

Opisthobranchia Of Japan (I)

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OPISTHOBRANCHIA OF JAPAN (I)¹⁾

Kikutarō BABA

The marine fauna of the coasts of Japan is very rich and varied and yet, so far, one is very little informed as to the taxonomy of the Opisthobranchia in current use. At the suggestion of Prof. Y. OKADA the present writer therefore has taken up the group for study, and this paper embodies the results of his observations made for a number of years past. This paper comprises also a list of species so far recorded by previous workers from Japanese waters. Special efforts have been made in taking notes and figures from life, because without these students of the Opisthobranchia might be obliged to face difficulties in the recognition of species. It is hoped that this paper will serve as a basis and indeed as a necessary preliminary for future works on ecology, morphology, embryology or other studies of the group in question.

The classification and nomenclature of the Opisthobranchia are serious problems still not satisfactorily solved. Subsequent investigations therefore will render it necessary to alter some of the accounts of the species, genera or even families contained in this paper, but care has been taken to make them as accurate as possible. The systematic arrangement here adopted is mainly that of Dr. J. THIELE (1931), with some necessary emendations in accordance with the current workers' opinions and on the basis of my study.

With this opportunity, I wish to tender my thanks to all those

¹⁾ Contributions from the Zoological Laboratory, Kyūshū Imperial University, No. 93. Papers from the Amakusa Marine Biological Laboratory, No. 46.

who have aided me in one way or another, in the course of the present study. First of all I desire to express my warmest thanks to Prof. N. YATSU for the privilege of referring to the extensive collection of literature on the Opisthobranchia, which was left by the late Sir Charles ELIOT¹⁾ for the Zoological Institute, Tôkyô Imperial University. I am also much indebted to Prof. H. OHSHIMA whose great sympathy enabled me to bring out this work in the printed form. Warm thanks must be extended to the following gentlemen: Professors T. FUKUI, T. UCHIDA, Y. MIYASHITA, S. EMURA, and Messrs. T. URITA, K. OKAMOTO, T. FUJITA, K. KOBAYASHI, S. TAKAHASHI, I. MIYASAKI, S. OKUDA, C. IWAKURA, for placing some specimens at my disposal; Prof. A. OKA for the loan of literature; Professors T. KOMAI, T. ESAKI, and Messrs. T. KURODA, Is. TAKI, for affording me facilities for ready reference to books. Finally my sincere acknowledgments are due to Doctors N. ODINER, H. ENGEL, C. H. O'DONOGHUE, T. SI, F. M. MACFARLAND, J. E. FORREST, K. H. BARNARD, J. RISBEC and Mme. A. PRIVOT-FOL, for their suggestions and for sending me valuable papers not accessible to me.

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I. PREVIOUS RECORDS

The first description of a Japanese Opisthobranch is due to ADAMS and REEVE in "Zoology of Samarang", 1850.—*Tethys dactylomela*, as *Aplysia fimbriata*. Then comes STIMPSON who reported 9 species in "New marine Invertebrates from the Chinese and Japanese seas", 1855.

Tethys laevigata, as *Aplysia laevigata*; *Notarchus longicaudus*, as *N. lineolatus*; *Placobranchus ocellatus*, as *P. guttatus*; *Gymnodoris maculata*; *Doris olivacea*; *D. rogersii*; *D. areolata*; *Dendrodoris nigra*, as *Doris nigra*; *Doris latens*.

Of these, nos. 1, 5-7 and 9 are at present indeterminate.

About six years afterwards, ADAMS (1861) recorded the following 5 species in "Mollusca from the North of China and Japan".

¹⁾ For his obituaries see TAKI: "Sir Charles ELIOT". *Venus*, vol. 2, no. 5, 1931, pp. 264-265;—R.W.: "Sir Charles ELIOT". *Proc. Malac. Soc. London*, vol. 19, pt. 5, 1931, pp. 224-226.

—*Glossodoris festiva*, as *Doriprismatica festiva*; *Coryphella alderi*; *Tethys marmorea*, as *Aplysia marmorea*; *T. marginata*, as *A. marginata*; *T. euchloru*, as *A. euchlora*. Of these, nos. 3 and 4 remain indeterminate.

In 1869, SOWERBY mentioned one species in "Conchologia Iconica", which however is not easy in subsequent recognition.—*Tethys japonica*, as *Aplysia japonica*. TAPPARONE-CANEFRI (1874) who examined specimens obtained by "Magenta" Expedition, recorded 4 species in "Malacologia".—*Aglaia gigliolii*; *Petalifera punctulata*, as *Phyllaplysia punctulata*; *Dendrodoris nigra*, as *Doriopsis inducus*; *Melibe papillosa*. COLLINGWOOD (1881) in his "Nudibranchiate mollusca from the eastern seas", mentioned 4 species.—*Doriopsis viridis*, as *Doris pecten*; *Glossodoris alderi*, as *Chromodoris alderi*; *Albania formosa*; *Trevelyana felis*. Of these, the third is considered by PRUVOT-FOL (1935) as *Hexabranhus lacer*, while the fourth suggested by me as belonging to either of the two genera, *Vayssierea* or *Okadaia*.

In 1899, CLESSIN recorded one species in "Conchylien-Cabinet": *Tethys japonica*, as *Aplysia japonica*. This is at present indeterminate.

BERGH in the following series of papers described certain genera and species, but unfortunately most of his works were done upon preserved specimens. An Arminid is recorded in "Anatomisk undersøgelse af *Sancara iaira*" (1865), and in "Monographi af Pleurophyllidierne" (1866).—*Armina iaira*, as *Sancara iaira*. An Aeolid, in "Aeolidiaden", 1 (1873).—*Fiona pinnata*. The next Aeolid, in "Aeolidiaden", 3 (1875).—*Coryphella athadona*.

In "Nudibrachiate gastropod mollusca of the North Pacific Ocean", 1 (1879), one species: *Duvaucelia tetraquetra*, as *Tritonia tetraquetra*. This is also recorded previously by PALLAS (1788) from Kurile water. In "Nacktschnecken der Südsee", 4 (1879), two species: *Glossodoris thalassopora*, as *Chromodoris thalassopora*; *G. pantharella*, as *Ch. pantharella*. The last-named species is characterized in "Neue Chromodoriden", 1879.

"Monographie der Polyceraden" 1 (1879) comprises two species: *Caloplocamus ramosus*, as *Euplocamus japonicus*; *Plocamophorus tilesii*. And "Japanische Nudibranchien", 1-2 (1880-81), the following 13 species:

? *Cuthona ceylonica*, as *Rizzolia modesta*; *Melibe vexillifera*; *Scyllaea bicolor*; *Armina comta*, as *Pleurophyllidia comta*; *A. fallax*, as *Linguella fallax*; *Dendrodoris nigra*, as *Doriopsis nigra* var. *coerulea*; *Caloplocamus ramosus*, as *Euplocamus japonicus*; *Platycamophorus tilesii*; *Gymnodoris inornata*, as *Trevelyania inornata*; *Glossodoris festiva*, as *Chromodoris marenzelleri*; *Homoeodoris japonica*; *Petelodoris triphylla*; *Duvaucelia reticulata*, as *Tritonia reticulata*.

"Gatting *Melibe* RANG" in 1884, accounts for the anatomy of *Melibe papillosa*, based upon the specimens collected during "Magenta" Expedition.

The pioneer worker on the Japanese coast was FUJITA, who recorded about 8 species in "Cryptobranchiate Dorididae from Misaki", 1892-94.

Glossodoris festiva, as *Chromodoris marenzelleri*; *G. pallescens*, as *Ch. sp.*; *G. aureopurpurea*, as *Ch. aureopurpurea*; *G. alderi*, as *Ch. alderi*; *Ceratosoma cornigerum*, as *C. sp.*; *Argus speciosus*, as *Platydorid sp.*; *A. tabulatus*, as *P. sp.*; *P. sp.*

Later ELIOT by three papers has contributed to our knowledge of the Opisthobranchs from Japan. Two species are included in "Some nudibranchs from the Pacific", 1905.—*Cuthona ceylonica*, as *Rizzolia modesta*?; *Glossodoris pallescens*, as *Chromodoris petechialis*. Two more species, in "Nudibranchs from the Indo-Pacific", 3 (1907): *Melibe pilosa*; *Dendrodoris gemmacea*, as *Doriopsis gemmacea*. The extensive work "Japanese nudibranchs" (1913), with beautiful illustrations, comprises about 41 species.

The second worker on the Japanese coast was HIRASÉ, who mentioned more than 23 species of Opisthobranchia in "Figuraro de Japanaj Bestoj, Moluskoj", 1927. Fragmentary records were also given by SUGITANI (1927), KURODA (1933), TAKAHASHI (1934) and some others. TAKI (1930-36) illustrated six species in "Miscellaneous notes on shells" (2, 4, 5, 7). Lastly 3 species were added to our fauna of Opisthobranchia by ODHNER (1936) and HIRASÉ (1936).

The total number of the valid species so far recorded by the above-mentioned workers is 73. This takes no account of 5 species of STIMPSON; 2 species of ADAMS; 1 species of SOWERBY; 2 species of COLLINGWOOD; 1 species of CLESSIN; nor of 1 species of HIRASÉ. To this number about 66 forms have been added by the present writer (BABA, 1928, 1930-33, 1935-36), of which 35 species, one subspecies, and 2 genera are recognized as new to science although some of them have already been reported as such in the preliminary papers of this work.

II. DISTRIBUTION

The Japanese coast-line extends roughly between latitudes 22° and 50°N, and it is not surprising to find that the cold- and warm-water faunas frequent within this considerable areas, the meeting place for the two faunas falling, so far as the Opisthobranchia at present known are concerned, at about Akkeshi Bay (43°N) of Hokkaidô (see also BABA, 1935). Thus the Opisthobranch fauna of the Bay consists of:

Cold-water species—*Acanthodoris pilosa*, *Aeolidia papillosa*,
Dirona albolineata.

Warm-water species—*Peltodoris mauritiana*, *Okadaia elegans*.

In more northern latitudes *Duvaucelia exsulans* and *Aeolidia papillosa* represent the Sakhalin Opisthobranchia, and *D. tetraquetra* the Kurile group.

The distribution of *Aeolidia papillosa* and *Acanthodoris pilosa* is interesting. They are essentially North Atlantic forms and are especially well-known from the British coasts. It is suggested by ELIOT (1910) that the Opisthobranch faunas of the North Atlantic and North Pacific show considerable similarity in genera and even species, and this depends largely, according to him, upon the easier passage between the two oceans through Bering Strait than round the extremities of Africa and South America (see also BERGH, 1879-80). In view of the hypothesis set forth by ELIOT, is it not justifiable to regard the two species in question as immigrants from the North Atlantic? They are distributed on one side on the Pacific coasts of North America while on the other they reach the northern region of Japan. The distribution of *Dirona albolineata* and *Duvaucelia exsulans* is also interesting, because they are recorded from the Californian coasts and Vancouver on the North American side, and from Hokkaidô and Sakhalin on the Japanese side.

The Opisthobranch fauna of the Japan Sea is represented by 3 species, namely *Tethys parvula*, *Cuthona emurai* and *Coryphella athadona*¹⁾.

The Opisthobranchia of the Pacific side of Japan proper, Okinawa Islands and Formosa consist of:

¹⁾ I now doubt if this species is really a cold-water form. It was originally found on drifting sea-weeds in the midst of the Japan Sea, and subsequently from Mutsu Bay and Akkeshi Bay.

