

Studies on Cirripedian Fauna of Japan

II. Cirripeds Found in the Vicinity of the Seto Marine Biological Laboratory

By

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With 43 Text-figures

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Introduction

The purpose of the present paper is to describe the thoracic cirripeds found in the waters around the Seto Marine Biological Laboratory. The material dealt with in this paper was collected almost entirely by myself during the period extending from the summer of 1930 up to the present time, except a few species obtained from the Sôyô-maru Expedition undertaken by the Imperial Fisheries Experimental Station during the years 1926-1930. Descriptions of the latter have already been given (HIRO, 1933a). The present material consists, with few exceptions, of specimens from the littoral zone and shallow water; none of the specimens are from deep water. However, I have paid special attention to the commensal forms from the ecological and faunistic standpoint, and have thus been able to enumerate a comparatively large number of species in such a restricted area as this district. The new and rare species of the collection have occasionally been described either fully or in part (HIRO, 1931, 1933b, 1934, 1935, 1936b, c, d). The following is the complete list of the species hitherto known to occur in this region:

LEPADOMORPHA

Scalpellidae

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The above list, if statistically explained, will amount to 9 families, 25 genera, 56 species, 11 subspecies and 3 varieties.¹⁾ The fact that the fauna of this district exhibits much tropical feature is readily noticed by anybody who takes a glance at the littoral material around this Laboratory, and depends largely on the direct influence of the warmer oceanic current, i. e. the Kuroshio, so that it is very natural that comparatively many tropical cirripeds are found in this district. The most pertinent example is shown in the occurrence of *Ibla Cumingi*, which I have previously discussed (HIRO, 1936c).

Of these 70 kinds including species, subspecies and varieties, the following 16 seem to be restricted to the coastal waters of Japan: *Euscalpellum squamosum*, *Oxynaspis pacifica*, *Malacolepas conchicola*, *Octolasmis clavula*, *O. Aymonini*, *Chthamalus Pilsbryi*, *Pachylasma japonicum*, *Balanus tintinnabulum volcano*, *B. tintinnabulum rosa*, *B. amphitrite albicostatus*, *B. granulatus*, *Acasta flexuosa*, *A. cancellorum*, *Tetraclita purpurascens nipponensis*, *T. Darwini* and *T. squamosa japonica*. These endemic species (or subspecies) seem to have their origin in tropical waters, most of them being found in the southern part of Japan only. Of these, the sessile group, mostly belonging to true shore forms, are much richer than the pedunculate group. This fact is apparently dependant on peculiarities in their larval life.

The following 34 species and subspecies are distributed far south to the Indomalayan region, a few of them extending farther south to South Africa: *Mitella mitella*, *Calantica scorpio*, *Scalpellum japonicum*, *Ibla Cumingi*, *Conchoderma virgatum Hunteri*, *Heteralepas (Heteralepas) japonica*, *H. (H.) quadrata*, *Trilasmis (Poecilasma) obliqua*, *T. (Temnaspis) excavatum*, *T. (T.) amygdalum*, *Octolasmis Nierstraszi*, *O. orthogonia*, *O. Weberi pennatulae*, *O. Grayi*, *O. angulata*, *Chthamalus Challengeri*, *Balanus amphitrite hawaiiensis*, *B. a. poecilotheca*, *B. Krügeri*, *B. tenuis*, *B. socialis*, *Acasta sulcata*, *A. Dofleini*, *A. pectinipes*, *Creusia spinulosa* with three varieties, species of *Pyrgoma* except *P. anglicum*, and *Tetraclita squamosa viridis*. Most of these species extend farther north to Sagami Bay.

The remaining species in this list are more widely distributed and may be even said to be cosmopolitan. No boreal forms are ever found in this district. It is a rather striking fact that no cirriped inhabiting the waters surrounding Japan, except certain boreal and cosmopolitan forms, is common to the species known from the west

1) Besides these species in this list, recently I have collected in this district two species belonging to the Trilasmidae, *Trilasmis eburnea* HINDS and *Octolasmis Warwicki* GRAY both of which are new to Japan. (See APPENDIX).

coast of America, except that GRUVEL (1905) reported *Heteralepas (Heteralepas) quadrata* from Lower California and NILSSON-CANTELL (1927) reported *Balanus tintinnabulum peninsularis* from Sagami Bay. These exceptional reports seem incredible from the geographical viewpoint. However, the littoral fauna of the Hawaiian Islands is somewhat related to that of the oriental region, and moreover it is more related to that of the Malayan waters than to that of Japan. For example, *Balanus amphitrite hawaiiensis*, which is, according to PILSBRY (1928), "very abundant between tides" in the Hawaiian coast, is quite common in some inland seas or gulfs in the southern part of Japan. It is also found in the Philippine waters. *Trilasmis eburnea* HINDS, *Chthamalus Hembeli* (CONRAD) and *Chthamalus intertextus* DARWIN are found in both Hawaiian and Malayan waters, but there is no reliable record from Japan.¹⁾ This is probably due to the fact that the shallow water species of *Balanus* are frequently transferred by ships from port to port, but in the case of *Chthamalus* there are hardly any possibilities of transmission to wider areas by the agencies of ships' bottoms. It may be recognized also by the fact that a number of species of *Chthamalus* are rather restricted to smaller areas than in the case of *Balanus*, either geographically or bathymetrically. Evidently the mode of larval life and oceanic currents are to be regarded as the most important factors determining the area of habitat.

In the present paper I shall give a systematic account of the cirripeds so far known to occur in the vicinity of this Laboratory, with only brief references to their habitat and biology, since my ecological study will be dealt with more fully in a separate paper. The particular spot, at which each species was obtained, will not be noted, since all of the localities are included in Tanabe Bay and Kanayama Bay.

Before going further, I wish to express my hearty thanks to Prof. T. KOMAI and Prof. Yô K. OKADA, former and present Directors respectively of the Laboratory, for their kindness and encouragement and for many valuable suggestions given me since the beginning of this work, and also to Prof. J. MORITA, of the Osaka Kôto-gakkô, for his taking trouble in looking through the MS of this paper. Thanks are also due to Mr. Y. SAIKA, a resident member of the Laboratory for his ceaseless help in collecting the material.

1) After the manuscript of this paper went to press, I ascertained the occurrence of *Trilasmis eburnea* and *Chthamalus intertextus* in Japan; the former species was found in the vicinity of Seto and the latter from the Ryûkyû (Okinawa) Islands.

DESCRIPTIONS

Suborder LEPADOMORPHA PILSBRY

Family Scalpellidae PILSBRY

Genus *Mitella* OKEN1. *Mitella mitella* (LINNÉ 1767).

Syn. PILSBRY, 1907b, NILSSON-CANTELL, 1921.

This species is very abundant between tides along the coasts of Japan.

Distribution: Indo-pacific along the littorals.

Genus *Calantica* GRAY2. *Calantica scorpio* (AURIVILLIUS, 1892).

Syn. HIRO 1933a.

This species was fully described by me, the description being based upon specimens brought by the Sōyō-maru Expedition from Station 397, off Gobō near Seto and from Station 132, off Minato, Ibaragi Prefecture. Its synonymy has also been discussed (HIRO, 1933a).

Distribution: Recorded from many localities of Japan, besides the above-mentioned two, such as Formosa Channel (NILSSON-CANTELL, 1921; BROCH, 1931), S. E. of Kyūsyū (GRUVEL, 1902a, 1905), Hirado St., Kyūsyū (AURIVILLIUS, 1894), Sagami Bay (KRÜGER, 1911) and Tango, the Japan Sea (WELTNER, 1922). Besides, it is known from the S. China Sea (AURIVILLIUS, 1894), the E. China Sea (BROCH, 1931 as *C. pedunculo-striata*) and Bangkok (WELTNER, 1897, 1922; KRÜGER 1911). Depth 35-140 m.

Genus *Smilium* GRAY3. *Smilium acutum* (HOEK, 1883).

Syn. HIRO, 1933a.

This species was found in association with the above-mentioned *Calantica scorpio*. It is worthy of note that this species has hitherto not been found in waters shallower than 300 m in depth, while here it was found at a depth of 61 m.

Distribution: Pacific, Atlantic and Indian Oceans. Hitherto known from 325 m to 2480 m in depth.

Genus *Euscalpellum* HOEK4. *Euscalpellum squamosum* n. nom.

Euscalpellum stratum HIRO, 1933a (not AURIVILLIUS, 1894).

In my previous paper (HIRO, 1933a), I regarded a specimen of scalpellid barnacle from Station 211 of the Sōyō-maru Expedition (off Tonda near Seto, 190 m in depth) as *Euscalpellum stratum* (originally recorded from Antilles Sea, West Indies at a depth of 360-680 m) but with some doubt as to its identification. However, at present I think it better to separate the Japanese form from the latter species as a distinct species. Both species have apparently a close resemblance in their external characters, but they are not the same, especially as regards their internal characters.

First, as to external appearance, the rostrum is longer than that of AURIVILLIUS' typical *stratum* and is widest in the middle. The rostral latus is a rather elongated triangle, with the rostral and lateral margins about half as long as the rostrum; in *stratum*, however, both margins are "in Länge 1/3 des Rostrum messend." The number of peduncular scales on each oblique circle is greater than in *stratum*. The color of the shell in spirit is white, and covered with a yellowish membrane.

The discrepancies of the internal parts seem to be of special significance, although there are no important differences in the mouthparts. Each segment of the posterior longer cirri bears only one extremely long spine at the posterior distal angle, nearly twice as long as a segment of the cirri, while, according to AURIVILLIUS, there is a tuft of 3 or 4 spines at the same position in *stratum*. The caudal appendage is unarticulate, rather stout and with bristles on the inner side and at the extremity; its length and breadth are similar to those of the proximal segment of the protopodite of cirrus VI. However, AURIVILLIUS mentions that "Die Schwanzanhänge sind sehr winzig, nur einen kleinen Bruchtheil des 6. Protopoditen ausmachend, mit Endbörstchen von der Länge des Anhangs versehen." The penis is absent in the present specimen, while in AURIVILLIUS' *stratum* it is present and very long. A further investigation on more materials may settle the question whether the present specimen is a pure female or not.

The other related species, such as *E. rostratum* (DARWIN 1851),

E. squamuliferum (WELTNER, 1894), *E. Renei* (GRUVEL, 1902b) and *E. bengalense* (ANNANDALE, 1906b) are distinguishable from this in the squamation of the capitulum.

Genus *Scalpellum* LEACH

Of the genus *Scalpellum*, fifteen or sixteen species have hitherto been recorded from Japan. The majority of them have been obtained from deep water in Sagami Bay and from off the Gotô Islands, W. of Kyûsyû. From the vicinity of Seto, I have not collected any specimens of *Scalpellum*, but the following two species have been recorded by PILSBRY (1911).

5. *Scalpellum japonicum* HOEK, 1883.

Scalpellum japonicum HOEK, 1883; ANNANDALE, 1906a; PILSBRY, 1911; WELTNER, 1922.

Scalpellum japonicum metapleurum PILSBRY, 1907a.

Scalpellum japonicum biramosum PILSBRY, 1911; WELTNER, 1922.

PILSBRY (1907a, 1911) recorded this species with its subspecies *biramosum* from Albatross Station 4,972 (N. Lat. 33°25'45", E. Long. 135°33', Depth 805 m) off Susami near Seto. The subspecies *biramosum* seems to be nothing but a developmental stage of the typical *japonicum*, since both forms are usually associated together, the former being older than the latter. Thus the difference between them, if distinct, is due to the degree of decalcification of the valves, as often seen in many other species of *Scalpellum*.

Distribution: Japan—Tôtômi nada (N. Lat. 34°7', E. Long. 138°0') (HOEK, 1883), Kii Channel (N. Lat. 33°25'45", E. Long. 135°33') (PILSBRY, 1907a, 1911); Gulf of Manaar (ANNANDALE, 1906a); West of Sumatra (WELTNER, 1922). Depth 805–1280 m.

6. *Scalpellum laccadivicum* ANNANDALE, 1906.

Syn. HIRO, 1933a.

Of this species I have given a detailed description based upon specimens from Toi-saki, Hiuga nada (depth 364 m). PILSBRY (1911) has described this species under the name of *Scalpellum molliculum* n. sp. from a depth of 446 m off Susami (N. Lat. 33°25'10", E. Long. 135°37'20") which is not far from Seto.

Distribution: Indo-malayan waters; South Japan. Depth 234–2077 m.

Family Iblidae ANNANDALE

Genus *Ibla* LEACH

7. *Ibla Cumingi* DARWIN, 1851.

(Fig. 1)

As regards the occurrence of *Ibla* in Japan and the geographical distribution of the species, a discussion has already been given (HIRO, 1936c). The specimens are invariably found attached to the peduncle of *Mitella mitella* in this district but they do not necessarily occur with the latter. The external and internal parts were described by DARWIN (1851), HOEK (1907) and NILSSON-CANTELL (1921), so that further descriptions are scarcely needed. However, for the help of Japanese students figures of the mouth-parts and the cirri are given here.

Distribution: Malay Archipelago and Peninsula, Red Sea, Gulf of Oman, Hongkong, Southern Japan. Intertidal.

Family Oxynaspidae (GRUVEL) NILSSON-CANTELL

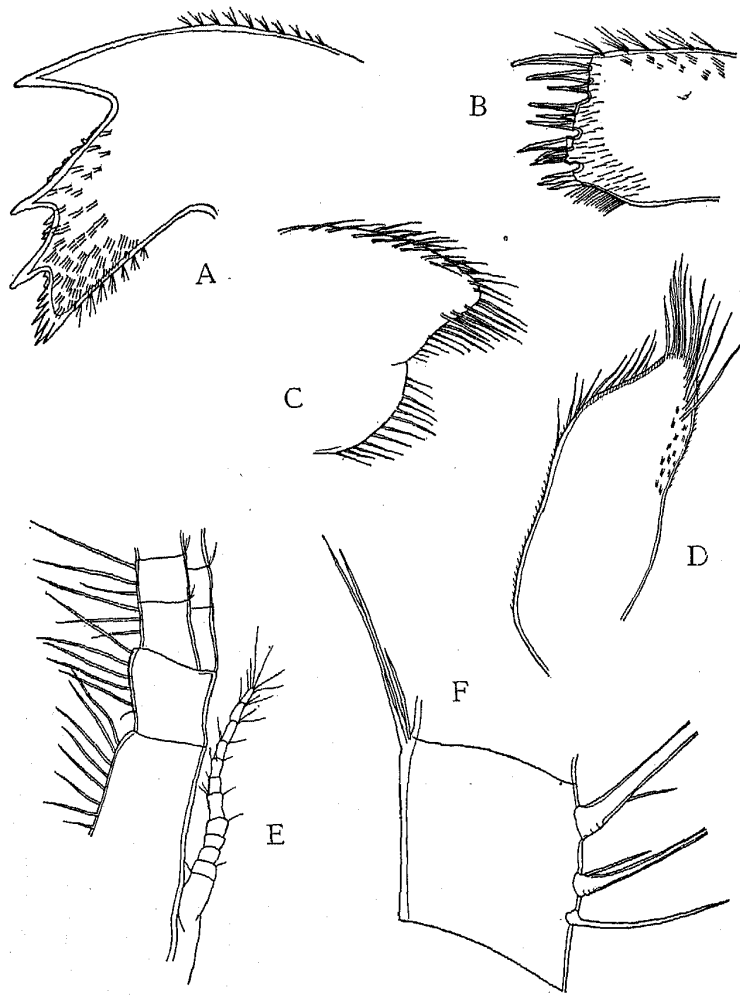
Genus *Oxynaspis* DARWIN

8. *Oxynaspis pacifica* HIRO, 1931.

Oxynaspis pacifica HIRO, 1931.

In my preliminary report dealing with some new cirripeds from Japan, this species has been described only briefly (HIRO, 1931). The genus *Oxynaspis* is represented by the following eight species: *Oxynaspis celata* DARWIN, 1851 with the forma *indica* ANNANDALE, 1909 (including *nova-zelandica* BROCH, 1922) and the forma *japonica* BROCH, 1922, *O. patens* AURIVILLIUS, 1892, *O. Aurivillii* STEBBING, 1900, *O. Bocki* NILSSON-CANTELL, 1921, *O. terrae-novae* TOTTON, 1923, *O. connectens* BROCH, 1931, *O. pacifica* HIRO, 1931 and *O. pulchra* NILSSON-CANTELL, 1934b. Certainly some of them are not different "species" but at most "forms", groups of variants developing in accordance with special biological conditions. At present, however, reasons for keeping them separate exist especially in the difference of the shape of the scutum as well as the carina, and in the presence or absence of the appendages of the cirri. In regard to these points a more thorough examination of more materials from different localities may be needed. Also a reexamination of specimens of this species described below would probably not be useless for future investigators.

The five valves on the capitulum are wholly white, solid and

Fig. 1. *Ibla Cumingi* DARWIN.

A, mandible. B, maxilla I. C, maxilla II. D, palpus. E, lower part of cirrus VI with caudal appendage. F, intermediate segment of cirrus VI.

bear strong radial ridges; the growth-lines are rather indistinct, as figured previously. The external surface of the capitulum as well as the peduncle is covered wholly by a thick cuticle studded with numerous chitinous spines. These spines, as well as the cuticle, are obviously produced by the cirriped alone and are in reality of a

white color. But the outer horny bark of the antipatharian covering gives a brownish hue to the cirriped, especially around the umbo of the valves.

The scutum is quadrilateral, the carinal and basal margins being straight and meeting at a right angle. The occludent margin above the umbo is usually a little concave and that below the umbo is slightly convex or straight. There is always a broad rectangular interspace between the scutum and carina.

The tergum is approximately triangular as in the other species, and the occludent margin is slightly arched.

The carina has the umbo subcentral as in *O. patens*, *O. Aurivillii* and *O. terrae-novae* and is curved at an angle of about 110° at the umbo. The preumbonal part is formed simply as a broad disc.

The peduncle is comparatively narrow and shorter than the capitulum.

Measurements of some specimens in mm:

Capitulum		Peduncle	
Length	Breadth	Length	Breadth
9.5	7.5	7.5	4
7.0	5.0	5.0	2
5.0	3.5	3.5	2

The mouth-parts have previously been figured and are on the whole like those of other representatives of this genus. They offer no important character of specific value.

The numbers of segments of the cirri are as follows:

Size	I	II	III	IV	V	VI
7 mm in length of capitulum	7	8	11	12	14	14
	15	16	16	16	14	16

Cirrus I is shorter than and separated widely from the others. In the posterior cirri, each segment is rather elongate and usually armed with three pairs of spines on the frontal edge, and also with a tuft of spines, including a very long one, at the dorsal distal end; the anterior ramus is a little shorter than the posterior or subequal.

TOTTON (1923) mentioned the presence of a filamentary appendage at the base of cirrus I for his *O. terrae-novae*, and BROCH (1931) also found the same for his *O. connectens*, together with an additional one situated on the median dorsal line of the body. A careful examination of the present specimens reveals no such filamentary appendage. Besides, TOTTON found in *O. terrae-novae* a protuberance

covered with short spinules on the inside of the proximal segment, of the protopodite of cirrus I and two conical bosses with spinules between the bases of the same cirri. Recently NILSSON-CANTELL (1934b) found similar protuberances and bosses in his newly described *O. pulchra*. I also ascertained the presence of such protuberances and bosses in the present species. These protuberances and bosses have been overlooked by several authors. Perhaps they existed in the species of this genus described earlier and did not deserve any special classification.

The caudal appendage is wanting and never indicated by bristles.

The penis is slender and shorter than half the total length of cirrus VI.

Distribution: Japan—earlier known from Misaki, Toba and Seto. On antipatharians.

Family Lepadidae (DARWIN) NILSSON-CANTELL

Genus *Lepas* LINNÉ

9. *Lepas anatifera* LINNÉ, 1767. (Figs. 2, 3A)

As several authors pointed out, the species of *Lepas* are very variable, so that it is often hard to distinguish them merely by an external examination of the shell, and only the number of filamentary appendages is constant in each species. Of *Lepas anatifera* the following three varieties are recognized:

- 1 *Lepas anatifera* var. *a* DARWIN (1851) which is synonymous with var. *punctata* GRUVEL (1905) and probably subsp. *indica* ANNANDALE (1909).
- 2 *Lepas anatifera* var. *b* DARWIN (1851) which is synonymous with *Anatifa dentata* BRUGUIÈRE (1789) and var. *dentata* GRUVEL (1905).
- 3 *Lepas anatifera* var. *testudinata* NILSSON-CANTELL (1928a) which is synonymous with *Lepas testudinata* AURIVILLIUS (1892), var. *c* JENNINGS (1915) and *Lepas affinis* BORRADAILE (1916).

The fourth variety, *nonfurcata*, which was first described by NILSSON-CANTELL (1927) was classified as a separate species by TARASOV (1935). So far as my experience goes, however, it is rather impossible to divide distinctly all my specimens into DARWIN's var. *a* and *b*, because the characteristics of these varieties given by him

are very variable and often common to each other. First, in var. *a*, according to DARWIN, "scuta and terga with one or more diagonal lines of dark greenish-brown, square, slightly depressed mark." However, such dark-colored stripes are often shown in forms with a dentated carina which are referable to var. *b*. The dentation of the carina is apparently a rather normal feature in some species of *Lepas*, such as *L. anatifera*, *L. anserifera*, and *L. pectinata*. In the latter two species such dentation, as well as the squamation of the valves, sometimes appears very strongly in the scutum and carina; these extreme variants may be regarded re-

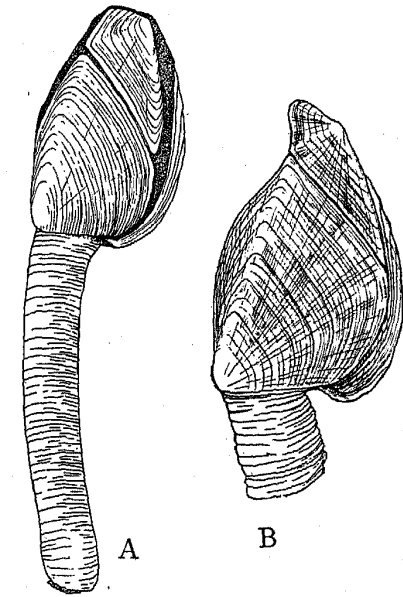


Fig. 2. *Lepas anatifera* LINNÉ.
A, smooth-valved form. $\times 1$. B, striated-valved form. $\times 1$.

spectively as *L. anserifera* var. *dilatata* (LEACH, 1818) and *L. pectinata* var. *squamosa* P. FISCHER, 1884. In the smooth-valved form, which is more abundant in Japanese waters, and perhaps in all oceans, than the form with striated valves, usually the apex of the capitulum is not projected but rounded, the dorsal roof of the carina is not very sharp, the peduncle tends to extend to a great length, and a rather wide interspace between the carina and scutum can be traced. All these characters seem to be worth calling distinctive characters, while the dark-colored stripes of the scutum and the dentation of the carina, which are rather typical of the form with striated valves, are sometimes seen in this smooth-valved form also.

In these respects the hitherto adopted classification as to varieties seems to be unsuitable. Therefore I propose to regard the smooth-valved form with the above-mentioned characters as a variety separated from the typical form with striated valves, and, if necessary, to name it var. *laevis*. This is synonymous with *Anatifa* (or *Anatifera* or *Pentalasmis* or *Pentalepas*) *laevis*, disused as a synonym of *Lepas anatifera* or *L. Hillii*. In external appearance the former

resembles closely *Lepas Hillii*, *L. australis* and the smooth-valved form of *L. anserifera* (cf. HOEK, 1883, Pl. I. fig. 1; GRUVEL, 1905, fig. 120; BROCH, 1924, fig. 15) (Fig. 2A), while the latter in its typical form approaches more the striated-valved form of *L. anserifera* and *L. pectinata* (cf. DARWIN, 1851, pl. I, fig. 1; GRUVEL, 1905, fig. 121; PILSBRY, 1907b, pl. IX, fig. 5) (Fig. 2B). In this sense DARWIN's var. *a* and *b* must on the whole be included in the latter form here described, but not as distinct varieties. In both forms, the umbonal tooth of the scutum is, as often mentioned by the authors, a variable character, but the filamentary appendages are typically two in number on each side for *L. anatifera*.

The other variety *testudinata*, which is first described by AURI-

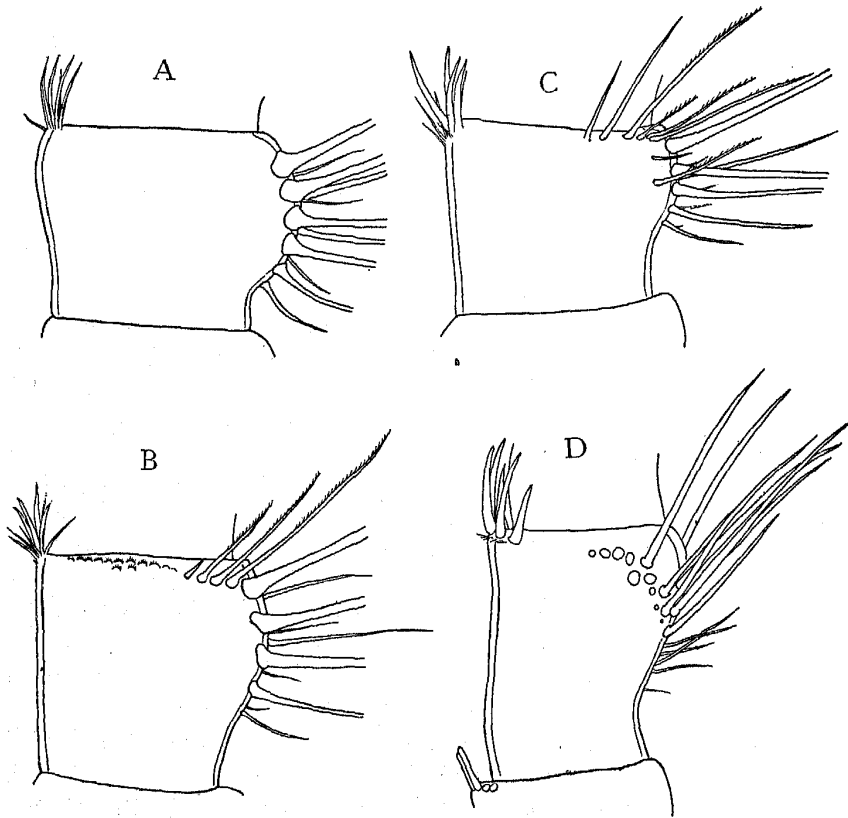


Fig. 3. Intermediate segment of cirrus III in the four species of *Lepas*. A, *Lepas anatifera*. B, *L. anserifera*. C, *L. pectinata*. D, *L. fascicularis*.

