of 40mm the opaline gland is 8-10mm long. The common genital aperture is brimmed with white, the spermatic groove pigmented.

The biggest of our shells (Fig. 28) measures 15 × 10mm; it belonged to a preserved 40mm long slug. An other shell of a 24mm long animal is 11 × 8mm. The anal incision (sinus) of a 12,5mm long shell is 4,5mm long. The calcareous layer is rather well developed. The spirally coiled larval shell (Fig. 29) with a diameter of 0,3mm is recurved on the ventral side of the umbo.

The jaws (Fig. 31, j) are light yellow. Each mandible of a 24mm long slug is 2,3mm long and 1,3mm high. The mandibular rodlets (Fig. 33, ji) and also the palatal rods (q) do not show any particularities. The buccal cavity and the pharyngeal canal are lined

with a pigmented cuticula that thins out at the beginning of the oesophagus (o). The oral cuticula (ci) is thickened dorsally, so that the jaw plates are connected (Fig. 33). In sections the aspect of the mandibles resembles MacFarland's figure of their development in *Dolabella* (Hoffmann 1938, p. 979, f. 672). The yellow radula of a 40mm long slug has the formula 46 × 23.1.23. The 3-4 marginal plates are rudimentary and have no cusp. The serration of the rhachidian and the following plates is weak, that of the farther outward ones stronger (Fig. 34). The pigmented salivary glands (Fig. 30, s) open into the cavity of the buccal mass to the sides of the pharyngeal crests (palatal rods, q) and extend backwards to the gizzard.

The crop (Fig. 30, c) is ample and as colourless as the gizzard (g). The anterior chamber of the gizzard contains a number of smaller teeth and three sets of four big ones each that arise from four-sided bases and form irregular pyramids with one or more points (Fig. 35). Some of them liken phrygian caps. The teeth of the posterior portion of the gizzard are needle-shaped. The small stomach is characterized by the openings of the liver ducts (v) and the entrances of the caecum (d) and the gut (i). The caecum has a typhlosole and projects backwards beyond the liver with a snail--like coil. The intestine (i) winds through the liver (l).

Osphradium (n), heart, and kidney do not show any specific characters. Three dissected slugs of 40, 40, and 24mm length had a penis filling nearly half the length of the sheath. The penis ends truncate, has light tip and edge, and velvety black surface. The sheath is slightly pigmented and folded longitudinally; at its basis it is provided with rosette-shaped warts. In the biggest specimen the pigmentation of the male organ is less intense and the verge smaller than in the others.

The cerebral ganglia are not so completely fused together as in *A. brasiliana*, but only closely applied to each other. The buccal ganglia are separate but connected by a very short commissure as in *A. cervina* (MacFarland 1909, p. 51). The visceral loop shows the supra-intestinal (right) and the visceral (left) ganglion forming a common mass like in *A. dactylomela* (l.c., p. 32). The biggest slug of the present collection has abnormally tiny cerebral and pleural ganglia, while the pedal ones are of normal size.

OCCURRENCE - Ubatuba, northeastern coast of the State of São Paulo; December 1954. Thirteen slugs were collected and several more seen among algae (Ulva, Gracilaria, etc.) on boulders and

stones in the upper littoral. Here they move gliding or stand on their fixed tail with erect fore end. They are not easy to be disengaged from their substratum, as they stick tight with the hind end of the sole. Loosed in the water they do not swim but sink. When they are seized, the glands of their pallial cavity secrete some whitish strands and a strong-smelling, colourless, mucous substance, that swells considerably in the water.

FURTHER DISTRIBUTION – Florida; South Africa; Mauritius; Timor; Riukiu Islands; Pacific coasts of Japan, northwards till Mutsu Bay.

DISCUSSION OF *APLYSIA JULIANA*

At first we had distinguished our material from *Aplysia badistes* Pilsbry (1951), the description of which we had just received. Later on Macnae's study (1955) appeared, where *badistes* is considered as a synonym of *A. juliana* (p. 226, 237). Dr. Nellie B. Eales, who's opinion concerning *Aplysia* is authoritative, kindly informed us that she endorses Macnae's view. Therefore we adopt the name of the Indo-west pacific species for the Floridan and our Brazilian sea-hares.

The shell of the Atlantic specimens is well calcified, not extremely thin and hyaline, as indicated in several descriptions of Indic slugs. All other differences between Macnae's and our material disappear, when one compares the further records on the animals with different names now united with *juliana*. The rhinophores that Macnae (p. 238) describes as "auriculate only at the tips" have in our material slits of variable length. The shell aperture of the mantle "varies in size from one-eighth of the width of the mantle down to a minute pore" in Macnae's material (p. 238, text-fig. 1 c). It is large in *capensis* (O'Donoghue 1929, p. 14) and "usually large" in the sea-hares of southern Japan (Baba 1937, p. 213). Macnae (p. 239) noted the absence of a cusp only on the outermost radula plate and sometimes also in the penultimate plate. The Japanese specimens, however, and those from South Africa described as *woodii* and *capensis* (Bergh 1907, p. 12, t. 2, f. 19; O'Donoghue 1929, p. 18) have several marginal plates reduced like Pilsbry's and our animals. The conical, pointed penis of Macnae's figure (text-fig. 3 d, not 3 c as he indicates) is exserted and erected. Probably therefore its shape is so different from that found by Pilsbry and us. Our specimens confirm Macnae's observation of tubercles in the basilar part of the penis sheath. The spicule

topping each tubercle is not developed in our animals, probably due to their immature state. Macnae (p. 238) says "there is no purple gland" and does not draw any in his text-figure 1 c (p. 227). There are, however, glands in the roof of the mantle cavity that are homologous to the purple gland, though their secretion is whitish. These were already observed by Baba (1937, p. 212), and have parallels among european species (Eales 1921, p. 23, note).

Pilsbry's slugs have ragged black spots on the outer side of the parapodia that do not occur in ours. Ours are provided with two light cephalic stripes absent in the Floridan sea-hares. After Baba (1937, p. 212) and Macnae (1955, p. 238) who, like Pilsbry and we, handled recently captured animals, the colours of *juliana* vary widely.

The light stripes of the head of our slugs occur also in *A. parva* Pruvot-Fol (1953, p. 38) from Morocco, a young slug with distinctly coiled larval shell. However Pruvot-Fol does not indicate any peculiar differentiation of the sole. This does not exclude her material from *juliana*, as Macnae (1955, p. 238) saw specimens with completely unmodified sole. If *A. parva* is maintained as separate species, it must be re-named, because Eliot (1899, p. 513) erroneously used *parva* for *parvula* Mörch (Engel & Hummelinck 1936, p. 23), now *A. spuria* Krauss (see Macnae 1955, p. 235).

The attempts to subdivide the genus *Aplysia* were not accepted by Eales (1944, p. 15) and Macnae (1955, p. 223). Notwithstanding, there are several species that have characters in common with *A. juliana*, the type species of the subgenus *Tullia* Pruvot-Fol (1933, p. 400). *A. sorex* Rang (1828, p. 57), f. ex. has a "sucker". The length of its shell, however, corresponds to half the body-length (Rang) or more (young animal of Pruvot-Fol 1953, p. 33); and the rhachidian plate of the latter (l.c., f. VII) differs from that of *juliana*. *A. rangiana* D'Orbigny (1837, p. 210), that is blackish in alcohol, has a very large oval mantle aperture which discloses a swollen shell. The foot of *A. bipes* (Pease 1860) is narrowed anteriorly (Pilsbry 1895, p. 91), and the shell is pointed behind.

A less pronounced anterior and a more distinct posterior expansion of the sole occur in Risbec's *Aplysia* sp. n° 1 (1931, p. 72) from Morocco. The firm consistence of Risbec's slug, "ce qui n'est pas habituel chez les Aplysia", is characteristic of our specimens of *juliana* too, but the fusiform aspect of Risbec's individuals differs from our material.

Like Pilsbry's animals do ours neither contract considerably when preserved, nor are they "to any useful degree sensitive to magnesium sulfate" (Pilsbry 1951, p. 4).

Berthella agassizii (MacFarland, 1909)

(Fig. 38–39)

The reproductive organs were not included in our first description of this species (Marcus 1955, p. 117). They are treated summarily by MacFarland (1909, p. 63), and are histologically very little known in the whole family Pleurobranchidae. Therefore it may be useful to supply this gap.

