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## The species of *Aplysia* belonging to the subgenus *Tullia* Pruvot-Fol, 1933: On a generic character in statu nascendi *)

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Mme PRUVOT-FOL, 1933, p. 400, established the subgenus *Tullia* for *Aplysia juliana* QUOY et GAIMARD, and 1934, p. 41 added other species of *Aplysia* with a distinct sucking disk at the end of the foot. Living animals have been figured and their variation has been described by BABA 1937a, p. 211, and 1949, p. 24 and 125 as *Tethys* and *Aplysia sibogae*. In a recent paper, PILSBRY, 1951, beautifully figured and described the living animals as *Aplysia* (subgen. nov. *Metaplysia*) *badistes* nov. spec. He points to the fact (verified in our preserved animals) that the anterior part of the foot-sole also tends to form a sucking disk. However, it is not separated by a (more or less distinct) groove from the rest of the foot (see PILSBRY's fig. 4) as is the posterior disk.

In 1955 a paper was published by MACNAE, who considers that at least five species of the subgenus *Tullia* belong to one species, ENGEL having suggested this identity when he had the pleasure of seeing Dr. MACNAE in Amsterdam and discussing his old notes on *Tullia* with him. We agree with him that most specimens of the subgenus *Tullia* belong to one species, viz. *juliana* (syn.? *sorex*). We only accept some *Tullia's* (cf. p. 22) as separate species. MACNAE gives valuable remarks on the living animals, their "progression in the way of a looper caterpillar" and the appearance of the sole of the foot. He observed that the sucking disk is visible only when the animal is "looping", and sometimes (not always!) after preservation. Is is probable that the posterior disk is distinct only in specimens which were preserved while the posterior pedal glands were in a state of active secretion. [1])

*) Received March 8, 1957.

[1]) After this publication was sent to the printer we received the interesting paper of MARCUS, 1955, which confirms our opinions.

We may here have, in our opinion, the case of a character in *statu nascendi*. For it is a curious habit of many species of *Aplysia* to fix themselves with the hinder part of the foot on some piece of rock and let the anterior part of the body float freely in the water, making searching movements. This was beautifully described by JORDAN (1917, p. 5, and Die Umschau, 1917, p. 509). In litteris, May 20, 1935, Professor JORDAN added: "The part of the foot fixed to the rock can become much smaller than my fig. 2 shows it. During these searching movements there is a constant waving movement over the surface of the foot from head to tail".

The same habit was described for other species (JORDAN worked with the mediterranean species of *Aplysia: A. fasciata* or *limacina* and *A. depilans*), so for *Aplysia* (*Syphonota*) grandis by PEASE, 1860, p. 23—24 (compare *S. bipes* p. 23), for *Syphonota punctata* (= *Aplysia peasei* PILSBRY, 1895, p. 95, a synonym of *A.* (*Pruvotaplysia*) *parvula* MÖRCH. cf. ENGEL et HUMMELINCK, 1936, p. 15) by PEASE, 1868, p. 77, for *Aplysia tryonii* by MEINERTZHAGEN, 1879, p. 270. In an article on the pedal locomotion of *Aplysia californica* PARKER, 1917, p. 144, remarked: "suction may appear anywhere on the full width of the foot", "the foot is so organized that its surface can temporarily and locally resolve itself into many sucking organs".

This is a rather strange statement of PARKER's. Since the whole surface of the foot of Gastropods bears mucous glands, any part of the foot may exert suction by means of mucus and muscles. But development of the anterior and posterior grouped glands enables the animal to cling by front and back portions better than by the whole surface. The anterior gland is not as large as the paired compound posterior glands, which the animal uses for attachment while waving the front portion of its body in the water.

It is a remarkable feature then, that the said habit results in some species in the formation of a separate sucking disk at the hinder part of the foot and a broadening and stronger muscularisation of the anterior part, permitting the animals to adhere with more effect and less exertion.

The foot of other species of *Aplysia* in the preserved state may be contracted in a way as to suggest a sucking disk. Yet there is an outspoken difference between this suggestion of a disk and the more accomplished sucking disk of the subgenus *Tullia*.

It should be emphasized that, when identification depends upon preserved material, a proportion of the specimens may not show the posterior sucker, since this is not a permanent feature, but indicates that the posterior pedal glands were active and the animal was clinging with the hind part of the foot at the time of preservation.

In the well-known Mediterranean species *A. depilans*, which has all the *Tullia* characters, the pedal sucker is usually not well shown; yet it is a *Tullia*.

This, however, in our opinion, does not detract from the fact that in most of the animals under consideration the sucker function has so distinctly emancipated the posterior part of the foot, that it may, and in most cases does, show as a "sucking disk". This feature does not occur in this measure in other *Aplysias*. We are convinced that it is important enough to distinguish the group of animals, which all agree in this character, as a subgenus *Tullia*. This is independent of the number

of species that may be distinguished in the subgenus. If, after all, no characters could be found to acknowledge more than one species, *Tullia* ought to stand as a subgenus for all that. This character of the foot has more than specific value, as we see it.

### Diagnosis of the subgenus *Tullia* Pruvot, 1933

*Aplysia*'s with usually a distinct sucking disk in the posterior part of the foot. The body is broader behind, narrower in front. The front margin of the foot is broad, the head itself usually not so very broad — though the tentacles are broad and wide, the broad foot, however, suggests a clumsy head. The rhinophores rather strong and cylindrical. The parapodia united behind, joined high up. They are wide and freely mobile unless the animal is too strongly contracted, usually natatory, except in *A. cedrosensis* and *A. dura*. Mantle cavity with closed posterior "pocket". Mantle foramen flat, round or oval, usually large, sometimes very small[1]). No purple secretion[2]), opaline gland simple, multiporous. Shell very variable, only slightly concave, the sinus shallow, rather straight and often with a nearly square corner. Mandibular rods with curved tips. The radula known to range between 25 (17—1—17) and 118 (80—1—80). The teeth resemble those of *A. dactylomela*, but they are simplified. The median tooth usually has one large cusp, with fine irregular or sometimes without denticulations. The first lateral tooth has a rather short median denticle (cusp) with denticulated margins. In the following lateral teeth this median cusp becomes longer and sharper, bearing no denticles on its point; only some outer and usually but one inner denticle at its base. The penis resembles that of *A. dactylomela*, it has a rather flattened long and thin or more short and broad glans, smooth, sometimes unarmed, sometimes armed at the base, along the seminal groove, or along the side opposite this groove, with warts, bearing spines. The praeputium consists for its proximal half or two thirds of a strong muscular wall with longitudinal brown folds, while the distal part, near the glans, is thinner-walled and bears longitudinal or transverse wrinkles with smaller or larger white irregular warts; sometimes (*A. dura* the warts are branched. The warts are armed with one or some (chitinous?) spines at the top. A small strip only along one side of the seminal groove has no warts. This thinner-walled distal part of the praeputium is not straight like the proximal part, but bent, as it has the retractor muscle inserted at its top. The penis is contained in this distal, curved part of the praeputium. The seminal groove is distinct, it has a broad border and can be easily followed to the tip or near the tip of the glans. Caecum inflated at the blind end and curved. Broad salivary glands.

Type species: *Aplysia juliana* Quoy and Gaimard, 1832.

The probability was considered that *A. juliana* and *A. sorex* differed *specifically*. It proved impossible to distinguish the specimens identified with *A. sorex* by Mrs. Pruvot-Fol from *A. juliana*.

Doubt, however, must be raised as to the identity of the specimen

[1]) Baba remarks: "the size varying in different specimens, not at different stages of growth".

[2]) According to Marcus, 1955, pag. 16, 19, pl. V, fig. 36 t, the purple gland has a whitish secretion.

preserved in the Paris Museum as the type specimen of *A sorex* Rang. This animal is an *A. juliana*, but it differs obviously from Rang's description and figure. So the real type of RANG, which must have underlain his description and figure, cannot be identified with any amount of certainty with *A. juliana*. We, therefore, add *A. sorex* to the synonyms only with a question mark

The animals, however, which Mrs. PRUVOT-FOL later on identified with *A. sorex* are certainly identical with *A. juliana* (with the exception of the specimens from Témara near Rabat and from Fédala, both Morocco, which need re-examination).

At first it was also thought that the armature of penis and praeputium might afford specific characters, but on examining a large number of specimens labelled *A. juliana, A. bipes* and *A. brunnea*, all of which belong to *A. juliana*, it was found that there is a very great variation in the armature of the male organ. The warts on the praeputial lining are usually numerous and scattered, but in East African specimens were found to be arranged in lines corresponding to the ridges on the narrow portion of the praeputium. The extent of the warted region also varies considerably. In most the praeputium alone exhibits the multi-spined warts, and the broad penis is naked; in others the warts may cluster round the base of the penis, as in some Australian specimens, or the warts may spread along one side of the seminal groove of the penis as in the New Zealand and South African examples, or along the penis side opposite to the seminal groove as in the melanic Australian and the Tasmanian specimens. Thus there are at least five variants of the typical condition.

There are also two distinct varieties of shell (cf. figs. 1, 7, 16) in animals otherwise indistinguishable, and apparently independent of age and size. One type is elongated and narrow, the other short and broad. Measuring the ratio between length and breadth of the shell, we have:

1 : b = 2.2 : 1 QUOY and GAIMARD, 1832
1.7 : 1 BERGH's *sibogae*, 1905
1.6 : 1 COPPINGER, Australia, 1881
1.5 : 1 CROSSLAND, Galapagos, 1923
1.5 : 1 New Zealand (*brunnea*)
1.5 : 1 WILTON, Tasmania
1.5 : 1 HANNAH, Peru
1.4 : 1 BABA's *sibogae*, Japan, 1937
1.3 : 1 O'DONOGHUE (*capensis*), 1928—9
1.2 : 1 Australia, 1886 (melanic)
1.2 : 1 KURACHEE, 1883.

A shell with a length at least one and a half times the breadth can be regarded as narrow; when the length is less than one and a half times the breadth as broad. The broad shelled variety might be designated var. *sibogae* (BABA, 1937, non BERGH) and the narrow shelled variety var. *Quoyana* n o v. v a r.

Most "species" examined (*A. bipes, sibogae, woodii, capensis, badistes, brunnea, hamiltoni*) proved to be identical with *A. juliana*. Some rather black animals had been identified with *A. nigra*. The type of *A. nigra*

d'Orbigny from Peru could not be found in Paris. Nothing can be said about its identity. For the black variety the name *nigra* n o v . v a r. was proposed, (cf. p. 101 sub XV, and p. 111).

*Aplysia cedrosensis* BARTSCH and REHDER, 1939 (see below XXVI) seems to be specifically distinct from *A. juliana*. The single type specimen has a doubtful posterior sucker, as the foot is strongly contracted and bent under in this region, but in many features, such as the broad foot, fused parapodia, small flat mantle foramen, simple opaline gland and radula, armed praeputium and large broad penis it resembles *A. juliana*. But most of these characters differ in detail from *A. juliana*. The parapodia are reduced and do not cover the mantle; they are probably useless for swimming. The radula is larger and has a much higher formula (118 × 80.1.80), the praeputial armature is simpler. Moreover the shape and appearance of the animal are different. No *juliana* is as broad and low, none has a flat non-tubular siphon, and none is tough-skinned. BARTSCH and REHDER rightly regarded it as a distinct species.

Two Tristan da Cunha specimens and a single New Zealand one resemble *A. cedrosensis* much more closely than *A. juliana*. They exhibit a clearly defined foot sucker, are low, broad and flat, with a similar flat non-tubular siphon, but differ in the smoothness of the tough skin, in the elaboration of the multispined warts lining the bulbous portion of the praeputium, and in the more strongly developed denticulations of the radula. They are described below (see XXVII) as a new species, *Aplysia* (*Tullia*) *dura*.