1. Pelagic forms
2. Species relating to the Atlantic
3. Those relating to the Mediterranean
4. Those common to the Red Sea
5. Those common to the Indo-Pacific
6. Those common to Pacific North America
7. Those recorded from Japan only

1. The pelagic forms such as *Phylliroe bucephala*, *Fiona pinnata*, and *Glaucus marinus* are naturally of a very wide distribution, their occurrence in Japan being therefore only to be expected. The distribution of *Cephalopyge orientalis* is limited to Japanese waters.

2. The Japanese fauna is for the most part distinct from the British fauna, but the following species are common to the two faunas.—*Elysia viridis*, *Hermaea dendritica*, *Goniodoris castanea*.

3. Besides the above-listed species, the following Mediterranean form is considered as specifically identical with the Japanese Opisthobranch: *Caloplocamus ramosus*.

Thus the Mediterranean fauna contains 4 littoral species in common with the Japanese fauna, and it is worthy of notice that all these species except one (*G. castanea*) are absent in the fauna of the Suez Canal (O'DONOGHUE, 1929), that of the Red Sea (O'DONOGHUE, 1929; PRUVOT-FOL, 1933) and even that of the Indian Ocean. In 1929, O'DONOGHUE came to an interesting conclusion that, so far as the Nudibranchia are concerned, the Red Sea and the Mediterranean present the most profound and fundamental differences, and that subsequent to the opening of the Suez Canal a number of Opisthobranchs have immigrated into it from the Red Sea but none (excepted for *G. castanea*) from the Mediterranean.

ELIOT (1908, '10) and O'DONOGHUE (1929) took a considerable interest in the peculiar distribution of *Goniodoris castanea*, and the first-named authority (1910) suggested that the occurrence of this species at Suez was no doubt attributable to the existence of the Suez Canal.

The distribution of the other species, namely *Elysia viridis*, *Hermaea dendritica* and *Caloplocamus ramosus* is none the less interesting, but their presence in Japanese waters seems to be due to natural distribution rather than to artificial importation through the Suez Canal (see also O'DONOGHUE, 1929).

4. The Red Sea fauna is distinctly Indo-Pacific in constitution, and not a few species occurring there are recorded from Japanese waters. The following is a list of littoral species common to the Red Sea and Japanese faunas.

Cryptophthalmus smaragdinus, *Tethys dactylomela*, *Dolabrifera dolabrifera*, *Notarchus longicaudus*, *Dolabella scapula*, *Placobranchus ocellatus*, *Elysia grandifolia*, *Goniodoris castanea*, *Casella atromarginata*, *Ceratosoma cornigerum*, *Asteronotus cespitosus*, *Dendrodoris nigra*, *Phyllidia varicosa*, *Bornella digitata*, *Crosslandia viridis*, *Phyllodesmium hyalinum*.

Of these, *Tethys dactylomela* is the most wide-spread, being recorded from almost all of the circumtropic seas, but not from the Mediterranean (see also ENGEL, 1929).

5. The fauna of the Indo-Pacific without accurately defining its limits is decidedly richer than that of any other region, and is especially characteristic in having the genera: *Hexabranchnus*, *Asteronotus*, *Phyllidia*, *Kalinga*, *Bornella*, *Casella*, *Ceratosoma* and others. *Glossodoris*, *Dendrodoris* and *Discodoris* comprise a considerable number of species. The majority of species occurring here have brilliant colorations. It is suggested of the Nudibranchia that, as a rule, the Cladohepatica are abundant in cool or cold waters, and the Holohepatica in warmer regions (O'DONOGHUE, 1924, '29). But RITSBEC (1928) proves that Cladohepatica are still abundant in New Caledonia. The following species are recorded from both the Indo-Pacific and Japanese waters.

Cryptophthalmus smaragdinus, *Aglata cyanea*, *Chelidonura hirundinina*, *Tethys dactylomela*, *T. parvula*, *T. sibogae*, *Dolabrifera dolabrifera*, *Notarchus leachii leachii* var. *freeri*, *N. longicaudus*, *Dolabella scapula*, *Cyerce nigricans*, *Placobranchus ocellatus*, *Elysia grandifolia*, *Berthella plumula delicata*, *Hexabranchnus marginatus*, *Cymnodoris citrina*, *G. inornata*, *G. alba*, *Plocamophorus imperialis*, *Kalinga ornata*, *Goniodoris castanea*, *Glossodoris alderi*, *G. pallescens*, *G. sibogae*, *G. lineolata*, *G. clitonota*, *Casella atromarginata*, *Ceratosoma cornigerum*, *Rostanga arbutus*, *Trippa inlecta*, *Peltodoris mauritiana*, *Discodoris concinna*, *D. pardalis*, *Asteronotus cespitosus*, *Halgerda graphica*, *Argus speciosus*, *A. labulatus*, *A. cruentus*, *A. striatus*, *Doriopsis viridis*, *Dendrodoris nigra*, *D. gemmacea*, *D. guttata*, *D. tuberculosa*, *Phyllidia pustulosa*, *P. nobilis*, *P. varicosa*, *Dermatobranchus striatus*, *Armina taeniolata*, *Bornella digitata*, *Notobryon wardi*, *Crosslandia viridis*, *Melibe pilosa*, *Madrella sanguinea*, *Coryphella ornata*, *Cuthona ceylonica*, *Pteracolidia semperi*, *Phyllodesmium hyalinum*, *Baeolidia major*.

Thus a review of species shows a close connection between the Indo-Pacific and Japanese faunas.

6. Pacific North America is, as a faunistic region, not entirely distinct from Japan, because the two regions have the following species in common: *Tethys parvula*, *Rostanga arbutus*,

Tethys parvula is recorded previously from the West Indies, Californian coast, Japan, Indo-Pacific regions and Natal Coast, and therefore it may be regarded as a circumtropic species (cf. ENGEL, 1936).

7. Besides those described by me as new in the present and the previous papers, the following are known to be limited to Japanese waters.

Aglaia giglioli, *Tethys euchlora*, *Elysia japonica*, *Duvaucelia reticulata*, *Gymnodoris maculata*, *Plocamophorus tilesii*, *Glossodoris pantharelli*, *G. festiva*, *G. thalassopora*, *Actinocyclus japonicus*, *Echinodoris armata*, *Ctenodoris aurantiaca*, *Petelodoris triphylla*, *Homæodoris japonica*, *Halgerda japonica*, *Dendrodoris rubra* var. *nigromaculata*, *Armina comia*, *A. japonica*, *A. similis*, *A. iaira*, *A. fallax*, *Melibe vexillifera*, *M. japonica*, *Doto japonica*, *Coryphella alderi*, *Cuthona bicolor*, *Eolidina japonica*.

III. SYSTEMATICS

Subclass Opisthobranchia

Order 1. Pleurocoela (= Tectibranchia)

Tribe 1. Cephalaspidea

Family Atyidae

Subfamily Cryptophthalminae

Genus *Cryptophthalmus* EHRENBERG, 1831

Cryptophthalmus EHRENBERG, *Symb. Phys.*, 1831; VAYSSIÈRE, *Ann. Fac. Sci. Marseille*, tom. 20, suppl., 1912, pp. 8-9.

Type: *Cryptophthalmus olivaceus* EHRENBERG.

1. *Cryptophthalmus smaragdinus* (RÜPPELL & LEUCKART, 1828)

Family Runcinidae

Genus *Runcina* FORBES, 1853

Runcina FORBES, *Brit. Moll.*, vol. 3, 1853, p. 611.

Pelta QUATREFAGES, *Ann. Sci. Nat., Zool.*, 1844, p. 151; VAYSSIÈRE, *Ann. Mus. Hist. Nat. Marseille, Zool.*, tom. 2, 1885, p. 104.

Type: *Runcina hancocki* FORBES.

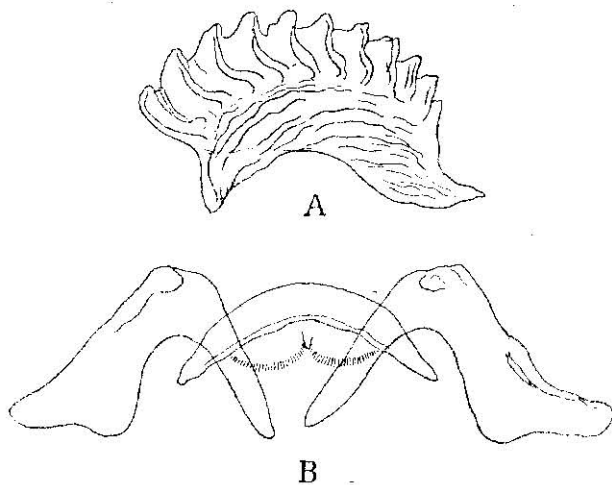
2. *Runcina elioti* nov. sp.

(Pl. 4, fig. 9; text-fig. 1)

Distribution in Japan: Oniike (Amakusa).

The living animal, about 8 mm in length, is elongated and limaciform. The head is simple without tentacles, and sharply truncated in front. It passes back into a mantle without line of demarcation. The mantle is quite smooth, extending beyond the foot all around except at the rounded posterior end where the tail protrudes in locomotion. The ctenidium consists of several plumes arranged in a semicircle, and lies in the median line beneath the posterior end of the mantle. The foot is flat and well-developed; it is rounded in front and passes back in a short tail.

The general colour of the back is dark brown, inclined to yellowish green towards the margin. It is sparsely sprinkled with white dots. The ctenidium is yellow and the foot yellowish green.



Text-fig. 1.—*Runcina clioti*. A. Stomachal plate ($\times 120$); B. A row of radula ($\times 720$).

The radula contains 30 rows of teeth, each row being formed of one central and two lateral teeth; it may be formulated as $30 \times 1.1.1$. The central tooth consists of a broad semilunar base with two thin anterior lobes symmetrically placed on both sides of a median emargination. These lobes bear a row of fine numerous (about 30) denticles on the edge. The lateral tooth is simply hamate without denticles. The stomach is armed with 4 chitinous plates, each composed of about 11 thick triangular pieces attached to a common base.

Locality: Oniike (Mar. 1935; 1 sp.)

The present species is undoubtedly a member of the genus *Runcina* and is the first species of that genus to be recorded from the Pacific Ocean. It differs from any recorded species in the characteristic body-coloration and type of radula, and is described here with the name *R. elioti* after the late Sir Charles ELIOT, who has contributed so much to our knowledge of the Japanese Nudi-branchia.

Family Aglaidae (= Aglajidae, Doridiidae)

Genus *Aglaiia* RENIER, 1804

Aglaiia RENIER, Tav. altab. Conch. Adriat., 16, 1804; O'DONOGHUE, Fish. Mar. Biol. Surv., rep. 7, no. 1, 1929, pp. 10-11.

Aglaja PILSBRY, TRYON'S manual Conch., vol. 16, 1895, p. 44.

Doridium MECKEL, Beitr. vergl. Anat., Bd. 1, Hft. 2, 1809, p. 14.

Type: *Aglaiia depicta* RENIER.

Synopsis of the Japanese species:

- a. Body dark yellowish brown spotted with ashy yellow... .. *gigholi*.
 b. Body uniformly black, or with yellow and brown mottles *cyanea*.

