

AN ACCOUNT OF THE INDIAN CIRRIPEDIA PEDUNCULATA.

By N. ANNANDALE, B.A., D.Sc., Superintendent, Indian Museum.

PREFACE.

The publication of Dr. P. P. C. Hoek's account of the Cirripedia Pedunculata collected in the Malay Archipelago by the "Siboga" Expedition,¹ and of several important papers dealing with the Pacific species by Dr. H. A. Pilsbry,² affords an occasion for revising the Indian collection in Calcutta. This collection is very nearly complete as regards specimens of the species as yet recorded from the seas of British India, but its chief importance lies in the fact that many of these species are represented by large numbers of individuals. A considerable proportion of the specimens has been collected by succeeding Surgeon-Naturalists on the R.I.M.S. ship "Investigator," but a large proportion has also been obtained from other sources. This is particularly the case as regards the family dealt with in this paper, many of its representatives being shallow-water forms. I am greatly indebted to Dr. P. N. van Kampen of the Dutch Fishery Board in Java, to Dr. W. T. Calman of the British Museum, to Dr. H. J. Hansen of Copenhagen, and to Prof. E. L. Bouvier of Paris for assistance in filling in gaps in the collection, while I owe the opportunity of investigating several of the semi-parasitic species largely to the specimens recently obtained by the Bengal Government's steam trawler "Golden Crown." The acquisition of new material from these sources has in many cases made it necessary to reconsider opinions I had previously expressed.

In the present contribution to the study of the Indian Cirripedes I propose to deal with those forms which may be conveniently referred to the family Lepadidæ in a restricted sense. The Pedunculata (that is to say, the Lepadidæ of older authors) have been variously subdivided, and it is perhaps impossible to discover a scheme for their classification that would satisfy all authorities. The fact seems to be that few groups afford so many or such perfect instances of convergence or adaptive resemblance. There is every justification for the belief that the primitive Cirripede was provided with a large number of calcareous plates or valves, and that from this ancestor evolution has taken place in several different directions both as regards the valves and as regards the internal anatomy of the animal and the various appendages

¹ "The Cirripedia of the Siboga Expedition," *Siboga-Expeditie*, A—Cirripedia Pedunculata, Monograph xxxia, 1907 (Leyden).

² "Notes on some Pacific Cirripedes," *Proc. Acad. Nat. Sci. Philadelphia*, July, 1907, p. 360; "Notes on the Cirripede genus *Megalasma*," *ibid.*, September, 1907, p. 408; "Hawaiian Cirripedia," *Bull. Bureau of Fisheries*, vol. xxvi, p. 181 (1907); "The Barnacles (Cirripedia) contained in the collections of the U. S. Nat. Museum," *Bull. U. S. Nat. Museum*, No. 60 (1907).

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PART I.—FAMILY LEPADIDÆ (*sensu stricto*).

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and processes with which it is provided. No matter how the group is subdivided, however, it is necessary to include in each subdivision forms in which the valves have become degenerate in accordance with a semi-parasitic mode of life. In some cases it is only the dwarfed and otherwise degenerate males which exhibit this feature, while in others the large hermaphrodites do so. Moreover, it is necessary to recognize that even within the limits of a single family both divergence and convergence may take place in the course of evolution. It is clear, for instance, that the genera *Dichelaspis* and *Conchoderma* are not very closely allied to one another; yet evolution has taken a similar direction in each of them, and has produced similar results, which are to some extent correlated with a similar mode of life. It is the fact of convergence that makes it so difficult to subdivide the group, for it is often impossible to say whether a similarity in any one organ or structure is due to direct phylogenetic relationship or to parallel evolution, while the value that is to be given to each character is a matter that calls for the nicest discrimination—which, indeed, must always remain largely a matter of opinion.

In these circumstances it seems best to build the system of classification on as broad a basis as possible, and, after considerable hesitation, I have decided to adopt that put forward in Gruvel's *Monographie des Cirrhipèdes* (1905), with certain modifications rendered necessary by more recent investigations. Gruvel recognizes the following families and subfamilies:—

Family I.—POLYASPIDÆ.