*A. vaccaria* WINKLER, 1955, from California is also a *Tullia*, but a sucker has not been observed.

*Geographical range :* 40° N to 40° S approximately. The subgenus is distributed over the whole world: in the Indo-Pacific from middle Japan, China and Formosa in the north to Sydney (Port Jackson), Tasmania and New Zealand in the south; from Pakistan, Bombay, Mauritius, Reunion, Madagascas, Kenya (Mombasa), along the South African coast to the Cape of Good Hope (False Bay) in the west, through the East-Indies (Timor, Ambon), to the Caroline Islands and Hawaii in the east. In the eastern Pacific from California (*A. cedrosensis*), Galapagos and Peru. In the Atlantic from Florida to Brazil in the west, to the Canaries, (Morocco?) and the Gold coast in the east, while *A. dura* is found on Tristan de Cunha (as also in New Zealand, Cook Strait).

An animal from the coast of Chile (described below under XI) has no distinct disk, though in other characters it resembles *A. juliana*.

The map (Fig. 17) shows the distribution records.

### a. THE SPECIMENS EXAMINED BY H. ENGEL

I have examined a series of these animals from our Amsterdam Museum (*A.sibogae* BERGH), from the Berlin Museum and from the Cape Town Museum, owing to the kindness of Prof. RENSCH (then at the Berlin Museum, now Münster) and Dr. BARNARD.

Dr. BABA, before the war, sent me two specimens of *Aplysia* for comparison, which proved to belong to *Tullia*. On my suggestion he

identified them with *A. sibogae* and described them as *Tethys* (later *Aplysia*) *sibogae*. (BABA, 1937a, 1949).

In the Paris Museum, thanks to the kind help of Dr. CHERBONNIER and Dr. RANSON, I was able to study the types of *A. juliana* and *A. sorex* and also some other specimens identified as *Tullia* by Mme PRUVOT-FOL.

I. The 2 specimens described by BERGH, 1905, as *Aplysia sibogae* from the Siboga Expedition, Station 60 (Haingsisi, Samau island near Timor), and 4 more specimens of the same lot from the same locality, which have not been mentioned by BERGH. The animals show a fading brownish coloration consisting of very fine lines and reticulations. It can be present everywhere, even on the underside of the foot and is only interrupted by irregularly scattered white patches and parts which occur especially on the outer side of the parapodia and are very distinct along the inner border of the last. Moreover on the animals not described by BERGH irregularly scattered deep black patches of very irregular contour are found on the outer side of the parapodia. After 50 years in alcohol these patches have kept their deep black color and they look as if one had been blotting with black india-ink. In 2 specimens they occur only on one side of the body and in the 2 specimens described by BERGH, they are lacking altogether.[1])

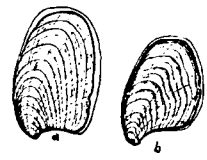
Remarkable are the parapodia, which are broadly united behind, and there is a distinct opening in the middle of the mantle-shield. The form of the head itself is rather narrow with nearly parallel sides on a broad foot. When these sides of the head are indistinct, it may seem very wide because of the broad underlying foot. The rhinophores are cylindrical, the tentacles are broadening out into a sort of frontal veil. The anterior part of the foot is rounded and broad, or when contracted, the longitudinal wrinkles show that it can be broadened. The anterior border is not double. The middle part of the foot is as usual narrower, not broadened. It shows here no distinct border. The posterior part forms a distinct sucking disk, heart-shaped, round, or of irregular form.

If we give the 2 specimens of BERGH the numbers 1 and 2, and the others 3, 4, 5, 6, we get the following measurements respectively: length 52, 39, 43, 37, 32, 29 mm; breadth 26, 21, 22, 22, 16, 13 mm; height 22, 21, 20, 18, 17, 15 mm, the length of the parapodia was 35, 30, 25, 23, 21, 18 mm, their breadth 15, 11, 7, 9, 9, 9 mm, the length of the mantle shield 22, 19, 18, 17, 17, 16, its breadth 14, 14, 13, 15, 11, 15 mm. The head was 11, 7, 7, 5, 5, 7 mm broad, measured with the tentacles 16, 11, 12, 9, 8, 8 mm. The distance between the rhinophores and the beginning of the parapodia is 7, 6½, 4, 4, 4 (to 12), 5 mm.

The shell (fig. 1) measured in length 21, 17, 17, 16, 14, 11 mm and

[1]) Here for comparison (and in addition to the colour plate and description of BABA, 1949) BABA (1937a) may be quoted about the colour: "The coloration of the body is subject to a considerable range of variation. Generally the whole upper surface is dark brown or olive brown covered with fine, darker, interlacing veins. In addition to this, some specimens have a varying number of white or black mottles, and others closely-set gray irregular figures". According to PILSBRY, 1951, p. 3, "the outside of the parapodia and the flanks are dark olive (near olivaceous black of RIDGWAY), indistinctly mottled with irregular spots of a dusky buff tint, and having small, sparsely scattered, ragged black spots. The inner surfaces of the parapodia are dark olive with marginal series of light and dark blotches. The mantle is dark olive with some indistinct spots near its free edge. The sole is yellowish olive". c.f. also MARCUS, 1955, p. 15.

FIGURE 1. *Aplysia* (*Tullia*) *juliana* Q. & G. Shell of "*Aplysia sibogae* BERGH" Stat. 60, Siboga Expedition. *a.* of the 43 mm animal (nr. 3), 17 × 11 mm. *b.* of the 29 mm animal (nr. 6), 11 × 10 mm.



in breadth 12, 11, 11, 9, 9, 10 mm, the opening in the mantle-shield 3, 4, ?, 2, 2, 2 mm. The foot was broad, its greatest breadth being 22, 16, 16, 12, 7, 11 mm. The sucking disk was 15, 9, 14, 9, 12, 7 mm long and 17, 13, 16, 12, 9, 7 mm broad. The form of the shell is the same as that figured by BERGH, the anterior border rounded, the posterior one with a nearly square corner, though this last feature is less distinct in the smallest specimen (compare the figures 1 a and b), reminding us of the fact that the shape of the shell in *Aplysiidae* cannot be regarded as an absolutely reliable character. One of the specimens figured (1a) belongs to the narrow shelled variety (cf. p. 86). There is no distinct spire. The horny shell is everywhere about 1 mm larger than the calcareous shell. The opaline gland is diffuse. The genital opening lies under the mantle shield.

The penis (fig. 2a and b) shows a praeputium with a distinct broadly bordered seminal groove. The part of this praeputium nearest to the body (first $\frac{1}{2}$ or $\frac{2}{3}$) has a strong muscular wall, its inner sides provided with dark coloured longitudinal grooves. The next part of the praeputium,

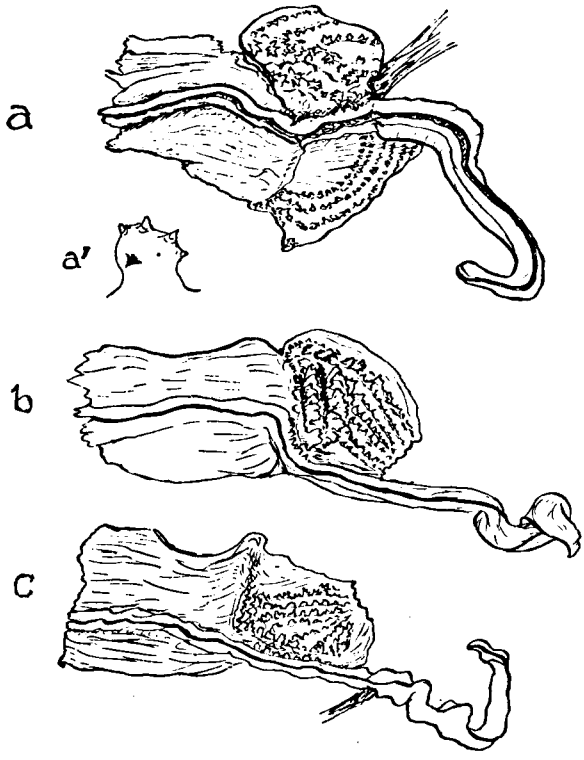



FIGURE 2. *Aplysia* (*Tullia*) *juliana* Q. & G. Penis of "*Aplysia sibogae* BERGH" Siboga Expedition. *a.* of the 39 mm animal (nr. 2); *a'*. one of the larger warts more enlarged; *b.* of the 32 mm animal (nr. 5); both from Stat. 60; *c.* of the 34 mm animal from Ambon reef (nr. 1).

on which the glans is implanted, is less muscular, it is separated from the first by a distinct transverse line or by fold(s). Inside, the latter part bears rugose transversal and longitudinal or oblique folds, beset with small white tubercles, which bear a (probably chitinous) fine point. While the proximal part is straight, this distal part is bent. The two parts are easily distinguishable from the outside, the distal crooked part contains the glans. The folds and warts are absent on a small strip along the right border of the seminal groove. The glans is smooth, somewhat flattened and provided with a distinct seminal groove along its whole length.

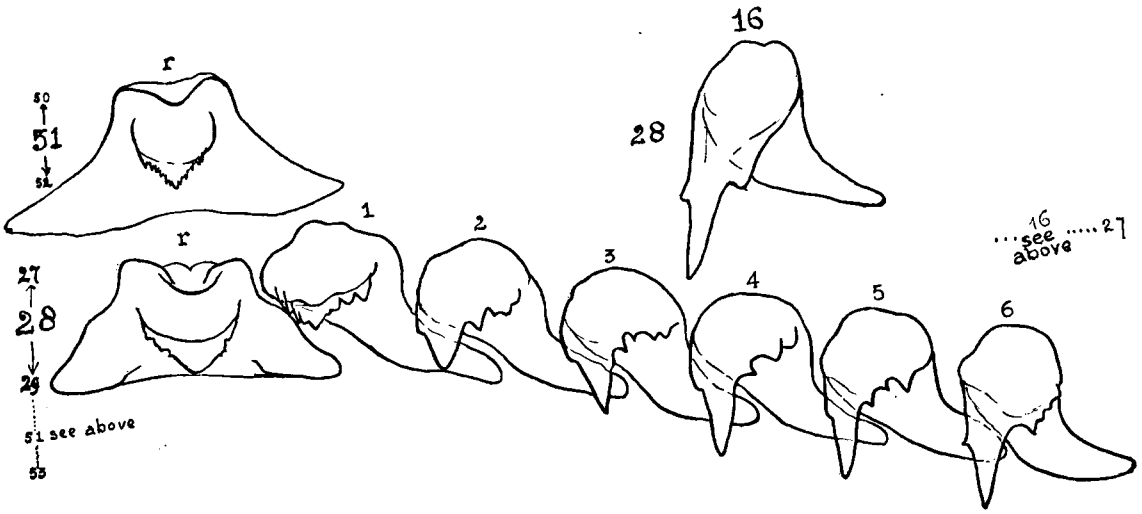



FIGURE 3. *Aplysia* (*Tullia*) *juliana* Q. & G. Radula of "*Aplysia sibogae* BERGH" Siboga Expedition, Stat. 60, of the 39 mm animal (nr. 2). The rhachidian tooth and 6 side teeth (27 side teeth in total on each side) of the 28th row; the 16th side tooth of this same row and the rachidian tooth of the 51st row (the whole radula counts 53 rows, 27-1-27).

As BERGH already figured, the radula has a rhachidian tooth which is nearly smooth. It bears very superficial denticulations only. Side teeth with a median cusp which increases in length to about the middle of the row, then decreases and finally disappears. The radula of specimen Nr. 2 showed the formula 53 (27-1-27) (figure 3, where only 6 of the 27 teeth are figured). The others looked very much like this one. Specimen Nr. 5 had the formula 48 (23—1—23).