VILLIUS (1892) as a separate species and afterwards placed by NILSSON-CANTELL (1928) in *L. anatifera* as a local variety, has a close resemblance to the above-mentioned smooth-valved form, but it differs from the latter in respect of the above-mentioned characters and also in other points. Moreover, this variety is, according to NILSSON-CANTELL, rather restricted to the southern hemisphere, while the other forms are cosmopolitan.

Distribution: Cosmopolitan and pelagic on ships' bottoms, driftwood, buoys and other floating objects.

10. *Lepas anserifera* LINNÉ, 1767.
(Fig. 3B)

In the typical form of this species usually found on pumice stones, the capitulum is depressed and more or less widened relatively to its length; the valves are finely furrowed radially and the peduncle is very short. In the specimens attached to driftwood or floating algae, however, the striation on the valves is sometimes indistinct and sometimes even does not appear; the capitulum is more elongated and the peduncle is rather long; the whole shape thus approaches that of *L. anatifera* more than that of the typical *L. anserifera*. The similar appearance was described by DARWIN (1851), i. e. the specimens attached to light floating objects such as *Janthina* and *Spirula* (in the case of var. *dilatata* LEACH) differ from the common appearance of *L. anserifera* and approach *L. pectinata* which is usually on *Janthina* or *Spirula*. This fact proves that this species is externally very variable like other species of *Lepas*, and that the species of this genus in the same circumstances resemble one another. Despite such external resemblance, the umbonal tooth of the right scutum is not so strong as that of *L. anatifera* and is often reduced to a mere ridge; also the filamentary appendages are five or six in number on each side.

Lepas denticulata GRUVEL (1900) appears to be nothing but an extremely denticulated form of this species and is to be regarded as a variety, as suggested by NILSSON-CANTELL (1921); in this form the filamentary appendages number five, according to R. MACDONALD (1929), as in the typical form, though GRUVEL mentions them as being absent. This is undoubtedly due to its smaller size, namely 1~7 mm in length of capitulum, instead of being 10~30 mm as in the typical form. This variety, if distinct, must be named *L. anserifera* var. *dilatata* (LEACH), since it seems to be synonymous with

Pentalasmis dilatata LEACH (1818), judging by the descriptions given by DARWIN (1851) and by GRUVEL (1900, 1905).

In the vicinity of Seto, this species is usually found attached to pumice stones and rarely to driftwood or floating sea-weeds.

Distribution: Pelagic, chiefly in tropical and temperate seas.

11. *Lepas pectinata* SPENGLER, 1793.

(Fig. 3C)

This species is commonly found here on shells of *Janthina* and often on other light floating objects such as charcoal, pieces of cork, cuttle-fish bone and gulf weed (e. g. *Colpomenia sinuosa*).

Distribution: Pelagic and almost cosmopolitan, common in tropical and temperate seas.

12. *Lepas fascicularis* ELLIS et SOLANDER, 1786.

(Fig. 3D)

This species is not so common as the above-mentioned species in this district or on the other coasts of Japan. In April, 1933, I found only five small specimens of this species associated with four specimens of *L. pectinata* attached to a floating feather. They have five developed filamentary appendages on each side. The general appearance conforms well with the descriptions of DARWIN (1851) and of BROCH (1924). As DARWIN mentions, the frontal face of each segment in the cirri is covered by a thick brush of spines instead of having more or less distinctly arranged five or more pairs as in the other species, and the dorsal spines at the distal end are rather stronger than those in other species (Fig. 3). This chaetotaxy of the cirri reminds one somewhat of that of *Paralepas*, a subgenus of *Heteralepas*. Nobody seems to have taken into account that this feature, which accompanied externally by remarkable differences from the others, especially in respect to the position of the umbo, is interesting and rather important from the viewpoint of the phylogeny of the pedunculates. However, it is difficult to tell whether such a resemblance is due merely to a convergence or not. A thorough comparative and statistical examination of various characters is desirable, in order to have a basis for judging the affinities of the genus or species.

Distribution: Pelagic, chiefly in tropical and temperate seas.

Genus *Conchoderma* OLFERS

13. *Conchoderma auritum* (LINNÉ, 1767).

(Fig. 4)

Certain rich material at hand was taken from specimens of *Coronula diadema* attached to the skin of whales. They show much variation as regards the coloration. In younger specimens the six broad, somewhat indistinct, black bands can be traced, but in larger or older ones they become confluent or sometimes even disappear

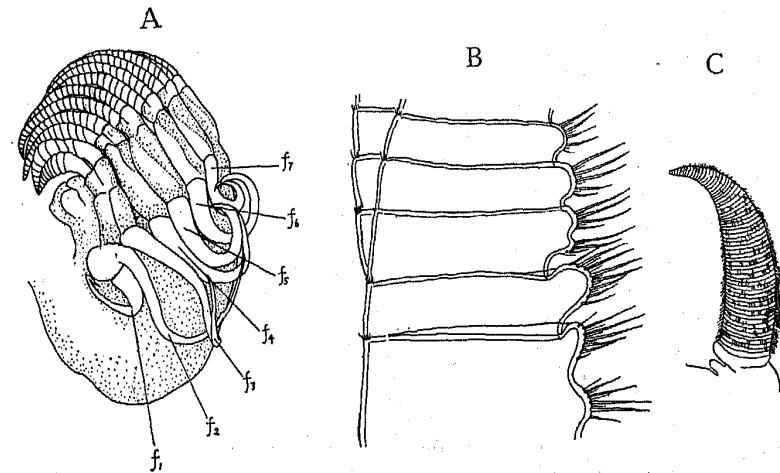


Fig. 4. *Conchoderma auritum* (LINNÉ).

A, lateral view of body showing seven filamentary appendages (f_1 - f_7). B, lower part of cirrus VI. C, penis.

altogether; those are thus uniformly greyish-brown or dark purple. Some of the specimens have a rudimentary tergum on each side of the apex, though the carina is mostly lacking. The largest specimen I have seen measures as follows: length of capitulum (excluding ear-like appendages) 40 mm, breadth of capitulum 25 mm, length of peduncle 70 mm, breadth of peduncle 18 mm.

It is of much interest to note that the penis of this species as well as that of the other whale barnacles is relatively short and stout, while in *Conchoderma virgatum* it is rather long as in the other lepadids. This fact appears to have been generally overlooked. However, our present knowledge is too meagre to decide whether the fertilization is effected as in those with a longer penis.

Distribution: Cosmopolitan and pelagic, usually on *Coronula* attached to whales.

14. *Conchoderma virgatum* (SPENGLER, 1790).
(Fig. 5)

This species has been found here attached to *Penella* taken from such fishes as *Mola mola*, *Makaira mitsukurii* and *Xiphias gladius*.

Distribution: Cosmopolitan and pelagic, usually on *Penella* and sometimes on ships' bottoms and driftwood.

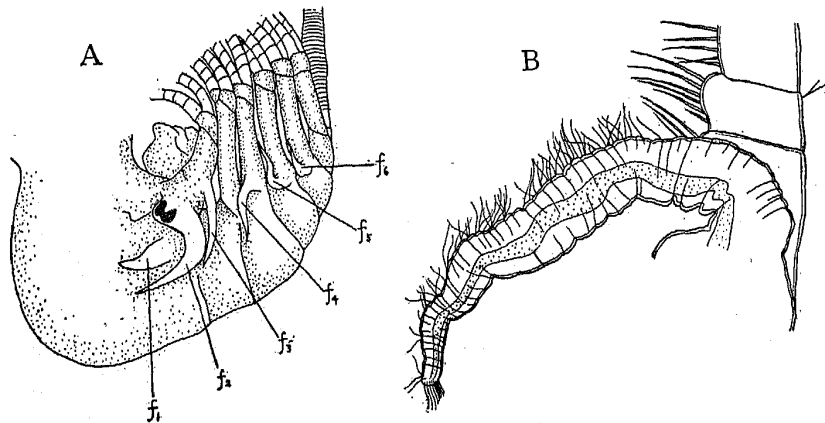


Fig. 5. *Conchoderma virgatum* (SPENGLER).

A, lateral view of body showing six filamentary appendages (f_1-f_6). B, penis.

15. *Conchoderma virgatum Hunteri* (R. OWEN, 1830).
(Fig. 6)

Cinerus Hunteri R. OWEN, 1830.

Conchoderma Hunteri DARWIN, 1851; WELTNER, 1897; STEBBING, 1900; BORRADAILE, 1903; GRUVEL, 1905.

Conchoderma virgatum var. *Hunteri* ANNANDALE, 1909; KRÜGER, 1911, 1912; BROCH, 1931.

Conchoderma virgatum var. *japonica* KRÜGER, 1911.

As regards the variabilities of *Conchoderma virgatum*, ANNANDALE (1909) says: "I do not consider it advisable to divide the species into subspecies or local races, it must be acknowledged that it is possible to distinguish several varieties which have a certain stability." It is rather uncertain whether this form *Hunteri* represents a distinct subspecies or variety, or nothing but a younger stage of the typical form. Indeed, there often appear specimens with

an appearance characteristic of this *Hunteri* in developmental stages of the typical form, so that it seems hardly defensible to separate this form from the latter (cf. BROCH, 1924, fig. 20b; NILSSON-CANTELL, 1928a, fig. 7). Most of the specimens of this form described by the authors referred to are small as compared with the typical form. For example, the specimens described by BROCH (1931) as forma *Hunteri* measured as follows: Length of capitulum 16-18 mm, length of peduncle 3-7 mm, and according to him, "they were found attached to a rope which had been in the water only 5 weeks."

All of the specimens I examined are likewise small; of these the largest one measures in mm as follows:

	Capitulum	Peduncle
Length	10	5
Breadth	6.5	3

The characteristics, by which it can be distinguished from the typical form, agree with DARWIN's description as a whole, though not closely. The scutum is slender and trilobed; the lateral lobe, which, according to DARWIN, is not wider than the lower, is as wide as the lower. The lateral lobe is rarely the widest and the upper lobe the narrowest and is sharply pointed, much like that of var. *japonica* KRÜGER (1911). The tergum is bent near the apex like a spoon; its carinal end, when viewed from the lateral side, is always situated inside separated widely from the carinal margin of the body. The carina is not concave at the upper end, but considerably arched at the umbo of which the position is slightly variable, although subcentral. The carinal side of the capitulum is evenly curved without any prominence. The peduncle is short, blending into the capitulum. The color is variable, some being uniformly dark purplish

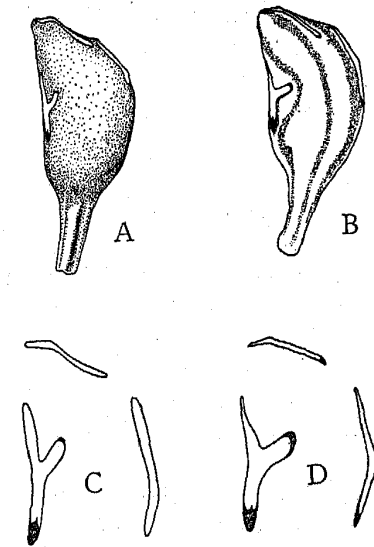


Fig. 6. *Conchoderma virgatum Hunteri* (R. OWEN).

A, dark-colored specimen. $\times 2.5$. B, specimen with distinct black bands. $\times 2.5$. C, valves of specimen shown in A. D, valves of specimen shown in B.

brown as in var. *japonica*, others with the six bands colored alike as in the typical form. The resemblance of these characters makes it hard to separate var. *japonica* from this *Hunteri*.

The internal parts are not different from those of the typical form, especially as regards the absence of the filamentary appendage at the base of cirrus II and the four-stepped lower frontal edge of maxilla I, which both are internal characteristics of *C. virgatum*.

Apart from the above-mentioned departures from the typical form, its habitat may be of interest. From the literature on the subject we know that this form has never been taken from *Penella*. It is usually found attached to a sea snake *Pelamidrus* (formerly *Hydrus*, *Hydrophis* or *Pelamis*) *platurus*, and often to a decapod *Neptunus pelagicus*. KRÜGER's var. *japonica* is from *Heteralepas* (*Heteralepas*) *japonica*. The specimens found in this district are all taken from the skin of sea snakes, such as *Pelamidrus platurus* and *Disteira spiralis melanocephala*. These differences may warrant the establishment of at least a subspecies for this form distinct from the typical *C. virgatum*.

Distribution: This form has a rather limited distribution. Authentic records are only from the Indian Ocean, Malay Archipelago and Japan.

Genus *Alepas* SANDER RANG

16. *Alepas pacifica* PILSBRY, 1907.

(Fig. 7)

Alepas pacifica PILSBRY, 1907b; NILSSON-CANTELL, 1921, 1925, 1934a.

Alepas investigatoris ANNANDALE, 1914.

This species is represented here by rich material from young to old. To the previous descriptions, especially that of NILSSON-CANTELL (1921), not much need be added. Some remarks regarding the present material, however, may be necessary.

All the specimens have a translucent and gelatinous integument. Inside the integument there is no muscular layer in the capitulum, except the rather powerful adductor muscle connecting the scuta of both sides and the simple layer running into the prosoma. The peduncle is lined within by three muscle layers, as in all the other pedunculates. The scutum is usually present, imperfectly calcified and trilobed; the end of the lobes sometimes diverges obscurely as mentioned by PILSBRY. The filamentary appendages, according to NILSSON-CANTELL (1925) and ANNANDALE (1914), number five at the

base of the cirri except the second and sixth on each side. However, there are truly six on each side, since besides one, which is small in younger specimens, is seated on the prosoma below the first cirrus, as in *Conchoderma virgatum* (Fig. 7). I wonder how both authors had overlooked the presence of a filamentary appendage on the prosoma.

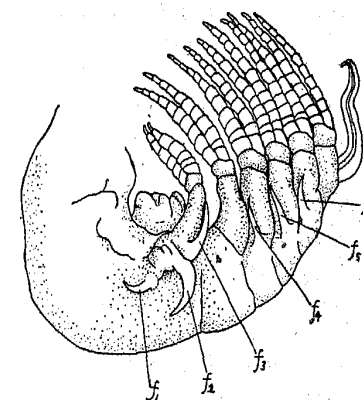


Fig. 7. *Alepas pacifica* PILSBRY.
Lateral view of body showing six filamentary appendages (f_1 - f_6).

In addition to this species, PILSBRY (1912) recorded two other species, i. e. *A. navigator* and *A. spectrum*, from Nogas

Point, Panay in the Philippine waters. However, it is difficult to recognize any specifically distinct characters between them from his brief account without any figure. Detailed descriptions of them are much to be desired.

As regards the host medusae, previous authors have given no exact name. At least around the Japanese coast, this species is commonly situated on the umbrella or the oral arms of the scyphomedusae, such as *Pelagia panopyra* PÉRON et LESUEUR and *Cyanea nozakii* KISHINOUE, and rarely *Cephea cephea* (FORSKÅL). So far as my experience goes, the host available for the attachment of *Alepas* seems to be limited to the above medusae.

The largest specimen I have seen measures in mm as follows:

Capitulum		Orifice	Peduncle	
Length	Breadth	Length	Length	Breadth
53	33	32	24	11

The peduncle is always shorter than the capitulum, at least in all the specimens more than one hundred I have examined.

Distribution: Pacific, Indian and South Atlantic, on medusae. Probably distributed widely in tropical and temperate seas.

Family **Heteralepadidae** NILSSON-CANTELLGenus **Heteralepas** PILSBRY17. *Heteralepas (Heteralepas) japonica* (AURIVILLIUS, 1892).

Syn. NILSSON-CANTELL, 1927.

This species is found in abundance in the deep waters of Sagami Bay. In waters around this Laboratory, however, it is usually found attached to the carapace or legs of *Macrocheira Kaempferi* (DE HAAN). It was also collected off Gobô near Seto by the Sôyô-maru Expedition (HIRO, 1933a).

Distribution: Japan and Indomalayan waters. Depth 48-500 m.

18. *Heteralepas (Heteralepas) quadrata* (AURIVILLIUS, 1894).

Alepas quadrata AURIVILLIUS, 1894; WELTNER, 1897; GRUVEL, 1905.

Heteralepas (Heteralepas) quadrata KRÜGER, 1911, 1912; NILSSON-CANTELL, 1921: HIRO, 1932a.

Heteralepas (Heteralepas) percnicola HIRO, 1931.

This is one of the commonest species in Japan and beautifully colored, as mentioned by AURIVILLIUS (1894) and HIRO (1931, 1932a). In the species of the subgenus *Heteralepas*, the inner ramus of the fifth and sixth cirri on the whole tends to be reduced in both size and length, though there are individual variations. In this species, however, the difference between the inner and outer rami is not so remarkable as in the other species. For comparison the measurements in three specimens are given below:

Size	I		II		III		IV		V		VI		Caudal appendage
total length 7mm	7	8	14	14	15	15	14	15	15	14	14	14	8
"	10	10	16	17	14	18	19	18	18	15	17	17	9
"	10	10	11	16	16	18	16	17	21	16	16	10	7

A full discussion concerning *Heteralepas (Heteralepas) percnicola*, which is synonymous with this species, was given earlier (HIRO, 1932a).

Specimens from Seto were found attached to the following hosts: *Panulirus japonicus* (v. SIEBOLD), *Scyllarus haani* v. SIEBOLD, *Scyllarus sieboldi* DE HAAN, *Dromidiopsis dromia* (LINNÉ), *Macrocheira kaempferi* (DE HAAN), *Schizophrys aspera* M.-EDW., *Thalamita prymna* (HERBST), *Acanthodes armatus* DE HAAN, *Plagusia dentipes* DE HAAN, *Percnon planissimum* (HERBST) (= *P. tenuifrons*), etc.

Distribution: Japan, Java Sea, (?) California coast, on crabs and lobsters. Depth 0-150 m.

Family **Malacolepadidae** n. fam.

As I have pointed out in my earlier paper (HIRO, 1933b), *Malacolepas conchicola* shows a somewhat close relationship with the Trilasmidae as regards its internal structure. However, it seems not quite natural to place it in the group of Trilasmidae, because it has some important characteristics which are never seen in any forms of the latter group. The Trilasmidae (formerly as Poecilasmidae) is now represented by *Trilasmis* (including *Trilasmis* s. str., *Poecilasma* and *Temnaspis*), *Octolasmis* and *Megalasma* (including *Megalasma* s. str. and *Glyptelasma*). These genera and subgenera are closely related to one another, so that we find a difficulty both externally and internally in drawing exact limits between the genera and subgenera, from the morphological view-point. On the other hand the superficial likeness of its external characters to those of *Heteralepas* and *Alepas* rather favors a relation between these genera. However, it is impossible at present to say that *Malacolepas* shows an intermingling of characters from the Trilasmidae and Heteralepadidae, or the Lepadidae. Therefore, it is better to establish a new family for this genus as a separate group, disregarding the problem of the phylogenetical tree.

For this new family I give the following definition:

Hermaphrodite. Integument of capitulum very thin, without internal muscle layers. Valves reduced. Peduncle short, blending into the capitulum. Palpus conical. Mandible with 6 or 7 teeth; lower edge of each tooth not pectinated. Maxilla I with long spines of almost similar length on a rather straight frontal edge. Maxilla II quadrangular with bristles along the whole edge. Filamentary and caudal appendages absent.

Genus **Malacolepas** HIRO19. *Malacolepas conchicola* HIRO, 1933.

Malacolepas conchicola HIRO, 1933b.

This curious cirriped was described fully by HIRO (1933b), the description being based on several specimens from Seto and Misaki, so that nothing need be added here. The specimens from Seto were attached to the inside of the shell of a mussel, *Cucullaea labiata granulosa* (JONAS). Its occurrence induces abnormally the gall-like accumulation of the calcareous substance of the host around the attachment-area of the cirriped.

Family *Trilasmatidae* (ANNANDALE) NILSSON-CANTELLGenus *Trilasmis* (HINDS) PILSBRYSubgenus *Poecilasma* DARWIN20. *Trilasmis (Poecilasma) Kaempferi* (DARWIN, 1851).

Syn. NILSSON-CANTELL, 1921.

This well-known species is one of the commonest forms in the Japanese waters. It is usually attached to the carapace and legs of *Macrocheira Kaempferi* (DE HAAN) from deep water.

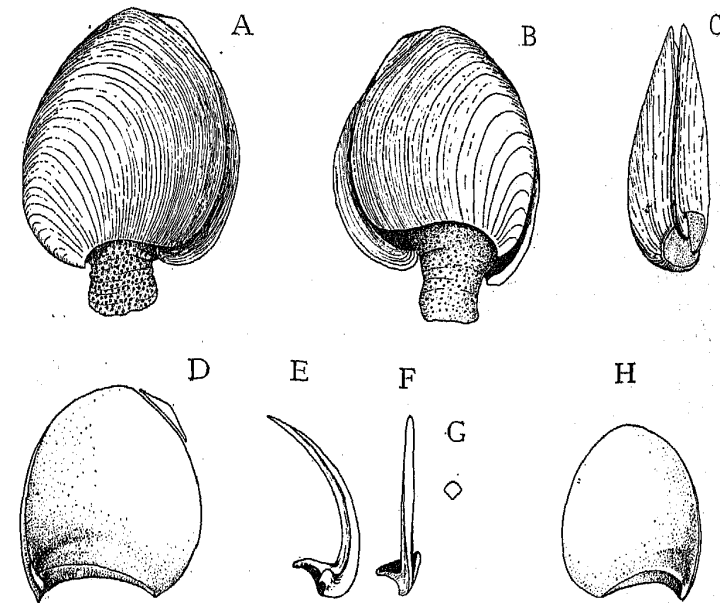
Distribution: Pacific, Indian and Atlantic Oceans, usually on decapods. Depth 19–1811 m.

21. *Trilasmis (Poecilasma) obliqua* (HOEK, 1907).
(Figs. 8, 9)*Poecilasma obliquum* HOEK, 1907.

This peculiar species was first described by HOEK (1907) on specimens taken from the south of Kur and Taam Islands, Malay Archipelago at a depth of 204–304 m. Concerning the habitat HOEK gave no statement, but judging from the fact that it was reported from the same station as that of *Trilasmis (Poecilasma) Kaempferi* (written as *Poecilasma dwivium* HOEK), it was taken probably from crabs. The present specimens attached to the maxillipeds of *Macrocheira Kaempferi* (DE HAAN) agree well with HOEK's description of this species. I have obtained 12 large specimens from a crab.

The valves on the capitulum are very peculiar in shape and always asymmetrical on both sides. The scutum, occupying almost the whole surface of the capitulum, is very thick, broad and rounded in outline. Of the 12 specimens I have examined, 8 have the right valve larger than the left, while in the remaining 4 the right is smaller. Similar feature, though not so remarkable as in this species, may be observed in the above-mentioned *Trilasmis (Poecilasma) Kaempferi*, as noted in my previous paper (HIRO, 1933a). In both of them, the occludent margin of the larger scutum is turned sharply inward, so that the smaller one on the opposite side is completely enveloped by the larger one. The basal margin of the larger scutum is wholly visible from the side of the smaller one, the latter being shorter than the former.

The tergum is triangular and quite rudimentary, so that it may

Fig. 8. *Trilasmis (Poecilasma) obliqua* (HOEK).

A, large specimen viewed from the side of larger scutum. $\times 3$. B, the same, viewed from the side of smaller scutum. C, carinal view of capitulum of the same. D, internal view of larger scutum with a rudiment of tergum. E, lateral view of carina. F, dorsal view of carina. G, cross-section of carina. H, internal view of smaller scutum.

give one the impression of being entirely absent at first sight. In this respect this species approaches *Trilasmis (Poecilasma) crassa* (GRAY), with which PILSBRY's *Poecilasma inaequilaterale breve* is, according to BARNARD (1924), identical, and even *Trilasmis eburnea* HINDS.

The carina is comparatively short, forking downwards. The forked preumbonal part is always curved towards the side of the smaller scutum and imbedded between the capitulum and peduncle. The postumbonal part is strongly arched and forms a prominent keel which is rather sharp on the inside and somewhat rounded on the outside.

The peduncle is very short, and its entire surface is studded with numerous, minute chitinous dots—a feature not mentioned originally by HOEK. The integument of the peduncle is white, but that of the capitulum is lemon yellow.