Subfamily (a).—POLLICIPINÆ (genera, *Pollicipes*, *Scalpellum*).

Subfamily (b).—LITHOTRYNÆ (genus, *Lithotrya*).

Family II.—PENTASPIDÆ.

Subfamily (a).—OXYNASPINÆ (genus, *Oxynaspis*).

Subfamily (b).—LEPADINÆ (genera, *Lepas*, *Megalasma*, *Pæcilasma*, *Dichelaspis*, *Conchoderma*).

Family III.—TETRASPIDÆ (genus, *Ibla*).

Family IV.—ANASPIDÆ.

Subfamily (a).—ALEPADINÆ (genus, *Alepas*).

Subfamily (b).—ANELASMINÆ (genera, *Chætolepas*, *Gymnolepas*, *Anelasma*).

In criticising this arrangement the first point to be noted is that the names are not altogether satisfactory. It would have been both more convenient and more correct to call the families Pollicipedidæ, Lepadidæ, Iblidæ and Alepadidæ.

Apart from this, there are one or two features of the scheme that require alteration. Pilsbry¹ has recently pointed out that two very distinct genera have hitherto been confused under the name *Alepas*, and has proposed for all the species included under this name by Gruvel except the species first described (*Alepas parasitica*), the generic name *Heteralepas*. He has shown, further, that the genus *Gymnolepas* of C. W. Aurivillius is identical with Sander Rang's genus *Alepas*. This

¹ "The Barnacles (Cirrhipedia) contained in the collections of the U. S. Nat. Museum," *Bull. U. S. Nat. Mus.*, No. 60, p. 100 (1907).

being so, it is necessary to modify the arrangement of Gruvel's "Anaspidæ" pretty considerably. It is difficult, moreover, to separate *Heteralepas* very widely from *Conchoderma*, which, again, has indubitable affinities with *Lepas*. *Alepas* on the other hand, as restricted by Pilsbry, stands in some kind of relationship to *Chætolepas*, *Anelasma* and Hoek's new genus *Microlepas*. It is not altogether clear, however, how far this relationship is genetic, and as I have not seen any of these forms I cannot express a definite opinion. The four genera may be considered provisionally as forming a subfamily of the Lepadidæ.

There does not seem to be any very great gain in subdividing the "Polyaspidæ," the characters on which Gruvel bases the separation being clearly adaptive and connected with a difference of habits. I think it as well, however, to emphasize the close relationship between the genera *Pæcilasma*, *Megalasma* and *Dichelaspis* by regarding them as constituting a subfamily. For these reasons I propose to arrange the Pedunculata as follows:—

Suborder PEDUNCULATA.

-Family I.—POLLICIPEDIDÆ.

Pedunculate Cirripedes in which the capitulum bears more than five valves with distinct centres of calcification. The peduncle clothed with well-defined scales or plates. Cirri long and curved; lateral appendages present or absent; anal appendages usually well developed, consisting of several joints. Parasitic males in one genus. Genera—*Pollicipes*, *Scalpellum*, *Lithotrya*.

Family II.—IBLIDÆ.

Pedunculate Cirripedes in which the capitulum bears four chitinous plates, which contain calcareous salts in older individuals. Peduncle not very clearly differentiated from the capitulum, bearing chitinous spines at any rate in young individuals. Cirri long and curved; lateral appendages absent; anal appendages with several joints. Parasitic males occur. Genus—*Ibla*.

Family III.—LEPADIDÆ.

Pedunculate Cirripedes with a well-defined capitulum, which typically bears five calcified plates. In many species, however, these plates tend to break up or even to disappear altogether. Cirri long and curved; lateral appendages present or absent; anal appendages, when present, with a single joint or with several or many joints. Parasitic males not produced.

Subfamily (a).—OXYNASPIDINÆ.

Small species with five well-developed valves. The valves bearing small calcareous points and covered by a membrane studded with chitinous spines. Lateral appendages absent; anal appendages very small or absent. Prosoma feebly developed. Genus—*Oxynaspis*.