The mandible is as usual, it forms a nearly complete ring, the rods are sometimes pointed and somewhat bent.

II. Also not mentioned by BERGH in the Siboga-Monograph, and only labelled "*Aplysia* spec.", were 9 specimens collected by the Siboga at Ambon, on the reef. They had been drying out, but they could easily be recognised as belonging to the same species. They show the typical sucking disk, the broadly united parapodia, a small but distinct opening in the mantle shield. Even the black dots described above in the first set of animals were present in 2 specimens. As they are so badly contracted, I

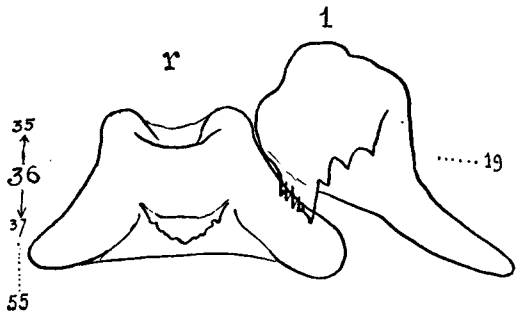



FIGURE 4. *Aplysia* (*Tullia*) *juliana* Q. & G. Radula of *"Aplysia sibogae* BERGH", Siboga Expedition, Ambon reef, the 26 mm animal (nr. 3). The rhachidian tooth and 1st side tooth of the 36th row (the whole radula counts 55 rows, 19-1-19).

only give their length: 34, 28, 26, 24, 20, 19, 18, 18, 14 mm. The shells are of the same form as that figured by BERGH and, like my figure 1 a, with almost a right angle. The radula looked very much like that of the animals of Siboga station 60. The rhachidian tooth yet more simplified. The formula for the specimen of 26 mm (fig. 4) is 55 (19—1—19), the first side-tooth seemed somewhat stronger, but, as the figure shows, it was seen more from the side and less from above. The formula of the 14 mm specimen was 50 (19—1—19). The mandible and the penis (fig. 2c) are like those of the preceding specimens.

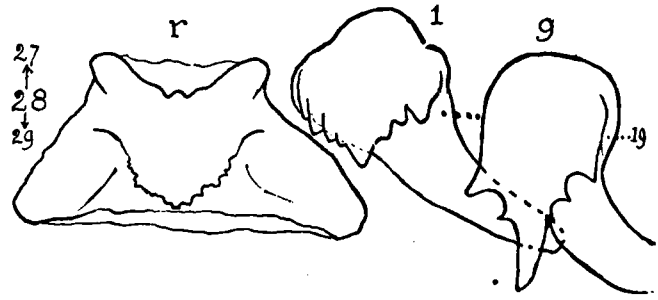



FIGURE 5. *Aplysia* (*Tullia*) *juliana* Q. & G. Radula of *"Aplysia sibogae* BERGH" from Japan, Tomioka. The rhachidian tooth, the 1st and 9th side teeth of the 28th row.

III. Through the kindness of Dr. BABA I could compare two Japanese specimens from Tomioka (spring 1935), which undoubtedly belong to the same species as the Siboga animals. BABA described the Japanese animals, 1937a, as *Tethys sibogae* and 1949, as *Aplysia sibogae*. They were very common in January—May, 1935 at Tomioka and showed the coloration which was quoted above. H.M. the Emperor of Japan collected them in Sagami Bay April, 1939 and 1941.

Referring to BABA for full information on the variability of the Japanese animals I may add some remarks. The genital pore lies under the mantle shield. The sucking disk is round and quite distinct, of rugose appearance. Only the middle part of the anterior brim is not quite clear, so that the disk for a short distance continues into the surface of the foot without a distinct border. Yet this is clearly caused by the muscular contraction, the disk is surely present.

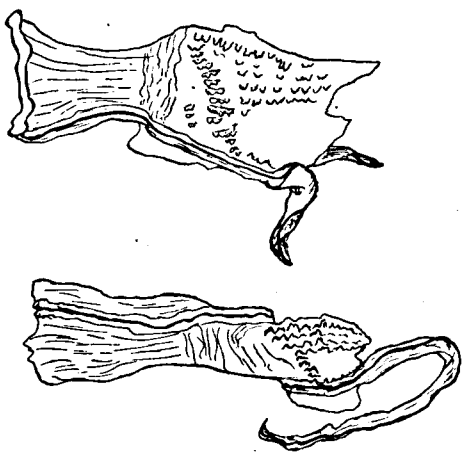


FIGURE 6. *Aplysia* (*Tullia*) *juliana* Q. & G. Penis of the two specimens of "*Aplysia sibogae* BERGH" from Japan.

The parapodia are broadly united and the mantle opening is present. I have taken the following measurements: length 42, 45, breadth 22, 23, height 11, 15, breadth of the head 8 mm, with tentacles 10 mm (in both specimens) distance from rhinophores to parapodia 5 resp. 7 mm., length of parapodia 26, 27, their height 16, 14, length of mantle- shield 20, 18, its breadth 12, 13, breadth of foot 19, 19, sucking disk 18 × 18 and 18 × 16, opening in the mantle-shield 6 × 7, 8 × 5, shell 19 × 17 and 11 × 11, all measurements in millimeters. The animals have a beautifully preserved outer appearance, but their inner parts are not so well preserved. The radulae had the formulae 40 (18—1—18) and 29 (19—1—19). The teeth (fig. 5) as in the others (compare also BABA's figures). Mandible and penis (fig. 6) as usual. The shell (cf. BABA, fig. 4) has the same form as the one described above, with the rather square angle.

IV. From the Berlin Museum I got a large unidentified specimen (Nr. 54057) collected by KREYENBERG in South China. Though it is nearly white, traces are visible of the brown reticulate coloration, on the head and neck and especially in the folds behind the tentacles and rhinophores and at the beginning of the parapodia. The parapodia are broadly united behind, the opening in the mantle shield is a small pore. The sucking disk is large and quite distinctly separated from the rest of the foot. The foot is very broad in front, broad side-flaps are extending on both sides of the head. Because of a posterior contraction of the mantle shield the genital opening is exposed, though in life it was certainly covered by the mantle. The horny shell (fig. 7) seemed to have the common form. I

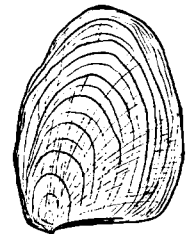


FIGURE 7. Shell of *A.* (*Tullia*) *juliana* Q. & G. from South China (Berlin Mus. 54057), 32 ×23 mm.

found the following measurements: length of the animal 96, breadth 58, height 35, the head is 14 mm broad, with the tentacles 21 mm, the distance between the rhinophores and the beginning of the parapodia is 10 and 12 mm. Length of parapodia 57, their breadth 21, length of mantle shield 36, its breadth 29, length of shell 32, its breadth 23, the breadth of the foot in front is 40, the sucking disk measures 31 × 42, all in mm. As our figure 8 shows, the radular teeth are as in the other animals, the formula was 77 (32—1—32). The mandible as in the others.

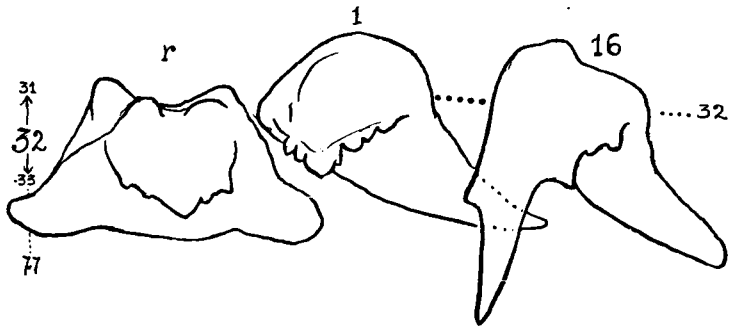



FIGURE 8. Radula of *A.* (*Tullia*) *juliana* Q. & G. from South China (Berlin Mus. 54057). The rhachidian tooth and the 1st and 16th side teeth of the 32nd row (the whole radula counts 77 rows, 32-1-32).

The penis (fig. 9) looks like that of the specimens above described, but the warts are less prominent. Whether this is due to conservation or to some other cause cannot be ascertained. The distribution of the warts is the same as in the East Indian specimens, as a comparison of the figures easily shows. The penis is a strong organ, measuring 38 mm in length (glans and praeputium together). The glans is unarmed, rather flat and broad as in the others.

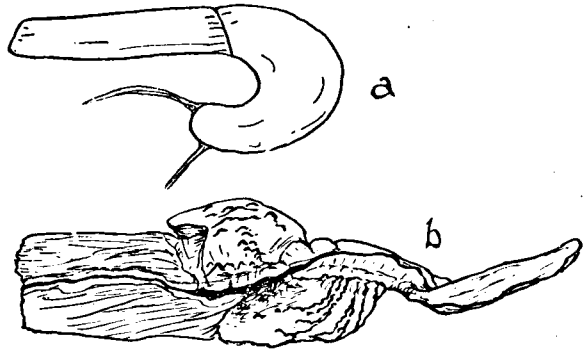



FIGURE 9. Penis of *A.* (*Tullia*) *juliana* Q. & G. from South China (Berlin Mus. 54057), *a* unopened, *b* opened.

V. Another unindentified specimen from the Berlin Museum was collected 28 III, . . 8 . . (label faded) at Port Jackson (Australia) by ASCHATZ. The sucking disk is clearly present, but the middle part of the anterior margin is indistinct. The colour is very dark, almost entirely black, there are only some white patches on the foot, along its margin and on the back between the parapodia. The exterior of the parapodia is provided with small white spots, the interior is more or less white, with a dark margin which shows small white spots. On the head also some similar white spots are seen.

The shell is of the common form. The radula (fig. 10) looks like that of the animals described above. Its formula is 52 (23—1—23). The mandible and penis are like those described in the first specimen.

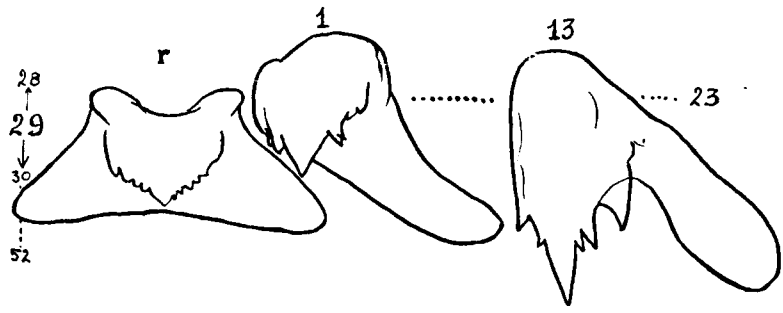



FIGURE 10. Radula of *A.* (*Tullia*) *juliana* Q. & G. from Port Jackson, Australia (Berlin Museum). The rhachidian tooth, the 1st and 13th side teeth of the 29th row (the whole radula counts 52 rows, 23-1-23).

This animal has, as a consequence of strong contraction, curled up ventralwards.

The following measurements were taken: length 41, breadth 21, height 26, head 7 mm broad, with tentacles 10 mm, the distance from the rhinophores to the parapodia 6 mm, length of parapodia 25, their breadth 9, length of mantle shield 20, its breadth 14, length of mantle opening 5, its breadth 4, length of shell 19, its breadth 11, breadth of foot 12, length of sucking disk 10, its breadth 9, all in mm.