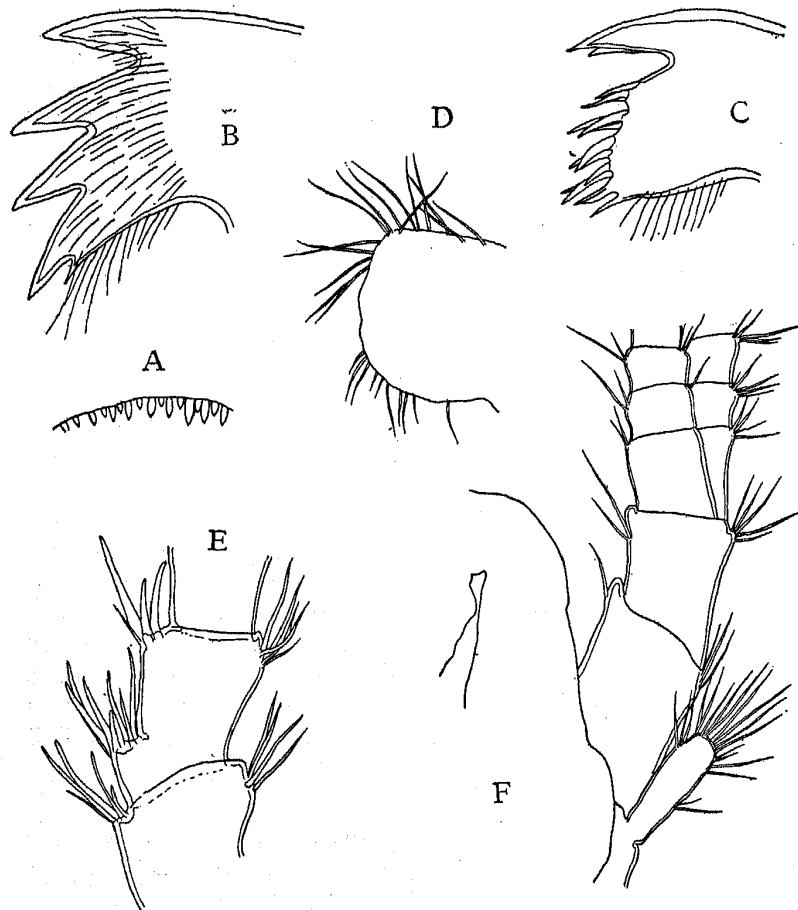


Fig. 9. *Trilasmis (Poecilasma) obliqua* (HOEK).

A, arrangement of teeth in labrum. B, mandible. C, maxilla I. D, maxilla II. E, abnormally coalesced segment found in cirrus IV. F, lower part of cirrus VI with caudal appendage.

Measurements of some specimens in mm :

Length of capitulum	11.25	9.3	7.0	5.3	4.8	4.6
Breadth of capitulum	9.35	7.0	5.4	4.2	3.6	3.6
Thickness of capitulum	4.8	4.2	3.2	2.5	2.3	2.0
Length of peduncle	3.2	—	3.2	3.0	1.8	1.5
Breadth of peduncle	2.5	—	2.0	1.8	1.8	1.5

The mouth-parts agree with the description by HOEK, except that the lower margin of teeth of the mandible is not pectinated.

Concerning the cirri, HOEK writes: "Cirri, short, very unequal, more or less rudimentary. The cirri of the right side (the side of the smaller scutum in his specimen) as a rule smaller than those of the left side (the side of the larger scutum)." Does the asymmetry of the valves affect the cirri of both sides, as he says? To clear up this question two specimens of different types are dissected here. However, a crucial examination of these specimens has made it clear that the external and internal characters are quite indifferent in respect to the matter of asymmetry. In this connection it may be remembered that in the group of *Verruca* the asymmetry of the valves is a normal and characteristic feature, but their internal characters are always symmetrical on both sides. The numbers of segments of the cirri in the dissected specimens (A and B) are as follows:

Sp.	Length of scutum	I	II	III	IV	V	VI
A	Left hand—4.2mm	8	7 10	8 13	11 14	13 14	13 14 11
	Right hand—5mm	7	7 10	8 12	10 14	11 12	14 12 12
B	Left hand—4.3mm	8	7 10	10 10	7 12	13 10	7 10 10
	Right hand—3.7mm	7	6 10	8 12	10 11	11 12	12 10 9

In both the specimens, the posterior (inner) ramus is as a rule reduced in length as compared with the anterior (outer) ramus in all the cirri of both sides. Such a feature is rather common throughout the species of *Trilasmidae* and *Heteralepadidae*. All the cirri on both sides are rather symmetrical as regards length and size. The right-hand cirrus VI in specimen A and the left-hand cirrus V and the right-hand cirrus VI in specimen B are somewhat shorter and more slender, compared with the adjoining cirri. But these reduced cirri are not only on the side of the smaller valve but also on the side of the larger one. In cirrus I, the protopodite is longer than the rami and the proximal segment of the former is about three times as long as the distal segment. In cirrus II the protopodite and rami are subequal in length. The rami of the remaining cirri are generally a little longer than the protopodite.

As regards the systematic position of this species, HOEK's note may be cited: "The new species *obliquum* with its quite rudimentary terga bridges the cleft which separates *P. crassum* with small terga and *P. eburneum* with no terga whatever." Thus, so far as the presence or absence of the terga is concerned, it is impossible to make an exact generic, or rather subgeneric, distinction between *Trilasmis* and *Poecilasma*. Internally, however, especially in the armature of the cirri, it appears to be most closely related to *Trilasmis*

(*Temnaspis*) *fissa* (DARWIN) and *T. (T.) amygdalum* (AURIVILLIUS) (vide infra). On this point I can not follow KRÜGER (1911, p. 39) and BROCH (1931, p. 128)—the former placing this species under the subgenus *Trilasmis* and the latter under the subgenus *Temnaspis*. In the presence of the terga and undivided scuta, this species must be placed as before in the subgenus *Poecilasma*.

Subgenus *Temnaspis* P. FISCHER

22. *Trilasmis (Temnaspis) excavatum* (HOEK, 1907).

Poecilasma excavatum HOEK, 1907.

Poecilasma (Temnaspis) excavatum NILSSON-CANTELL, 1925.

Temnaspis excavatum BROCH, 1931.

Two well-grown specimens taken from the maxillipeds of *Macrocheira Kaempferi* (DE HAAN), which was from deep water off Seto, were associated with the above-described *Trilasmis (Poecilasma) obliqua* (HOEK). The measurements of a typical specimen are: length of capitulum 5.5 mm, breadth of capitulum 3.3 mm, length of peduncle 2.2 mm, and breadth of peduncle 1.3 mm. This species is easily separated from *Trilasmis (Temnaspis) amygdalum* (AURIVILLIUS) by the external appearance, especially in the short and swollen peduncle and the capitulum, which is not so oval in shape. For descriptions I refer to those earlier given by HOEK (1907) and NILSSON-CANTELL (1925).

Distribution: Malay and Philippine Archipelagoes, Gotô Islands (S. Japan), on crabs and rarely on cirripeds. Depth 200–400 m.

23. *Trilasmis (Temnaspis) amygdalum* (AURIVILLIUS, 1894).
(Figs. 10, 11)

Syn. NILSSON-CANTELL, 1921.

NILSSON-CANTELL (1921) emphasized that DARWIN'S *Poecilasma fissa* is not identical with AURIVILLIUS' *P. amygdalum*, and he accordingly divided the specimens which had been identified by earlier authors as *P. fissum* into *Trilasmis (Temnaspis) lenticula*, *T. (T.) amygdalum* and *T. (T.) vagans*. The present specimens to be described here have closer resemblances to *T. (T.) amygdalum* both externally and internally, irrespective of his opinion.

Concerning the structure of this species, there is not much to add to the descriptions by AURIVILLIUS (1894) and NILSSON-CANTELL (1921). NILSSON-CANTELL described the specimen from Madagascar

as a subspecies of this species under the name, *P. amygdalum madagascariense*. In this subspecies, according to him, "Bei den zahlreichen untersuchten Exemplaren war diese kräftig, die Zähne sassen dicht und gingen an der Basis ineinander über. Die Hauptform konnte zwar auch recht kräftige Zähne haben, doch waren diese stets spärlich, voreinander weit entfernt." In this respect, the present specimen approaches more closely to his *madagascariense* than the typical form. However I think this character to be of less significance, because it is a variable character which mainly depends on age. Besides there is in my opinion every possibility that *T. fissum hawaiense* PILSBRY (1928) is synonymous with this species.

The present specimens were taken from *Panulirus japonicus* (VON SIEBOLD), *Dromidiopsis dromia* (LINNÉ) and other crabs caught by fishing nets in the vicinity of Seto. Of these the largest one measures as follows: length of capitulum 4.3 mm, breadth of capitulum 3.2 mm, length of peduncle 3.7 mm and breadth of peduncle 1 mm.

Distribution: Malay Archipelago and Japan, on decapods. Probably distributed widely in the Indo-pacific.

Genus *Octolasmis* GRAY

24. *Octolasmis clavula* HIRO, 1936.

Several specimens were found on the maxillipeds of a crab *Acanthodes armatus* DE HAAN at Seto. Concerning the structure of this species, a detailed description has already been given (HIRO, 1936d).

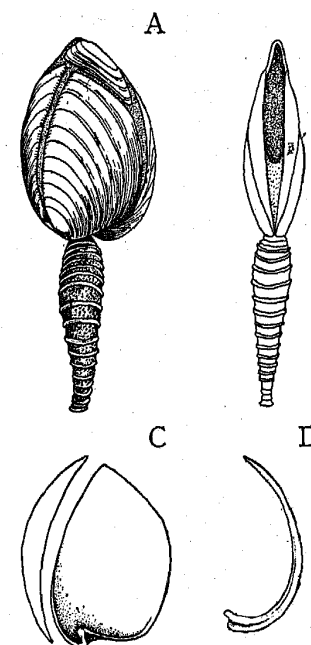


Fig. 10. *Trilasmis (Temnaspis) amygdalum* (AURIVILLIUS).

A, lateral view of specimen. $\times 7$.
B, rostral view of the same. $\times 7$.
C, internal view of scutum divided into two parts. D, carina.

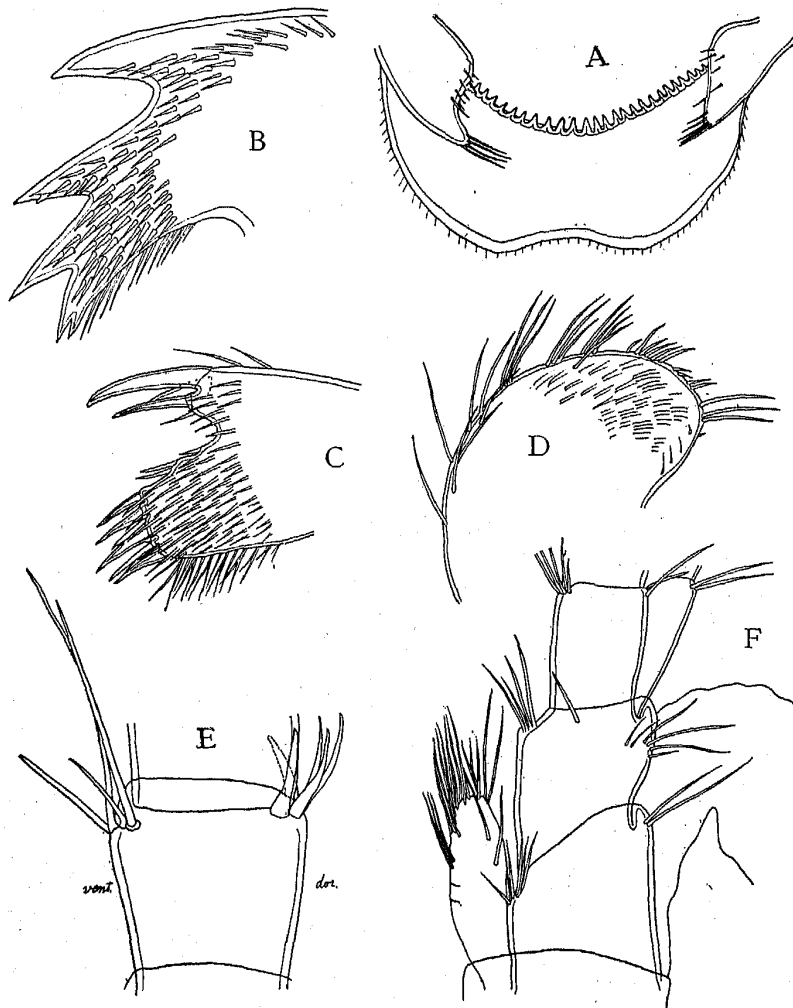


Fig. 11. *Trilasmis (Temnaspis) amygdalum* (AURIVILLIUS).
A, labrum and palpi. B, mandible. C, maxilla I. D, maxilla II. E, intermediate segment of cirrus VI. F, lower part of cirrus VI with caudal appendage.

25. *Octolasmis Nierstraszi* (HOEK, 1907).

Dichelaspis Nierstraszi HOEK, 1907.

Octolasmis Nierstraszi NILSSON-CANTELL, 1921, 1927, 1934a, 1934b; BROCH, 1931.

A single specimen was found attached to a stem of an hydroid from Tanabe Bay at a depth of ca. 24 m. It measures: length of

capitulum 3 mm, breadth of capitulum 1.7 mm, length of peduncle 0.8 mm, and breadth of peduncle 0.5 mm.

Distribution: Malay Archipelago, Pelsian Gulf, Japan (Ogasawara Is.), usually on bottom animals. Depth 16-135 m.

26. *Octolasmis orthogonia* (DARWIN, 1851).

Syn. HIRO, 1933a.

Several small specimens were found attached to hydroids taken from Tanabe Bay, associated with *Octolasmis Nierstraszi*.

Distribution: Malay Archipelago, Japan, East African coast, usually on hydroids. Depth 18-818 m.

27. *Octolasmis Weberi pennatulae* n. subsp.

(Fig. 12)

Octolasmis Weberi KRÜGER, 1911.

Octolasmis orthogonia BROCH, 1922, 1931 (in part).

It is rather difficult to say whether *Octolasmis Weberi* (HOEK, 1907) is exactly identical with *O. orthogonia* or not. NILSSON-CANTELL (1928a) assigned both species to a single species, an opinion which was followed by BROCH (1931). However, as a result of my study on the cirripeds obtained by the survey of the continental shelf bordering Japan, I found some distinctive characters between the two species and therefore preferred to keep *O. Weberi* as a separate species (HIRO, 1933a). A revised examination based on the new material is given below.

As earlier pointed out by HOEK (1907) and HIRO (1933a), the typical form of *O. Weberi* differs from *O. orthogonia* in its size, the shape of the tergum and the basal disc of the carina. First, the size of the

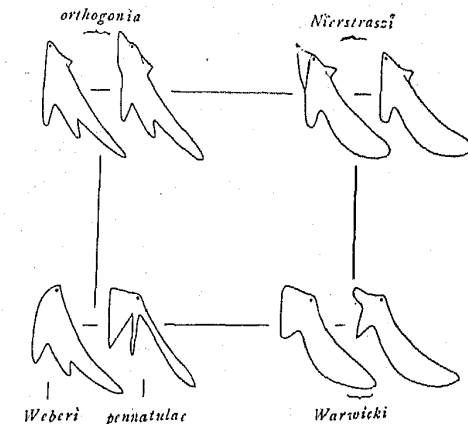


Fig. 12. Diagram showing the affinities between *Octolasmis orthogonia*, *O. Weberi*, *O. Weberi pennatulae*, *O. Nierstraszi* and *O. Warwicki* as regards the shape of the tergum. The point in each tergum indicates the position of umbo.

former species usually exceeds that of the latter. For comparison, the measurements in mm given by several authors may here be cited:

Species	Length of capitulum	Breadth of capitulum	Length of peduncle	Breadth of peduncle	Authors
<i>O. Weberi</i>	10-12	—	3-4	—	HOEK (1907)
	15	9	8	—	BARNARD (1924)
	9	5.5	3.5	5	HIRO (1933a)
	7	5	3	2.5	"
<i>O. orthogonia</i>	5.08	—	—	—	DARWIN (1851)
	6.6	—	1.6	—	HOEK (1907)
	7	4	2	—	WELTNER (1922)
	7	3.2	2	1	NILSSON-CANTELL (1925)
	4	2.1	1.7	1	"
	5	3	1.2	1	HIRO (1933a)

Probably *O. orthogonia* does not grow to a great size. The tergum is variable in shape, as is often the case in other species of this genus. In *O. Weberi*, the basal margin of the tergum is more or less trilobate, somewhat like that of younger specimens of *O. orthogonia*, but not so deeply notched as in that of older specimens of the latter species. In the typical form of *O. Weberi*, contrary to what we see in *O. orthogonia*, the shape of the tergum appears to be rather constant from young to old.

In this connection it is necessary to note the fact that the specimens which were identified by KRÜGER as *O. Weberi* (cf. KRÜGER, 1911, pp. 42-43, Taf. III, Fig. 27) and those made by BROCH as *O. orthogonia* (cf. BROCH, 1931, pp. 38-40, fig. 14a) offer quite a different

Length of capitulum	Breadth of capitulum	Length of peduncle	Breadth of peduncle	Authors
9	6	4	3.5	KRÜGER (1911) ¹⁾
13-9	7-4	6.5-3	—	BROCH (1922)
14	—	6	—	BROCH (1931)
9	5.5	3	2	Sp. from Seto
10.5	6.5	4	3	Sp. from Kumano-nada ²⁾
14	9	11	4	"
16	10	7	5	"

1) Measured from a photograph given in BALSS, H.: Japanische Pennatuliden. Abh. d. math.-phys. K. bayer. Akad. d. Wiss. I. Suppl.-Bd. 10. Abh. 1910, Taf. I, Fig. 8.

2) These three specimens were sent me for identification by Mr. Isao TAKI of the Tokyo Imperial University, to whom my hearty thanks are due.

feature as regards the calcification of the tergum. The specimen dealt with here from Seto shows a similar appearance too. In these specimens the notches between each three basal prominences are definitely deep, so that the prominences are long and narrow. This peculiar form is mostly larger than the typical *O. Weberi* and much more so than *O. orthogonia*, as shown in the measurements in mm given above.

BROCH (1931, p. 38) pointed out for the specimen from Amboina Bay that "it represents the last step of a development indicated in most larger specimens." However, it seems no more likely that this peculiar tergum has been developed from the tergum, as seen in *O. orthogonia*, than that the tergum of *O. Warwicki* has been derived from the tergum, as seen in the allied *O. Nierstraszi*. Usually the occludent margin of the tergum is straight in *O. orthogonia* and a little convex in *O. Weberi*. However, in exceptional cases a small occludent or apical projection is present on the upper half of the same margin, as figured by DARWIN (1851, pl. 2, fig. 10) and HOEK (1907, pl. 3, fig. 1b). Such case is fairly common in *O. orthogonia* as well as in *O. Nierstraszi* (cf. HOEK, 1907, pl. 2, figs. 3b, 4b), but it is not seen in *O. Weberi*. However, in the peculiar type here described, the occludent part always forms a large triangular plate, so that the apical margin above the umbo and the occludent margin, which are both straight, meet at a right angle as in that of *O. Warwicki*. Moreover, the small projection on the carinal side situated above the apex of the carina, which is developed in *O. orthogonia*, is absent in *O. Weberi* and also in the peculiar form here described. Such a carinal projection is developed in *O. Nierstraszi*, but is lacking in *O. Warwicki*. At any rate the tergum is very variable in all the species of this genus, some of them showing a superficial resemblance according to the degree of decalcification of the valve, e. g. between *O. orthogonia* and *O. Weberi*, and also between *O. Nierstraszi* and *O. Warwicki*. However, as regards the above-mentioned characters, the tergum of *O. Weberi* together with the peculiar form here described seems to be most nearly related to that of *O. Warwicki*, just as that of *O. orthogonia* is most closely related to that of *O. Nierstraszi*. The relation between them may be fairly illustrated in Fig. 12. Furthermore, the carina of this peculiar form shows apparently a more or less intermediate stage between those of the typical forms of *O. Weberi* and *O. orthogonia*.

Lastly, we must take into consideration the habitat of these allied

forms. Both the species *O. orthogonia* and *O. Weberi* have hitherto been known from deep water (the former from a depth of 18–818 m and the latter from a depth of 137–560 m), and have usually been found on bottom animals such as hydroids and gorgonarians. I have obtained a specimen of *O. orthogonia* in Sagami Bay at a depth of ca. 502 m. However, all the specimens belonging to the above-mentioned peculiar type have hitherto been found attached to the stem of pennatulids occurring in shallower water; that is, the specimen described by KRÜGER (1911) as *O. Weberi* was obtained from *Virgularia (Halisceptrum) abies* KÖLLIKER, as well as that described by BROCH (1922) as *O. orthogonia* from *Virgularia* sp. and also that described by BROCH (1931) from *Pennatula* sp. The present specimen here described was, as in the case of KRÜGER, attached to *Virgularia (Halisceptrum) abies* KÖLLIKER taken from 10–30 m deep in Tanabe Bay. It is thus a shallow water form.

To summarize, all of the specimens mentioned above show such similarities as regards their structure and habit, that there seems to be no question that they belong to the same form. However it is a question whether they represent an aberrant form of *O. Weberi*, or a distinct species. The most important difference, as regards these allied species, lies in the tergum. That is to say, the carino-basal projection is long and narrow, but slightly widened toward the end. The median basal projection is equally narrow throughout. However it approaches *O. Weberi* than *O. orthogonia* in respect to its size, in the absence of a carinal projection in the tergum and in the carina forming a somewhat spatulate disc. Therefore, from our present knowledge it seems suitable to refer it to the former species as a subspecies *O. Weberi pennatulae*.

Distribution: Formerly recorded from Japan (Sagami Bay, in 20 m deep), Malay Archipelago (Cebu, at low tide; Amboina Bay, in 2 m deep). Attached to the stem of pennatulids.

28. *Octolasmis Grayi* (DARWIN, 1851).

Syn. NILSSON-CANTELL, 1930b.

Several specimens were found on a sea-snake, *Pelamydrus platurus* (LINNÉ), a host earlier noted by the authors. As regards the structure of this species, full descriptions have already been given by ANNANDALE (1909) and NILSSON-CANTELL (1930b), so that no further statements are needed.

Distribution: Tropical Indian and Pacific Oceans. Pelagic on sea snakes.

29. *Octolasmis Aymonini* (LESSONA et TAPPARONE-CANEFRI, 1874).
(Figs. 13, 14)

Dichelaspis Aymonini LESSONA et TAPPARONE-CANEFRI, 1874; WELTNER, 1897; GRUVEL, 1905.

Octolasmis Aymonini KRÜGER, 1911.

Dichelaspis (Octolasmis) trigona WELTNER, 1922 (not AURIVILLIUS, 1894).

This species is always found in the branchial cavity of *Macrocheira Kaempferi* (DE HAAN), as also found by the above authors. So far as my experience goes, a number of specimens of *Macrocheira* caught in this district are always infested by this cirriped. Usually it is represented by three hundred to a thousand individuals in a single crab.

NILSSON-CANTELL (1927) announced that *O. Loweii* (DARWIN, 1851), *O. Darwini* (DE FILIPPI, 1861), *O. neptuni* (MACDONALD, J. D., 1869), *O. Aymonini* (LESSONA, 1874), *O. sinuata* (AURIVILLIUS, 1894), *O. trigona* (AURIVILLIUS, 1894), *O. Mülleri* (COKER, 1902), *O. Vaillanti* (GRUVEL, 1902b) and probably *O. geryonophila* PILSBRY, 1907b may possibly be synonymous, and classified them as *O. Loweii* (DARWIN). He says that "This species would then be cosmopolitan. It is then tempting to assume that we have to do with local races." He further states that "The differences between the species, chiefly limited to the strongly reduced shape of the plates, or the animals seem insignificant." So far as the external characters are concerned, his view seems to be quite natural, because there are great individual variations according to the degree of calcification or decalcification of the plates. However, at least in the case of *O. Aymonini*, I cannot follow him, as described below.

When the previous descriptions of *O. Aymonini*, e. g. KRÜGER's (1911) are carefully compared with those of the above-mentioned allied forms, one may find some differences, especially in the internal characters. By a comparison between rich material found on the gills of *Macrocheira Kaempferi* from Seto and those found on the gills of *Neptunus trituberculatus* (MIERS) from Mutsu Bay, in northern Japan, I could find several remarkable, and even important, differences between them both as regards their external and internal characters. All the specimens on the former crab correspond well with *O. Aymonini* (Fig. 13A–C), while those on the latter show close resemblance

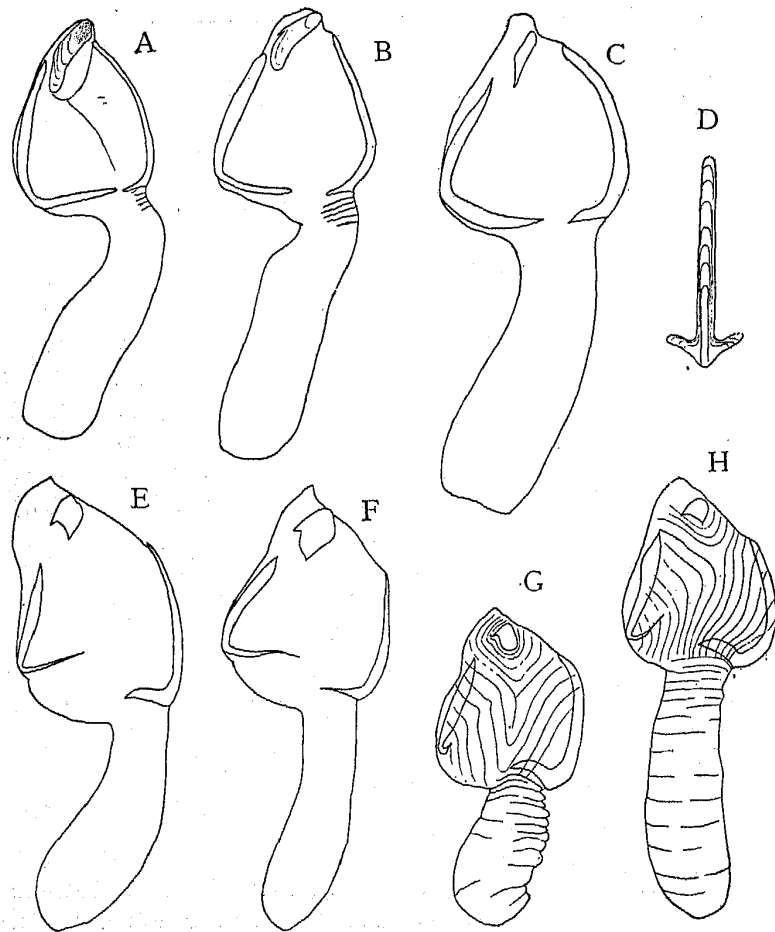


Fig. 13. A, B, C, D, *Octolasmis Aymonini* (LESSONA, etc.).