Subfamily (b).—LEPADINÆ.

Species typically with five valves which occupy the greater part of the surface of the capitulum. These valves frequently much reduced or

altogether absent but never showing any tendency to split up in a secondary manner. When they are absent or degenerate the membrane of the capitulum is greatly thickened; a muscular layer is sometimes present under the membrane. Lateral appendages normally present, only absent in a very few instances; anal appendages absent or consisting of a single claw-like joint, or multiarticulate. Mandibular teeth usually pectinate. Prosoma well developed. Genera—*Lepas*, *Conchoderma*, *Heteralepas*.

Subfamily (c).—PÆCILASMATINÆ.

Species in which the five valves, unless they are degenerate, cover the whole of the capitulum. If degenerate they tend to split up in a secondary manner, the scutum being split into two by a vertical break in most species. The valves may be almost entirely absent, but the capitular membrane is not much thickened and is not lined by a muscular layer. Lateral appendages absent; anal appendages with several joints. Mandibular teeth not regularly pectinate. Genera—*Pæcilasma*, *Dichelaspis*, *Megalasma*.

Subfamily (d).—ALEPADINÆ.

Degenerate pelagic forms with transparent membrane devoid of a muscular layer and with short, straight cirri. Valves absent or represented by the scutum only. Filamentous lateral appendages absent; anal appendages absent or consisting of a single joint. Mouth parts much simplified. Genera—*Alepas* (s. s.), *Chætolepas*, *Microlepas*, *Anelasma*, (?) *Koleolepas*.

All the genera included in this table are described in Gruvel's "Monographie" except (1) *Heteralepas*, which has recently been established by Pilsbry (1907) for the reception of most of the forms previously referred to *Alepas* and of several new species, and (2) *Microlepas*, which has recently been discovered by Hoek (1907) in the "Siboga" collection.

PART I.—FAMILY LEPADIDÆ (*sensu stricto*).

INTRODUCTION.

There are few groups in which the subdivision into genera and species is more difficult than it is in the Pedunculata, and perhaps this is the case more particularly as regards the Lepadidæ than as regards the more primitive forms included in the Pollicipedidæ. I have already dwelt on the part played by convergence in the history of the group as a whole, and it is perhaps in the Lepadidæ that this phenomenon is most manifest. Convergence, moreover, is here accompanied definitely by a marked tendency to variation, which is strongest in those forms most degenerate as regards their external characters (see plate vi). The early ancestor of the Cirripedes must have been a free-swimming crustacean devoid of regular calcareous plates, which developed on the integument of its descendants after they adopted a sedentary life.

In the Lepadidæ, however, these plates (or valves, as they are called) have no sooner attained in the course of their evolution a definite number, form and relationship to one another, than their history takes another course and they commence to break up and disappear. I have already remarked that even within the limits of this family it is possible to distinguish different groups in which this degeneracy of the valves does not appear to be due to a common ancestry but rather to the influence of a similar environment on forms which stand to one another in the relationship of distant cousins rather than ancestors and descendants. The degeneracy is not, however, of exactly the same nature in all cases.

In one species of the genus *Lepas* (*L. tenuivalvata*) the valves have almost disappeared owing to their lack of calcification. Their shape, however, still remains the typical one; they show no tendency to split up, and they cover practically the whole of the capitulum.

In the genus *Dichelaspis* a nicely graduated scale of progressive degeneracy occurs. In the most primitive species (e.g., *D. tridens* and *D. bathynomi*) the valves are still calcified and cover the greater part of the capitulum. The scutum, however, is split (as it is in several species of *Pæcilasma*) into two distinct segments, which diverge from one another slightly above, while the part of the same valve that is directed towards the carina has commenced to disappear to a degree differing in different individuals of the same species. Other species of the genus (e.g., *D. warwickii*) still have a considerable part of their capitulum covered by the valves, but the two branches of the scutum are more divergent and the tergum is much reduced in size. In such species also the extent of the degeneracy is a variable character. Again, we find other species (e.g., the typical form of *D. grayii*) in which the area covered by the five valves, which are still present, is relatively much smaller, and finally we arrive at forms in which some (or, in one case, all) of the valves have disappeared as calcified plates. In some specimens, however, of even the most degenerate forms it is generally possible to trace the outlines of the original five valves as raised lines on the integument, and often even the concentric lines on the calcified plate, representing the lines of growth, can still be traced on the soft tissues of the capitulum. This is the case as regards some individuals of *D. grayii* var. *pernuda*, in which there is no trace of calcification on any part of the capitulum.