The follicles of the ovotestis contain ovocytes or sperm. The long, winding ampulla (a) is a simple dilatation of the spermoviduct. Efferent duct (d) and oviduct (o) separate immediately behind the end of the ampulla. The oviduct is short and enters the folded female gland mass (w) that opens (f) to the exterior without narrowing into a nidamental duct.

The efferent duct is glandular ("prostatic", q) in the greater part of its sinuous course, nearly up to its entrance into the penis (p). At this point the male duct unites with a long, tubular, entally slightly dilated appendage (b) that Vayssière (1898, p. 235) called a supplementary prostate and figured in various species of *Berthellina* and *Berthella* (t. 27, f. 180, 182, 183, D). Sections show a spacious muscular tube lined with a thin, glandular epithelium and filled with a solid mass of erythrophilous secretion. Hence the denomination as accessory prostate is justified.

The conical penis (p) consists of a thick, mainly circular muscle mass (z) pierced by the efferent duct (d) that is widened near its end. The penis is pleurembolic and projects into the male vestibulum (n) that opens (m) on the tip of a genital papilla. This outer opening is provided with gland cells (g) producing a black granular secretion, a mass of which (r) is found in the spermatheca (t).

The muscular vagina (v) goes out from the male vestibulum, from which it is separated by a thick sphincter (c). The two seminal vesicles, spermatheca (t) and spermatocyst (s) are connected according to the semi-serial scheme (Odhner 1926, p. 51), while *Pleurobranchus* has the vaginal type (l.c.). The spermatheca of *B. agassizii* is spherical, the spermatocyst barrel-shaped with rings of black pigment which are also visible in the sections. The short uterine duct (u) enters the mucous part of the female gland mass.

In his description of *Pleurobranchus* (*Oscanius*) *amarillius* Mattox (1953, t. 10, f. 10) does not indicate the course of the uterine duct from the spermatocyst to the oviduct. Notwithstanding its existence can be inferred from the topography of vagina and oviduct, and hence the female system of Mattox's species seems to have semi-serial seminal vesicles too.

The generic name of Mattox's slug needs a commentary. He refers (p. 109) to Thiele's taxonomy of the Pleurobranchinae (1931, p. 418-419). This system is that elaborated by Odhner (1926, p. 19-24) with exception of *Gymnotoplax*. It is still valid, though modifications of the nomenclature (Engel 1934; Gardiner 1936) have proved necessary (Odhner 1939, p. 19-24). Mattox does not mention the presence of a foot gland nor tubercles on the rhachis of the gill. His figure 2 (plate 10) shows a smooth rhachis. Oviduct and vagina are separate in their entire course (f. 10). The radula plates are lamelliform with serrated posterior margin, not hook--shaped. By all these well figured characters it is evident that his species is not a *Pleurobranchus*, as *P. atlanticus* Abbott, 1949 (p. 73) is, but belongs to the triaulic Pleurobranchinae. As the radula and the prostate show, it is a *Berthellina* Gardiner, 1936 (= *Berthella* Vayssière 1896, non Blainville 1825) and very near *B. quadridens* (Mörch 1863, p. 29-30) with which Mattox duly compared it. This species has about 70 rows of radula plates each with approximately 150 teeth (Bergh 1898*a*, p. 137), not 150 rows with 70 teeth, as Mattox mentioned.

In the sections of *Berthella agassizii* we found that the young, ental half of the mandibles is supported by two high (about 60 micra) cushions of elongated vesiculous cells. Each cuticular platelet is formed by one huge cell with a nucleus distinct even in the old part of the jaw.

Pleurobranchaea hamva, spec. nov.

(Fig. 40–52)

The two living slugs were 50 and 60mm long; the biggest preserved animal is 33mm long, 20mm broad and 15mm high. The smallest measures 22, 14 and 9mm respectively. The body is broadly oval in outline and the tail set off. The latter has a 1,5mm high dorsal spur (zi) and on the ventral side a 6mm long and 1,5mm broad foot gland (ti).

The frontal velum with the tentacles is 13mm broad in the biggest slug; its rhinophores (r) are 2,5mm long. The mantle is convex; the sides are almost vertical, and the flat foot is 15mm broad. It projects as a narrow flange all around the body. Anteriorly its margin is thickened and has a transverse furrow; on the sides the flanges are narrow and continue into the tongue-shaped tail. The mantle passes evenly to the left side of the body, while it overhangs a little on the right side, forming a kind of siphon over the tip of the gill (Fig. 40, gi).

The mantle is gibbous with furrows between the bosses. The latter form two irregular rows of warts on the velum between the tentacles. The body sides are smooth, and the upper side of the foot is wrinkled.

The mantle bears white glands on the bosses, and the folds between them are dark brown. The general aspect of the back is violet-brown, that of the sole light pinkish brown. The living animals are rather transparent. The sides of the body have no pigment. A median dark stripe runs over the tail and ends on the spur (zi). The area around the mouth is blackish. The rhinophores are dark and trimmed with white; the rhachis of the ctenidium and its continuations between the lamellae of the pinnules are sprinkled with brown. Dark pigment occurs also in the median furrow of the pedal gland (ti). The black oesophagus shines through the dorsum, the eyes do not.

In the biggest slug the ctenidium is 16mm long and 5,5mm broad. It has 24 pinnules on each side. The branchial membrane (Fig. 43, ig) extends to the 15th pinnule that is about three quarters of the length of the gill, as the posterior pinnules are much smaller. The anus (a) lies on the level of the middle of the gill, over the 7th pinnule, the renal pore (n) under the 2nd. When the wide and folded opening of the prebranchial gland (b) is somewhat everted, its margin is seen to be split below. The genital apertures (Fig. 42, g) are surrounded by a common collar-like membrane with a dorsal flap (ge). The round male orifice (m) is located in front of the slit-like female opening (f).

The cerebral and pleural ganglia (c) are, as stated by Vayssière (1901, p. 25, "ganglions cérébroides"), completely united, but more differentiated than in his figure (f. 205) copied by Hoffmann (1936, f. 739 A). The rhinophore nerve (Fig. 43, rn) and the eye nerve (ei) originate from a thickening that lies on the rest of the cerebro--pleural mass (see Hoffmann, l.c., text on p. 792). Hoffmann was

right to suppose that Vayssière's nerve 5, Hoffmann's c7, is the eye nerve.

The mouth cavity is purplish and the folded oesophagus (e) velvety black. The ampullae (sa) of the salivary ducts (s) are small and white. The completely fused salivary glands (h) lie on the anterior surface of the liver (l). The tubules of the acid gland (z) spin all round the inner organs from the dorsal to the ventral side, but leave the surface of the blood gland (x) free, as Bergh observed (1897, p. 12). Their ductules unite without forming two distinct stem-branches ("stammäste" Bergh) to a duct(di) that begins wide and narrows from the middle of the pharynx (pa) forward.

The pharyngeal musculature (Fig. 44-46) differs from that of *P.meckelii* (Bergh 1897, t. 2, f. 6, 7) in some details. Muscles 2 (terminology of Hoffmann 1938, p. 961-963) described but not drawn by Bergh originate on the buccal tube, run below 1, and one part inserts under 7, one bundle continues backwards where it surrounds 11 together with 9. Muscle 6 originates on the ventro-lateral face of the mouth tube, runs loosely and superficially backwards, accompanies 10 for a little way, passes under 12, and inserts on the sides of the oesophagus. The origin of muscle 9 consists of three portions that appear on different levels on muscle 7. Muscles 11 and 13 seem to be connected; the latter can be separated from 8, but the separation is not very distinct. Hoffmann's figure 663 A contains a muscle 18, but this is "16" of his text, Bergh's musculus radularis lateralis. No. 18 is suppressed here as designation for a superficial pharyngeal muscle to avoid confusion. This number may be reserved for the musculus mandibularis proprius, an inner muscle not visible in Bergh's nor our figures. While Bergh gives only two lateral radular muscles, 16 and 17, the former consists of a dorsal (16) and a ventral (19) portion in the present species.

As retractors and protractors probably the muscles 20 and 21 respectively function. The retractors originate on the sides of the body wall and insert between the muscles 1. Retractors that insert at the hind end of the pharynx as in *Pleurobranchus* (Hoffmann 1938, f. 659) do not exist. The bundles of the protractor come from the dorso-lateral body wall, unite ventrally near the anterior third of the pharynx and insert between muscles 10 and 14. Protractor 21 seems also to function as levator. The muscles between the body wall and the buccal tube were not considered.