E, F, G, H, *Octolasmis Lowei* (DARWIN).

A, B, C, specimens from gills of *Macrocheira Kaempferi*. $\times 4$. D, carina of a specimen in Fig. C. E, F, specimens from gills of *Neptunus trituberculatus* (i. e. *Vaillanti*-form). $\times 6$. G, H, specimens from maxillipeds of *Neptunus trituberculatus* (i. e. *neptuni*-form). $\times 6$.

to *O. neptuni* (Fig. 13G, H) or *O. Vaillanti* (Fig. 13E, F). For comparison I will give a detailed description of the specimens from the two different crabs.

The capitulum is similar in shape in both forms. The integument of the specimens from *Macrocheira* is very thin, translucent

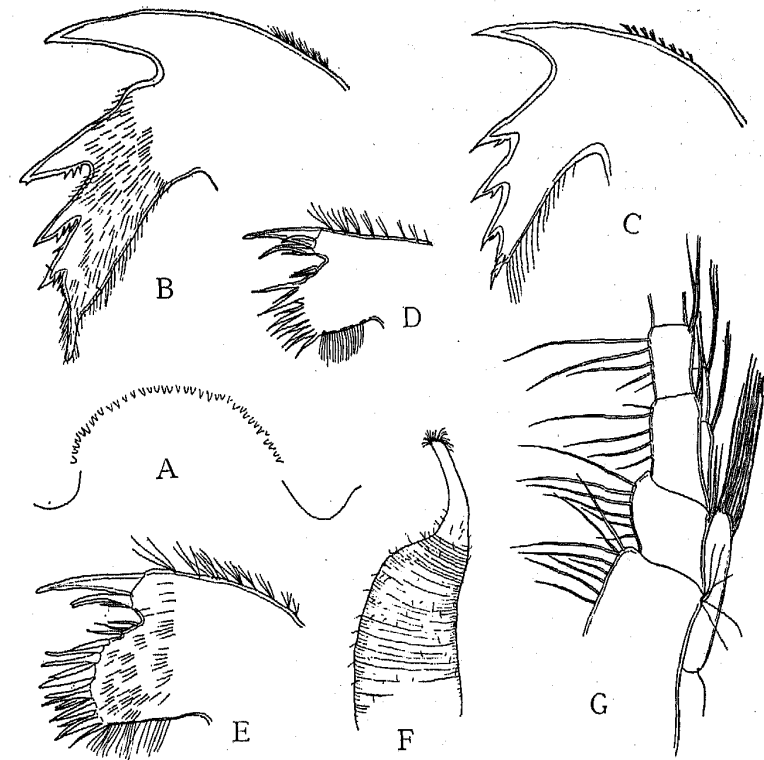


Fig. 14. *Octolasmis Aymonini* (LESSONA, etc.).

A, labrum. B, C, mandible. D, E, maxilla I. F, end of penis. G, lower part of cirrus VI with caudal appendage.

and uncolored. The specimens attached to the gills of *Neptunus* have a similar translucent integument, but in those attached to the maxillipeds of the same host the integument is somewhat thick, yellowish and marked with concentric lines having three centres, as figured originally for *O. neptuni* (MACDONALD, J. D., 1869, pl. 33, fig. 3) and for *O. Müllerii* (COKER, 1902, fig. 3).

In the specimens from *Macrocheira*, the basal segment of the scutum is a little shorter and wider than, or nearly equal to, the occludent segment. In the specimens from *Neptunus*, however, the basal segment is extremely narrow, like a needle, short and often rudimentary. Both segments are separated by an angle of 70° to 80° in the former specimens, but by an angle of 40° to 60° in the latter.

The tergum in the specimens from *Macrocheira* is invariably

trapeziform, mostly about three times as high as wide, while in the specimens from *Neptunus* it is broad and roughly semilunar in shape. In those from *Macrocheira*, there is often a minute point along the occludent margin, as usually seen in those from *Neptunus*. However, it never shows the saddle-like shape, typical of *O. Lowei*.

The carina in the specimens from *Macrocheira* is long, almost attached to the apex of the tergum, and its postumbonal part is about (or more than) four-times as long as the forked preumbonal part. In those from *Neptunus*, as well as in the allied forms, it is shorter and the postumbonal part is about (or less than) three-times as long as the forked preumbonal part which is rather longer than that of the specimens from *Macrocheira*. Usually, in those from *Macrocheira* the basal segment of the scutum and the preumbonal segment of the carina are situated on the same horizontal level, while in those from *Neptunus* as well as in the typical *Lowe*i-form the end of the basal segment of the scutum is situated above the preumbonal segment of the carina. This is probably a distinguishing character in the two forms, although there are individual variations to a certain degree.

The internal characters of both forms exhibit some remarkable differences which are sufficient for separating the one from the other.

Mouth-parts: The labrum and palpus are ordinary and similar in both forms.

The mandible in the specimens from *Macrocheira* has only four long, sharply pointed teeth and a very acute, dentate lower point. There is no trace of the fifth tooth. Of teeth II to IV each has one, rarely two or three, acute additional teeth along the lower edge. The hairs on the upper edge of the blade are rather short and situated widely apart from the first tooth (cf. fig. 14 B, C and KRÜGER's fig. 77). In the specimens from *Neptunus*, however, the mandible has five short and rather blunt teeth, and a lower angle which is usually pointed and bifid. Each tooth from III to V has a blunt additional tooth along the upper edge. The hairs on the upper edge of the blade are comparatively long and situated near the first tooth on the frontal edge (cf. fig. 15 A-C and NILSSON-CANTELL's (1927) fig. 10b).

The maxilla I in the specimens from *Macrocheira* has a very protruded lower part, which is, furnished with more than 10 spines of irregular size, below a very deep and wide notch along the frontal edge (cf. fig. 14 D, E and KRÜGER's fig. 78). In those from *Neptunus*, however, the frontal edge is rather straight, and the lower part just

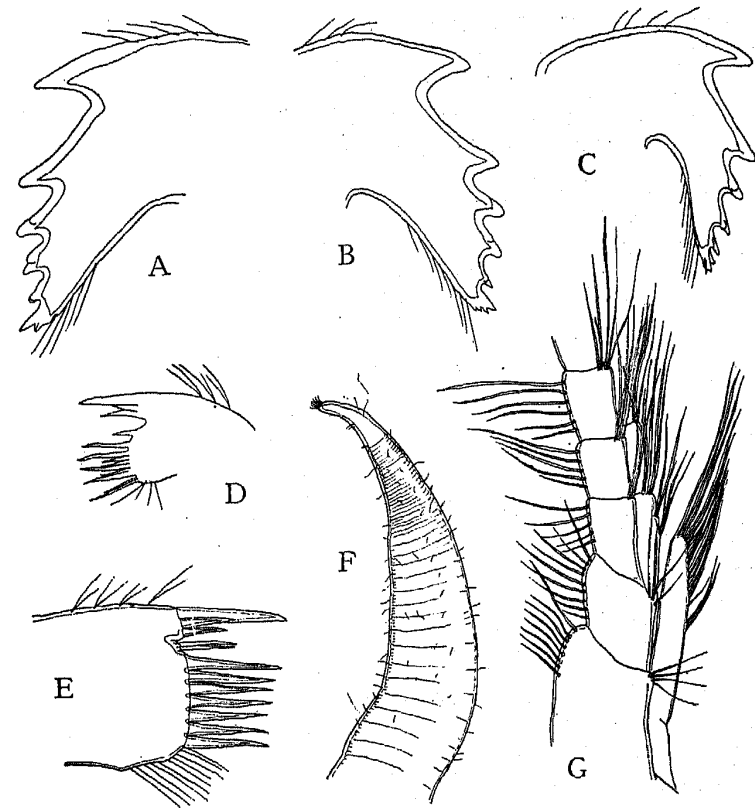


Fig. 15. *Octolasmis Lowei* (DARWIN) f. *neptuni* (MACDONALD). A, B, C, mandible. D, E, maxilla I. F, end of penis. G, lower part of cirrus VI with caudal appendage.

below a rather narrow and shallow notch is broad and protrudes a little from the upper part above the notch, and also is armed with 6 or 7 spines of subequal length and width (cf. fig. 15 D, E, NILSSON-CANTELL's fig. 10 c and MACDONALD's fig. 8).

The maxilla II has bristles evenly distributed along the whole edge in both forms.

The cirri are not different from those of the allied forms. The numbers of segments as well as the length of rami are variable. Each segment bears 8 to 10 pairs of long spines along the frontal edge and a tuft of long spines at the dorsal distal end.

The caudal appendage is variable in length, as AURIVILLIUS mentions, but it differs slightly in both forms. In the specimens

from *Macrocheira*, its end is rather rounded and furnished with a brush of long bristles, while in those from *Neptunus* the bristles are arranged, usually in both upper and lower groups, on the outer edge of the upper half to one-third of the length, but not on the inside of its end, which is more or less pointed. This feature agrees with the descriptions given by previous authors.

The penis in the specimens from *Neptunus* is stout, hairy, delicately annulated and uniformly tapering. In those from *Macrocheira*, however, it tapers abruptly near the extremity as in *O. orthogonia* and *O. Weberi*.

The above-mentioned differences, especially in the internal characters, between those from *Macrocheira* and *Neptunus* seem to justify the separation of both forms. Therefore, I prefer to keep the name of *O. Aymonini* for the specimens from *Macrocheira* as a distinct species.

Measurements of two ordinary specimens in mm :

	Sp. from <i>Macrocheira</i>	Sp. from <i>Neptunus</i>
Length of capitulum	5	3.5
Breadth of capitulum	4	3
Length of peduncle	17	3
Breadth of peduncle	2	1.5

Remarks: As should be clear from the above statements, the uniting together of various forms of *Octolasmis*, as previously reported, into a single species *O. Loweii* (DARWIN), as NILSSON-CANTELL (1927) did, is a point requiring reconsideration. The tergum of *O. Aymonini* shows a close resemblance to that of *O. trigona* (AURIVILLIUS, 1894), so that WELTNER (1922) regarded the specimens on *Macrocheira* from Japan as *O. trigona*; KRÜGER (1911) also regarded both forms as synonymous. Judging from AURIVILLIUS' original description, however, *O. trigona* seems to be more closely allied to typical *O. Loweii* than to *O. Aymonini*, especially as regards the internal parts. Between *O. Loweii* and *O. neptuni* from *Neptunus*, there seem to be no internal differences. In this connection, one must take into account the fact that the saddle-shaped tergum of *Darwini*- or *Loweii*-form often tends to be reduced to the semilunar shape as seen in *neptuni*-form by the degeneration of two basal projections on the one hand, and also to the trapeziform shape as seen in *trigona*-form, which resembles that of *Aymonini*-form superficially by the degeneration of the basal projection at the occludent side on the other (Fig. 16).

However, it is hard to consider that the trapeziform tergum develops into the saddle-shaped one, since I could not find any specimens having such a saddle-shaped tergum in the rich material of *O. Aymonini* here described.

At any rate, the similarity in external appearance found among various forms of *O. Loweii* and *O. Aymonini*, which have themselves resulted from the degeneration of plates,

seems to be due to parallel evolution and produced by a similar mode of life. The same is true of the relation between *O. Weberi* and *O. orthogonia* as mentioned before. *O. geryonophila* seems to more related to *O. Aymonini* than to *O. Mülleri* externally, but differs from these allied forms in the very wide and short basal segment of the scutum. However, it is still dubious whether this species is definitely distinct or not, because the internal characters have not yet been described.

If the above statement based on the present material is warranted, the following tentative classification of the allied forms of *O. Loweii* seems possible :

1. *Octolasmis Loweii* (DARWIN, 1851).

External differential characteristics: Basal segment of scutum usually situated above basal fork of carina and separated widely from basal margin of capitulum; preumbonal part of carina rather long and postumbonal part rather short, the former being about 1/3 as long as the latter.

Distribution: Shallow water in all tropical and temperate seas.

(a) Forma *Loweii* DARWIN (Syn. *Loweii* DARWIN, 1851, *Darwini* DE FILIPPI, 1861, *sinuata* AURIVILLIUS, 1894, *trigona* AURIVILLIUS, 1894, *Mülleri* COKER, 1902).

Ext. diff. char.: Basal segment of scutum moderately wide, long and usually extending over end of carinal fork; tergum saddle-shaped or trapeziform with a small occludent projection.

Hosts: *Panulirus vulgaris* (after DE FILIPPI), *Panulirus* sp. (after AUR.), *Callinectes sapidus*, *Menippe mercenaria*, *Libinia canaliculata* (after COKER), *Pseudocarcinus gigas*, *Thenus orientalis* (after NIL-CANT.).

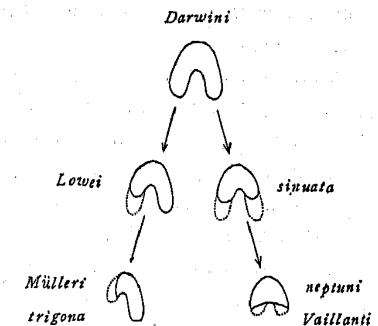


Fig. 16. Diagram showing the affinities of various forms of *Octolasmis Loweii* arisen by the reduction and modification of the tergum.

(b) Forma *neptuni* MACDONALD (Syn. *neptuni* MACDONALD, 1869, *Vaillanti* GRUVEL, 1900).

Ext. diff. char.: Basal segment of scutum narrow, needle-like and usually not reaching end of carinal fork; tergum broad, semi-lunar or quadrangular with a small occludent projection.

Hosts: *Neptunus pelagicus* (after MACDONALD, GRUVEL), *Neptunus trituberculatus* (for the present).

2. *Octolasmis Aymonini* (LESSONA etc., 1874).

Ext. diff. char.: Basal segments of scutum and carina extending from both sides close to basal margin of capitulum, but not meeting in the middle; tergum elongated trapeziform with or without a small occludent projection; postumbonal part of carina comparatively long, about or beyond four times as long as preumbonal part, which is rather short.

Distribution: Deep water in Pacific coast of S. Japan.

Host: *Macrocheira Kaempferi*.

3. *Octolasmis geryonophila* PILSBRY, 1907b.

Ext. diff. char.: See PILSBRY's description (1907b, pp. 94-95).

Distribution: Deep water in Atlantic coast of N. America.

Host: *Geryon quinquedens*.

30. *Octolasmis angulata* (AURIVILLIUS, 1894).

(Figs. 17, 18)

Syn. NILSSON-CANTELL, 1934a.

This species has been fully described by NILSSON-CANTELL (1934a), with a discussion of the synonymy, so that there is not much to add here. The present specimens from Seto are found attached to the gills of a crab *Carcinoplax longimanus* (DE HAAN) and a lobster *Panulirus japonicus* (VON SEBOLD). Of those, all the specimens from the former host agree with the typical form of *O. angulata* (AURIVILLIUS, 1894) in having a carina which is rather variable in shape, though the base forms a fork (Figs. 17 A-D). However, those from the latter host agree with the *bullata*-form of AURIVILLIUS in having no carina at all. The scutum in the typical form is roughly L-shaped and widens upward, while in the *bullata*-form it is roughly ski-shaped and tapers towards the ends. In the latter form there is a narrow black band running from the scutum to the apex of the capitulum which is parallel to the margin of the orifice.

In spite of such external differences, the internal structures of

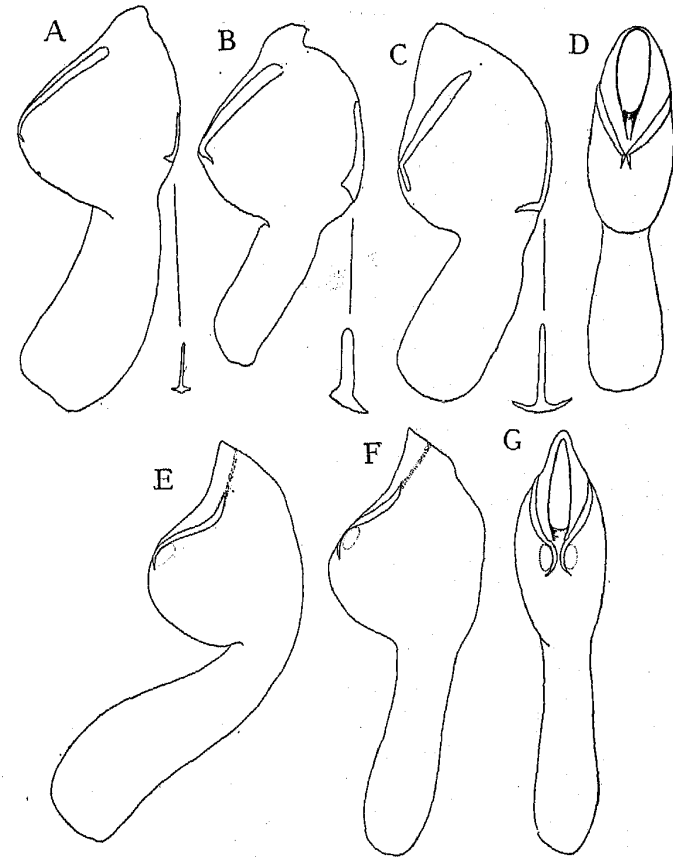


Fig. 17. *Octolasmis angulata* (AURIVILLIUS).

A, B, C, D, specimens from *Carcinoplax longimanus* (i. e. *angulata*-form). $\times 6$. E, F, G, specimens from *Panulirus japonicus* (i. e. *bullata*-form). $\times 6$. (A, B, C, lateral view, each with carina. D, rostral view. E, F, lateral view. G, rostral view. The dotted circles indicate the position of attachment of the adductor muscle.)

both forms are quite similar, so that it is certain that they belong to the same species.

Mouth-parts: The labrum has 10 to 15 strong teeth along the concave margin in a row (according to NILSSON-CANTELL, in two rows).

The palpus is club-shaped, with bristles at the rounded end and along the inner margin.

The mandible, like that of the above-stated *O. Loweii*, has four

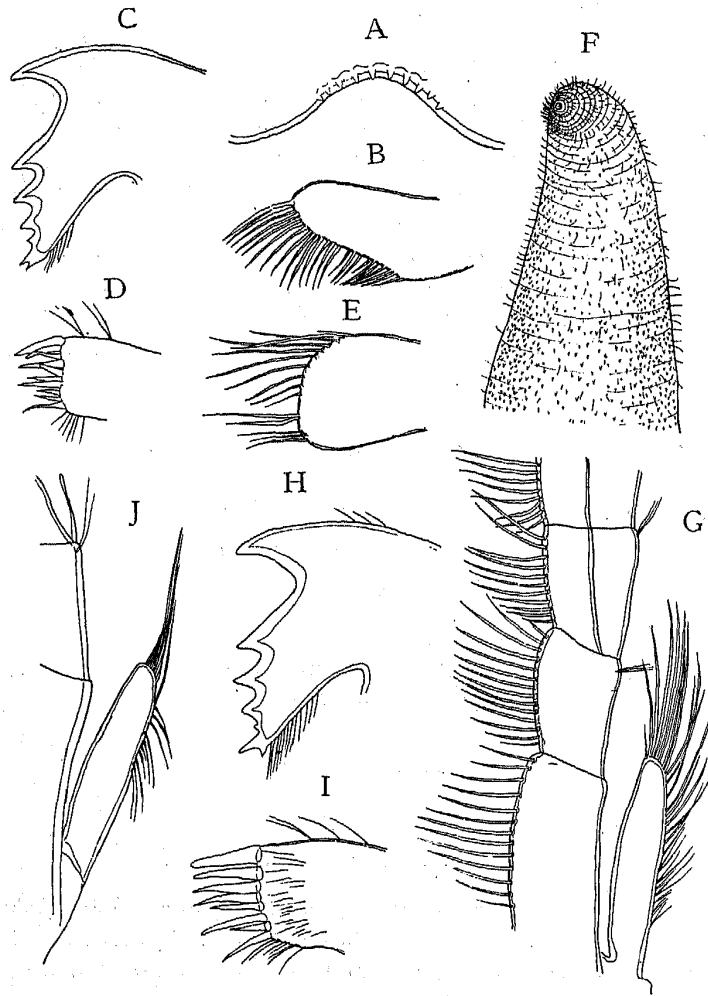


Fig. 18. *Octolasmis angulata* (AURIVILLIUS).

A, labrum. B, palpus. C, mandible. D, maxilla I. E, maxilla II. F, end of penis. G, lower part of cirrus VI with caudal appendage. H, mandible. I, maxilla I. J, caudal appendage. (A-G, from *Panulirus japonicus*. H-J, from *Carcinoplax longimanus*).

short, but distinct, teeth and the rudiment of a fifth tooth. The lower angle is bifurcate.

The maxilla I has a straight frontal edge without any notch, as stated by the authors.

The maxilla II is broad and bears long bristles along the whole edge.

The caudal appendage is single jointed and a little longer than the proximal segment of the protopodite of cirrus VI in both the forms dissected; many long bristles are planted at the end and on the distal half or three-fourths of the outer side.

The penis is very plump, half as thick as the thoracic region of the body, and furnished with many hairs and minute prickles. Its extremity is not narrower. This feature, which has not been mentioned by earlier authors, is very peculiar, in contrast to that of *O. Loweii* and *O. Aymonini* as figured above.

Distribution: Indian Ocean, Malay Archipelago, Japan, on gills or mouth-feet of decapods.

Suborder BALANOMORPHA PILSBRY

Family Chthamalidae DARWIN

Genus Chthamalus RANZANI

31. *Chthamalus Challengeri* HOEK, 1883.

This small-sized species occurs abundantly on shore rocks around the mainland of Japan. As regards the variation in the opercular valves and mouth-parts, I have described them in a previous paper (HIRO, 1932b).

Distribution: Japan and Malay Archipelago; Suez Canal (after BROCH, 1927b). Intertidal.

32. *Chthamalus Pilsbryi* HIRO, 1936.

As mentioned before in my original description (HIRO, 1936d), this species is depressed and much larger than *C. Challengeri* HOEK. The feature of the sutural edge between the scutum and tergum presents a good key of differentiation between these two species.

It is worthy of note that the occurrence of this species is very restricted both horizontally and vertically, in contrast to *C. Challengeri* which shows a rather wide distribution. Around Seto, this species, as well as *C. Challengeri*, is rather common, but occurs only on coastal rock which is washed directly by rough waves and above the community of the latter species.

Distribution: Seto. Besides known from Siwo-misaki and Muroto-zaki.

Genus *Pachylasma* DARWIN33. *Pachylasma japonicum* HIRO, 1933.*Pachylasma japonicum* HIRO, 1933a.

This species, first recorded from off Toi-saki, Hiuga-nada, is found off Seto. A single specimen of the same species attached to a gastropod shell, *Fulgoraria* from Tosa Bay was presented to me by Mr. T. KAMOHARA. These measure in mm as follows:

	from Seto	from Tosa Bay
Carino-rostral diameter	21	12
Height of rostrum	11	8
Carino-rost. diam. of orifice	18	11

Distribution: S. W. coast of Japan (Seto, Tosa Bay and Hiuga-nada). Depth 55-364 m.

Family *Balanidae* GRAYSubfamily *Balaninae* DARWINGenus *Balanus* DA COSTASubgenus *Megabalanus* HOEK34. *Balanus tintinnabulum volcano* PILSBRY, 1916.

(Fig. 19 A)

Balanus tintinnabulum volcano PILSBRY, 1916; NILSSON-CANTELL, 1932a.
Balanus tintinnabulum communis WELTNER, 1897 (in part, from Japan).

This subspecies is known only from Japan and the largest of the shore barnacles found in the Japanese coast. Specimens showing the carino-rostral diameter more than 50 mm are not rare. The external appearance agrees well with the description of PILSBRY (1916). The minute spines scattered on the surface of the parietes are distinct in young specimens, but indistinct or even defaced in older ones, as is also the case with *Balanus tintinnabulum occator* DARWIN, which is found in the Bonin (Ogasawara) Islands.

As regards the internal parts there are no important differences between the subspecies. Still, maxilla I shows a slight difference between subsp. *volcano* and *rosa*. The frontal edge of maxilla I of both the subspecies is rather straight and furnished with two strong spines above a small notch and with spines of two groups and a tuft of spinules below the notch. In subsp. *rosa*, the spines of the

median part below the notch (6 or 7 in number) are rather slender and shorter, and the lowest two spines are strong, as large as the upper two spines above the notch. While in subsp. *volcano*, the lowest two spines are not larger than the upper two spines and those of the median part are not so slender as in subsp. *rosa*. Moreover, the notch in subsp. *volcano* is rather indistinct.

This subspecies is found on shore rocks below the mean tide level, but as a rule not found on any coast where the water is always calm. Its bathymetrical range is, as far as my experience goes, not so wide as that of *B. tintinnabulum rosa*.

Distribution: Pacific coast of S. Japan as far north as Sagami Bay; Tôzinbô, on the Japan Sea side.

35. *Balanus tintinnabulum rosa* PILSBRY, 1916.