In the Muséum at Paris I examined the following specimens of *A. juliana* :

VI. One specimen, type of *Aplysia juliana* QUOY et GAIMARD, 1832 from Mauritius (Ile de France), 1829, described and figured in the Astrolabe, Zoologie, pl. 24, f. 8, and by Mme PRUVOT-FOL, 1933, p. 42. She mentions 2 specimens, the bottle contains only one. The animal is 100 mm long, 44 mm broad. The head is 18 mm broad, measured with the front tentacles the breadth is 27 mm. Mantle foramen 1—1½ mm. rayed. The parapodia begin 15 mm behind the rhinophores, their rather large lobes can cover the mantle. Mantle length 35 mm; parapodia 50—60 mm long. Genital groove distinct, with overhanging dorsal lip. Visceral mass beneath the mantle region. Foot discoloured. The posterior disk is quite

clear. An anterior disk is indicated. The penis (fig. 11) looks like that of the preceding specimens. The glans is unarmed, the praeputium shows the usual armature.

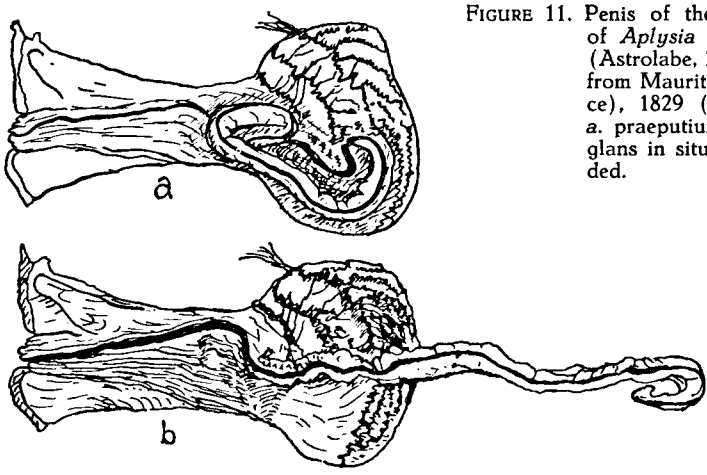



FIGURE 11. Penis of the type specimen of *Aplysia juliana* Q. & G. (Astrolabe, Zool. pl. 24 f. 5) from Mauritius (Ile de France), 1829 (Muséum Paris). *a.* praeputium opened with glans in situ, *b.* glans extended.

VII. 3 Specimens from Ile de Bourbon (= Réunion), DESHAYES, 1870, labelled "*Tullia* ? *juliana*, PRUVOT det. 1954", are long resp. 68, 48, 39 mm, broad 22, 33, 17 mm. All three show a distinct posterior disk, in the second specimen the anterior border of this disk is not absolutely distinct because the foot is wrinkled in this region. The penis of the largest specimen was examined and proved to be like that of the animals described above, the glans is unarmed.

In the first specimen the head is 13 mm broad, with tentacles 18 mm, the parapodia are so strongly contracted that in the preserved animal they certainly cannot cover the mantle. The breadth of the foot is 25 mm in front, posteriorly 30 mm. The posterior disk measures 18 × 18 mm. The distance from the rhinophores to the parapodia is 12 mm, so they cannot be said to begin close behind the rhinophores. The length of the parapodia 38 mm, length of mantle 25 mm, its breadth 17 mm. The mantle opening is very small, 0.1 mm, oval with indistinct radiation. The visceral mass ends about half-way along the posterior disk.

The second and third specimens show a distinct resemblance to both *A. juliana* and *A. sorex*. The anterior part of their body is much less contracted than the posterior part, hence much broader than the strongly wrinkled posterior part. The wrinkles in the foot more or less obscure the anterior limit of the posterior foot disk, which measures 14 × 14 mm in the second and 15 × 12 mm in the third specimen.

In the second specimen the foot is 16 mm broad anteriorly, posteriorly 17 mm. The head is 13 mm broad, with tentacles included the breadth is 14 mm. There is a distance of 11 mm between the rhinophores and the beginning of the parapodia. The length of the mantle is 21 mm, the opening is distinct, without radiation. The genital groove as in the first specimen. This animal shows some dark blotches on the parapodia.

In the third specimen the foot is 17 mm broad anteriorly and 13 mm

posteriorly. The distance between the rhinophores and the beginning of the parapodia is 9 mm. The parapodia are strongly contracted. The mantle opening is small, with a ring. The mantle is 12 mm broad.

Here follow some specimens labelled *Aplysia sorex* in the Muséum, Paris, among which was the type specimen of RANG. The other specimens had been identified by Mme PRUVOT-FOL. None of these specimens shows a curled foot.

VIII. The real type specimen (RANG, 1828, p. 57) was collected in "Océanie" by LESSON et GARNOT with the "Coquille".

A specimen, labelled "Océanie, LESSON et GARNOT, type", is present in the Paris Museum. LESSON (1830, p. 294) tells us that the specimen came from the island Oualan, i.e. Kusai, 5° 15′ N, 163° 5′ E, the most eastern island of the Carolines.

It is 36 mm long, 19 mm broad and has a quite distinct posterior disk, which has not been figured by RANG ! As the figures 5 and 6 on RANG's Pl. X are unequal in length (50 and 43 mm. resp.) one may either suppose that the animal preserved in the Muséum is not the type (as examined and figured by RANG, who in his text gives the length as 50 mm) or suppose that RANG's figures are not quite exact. In any case we are uncertain as to the identity of RANG's real type specimens. We can only suppose that the animal preserved in Paris is an animal from the same locality and the same collector. This specimen has a posterior sucking disk and belongs to the subgenus *Tullia*. The penis is like that of *A. juliana* from Mauritius. The foot is 14 mm broad in front and 12 mm posteriorly. The posterior disk measures 13 × 11 mm, its anterior brim is quite distinct. The head is 7 mm broad, with the tentacles 12 mm. Between the rhinophores and the beginning of the parapodia I measured a distance of 4 to 5 mm, the parapodia begin nearer to the rhinophores than to the mantle. The parapodia are 27 mm long and in the living animal they certainly covered the mantle. The mantle is 20 mm long (½ the length of the animal), 13 mm broad, rather thin, the opening 1—2 mm, not rayed. It has a distinct tail about $^1/_{10}$ of the body length. The visceral mass, as in *A. juliana*, ends about half way along the length of the posterior disk. The genital groove is very distinct with an overhanging dorsal lip as in *A. juliana*. The radula was not preserved, it has been investigated by Mme PRUVOT-FOL.

As it seems to us that we may be sure that the animal preserved as "type" was not the animal which RANG used for his description and figures (which show no posterior disk), it is better to add *A. sorex* RANG, 1828 with doubt to the synonyms of *A. juliana*. This has the advantage that we need not consider the problem that *A. sorex* RANG, 1828 is the older name and would have priority over *A. juliana* QUOY et GAIMARD, 1832 if the type of *A. sorex* RANG could be identified with certainty as that species. If, later on, this ever might prove true, it is desirable to ask the International Commission on Zoological Nomenclature for a decision suppressing *A. sorex* RANG, 1828.

IX. A young specimen from Madagascar (Port Dauphin, collected 1901 by Mr. A. RUAUD) was identified by Mme PRUVOT-FOL as *Tullia sorex*.

It is 43 mm long, 22 mm broad. It has a very distinct posterior disk on the foot, and the penis, though juvenile, looks like the preceding one. The foot is 15 mm broad in front, 17 mm behind, the disk is 17 to 14 mm. The mantle 20 to 13 mm; the opening 2 mm, without rim, it lies rather anteriorly. The parapodia begin half way between the mantle and the rhinophores, about 7—8 mm behind these. The head resembles that of the type of *A. sorex,* is 7 mm broad, with tentacles 12 mm. The parapodia easily cover the mantle. The tail is distinct, the visceral mass ends about half way above the disk.

X. Another specimen, identified by Mme PRUVOT-FOL as *T. sorex,* was collected in 1835 at Bombay by Mr. DUSSUMIER. It is 42 mm long, 17 mm broad, has a distinct disk and a penis that looks like that of the two preceding specimens. In front the foot is 12 mm broad, behind 17 mm. The disk measures 15 × 14 mm. The head is 8 mm broad, with the tentacles 9 mm. The distance between rhinophores and parapodia is 9 mm. The mantle is 18 mm long, 12 mm broad and it has an opening of less than 1 mm.

XI. A specimen collected in 1834 by M. FONTAINE in Chile was likewise identified as *A. sorex* by Mme PRUVOT-FOL on account of the radula. It is 27 mm long, 19 mm broad. The penis is too young for identification. There is *no* disk on the posterior part of the foot, though there is to be seen something of a rounding and incurvation of the sides of the foot. The radula is only very defectively preserved, a fragment of the distal part, which shows side teeth that might belong to any *Aplysia.*

The identification "*A. sorex*" seems rather uncertain. Its colour is blue grey greenish. The foot measures anteriorly 12 mm, posteriorly 14 mm. The mantle is 13 tot 10 mm, the opening is large, 2½ mm. The distance between the rhinophores and the parapodia is 3 mm. The head is 6 mm broad, with parapodia 9 mm. The ganglia are distinct as in the other specimens of *Tullia.* The animal has a distinct small tail as in the preceding specimens.

The only character that might be used to distinguish the animals labelled "*Aplysia* (*Tullia*) *sorex* RANG" by Mme PRUVOT-FOL from *Aplysia* (*Tullia*) *juliana* seems to be the size. It is obvious that these "*A. sorex*" PRUVOT-FOL are only young *A. juliana,* while the real *A. sorex* RANG remains a doubtful synonym.

XII. One large specimen, from the Berlin Museum, was collected near Grahamstown on the South African Coast by SCHÖNLAND on May 2, 1891.

It possesses a distinct sucking disk, only a very small portion of the anterior margin of this disk has become indistinct. The broadly united parapodia and the mantle opening are like those in the specimens described above.

The mandible is as usual. The radula (fig. 12) has the formula 65 (21-1-22).

A curious feature distinguishing this South-African animal from the preceding specimens is the armature of the glans penis (figure 13). The

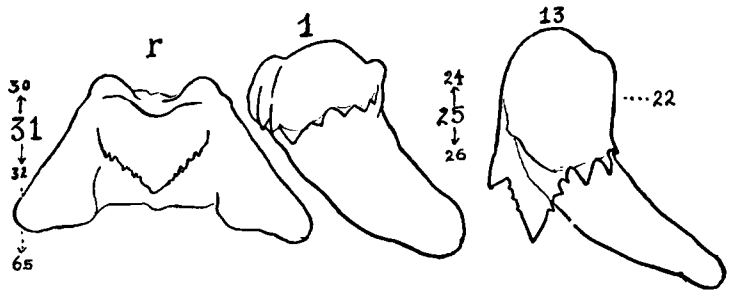



FIGURE 12. Radula of *A.* (*Tullia*) *juliana* Q. & G. from Grahamstown (Sth. Africa), (Berlin Museum, leg. Schönland, 2-V-1891). The rhachidian and the 1st side tooth of the 31st row, the 13th side tooth of the 25th row (the whole radula counts 65 rows: 21-1-22).

whole penis is more strongly armed. One of the larger warts is shown in figure 13a. The larger warts often bear more than one spine, but in this they do not differ from the warts of the preceding specimens. The praeputium consists of the two characteristic parts. The first part is again muscular with strong folds. The second (bulbous) part, containing the glans, shows a very conspicuous irregular tuberculation. Sometimes

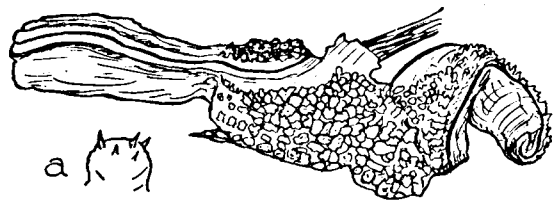



FIGURE 13. Penis of *A.* (*Tullia*) *juliana* Q. & G. from Grahamstown (Sth. Africa), (Berlin Museum, leg. Schönland, 2-V-1891). *a.* one of the warts more enlarged.

these strong warts seems to form transverse or longitudinal rows. The wartless portion along the right side of the seminal groove is present as usual. The most characteristic feature, however, is the very strong rather short penis with a distinct row of warts along the left side of the seminal groove. Near the base (which is flattened as in other specimens) more than one row of tubercles is present.