The wide stomach (so) is thin-walled in the two dissected

specimens. A small radula and jaws of a slug of the same species were found in the contents of the stomach. Also Bergh (1899, p. 27) observed that *P.meckelii* feeds on smaller "Artgenossen", and Pruvot-Fol (1926, p. 277, f. XXVI) saw one slug of this species in captivity eat another of its own size. Eales (1937) found 14 young *Pleurobranchaea capensis* Vayssière, 1900 swallowed by a *Pleurobranchoides gilchristi* O'Donoghue, 1929.

The very light yellow jaws are each 8mm long and 3mm broad. Their rodlets are generally hexagonal prisms. The platelets that form the outer surface overlap one another with denticulate borders. The 5-13 denticles vary in breadth and shape in the biggest slug (Fig. 47) and were more uniform pointed teeth in the evidently smaller slug (Fig. 48) that was found in the stomach.

The radula (Fig. 49-51) has 38 series with 60 plates in each half row. The rhachis is smooth. The plates have a long and pointed cusp and a denticle on the inner side. The size of this denticle is largest in the middle of the half row and decreases towards the middle and the sides of the radula. On the innermost and outermost plates it may disappear.

The ovotestis (Fig. 43, o) is a compact mass on the hinder side of the liver. The spermoviduct (Fig. 52, si) passes winding (straight in *inconspicua* Bergh) through the liver and increasing in diameter forms the tubular ampulla (as). Behind the ampulla the male and female branch separate. The former enters the flat and round prostate (q) from which a twisting efferent duct (diameter 0,14mm) emerges. This duct (d) passes through the wall of the penial sheath (pi) where it forms many coils and gradually increases to 0,3mm diameter. Unravelled the efferent duct is 12cm long (7,5cm in *inconspicua*). Its lining is cuticular but not spiny. It opens into the penis (p) that is 5mm long and 2,5mm thick. The inverted pouch-like penis is lined with a longitudinally folded epithelium. Where the efferent duct opens into the penis, a strong muscle (j) inserts that consists of two bundles. These bundles embrace the efferent duct and unite where they pass through the wall of the penis sheath. The muscle originates on the left side of the back.

The wide oviduct (v) forms several loops (Bergh's spermatheca), communicates with the globular, unstalked and thin-walled spermatheca (t) (Bergh's spermatocyst, Vayssière's "poche copulatrice") and enters the female gland mass (w) with a wide entrance, Bergh's "bulbus oviductus". The ectal part of the oviduct is a membranous tube.

Together with the two living slugs two spawns were found in low water on a stone that lay on sand with mud. They are straight hollow cylinders, one about 70mm, the other 40mm long, and about 7mm in diameter. The colours of the eggs, violet-pink in the longer, white in the smaller spawn, corresponded to those of the female gland mass in the two slugs, that shone through the body wall. The egg strings, each composed of innumerous capsules with 2-5 eggs, form a spiral lying in about three different layers of the gelatinous wall of the spawn. Probably several of these strings come out of the stellate nidamental pore at the same time.

OCCURRENCE - 1) Ilhabela, Island of São Sebastião, 2 slugs together with their spawns above low water-line, 14.XI.1955. 2) Cananéia, 200km SW of Santos, 3 specimens in December 1953 collected by Dr. Peter Kaiser from Hamburg. 3) Same locality, 2 animals in the collection of the Oceanographic Institute of the University S. Paulo.

DISCUSSION OF *PLEUROBRANCHAEA HAMVA*

Only one species of the Genus *Pleurobranchaea* Leue 1813 has been described from the brazilian coast (*inconspicua*, 1 specimen from Sergipe). For separation of *P.hamva* from the previously published species and varieties one or more disjunctive characters of each of them are mentioned in the following list. The description of *P.algoensis* Thiele 1925 (Deutsche Tiefsee-Exped., v. 17, p. 282) was not available, but as this expedition was not in the Western Atlantic it is highly improbable that *algoensis* is identical with the present species.

1) – *agassizii* Bergh (1897, p. 48). 32 branchial pinnules; anal opening at hind end of branchial membrane; 90 plates in half row of radula.

2) – *brockii* (Bergh 1892, p. 28; 1897, p. 41); Vayssière (1901, p. 62). First mentioned as Pleurobranchillus Bergh 1892, a genus dropped later on (see morosa). 33-41 branchial pinnules; anus at hind end of branchial membrane (Vayssière) or a little behind (Bergh).

3) – *brockii* var. Bergh (1897, p. 46). Frontal velum with one series of papillae; anal opening at hind end of branchial membrane.

4) – *capensis* Vayssière (1900, p. 10; 1901, p. 46); Bergh (1907, p. 30); O'Donoghue (1929, p. 48). Anus a short distance posterior to gill insertion; border of genital openings evidently simple (see Vayssière 1901, p. 47 compared with p. 54).

5) – *capensis* var. Bergh (1907, p. 32). Anus at base of free part of ctenidium.

6) – *dorsalis* Allan (1933, p. 445). Purplish brown; foot produced behind to a rounded tail without caudal spur (t. 56, f. 4). The latter character is perhaps variable, as is shown by the descriptions of capensis and melanopus (Bergh 1907; O'Donoghue 1929).

7) – *hedgpethi* Abbott (1952, p. 1). The tongue-like extension of the membrane that surrounds the genital apertures is directed forward.

8) – *inconspicua* Bergh (1897, p. 49). Caudal spur with red tip; 19mm long slug has 72 plates in half row or radula.

9) – *maculata* (Quoy & Gaimard 1832); Bergh (1898, p. 492; 1898a, p. 153); Vayssière (1901, p. 49); White (1948, p. 200). Anus over posterior third of ctenidium; 80 plates in half row of radula. Bergh's specimens are young or belong to another species; White's animal has the size of the typical material, but only 61 plates in half row of radula.

10) – *meckelii* (Blainville 1825). Vayssière: "meckeli Leue 1813". Bergh (1897, p. 7); Vayssière (1901, p. 42). Mantle and back of foot with small tubercles surrounded by dark furrows; sole dark (also in var. occidentalis Bergh, p. 28); border of genital openings simple, not lobate (Bergh 1897, p. 28; Vayssière 1901, f. 227; 1902, t. 9, f. 1, o).

11) – *meckelii* var. *occidentalis* Bergh (1897, p. 28). Sole and border of genital openings as in meckelii; tip of rhinophores black.

12) – *melanopus* Bergh (1907, p. 33); O'Donoghue (1929, p. 50). The two known specimens differ in colour, caudal spur, mandibular rodlets and number of branchial pinnules (Bergh: 20; O'Donoghue: 36-37). Anus a short way posterior to insertion of gill; border of genital openings simple, not lobate.

13) – *morosa* (Bergh 1892, p. 28). Described as type of Pleurobranchillus (ibid., p. 27) a genus abandoned later on (id. 1897, p. 3, note 2; 1898a, p. 64). Anus on level of hind end of branchial membrane; 68-70 plates in half row of radula of 15mm long slug.

14) – *morula* Bergh (1905, p. 48). Frontal velum with 2 regular rows of 12 small cones each; border of genital openings simple; only 50 plates in half row of radula in 70mm long slug.

15) – *novaezealandiae* Cheeseman (1878, p. 276); Bergh (1898a, p. 150); Clessin (1899, p. 43); Vayssière (1901, p. 69); Baba(1949, p. 38, 133). Tail without spur; anal opening in posterior fourth of branchial membrane; half row of radula with 80-90 plates, but only 65 in just as long Japanese slugs.

16) – *obesa* (Verrill 1882, p. 546); Bergh (1897, p. 30); Vayssière (1901, p. 72). Described as type of Koonsia, a genus suppressed by Bergh and Vayssière, because the body shape is a consequence of contraction, and hooks on the penis do not exist. Anal opening near posterior end of branchial membrane; half row of radula with 80 plates.

17) – *tarda* Verrill (1880, p. 384; 1882, p. 546); Bergh (1897, p. 33); Vayssière (1901, p. 57). Not more than 20 branchial pinnules; anal opening near hind end of branchial membrane; half row of radula with 70-85 plates. Absence of pedal gland (Bergh) is strange for a Pleurobranchaea with smooth branchial rhachis.

18) – *tarda* var. Bergh (1897, p. 39). 18 branchial pinnules; half row of radula with 80 plates. This "variety" has a pedal gland.