3. *Aglaiia gigholii* TAPPARONE-CANEFFI, 1874

(Pl. 4, fig. 5; text-fig. 2)

Aglaiia gigholi TAPPARONE-CANEFFI, Zool. Viag. Magenta, 1874, pp. 110-111, pl. 1 fig. 18.
 —Japan.

Aglaja gigholii PILSBRY, TRYON'S manual Conch., vol. 16, 1895, p. 50; TAKI, Venus, vol. 6, no. 1, 1936, pp. 48-49, fig. 1.—Onomichi.

Distribution in Japan: Tomioka (Amakusa) and Onomichi (Inland Sea).

The living animal, about 50 mm in length, is elongate-oval, with dorsal shields separated by a transverse furrow. The head-shield is oblong, truncated in front and obtusely pointed behind. The mantle-shield at its posterior end is divided by a median sinus into two symmetrical lobes. The whole of the back is smooth. The foot is oblong, the sides extending in fleshy parapodial lobes which stand recurved on both sides of the body. The mouth opens as a tiny circular pore at the foremost end of the head, between head-shield and foot. The bipinnate ctenidium lies under the right posterior end of the mantle-shield. The anus opens on a small papilla situated beneath the insertion of the ctenidium. Antero-laterally to the insertion of the ctenidium is a genital orifice from

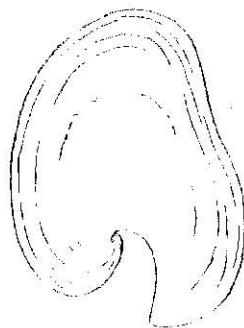
which the genital groove extends forward to the penial orifice below the front right end of the head-shield. The small shell, embedded in the mantle-shield at its posterior end, consists of a flat spiral whorl and a minute spire. The upper layer of the shell is horny and the lower one calcareous.

All the living specimens are nearly alike in coloration. The whole outer surface of the body including the sole is dark yellowish brown closely covered with ashy yellow spots, while the parapodial lobes have a faint sub-marginal black line.

The pharyngeal bulb is destitute of jaw-plates and radula.

Locality: Tomioka (Mar. 1933; many sps., on the muddy *Zostera* zone).

Our specimens appear to be referable to *Aglaia giglioli* TAPPARONE-CANEFRI, as they agree with that form in the general form and coloration of the body.



Text-fig. 2.—*Aglaia giglioli*.
Shell ($\times 4$).

4. *Aglaia cyanea* (MARTENS, 1879)

(Pl. 4. fig. 6.)

Aglaia cyanea BARR, Journ. Dept. Agric. Kyūshū Imp. Univ., vol. 5, no. 1, 1936, pp. 6-7, pl. 3, fig. 8.—Ishigaki-shima.

Doridium cyaneum var. *vittatum* MARTENS, Mollusken, 1880, pp. 129-130.—Mauritius.

Aglaia cyanea var. *vittata* PULSBY, TRYON'S manual Conch., vol. 16, 1895, p. 47.

Distribution in Japan: Ishigaki-shima and Tomioka (Amakusa).

The body in life is elongate-oval, ranging from 25 to 50 mm in length. The head-shield is oblong, truncated in front and obtusely pointed behind, while the mantle-shield is produced behind into two symmetrical lobes. The bipinnate ctenidium lies in a rudimentary branchial cavity under the right postero-lateral end of the mantle-shield. The foot is large and truncated both in front and behind. The parapodial lobes are fleshy membranes standing recurved on both sides of the body. The whole body is smooth and free from any projection. The anus, genital orifice, genital groove, penial orifice and mouth are as in the preceding species. The small shell lies embedded in the mantle-shield near its posterior end. It consists of a flat spiral whorl and a minute spire.

All the specimens from Tomioka are nearly alike in colour, though the various markings are greatly variable in shape and position. The body is usually of a glossy purplish black, sometimes blackish brown or brownish black. The head-shield bears a mid-dorsal series of yellow mottles on each side of which is a brown, continuous or discontinuous streak. Its lateral margins are mottled with brown and yellow, while the hinder end is blue-tinted. A few brown and sometimes yellow mottles are irregularly scattered over the mantle-shield. The posterior sinus of the latter is bordered with yellow; the posterior margin of the same, with blue, brown and yellow mottles. The edge of each parapodial lobe is ornamented with a double discontinuous border, the outer line of which is yellow (and sometimes blue) and the inner line brown. Sometimes it has a brown submarginal border interrupted by yellow markings. There are yellow mottles scattered on the outer surfaces of the parapodial lobes. The sole is of the same ground-colour as the back, very rarely with ashy mottles.

Jaw-plates and radula are wanting.

Locality: Tomioka (Mar. 1933, 1 sp.; Feb.-Mar. 1935, 4 sps.; Dec. 1936, 5 sps., on the muddy *Zostera* zone).

On the whole the material before me resembles *Doridium cyaneum* var. *vittatum* MARTENS which, according to ELIOT (1903), is to be included within a limit of colour variation of *Algaia cyanea* (MARTENS). Also I am inclined to doubt if *A. iwasai* HIRASÉ (Zool. Mag. Japan, vol. 48, nos. 8-10, 1936, pp. 731, 732-734, pl. 30, fig. 1.—Misaki) is specifically distinct from *A. cyanea* (MARTENS).

Genus *Chelidonura* A. ADAMS, 1850

Chelidonura A. ADAMS, Thes. Conch., vol. 2, 1850, pp. 561, 601.

Type: *Bulla hirundinina* QUOY & GAIMARD.

5. *Chelidonura hirundinina* (QUOY & GAIMARD, 1833)

Bulla hirundinina QUOY & GAIMARD, Voy. Astrolabe, 2, 1833, pp. 367-369, pl. 26, figs. 20-25.

Chelidonura hirundinina MARTENS, Mollusken, 1880, p. 129, pl. 21, fig. 5.—Mauritius; PILSBRY, TRYON'S manual Conch., vol. 16, 1895, pp. 34-36, frontispiece, figs. 15, 10; pl. 2, figs. 25-26, 31-35; TAKI, Venus, vol. 2, no. 2, 1930, pp. 57-61, fig. 3—Seto.

Tribe 2. Anaspidea

Family Tethyidae (= Aplysiidae)

Subfamily Tethyinae

Genus *Tethys* LINNÉ, 1758

Tethys LINNÉ, Syst. Nat., ed. 10, 1758, p. 653; O'DONOGHUE, Journ. Linn. Soc., Zool., vol. 35, no. 237, 1924, p. 528.

Laplysia LINNÉ, Syst. Nat., ed. 12, 1767, p. 1082.

Aplysia GMELIN, Syst. Nat., ed. 13, 1791, tom. 1, pars. 6, p. 3103.

Type: *Tethys leporina* LINNÉ (*T. limacina* LINNÉ being unidentifiable).

ENGEL (1927, '36) and PRUVOT-FOL (1931, '34) maintain that *Aplysia* is more pertinent for a Tectibranch genus than *Tethys*.

There are 11 species of *Tethys* in Japan. Of these the following 5 are insufficiently characterized: *marginata* (ADAMS); *marmorea* (ADAMS); *japonica* (SOWERBY); *japonica* (CLESSIN); *laevigata* (STIMPSON).

Synopsis of the valid species of Tethys from Japan:

- I. Tail very long; shell elongated, apex not involuted; body green *euchlora*.
- II. Tail of moderate length.
 - A. Posterior portion of foot developed into a sucking disk. Right border of mantle without a purple gland; mantle foramen very large; parapodia united behind; opaline gland with multiple pores *sibogae*.
 - B. Posterior portion of foot simply narrowed. Right border of mantle with a purple gland.
 1. Mantle foramen very large; parapodia united behind; opaline gland with multiple pores. Body brownish chocolate; mantle foramen, siphon, parapodia, etc. bordered with black (and orange)..... *parvula*.
 2. Mantle foramen nearly closed, often papilliform.
 - a. Parapodia separated behind; opaline gland with multiple pores. Body blackish mottled with gray *kurodai* nov. sp.
 - b. Parapodia united behind; opaline gland with a single pore. Body dark olive covered with large black rings and anastomosing lines *dactylomela*.
 - c. Parapodia separated behind; opaline gland with a main pore and numerous accessory pores. Body dark yellowish brown covered with many small black rings *hirasei*.

6. *Tethys dactylomela* (RANG, 1828)7. *Tethys laevigata* (STIMPSON, 1855)8. *Tethys euchlora* (A. ADAMS, 1861)

Aplysia (*Phycophila*) *euchlora* A. ADAMS, Ann. Mag. Nat. Hist., ser. 3, vol. 8, 1861, p. 141.—Tsugaru Strait.

Tethys (*Phycophila*) *euchlora* PILSBRY, TRYON'S manual Conch., vol. 16, 1895, p. 114, pl. 61, fig. 54.

The subgenus *Phycophila* was proposed by A. ADAMS (1861) for reception of the present species.

9. *Tethys marginata* (A. ADAMS, 1861)

Aplysia marginata A. ADAMS, Ann. Mag. Nat. Hist., ser. 3, vol. 8, 1861, p. 141.—Port Hamilton (Korea).

Tethys marginata PILSBRY, TRYON'S manual Conch., vol. 16, 1895, p. 105.

10. *Tethys marmorea* (A. ADAMS, 1861)

Aplysia marmorea A. ADAMS, Ann. Mag. Nat. Hist., ser. 3, vol. 8, 1861, pp. 140-141.—Port Hamilton.

Tethys marmorea PILSBRY, TRYON'S manual Conch., vol. 16, 1895, p. 105.

11. *Tethys parvula* (MÖRCH, 1863)

(Pl. 4, fig. 11; text-fig. 3)

Aplysia parvula MÖRCH, Journ. Conchyl., Paris, tom. 11, 1863, pp. 22-23.—St. Thomas, St. Vincent (West Indies); ENGEL, Bijdr. Dierk., Afl. 25, 1927, pp. 90-92, figs. 4-6.—Curaçao, Jamaica (West Indies).

Aplysia (*Pruvotaplysia*) *parvula* ENGEL, Capita Zoologica, vol. 8, pt. 1, 1936, pp. 15-18, text-figs. 8-14.—'Bonaire' (West Indies).

Tethys parvula PILSBRY, TRYON'S manual Conch., vol. 16, 1895, pp. 83-84, pl. 37, figs. 23-25; MACFARLAND, Proc. Calif. Acad. Sci., ser. 4, vol. 13, no. 25, 1924, pp. 398-404, pl. 11, figs. 1-4; pl. 12, figs. 1-11.—San Marcos Island (Gulf of California).

Aplysia nigrocincta MARTENS, Mollusken, 1880, p. 131, pl. 21, figs. 3, 3a-3b.—Mauritius; ELIOT, Proc. Acad. Nat. Sci. Philadelphia, 1899, p. 513.—Apia (Samoa).