(Fig. 19 B)

Balanus tintinnabulum rosa PILSBRY, 1916; NILSSON-CANTELL, 1931, 1932a; BROCH, 1931; HIRO, 1932b.
Balanus tintinnabulum communis KRÜGER, 1911.

This beautiful balanid is very prevalent in Japanese waters. The shell is usually roseate, but sometimes wholly white, as previously mentioned (HIRO, 1932b). As regards the specimens from Sagami Bay identified by KRÜGER (1911) as *Balanus tintinnabulum communis*, there is no detailed description. However, the opercular valves and mouth-parts figured by him may prove that his specimens correspond to this subspecies, in spite of the fact that DARWIN's *Balanus tintinnabulum communis* (= *B. tintinnabulum tintinnabulum* LINNÉ) is more allied to *B. tintinnabulum volcano* than to this subspecies. This subspecies is rather scarce near tide level, but shows a wide bathymetrical distribution.

Distribution: All the seas around Japan, from Formosa to Mutu Bay. Shore to 300 m in depth.

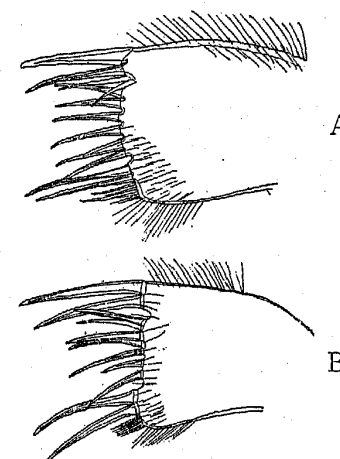


Fig. 19. Maxilla I of *Balanus tintinnabulum volcano* (A) and of *B. t. rosa* (B).

Subgenus *Balanus* DA COSTA36. *Balanus amphitrite communis* DARWIN, 1854.

This subspecies is commonly found in large quantities attached to any submerged things but not on shore rocks.

Distribution: West Indies, European seas, Mediterranean, West and South Africa, New South Wales, Malay Archipelago, Japan.

37. *Balanus amphitrite albicostatus* PILSBRY, 1916.

Balanus amphitrite albicostatus PILSBRY, 1916; NILSSON-CANTELL, 1921.

Balanus amphitrite communis KRÜGER, 1911.

This subspecies is easily defined by the developed white longitudinal ribs on the parietes and the purplish or grayish ground between the ribs. Its bathymetrical and geographical distribution is of great interest, because it is apparently a form inhabiting still water and often lives in blackish water. In the Inland Sea (Seto-naikai), remote from the direct influence of oceanic currents, it is very prevalent on coastal rocks and occurs rather widely in the intertidal zone. While in Tanabe Bay, which lies on the Pacific coast, it is restricted to rather small areas protected from strong wave action, and there it occurs above the mean tide level. Thus its bathymetrical range is more or less similar to that of *Chthamalus Pilsbryi*, as mentioned before, but the habitat is quite different from that of the latter species, because this subspecies seems to be a still-water dweller while the latter is a rough-water dweller, though both are able to remain dry for long periods.

Distribution: Mainland of Japan (north to Mutsu Bay); Hongkong.

38. *Balanus amphitrite hawaiiensis* BROCH, 1922.

(Figs. 20, 21)

Balanus amphitrite hawaiiensis BROCH, 1922.

Balanus amphitrite PILSBRY, 1928.

It is of interest to report the occurrence of this form in Japanese waters, because it has hitherto been recorded from Hawaii and the Philippine Islands but not yet from Japan. Finding it in several places in Japan thus links the two widely separated areas. I have found specimens referable to this subspecies in such localities as Saseho, Seto and Misaki of the Pacific coast and Kure of the Inland sea (Seto naikai). This subspecies is rather poor in Seto and Misaki as compared with other representatives of *Balanus amphitrite*, while it is

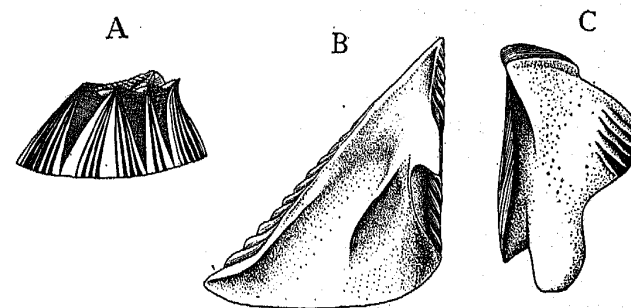


Fig. 20. *Balanus amphitrite hawaiiensis* BROCH.

A, lateral view of specimen $\times 1$. B, internal view of scutum. C, internal view of tergum.

extraordinarily dominant in Kure Port. According to PILSBRY (1928), this subspecies is "very abundant between tides on an Anomia reef (Hawaii)." In Japan, however, it is apparently submerged during tidal periods, as is the case with *Balanus amphitrite communis*.

The shell is conical with a large rhombiform orifice. The parietes are glossy white, smooth, and furnished with dark purple longitudinal stripes without any transverse stripes; these longitudinal stripes are almost or entirely indistinct along the median part of the compartments except the narrow carinolateral and also along the side margins. The radii are pale brown or almost white, very broad and with the upper margin more or less oblique to the base; its side or lower margin reaches perfectly the paries of the adjoining compartment. The alae have a very oblique and convex upper margin. The base is flat and porous.

The scutum has externally distinct growth-lines only. Internally, it has a well-developed adductor ridge parallel to the occludent margin. The pit for the lateral depressor muscle is distinct but small. Below the adductor ridge there is a long furrow. The articular ridge is strongly developed, about half as long as the tergal margin.

The tergum is very broad and triangular. The spur is short, rather roundly ended and about one-third as wide as the basal margin of the valve. In this respect the Japanese specimens more closely approach those described by PILSBRY than those described by BROCH. The crests for the depressor muscles are distinct and 5 in number.

Measurements of some specimens in mm:

Carino-rostral diameter	21.0	19.5	19.3	19.2	19.0	18.3
Height	9.4	10.5	9.0	9.4	9.6	9.4

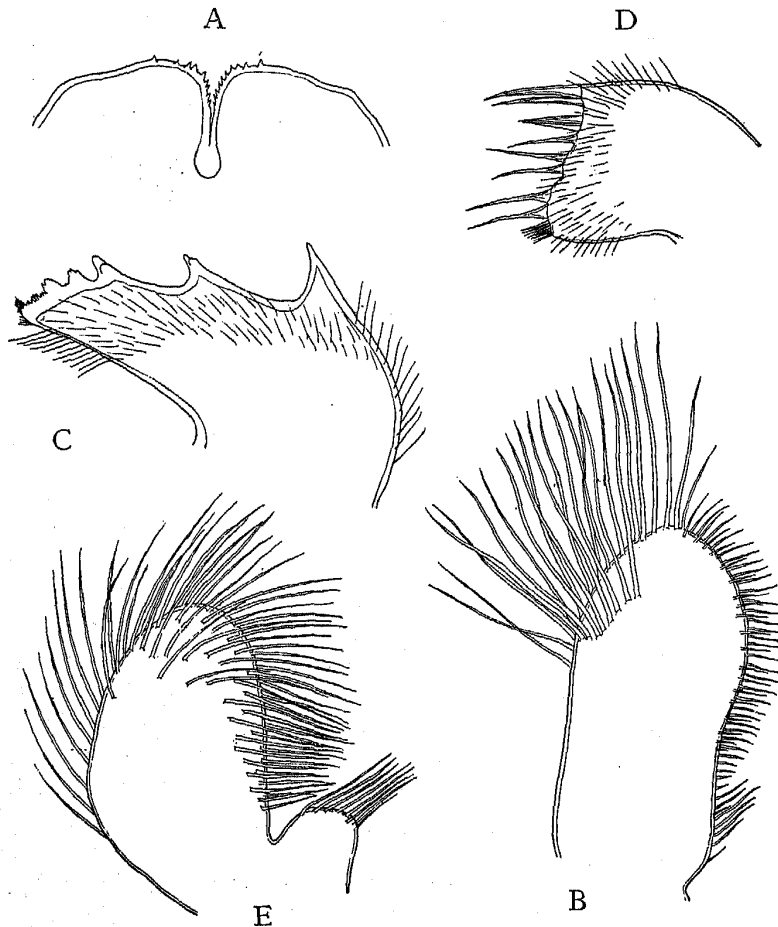


Fig. 21. *Balanus amphitrite hawaiiensis* BROCH.
A, labrum. B, palpus. C, mandible. D, maxilla I. E, maxilla II.

Mouth-parts: The labrum is highly characteristic in having numerous teeth on each side of the median notch.

The palpus is typically club-shaped.

The mandible has five teeth and a pectinated lower angle. The teeth, except the uppermost one, have often each an additional tooth.

The maxilla I and II are of the shape typical of *Balanus amphitrite*.

Numbers of segments of the cirri:

	I		II		III	IV		V		VI
Carino-rost. d. 21 mm	20	12	17	17	18	16	33	35	39	37
Height 9.4 mm										39
										38

The rami in each of the three shorter anterior cirri are unequal in length, especially in cirrus I. In cirrus III, several lower segments of the rami on the posterior distal part carry strong teeth recurved upward and on the whole anterior side many small denticles, as in *B. amphitrite communis*, as described by NILSSON-CANTELL (1921). The three long posterior cirri have usually 7 to 9 pairs of ventral spines in most segments of the rami.

Distribution: Hawaiian Islands, Japan, Philippines. Littoral.

39. *Balanus amphitrite poecilotheca* (KRÜGER, 1911).

(Figs. 22, 23)

Balanus poecilotheca KRÜGER, 1911; PILSBRY, 1916; BARNARD, 1924.

? *Balanus amphitrite poecilosculpta* BROCH, 1931; NILSSON-CANTELL, 1934b.

The specimens here dealt with were found in groups attached to a stem of a dead gorgonarian from deep water off Seto. Similar specimens with the same habitat were taken from Misaki and Amakusa. While examining these rich materials from different localities, I had great difficulties in regard to identification. The external appearance of these specimens shows a close resemblance to that of *Balanus amphitrite poecilosculpta* which is described by BROCH (1931) and NILSSON-CANTELL (1934b) from S. China and the Malayan waters on the one hand, and to that of *Balanus poecilotheca*, described by KRÜGER (1911) from Sagami Bay, Japan on the other. The opercular valves of these specimens, however, are quite similar to those of the latter species. The important difference between both species, if distinct, exists in the internal sculpturation of the opercular valves, which is weak in *B. amphitrite poecilosculpta*, but strong in *B. poecilotheca*. PILSBRY (1916) reported the latter species from the Philippine Archipelago, and BARNARD (1924) also from South Africa; the former author (p. 89) says that "In some Philippine forms of *amphitrite* the adductor ridge of the scutum is very much reduced, making a close approach to the condition found in *B. alatus* and *B. minutus* of HOEK." Therefore, I am inclined to consider both species to be synonymous. If the differences prove constant, when a large series is examined, the Malayan race i. e. *B. amphitrite poecilosculpta* may be regarded as a local form of *B. poecilotheca*. The habitat which is quite similar in both species may support this view. In many respects this species is not very different from any other subspecies

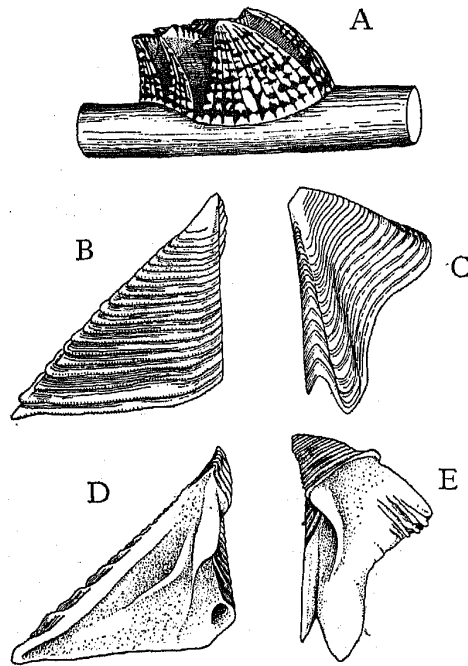


Fig. 22. *Balanus amphitrite poecilotheca* (KRÜGER). A, lateral view of specimen. $\times 3.5$. B, external view of scutum. C, external view of tergum. D, internal view of scutum. E, internal view of tergum.

photograph. The narrow longitudinal stripes crossed by irregularly arranged freckles on the compartments are usually dark-red or red-dish purple. The radii and alae are very broad and wholly white, though often dark colored. The base is porous and externally concave, owing to the attachment to the gorgonian stem, so that the shell necessarily does not develop to a large size.

Measurements of some specimens in mm:

Carino-rostral diameter	9	8	7	5
Lateral diameter	4	4.5	4	4
Height	4.5	3.2	4	4

The shape of the opercular valves corresponds with previous descriptions. Externally the ocludent and tergal border of the scutum is slightly upraised and tinged with the same color as in the compartments. Internally there are some remarkable differences.

of *B. amphitrite*, so that I prefer to place it in the latter species as a subspecies.

The external features of the shell as well as the coloration agree with the descriptions and figures of *B. poecilotheca* given by KRÜGER (1911) and with those of *B. amphitrite poecilosculpta* given by BROCH (1931) and NILSSON-CANTELL (1934b). In the coloration of the shell which tends to bring forth individual or local variation, the material from Seto and Misaki resembles the specimens in KRÜGER's photographs, while those from Amakusa approach the specimens in NILSSON-CANTELL's

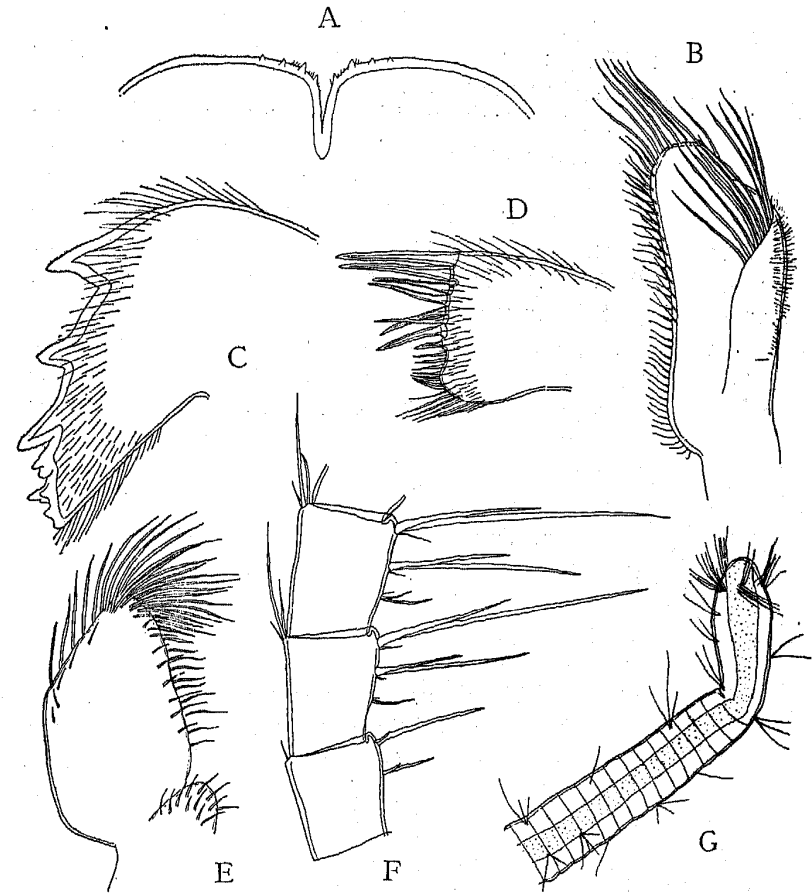


Fig. 23. *Balanus amphitrite poecilotheca* (KRÜGER). A, labrum. B, palpus. C, mandible. D, maxilla I. E, maxilla II. F, intermediate segments of cirrus VI. G, end of penis.

According to BROCH's description of *B. amphitrite poecilosculpta*, "There is a faint indication of an adductor ridge and a furrow between this and the articular ridge above the shallow depression for the adductor muscle." NILSSON-CANTELL says for the same form that "the scutum has only a weak indication of an adductor ridge, otherwise internally no sculptures." In all the present specimens, however, the adductor ridge is very distinct and the cavity for the adductor muscle is well defined, though shallow. The adductor and articular ridges are separated by a narrow furrow. The articular

ridge is about half as long as the height of the valve and reflexed in the middle. The pit for the lateral depressor muscle is distinct and rounded as in other subspecies. In the original description of *B. poecilotheca*, KRÜGER says that, "Die Höhlung für den Depressor ist kaum vorhanden. Die Stärke der Crista adductoris variiert etwas, oft kaum bemerkbar, stellt sie kleine bei der braunen Varietät eine Schneiderartige Kante dar. Parallel mit ihr können öfter kleine Erhöhungen laufen. Die Höhlung für den Adduktor ist gleichfalls nur gering ausgeprägt." In these respects the present specimen approaches KRÜGER's specimen.

The tergum agrees with previous descriptions of the above-mentioned two forms. The spur, about one fourth as wide as the basal margin, is short, with a rounded end. The basi-carinal corner of the valve is roundly protruded. The crests for the depressor muscles are distinct and usually 6 in number.

Mouth-parts: The labrum has four teeth on each side of the median notch. The mandible has five teeth and a lower angle rather obtusely ended; of the teeth the second to fifth are often bifid and the fourth is always the smallest. The other blades are typical, being like those of the other subspecies of *B. amphitrite*.

As regards the cirri, KRÜGER gave no description for *B. poecilotheca*, but BROCH pointed out that the armature of cirrus III was characteristic of *B. amphitrite poecilosculpta*. In the present specimen dissected, the numbers of segments of the cirri are as follows:

Carino-rostral diam. 7mm.	I	II	III	IV	V	VI						
	12	9	12	10	12	11	22	20	25	23	26	26

Several small teeth are arranged distally in a row on the frontal side of the median and upper segments of the anterior ramus of cirrus III. Such teeth are very few in number in the segments of the posterior ramus. The posterior longer cirri have three, sometimes four, pairs of spines on the frontal side of the segments.

The penis is a little longer than cirrus VI, slender and annulated all over; some few hairs are scattered sparsely over the surface, but those around the terminal end are gathered in four tufts. A small, nude basidorsal point is present, as mentioned by BARNARD.

Distribution: Japan, Sulu Archipelago (Philippines), South Africa—as *B. poecilotheca*; South China, Malay Archipelago, Singapore—as *B. amphitrite poecilosculpta*. Depth 33–304 m. Found on stems of gorgonarians and hydroids.

40. *Balanus trigonus* DARWIN, 1854.

This species is one of the widely distributed balanids. It is easily differentiated from all other species by the trigonal orifice and the scutum with one to six longitudinal rows of small pores.

Distribution: Pacific—Japan, Malay Archipelago, New South Wales, New Zealand, West America from Peru to S. California; Indian Ocean; Red Sea; Mediterranean; Atlantic—West Indies to Southern Brazil, Madeira, Azores to South Africa.

From low tide to 100 m: further reported from 450 m (NILSSON-CANTELL, 1921) and even from 3000 m (GRUVEL, 1907a).

Subgenus *Chirona* GRAY41. *Balanus tenuis* HOEK, 1883.

(Fig. 24)

Balanus tenuis HOEK, 1883, 1913; PILSBRY, 1916; BARNARD, 1924; NILSSON-CANTELL, 1925, 1927; BROCH, 1931.

Balanus albus HOEK, 1913.

The largest specimen examined here measures 15 mm in carino-rostral diameter and 13 mm in height. It was attached to a dead shell of *Paphia (Paphia) euglypta* (PHILIPPI) taken from Tanabe Bay at a depth of ca. 50 m. The external parts agree well with HOEK's and NILSSON-CANTELL's descriptions. Concerning the internal parts, however, there are some slight differences, which are, however, not very important. For comparison a description with the figures is here given.

Mouth-parts: The labrum has three teeth on one side of the notch, but none on the other side in the specimen dissected.

The palpus is typically club-shaped.

The mandible has five strong teeth, of which the second and third are bifurcate, and a lower angle which is often combined with the fifth tooth.

The maxilla I, according to HOEK and NILSSON-CANTELL, has a small notch on the rather straight frontal edge. But I could not find any trace of it.

The maxilla II has an upper lobe, short and oval, of which the frontal edge is straight.

Numbers of segments in the cirri:

I	II	III	IV	V	VI						
14	12	14	17	18	18	37	39	39	46	50	50

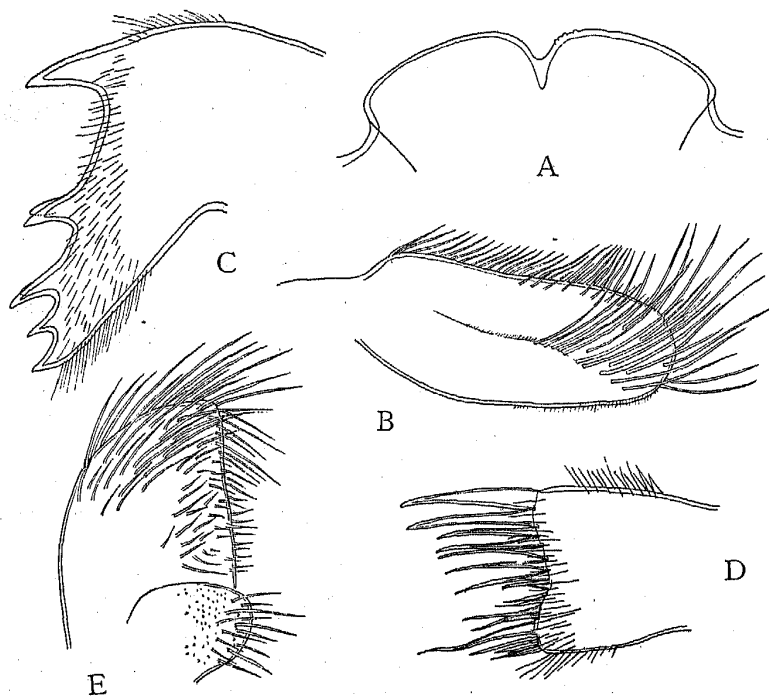


Fig. 24. *Balanus tenuis* HOEK.
A, labrum. B, palpus. C, mandible. D, maxilla I. E, maxilla II.

In cirri I to III, the posterior ramus is shorter than the anterior. The other posterior cirri are about three times as long as the three anterior cirri; in both the rami of these cirri, the segments of the lower half are provided with fine spinules along the posterior margin and two pairs of strong spines on the anterior margin.

The penis is short and has a well-developed basidorsal point.

Distribution: Philippine Islands, China sea, Southern Japan, South Africa. Depth 50-522 m.

42. *Balanus Krügeri* PILSBRY, 1916.
(Fig. 25)

Balanus Krügeri PILSBRY, 1916; BROCH, 1931; HIRO, 1933a.

This small balanid was collected by the Sōyō-maru Expedition from Station 211, off Tonda near Seto (HIRO, 1933a). Besides, this species has been reported from various localities in Japan, such as

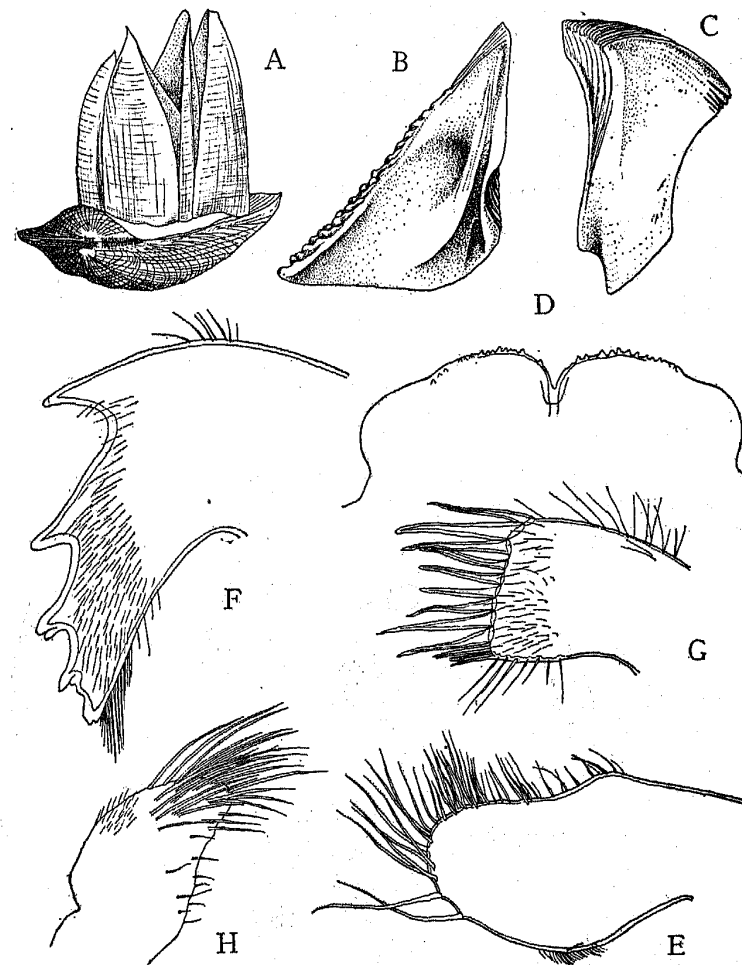


Fig. 25. *Balanus Krügeri* PILSBRY.
A, lateral view of specimen. $\times 3.5$. B, internal view of scutum. C, internal view of tergum. D, labrum. E, palpus. F, mandible. G, maxilla I. H, maxilla II.

Sagami Bay (BROCH), Suruga Bay (PILSBRY), Siwo-misaki, Tosa Bay (HIRO), and off Kagosima Gulf (PILSBRY).