☆

RESUMO

A espécie mais comum de Aplysia, no litoral superior da costa de S.Paulo, é A.brasiliana Rang, 1828, descrita do Rio. A.livida d'Orbigny, 1837, também do Rio, foi expressamente separada de brasiliana por d'Orbigny e, por isso, figura no Manual de Pilsbry (1895-96) como espécie a parte. As diferenças, porém, revelam-se como variações da côr. Há lesmas acastanhadas escuras, côr de chocolate, esverdeadas, oliváceas, e outras quase côr de creme. As mais das vêzes, são malhadas. Contribuem para a composição do colorido: 1) a côr geral do corpo, verde garrafa, ora mais clara ora mais escura, acinzentada, ou mais ou menos carregadamente amarelada; 2) o pigmento superficial preto ou sépia, de quantidade muito variável; e 3) o conteudo de glandulas cutaneas, também extremamente variável e caduco como caráter colorativo nos liquidos de conservação. Areas claras e escuras alternadas no lado interno da orla dos parapódios ocorrem na maioria dos exemplares, mas, são variávelmente nitidas e, ás vêzes, faltam. As relações entre as algas alimentares e a idade por um lado e o colorido pelo outro merecem estudo. Rang descreveu material conservado; d'Orbigny, lesmas viventes. O aspecto das figuras difere muito, porque a região anterior se contrai especialmente, no momento da conservação, e os animais de d'Orbigny, um em natação e o outro deslizando sôbre o substrato, se apresentam máximamente estendidos. Conchas de individuos de brasiliana de tamanho semelhante variam menos em comprimento do que em largura.

Lesmas adultas foram vistas em tôdas as estações do ano, quase em todos os meses. Ovipostura ocorre defins de agôsto até meados de dezembro; de outras épocas faltam talvez apenas as observações. Lesmas de 0,9mm, ao comprido, quando vivas, incolores, sem rinóforos, mas com olhos, consideramos como recém-metamorfoseadas. Um animal de 2,5mm foi o primeiro a produzir secreção purpurea. Osnervos que suprem os tentáculos desenvolvem-se antes dos rinoforiais; órgãos copuladores, muito mais cedo que as gônadas.

Aplysia dactylomela Rang, 1828, verificada nos dois lados do Atlantico, aproximadamente entre Lat. 35º N e 35º S, vive também na costa de S.Paulo, mas não é comum no eulitoral, na zona das nossas pesquisas.

O caráter principal de **Aplysia juliana** Q. &G. é a sola. Anteriormente, é sub-dividida em dois lóbulos contrácteis; posteriormente, é arredondada e forma um disco sólido, firmemente aderente ao substrato. Os parapódios apresentam-se bastante concrescidos; lesmas desprendidas do substrato e soltadas nágua afundaram-se sem nadar. A secreção da glandula purpurea é esbranquiçada; a da glandula opalina, viscosa e cheirosa. A espécie, até agora encontrada sómente em uma localidade da costa de São Paulo, Ubatuba, foi comparada com as descrições de juliana da Florida (**badistes**, Pilsbry 1951), da Africa do Sul, e do Indico-Pacifico ocidental. A extensão do sulco nos rinóforos varia; a abertura do manto é grande (**badistes, capensis, sibogae** do Japão); a concha é bem calcificada (também em **badistes**); 3-4 placas marginais de rádula não possuem ponta (1-2 no material de Macnae, 1955). Confirmam-se os tubérculos na base da bainha penial (Macnae).

Cada plaquinha cuticular damandibula de **Berthella agassizii** (MacFarland 1909) é formada por uma célula muito alta. Os órgãos reprodutivos desta espécie foram descritos. **Pleurobranchus (Oscanius) amarillius** Mattox 1953 pertence a **Berthellina** Gardiner 1936 e aproxima-se muito a **B.quadridens** (Mörch 1863).

Em **Pleurobranchaea hamva**, spec.nov., de Cananéia e Ilhabela, a membrana branquial ocupa três quartos do comprimento do ctenidio; o anus localiza-se ao nivel do centro da branquia; o nefróporo, ao da segunda pinula. **P.hamva** difere da outra espécie brasileira, **P.inconspicua** Bergh 1897, da qual se conhece um exemplar de Sergipe, pelo numero das placas da rádula e por pormenores dos dutos do sistema reprodutivo. O colar ao redor do orificio genital tem um processo dorsal. Como foi visto por Bergh (1898) e Pruvot-Fol (1926), as lesmas comem, ás vêzes, outras da mesma espécie. Além de **inconspicua**, foram comparadas ainda 17 espécies e variedades de **Pleurobranchaea**.

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Plate I

Aplysia brasiliana Rang

Fig. 1 - Opaline gland, opened.

Fig. 2 - Dorsal view of shell.

Fig. 3 - Jaws of a 15cm long slug.

Fig. 4 - Mandibular rodlets of an 8mm long slug.

Fig. 5 - Palatal rods of same.

Fig. 6 - Rhachidian plate of a 12cm long slug.

Fig. 7 - Sixth pleural plate of same.

Fig. 8 - Twentieth pleural plate of same.

Fig. 9 - Hinder part of alimentary canal.

Fig. 10 - Big tooth from gizzard.

Fig. 11 - Spine from gizzard.

Fig. 12 - Copulatory organ.

b - big teeth of gizzard; *c* - caecum; *f* - three first rows of gizzard teeth; *g* - anterior part of gizzard; *h* - posterior part of gizzard; *i* - intestine; *l* - liver; *m* - male opening; *o* - ovotestis; *p* - penis; *q* - penial sheath; *r* - retractors of verge; *s* - stomach; *v* - gastric valves; *w* - caecal ridge; *x* - crop.

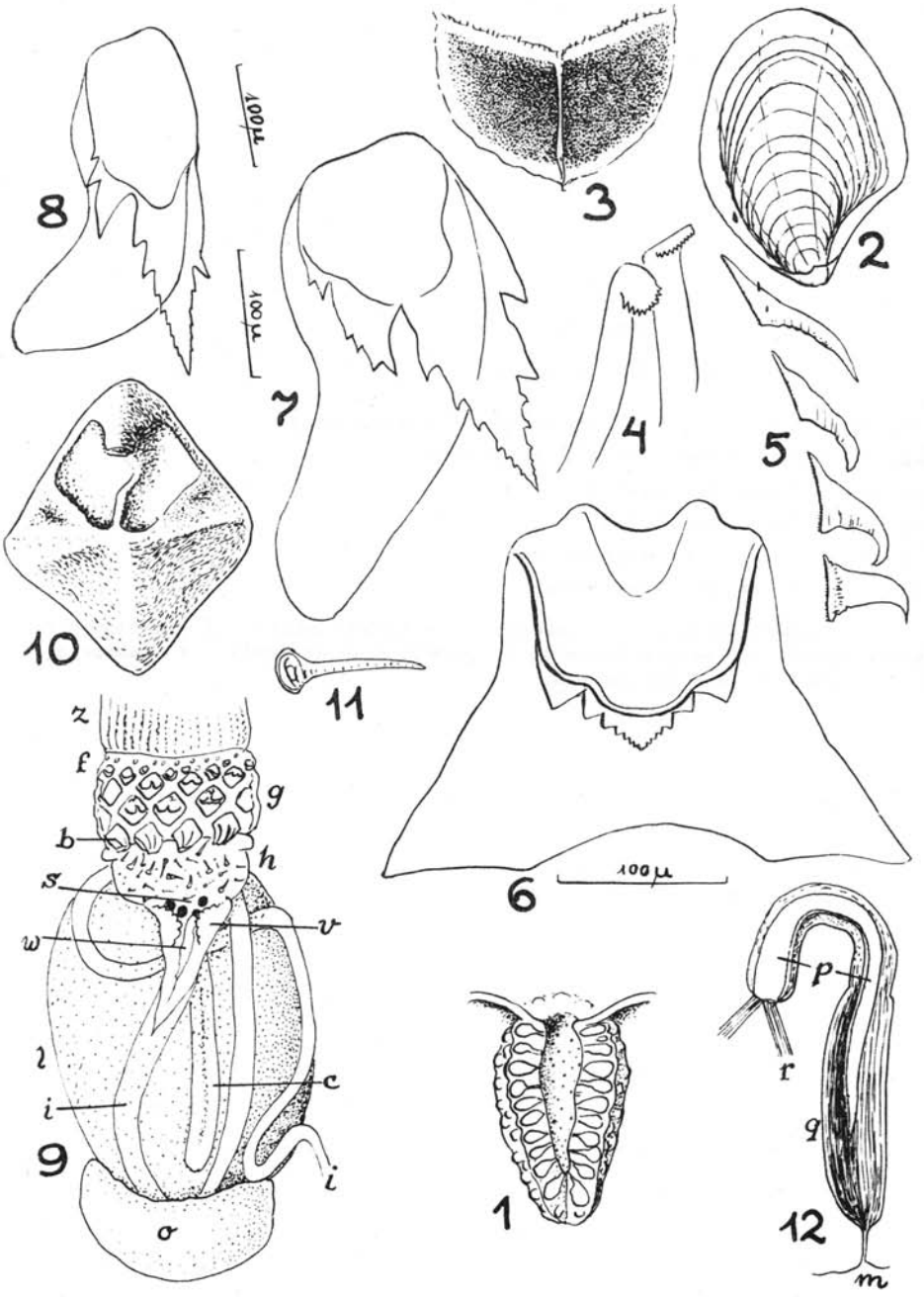
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Plate II

Aplysia brasiliana Rang

Fig. 13 - Stage I, three sketches of living slug.