Degeneration of the valves has taken a third course in *Conchoderma*, in which the membrane has become stout and the valves are very small (although never split up into secondary valves), altogether absent or devoid of calcium salts, while in *Heteralepas*, in which the thickening of the membrane is accompanied by a strong development of muscular tissue, the valves have practically disappeared, only the scutum persisting as a chitinous, ill-defined plate, and this only in some species. In neither of these genera is it ever possible to distinguish the outline of the original five valves on the capitulum.

These different types of external degeneracy are correlated with distinct differences in the structure of the appendages and therefore form a sound basis for the larger divisions of the family; it is worthy of note that they are not accompanied

(except to some extent in some species of the genus *Heteralepas*) by any degeneracy of the cirri and mouth parts such as characterizes the Alepadinæ.

The number and nature of the valves has formed the main consideration in all the systems of classification that have been worked out in detail as regards the Pedunculata, but the variation displayed by these structures is so great that it is often difficult to depend on them alone. Although, therefore, it is evident that even the appendages and mouth parts do not exhibit altogether constant generic and specific characters, they afford, considered together with the valves, most important information as regards the classification of the minor groups included in the Lepadidæ.

As regards the valves it may be noted that in some species (*e.g.*, in *Dichelaspis angulata* or *Conchoderma virgatum*) even the number of the primary valves is not constant, while their shape, relationship to one another and degree of calcification appear, if only a few specimens are examined, to provide sufficient justification for the subdivision of the species. When larger numbers of specimens are examined, however, it is seen that variation in any one character is not always or even usually correlated with variation in any other, so that, unless an indefinite number of species, based on various combinations and permutations of characters, is to be recognized, many forms which at first appeared distinct must be grouped together under one specific name.

The exact proportions of the various appendages, the arrangement of the hairs on each and the exact outline of those connected with the mouth have been regarded by some authors as characters so constant that they may, in the opinion of these authors, be considered as practically devoid of variation. In many species, however, the examination of a large number of specimens shows that not only (in the individuals examined) do these characters differ from published descriptions and figures, but also that they vary in different individuals captured in the same place and in identical conditions, although the limits of variation are sometimes narrower in their case than in that of the valves. For example, in three specimens of *Pæcilasma minutum* from the same specimen of *Panulirus* chosen at random and dissected consecutively, the anal appendages failed to reach the tip of the basal joint of the sixth cirri in one, greatly surpassed this point in the second, and just reached it in the third. In the genera *Dichelaspis* and *Pæcilasma*, moreover, the number of teeth is not always the same on the two mandibles of the same individual.

Such difficulties arise not only as regards species but also as regards genera. Darwin was abundantly justified in separating the species he grouped in the genus *Dichelaspis* from those he grouped in the genus *Pæcilasma*, although he recognized that the main, if not the only, difference between the two genera consisted in the degeneracy of the valves in *Dichelaspis*. Since his time, however, several species have been discovered which link the two genera together in such a way that any separation between them must be regarded as a purely artificial one, maintained for the sake of convenience and not on morphological grounds.