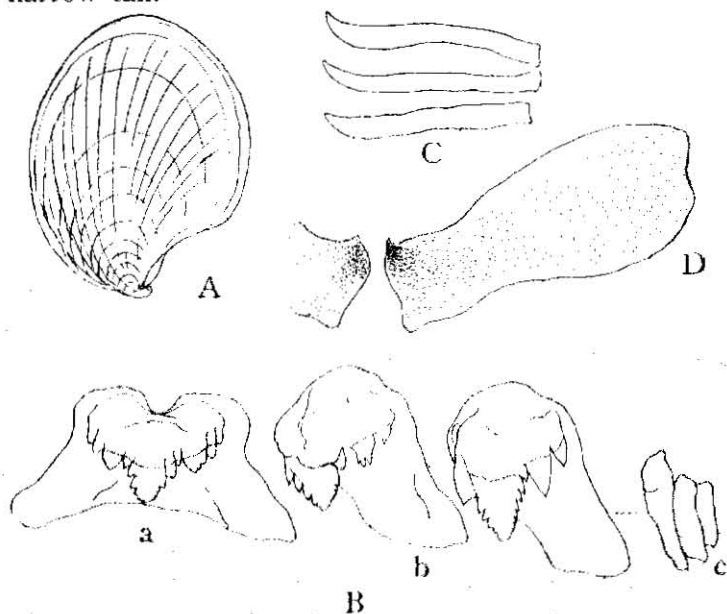
Tethys nigrocincta PILSBRY, *ibid.* vol. 16, 1895, p. 107, pl. 17, figs. 14-16; BORNE, Proc. Malac. Soc. London, vol. 7, 1906, pp. 56-57, fig. 9.—Scottsburg, Natal (South Africa); HIRASÉ, Moluskoj, 1927, p. 1466, fig. 2819. Misaki.

Aplysia atomarginata BERGH, Siboga Exped., 1905, pp. 89, pl. 6, figs. 30-35.—'Pulu-Pasi-Tannette'.

Tethys norfolkensis ALLAN, Austr. Mus. Mag., vol. 4, no. 12, 1932, p. 423, fig.—Sydney.

Distribution in Japan: Tomioka (Amakusa), Misaki and Fukui-ken (KURODA, 1933)

Small *Tethys* measuring about 40-90 mm in length. The living animal has a swollen body, a long neck and a tail. The head carries a vertical slit-like mouth in the middle line at the anterior end. The anterior tentacles form two large auriculate appendages with a widely-open slit facing laterad. The rhinophores are small cylindrical structures which bear an upper slit. The parapodial lobes are not very wide, freely mobile, and recurved over the lateral sides of the body. Posteriorly they unite to form a transverse fold across the hinder end of the mantle. This latter is very large relative to the size of the body, and has a large oval foramen over the centre. This foramen is inclined to vary in size in different specimens not at different stages of growth. The mantle-margin extends posteriorly into a rolled anal siphon, while on the right it overlies the ctenidium, forming a purple gland. The genital orifice lies in front of the ctenidium. From it the ovo-seminal groove runs forward to the penial orifice which lies ventro-laterally to the right anterior tentacle. The opaline gland has multiple pores. The foot is truncated in front and continued posteriorly into a long narrow tail.



Text fig. 3.--*Tethys parvula*. A. Shell ($\times 2$); B. A half-row of radula ($\times 120$), a. central tooth, b. 1st lateral tooth, c. outermost teeth; C. Elements of jaw-plate ($\times 300$); D. Jaw-plates ($\times 10$).

The shell is very large in proportion, and its dimension in a specimen 40 mm long is 15×12 mm; in another specimen 60 mm long, 17×13 mm; and in a third 90 mm long, 22×17 mm. It is strongly convex dorsad and oval in outline, and consists of an upper horny and a lower brown calcareous layer. The rostrum is produced with a small involuted apex; the posterior sinus on the right is shallow.

The whole upper surface of the body is brownish chocolate covered with white spots which tend to collect together to form mottles. The parapodial lobes, siphon, anterior tentacles and rhinophores have each a double border, the inner line of which is black and the outer orange. Sometimes this orange line becomes obsolete. The mantle-foramen is edged with black. The foot is pale brown outlined with orange and black, or this latter is often confined to the anterior and the posterior edges of the organ in question.

The jaws are collar-like plates consisting of densely-packed rodlets. The individual rodlets are slightly curved or nearly straight elements, the tips being directed forward.

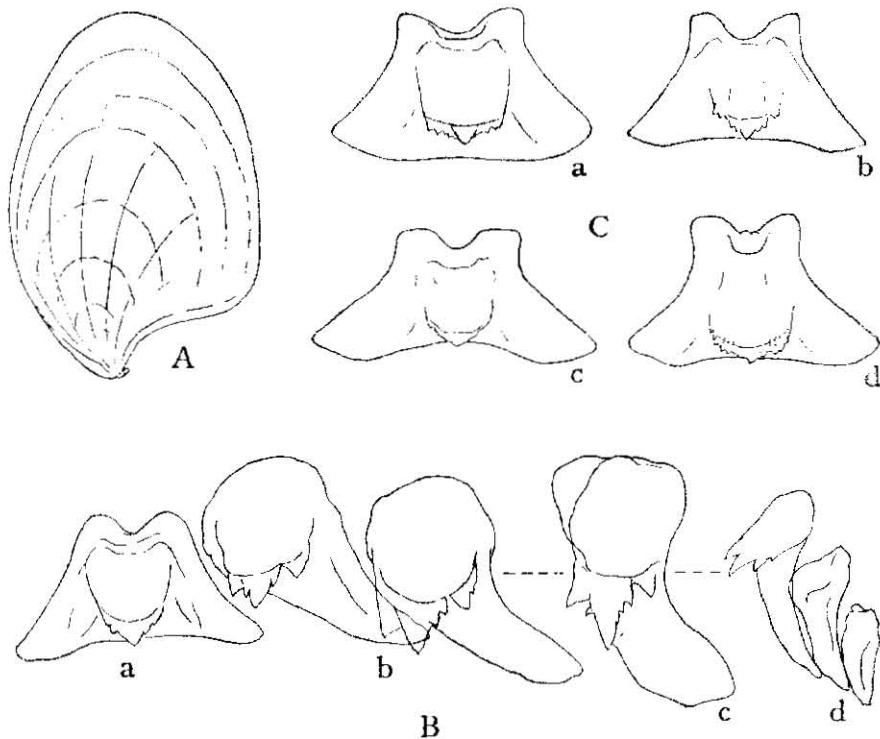
The radula gradually increases in size with the growth of the body. Its formula in a specimen 40 mm long is $22 \times 12.1.12$; in a second 60 mm long, $30 \times 15.1.15$; and in a third 90 mm long, $35 \times 18.1.18$. Usually the central tooth is of trapezoid form, having 2-4 sharp denticles on each side of a median cusp which is also flanked by (4-5) minute denticles. The hook of the 1st lateral tooth bears a large denticulate median cusp and a series of (2-3) outer denticles. The successive lateral teeth present the same general form as the 1st, while towards the outer end of the row they are reduced to become oblong plates.

Locality: Tomioka (Jan.-July, 1936; very common).

The present species, with which *Tethys nigrocincta* (MARTENS), *T. norfolkensis* (SOWERBY) and *T. atromarginata* (BERGH) are without doubt identical, is especially characterized by (1) the small size of body; (2) the parapodial lobes united behind; (3) the large mantle with a widely-open foramen; (4) the large, strongly convex shell; (5) an unmistakable body-coloration and (6) the comparatively small radula. It is very widely spread, from the West Indies to as far west as Natal Coast (cf. ENGEL, 1936).

12. *Tethys japonica* (SOWERBY, 1869)*Aplysia japonica* SOWERBY, Conch. Icon., 1869, pl. 5, fig. 16, a-b.—Japan.*Tethys japonica* PILSBKY, TRYON'S manual Conch., vol. 16, 1895, p. 106, pl. 18, figs. 22-23.13. *Tethys japonica* (CLESSIN, 1899)*Aplysia japonica* CLESSIN, Conch.-Cab., 1899, p. 21, pl. 8, figs. 4-5.—Hakodate.14. *Tethys hirasei* BARA, 193615. *Tethys sibogae* (BERGH, 1905)

(Pl. 4, fig. 10; text-fig. 4)

Aplysia sibogae BERGH, Siboga-Exped., 1905, pp. 9-10, pl. 6, figs. 36-42; pl. 7, figs. 1-6.—Timor.*Distribution in Japan*: Tomioka (Amakusa).

Text-fig. 4.—*Tethys sibogae*. A. Shell ($\times 1$); B. A half-row of radula ($\times 120$), a. central tooth, b. 1st lateral tooth, c. 15th tooth, d. outermost teeth; C. Central teeth from different specimens ($\times 120$).

The young specimens in life measure 30-70 mm in length, while the adult may exceed a length of 300 mm. The body is swollen behind, narrowed in front, with a long neck and head. The anterior tentacles are long and folded. The rhinophores are small, cylindrical, and with an upper slit facing laterad. The parapodial lobes are ample and freely mobile. They are widely separated in front, but united behind. The moderate-sized mantle is perforated by a round or oval foramen over the centre of the shell. This foramen is usually large, sometimes very small, the size varying in different specimens not at different stages of growth. The anal siphon is formed by a posterior membranous extension of the mantle. On the right side the mantle-margin develops unicellular glands which, upon irritation, exude a milky white fluid, and come to replace entirely the purple gland usually found in other *Tethys*. The opaline gland is extraordinarily well-developed, and exudes an ashy fluid from multiple pores. The ovo-seminal groove commences at the common genital orifice which is just in front of the ctenidium, and runs forward to the outer base of the right anterior tentacle, where the penial orifice opens. The foot is obtusely truncated and more or less expanded in front. Posteriorly it continues into a well-developed sucking disk.

The shell is elongate-oval in form. It is slightly convex dorsad, and is made up of an upper horny and a lower calcareous layer. The rostrum is produced with an involuted apex. The posterior sinus on the right of the rostrum is shallow. The dimensions of the shell: 12 × 9 mm (in a specimen 40 mm long); 25 × 17 mm (in a second specimen 100 mm long); and 46 × 34 mm (in a third specimen 220 mm long).

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 varying number of white or black mottles, and others closely-set gray irregular figures.

The elements of the collar-like jaw-plates are rod-like with curved tips. The radula gradually increases in size with the growth of the body. Its formula in a specimen 40 mm long is 25 × 17.1.17; in another specimen 100 mm long, 30 × 23.1.23; in still other specimens about 220 mm long, 55 × 15.1.15, and 60 × 28.1.28. In general, the teeth of the radula are more or less sim-

plified. The trapezoid central tooth bears usually a single large cusp flanked by a row of (2-4) faint denticles, sometimes becoming smooth. The hook of the 1st lateral tooth consists of a large denticulate median cusp, a single inner denticle, and 1-2 outer ones. The successive lateral teeth present the same general form as the 1st, while towards the outer end of the row, they are reduced to oblong plates without denticles.

Locality: Tomioka (Jan-May 1936; very common).

Dr. H. ENGEL of Amsterdam kindly called my attention to the fact that the specimens in hand possess all the subgeneric characters of *Tullia* PRUVOT-FOL, 1934, i.e. the development of a sucking disk and the simplicity of central teeth. The present specimens in their coloration recall *T. bipes* (PEASE) but differ in the shape of a shell. They are fairly close to *T. sibogae* (BERGH), with which they are here identified, in having a large mantle foramen and a small radula with much reduced denticulations.