Fig. 14 - Six views of same, preserved.

Fig. 15 - Stage II, living.

Fig. 16 - Same, preserved.

Fig. 17 - Stage III, preserved.

Fig. 18 - Stage IV, preserved.

a - cloacal sipho; *d* - shell; *e* - larval shell; *j* - border of larval shell; *k* - mantle border; *n* - growth line of shell; *t* - tentacle; *u* - rhinophore; *x* - parapodium.

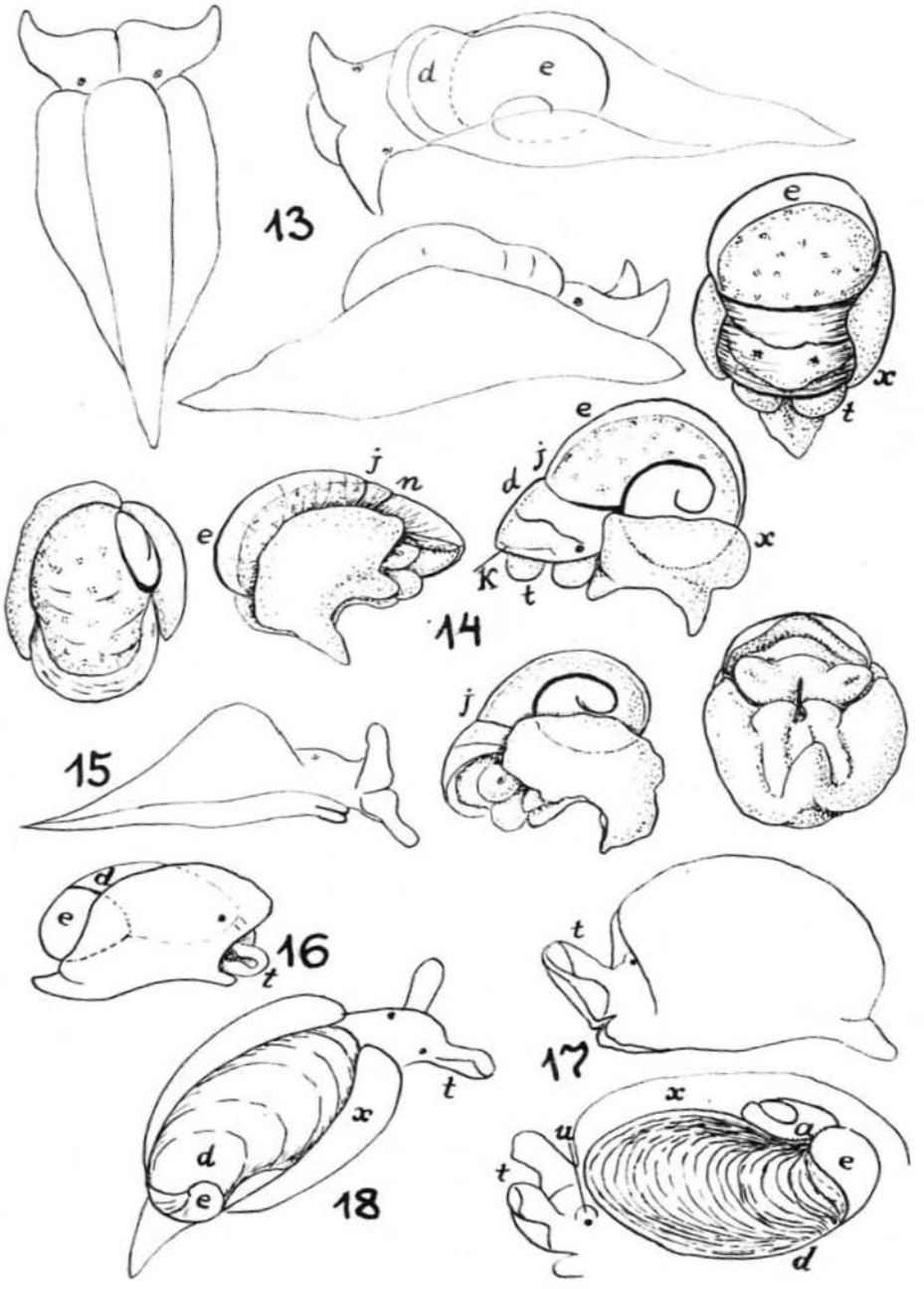
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Plate III

Aplysia brasiliana Rang

Fig. 19 - Stage V, alive.

Fig. 20 - First and seventh rhachidian plate of stage I.

Fig. 21 - First and eighteenth rhachidian plate of stage IV.

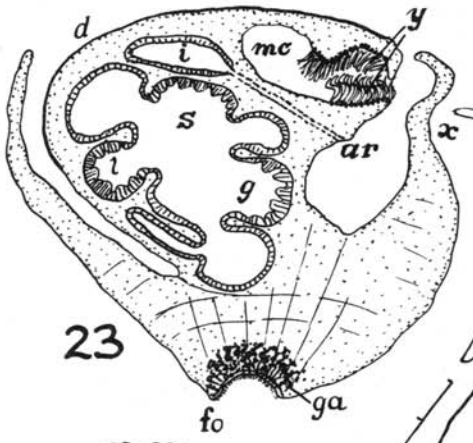
Fig. 22 - Half row of radula of stage VI.

Fig. 23 - Combined transverse section of stage II, to show ciliated areas (*y*).

a - cloacal sipho; *ar* - anus; *d* - shell; *fo* - foot; *g* - anterior part of gizzard; *ga* - foot glands; *i* - intestine; *l* - liver; *mc* - mantle cavity; *s* - stomach; *t* - tentacle; *u* - rhinophore; *x* - parapodium; *y* - ciliated areas.

Aplysia juliana Q. & G.

Fig. 24 - Seven sketches of living slugs.



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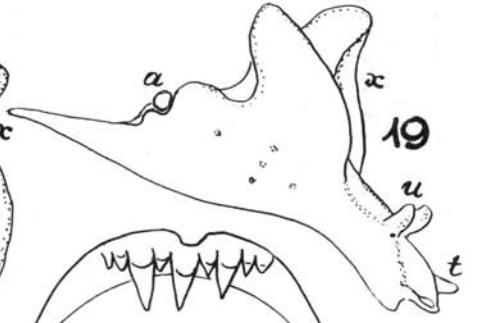

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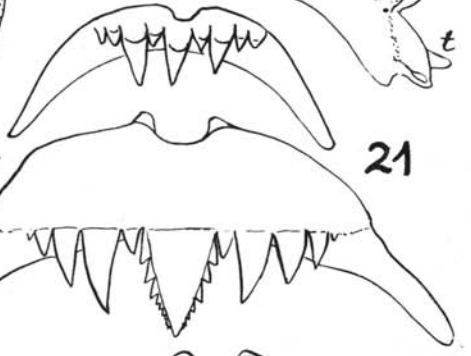

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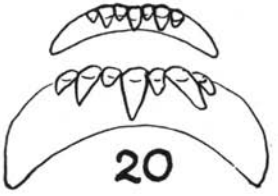

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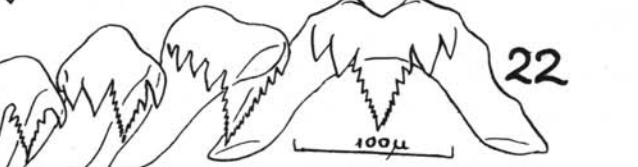