It is often convenient to recognize genera erected on a purely artificial basis, because it becomes extremely difficult to deal with long lists of species grouped under one generic name; but it should be clearly understood that the division in such cases

is artificial. The question need not arise as regards genera containing a small number of species, for in such cases it is clear that the multiplication of divisions is unnecessary and apt to confuse rather than elucidate. In the case of species, however, I am in favour of only recognizing those which are clearly different from one another and separated by a distinct gap in the line of variation. Narrow gaps as regards structure, which cannot be bridged over completely, exist between the offspring of a single parent or pair of parents, as we see in the larger animals, in which they are easily detected; and narrow gaps, a little wider in many cases, are clearly visible between the children of different parents. It is impossible to take notice of all such gaps, many of them being incapable of detection by the senses and rather inferred than proved to exist, while others, which can be detected, are so inconstant, and obey any known law so little, that to recognize them causes confusion and does not assist in a rational system of classification. There are other narrow gaps which can not only be detected but also proved to separate large groups of individuals to some slight extent. They are still so narrow, however, that they can only be detected by the closest study (or even by a comparison of specimens), and are not sufficiently marked to be used as arguments in proving any divergence in genetic relationship between the groups they separate.

Groups thus separated are peculiarly common in the Cirripedes and occur in many species of Lepadidæ. To regard them as distinct species would militate against any investigation of the geographical distribution of the group, and would only complicate its study from a morphological point of view. It must be clearly understood, moreover, that the gap which separates them is not of the same nature in all cases, or due to the same causes; and therefore it is inadvisable to call all of them either "varieties," "subspecies," or "races," or to designate them in any other way that fails to mark their divergence in character.

Apart from developmental phases, which have been little studied in the Lepadidæ and are not always easy to distinguish, we find that the smaller groups into which the species may be divided are mainly of two kinds. In the first place it is easy to prove that certain species are peculiarly liable to give rise to local races, the individuals of which are more or less constant among themselves and differ from individuals from any other locality. Such groups I have called races or subspecies. Another kind of group, however, occurs not infrequently, consisting of a number of individuals not separated by any geographical boundary from others of the same species but differing from the typical form (*i.e.*, the form first described) in unimportant characters, which may or may not be hereditary. Such groups I have called "varieties." In most cases there is nothing definite to prove whether the varieties of a species do or do not interbreed, but the probabilities are in favour of the former mode of propagation.

The best example of a species with different races that I know among the Lepadidæ is *Pæcilasma kæmpferi*, which occurs in its typical form in Japan and the S. Pacific but is represented by subspecies in several different parts of the Indian and Atlantic Oceans. True varieties are less common among the Lepadidæ than they are

among some other families of Cirripedes (for instance, in the genus *Balanus* in the Balanidæ) and I cannot find a very good example among the Indian species of the Lepadidæ, for in cases in which variation is most common and most extreme it is very difficult (and therefore inadvisable) to subdivide species at all, one of the first requisites of a sound classification being that it should be free from unnecessary complexities. The best example of a variety among the species described in this paper is the var. *fissicarina* of *Dichelaspis geryonophila*. This form has the carina split transversely, while the valve is entire in the typical form of the species, which occurs side by side with *fissicarina* on the same crab.

Distinct as the two kinds of groups into which species may be subdivided really are as regards origin, it is not always easy to say whether a group should be regarded as representing a variety or a race. The only way to settle such a question is to examine a very large number of specimens from different localities and districts that have been recorded accurately. Few museums possess collections of sufficient scope to render this possible, and even in cases in which it has been possible to examine series including hundreds of specimens from one or several localities, such series rarely represent more than one region or district. A case in which a difficulty of the kind arises is that of the forms assumed by *Conchoderma virgatum*. To some extent these several forms appear to have a geographical significance, but individuals intermediate between them occur in the same localities as other individuals that agree exactly with local types, and in any case the number of specimens examined by any one specialist has been comparatively small. There are doubtless European and American museums in whose collections fairly large European and American series of the species are included, while the Indian Museum contains a very fair series of Indo-Malayan specimens; but it has not been possible to make arrangements to compare all the specimens already preserved in collections, much less to collect sufficient material from widely separated stations for a proper study of the species as a whole.

In preparing this paper, therefore, I have thought it best to restrict my attention so far as possible to species occurring in the Bay of Bengal (including the Andaman Sea and the Gulf of Manaar) and the Arabian Sea, as parts of which the Laccadive Sea to the south and the Persian Gulf to the north may be conveniently regarded. Until recently the two subfamilies Alepadinæ and Oxynaspidinæ were not known from within these limits, but during the last few weeks a species of *Oxynaspis* has been found at the head of the Bay of Bengal in considerable numbers, and there can be little doubt that representatives of the Alepadinæ will also be discovered at some future date. In the meanwhile, however, I cannot, through want of material, deal with this subfamily.