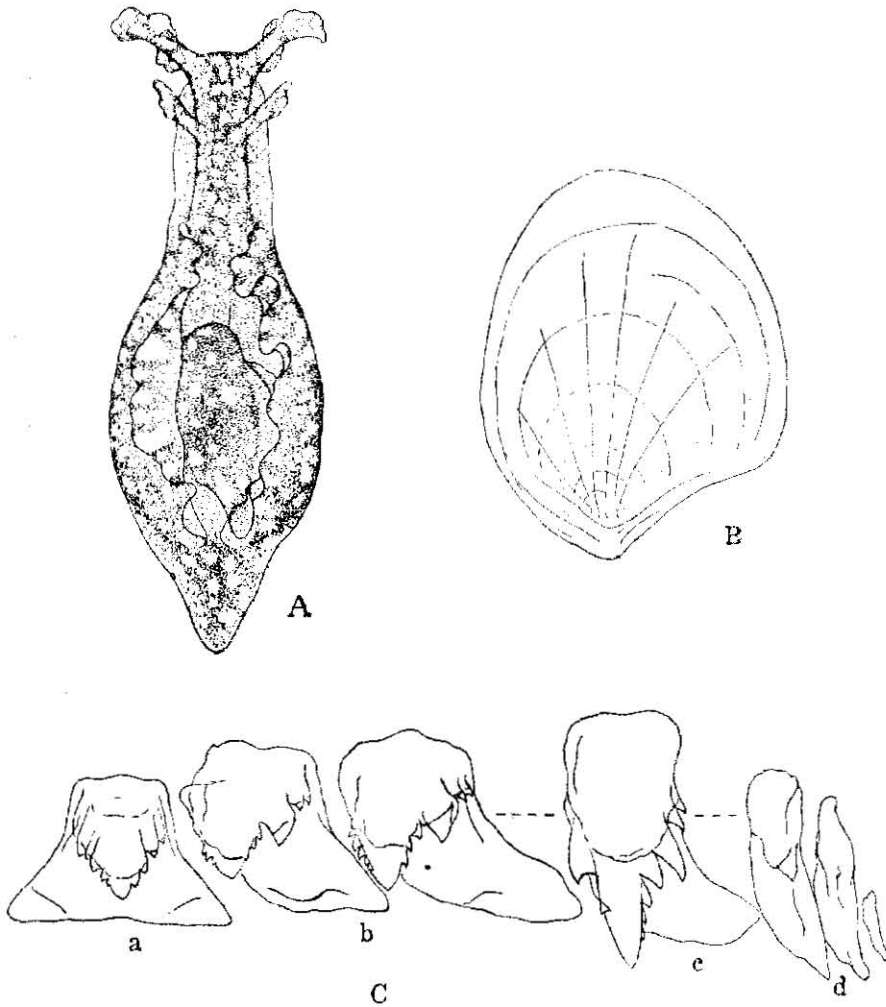
16. *Tethys kurodai* nov. sp.

(Text-fig. 5)

Distribution in Japan: Formosa (TAKAHASI, 1934), Tomioka (Amakusa), Misaki and Tateyama.

The commonest *Tethys* in Japan. The body is swollen behind, narrower in front, with a long neck and a head. It grows up to 350-400 mm in length. At the anterior end of the head is a vertical slit-like mouth guarded by a pair of large folded anterior tentacles. The rhinophores are cylindrical structures with an upper slit facing laterad. The parapodial lobes arising posterolaterally from the rhinophores are ample and free throughout their length; that is, they are separated both in front and behind. The mantle is oval and has a median foramen communicating with a shell-cavity. This foramen is very small even in young individuals. It may be almost closed or may take the form of a small papilla in the adult. At the posterior end the mantle is produced into a short rolled anal siphon. The right margin of the mantle develops a purple gland. The whole skin of the dorsal surface is soft and smooth. The opaline gland, with multiple pores, lies anterolaterally to the ctenidium. It exudes a milky white fluid. The

ovo-seminal groove leaves the common genital orifice lying in front of the ctenidium, and extends forward to the base of the



Text-fig. 5.—*Tethys kurodai*. A. Dorsal view of entire animal ($\times 1$); B. Shell ($\times 1$); C. A half-row of radula ($\times 90$), a. central tooth, b. 1st lateral tooth, c. 15th tooth, d. outermost teeth.

right anterior tentacle, where the penial orifice opens. The foot is large, truncated in front and produced behind in an obtuse tail.

The shell is thin, oval and slightly convex dorsad. It measures 13×9 mm in a specimen 50 mm long; 26×19 mm in a second specimen 120 mm long; and 68×55 mm in a third specimen

350 mm long. The shell itself consists of an upper horny and a lower calcareous layer. The rostrum is produced with a small involuted apex. The sinus at the right of the rostrum is shallow.

The coloration of the body is more or less variable in different specimens. Usually the whole upper surface of the body is brownish or purplish black covered everywhere with small, oval or irregular, grayish mottles. In some specimens these mottles are especially large and abundant, obscuring the ground-colour. The sole is uniformly dark-coloured. The ctenidium is yellow, and the opaline gland yellowish white.

The opening of the mouth is guarded by a pair of collar-like jaw-plates composed of a large number of densely-packed chitinous rods. The growth of the radula is more or less remarkable. The radula formula in a specimen 50 mm long is $30 \times 23-25.1.23-25$; in another specimen 120 mm long, $55 \times 36-40.1.36-40$; and in a still other specimen 350 mm long, $70 \times 43.1.43$. The trapezoid central tooth has a median denticulate cusp and 1-2 smaller lateral denticles. The hook of the 1st lateral tooth consists of a large denticulate median cusp, and 1-2 outer denticles. The succeeding teeth are almost similar in shape to the 1st lateral tooth, but towards the outer end of the row they decrease in size, the hooks becoming smooth, so that the last 3-4 teeth are simply plate-like.

Locality: Tomioka (Jan.-June 1936; very common).

The present form to a certain extent in its coloration, opaline gland with multiple pores and general structures of viscera, resembles the Atlantic and Mediterranean species, *Tethys punctata* (CUVIER). But it differs in the possession of parapodial lobes separated behind, having a little larger radula formula, smaller mantle-foramen and a different shape of shell. These differences may merit systematically its being considered as a distinct species. It is here named *T. kurodai* in honour of the malacologist, Mr. Tokubei KURODA.

Subfamily Dolabriferinae

Genus *Dolabrifera* GRAY, 1847

Dolabrifera GRAY, Proc. Zool. Soc. London, 1847, p. 162.

Type: *Aplysia dolabrifera* RANG.

17. *Dolabrifera dolabrifera* (RANG, 1828)

Dolabrifera dolabrifera ENGEL, Capita Zoologica, vol. 8, pl. 1, 1936, pp. 29-43, text-fig. 16.
Dolabrifera tahitensis BABA, Journ. Dept. Agric. Kyūshū Imp. Univ., vol. 5, no. 1, 1936,
 pp. 12-14, pl. 3, fig. 2; text-fig. 4.—Ishigaki-shima.

According to ENGEL (1936), *Dolabrifera tahitensis* PEASE is synonymous with *D. dolabrifera* (RANG) which is widely distributed in the circumtropic regions.

Genus *Petalifera* GRAY, 1847

Petalifera GRAY, Proc. Zool. Soc. London, 1847, p. 162.

Type: *Aplysia petalifera* RANG.

18. *Petalifera punctulata* (TAPPARONE-CANEFRI, 1874)

(Pl. 4, fig. 3; text-fig. 6)

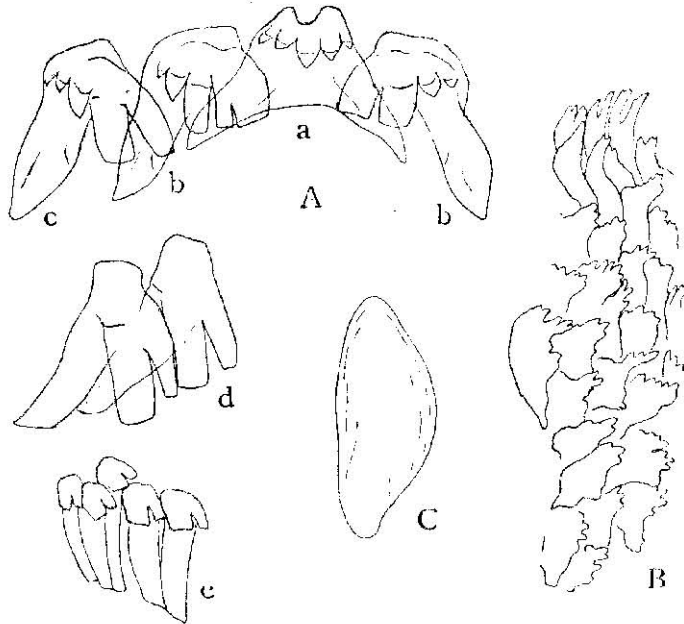
Phyllaplysia punctulata TAPPARONE-CANEFRI, Zool. Viag. Magenta, 1874, pp. 112-113, pl. 2,
 figs. 3, 3a-3c.—Yokohama.

Petalifera punctulata PILSNERY, TRAYON'S manual Conch., vol. 16, 1896, pp. 131-132,
 pl. 36, figs. 4-7; HIRASÉ, Moluskoj, 1927, p. 1466, fig. 2820.—Misaki; Si. Anim.
 Chefoo, 1935, pp. 33-35, text-fig. 24.—Chefoo (China).

Distribution in Japan: Tomioka (Amakusa), Misaki and Yokohama.

The living animal is limaciform and somewhat flattened, and measures 20-35 mm in length. The small head and neck are not distinctly marked off from the body. The anterior tentacles are stout and auriculate, and the rhinophores small, cylindrical with outer slits. The small parapodial lobes arise far behind the rhinophores and are overlapping, separated in front and continuous behind. They cover the middle of the dorsal slit, and an anterior and a posterior aperture are thus formed. The left parapodial lobe fits the underlying shell, the right margin of which alone is covered by the mantle. The ctenidium lies concealed under the free right margin of the mantle. The genital groove commences at the common genital orifice just in front of the dorsal slit, and runs forward along the right lateral margin of the body and neck to the outer base of the right anterior tentacle, where the penial orifice opens. The whole upper surface of the body is sparsely covered with small papillae which disappear after preservation. The mouth is a vertical slit on each side of which

is a small flange-like appendage. The foot is of the full length and width of the body.



Text-fig. 6.—*Petalifera punctulata*. A. A half-row of radula ($\times 250$), a. central tooth, b. 1st lateral tooth, c. 2nd tooth, d. two teeth from the middle of a half-row, e. outermost teeth; B. Elements of jaw-plate ($\times 650$); C. Shell ($\times 5$).

The shell is small, 5-6 mm in length, always narrow and slightly convex dorsad. The rostrum is distinct but without a spiral tendency; the right posterior sinus is scarcely concave. The shell itself consists of an upper horny and a lower calcareous layer.

The coloration of the body varies from grass-green to dark brown. (1) Grass-green specimens: The ground-colour of the body is grass-green. Dorsally it is covered everywhere with purplish brown dots. Sometimes there occur a number of pale longitudinal striations without dots. The foot and insides of parapodia are without markings. (2) Dark-brown specimens: The ground-colour is pale (watery white), almost hidden by conspicuous purplish brown spots. Also there are specimens which stand midway between these two types.

The jaw-plates consist of closely-set tiny rods. Each rod is

irregular in shape, having a jagged edge. The radula gradually increases in size with the growth of the body. Its maximum formula in a specimen 20 mm long is 28×43.143 ; in another specimen 35 mm long, 25×56.156 . The central tooth takes the form of an inverted V with legs widened, and its head is always provided with two cusps on each side of a median larger cusp. The 1st lateral tooth is hamate and bicuspid at the apex, with 2-3 small outer accessory spine. The succeeding teeth are similar in shape to the 1st, but towards the outer end of the row they decrease in size and the accessory spines disappear.