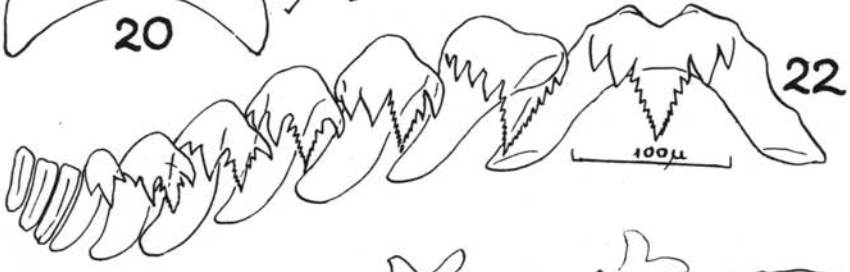

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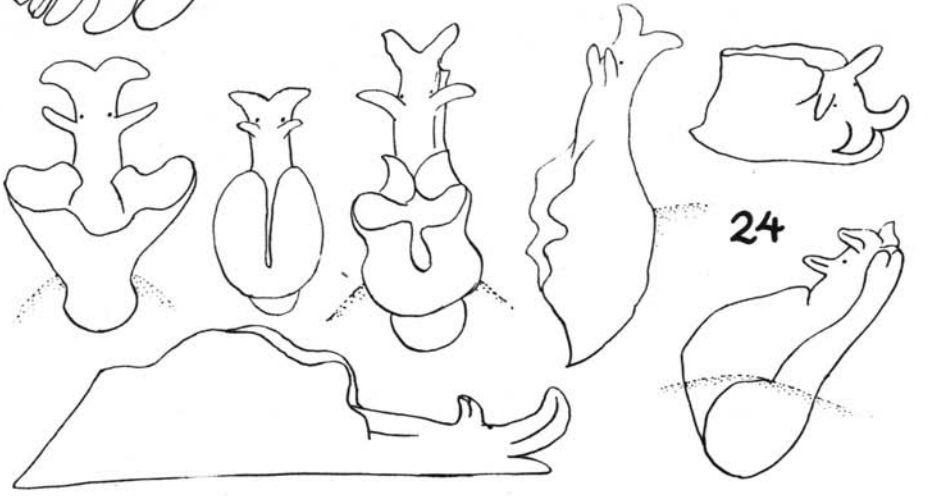

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Plate IV

Aplysia juliana Q. & G.

Fig. 25 - Dorsal view of preserved slug.

Fig. 26 - Ventral view of same, sole relaxed.

Fig. 27 - Ventral view of other specimen with contracted sole.

Fig. 28 - Shell.

Fig. 29 - Spire of shell with larval shell.

Fig. 30 - Digestive tract.

Fig. 31 - Cuticular lining of buccal region.

Fig. 32 - Transverse section on level of jaws.

Fig. 33 - Detail of same.

Fig. 34 - Plates of radula.

a - anus; *b* - brain; *c* - crop; *ci* - cuticula of buccal cavity; *d* - caecum; *f* - pharynx; *g* - gizzard; *i* - gut; *j* - jaw; *ji* - mandibular rodlets; *l* - liver; *ne* - tentacle nerve; *o* - oesophagus; *p* - penis; *q* - palatal rods; *r* - radula; *s* - salivary glands; *te* - tentacle; *v* - opening of liver ducts into stomach; *w* - foramen of mantle cavity; *x* - anal spout.

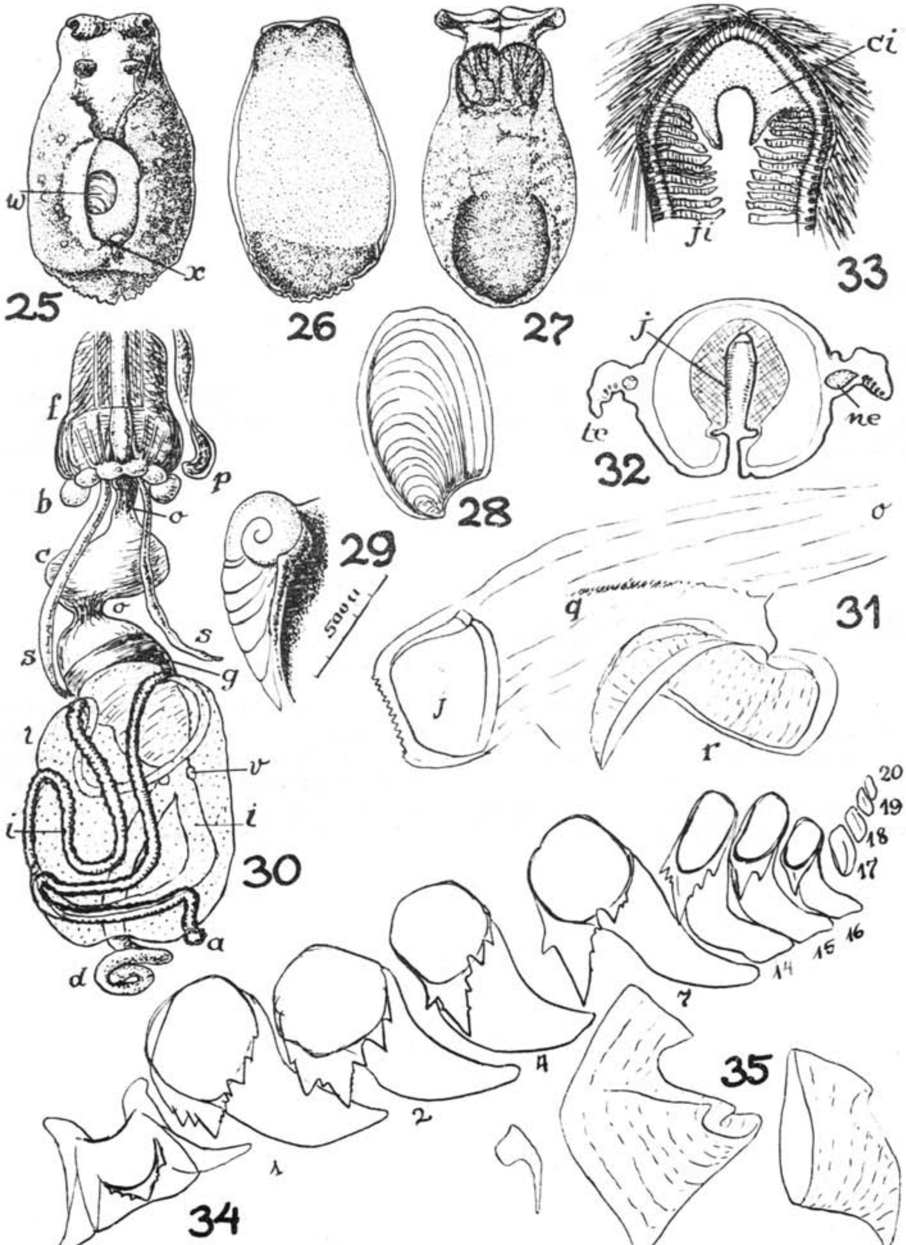
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Plate V

Aplysia juliana Q. & G.

Fig. 35 - Teeth of gizzard.

Fig. 36 - Transverse section of middle region of 4mm long slug.

Fig. 37 - Transverse section of hind end of same with foot glands.

c - crop; *e* - genital opening; *g* - gizzard; *h* - heart; *k* - kidney; *m* - shell chamber; *n* - osphradium; *s* - salivary gland; *t* - purple glands; *u* - opaline glands; *w* - mantle aperture; *y* - blood lacuna; *z* - genital ganglion.

Berthella agassizii (Mac Farland)

Fig. 38 - Diagram of reproductive organs.

Fig. 39 - Combined section of anterior part of reproductive organs.

a - ampulla of spermoviduct; *b* - accessory prostate; *c* - sphincter of vagina; *d* - efferent duct; *e* - oesophagus; *f* - nidamental opening; *g* - black glands; *m* - male opening; *n* - male vestibulum; *o* - oviduct; *p* - penis; *q* - glandular (prostatic) part of efferent duct; *r* - secretion of black glands; *s* - spermatocyst; *t* - spermatheca; *u* - uterine duct; *v* - vagina; *w* - female gland mass; *z* - circular muscles of penis.