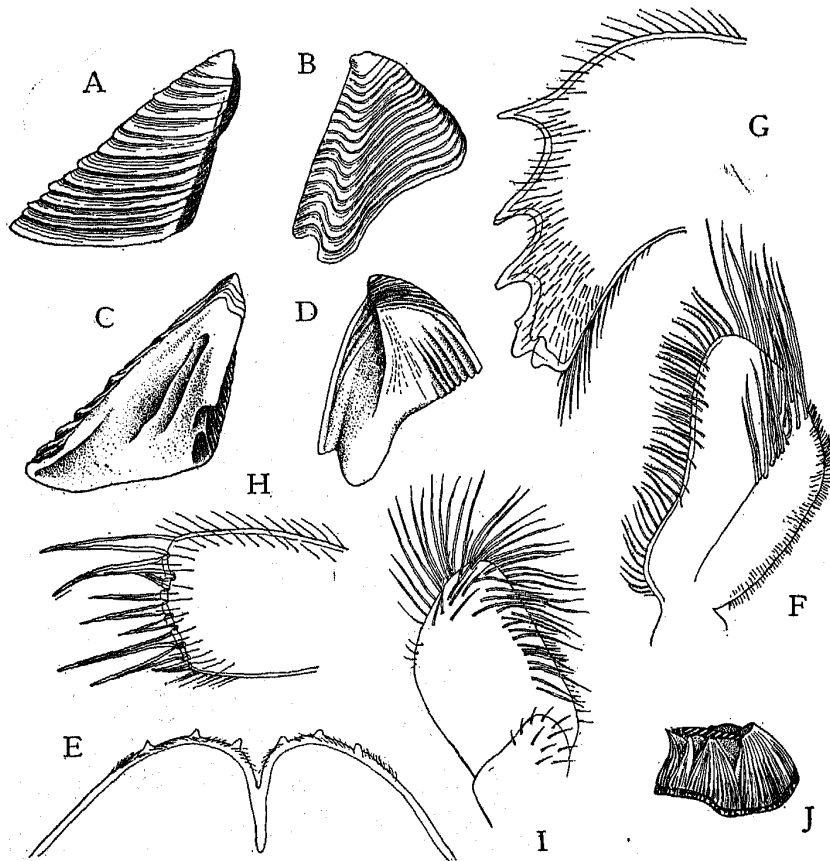
Distribution: Japan, Kei Islands in Malayan waters (BROCH). Depth 115-250 m.

Subgenus *Solidobalanus* HOEK43. *Balanus socialis* HOEK, 1883.

(Fig. 26)

Balanus socialis HOEK, 1883, 1913; GRUVEL, 1905; NILSSON-CANTELL, 1932b, 1934a.
Balanus aeneas LANCHESTER, 1902; GRUVEL, 1905; ANNANDALE, 1906a.

A single specimen of this species was collected off Tanabe Bay, probably from deep water. The surface of the parietes is glossy white and provided longitudinally with hyaline stripes as mentioned by HOEK (1883, 1913). The radii are very narrow, while the alae

Fig. 26. *Balanus socialis* HOEK.

A, external view of scutum. B, external view of tergum. C, internal view of scutum. D, internal view of tergum. E, labrum. F, palpus. G, mandible. H, maxilla I. I, maxilla II. J, lateral view of specimen. $\times 3.5$.

are very wide and has the upper margin parallel to the base and slightly convex. The opercular valves and internal parts agree well with the descriptions given by previous authors.

PILSBRY (1916, p. 221) emphasized the similarity between this *B. socialis* and *B. aeneas* LANCHESTER (1902), though the former species occurs in deep water, while the latter occurs in shallow water. The present specimen figured here favours his opinion.

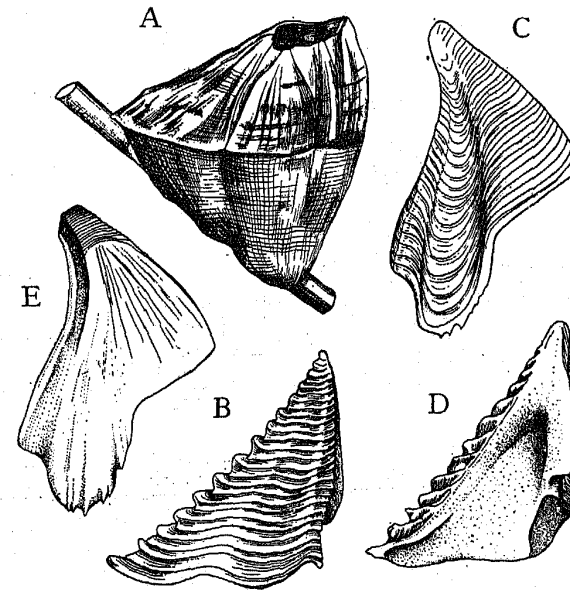
Distribution: Malay Archipelago, Indian Ocean and Japan as reported here. Japan is a new locality for this species. Depth 0-91 m.

Subgenus *Conopea* SAY44. *Balanus calceolus* DARWIN, 1854.

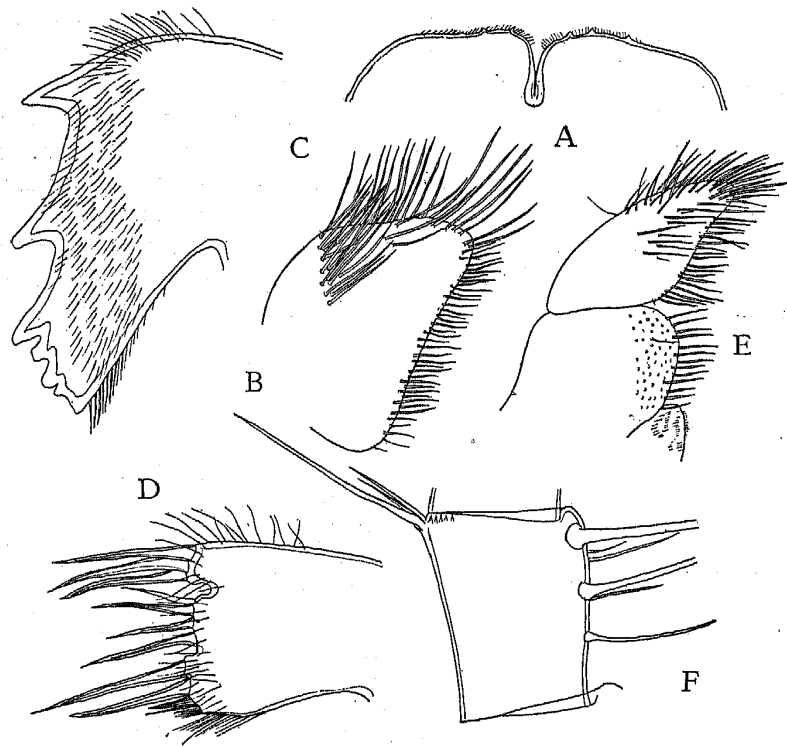
(Figs. 27, 28)

Balanus calceolus DARWIN, 1854; WELTNER, 1897; GRUVEL, 1903, 1905, 1906, 1907b; HOEK, 1913; PILSBRY, 1916; BROCH, 1922, 1927a, 1931; NILSSON-CANTELL, 1928a.

This species is very characteristic in that the scutum has a deep and large pit for the lateral depressor muscle and the tergum has

Fig. 27. *Balanus calceolus* DARWIN.

A, lateral view of specimen. $\times 4$. B, external view of scutum. C, external view of tergum. D, internal view of scutum. E, internal view of tergum.

Fig. 28. *Balanus calceolus* DARWIN.

A, labrum. B, palpus. C, mandible. D, maxilla I. E, maxilla II. F, intermediate segment of cirrus IV.

a spur dentated finely at the end. To the descriptions by DARWIN (1854) and HOEK (1913) there is nothing to add.

In the vicinity of Seto, this species is usually found imbedded in *Euplexaura* sp., while in Sagami Bay it is usually found on *Anthoplexaura dimorpha* and rarely on *Melitodes*, associated with *B. cymbiformis*.

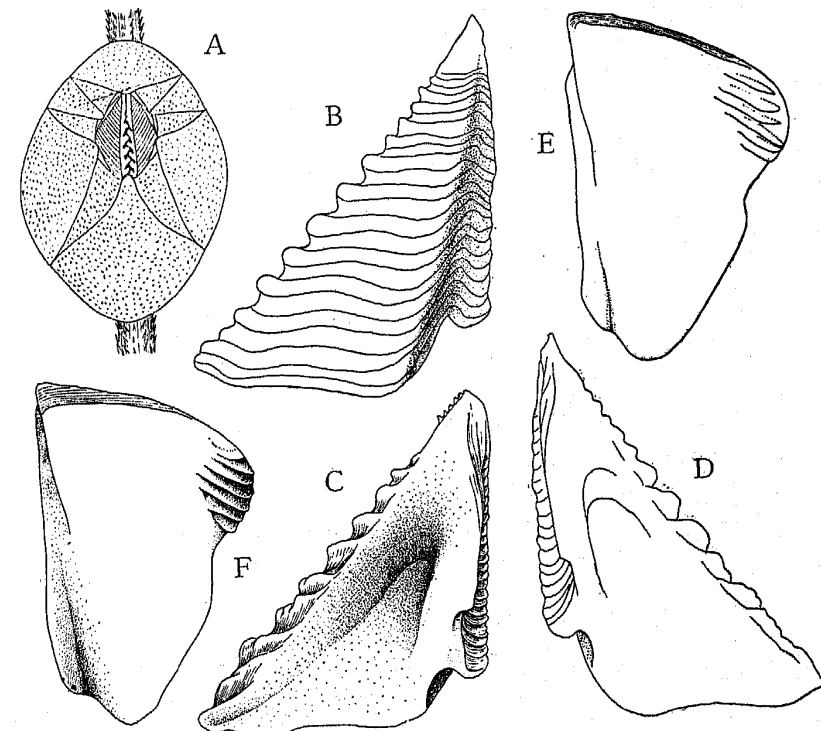
Distribution: West coast of Africa, Mediterranean, British East Africa, West Australia, Madras, Malay Archipelago, Japan. On gorgonarian stems.

45. *Balanus granulatus* n. sp.
(Figs. 29, 30)

The specimens are found attached to the antipatharian stems which are commonly obtained in Tanabe Bay at a depth of 10-30 m,

associated with *Oxynaspis pacifica* HIRO. All the characters show that these specimens belong to the subgenus *Conopea*. A number of species of *Conopea* have hitherto been known from gorgonarians, excepting only *Balanus stultus* DARWIN, which is, according to DARWIN, attached to *Millepora*. Recently, however, I found a new balanid *Balanus folliculus* HIRO, certainly belonging to *Conopea*, imbedded in an antipatharian from Saipan, Mariana Islands (HIRO, 1937b). Besides, *Acasta antipathidis* BROCH found on antipatharian (1916) from Pearling-Ground W. S. W. from Cap Jaubert, W. Australia is probably a species of *Conopea*, though exact identification is now impossible, nothing having been said about the internal parts.

In general appearance all the specimens here examined exhibit

Fig. 29. *Balanus granulatus* n. sp.

A, apical view of specimen. $\times 5.5$. B, external view of scutum. C, D, internal view of scutum. E, F, internal view of tergum.

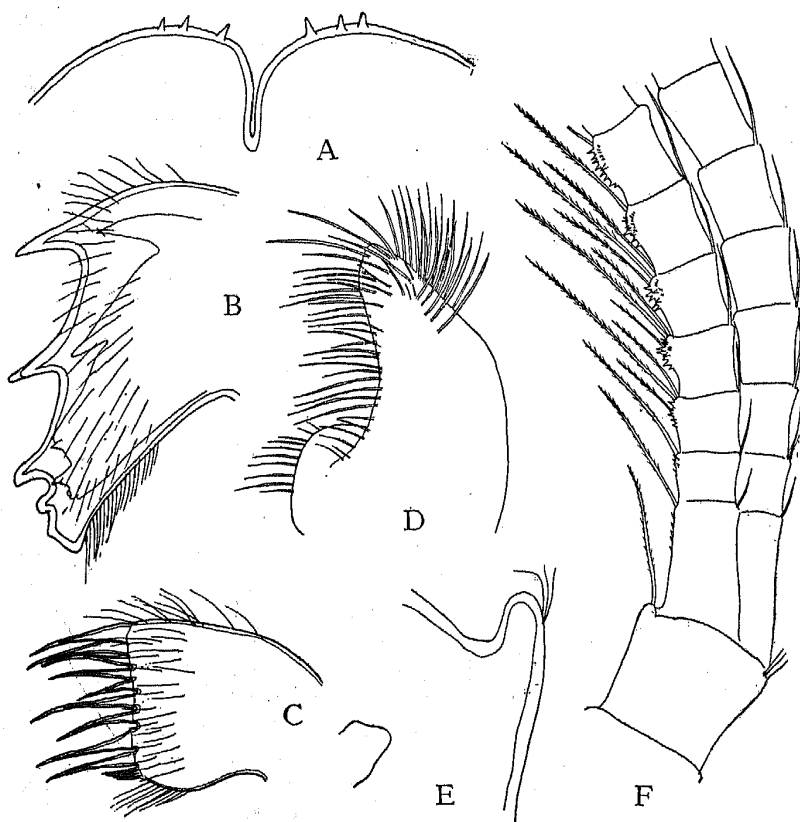


Fig. 30. *Balanus granulatus* n. sp.

A, labrum. B, mandible. C, maxilla I. D, maxilla II. E, basidorsal point of penis. F, cirrus IV.

much closer resemblance to *Balanus scandens* PILSBRY¹⁾ than to any other species, so that I am inclined at first to assign them to the latter species. However, in many important points these specimens show peculiarities.

The shell is oval in outline and never elongated in the carino-rostral axis, though forming a slight keel outside the basal cup. The whole shell is covered entirely by the rather thick and spiniferous,

1) Concerning the habitat of *B. scandens* from Japan, PILSBRY (1916) gave no statement, and NILSSON-CANTELL (1921) mentioned only that "auf Scleraczone." Afterwards, BARNARD (1924) reported the same species from South Africa, as attached to the stem of *Villogorgia mauritensis*. I have not yet obtained any specimens referable to this species.

horny bark of the antipatharian. When this brownish horny bark is removed, the surface of the shell, including the parietes and radii, is uniformly white and finely roughened with minute dots, distinguishable only with the aid of a lens. The base is conical, thick, solid, and usually has a slight furrow for clasping the supporting stem; the external and internal surface is smooth, wholly white or partially purple drab. All the compartments are thick and solid. Internally the parietes below the sheath are short and strongly ribbed. The sheath is long, about 2/3 the length of the compartment and transversely striated. The radii are very broad and have their summits almost parallel to the base. The orifice is small, quadrangular and situated obliquely to the basal margin of the shell.

The carina is high and rather steep, while the rostrum is short, more sloping than in the carina, and roundly ended. The carino-lateral compartment is moderately narrow and about one-fourth as wide as the lateral. The mode of attachment to the supporting stem is very variable. That is, the supporting stem reaches the carinal end of the walls in one specimen, while it reaches the rostral end in the other. Further, when solitarily lodged, both of the ends are sometimes attached wholly to the supporting stem, and when lodged in profusion, the supporting stem is clasped only by the bottom of the basal cup. In either case, the walls of the shell and the basal cup always form together an angle on every side.

Measurements of some specimens in mm:

Carino-rostral diameter	8	7.7	7.3	7.2	6.8
Lateral diameter	6	6	6.1	5.7	5
Total height	7.8	7.8	9	7	5.7

The scutum is more related to that of *B. calceolus* DARWIN than that of *B. cymbiformis* DARWIN and *B. scandens* PILSBRY. It is very thick and somewhat narrow. The growth-ridges are well developed, terminating along the slightly upraised occludent border as strong articulating teeth. The tergal side of the valve is strongly inflected. The basitergal corner is very rounded and separated from the tergal margin of the valve by a deep notch. The articular ridge is long, moderately developed, and its lower end is truncated rectangularly to the tergal margin, as in *B. calceolus*. The pit for the adductor muscle is large and deep, while the adductor ridge is missing. There is a small distinct pit for the lateral depressor muscle close to the basitergal corner.

The tergum is, on the contrary, more related to that of *B. scandens*

and *B. cymbiformis* than that of the other species. It is very broad, rather flat and thin. The carinal margin is slightly arched and a little shorter than the scutal margin which is straight; both the margins meet at the apex at an angle of about 80°. The carinobasal corner is very rounded and there exist the prominent but short crests for the depressor muscles, usually 6 in number. The spur is short, broad, about 2/3 the width of the valve and obliquely truncated. The articular ridge is low, short and close to the scutal margin.

Mouth-parts: The labrum has three sharp teeth on each side of the deep median notch.

The palpus as in *B. scandens*.

The mandible has four distinct teeth and a lower angle squarely truncated.

The maxilla I has a straight frontal edge without any notch and is armed with nine spines of irregular length and a tuft of spinules at the lower end.

The maxilla II has the upper lobe rather pointed.

The cirri have the typical appearance of *Conopea*, and may even provide sufficient ground to separate this species from *B. scandens*. The numbers of their segments are as follows:

I	II	III	IV	V	VI
15	7	10	6	10	10
16	19	18	19	18	17

All the cirri, especially the three posterior pairs, are badly developed, as is usual in the others. The comparative lengths of the rami are not very different from those of other species. The three longer posterior pairs are subequal between the rami, the segments being short and armed with 2 or 3 pairs of feathered ventral spines and a tuft of long, feathered spines at the dorsal distal end. In the anterior ramus of cirri III and IV, most segments have many small erect teeth scattered wholly on the frontal face, as figured by HOEK for *B. cornutus* and *B. proripiens* (HOEK, 1913, pl. 23, fig. 15 and pl. 24, figs. 2, 3). These teeth showing such shape and arrangement seem to be an important characteristic of the subgenus *Conopea*, though there are some species carrying no such armature.

The penis is longer than the last cirri, multiarticulated and with a few long hairs. A small basidorsal point is present.

Distribution: Japan. Besides Seto, this species has been obtained from Misaki, Toba and Amakusa, the habitat in all cases being similar.

Genus *Acasta* LEACH

As regards the systematic position of the genus *Acasta*, DARWIN (1854) at first considered it a subgenus of the genus *Balanus*, but he actually treated it as a separate genus for describing the species. He (p. 176) says that "The sub-genus *Acasta* is, in one sense, very natural, as it includes species most closely allied: in another sense it is far from natural, as some of the species can hardly be distinguished from those species of *Balanus*, which live attached to Gorgoniae: I almost regret I did not merge the species of *Acasta* into *Balanus*." Since DARWIN's time all authorities have placed *Acasta* in the generic rank, mainly for the sake of convenience, but partly also because of the characteristic shape arising from its peculiar habitat. In this respect I also follow previous authors. However, these authors gave no morphological characteristics distinguishable exactly from the subgenera of *Balanus*.

As pointed out by such authorities as HOEK, PILSBRY and NILSSON-CANTELL, *Acasta* is related to *Membranobalanus*, *Armatobalanus* and *Conopea* of the subgenera of *Balanus*. However, it is very difficult to say whether the characteristics of *Acasta* may be of generic or subgeneric importance. In the great majority of *Acasta*, the basal cup is calcareous and rounded to oval in outline. However, *Acasta membranacea* from hexactinellid sponges has, according to BARNARD (1924), the membranous or partially calcified basal cup. The membranous basal cup is regarded as one of the characteristics of *Membranobalanus*. In external appearance some species of *Conopea* show a close resemblance to *Acasta*, but there are apparently some internal differences between them, especially in the armature of the cirri. In *Conopea*, the teeth on the anterior ramus of cirrus IV, when present, which are not recurved, are very small, numerous and scattered irregularly on the frontal face, while in *Acasta* they, which are usually recurved strongly, are few in number and arranged in a row along the frontal edge. Such teeth are likewise present in the propodite of the same cirrus in *Acasta*, but absent in *Conopea*. The teeth found in *Armatobalanus* remind one of those in *Acasta*, but they are less in number and situated on the upper half of each more elongated segment. So far as the above-mentioned characters are concerned, *Acasta* seems to be of no greater taxonomic rank than the subgenera of *Balanus*.

Concerning the habitat of the species of *Acasta*, to which their

peculiar structure is apparently due, it may be necessary to review the records given by other writers. The great majority of *Acasta* are known from tetraxonid sponges, except only *Acasta membranacea* from hexactinellid sponges. However, there are some exceptional records as follows: *Acasta purpurata* DARWIN (1854) is found embedded in the outer layer of a gorgonian, *Isis* and *A. sculpturata* BROCH (1931) and *A. echinata* HIRO (1937a) are found embedded in the stalk tissues of alcyonarians.

Besides, *A. funicularum* ANNANDALE (1906a) and *A. madreporicola* BROCH (1922) were found attached to the madreporarian corals. Moreover, BROCH (1916, 1931) described *A. antipathidis* from antipatharians and *A. hirsuta* and *A. spinitergum* from gorgonarians. Judging from the descriptions of their structures and habitats, however, I am inclined to the view that the former two species may be assigned to *Armatobalanus* and the latter three to *Conopea*. Further findings and investigations will prove whether this view is correct or not.

It is worthy of note that in the *Acasta*-group there is no distinct parallel relation between the walls and the opercular valves, nor between the external and internal parts. On the whole, all the species belonging to the same subgenus of *Balanus* exhibit the opercular valves as well as the internal parts more or less related to one another. However, the species of *Acasta* are rather variable in respect to the structure of the walls and base, the shape of the opercular valves, and also the armature of the cirri. Concerning the external characters, for example, the size of the carinolateral parietes, the slits or gaps between the compartments and the basal cup are the most variable characters. The opercular valves show great disparities between the species, but when a large series is examined, it may be found that they are related to one another to a certain degree. For convenience, it is possible to divide them roughly into the following three groups.

A-type: Scutum higher than wide, with radial striae or none; Tergum without radial striae, with the spur long and broadly truncated.

(e. g. *A. aculeata*, *A. cyathus*, *A. denticulata*, *A. dofeini*, *A. fenestrata*, *A. flexuosa*, *A. foraminifera*, *A. glans*, *A. laevigata*, *A. spongites*, *A. sporillus*, *A. sulcata*, *A. zuiho*, etc.)

B-type: Scutum wider than high, or higher than wide; cancellated or strongly sculptured; Tergum cancellated, strongly sculptured

or without radial striae, and with the spur distinct from the valve itself.

(e. g. *A. angusticalcar*, *A. cancellorum*, *scuticosta*, *A. sculpturata*)

C-type: Scutum half as high as wide, smooth or with faint radial striae near the apex; Tergum cancellated, triangular, and with the spur short and broad.

(e. g. *A. pectinipes*)

The intermediate form between the A- and B-types. (*A. conica*)

The intermediate form between the B- and C-types. (*A. crassa*)

The intermediate form between the C- and A-types. (*A. purpurata*)

The differences between these three series are of no subgeneric value, not being directly related to all the internal structures characterizing the species. The segments of the fourth cirrus bear some recurved teeth in some species, but none in the others, as seen in the species of *Conopea*. The shape of the teeth, however, shows a great resemblance to that of *Armatobalanus*, and indicates an actual affinity between *Acasta* and *Armatobalanus*. Yet this character is variable in individuals of the same species of *Acasta* too. Generally speaking, it is possible that in the *Acasta*-group there is no distinct connection between the external characters and the internal characters.

Therefore, I am inclined to consider that *Acasta* may be a large and rather fluctuating group derived independently from *Balanus* and has undergone adaptive changes of structures consequent upon life in sponges or coelenterates. On the other hand, *Armatobalanus*, *Membranobalanus* and also *Conopea* represent independent offshoots from the porous and poreless Balani, and even rather small and comparatively invariable groups respectively, though most closely related to *Acasta*. It seems, therefore, more improbable that *Armatobalanus* could have given rise to *Acasta*.

46. *Acasta sulcata* LAMARCK, 1818.
(Figs. 31, 32)

Acasta sulcata DARWIN, 1854; WELTNER, 1897; BORRADAILE, 1903; GRUVEL, 1905; KRÜGER, 1911.

Acasta sulcata, first reported from Australia, was recorded by WELTNER (1897) from Kagosima Bay, Japan and afterwards by KRÜGER (1911) from Tokyo Bay. For this identification, however, the two authors gave no detailed descriptions. I also obtained numerous

specimens in Tanabe Bay which were imbedded in a sponge similar to the host of KRÜGER's specimen. A careful examination of the material revealed that they agree in detail with the description of *A. sulcata* given by DARWIN (1854) based upon the Australian specimens. As the external and internal structures of this species are not well known, I give here a complete description based on the present rich material.

In addition to the typical form of this species, DARWIN described two varieties. But in the present material, specimens referable to his varieties are not included.

In external appearance, this species resembles *Acasta japonica* (PILSBRY, 1911) recorded from Japan and the Malay Archipelago, but it differs in many respects, especially in the internal characters. The shell is white all over, sometimes tinged with pinkish towards the apex. The surface of the compartments is generally smooth, but often furnished with small calcareous projections in irregular lines.

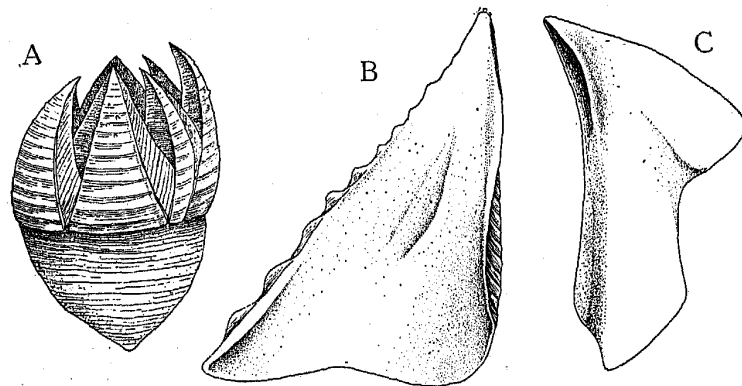


Fig. 31. *Acasta sulcata* LAMARCK.