The greater number of the Indian species of Lepadidæ have already been well figured, either in the *Illustrations of the Zoology of the R.I.M.S. "Investigator"* or elsewhere. I have therefore been forced to economize as regards illustrations and to do without detailed figures. I am much indebted, however, to the draftsmen of the Indian Museum and the Indian Marine Survey for assistance in preparing the outline figures here reproduced.

SYSTEMATIC ACCOUNT OF THE INDIAN SPECIES.

Subfamily OXYNASPIDINÆ.

Genus OXYNASPIS, Darwin (1851).

Lepadidæ with five calcified valves, which are covered (as well as the peduncle) by a membrane bearing horny spines. The valves themselves bear minute calcareous projections corresponding to the spines. The umbo of the scutum is on the occludent margin. Mandibular teeth sometimes pectinated; edge of maxilla with an excavation but not regularly scalariform. No lateral appendages; anal appendages (if present) short, bearing a terminal bunch of hairs, by no means claw-shaped. Prosoma feebly developed or absent.

Darwin was of the opinion that the spiny membrane which covers the whole surface in this genus, did not belong to the barnacle but to the horny coralline to which it was attached. Other writers have followed him in this view, which, despite the great weight of his authority, I am forced to consider incorrect after an examination of a considerable number of specimens of an Indian form. Some of these were fresh, others dry, and others preserved in spirit and formalin. The Antipatharian to which they were attached bore no spines on its surface similar to those which covered the barnacle, and the spines corresponded exactly with the calcareous projections on the valves. Moreover, the Antipatharians were of a neutral blackish tint, while the membrane was purplish red. In my specimens the whole of the membrane was extremely thin, and there were no signs of the surface being covered by a "horny muricated bark"—a description, indeed, hardly applicable to any part of the particular species of Antipatharian to which the specimens were fastened.

Hitherto the genus *Oxynaspis* has been known from the Atlantic and Pacific. The discovery, therefore, of a species in shallow water in the Bay of Bengal is particularly interesting. It must be remembered, however, that the Atlantic species are very rare and that others will probably be found in intermediate localities.

Oxynaspis celata, Darwin, subsp. *indica*, nov.

CAPITULUM laterally compressed, sharply pointed and slightly retroverted at the apex, about half as broad as long. The inner membrane deep brownish purple; the body of the animal and the pedicels of the cirri covered with pigment spots of the same shade; the rami of the cirri, except at the extreme base, milky white. Valves thick, deeply tinged with orange-red; the spines on the membrane covering them of the same colour but darker; the surface of the valves ornamented with strong ridges radiating from the umbo and also with numerous minute rounded prominences corresponding to the spines on the membrane; the distal ends of the ridges produced so as to form well-marked rounded projections on the edges of the valves. *Tergum* triangular, the apical and carinal angles acute, the occludent angle greater than a right angle; the extreme length of the valve about twice that of its occludent margin; the

occludent margin considerably thickened; the carinal margin straight or slightly convex; the scutal margin almost straight. *Scutum* subtriangular, its lower part inflated; the occludent margin more or less convex; the carinal margin straight or convex backwards, the basal margin almost straight; the umbo nearer the base of the occludent margin of the valve than the apical angle, which is more or less produced; a prominent ridge, which runs down the occludent margin, and a deep impression for the adductor muscle, present on the inner surface of the valve. *Carina* very broad, elbowed, the basal branch about half as long as the vertical one; the external surface tuberculate, the internal surface smooth, with a deep vertical groove; the base expanded into a small transversely oval or subquadrangular, flat disk.

PEDUNCLE short, cylindrical, irregularly annulated, very hard and stiff, covered with chitinous spines.