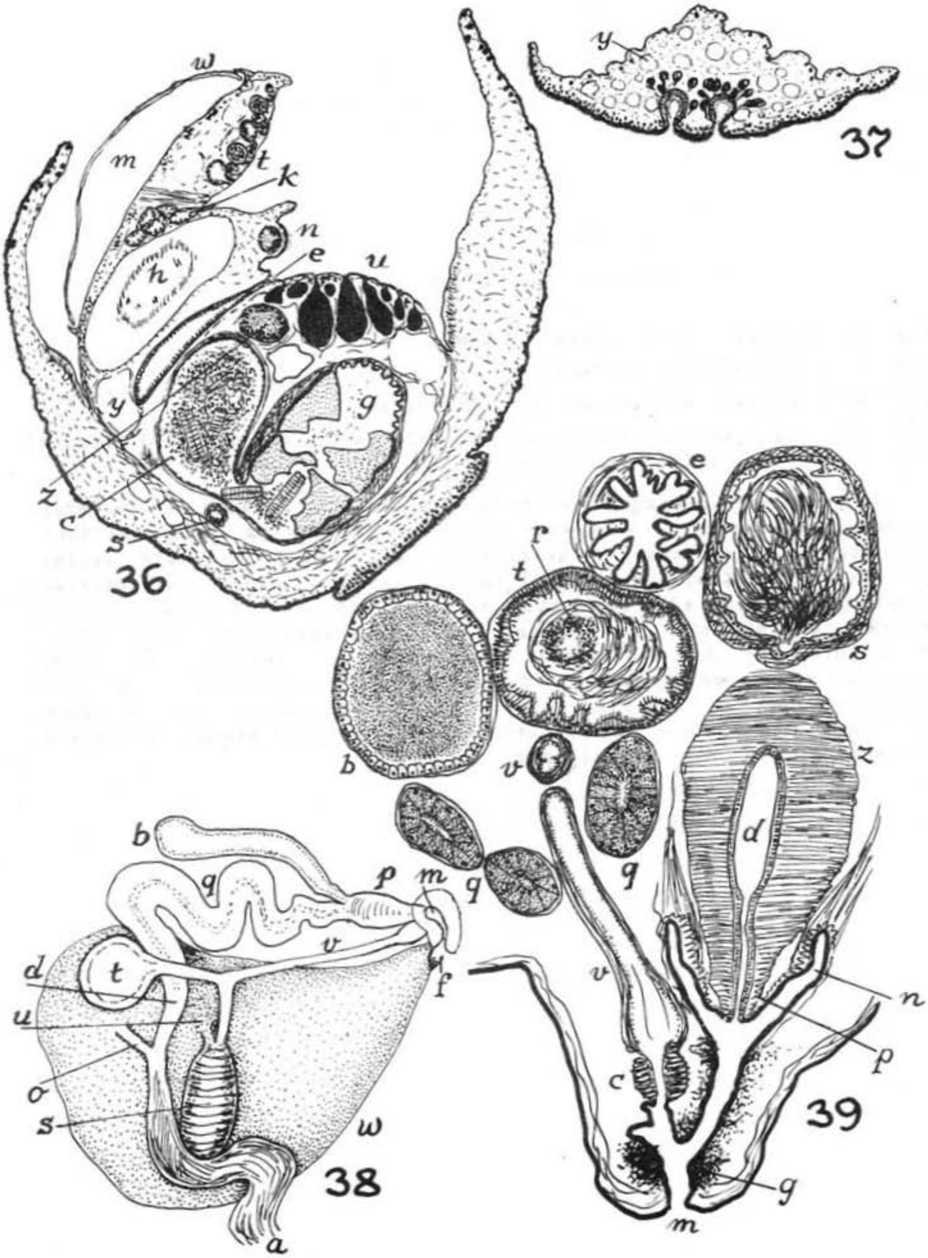
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Plate VI

Pleurobranchaea hamva, spec. nov.

Fig. 40 - Dorsal view of preserved slug.

Fig. 41 - Ventral view of tail.

Fig. 42 - Genital papilla and beginning of gill.

Fig. 43 - Organization. Acid gland (*z*) only partly drawn; blood gland(*x*) and gill (*gi*) diminished.

a - anus; *b* - opening of Bourne's (prebranchial) gland; *c* - cerebro--pleural ganglion; *co* - cerebro-pedal connective; *d* - efferent duct; *di* - duct of acid gland; *e* - oesophagus; *ei* - eye; *f* - female opening; *g* - genital papilla; *ge* - dorsal lobe of same; *gi* - gill; *h* - salivary gland; *i* - gut; *ig* - insertion of gill membrane; *j* - retractor of verge; *k* - kidney; *l* - liver; *m* - male aperture; *mo* - mouth; *n* - nephropore; *o* - ovotestis; *p* - penis; *pa* - pharynx; *pe* - pedal ganglion; *pi* - penial sheath; *q* - prostate; *r* - rhinophore; *rn* - rhinophore nerve; *s* - salivary duct; *si* - spermoviduct; *so* - stomach; *ti* - pedal gland; *w* - female gland mass; *x* - blood gland; *y* - heart; *z* - acid gland; *zi* - caudal spur.

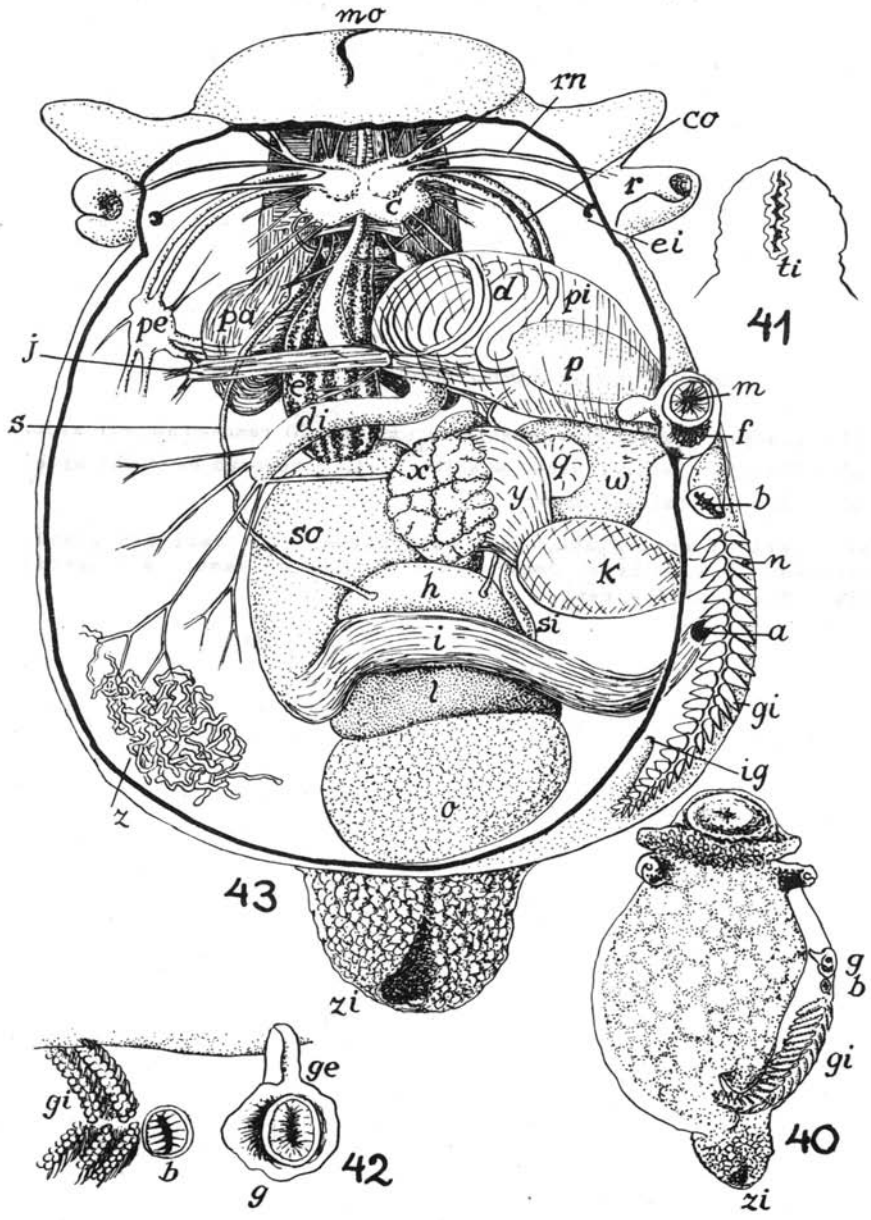
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Plate VII

Pleurobranchaea hamva, spec. nov.