Locality: Tomioka (from late winter to early spring, 1936; very common on *Zostera*).

The present form is regarded by ENGEL (1936) as a subspecies of *Petalifera petalifera* (RANG). It is distinct in having always a narrow body and a narrow shell.

Subfamily Notarchinae

Genus *Notarchus* CUVIER, 1817

Notarchus CUVIER, Règne Animal, tom. 2, 1817, p. 398.

Type: *Notarchus indicus* SCHWEIGGER.

With 4 subgenera: *Nortarchus* s.s., *Bursatella* (= *Aclesia*), *Stylocheilus* and *Barnardaclesia*. All these subgenera are regarded by ENGEL (1935) as separate genera.

19. *Notarchus* (*Bursatella*) *leachii leachii*

var. *freeri* (GRIFFIN, 1912)

(Text-fig. 7)

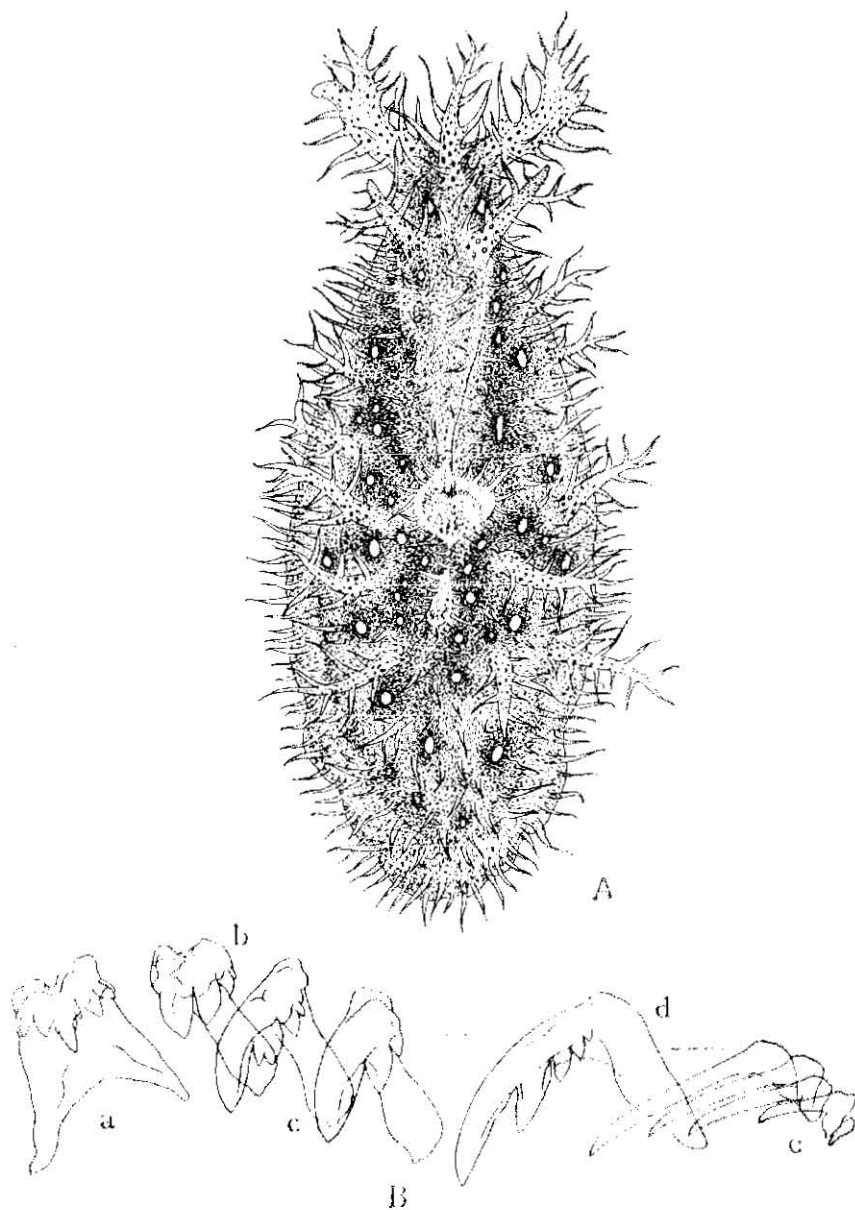
Aclesia freeri GRIFFIN, Philippine Journ. Sci., vol. 7, sec. d, no. 2, 1912, pp. 65-86, text-figs. 1-5, pls. 1-6.--Manila Bay; HIRASE, Moluskoj, 1927, p. 1467, fig. 2821.--Awaji, Isé, Misaki.

Bursatella leachii leachii BLV. var. *freeri* EALES & ENGEL, Proc. Malac. Soc. London, vol. 21, pt. 5, 1935, pp. 292-293, text-fig. 10.--Manila Bay.

Bursatella leachii leachii BLV. var. *hirasei* EALES & ENGEL, ibid., 1935, p. 298.

Distribution in Japan: Tomioka (Amakusa), Awaji, Isé and Misaki.

The animal is roughly fusiform with a head and neck, and its ovoid body passes off into a short tail. When living the mature



Text-fig. 7.—*Notarchus leachii leachii* var. *frecri*. A. Entire animal in dorsal view ($\times 1$); B. A half-row of radula ($\times 120$), a. central tooth, b. 1st lateral tooth, c. 2nd tooth, d. 25th tooth, c. outermost teeth.

individuals measure 90-120 mm in length. The anterior tentacles are two stout auriculate structures with a widely-open slit facing laterad, and are covered with simple and branched papillae. The rhinophores are cylindrico-conical, covered with papillae. They are cleft over the distal half and the slit faces laterally. The parapodial lobes are small flaps which unite behind and almost touch each other in front, and provide a short keyhole-shaped dorsal slit communicating with a spacious branchial cavity. The mantle is almost rudimentary and without a shell, and its free right border develops a purple gland. The ovo-seminal groove leaves the genital orifice lying in front of the large ctenidium and within the dorsal slit. It runs forward to the outer base of the anterior tentacle, where the penial orifice opens. The animal is soft and the entire upper surface is so closely covered with papillae that the creature has a woolly appearance. Many of the papillae are small and simple, but some are very large, branched and standing out markedly. The head carries at its fore end a vertical slit-like mouth guarded on each side by a transverse flap. The front end of the foot is abruptly truncated and very deeply bilabiate, and the hinder end passes into a bluntly pointed tail.

The upper surface of the body, including the anterior tentacles, rhinophores and dorsal papillae, is yellowish gray closely overlaid with dark spots, presenting mottles of various shades. In addition, there are large, greenish blue or blue spots, often surrounded by a narrow brown line, extending rather irregularly along the back and sides. The foot is yellowish gray covered with dark mottles.

The jaw-plates are roughly oval, consisting of tightly-packed irregular rods. The radula increases in size with the growth of the animal. Its maximum formula in a young specimen about 50 mm long is $28 \times 30.1.30$; in two mature specimens $40 \times 50.1.50$, respectively. The central tooth consists of a trapezoid plate bearing 2-4 cusps on each side of a larger median cusp which, in turn, is flanked by minute denticles. The 1st lateral tooth is hamate and the lateral margin of the hook bears two cusps. The succeeding teeth are almost similar in form to the 1st, but getting larger till beyond the middle of the row, and bearing 2-4 distinct lateral cusps. The last 8-9 teeth rapidly decrease in size to become smooth.

Locality: Tomioka (Sept.-Nov. 1936; very common).

Our knowledge of the anatomical details of *Notarchus* (*Bursatella*) *leachii* (DE BLAINVILLE) has been considerably increased thanks to the work of EALES and ENGEL (1935) on a type specimen preserved in the British museum, and we can reasonably identify the Japanese specimens with that form, as the two agree in many essential characters, except for a slight difference in the formation of lateral teeth. Unfortunately the coloration of the type specimen is unknown. EALES and ENGEL consider that the species in question may be divided into a number of subspecies and varieties, and that one of these varieties is *Aclesia freeri* GRIFFIN, to which our specimens practically agree.

20. *Notarchus* (*Stylocheilus*) *longicaudus*
(QUOY & GAIMARD, 1824)

Stylocheilus longicaudus ENGEL, Capita Zoologica, vol. 8, pt. 1, 1936, pp. 57-72, text-figs. 24-43.

Notarchus (*Stylocheilus*) *stimpsoni* BADA, Journ. Dept. Agric. Kyūshū Imp. Univ., vol. 5, no. 1, 1936, pp. 14-15, pl. 2, fig. 3; text-fig. 5.—Ishigaki-shima.

I agree with ENGEL (1936) who regards *Notarchus stimpsoni* PILSBRY as specifically identical with *Stylocheilus longicaudus* (QUOY & GAIMARD), a species known to occur widely in the West Indies, the Red Sea, the Indian Ocean and the Pacific.

Subfamily Dolabellinae

Genus *Dolabella* LAMARCK, 1801

Dolabella LAMARCK, Syst. anim. sans Vert., 1801, p. 62; MACFARLAND, Albatross, 1918, pp. 303-304.

Type: *Dolabella callosa* LAMARCK.

21. *Dolabella scapula* (MARTYN, 1789)

Oder 2. Sacoglossa (= Ascoglossa, Elysiomorpha)

Family Caliphyllidae

Genus *Cyerce* BERGH, 1870

Cyerce BERGH, Malac. Unters., Hft. 1, 1870, p. 98

Type: *Cyerce elegans* BERGH.

22. *Cyerce nigricans* (PEASE, 1866)

Family Stiligeridae

Genus *Stiliger* EHRENBERG, 1831

Stiliger EHRENBERG, Symb. phys., 1831.

Type: *Stiliger ornatus* EHRENBERG.

The genus comprises the subgenera: *Stiliger* s.s. and *Ercolania*.

Synopsis of the Japanese species:

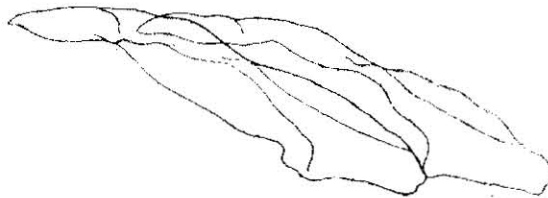
- a. Rhinophores simple *berghi* nov. sp.
 b. Rhinophores auriculate *akkeshiensis*.

23. *Stiliger (Stiliger) berghi* nov. sp.

(Pl. 4, fig. 7; text-fig. 8)

Distribution in Japan: Tomioka (Amakusa).

The body in life is elongated and acolidiform, and continues back into a well-defined, sharply pointed tail. It measures 2.5 mm in length. The head is abruptly truncated in front and is without oral tentacles. The simple rhinophores are slender, passing forward and outward. The back is not sharply marked off from the sides of the body and bears on each side a single row of 7-9 distant branchial papillae, consisting of the large and the small papillae arranged alternately, with small one foremost. The papillae themselves are fairly long and approximately lanceolate. A single liver-diverticulum passes into each papilla which falls off readily after preservation. The whole back, sides and papillae are quite smooth. The foot is elongated and gradually gets narrower from the abruptly rounded front end to the pointed tail.