CIRRI, etc.—All the cirri long and curved, the rami of the second pair subequal, about three times as long as the pedicel. First pair not widely separated from the second; rami slender, subequal, with about 11 joints; the anterior face of each joint covered with transverse rows of bristles with distinct circular sockets; the distal joint ending in two very long bristles with several shorter hairs. *Anal appendages* reduced to mere minute prominences bearing five or six long, delicate hairs. *Penis* long, slender, pointed, bearing scattered hairs; the distal half annulated and ridged longitudinally; the whole organ densely pigmented except for a comparatively large area near the base.

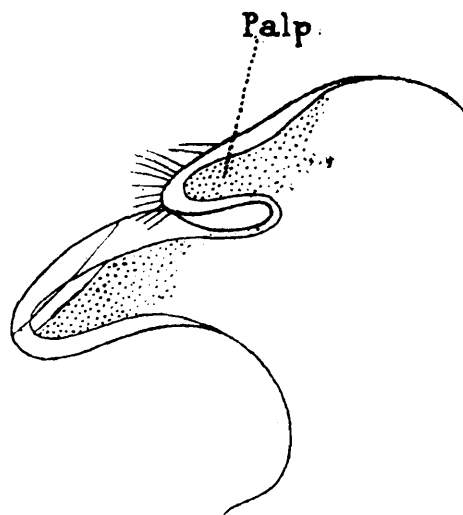


FIG. 1.—Labrum of *O. celata* sub-sp. *indica*, viewed from the left side.

MOUTH PARTS.—*Labrum* produced into an oval, concave, somewhat spatulate plate, which is relatively broad when seen from above but appears cylindrical and horn-like when viewed from the side; it is almost twice the length of the palpi. *Palpi* stout, bluntly pointed, bearing a fringe of rather long, delicate hairs at their tip. *Outer maxilla* broadly oval, subtruncate, bearing an irregular fringe of hairs of different lengths which is best developed on the anterior border. *Maxilla* narrow; its cutting edge with an excavation near the outer margin and with the inner part very prominent; external to the excavation one large bristle and on either side of it (*i.e.*, on either face

of the maxilla) one rather smaller bristle; the bristles internal to the excavation not very long, of different sizes. *Mandible* with five teeth (including the inner angle); the first tooth separated from the second by a space at least as great as that which separates the second from the internal margin of the maxilla; second, third, fourth and fifth teeth subequal; the fifth directed outwards from the inner margin; the base of the second distinctly but minutely pectinated on the outer margin; the third similarly but less distinctly ornamented.

Large specimens measure 9-10 mm. in length of capitulum.

HABITAT.—Off Akyab, Northern Burma: on Antipatharians growing in about 17 fathoms (S.S. "Golden Crown," January 1909); off Orissa, Bengal: on Antipatharians growing in 20 fathoms (S.S. "Golden Crown," February 1909).

This form agrees in so many respects with Darwin's *Oxynaspis celata*¹ from Madeira that I cannot regard it as a distinct species. There are certain differences, however, which seem to justify its being considered a local race. I have therefore called it "subspecies *indica*." The chief points of difference between it and the typical form are, judging from Darwin's description and figures:—(1) the basal arm of the carina is much shorter than the vertical arm; (2) the concavity of the inner surface of the carina is greater; (3) the margins of the scutum and tergum are more strongly serrated; (4) the two rami of the second pair of cirri are subequal; (5) all the cirri are curved. It must be remembered, however, that Darwin says that all the specimens he examined were in a bad state of preservation, and that, therefore, it is possible that his descriptions of the soft parts would have differed in detail had he examined fresh specimens.

Subfamily LEPADINÆ.

Key to the Genera.