Fig. 44 - Pharynx, dorsal view. Muscles 1, 6, 10, 20 removed on left side.

Fig. 45 - Pharynx, ventral view. Muscles 3, 4, 5 removed on right side.

Fig. 46 - Pharynx, lateral view.

di - duct of acid gland; *e* - oesophagus; *h* - salivary gland; *ra* - radula; *s* - salivary duct; *sa* - ampulla of same; *u* - buccal ganglia. For 1-21 see text.

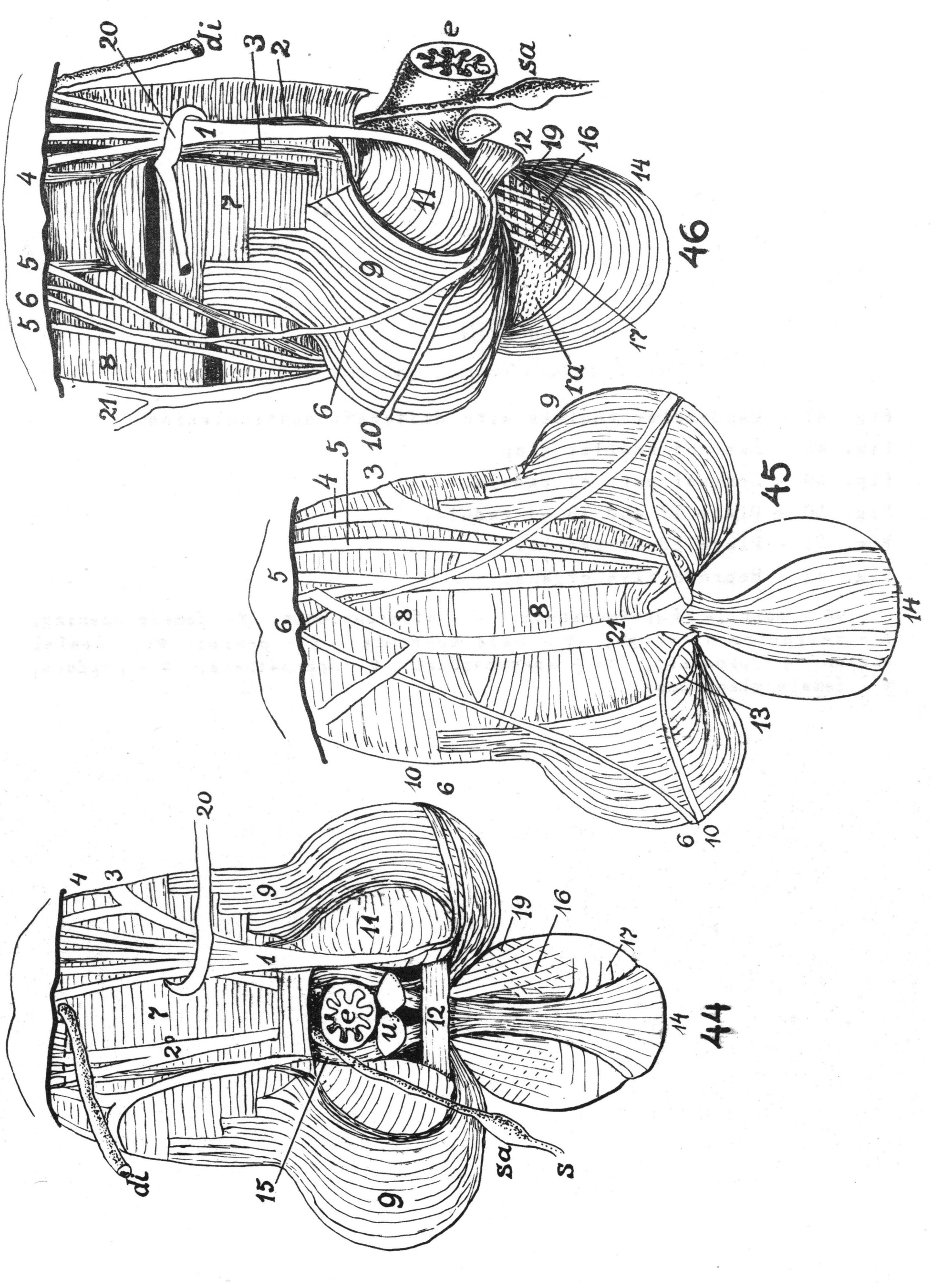
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Plate VIII

Pleurobranchaea hamva, spec. nov.

Fig. 47 - Mandibular rodlets with different denticulation.

Fig. 48 - Same of smaller slug.

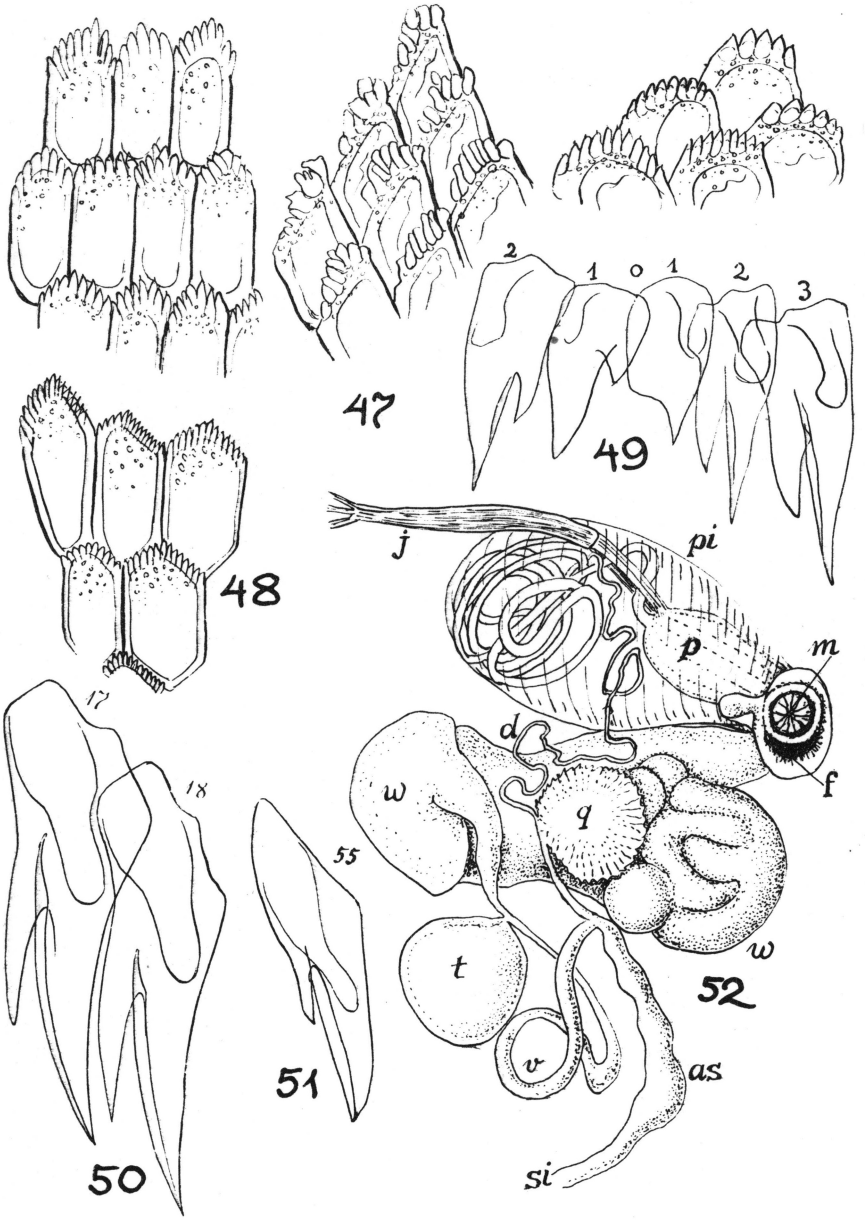
Fig. 49 - Central part of radula.

Fig. 50 - Plate 17 and 18 of radula.

Fig. 51 - Plate 55 of radula.

Fig. 52 - Reproductive organs.

as - ampulla of spermoviduct; *d* - efferent duct; *f* - female opening; *j* - retractor of verge; *m* - male aperture; *p* - penis; *pi* - penial sheath; *q* - prostate; *si* - spermoviduct; *t* - spermatheca; *v* - oviduct; *w* - female gland mass.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