Text-fig. 8.—*Stiliger berghi*. Teeth ($\times 720$).

The colour is translucent white all over the body and foot alike. On the back, sides and branchial papillae are dark (choco-

late brown) mottles of irregular shapes and sizes. The liver, passing down the sides of the body and giving off branches to the branchial papillae, is brown or olive-coloured. The rhinophores are each marked with a dark ring down the tip.

The radula consists of a single row of teeth, 5 in the descending and 19 in the ascending series, and is formulated as $24 \times 0.1.0$. Each tooth is in the form of a large blade. The anterior margin is somewhat sinuous and non-denticulated, and the hinder margin slightly depressed in the middle.

Locality: Tomioka (Feb. 1935, '37; 15 sps., on *Zostera* weeds).

The present species is classed within the genus *Stiliger* (subgenus *Stiliger*) by virtue of having simple rhinophores and Sacoglossan non-denticulate teeth, but differs from any previously recorded species in (1) the peculiar arrangement of branchial papillae; (2) the coloration; and (3) the shape of teeth. I propose to call it *S. (S.) berghi*, after the late Prof. Rudolf BERGH, who has contributed to our knowledge of the Japanese Nudi-branchia.

24. *Stiliger (Ercolania) akkeshiensis* BABA, 1935

Genus *Hermaea* LOVÉN, 1844

Hermaea LOVÉN, Ofvers. Vet. Akad. Förhandlg., vol. 1, 1844, p. 50.

Type: *Doris bifida* MONTAGU.

25. *Hermaea dendritica* (ALDER & HANCOCK, 1843)

(Pl. 4, fig. 8; text-fig. 9)

Calliopaea dendritica ALDER & HANCOCK, Ann. Mag. Nat. Hist., ser. 1, vol. 12, 1843, p. 233: --Tor Bay (Devon).

Hermaea dendritica ALDER & HANCOCK, Mongr. Brit. Nudib., pt. 4, 1848, fam. 3, pl. 40; BERGH, Verh. k. k. zool.-bot. Gesell. Wien, Bd. 35, 1885, pp. 2-10, pl. 1, figs. 1-16; pl. 2, figs. 1-12; pl. 5, fig. 6.—Trieste.

Distribution in Japan: Tomioka (Amakusa).

The living animal, about 5 mm in length, is elongated and aeolidiform, and continues back in a long pointed tail. The head is well-defined, and its antero-lateral corners are produced into a pair of slender rhinophores, each bearing a longitudinal slit facing antero-laterad. No oral tentacles are present. The branchial

papillae are slender and fusiform and closely arranged in transverse rows on the dorso-lateral sides, the largest being on the inside and the smallest outside. The antero-lateral corners of the foot are obtusely produced.

The body is greenish white ornamented almost everywhere



Text-fig. 9. *Hermaea dendritica*. Tooth ($\times 130$).

with dark green liver diverticula, which ramify in all directions. White spots are scattered on the branchial papillae.

The radula is long and consists of a single row of Sacoglossan teeth, the basal portion of the radula passing into a loose spiral coil. The radula formula is $45 \times 0.1.0$. Each tooth has the form of a large blade. Its antero-ventral margin is quite smooth.

Locality: Tomioka (Feb. 1935; 1 sp.).

In many respects, such as general form, coloration, and type of radula, the present specimen allies very well with an Atlantic and Mediterranean species, *Hermaea dendritica* (ALDER & HANCOCK), with which it is reasonably identified.

Family Elysiidae

Genus *Placobranchus* van HASSELT, 1824

Placobranchus van HASSELT, Allgem. Konst en Letter-Bode, 1824, p. 31.

Type: *Placobranchus ocellatus* van HASSELT.

26. *Placobranchus ocellatus* van HASSELT, 1824

Genus *Elysia* RISSO, 1818

Elysia RISSO, Journ. Physique, tom. 87, 1818, p. 375.

Type: *Notarchus timidus* RISSO.

The genus is divided into 3 subgenera: *Elysia* s.s., *Thuridilla* and *Elysiella*.

Synopsis of the Japanese species :

1. Mantle-lobes exceedingly wide with wavy margins *grandifolia*.
2. Mantle lobes moderately wide.
 - a. Body uniformly green or dark green *viridis*.
 - b. Body green or brownish green, each rhinophore tipped with yellow, mantle-lobes bordered with orange-yellow *yaeyamana*.
 - c. Body light chocolate; rhinophores and tail tipped with dark violet *japonica*.

27. *Elysia (Elysia) viridis* (MONTAGU, 1804)

28. *Elysia (Elysia) grandifolia* KELAART, 1858

(Pl. 4, fig. 2)

Elysia grandifolia KELAART, Journ. Asiatic Soc. Colombo, vol. 3, pt. 1, 1858, p. 119; KELAART, Ann. Mag. Nat. Hist., ser. 3, vol. 3, 1859, p. 493.—Ceylon; ELIOT, Proc. Zool. Soc. London, 1906, pt. 2, p. 689, pl. 46, fig. 4.—India; ELIOT, Journ. Linn. Soc. London, Zool., vol. 31, 1908, pp. 96-97.—Shahul Shubuk (Red Sea); O'DONOGHUE, Proc. Malac. Soc. London, vol. 20, pt. 3, 1932, pp. 141-142, fig. 1.—Gulf of Manaar.

Distribution in Japan: Tomioka (Amakusa).

The living animal, about 50 mm in length, is smooth and limaciform. The rhinophores are auriculate and lie at the antero-lateral corners of the small head. The mantle-lobes are exceedingly wide with wavy margins, and are continuous behind with the posterior end of the body. The antero-lateral corners of the foot are slightly produced into points.

The whole surface of the body is yellowish green ornamented with a large number of black and white spots. The edges of the rhinophores and mantle-lobes have a black line, within which is a yellow shade.

The radula consist of a single row of about 20 teeth (exclusive of those in a basal heap), each having fine serrulations at its antero-ventral margin.

Locality: Tomioka (Mar. 1933; 1 sp.).

The present species is especially characterized by its coloration, exceedingly wide mantle-lobes and serrulated teeth. When stimulated it may exude a copious supply of mucus.

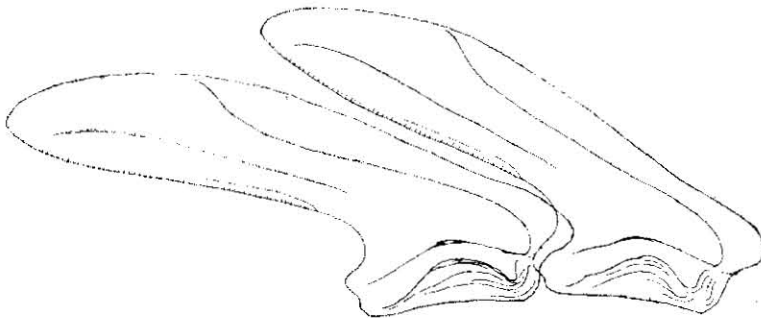
29. *Elysia (Elysia) japonica* ELIOT, 1913

(Pl. 4, fig. 4; text-fig. 10)

Elysia japonica ELIOT, Journ. Coll. Sci. Imp. Univ. Tôkyô, vol. 35, art. 1, 1913, pp. 46-47.—Japan.

Distribution in Japan: Tomioka (Amakusa).

The body is smooth, limaciform and 10-15 mm in length in the living state. Each rhinophore lies at the antero-lateral corner of the head and bears a longitudinal slit facing laterad. The mantle lobes are not very wide, free throughout their length, and recurved over the lateral sides of the body. The pericardium is elongate-oval without a median constriction. The foot is narrow, and its antero-lateral corners are slightly angulated.



Text-fig. 10.—*Elysia japonica*. Teeth ($\times 700$).

The whole upper surface of the body is light chocolate covered with yellowish white dots which are either sparsely scattered, or gathered to form mottles. The rhinophores and tail are tipped with dark violet.

The radula consists of a single row of teeth, 10-12 in the ascending and 8-9 in the descending series, and 15-20 in the basal heap. Each is blade-like and the anterior border is always finely serrulated.

After preservation, the dark markings on the tip of the rhinophores and tail remain conspicuous.

Locality: Tomioka (Dec. 1934; very common on *Zostera*).

I think the specimens in hand are safely referable to *Elysia japonica* ELIOT, the main point of agreement being that of colour. But ELIOT describes for his specimens that the teeth are without denticles.

30. *Elysia (Elysia) yaeyamana* BABA, 1936

Order 3. Acoela

Suborder Notaspidea

Family Pleurobranchidae

Subfamily Pleurobranchinae

Genus *Berthella* DE BLAINVILLE, 1825

Berthella DE BLAINVILLE, Manuel Malac. Conchyl., 1825, p. 469; O'DONOGHUE, Journ. Linn. Soc., Zool., vol. 35, no. 237, 1924, p. 536.

Type: *Berthella porosa* DE BLAINVILLE.

31. *Berthella plumula delicata* (PEASE, 1861)

(Pl. 4. fig. 1; text-fig. 11)

Pleurobranchus delicatus PEASE, Proc. Zool. Soc. London, 1861; p. 245, PEASE, Amer. Journ. Conch., vol. 4, 1868, pp. 79-80, pl. 9, fig. 1.—Huahine; PILSBRY, TRYON'S manual Conch., vol. 16, 1896, p. 202, pl. 45, figs. 7-9.

Berthella borneensis BERGH, Siboga-Exped., 1905, pp. 69-70, pl. 5, fig. 3; pl. 11, figs. 45-47.—¹Pulu Sebangkatan (Borneo-Bank)¹.

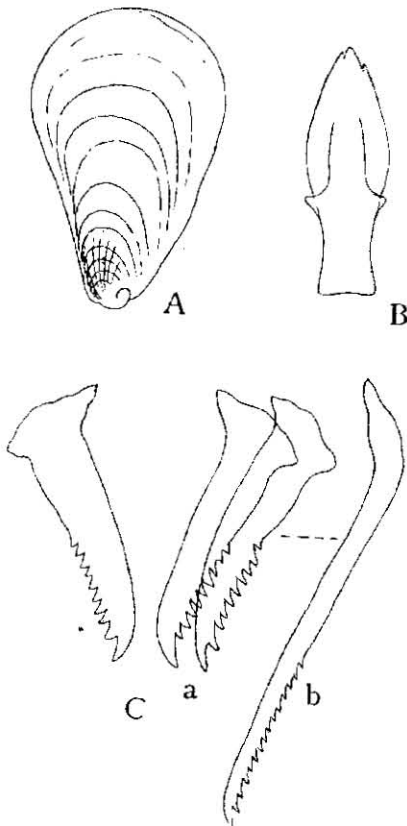
Oscanius sp. HIRASÉ, Moluskoj, 1927, p. 1467, fig. 2825.—Misaki.

Berthella gotoi HIRASÉ, Zool. Mag. (Japan), vol. 48, nos. 8-10, 1936, pp. 731, 734-736, pl. 29, figs. 1-12; pl. 30, fig. 2.—Misaki.

Distribution in Japan: Tomioka (Amakusa) and Misaki.