The following measurements were taken: length 78, breadth 39, height 35, breadth of head 16 mm, with tentacles 17 mm, distance from rhinophores to parapodia, on the left 8 mm, on the right 12 mm, length of parapodia 45, their breadth 22, length of mantle shield 32, its breadth 29, the length of the mantle opening 9, its breadth 7, breadth of foot 25, length of sucking disk 25, its breadth 31 mm.

XIII. From the South African Museum (nr. A 5655) I got one large specimen, without locality, but presumably from the South African coast.

The sucking disk is quite distinct, even its front-margin is continuously visible.

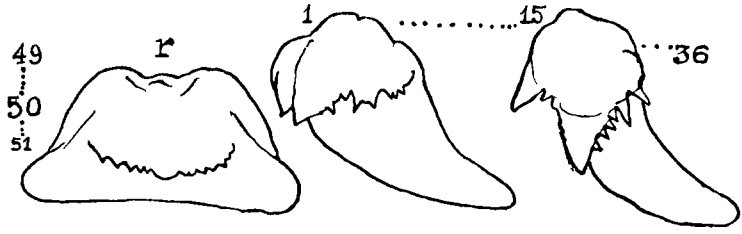



FIGURE 14. Radula of *A. (Tullia) juliana* Q. & G. from the Sth. African Mus. (Nr. A 5655). The rhachidian and the 1st and 15th side tooth of the 50th row (the whole radula counts 88 rows: 36-1-36).

The mandible as in the other specimens described above. The radula (fig. 14) shows the formula 88 (36--136). As in the preceding specimen the glans penis (fig. 15) is rather short, thick, conical, broad and flat at the base. It shows the series of warts along the left side of the seminal groove. In all respects it looks like the penis of the preceding specimen.

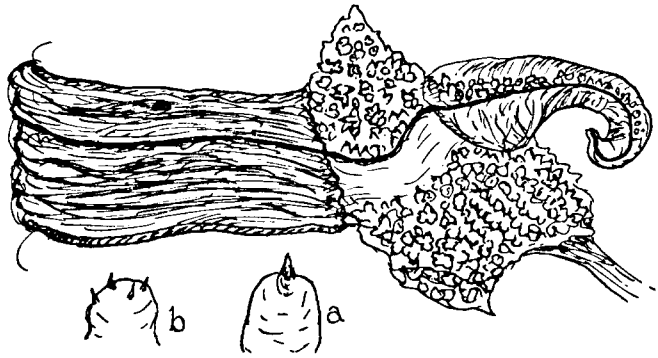



FIGURE 15. Penis of *A. (Tullia) juliana* Q. et G. from the Sth. African Mus. (Nr. A 5655). *a.* Wart (more enlarged) with one spine, *b.* Wart (more enlarged) with several spines.

This likeness strengthens the suggestion that a separate species or subspecies is living in South Africa. Both specimens are larger than the others which I examined, with the exception of Nr. IV, the Chinese animal (here the penis was rather slack and soft, the glans being longer and the warts much less conspicuous).

The following measurements were taken (all in mm.): length 130 mm, breadth 48 mm, height 43 mm, head 18 mm broad, with tentacles 32 mm, distance from rhinophores to beginning of parapodia on the left side 25, on the right side 21 mm, length of parapodia 80, their breadth 33 mm, length of mantle shield 48 mm, its breadth 38 mm, length of mantle opening 9 mm, its breadth 4 mm, breadth of foot 38 mm, length of sucking disk (strongly contracted) 40 mm, its breadth 29 mm.

## b. The specimens examined by N. B. Eales

The following animals, except XXVI, XXVIII and XXIX are from the collections in the British Museum, Natural History. I am indebted to the Trustees and to Mr. I. C. T. Galbraith for unrestricted access to the collections.

XIV. A single specimen from Port Jackson, Australia, collected by Dr. Coppinger, of the Alert, 1881. The specimen is heavily pigmented and measures 57 mm long, 31 broad and 28 high. The posterior sucker on the foot is not well marked, but in all other characters the specimen is a typical *juliana*. The shell, which measures 39 × 25 mm is elongated and narrow (fig. 16a). The very large ctenidium carries numerous specimens of the supposed ectoparasitic copepod *Strongylopleura pruvoti* Monod and Dolfuss, 1932, who recorded it on an *Aplysia* from New Caledonia. This is the only parasite known to me upon or within any species of *Aplysia*, the acrid secretion of the opaline gland probably inhibiting parasitic infestation.

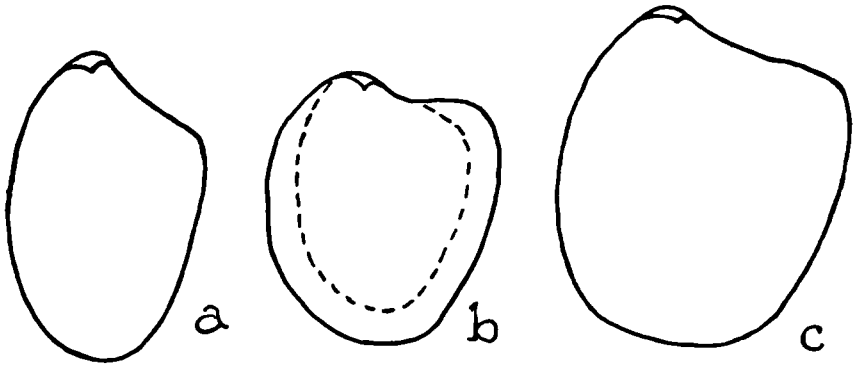



Figure 16. Shells of *A. (Tullia) juliana* Q. & G. in ventral view. All natural size.
*a*. Narrow type of shell from a 57 mm specimen from Port Jackson, Australia, var. *quoyana* nov., 39 × 25 mm.
*b*. Broad type of shell from a 90 mm specimen from Kurachee. The dotted line represents the limit of the calcareous portion, var. *sibogae* Baba non Bergh, 36 × 30 mm.
*c*. Broad type of shell from a 100 mm specimen from Port Jackson, Australia, var. *sibogae* Baba non Bergh, 44 × 37 mm.

XV. A specimen from Port Jackson, Australia, collected in 1886, labelled *Aplysia nigra*. This measures 100 mm long, 52 broad and 60 high. It is of dense black colour, although in places the pigment has bleached. Ctenidium and foot are both black. The tail is short, rounded and forms a sucker. The shell measures 44 × 37 mm and is broad and shallow (fig. 16c), with the usual almost square angle at the termination of the anal sinus. The bulbous base of the praeputium is well marked, with many scattered warts on its lining; most of these bear several spine-tipped conical projections. The warts run up along the base of the penis itself. They do not extend along the seminal groove. The specimen appears to be a melanic example of *A. juliana*, and raises the question whether

D'ORBIGNY's *A. nigra* is the same. He mentions the white secretion (sometimes slightly tinged with violet), the high fusion of the parapodia posteriorly, the small round mantle aperture, and the strong smell of musk, all of which are features of *A. juliana*. The only difference is the shape of the anal siphon, which is not of great specific value. It is unfortunate that the type of *A. nigra* D'ORBIGNY from Peru could not be found in the Paris Museum (compare our note on *A. nigra* D'ORBIGNY below; p. 111). Specimens from Wellington and Portobello, New Zealand, are identical. They could be called *A. juliana*, var. *nigra* n o v. v a r.

XVI. Two specimens from Misaki, Japan, collected by A. V. INSOLE in 1921. The foot sucker is poorly defined. Both are of the narrow shelled type; all other characters are typical of *A. juliana*.

XVII. A specimen from the Gold Coast, the first reported from there, collected by Mr. R. BASSINDALE near Accra in 1949. A typical *A. juliana*, with indications of the foot sucker, and a narrow shell.

XVIII. One specimen from Kurachee, Pakistan, collected in 1883. It measures 90 × 43 × 48 mm. It is of a dirty sooty black colour, but not as heavily pigmented as the Australian individuals. The foot shows a distinct sucker posteriorly. The shell, 36 × 30 mm, is broad, with a smaller, but strongly calcified lining (fig. 16b).

XIX. One specimen from Galapagos Island, collected by Dr. CYRIL CROSSLAND on the Scientific Expedition of the Research Association's Pacific Cruise, 1923-4. The animal is much contracted and measures 36 × 29 × 20 mm. The foot sucker is not evident. The shell is narrow, 15 × 10 mm. *A. juliana*.

XX. Fourteen specimens from New Castle, Tasmania, collected by the Rev. C. N. WILTON, date unknown. The specimens are all small, and range from 56 mm long, 19 broad and 19 high, to 10 mm long, 4 broad and 5 high. All have black pigment and show no markings of a regular kind. The foot is curled antero-posteriorly, so that many are contracted almost into a ball, but the posterior end of the foot exhibits a heart-shaped sucker. The shell, 25 × 17 mm in the largest specimen, is narrow. The praeputium has the usual spiny warts, and these are also clustered round the base of the penis, then extend along the penis itself, but not along the side bearing the seminal groove. All other characters are typical of *A. juliana*; the specimens were labelled *A. bipes*.

XXI. Five specimens, labelled *A. bipes*, from Mombasa, Kenya, collected by L. F. BROWN in 1952. These more recently acquired specimens had been preserved in formalin; they have lost their colour but are well inflated. All are in the "sitting hare" position. The swollen foot shows no distinct edges, except posteriorly, where there is a rounded sucker. The warts on the bulbous base of the praeputium are arranged in straight lines corresponding to the longitudinal ridges of the proximal portion. Other features are those of *A. juliana*.

XXII. A single specimen from Peru, collected by the REV. W. HANNAH, labelled *Syphonota bipes* PEASE, 1860. The small pale specimen, 38 mm long, 14 wide and 19 high, shows little trace of pigment. The foot has a posterior sucker, which is bifid at its hind end. The delicate shell, 16 × 11 mm, is of the narrow type. Other characters as in *A. juliana*.

XXIII. Two specimens labelled *A. sorex* from Las Palmas, Grand Canary, collected by Dr. J. C. TAYLOR in 1908. The larger measures 38 mm long, 16 broad and 15 high. It is dull grey, with traces of black pigment and a few white flecks. The foot is curved ventralwards, the head and neck are thick and long. There is no evidence of a sucker, the posterior end of the foot being rounded, without visible tail. The parapodia are very small and contracted; they expose the mantle and shell area, as is often the case in young animals. The mantle aperture, 3 mm in diameter, has white radiating lines around it. The rather narrow shell is 17 × 12 mm. The radula has 60 rows and a formula 33.1.33; the denticulations on all the teeth are better developed than in an adult *A. juliana*. The internal organs are badly preserved, but it was possible to make out that the bulbous part of the praeputium has the usual spiny warts.

XXIV. One specimen, labelled *A. brunnea* HUTTON, 1875, from Dunedin, New Zealand. This is a typical *A. juliana*. It is 100 mm long, 65 broad and 50 high, brown in colour, without markings. The foot is broad, with a rather flabby sucker posteriorly, the shell 35 × 23 mm, long and narrow, with a square angle where the anal sinus meets the right hand border. The radular teeth are corroded and broken, there are about 60 rows, with a formula of 30.1.30; the teeth very simple. The praeputium is attached, as usual, by two strong muscles, right and left, springing from its bulbous base, the interior of which is warted, with the usual spiny excrescences. The warts extend along the root of the penis, and up one side only of the seminal groove. It is probable that *A.hamiltoni* KIRK, 1882, from Hawke's Bay, New Zealand, is also *A. juliana*, but I have not seen an example. Suter, 1913, regards them as synonyms.