A, lateral view of specimen. $\times 4$. B, internal view of scutum. C, internal view of tergum.

The parietes are strongly ribbed internally, and the sheath, which occupies more than half the height of the parietes, is not marked with growth-lines. The radii are as wide as the alae and furnished with several parallel shelves internally. The orifice is rather small and strongly dentate. The comparative widths of the carinolateral and lateral parietes are variable, from 1:4 to 1:6. The rostrum is the widest and shortest of all the compartments, and the carina is the highest.

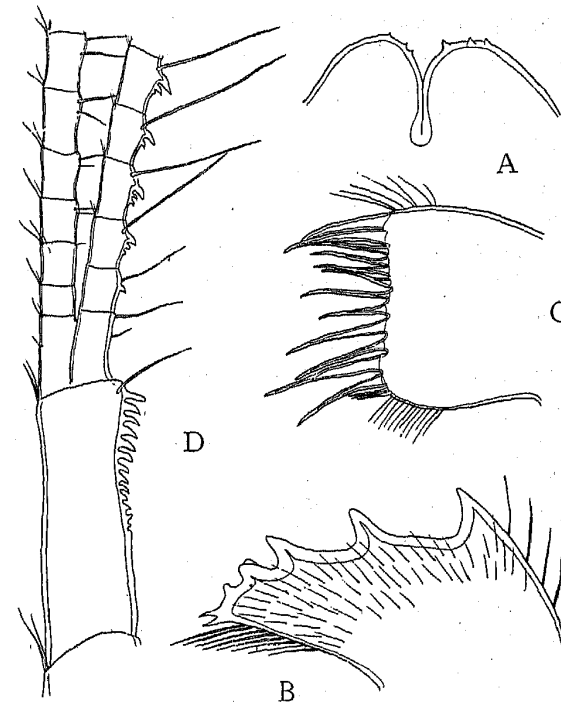


Fig. 32. *Acasta sulcata* LAMARCK.

A, labrum. B, mandible. C, maxilla I. D, cirrus IV.

Measurements of some specimens in mm:

Carino-rostral diameter	6.3	5.7	5.6	4.8	4.2
Total height	8.0	9.2	7.6	7.0	6.5

The scutum is flat externally, thin, transparent, and marked with smooth growth-lines only. Internally, a shallow oblong pit for the adductor muscle is defined only by the low adductor ridge. No other muscle impression exists inside. The articular ridge is very low, not extending over the tergal margin, and sloped gradually towards the lower end. The articular furrow is very narrow and shallow. The basal margin is slightly concave in the middle.

The tergum is long, very thin, and transparent, as in the scutum. The spur is half as wide as the whole valve and truncated at the end. There is a slight longitudinal furrow running towards the spur, the scutal border being a little raised. The articular ridge is very low and short. There is no crest for the depressor muscles.

The mouth-parts are figured by KRÜGER; they are not very different from those of the other species of *Acasta*.

Numbers of segments of the cirri:

I	II	III	IV	V	VI
19	8 13	8 14	11 20	25 28*	29 30* 32*

*) mutilated at their end.

In cirrus I the ratio of the length of the rami is about 3:1. In cirri II and III, the anterior ramus is a little longer than the posterior. Cirrus IV bears two or three recurved teeth at the frontal edge of the lower segments of the anterior ramus and also a series of similar teeth (13 in a specimen dissected) along the frontal edge of the distal segment of the protopodite. Each median segment of the anterior ramus of cirrus V bears also a recurved tooth. The longer cirri, carrying none of such teeth, are armed with three pairs of ventral spines on each segment.

The penis is very long and hairy. There is no basidorsal point.

Distribution: Australia, Maldives and Laccadive Archipelagoes, Philippines, Japan (Kagosima Bay, Tôkyô Bay and Tanabe Bay, as described here).

47. *Acasta Dofleini* KRÜGER, 1911.
(Figs. 33, 34)

Acasta Dofleini KRÜGER, 1911; PILSBRY, 1916; BROCH, 1922, 1921; NILSSON-CANTELL, 1921.

Acasta aperta HIRO, 1931.

In a former paper describing some new cirripeds from Japan (HIRO, 1931), I mentioned that *Acasta aperta* HIRO is closely related to *A. Dofleini* KRÜGER in various respects, but it may be distinguished from the latter species in the extremely large orifice and in the feature of cirrus IV. However, a crucial reexamination of more rich specimens, externally referable to both *A. Dofleini* and *A. aperta*, has made it clear that there can be great individual variations in either the external features of the shell or the opercular valves and also in the internal characters. It is possible that *A. aperta* is only an extreme variant of *A. Dofleini* determined by special biological conditions, as may be inferred from various features described below.

First, in the carinolateral compartment the parietal area is usually lacking, but rarely present as a very narrow area without pores; its radius and ala reach down to the base, though not perfectly. The orifice is usually small, but in rather older specimens, imbedded

deeply in tissues of sponges, it is often extraordinarily large and about as broad as the basal area of the shell. The base is flat or shallowly cup-shaped, and square to rounded in outline, externally with two shallow grooves crossed at its center. Long flexible hairs are scattered on the surface of the compartments.

The opercular valves of the specimens here examined afford some new facts as to their external and internal sculptures.

After the previous descriptions, the scutum has developed but smooth growth-ridges. However, a number of specimens examined show that the growth-ridges on the scutum are finely crenated, though not extending all over, as crossed by longitudinal ridges, nearly like those of *Balanus tintinnabulum*. Still, there are specimens with smooth growth-ridges only. The inside of the valve is feebly sculptured with a low adductor ridge only in the middle, and the pit for the adductor muscle is not indicated distinctly. The pit for the lateral depressor muscle is usually distinct, though not deep. Such internal sculptures may be often obliterated. While, the tergum agrees well with the previous descriptions, no such variation as in the scutum being found.

The internal parts have hitherto been described only by BROCH (1922). Concerning the mouth-parts there are no important differences

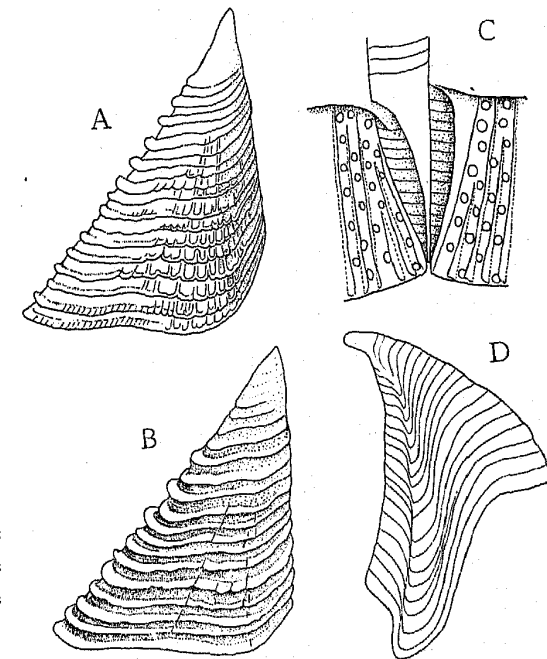


Fig. 33. *Acasta Dofleini* KRÜGER.
A, external view of scutum with longitudinal ridges. B, external view of scutum without longitudinal ridges. C, internal view of base of carinolateral compartment and its surrounding. D, external view of tergum.

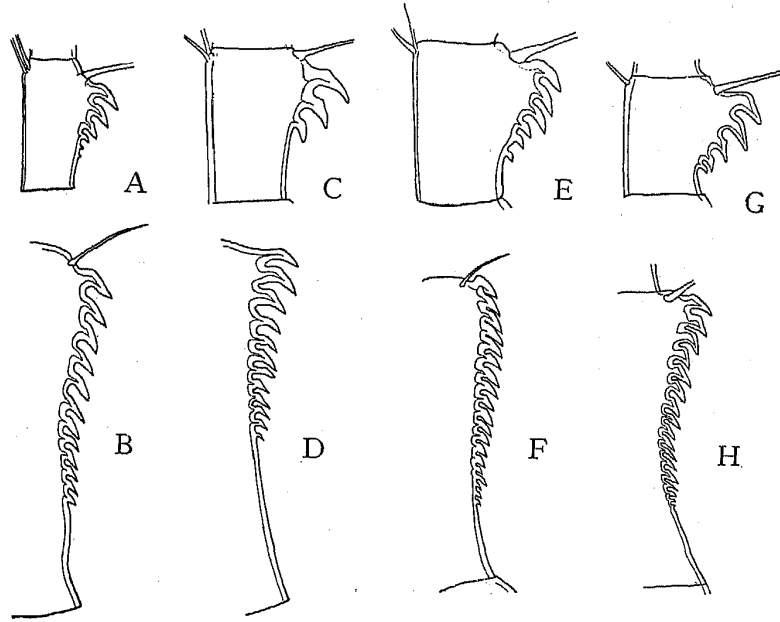


Fig. 34. *Acasta Dofleini* KRÜGER.

A, B, sixth segment of anterior ramus of cirrus IV (A) and distal segment of its protopodite (B) in specimen *a*. C, D, the same in specimen *b*. E, F, the same in specimen *c*. G, H, the same in specimen *d*. (A, B, C, E, G, $\times 150$; D, F, H $\times 100$)

from those of other species, although a slight individual variation may be seen. The labrum has 1 to 3 teeth on each side of the median deep notch. The mandible has 5 teeth, of which the second to fourth are bifid, and a lower angle with usually 5 to 6 denticles. The maxilla I is broad and furnished with long spines along the straight frontal edge without any notch.

The armature of cirrus IV is very variable. According to BROCH (1922), each median segment of the anterior ramus has only two teeth. In the present specimens, however, the number of teeth on each segment varies as much as one to ten, though mostly three to five. On the protopodite of the same cirrus there are 10 to 20. On the whole these variations are apparently dependant on the age of individuals. In a rather slender and elongated segment the teeth are few in number. Such teeth are sometimes present in the median segments of the anterior ramus of cirrus V and also rarely in those of the posterior ramus of cirrus IV, though each always with 1 or 2 teeth.

The penis is very long, hairy and annulated all over. There is no basidorsal point.

Distribution: Japan (Misaki, Seto, Toba, usually living in *Reniera*), Philippine and Malay Archipelagoes.

48. *Acasta flexuosa* (NILSSON-CANTELL, 1931).
(Fig. 35)

Pseudoacasta (?) *flexuosa* NILSSON-CANTELL, 1931 (May).

Acasta amakusana HIRO, 1931 (Nov.).

Acasta amakusana described by HIRO (Nov., 1931) from Amakusa, South Japan is apparently synonymous with *Pseudoacasta* (?) *flexuosa* described by NILSSON-CANTELL (May, 1931) from an unknown locality of North Japan. The former specific name must be given up, because it is preceded by the latter a few months. This species is found also in somewhat deep water off Seto. NILSSON-CANTELL

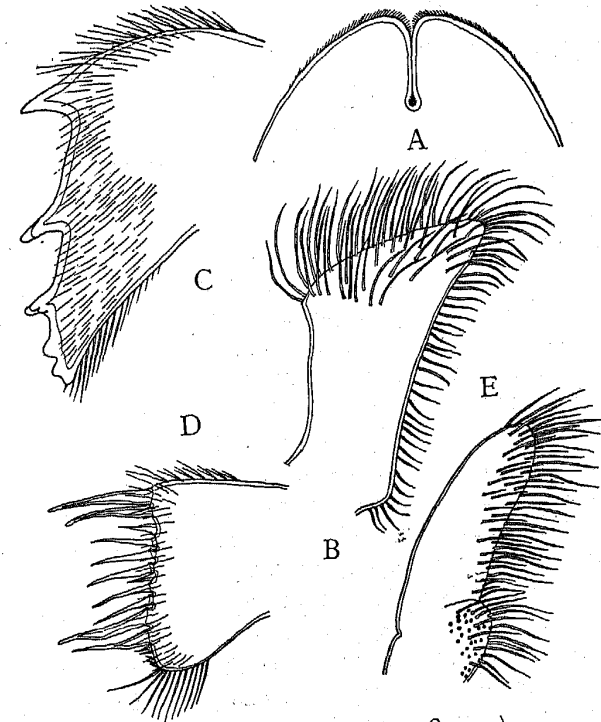


Fig. 35. *Acasta flexuosa* (NILSSON-CANTELL).

A, labrum. B, palpus. C, mandible. D, maxilla I. E, maxilla II.

ranked it in his own genus *Pseudoacasta* (the type: *P. libera* NILSSON-CANTELL, 1930a, b), but with a question mark. Judging from his description, the absence of the radii is apparently the only differential character of *Pseudoacasta*, since in most species of *Acasta* the radii are comparatively broad and even wider than the alae. However, it is a rather variable character throughout the balanids. In my opinion, therefore, it is better to consider *Acasta* as a group in more enlarged sense, as I mentioned before.

The external structure of the shell, as well as the opercular valves, is described fully by NILSSON-CANTELL, but not the internal parts.

Measurements of some specimens in mm:

Carino-rostral diameter	9.0	8.0	7.0	6.5
Height of carina	9.5	7.5	8.5	7.0
Depth of basal cup	7.5	4.5	5.0	5.5

The scutum is small, somewhat thick and as high as broad or a little higher. The basal margin is slightly convex and a little pointed suggesting a denticle in the middle. Externally there are only smooth growth-lines, though marked with a slight longitudinal depression running from apex to base. The articular ridge is very low and about 1/3 as long as the tergal margin. The adductor ridge is absent but a shallow depression for the adductor muscle is defined. There is no pit for the lateral depressor muscle.

The tergum is flat, very thin and wider than the scutum. The articular ridge is feebly developed. The spur is short, about 2/5 as wide as the basal margin and obliquely truncated. No crest for the depressor muscle, though according to NILSSON-CANTELL a crest is present. Externally a shallow furrow runs from the apex to the spur.

Mouth-parts: The labrum is hairy but without teeth on either side of a deep notch in a specimen dissected.

The palpus is elongately club-shaped; the distal margin is convex and both the inner and outer margins are slightly concave.

The mandible has five teeth, of which the second and third are bifid, and a lower angle with a spinule.

The maxilla I is broad and with a feeble notch indicated below the two upper spines.

The maxilla II has the upper lobe elongated and club-shaped; the lower lobe is small and oval. Both the lobes are furnished with bristles along the inner margin.

Numbers of segments of the cirri:

Carino-rost. Diam. 8mm.	I		II		III		IV		V		VI	
		22	7	10	9	13	13	19	22	24	24	26

Cirri I to III are not different from those of the other forms of *Acasta* about the comparative length of their rami. The armature of cirrus IV is very characteristic; each segment of the anterior ramus as well as the protopodite bears no trace of teeth, but along the posterior margin of the lowest segment of the anterior ramus there is a row of small teeth decreasing upwards in size. Each segment of the longer cirri is armed with two or three pairs of spines on the frontal edge, which is a little swollen.

The penis is very long, hairy and annulated all over.

Distribution: Japan.

49. *Acasta cancellorum* HIRO, 1931.

(Figs. 36, 37)

Acasta cancellorum HIRO, 1931.

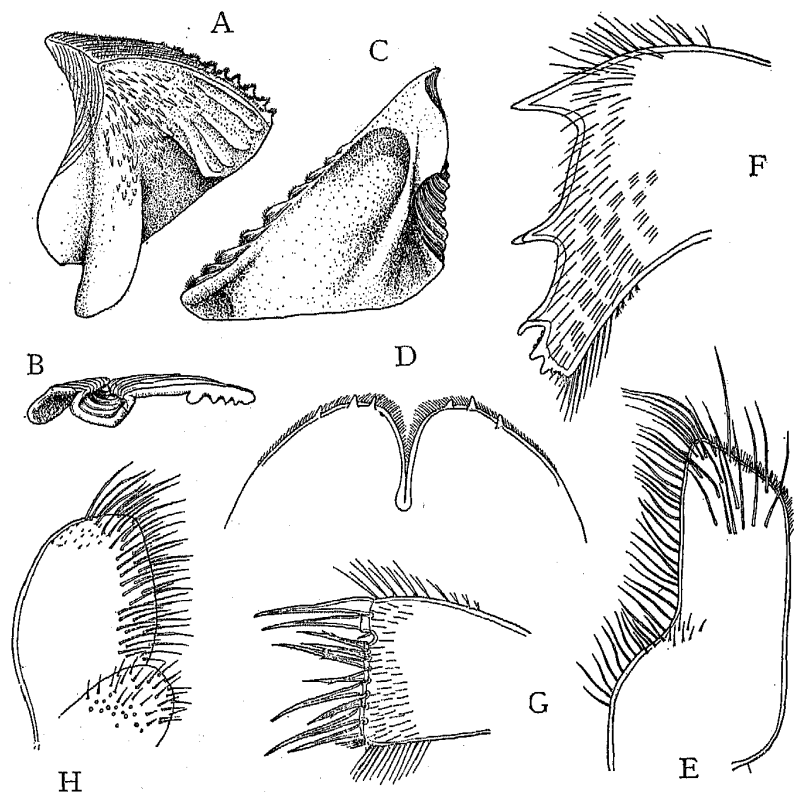
In external appearance, this species exhibits a closer resemblance to *Acasta sculpturata* BROCH (1931) from Java Sea than to any other species. Still there are some remarkable differences between them, particularly as regards the sculpture of the opercular valves and the armature of the cirri.

The shell, together with the basal cup, shows a globular shape and is white all over. The compartments are furnished with many small calcareous projections arranged in longitudinal rows, or sometimes irregularly; these projections are not hollow and may even disappear owing to the corrosion of the surface. The parietes are marked with distinct growth-lines from base to apex and also with deep longitudinal incisions in places on the lower half, as seen in *A. sculpturata*, but there are no 'slits' or 'openings'. The carino-lateral compartment is rather large and about 1/2 to 3/5 as wide as the lateral compartment. The apices of all the compartments are strongly curved inwards, so that the orifice is very small. The radii and alae are broad and have very oblique summits. The internal side of the parietes is quite smooth or somewhat rugged; the sheath occupying the upper half of the wall is marked with faint growth-lines.

The base as well as the wall is very thick and solid, and is bowl-shaped. Its upper edge is dentate here and there.

Measurements of some specimens in mm:

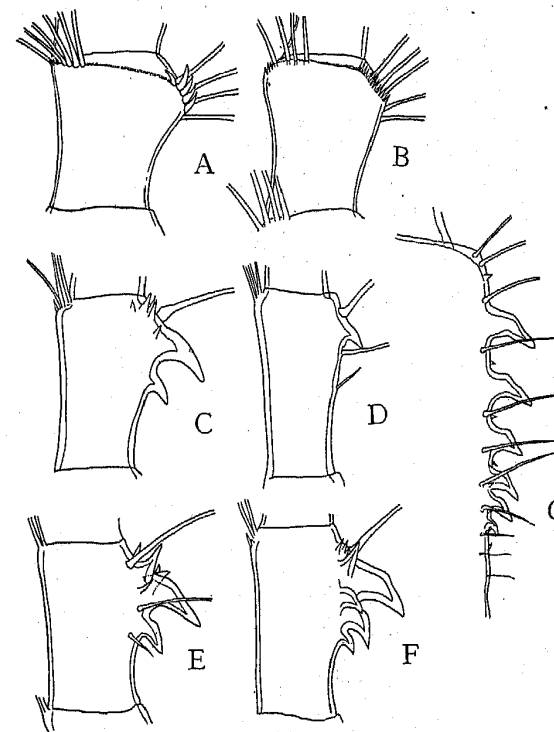
Carino-rostral diameter	9.7	9.4	9.0	8.2	7.5
Total height	12.2	12.0	12.0	10.4	9.0

Fig. 36. *Acasta cancellorum* HIRO.

A, internal view of scutum. B, basal view of scutum. C, internal view of tergum. D, labrum. E, palpus. F, mandible. G, maxilla I. H, maxilla II.

The scutum is thick and a little wider than high; its external surface is cancellated, but not so strongly as in the tergum, and is covered with a yellowish chitinous membrane which is hairy along the growth-ridges. The articular ridge is strongly developed and half as long as the tergal margin. The adductor ridge is very prominent and separated from the articular ridge by a narrow groove, but its middle portion attaches directly to the lower end of the articular ridge. The pits for the adductor and depressor muscles are distinct and broad. At the rostral corner there is a prominent pit for the rostral depressor muscle.

The tergum has well-developed growth-ridges crossed by deep and broad longitudinal furrows and covered with a yellowish chitinous

Fig. 37. *Acasta cancellorum* HIRO.

A, seventh segment of anterior ramus of cirrus III. B, seventh segment of posterior ramus of cirrus III. C, seventh segment of anterior ramus of cirrus IV. D, seventh segment of posterior ramus of cirrus IV. E, fifth segment of anterior ramus of cirrus IV. F, sixth segment of anterior ramus of cirrus IV. G, distal segment of protopodite of cirrus IV. (A-D, in the same specimen; E-G, in another specimen. All figs. $\times 150$.)

membrane. Externally a deep and broad groove runs from the apex to the spur; this groove is closed like a hollow tube, except on the spur itself where it is open. The spur is strongly developed, $1/4$ the width of the basal margin and roundly truncated. The scutal margin is shaped like the letter S. The articular furrow is very shallow, the articular ridge being scarcely raised. The internal surface is strongly rugged with many sharp spines. The crests for the depressor muscles are remarkable and usually 4 in number. Between these crests and the internal ridge of the spur there is a broad and triangular interspace which is a little sunken.

Mouth-parts: The labrum is hairy with three teeth on each side of the median deep notch.

The palpus is elongately club-shaped.

The mandible has five distinct teeth of which the second and third are bifurcate; the upper margin of the fourth is usually rugged or slightly pectinate. The lower angle varies, from having two or three short spinules to being evenly rugged.

The maxilla I has a small but distinct notch along the straight frontal edge. The spines situated in the median part are sometimes denticulate on either side.

The maxilla II is bilobate, with the appearance typical of this genus.

The armature of the cirri exhibits some peculiarities which are not seen in any other species. The numbers of segments are as follows:

Carino-rostral diam. 7.5 mm.	I	II	III	IV	V	VI
	19	7 11	8 16 12	26 29	30 31	35 32

In cirrus I, the anterior ramus is one-third as long as the posterior. Cirri II and III have the anterior ramus somewhat longer than the posterior. In cirrus III, both the rami bear a comb-like row of erect teeth on the distal angle at the base of a row of spines in each segment; these teeth are minute and numerous in the posterior ramus, while in the anterior they are strong and 4 to 7 in number, as seen in *Membranobalanus*. In cirrus IV, each segment of the anterior ramus is armed with several upward and downward recurved, additional teeth around 1 to 3 downward recurved, strong teeth at the frontal edge. In the posterior ramus of the same cirrus, each segment has usually a recurved strong tooth, but often none. The protopodite of the same cirrus has also 5 or 6 stronger hook-like teeth on the upper half of the distal segment; in addition there is a minute tooth each between these strong hook-like teeth. The other two posterior cirri have three pairs of ventral spines and a minute erect tooth and a tuft of spines at the posterior distal angle in each segment.

The penis is annulated all over and about as long as cirrus VI. A well-developed basidorsal point is present.

Distribution: Seto. Imbedded in tetraxon sponges, associated with *Acasta sulcata*.

50. *Acasta pectinipes* PILSBRY, 1912.
(Fig. 38)

Acasta pectinipes PILSBRY, 1912, 1916; BROCH, 1922, 1931; BARNARD, 1924, 1925.
Acasta nitida HOEK, 1913.
Acasta Komaii HIRO, 1931.

In my preliminary description of *Acasta Komaii* HIRO (1931), I mentioned that the surface of the compartments is smooth in the species. However, a closer reexamination of richer material at hand revealed that this character is variable, various degrees of sculpture of the compartments being met with.

In *Acasta nitida* HOEK, which according to PILSBRY (1916) corresponds to *A. pectinipes* PILSBRY (1912), the prickly longitudinal ribs on the compartments are developed and few in number, viz., five on the rostrum, four on the lateral, two on the carina and two on the carinolateral plate. About this point, PILSBRY gave no detailed description for his *A. pectinipes*; but the present specimens agree well with BARNARD's note, for the latter species from South Africa, that "The number of external 'prickly threads' varies, increasing with age. The strength of these 'prickles' also varies, some being smooth points, the others being almost tuberculate and strongly scabrous." These prickles arranged on longitudinal ribs are generally so minute as to escape notice and may even be absent, as earlier described for *A. Komaii*. They are delicately arranged in reticulated structure. The number of the internal ribs which correspond with the interspaces between the external ribs are more than that of the external ribs, as follows:

		Rostrum	Lat.	Car.-lat.	Carina
Carino-rost. d. 6 mm	{Ext. ribs	20	15	1	13
	{Int. ribs	25	16	1	19
Carino-rost. d. 5 mm	{Ext. ribs	13	7	1	12*
	{Int. ribs	22	18	2	13

*) Of these, 5 are strongly developed as figured for HOEK's *A. nitida*.

In each compartment, the paries has externally two broad and smooth areas along the side margin extending from apex to base, viz. a radiiform area at the side of the true radius and an aliform area at the side of the true ala. This feature, which is shared also by *A. echinata* HIRO (1937a), has not yet been described by any previous authors for this species. There are very narrow membrane-covered slits between these smooth areas of the parietes. Accordingly, the radii and alae do not reach the base and both are a little longer than half the whole length of the compartment.