The body is elongate-oval, varying in length from 30 to 55 mm. The mantle-shield is elongate-oval, free all around, and not sinuated in front. The head is expanded in a small trapezoid cephalic veil, which is deeply cleft along the latero-ventral edges. The rhinophores are cylindrico-conical structures with fused bases and are deeply sulcate on their outer margins. The ctenidium lies on the right side of the body under the mantle. It is attached at the front end, but passes backward as an elongated feather-like structure, bearing about 26 pinnæ on each side of a smooth (non-tuberculated) rachis. The genital orifice lying just in front of the ctenidium is not guarded by a membranous appendage. The anus is situated just at the hinder end of the insertion of the ctenidium. The foot is well-developed and extends beyond the mantle-shield all around. Its anterior margin is bilabiate, with the upper lip notched in the middle. The whole animal is smooth and very soft to the touch.

The shell, about 6 mm in length, lies embedded within the anterior half of the mantle-shield. It is haliotiform, widened in front but narrowed behind, and with a terminal spire. It consists



Text-fig. 11.—*Berthella plumula delicata*. A. Shell ($\times 7$); B. Element of jaw-plate ($\times 300$); C. A half-row of radula ($\times 300$), a. innermost lateral teeth, b. outermost tooth.

of an upper horny and a lower calcareous layer.

The colour of the animal is a translucent yellow or orange-yellow.

The jaws are two collar-like plates consisting of a large number of close-fit lanceolate blades. Each blade is smooth, or rarely with an indistinct denticle on each side. The radula formulae in 3 specimens are about $80 \times 150.0.150$, $70 \times 180.0.180$, and $90 \times 180.0.180$. The rachis is naked. The lateral teeth are all of very similar shape, but increase in size from the inside outward. Each has a long knife-like blade bearing a set of saw-like denticles on the distal margin.

Localities: Misaki (June 1929; common) and Tomioka (May 1935; common).

The present specimens agree closely with *Berthella delicata* (PEASE) in external aspects and shape of a shell, and again with *B. borneensis* (BERGH) in all the essential characters both external

and internal, leaving little doubt as to their specific identity. *B. delicata* (PEASE), possibly with *B. borneensis* (BERGH) as a synonym, can be no more than a subspecies or a variety of *B. plumula* (MONTAGU), as it agrees exactly with that form in the external appearance and in the configuration of jaws and radula, the only difference between the two being, as far as I can go, the character of a shell. While *B. delicata* (PEASE) has a shell narrow behind and rounded in front, in *B. plumula* (MONTAGU) the shell is approximately haliotiform with both ends equally rounded. *B. plumula* (MONTAGU), a wide-spread species

hitherto recorded from the Atlantic, the Mediterranean, the Abrolhos Islands (Western Australia) and Lower California, recalls in colours the Mediterranean form, *B. aurantiaca* (Risso), but differs in having denticulate teeth.

Genus *Pleurobranchus* CUVIER, 1804

Pleurobranchus CUVIER, Ann. Mus. Hist. Nat., tom. 5, 1804, p. 275.

Type: *Pleurobranchus peronii* CUVIER.

With three subgenera: *Pleurobranchus* s.s., *Oscanius* and *Pleurobranchopsis*.

32. *Pleurobranchus (Oscanius)* sp. BABA, 1936

Subfamily Pleurobranchaeinae

Genus *Pleurobranchaea* LEUE, 1813

Pleurobranchaea LEUE, De Pleurobranchaea, 1813, pp. 1-12.

Type: *Pleurobranchidium meckeli* DE BLAINVILLE.

33. *Pleurobranchaea novaezealandiae* CHEESEMAN, 1878

(Text-fig. 12)

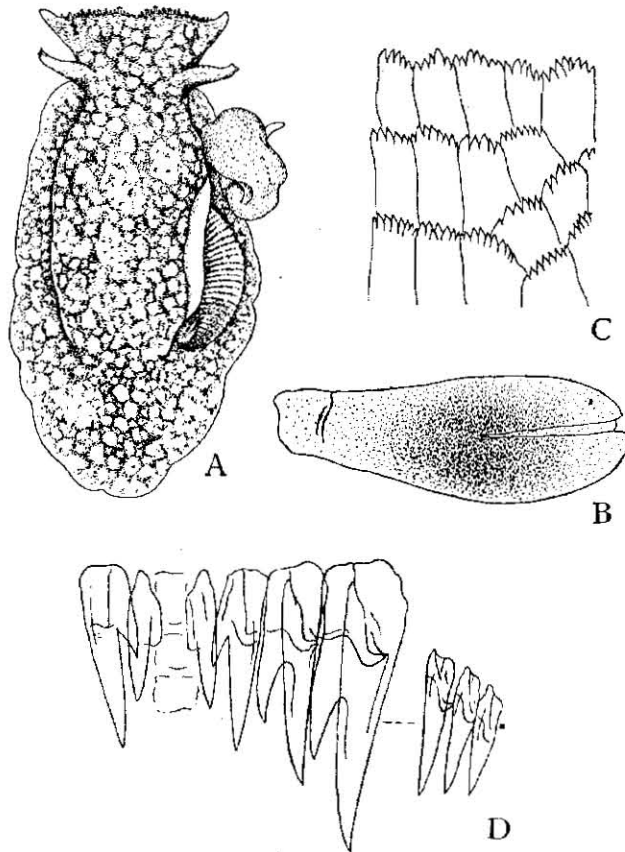
Pleurobranchaea novaezealandiae CHEESEMAN, Proc. Zool. Soc. London, 1878, p. 276, pl. 15, fig. 3.—Auckland Harbour (New Zealand); PILSBRY, TRYON'S manual Conch., vol. 16, 1896, pp. 227-228, pl. 53, fig. 87; BERGH, Zool. Jahrb., Syst., Bd. 13, 1900, pp. 208-209, pl. 20, figs. 56-57; pl. 21, fig. 69.—'Akarva-Harbour', Cook's Strait (New Zealand); SUTER, Manu. New Zeal. Moll., 1913, pp. 553-554, pl. 36, fig. 2.—Shelly Beach, St. Helier's; SI, Contrib. Inst. Zool. Nat. Acad. Peiping, vol. 2, no. 2, 1936, pp. 63-87, text-figs. 32-40; pl. 2, figs. 4-6; pl. 3, figs. 9-11; pls. 12-13.—Tsingtao.

Pleurobranchaea novaezealandiae var. *granulosa* BERGH, *ibid.*, 1900, p. 209.—French Pass; SUTER, *ibid.*, 1913, p. 554.—Lyttleton.

Distribution in Japan: Tomioka (Amakusa).

The living animal, about 60-110 mm in length, is plump, roughly oblong, and very lubricous to the touch. The head-veil is approximately trapezoid in shape, and continues laterally into short conical projections which are cleft along the distal ventral sides. The slightly bilobed anterior edge of the veil bears a series of subconical papillae with minute projections on their sides. The

rhinophores are placed far apart at the postero-lateral corners of the head-veil. They are fairly stout cylindrical structures with a cleft facing laterad. The mantle is oval and free all around except in front and behind, where it is continuous with the head-veil and the foot. On the right side the mantle projects noticeably,



Text-fig. 12.—*Pleurobranchaea novaezealandiae*.—A. Entire animal in dorsal view ($\times 1$); B. Jaw-plate ($\times 4$); C. Elements of jaw-plate ($\times 300$); D. A half-row of radula ($\times 115$).

and the outstanding flange overhangs the ctenidium. The ctenidium is inserted into the body wall a little distance behind the genital orifice, and passes back as an elongated feather-like structure, with about 22 pinnae on each side of a smooth rachis. The anus lies immediately above the insertion of the ctenidium. A shell is

wanting. The foot is well developed, and projects out from the body all around. At the anterior end it is broadly rounded and bilabiate with a notch in the middle of the upper lip. The sides stand out as wide flanges, which are continued backward to form a tongue-shaped tail. On the under side of the tip of the tail is a short median gland, and the dorsal side above this is smooth, without a horn-shaped process. The body is usually smooth, but sometimes the upper surface is everywhere scattered with very small conical papillae. These latter are especially numerous on the head-veil, margin of the mantle and the foot above.

The ground-colour of the body above (head-veil, mantle and foot) is yellowish gray. It is almost everywhere streaked with irregular anastomosing lines of dark (blackish brown), and sometimes sprinkled with groups of white dots. The ctenidium is yellowish gray, inclined to dark near the posterior extremity; the rachis is black-tinted. The under sides of the head-veil and foot are of a glossy dark (blackish brown) colour.

The mouth is probosciform with a pair of jaw-plates. Each jaw-plate is roughly elongate-oval in shape, and is composed of an enormous number of close-fit plates. The number of denticles they bear varies from 4-12. The radula formula in one specimen is $36 \times 53-65.0.53-65$; and in another $46 \times 60-65.0.60-65$. The teeth are all more or less similar in shape but vary in size, being small near the bare rachis, reaching their maximum size near the middle of the row and decreasing again on the outside. Each is roughly an elongated triangle in shape passing into a stout cusp which bears usually an inner accessory denticle about half-way down.

Locality: Tomioka (Apr. 1933, Apr.-May 1936; 3 sps.).

The present specimens are no doubt referable to *Pleurobranchaea novaezealandiae* CHEESEMAN which appears to be different from the Mediterranean species, *P. meckeli* (DE BLAINVILLE) in the body-coloration, in having a mantle continuous behind with the foot, and in the absence of a horn-shaped process on the tip of the tail. The presence or absence of papillae (or granules) on the upper surface of the body does not appear to be a constant varietal character. And so *P. novaezealandiae* var. *granulosa* BERGH is regarded here as a synonym of *P. novaezealandiae* CHEESEMAN.

IV. SUMMARY

1. A critical survey of the species of Opisthobranchia previously recorded from Japanese waters results in the enumeration of 73 valid forms. To this number about 66 have been added by me.

2. A detailed analysis of the Japanese Opisthobranch fauna shows that this latter has several littoral species in common with the Atlantic and Mediterranean faunas; that it is closely related to the Red Sea fauna, more closely to the Indo-Pacific fauna; further, that it is not entirely distinct from the fauna of Pacific North America.

3. A comprehensive list of the species of Pleurocoela, Saccoglossa and Acoela known to occur in Japanese waters is given. The following three are placed on record as new species: *Runcina elioti*, *Tethys kurodai* and *Stiliger berghi*.

4. The following species has been recorded previously from the Atlantic and the Mediterranean and so has its range extended eastward: *Hermaea dendritica*.

5. Complete coloured sketches from living specimens have been given for the first time for the previously noted forms: *Aglaia giglioli*, *A. cyanea*, *Petalifera punctulata* and *Elysia japonica*. Additional coloured sketches have been given of *T. parvula*, *Hermaea dendritica* and *Berthella plumula delicata*.

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EXPLANATION OF PLATE 4

- Fig. 1. *Berthella plumula delicata* (PEASE). × 1.
Fig. 2. *Elysia grandifolia* KELAART. × 1.
Fig. 3. *Petalifera punctulata* (TAPPARONE-CANEFRI). × 2.
Fig. 4. *Elysia japonica* ELIOT. × 4.
Fig. 5. *Aglaia gigliolii* TAPPARONE-CANEFRI. × 1.
Fig. 6. *Aglaia cyanea* (MARTENS). × 1.
Fig. 7. *Stiliger berghi* nov. sp. × 14.
Fig. 8. *Hermæa dendritica* (ALDER & HANCOCK). × 14.
Fig. 9. *Runcina elioti* nov. sp. × 8.
Fig. 10. *Tethys sibogae* (BERGH). × 1.
Fig. 11. *Tethys parvula* (MÖRCH). × 1.