XXV. Recently a consignment from the Canary Islands, of marine animals collected by Captain A. K. TOTTON in the spring of 1955, has arrived at the British Museum (Natural History). Eight specimens of *Aplysia* are in the collection. Two of these proved to be *A. fasciata* POIRET, and six *A. juliana*, all of wich are small and immature. Three of the six exhibit no posterior pedal sucker, three show it clearly. The measurements of the first group are 43 × 26 × 22 mm, 39 × 19 × 20 mm, 24 × 16 × 14 mm., and of the second group 29 × 20 × 19 mm, 20 × 14 × 12 mm and 21 × 11 × 9 mm. They had been preserved in formol sea water, and are less contracted than alcohol specimens. The largest shows best the *juliana* aspect. The general colour is grey, with occasional white spots, and one specimen has a dark stripe near the border of the mantle. In all the specimens the opaline gland is large and pigmented. In the 29 mm. specimen it measures 9 × 2.5 mm. The 20 mm animal has the foot curled ventralwards. While the penis is well developed, the praeputium bears multinodular warts only, without spines; the absence of the

latter may be due to immaturity, for the genitalia are very small[1]). The radula resembles that of TAYLOR's specimens (XXIII above); its formula is 42 × 20.1.20 in one specimen, and the teeth are well denticulated.

This little group ranges in appearance from "*sorex*" to *juliana*. I think it demonstrates that "*sorex*" is a young *juliana*, although it does not explain why up to the present no one has recorded a mature *juliana* from the Canary Islands.

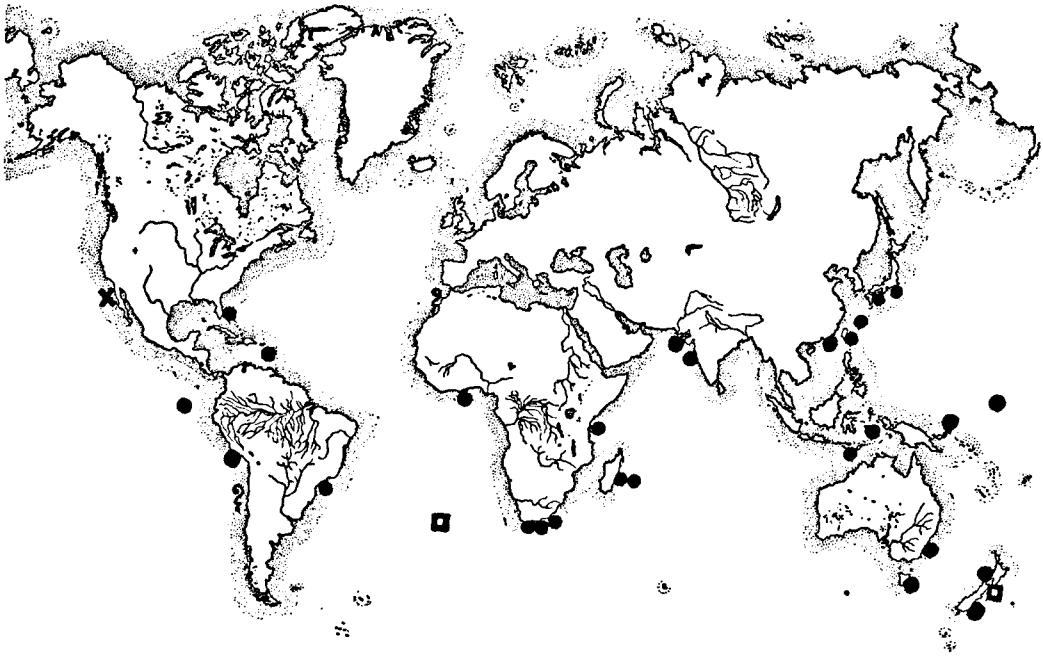


FIGURE 17. Map of the world to show the distribution of the subgenus *Tullia*; *A.* (*T.*) *juliana* indicated by a solid circle, *A.* (*T.*) *cedrosensis* indicated by a cross and *A.* (*T.*) *dura* indicated by a square. *A. depilans* and *A. vaccaria* are not included on this map.

XXVI. Through the kindness of Dr. HARALD A. REHDER, of the American National Museum, Smithsonian Institution, Washington, D.C., U.S.A. I was able to examine the holotype of *Aplysia cedrosensis* BARTSCH and REHDER [2]), which was figured by them. It was collected on the east side of Cedros Island, Lower California, Mexico, July 17, 1938 on the Presidential Cruise, 1938. It is a large bulky animal, measuring 165 mm in length, 90 mm broad and 85 mm high, but must have been longer when alive. Breadth of the head including the cephalic tentacles 55 mm, cephalic tentacles to rhinophores 40 mm, rhinophores 27 mm apart, rhinophores to commencement of parapodia 42 mm, distance between parapodia at their origin 53 mm, height of parapodia (much

[1]) Dr. ERNST MARCUS, Sao Paulo, Brazil writes that he has found young Brazilean specimens exhibiting the warts but not the spines.

[2]) Registered number 472859.

contracted) 50—60 mm, height posteriorly at fusion 38 mm. Ctenidium 94 × 30 mm, mantle 75 × 80 mm. Foot (curled up posteriorly) 115 long and 65 broad.

The skin is very tough and leathery. The general background colour is black on the head, foot and sides of the body and parapodia, but in places the pigment has bleached to brown. Parts were grey originally, with a black patch mid-dorsally on the neck. The mantle is mottled irregularly. The parapodia are blotched with black on their inner faces.

The general shape is low and broad. The head is not much contracted, the neck is thick, the ctenidium of enormous size and projecting from the mantle cavity, the parapodia short and exposing the whole of the mantle region. The cephalic tentacles are widely spaced, hardly rolled at the edges and not continued to the mouth as oral lobes. The rhinophores are conical, stout, slit half-way down and widely spaced. The eyes are small, on clear patches of skin. The foot is broad, rounded in front, with a tendency to form lateral wings; its edges are well defined, and the tail is short, broad and rounded, strongly contracted, bent under and very tough. It might represent a posterior sucker, but this is not clear in the single specimen examined.

The parapodia are small, short, widely separated, at first upstanding, then sloping downwards to become completely fused posteriorly, forming a low wall about 2.5 cm high, with a small mantle pocket. They are very thick and tough, and do not cover either the ctenidium or the mantle.

The mantle is short and very broad. It does not cover the genital aperture or the ctenidium, and its overhang is slight. There is a small round flat foramen, with radiating lines of contraction around it, 1.5 mm wide. The anal siphon is 20 mm high and 35 mm broad, flat on the side of the mantle and fastened to it, so that only about 6 mm of its edge is free. I have seen such a siphon only in this species and that from Tristan da Cunha. The free edge is crenate, but not frilled, and it does not form a tube.

The mantle cavity is rather small, with a small pocket behind. The opaline gland is simple, with numerous apertures, and is relatively small. The genital aperture is large and frilled and is fully exposed. The genital groove is deep, with strongly developed lips, especially the dorsal one.

The shell, fig. 18a, is large and broad, measuring 76 × 57 mm. It is thin and rather flat. BARTSCH and REHDER mention light calcification, but none of this now remains, although from the difference in thickness between the central portion and the edge zone, the size of the calcareous layer may be estimated. In colour it is very dark brown, and is ridged both concentrically and radially. There is no spire, but a slight turnover at the apex. The anal sinus is shallow. The dorsal edge is not recurved.

The radula (fig. 18b) is the largest I have seen. There are 118 rows, with a formula of 80—1—80. The teeth resemble those of *A. juliana* in their simplicity and shortness of the main cusp, with rarely more than a pair of irregularly placed denticulations.

The cerebral ganglia form a fused band; the visceral ganglia are joined but recognisable.

The penis and praeputium have the characters of *A. juliana*, but differ in detail. There are the same two parts of the praeputium, but the bulbous base is much smaller; it is anchored by two stout muscles. The penis is

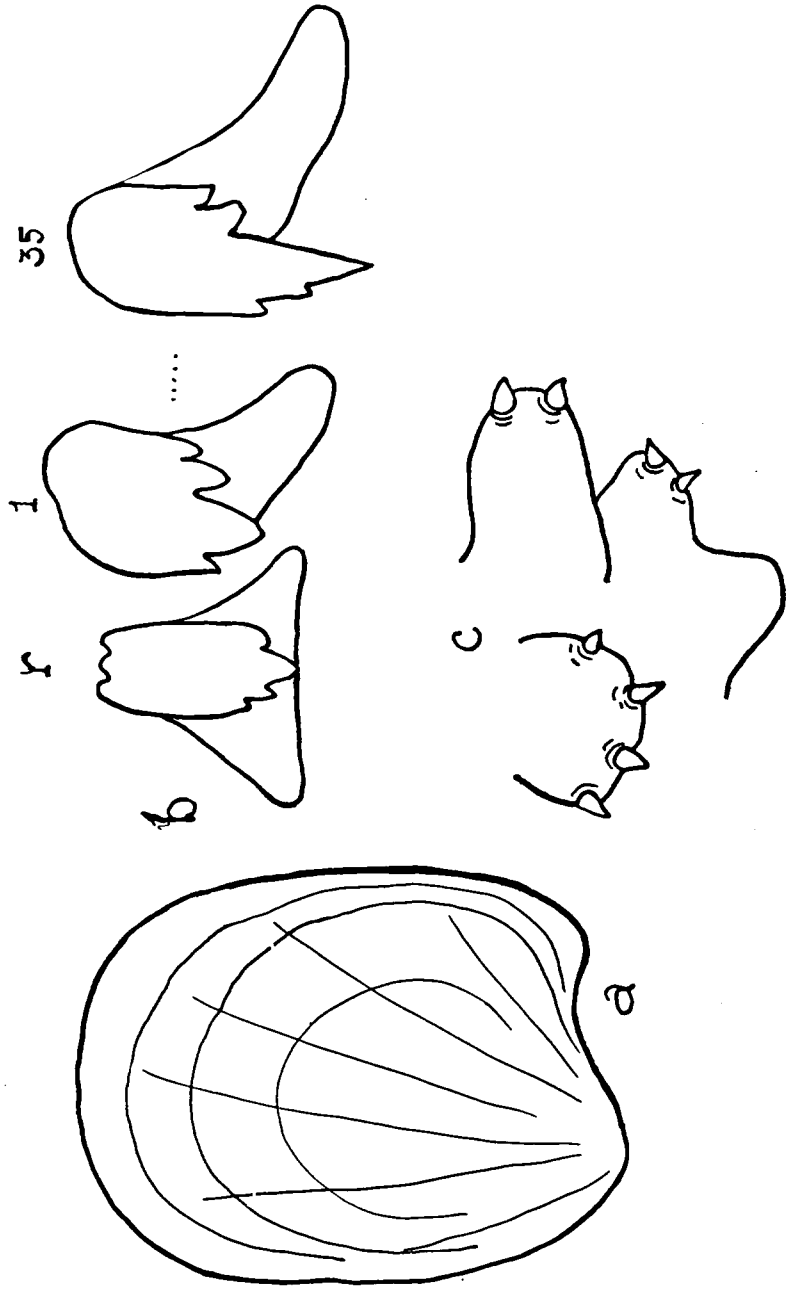



FIGURE 18. *A.* (*Tullia*) *cedrosensis* BARTSCH and REHDER, from Cedros Island, Lower California. Smiths. Inst. Washington, 472859.
*a.* Shell in dorsal view, 76 × 57 mm.
*b.* Radular teeth. Rhachidian, first and thirty-fifth laterals (118 × 80-1-80).
*c.* Warts from the praeputial lining. The warts are simple and rounded. Few spines are present and not all the warts bear spines.

of enormous size, and is bent back on itself in the muscular portion of the praeputium, being much too large to be accommodated in the bulbous portion. The internal surface of the latter bears spiny warts, much simpler than those of *A. juliana*, and rarely branched (fig. 18c). The warts extend a short distance in a double row along the ungrooved side of the penis itself.