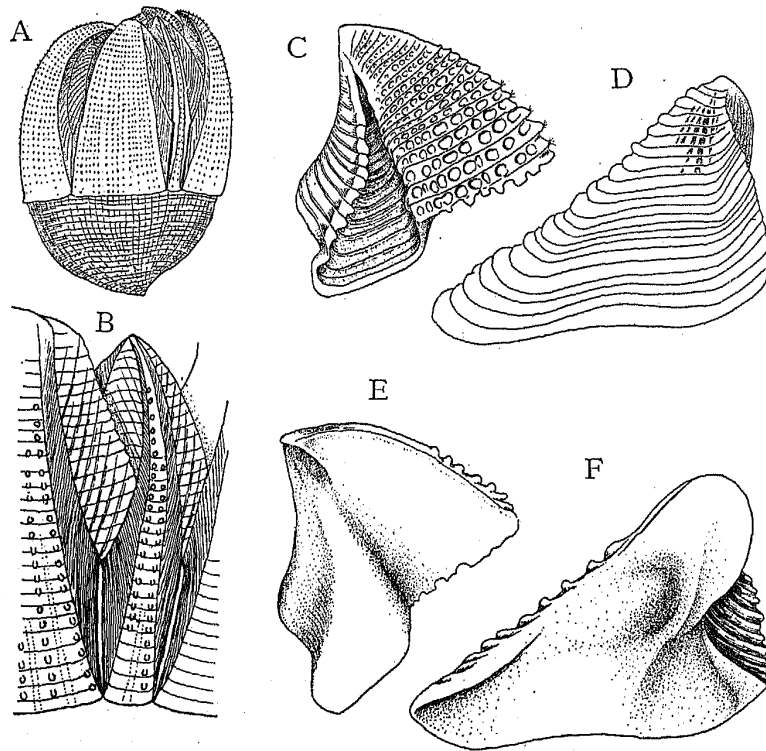


Fig. 38. *Acasta pectinipes* PILSBRY.

A, lateral view of specimen. $\times 4$. B, external view of carinolateral compartment and its surrounding (The dotted lines indicate the position of the internal ribs). C, external view of tergum. D, external view of scutum. E, internal view of tergum. F, internal view of scutum.

The opercular valves and the mouth-parts agree with the previous descriptions.

In numbers of segments and armature of the cirri, the Japanese form approaches the Malayan form described by HOEK more than the South African form described by BARNARD. For comparison with the present specimens the two authors' descriptions are cited below.

	I		II		III		IV		V		VI	
The present specimen C. -r. diam. 5 mm.	15	7	9	7	11	11	19	22	24	23	23	25
HOEK's specimen	18	8	12	9	12	11	24	—	26	28	30	30
BARNARD's specimen	19	7	10	8	13	12	24	30	35	35	40	40

In cirrus IV, the distal segment of the protopodite and the lower

segments of the anterior ramus, and also sometimes the median segments of the posterior ramus bear strongly recurved teeth. Similar teeth are often met with in the anterior ramus of cirrus V. The numbers of these teeth on each segment are as follows:

Specimens	Cirrus	Protopodite	Anterior ramus	Posterior ramus
A	IV	17	1 to 5 (in I-XVI)	0
B	IV	19	2 to 5 (in I-XVI)	1 to 6 (in X-XXVI)
	V	0	1 to 2 (in VIII-XIV)	0

The shell is white or slightly pinkish, but usually its apex around the orifice is dark bluish-green colored owing to minute algae growing over the surface.

It is interesting to note the fact that in the vicinity of Seto this species is found only living in *Reniera*, common in the littoral zone, associated with *A. Dofleini*. While the foreign specimens of this species have hitherto been reported from deep water.

Distribution: Philippine Islands in 18 fms., Malay Archipelago in 10-50 m, South Africa in 17-85 fms., Japan (Gotô Islands in 82 m).

Genus *Creusia* LEACH

Concerning the structure of the species of *Creusia* and *Pyrgoma*, associated with corals, I have already given detailed descriptions (HIRO, 1935), so that nothing need be added here. However, some additional notes about their habitats with the revised names of host corals may be given.

51. *Creusia spinulosa* var. *eu-spinulosa* BROCH, 1931.
(Fig. 39)

The opercular valves of the specimens from Seto somewhat differ from those of the type of DARWIN's var. 1. This identification is rather provisional even now. Here I give only a figure of the mouth-parts of this form for comparison with those of *Pyrgoma*.

This form is always found on *Acropora*.

Distribution: Indian and Malayan Coral Reefs, Japan (Seto).

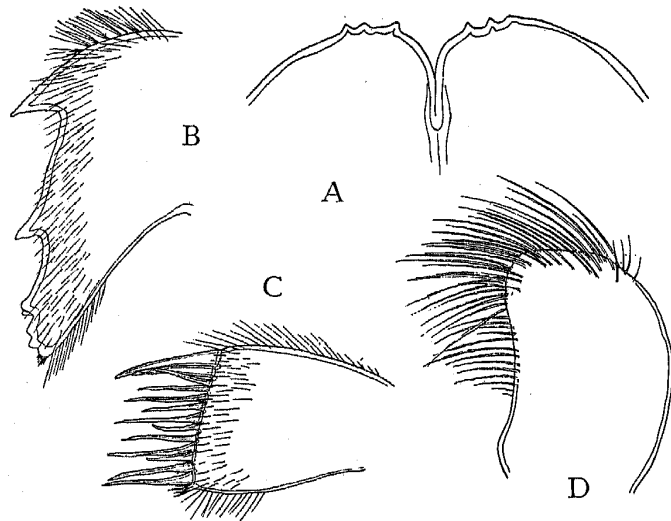


Fig. 39. *Creusia spinulosa* var. *eu-spinulosa* BROCH.
A, labrum. B, mandible. C, maxilla I. D, palpus.

52. *Creusia spinulosa* var. *pallida* BROCH, 1931.

This form is found commonly on *Alveopora* cfr. *verrilliana*, *Caulastraea tumida*, *C. tumida* f. *conglobata*, *C. tumida* f. *gracilis*, *C. tumida* f. *multiseptata*, *Coeloria* (= *Maeandra*) *lamellina*, *Cyphastrea chalcidicum*, *Montipora* sp., *Pocillopora damicornis*, *Podabacia elegans lobata* f. *kiiensis*, *P. elegans lobata* f. *vanderhorsti*, *Stylocoeniella hanzawai* (= *Stylophora* sp.), and *Tridacophyllia lactuca* (= *Pectinia laciniata*). Specimens with the elongated base are scarce.

Distribution: Malayan Coral Reef, South Sea Islands, Japan (Seto).

53. *Creusia spinulosa* var. *angustiradiata* BROCH, 1931.

This form probably represents a distinct species of this genus. As formerly pointed out, *Pyrgoma indicum* ANNANDALE (1924) is undoubtedly synonymous with this form. It is very common on such corals as *Favia speciosa*, *Favites fava* (formerly written as *F. virens*), *Caulastraea tumida*, *C. tumida* f. *gracilis*, *Hydnophora exesa*, *Leptastrea purpurea*, *Oxyphyllia aspera* (formerly written as *Mycedium* sp.), *Podabacia elegans*, *P. elegans lobata*, *P. elegans lobata* f. *kiiensis*, and *Tridacophyllia lactuca*.

Distribution: Indian and Malayan Coral Reefs, South Sea Islands, Japan (Seto).

Genus *Pyrgoma* LEACH

54. *Pyrgoma anglicum* SOWERBY, 1823.

This species shows a rather wide distribution, both geographically and bathymetrically. In the North Atlantic Ocean, it is usually found attached to deep-sea corals such as *Caryophyllia*, while in warmer waters it is often found attached to reef-building corals. I found two specimens on *Psammocora profundacella* and several specimens on *Dendrophyllia* sp. From the Pleistocene of Makuta-mura, Tiba-ken, SAKAKURA (1934) found this species attached to *Heterocyathus* (*Stephanoseris*) *carthausi*.

Distribution: North Atlantic, Mediterranean, Malay Archipelago, Japan (Seto, Sagami Bay).

55. *Pyrgoma cancellatum* LEACH, 1824.

Lodged on *Turbinaria contorta* and *Dendrophyllia micranthus*.

Distribution: Bay of Bengal, South Sea Islands, Japan (Tōkyō Bay, Seto).

56. *Pyrgoma dentatum* DARWIN, 1854.

This species is scarcely represented in Tanabe Bay and found on *Tridacophyllia lactuca* (op. cit.) only.

Distribution: West Indies (?), Red Sea, Malay Archipelago, South Sea Islands, Japan (Seto).

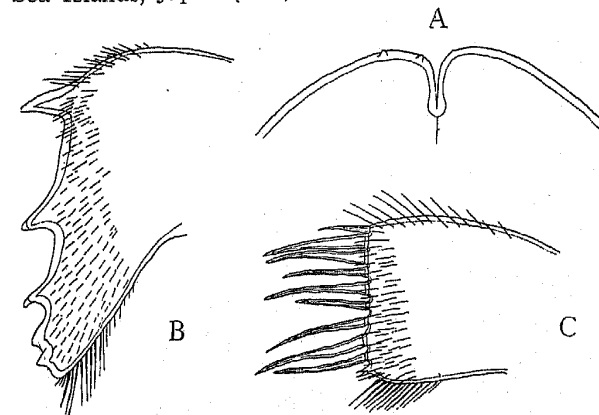


Fig. 40. *Pyrgoma crenatum* SOWERBY.
A, labrum. B, mandible. C, maxilla I.

57. *Pyrgoma crenatum* SOWERBY, 1823.
(Fig. 40)

Found abundantly on *Oxyphyllia aspera* (op. cit.) and *Tridacophyllia lactuca*.

Distribution: Malayan and Indian Coral Reefs, South Sea Islands, Japan (Seto).

58. *Pyrgoma conjugatum* DARWIN, 1854.

The measurements of four specimens from *Orbicella versipora* given in my former paper (HIRO, 1935) as "*Pyrgoma crenatum*" were given mistakenly for those of *Pyrgoma conjugatum* taken from *Cyphastrea chalcidicum*. This is confirmed also by the fact that the number of radiating ridges on the shell of this species is more than that of *P. crenatum*.

Distribution: Red Sea, Ceylon (?), Japan (Seto).

59. *Pyrgoma grande* (SOWERBY, Jr., 1839).

Found on *Euphyllia fimbriata*.

This species is found also on *Galaxea fascicularis*, *Galaxea musicalis* and *Coeloseris mayeri* which are known to occur in Ryūkyū, Ogasawara Islands, and further southwards.

Distribution: Malayan and Indian Coral Reefs, South Sea Islands, Japan (Ogasawara Islands, Seto).

60. *Pyrgoma orbicellae* HIRO, 1934.

Found exclusively on the species of *Goniopora* everywhere.

Distribution: Japan (Seto, Ryūkyū Islands), South Sea Islands.

61. *Pyrgoma monticulariae* GRAY, 1831.

Exclusively found only on *Hydnophora exesa*.

Distribution: Singapore, Indian and Malayan Coral Reefs, Japan (Seto).

62. *Pyrgoma elongatum* HIRO, 1931.

Lodged on *Tridacophyllia lactuca* and *Favia speciosa*, but rare in Tanabe Bay.

Distribution: Japan (Seto), South Sea Islands.

Subfamily Tetracitinae NILSSON-CANTELL

Genus *Tetraclita* SCHUMACHER

63. *Tetraclita purpurascens nipponensis* HIRO, 1931.

Tetraclita purpurascens nipponensis HIRO, 1931, 1932a.

This subspecies is commonly found attached to *Mitella mitella* and sometimes on rocks in the littoral zone. The radial ribs on the parietes are few in number as compared with those of other subspecies, each paries having usually three distinct ribs, or sometimes more. The color is variable, but usually grayish white. In the scutum, the adductor ridge is well-developed and the basal margin is hollowed out at the end of the adductor ridge near the rostral angle, though not so strongly as figured for *T. purpurascens chinensis* NILSSON-CANTELL (1921). The internal parts are similar to those of other subspecies.

64. *Tetraclita squamosa japonica* PILSBRY, 1916.

Tetraclita porosa var. *rubescens* WELTNER, 1897 (from Nagasaki).

Tetraclita porosa var. *nigrescens* KRÜGER, 1911.

Tetraclita squamosa japonica PILSBRY, 1916; HIRO, 1932a, 1932b.

Tetraclita porosa japonica NILSSON-CANTELL, 1927, 1931, 1932a.

This subspecies is very prevalent on rocks in the littoral zone surrounding the mainland of Japan.

Distribution: Japan, Korea.

65. *Tetraclita squamosa viridis* DARWIN, 1854.

This subspecies is not so common on the mainland of Japan as the former subspecies, for its occurrence seems to be restricted only in the Pacific coast of South Japan under the influence of the Kuroshio. In the vicinity of Seto it is found commonly, but not so abundantly as in the subspecies *japonica*.

Distribution: Pacific coast of S. Japan north to Sagami Bay, S. China, South Sea Islands, Malay Archipelago, Australia, West Africa (?), Panama Bay (after BROCH, 1922).

66. *Tetraclita darwini* PILSBRY, 1928.

Tetraclita darwini PILSBRY, 1928; NILSSON-CANTELL, 1931.

This peculiar species has been described and figured by PILSBRY (1928), so that further descriptions are scarcely needed. It is not often found in this district.

Distribution: Japan.

Subfamily *Chelonibiinae* PILSBRYGenus *Chelonibia* LEACH

67. *Chelonibia testudinaria* (LINNÉ, 1758).
(Fig. 41)

Syn. NILSSON-CANTELL, 1921.

This common turtle barnacle is found attached to the carapace of *Caretta olivacea* ESCHSCHOLTZ which is captured in front of the Labo-

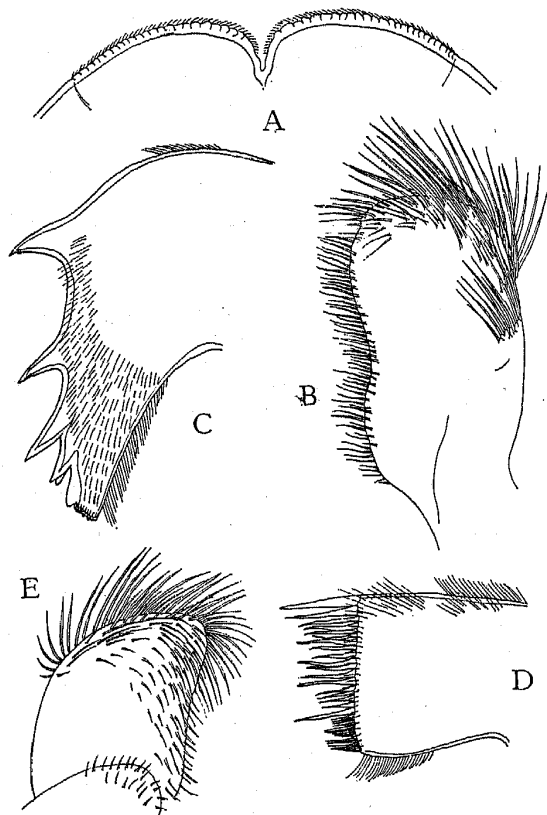


Fig. 41. *Chelonibia testudinaria* (LINNÉ).

A, labrum. B, palpus. C, mandible. D, maxilla I. E, maxilla II.

ratory in the summer of every year. The largest specimen I have seen measures 78 mm in carinorostral diameter and 21 mm in height.

Distribution: All tropical and warm temperate seas. On turtles.

Subfamily *Coronulinae* (LEACH) PILSBRYGenus *Coronula* LAMARCK

68. *Coronula diadema* (LINNÉ, 1767).
(Fig. 42)

Syn. NILSSON-CANTELL, 1921.

The specimens examined here were probably obtained from the Humpback whale, *Megaptera nojosa* (BONNATERRE). Of these

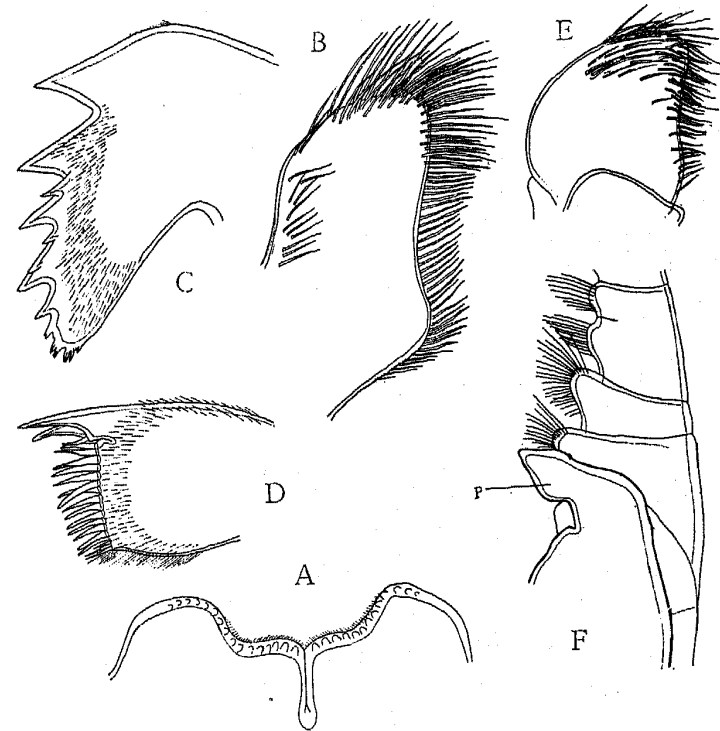


Fig. 42. *Coronula diadema* (LINNÉ).

A, labrum. B, palpus. C, mandible. D, maxilla I. E, maxilla II. F, lower part of cirrus VI and penis (p).

the largest one measures 67 mm in carino-rostral diameter and 32 mm in height.

Distribution: Probably cosmopolitan. On whales.

Genus *Platylepas* GRAY

69. *Platylepas hexastylus* (O. FABRICIUS, 1798).
(Fig. 43)

Syn. PILSBRY, 1916.

This species is very common on the sea turtles, *Caretta olivacea* ESCHSCHOLTZ and *Chelonia japonica* (THUNBERG). The specimens are usually attached to the soft skin between the carapace and

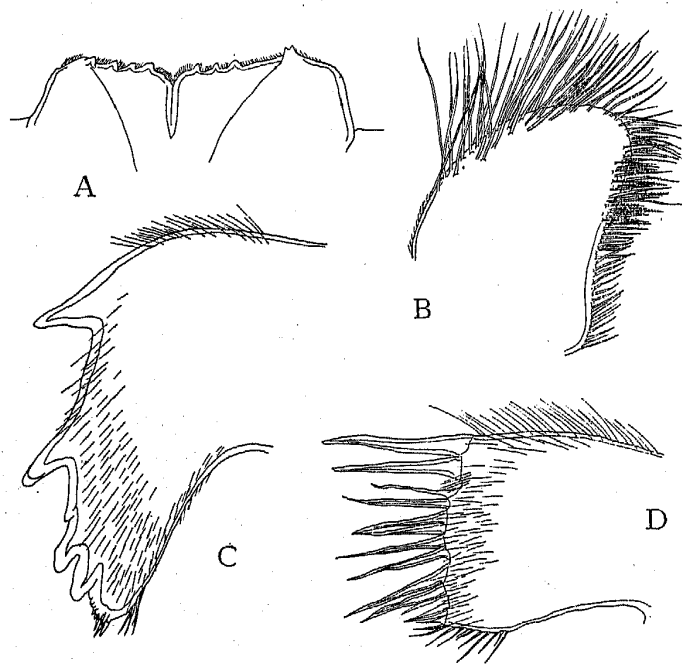


Fig. 43. *Platylepas hexastylus* (O. FABRICIUS).
A, labrum. B, palpus. C, mandible. D, maxilla I.

plastron, and also on the four legs. Sometimes they are deeply embedded between the marginal plates of the carapace. RICHARDS (1930) reported this species attached to the skull of *Chelonia mydas* (LINNÉ) taken from New Jersey, Atlantic coast of North America. However, I have not met with such a case as yet. The largest specimen I have seen was 15 mm in carino-rostral diameter and 4 mm in height.

The external appearance agrees well with the descriptions and figures given by DARWIN (1854) and PILSBRY (1916). The mouth-

parts have been figured by KRÜGER (1911), but the other internal parts were not described.

Mouth-parts: The labrum is rather small and has three teeth on each side of a deep median notch. Besides, there is a tooth at each anterolateral corner, widely separated from the other teeth.

The palpus is club-shaped and furnished with long bristles along the rounded distal end and the outer margin; the bristles on the straight inner margin in the median part are feathered, as in the other species of *Platylepas*.

The mandible has four strong teeth, of which the second and third are bifid, and a pectinated lower angle. Between the second and third teeth there is an additional tooth.

The maxilla I has a straight frontal edge with a slight notch beneath the upper two stronger spines.

The maxilla II is bilobed; the upper lobe is large and furnished with bristles along the straight inner margin and at the rounded end.

The numbers of segments of the cirri are as follows:

I	II	III	IV	V	VI
14	7	10	8	11	10
20	19	21	23	27	26

Cirrus I has its anterior ramus about twice as long as the posterior. In cirri II and III, the posterior ramus is a little longer than the anterior. The remaining three longer cirri have almost equally long rami; each segment is usually armed with four pairs of ventral spines and also with a dense tuft of small dorsal spines at the distal end.

The penis is very long and annulated.

Distribution: All tropical and subtropical seas. On turtles, manatees and dugong. A variety on *Lepidosteus*.

Genus *Stomatolepas* PILSBRY

70. *Stomatolepas elegans* (COSTA, 1838).

Coronula elegans COSTA, 1838 (after PILSBRY, 1916).

Chelonibia elegans COSTA, 1839 (after PILSBRY, 1916).

Stomatolepas elegans PILSBRY, 1916; HIRO, 1936b.

Stomatolepas praegustator PILSBRY, 1910, 1916.

? *Stomatolepas transversa* NILSSON-CANTELL, 1930a, b.

This little known species has already been described fully by HIRO (1936b) with a discussion of the synonymy. The specimens were found embedded in the soft skin of *Caretta olivacea*, together with *Platylepas hexastylus*.

Distribution: Taranto, Italy (Mediterranean); Tortugas, Florida (W. Atlantic); Aroe Archipelago (W. Pacific); Seto, Japan.

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APPENDIX

Family Trilasmatidae (ANNANDALE) NILSSON-CANTELL

Genus Trilasmis (HINDS) PILSBRY

71. *Trilasmis (Trilasmis) eburnea* HINDS, 1844.

Trilasmis eburnea HINDS, 1844; NILSSON-CANTELL, 1934a.

Trilasmis eburneum PILSBRY, 1907c.

Trilaspis eburnea BROCH, 1931.

Poecilasma eburnea DARWIN, 1851.

Poecilasma eburneum WELTNER, 1897; GRUVEL, 1905; HOEK, 1907; ANNANDALE, 1907.

Very recently (13 IV, 1937) I have found a single specimen attached to a spine of an echinoid, *Leiocidaris baculosa* (LAMARCK) which was obtained from off Tonda near Seto at a depth of ca. 50 m. From its peculiar shape I referred this specimen to *Trilasmis eburnea* without any hesitation. This is the first record of

this curious species from Japan. The specimen is small, the capitulum being 4.3 mm in length and 2.7 mm in breadth and the peduncle 1.5 mm in length and 1.7 mm in breadth. The color of the shell is white and the peduncle is purplish in living state, though fading away in spirit.

Distribution: This species has hitherto been recorded from the Malay Archipelago, Hawaiian Islands and northern part of the Indian Ocean, with a questionable record of its occurrence in Red Sea by WELTNER (1897). In the Malayan region its host seems, according to previous reports, to be limited to two echinoids, *Prionocidaris bispinosa* (HOEK, 1907; BROCH, 1931; NILSSON-CANTELL, 1934a) and *Salmacis virgulata* (BROCH, 1931).

Genus *Octolasmis* GRAY

72. *Octolasmis Warwicki* J. E. GRAY, 1825.

Syn. NILSSON-CANTELL, 1928a.

Of this species two large individuals were found attached to the carapace of the crab, *Carcinoplax longimanus* (DE HAAN) at a depth of ca. 25 m in Tanabe Bay. The largest specimen measured 8.5 mm in length of capitulum, 5.3 mm in breadth of capitulum, 5 mm in length of peduncle and 2.3 mm in breadth of peduncle.

Distribution: Hitherto recorded from South China Sea to Indian Ocean. Usually attached to crabs. *

Bopyrids from Tanabe Bay IV

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With 10 Text-figures

(Received June 3, 1937)

The present paper is a continuation of my earlier ones (1933, 1934, 1936). Four species described here are new to science, 2 of them even constituting new genera. The following is the list of the species:

Pseudione longicauda n. sp.

Procepon insolitum n. gen. & n. sp.

Portunicepon tiariniae n. sp.

Anomophryxus deformatus n. gen. & n. sp.

Gen. PSEUDIONE KOSSMANN

1881, R. KOSSMANN, Zeitschr. Wiss. Zool., vol. 35, p. 663.

Pseudione longicauda n. sp.

Female (fig. 1, A & B): Asymmetrical, dorsal flat, ventral convex. No pigment. Length excluding uropoda 5.4 mm., width 3.5 mm.

Cephalon round, slightly bilobed in front, distinct from thorax. Frontal lamina narrow, produced on each side. Eye absent.

Thoracic segments separate, with bilobed margin. Postero-lateral parts well developed in first 4 segments, much reduced and retreating from general outline of thorax in last 3 segments. Coxal plates present in first 4 segments, much reduced and irregular in shape. Ovarian bosses conspicuous only in 2nd to 4th segments. Anterior