Comparing this species with *A. juliana*, it is larger, tougher and probably less mobile than the latter. Both sets of head tentacles are different, mantle and anal siphon are of unique shape, the ctenidium and penis are much larger, the praeputial armature simpler, the opaline gland much smaller. The parapodia are so thick and short that they are probably useless for swimming. It is, in my opinion, a *Tullia* qualified to be considered a separate species.

A second specimen of *A. cedrosensis*, on loan from the Smithsonian Institution, had been in the Museum unidentified since 1889. It was collected not far from Cedros island by the United States Fisheries Commission in San Bartholomé Bay, Mexico, on the Pacific Coast, and measures 137 mm long, 89 broad and 62 high. In shape it resembles at first a *Dolabella*, owing to the enormous size of the visceral region. It is dark all over, with a coarse knobbly skin resembling crocodile skin, and is very tough and hard. A few dark brown blotches remain on the mantle and the inner sides of the parapodia. As in the type specimen the foot is thick and rounded posteriorly, but does not show a sucker. The only difference noted is the more elaborate wartiness of the penis sheath, some of the warts being branched, with a single spine on each branch.

XXVII. Two specimens from the inshore waters of Tristan da Cunha, South Atlantic, collected by H. F. I. Elliot in 1952, now in the British Museum Nat. History. The larger (made the type specimen by me) measures 130 mm long, 54 mm wide and 54 mm high, the smaller 75 × 30 × 32 mm. The body is long, low and unwrinkled, almost flat, the head broad, the neck long and wide, the mantle and visceral region low and hardly wider than the head, the mantle region especially small. The larger specimen was investigated (fig. 19a).

The skin is tough but very smoot, unlike *A. cedrosensis*, which is corrugated and rough to the touch. Black pigment, partly bleached, is present on the tentacles, outer sides of the parapodia, genital aperture and genital groove and ctenidium. The foot is intensely black. The inner sides of the parapodia are blotched with black.

The head projects 18 mm in front of the foot. The rhinophores are wide apart, short, stout and slit half-way. The eyes are rather large, widely spaced and as usual on clear areas of skin.

The foot is 106 mm long and from 36 to 40 mm wide, rounded anteriorly and posteriorly, and possessing a well defined posterior sucker. The parapodia are very small, rising only 28 mm above the mantle floor. They are set far back and are thick and low, with little flexibility; posteriorly they are joined to form a small mantle pocket. They do not cover the mantle, anal siphon or genital aperture.

The mantle measures only 45 × 30 mm, and is triangular in shape, with no overhang anteriorly. The mantle foramen is small, flat and has radiating lines of contraction around it. The anal siphon is very short and

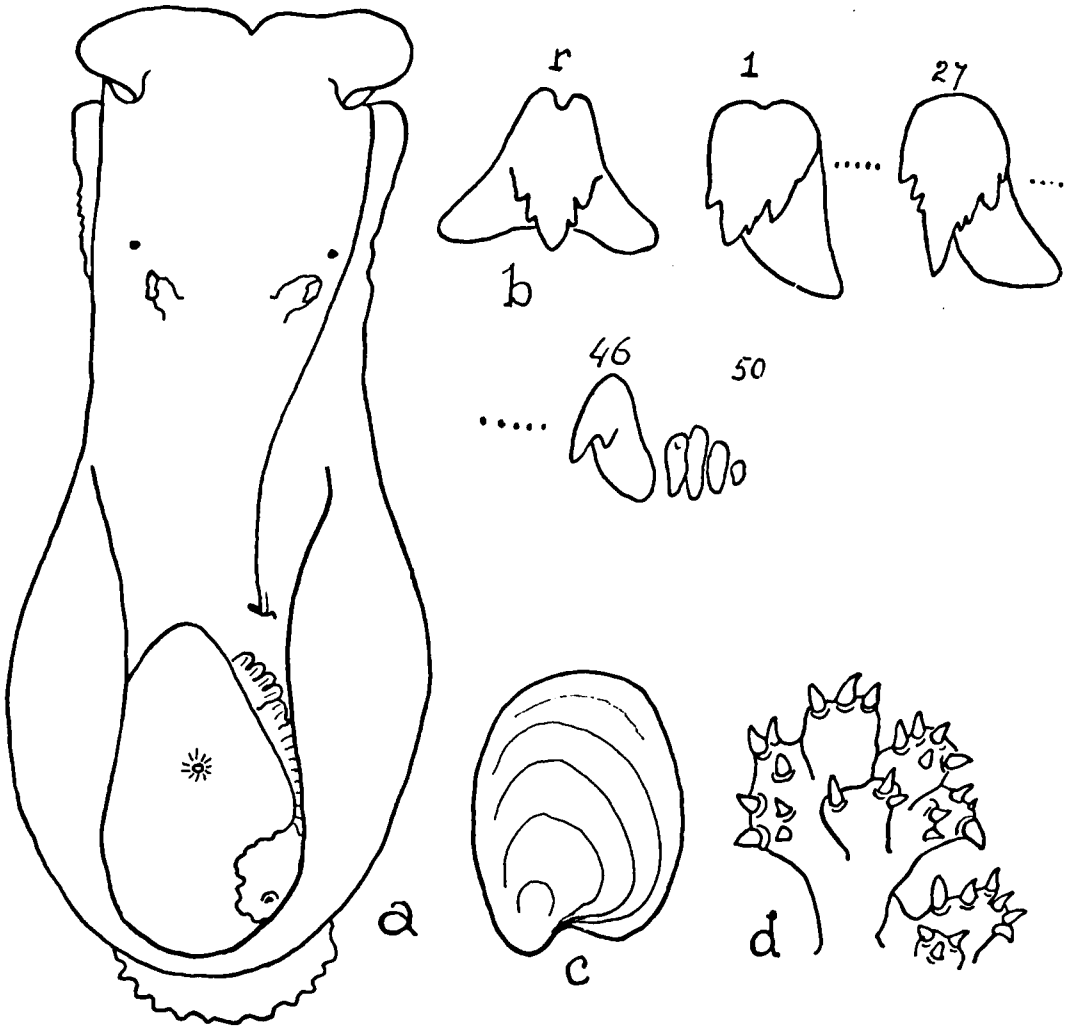



FIGURE 19. *A.* (*Tullia*) *dura* nov. spec. from Tristan da Cunha. B.M.N.H. 1957. 6.11.1.
*a.* Type specimen in dorsal view, length 130 mm, width 54 mm.
*b.* Radular teeth. Rhachidian, first, twenty-seventh and outermost laterals (90 × 50-1-50).
*c.* Shell in dorsal view, 40 × 26 mm.
*d.* Warts from the praeputial lining. Note the branching, and the numerous spines on each wartlet.

broad, and as in *cedrosensis* lies flat on the mantle, so that it is not tubular. The opaline gland is small and consists of unicellular gland cells hidden beneath the fibres and muscles of the mantle floor; the apertures are not visible. The broken and corroded shell resembles that of *cedrosensis* in the complete absence of a down-turned apex, shallow anal sinus with a rounded lateral angle and small convexity. It measures 40 × 26 mm (fig. 19c).

The radular formula is 90 (50.1.50) (fig. 19b). The teeth are all denticulate. The four vestigial teeth at the end of a row are very small. The salivary glands are broad and flat, the caecum large, inflated at the apex and crozier-shaped. Cerebral and visceral ganglia are fused with their partners.

The penis lies in the lower bulbous portion of the praeputium, which is not much inflated. It is smooth and black. The bulbous part of the praeputium bears spiny warts on its lining, arranged in rows on the left side of the sperm groove, scattered on the ventral side, but absent from the right side of the sperm groove. The warts differ from those of other specimens examined in that they are much branched on slender stalks, so that a wart may carry from 3 to 5 branches, each with several spines (fig. 19d).

Recently a third specimen clearly identical with the two just described belonging to the Wellington Museum was loaned to me by Mr. R. K. DELL (together with seven examples of *A. juliana*). It was washed ashore at Lyall Bay, Cook Strait, after a heavy gale in February 1947.

These three specimens are undoubtedly *Tullia*'s. They resemble the Californian species, *A. cedrosensis*, in the hard, tough, unwrinkled skin, the long low shape, exceptionally broad head and neck, very small mantle and shell, thick parapodia joined so low posteriorly that they do not cover the mantle, ctenidium or genital aperture, weak opaline gland, shape of the shell and flat non-tubular anal siphon. They differ from *cedrosensis* in the smoothness of the skin, the well defined radular denticulations, and the branched, stalked warts on the penis sheath.

This species is hereby named *Aplysia* (*Tullia*) *dura* n o v. s p e c., the type specimen (see above, 130 mm long) from Tristan da Cunha is in the British Museum Natural History, and has the registered number B.M.N.H. 1957. 6.11.1.

XXVIII. Two specimens on loan from the Smithsonian Institution, labelled *A. cailleti* DESHAYES, 1857, from the Island of Guadeloupe, West Indies. Both are of the grey type, with a few darker blotches, a well developed posterior sucker and the anterior portion of the foot winged laterally. The larger measures 82 × 41 × 36 mm and the smaller 61 × 26 × 27 mm. They are typical *juliana*. It would be interesting to know who identified these specimens as *A. cailleti*; DESHAYES' description is too vague to be of use and his species is by some authors considered to be *A. brasiliana*.

XXIX *Aplysia vaccaria* WINKLER, 1955.

Holotype in the Allan Hancock Foundation, University of South California, No. 983. Found at Point Fermin, San Pedro, and at Palos Verdes, South California. I have seen parts only of this species, but have been in

communication with Dr. WINKLER about it. It could not be included in map fig. 17.

It is large, about 255 mm long, 135 wide and 110 high when alive, stout, firm bodied, soft skinned and smooth, without odour. The colour is deep purplish black, without markings, or with fine grey or white spots on the sides, head and parapodia. The foot sole is deep blue black.

The cephalic tentacles are broad, folded and black. The rhinophores are 20 mm high, slender. The broad foot is 100 mm wide, with a short, pointed tail. Dr. WINKLER kept specimens alive in the aquarium, but saw no signs of a posterior sucker. The penis sheath, which I have examined, is very large, with a bent bulbous base anchored by two retractor muscles and lined by branched mammillate projections bearing from 3 to 5 spines on each branch. The penis is large, stout and densely black in colour. The parapodia are 60 mm apart in front, upstanding, 120 mm long and united behind, forming a wall 50 mm high around the mantle cavity. There is some mottling on their inner faces.

The mantle aperture is 10 mm wide. Anal siphon tubular and crested, about as high as wide. Ctenidium striped black and white. Glands under the mantle edge secreting a sparse white fluid. Opaline gland simple, multiporous.

Shell large, 70 × 60 mm and 25 mm deep, broad, rounded and rather thick, with both horny and calcareous layers. No spire but the edge thickened, with ridges radiating from the umbo. Anal sinus very shallow and short.

Radula 80.1.80, teeth simple. Rhachidian without denticulations, laterals with short narrow cusps and a single denticle on each side near its base, basal plate long, rounded. Caecum long, its tip curved inwards, but not spiral.

Cerebral ganglia fused, visceral ganglia partly fused.

*A. vaccaria* is a *Tullia* in all its characters except the nature of the foot sole, on which a sucker has not been observed.

## THE SPECIES OF *Tullia* FROM LITERATURE

Comparing our data with those in literature on the species of *Tullia*, our conclusions are the following :

*Aplysia juliana* QUOY et GAIMARD, 1832, p. 309, Pl. II, from Mauritius (Ile de France) (was copied by REEVE-SOWERBY, 1870, *Aplysia* Pl. V, Fig. 20, by VON MARTENS, 1880, p. 307 and PILSBRY, 1895, p. 108, Pl. 17, Fig. 9—10); PRUVOT-FOL, 1934, p. 42, Fig. 8—10 (studied the old specimens of QUOY and GAIMARD again and founded the subgenus *Tullia* on them, Mme PRUVOT-FOL speaks of 2 specimens, only one was found in the Paris Museum, see above).

MACNAE, 1955, (p. 237—240, textfigs 1c, 2c, 3c, and 7a—c) identifies all *Tullia*'s with *A. juliana*, except *Syphonota bipes* and *Aplysia sorex*. He studied 6 specimens from the South African Coast (False Bay and Hermanus in the Klein river estuary) and 10 specimens from Mauritius. Though the author figures a penis with part of the praeputium, and records the spiny tubercles on the praeputial lining, he seems not to have

searched for tubercles and spines on the penis itself. It is not mentioned from which specimen his figure was taken. We are looking forward to more exact statements about the variability of the genital armature as Dr. MACNAE is geographically best situated to solve this problem.

MARCUS, 1955, reports *A. juliana* from Ubatuba near Sao Paulo.

*Syphonota bipes* PEASE, 1860, p. 23 describes specimens from the Sandwich (Hawaiian) islands. His description is sufficient to recognize the genus *Tullia*, but no characters are given that might be of specific value. The author is copied by PILSBRY, 1895 p. 91 Pl. 20, Fig. 43—44 (REEVE-SOWERBY, 1870, *Aplysia*, Pl. VI Fig. 26a—b, figures a shell from the Museum Cuming under this name. Of course it has no value).

*Aplysia sibogae* BERGH, 1905 p. 9, Taf. VI, Fig. 36—42, Taf. VII, Fig. 1—6. Two specimens from the reef of Haingsisi, Samau island near Timor. These specimens and others were redescribed above, as also 9 specimens from Amboina, not mentioned by BERGH. The penis is unarmed (see above). We can only conclude, with MACNAE, that these Malaysian animals are identical with *A. juliana* from Mauritius.

BABA, 1937a, p. 211, Textfig., 4, Pl. 4, Fig. 10 described many specimens from Tomioka, Amakusa which he wanted to make a new species. On my (ENGEL's) advice he identified them with BERGH's animals. He described them under the name *Tethys sibogae*. He stressed the great variability and gave a description of the colour.

He mentions the species again for Japan in BABA, 1937b, p. 62, and in 1938, p. 2, from Kii, Middle Japan, near Seto Marine Laboratory. BABA, 1949, p. 24, 125, Textfig. 4, Pl. III, Fig. 9—11 describes the animals collected by H. M. The Emperor of Japan as *Aplysia sibogae* (1 specimen from Kurosaki, Sagami Bay, shallow water, April 1941, 1 specimen off Sajima, Sagami Bay, 8 m, April 1939, 1 specimen from Hayama, Sagami Bay, shallow water, April 1939). The author mentions the species as common on the Pacific Coasts of Japan from Asamushi southwards, also from Riukiu, Formosa, and Timor. The 3 specimens are pictured in colours. BABA and HAMATANI, 1952 p. 2 again mention the species in a list of Opisthobranchia from Kii, Middle Japan.

*Aplysia woodii* BERGH, 1907, p. 12, Pl. II, Fig. 13—19 describes one specimen from East London, as allied to his *A. sibogae*. It certainly is a *Tullia*, but BERGH's description of the penis is insufficient. I presume MACNAE is right in identifying it with *A. juliana*.

*Tethys capensis* O'DONOGHUE, 1929, p. 14, Pl. I, figs. 9—14 from False Bay is described insufficiently. Probably MACNAE is right in identifying it with *A. juliana*. We should like to study the type specimen before giving a definite opinion.

*Aplysia* (*Metaplysia*) *badistes* PILSBRY, 1951, p. 1—6, Fig. 1—9 is a beautiful description of two *Tullia*'s from Biscayne Bay, on the Atlantic coast of Florida. The armature of the penis has to be investigated yet. Comparing the important figures of the living animal with the figures of

BABA, we are at a loss to give any distinguishing character between *A. badistes* and *A. juliana*. We can follow MACNAE in regarding it as identical with *A. juliana* and *A. sibogae*.

*Aplysia sorex* RANG, 1828, p. 57, Pl. X, Fig. 4—8 (copied by REEVE-SOWERBY, 1870, *Aplysia* Pl. VIII Fig. 36 a, b, c and by PILSBRY, 1895 p. 94, Pl. 22 Fig. 1—5). RANG says that it was collected by LESSON on the Coquille, that the locality is unknown. LESSON, 1830, p. 294 states that the species described by RANG came from the island Oualan (i.e. Kusaie, the most eastern island of the Carolines, 5° 15′ N, 163° 5′ E). A specimen labelled "type" and some other small *Tullia*'s identified with it by Mme PRUVOT-FOL have been described above (see VIII).

Serious doubt was raised as to the identity of the specimen labelled "type" with the real type as described and figured by RANG (see above: difference in size and in the morphology of the foot-sole). Since RANG's description and plate are insufficient for identification, we can only put the real type of *A. sorex* with a note of interrogation in the synonymy of *A. juliana*. The animals which we have seen and which had been identified as *A. sorex* all proved to belong to *A. juliana* (see above).

Mme PRUVOT-FOL, 1953, p. 33, Textfig. VII a—i and Pl. III Fig. 4, identifies a specimen from Témara near Rabat and one probably from Fédala, both from Morocco, with *A. sorex*. This identification seems rather doubtful as Mme PRUVOT in her article raises some doubtful points and as the animals have no real sucking disk on the tail. Yet Mme PRUVOT's knowledge of the subgenus is a guarantee that they probably are very nearly related to it. New material from Morocco is needed to prove their real relationship.

*Aplysia brunnea* HUTTON, 1875, p. 279, pl. 21, id. 1880, p. 123, PILSBRY 1895, p. 97, Pl. 59 f. 44 (copy of HUTTON), SUTER, 1913, p. 544. From Wellington and Dunedin (New Zealand). We have not seen the type but Dr. EALES studied a named specimen (see above XXIV) from the British Museum. SUTER's description is clear enough to conclude that *A. brunnea* is a synonym of *A. juliana*. It is one of the commonest of New Zealand species. There are local variations in New Zealand, as regards colour, shape of parapodia, etc., but structurally they are not different.

*Aplysia hamiltoni* KIRK, 1882, p. 283, PILSBRY, 1895, p. 99, (copy of KIRK's description), from Hawke's Bay, New Zealand. We have not seen a specimen, but SUTER's opinion (see above, under XXIV) is that this is a synonym of *A. brunnea*.

*Aplysia nigra* D'ORBIGNY, 1837, p. 209, Pl. 18 figs. 1, 2, PILSBRY 1895, p. 85, Pl. 22 figs. 10, 11. As a melanic specimen of *A. juliana* (see above under XV) from Port Jackson, in the British Museum was labelled. "*Aplysia nigra*", Dr. EALES raised the question whether *A. nigra* itself (from Island south of San Lorenzo, Callao, Peru) was *A. juliana*? D'ORBIGNY mentions the white secretion (sometimes slightly tinged with violet), the high fusion of the parapodia posteriorly, the small round mantle aperture, and the strong smell of musk, all of which are features of *A. juliana*. The only difference is the shape of the anal siphon which

is not of great specific value. Nothing, however, is said of a posterior sucker on the foot. Since the type specimen could not be found in the Paris Museum, nothing can be said about *A. nigra* itself.

*Aplysia cedrosensis* BARTSCH and REHDER, 1939. The type specimen was reexamined (see above XXVI). It seems to be a species differing from *A. juliana*, but certainly belongs to the subgenus *Tullia*. *A. dura* is related to it, rather than to *A. juliana*.

*A. depilans* L. has all the characters of the subgenus *Tullia*, although the pedal disk is less pronounced.

*A. vaccaria* WINKLER, 1955 (see above XXIX) is soft skinned like *A. iuliana* and *depilans*. A sucker has not been observed in the few specimens found; it is, however, a true *Tullia*.

## CONCLUSIONS

*Tullia* probably is a genus in statu nascendi. The capacity of the posterior part of the foot of *Aplysia* to adhere to some solid substrate results in this subgenus in the formation of a "sucking disk". It is not easy to distinguish more than three species. We unite most specimens in the type species *A. juliana* QUOY and GAIMARD. The animals preserved in the Paris Museum and named *A. sorex* by Mme PRUVOT-FOL are young *A. juliana* according to us. The real type of *A. sorex* Rang, however, gives rise to doubt about its identity. The animals from Morocco published as *A. sorex* by Mme PRUVOT-FOL also are dubious. We consider *A. cedrosensis* BARTSCH and REHDER, *A. vaccaria* WINKLER, *A. depilans L.* and *A. dura* nov. spec., as species distinct from *A. juliana*. We are convinced that a thorough examination of the populations of *A. juliana* from the different localities will point out certain differences which may be of subspecific or even specific value. For the broad shelled variety the name *sibogae* was proposed (p. 86), for the narrow shelled variety *quoyana* (p. 86), for the black variety *nigra* (p. 86, 101, 111).

One might ask, what is the use of the subgenus, if nearly all species are fused in one ? The answer is that is seems important, when the whole of the *Aplysia* genus is considered, to mark the animals with this characteristic posterior foot-disk as a special group, as it must be considered an evolutionary specialisation in the genus *Aplysia*. For this group the subspecific name *Tullia* PRUVOT-FOL, 1933, (syn. *Metaplysia* PILSBRY, 1951) is a suitable name.

As a subgenus, *Tullia* is of interest, not only on account of the specialised condition of the posterior portion of the foot for fixation, but as Mme PRUVOT-FOL pointed out (in litt. 30.9.1956) *Tullia* provides a link between two sections of the family *Aplysiidae*, the *Aplysiinae* and *Dolabellinae* with their typically unarmed penis and praeputium and the *Dolabriferinae* and *Notarchinae* with their more elaborate armature of the praeputium and frequently also of the penis.

At present the following species and synonyms belong to the subgenus *Tullia* PRUVOT-FOL, 1933.

*Aplysia* (*Tullia*) *juliana* QUOY and GAIMARD, 1832

*Aplysia juliana* QUOY and GAIMARD, 1832; PRUVOT-FOL, 1933, 1934 ; MARCUS, 1955.

? *Aplysia sorex* RANG, 1828. (The type remains an uncertain synonym, the animal preserved as such does not fit in with the original description and illustration but it is itself *A. juliana*, the animals identified with it by Mme PRUVOT-FOL certainly belong to *A. juliana*, with the exception of *A. sorex* PRUVOT-FOL, 1953, from Morocco, which is dubious).

*Syphonota bipes* PEASE, 1860

*Aplysia* (or *Tethys*) *sibogae*, BERGH, 1905; BABA, 1937a, b, 1938, 1949; BABA and HAMATANI, 1952

*Aplysia woodii* BERG, 1907

*Tethys capensis* O'DONOGHUE, 1929

*Aplysia* (subgenus *Metaplysia*) *badistes* PILSBRY, 1951

*Aplysia juliana* MACNAE, 1955

? *Aplysia* (*Tullia*) *sorex* PRUVOT, 1953 (see above)

*Aplysia brunnea* HUTTON, 1875

*Aplysia hamiltoni* KIRK, 1882

? *Aplysia nigra* D'ORDIGNY, 1837

*Aplysia hyalina* SOWERBY, 1869, local name for the Australian *A. nigra* (cf. ALLAN, 1950, p. 213)

*Aplysia* (*Tullia*) *cedrosensis* BARTSCH and REHDER, 1939

*Aplysia* (*Tullia*) *depilans* L.

*Aplysia* (*Tullia*) *dura* nov. spec.

*Aplysia* (*Tullia*) *vaccaria* WINKLER, 1955

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