1. Valves covering practically the whole of the capitulum.
 - (a) Lateral appendages not more than 6 *Lepas.*
2. Valves reduced in size or absent, capitular membrane swollen.
 - (a) Lateral appendages numbering 12 or 14; no anal appendages; at least three valves distinguishable *Conchoderma.*

¹ Dr. W. T. Calman of the British Museum has been kind enough to examine some specimens of the Indian form and to send me the following note:—"The types of *Oxynaspis celata*, or what I take to be the types—they are from Madeira and labelled in Darwin's writing—are dried and include several separated valves stuck on a card. I have cleaned the valves of one of your specimens to compare with them. There are certain differences which may indicate that the species are distinct, although, without a larger series and more careful study, I should hesitate to state that this is so. The most obvious differences are that the scutum is more acutely produced above and the carina much wider and more deeply cupped than in the Indian specimen. Also the margins of the valves are less strongly toothed than in your specimen. Darwin's figures of the separated valves give a very accurate impression of the type specimens and show the differences I have mentioned from yours."—*March 3rd, 1909.*

- (b) Lateral appendages numbering 2 ; anal appendages multi-articulate ; not more than one pair of valves

Heteralepas.

Genus *LEPAS*, Linné (1767).

The inclusion in the genus of *Lepas tenuivalvata* renders it necessary to modify the description of the genus a little, but I have no doubt as to the propriety of adopting this course. The possession by the species in question of filamentous appendages, the structure of its anal appendages, mandibles and maxillæ and the form of its valves, so far as this is perceptible, ally it indubitably to *Lepas* if considered together, while the curious modification in structure exhibited by its shell is clearly an adaptation to a mode of life somewhat unusual in the genus. It may be convenient, however, to regard it as the type of a new subgenus, for which I propose the name *Hyalolepas*. I am of the opinion, with Pilsbry and other writers on the Cirripedia, that *Lepas fascicularis*, Ellis and Solander, should also be considered as representing a subgenus distinct from that of the typical *Lepas*; Gray's name *Dosima* may be used for the former while the latter may be called *Anatifa*, Brugière, for it is desirable to avoid the duplication of names as regards subgenera when possible.

The genus and its subgenera may therefore be diagnosed as follows :—

Genus *LEPAS*, Linné (1767).

Lepadidæ with five valves, which are usually well calcified and more or less approximate; the carina extending between the terga above, terminating below in an embedded fork or an external disk; scuta triangular or subtriangular, with their umbones at the rostral angle. Lateral appendages usually present; anal appendages consisting of a single joint, uncinatè; without long hairs. Mandibles with five or six teeth; maxillæ with the free edge scalariform. Peduncle usually well developed, naked, or provided with chitinous plates.

Subgenus *Anatifa*, Brugière (1789).

Valves fully calcified, usually opaque; base of the carina forked, the branches of the fork being short or widely extended.

Subgenus *Dosima*, Gray (1825).

Valves fully calcified but translucent; base of the carina expanded into an external disk.

Subgenus *Hyalolepas*, nov.

Valves barely calcified; the umbones indistinct; carina forked at the base, the branches of the fork, so far as they are distinguishable, being long and almost parallel to one another.

Subgenus *ANATIFA*, Brugière.

Seven species of this subgenus have been described, of which five are common and widely distributed, while two are rare or possibly have a restricted geographical

range. So far as is known, only two species occur in Indian seas, but it is probable that at least three others are brought in as occasional and adventitious immigrants on the bottoms of ships.

No specimens in the collection have given me so much trouble as the representatives of *Anatifa*, partly because they are, for the most part, so well known that few authorities have given a detailed account of the specimens they have examined, partly because the specific differences between three of the common species appear to break down to a considerable extent so far as Oriental specimens are concerned. These three species are *Lepas anatifa*, *L. anserifera* and *L. pectinata*. Judging from Darwin's descriptions, from Hoek's figures in the "Challenger" Reports, and from the few European specimens I have examined, I have no reason to doubt that they are specifically distinct from one another. Unfortunately, however, Darwin had few Indian specimens before him while preparing his incomparable monograph on the Cirripedia, and the definitions he gives are not always applicable in all respects to such specimens. I have not been alone in my difficulties as regards Oriental specimens of the common Indian species (*L. anserifera*), for Hoek, in his recent account of the Pedunculate Cirripedes of the "Siboga" Expedition (1907), writes as follows:—

"The specimens [of *L. anserifera*] collected in the Bay of Labuan Tring (Lombok) caused me some difficulty as they differed from the usual appearance of *L. anserifera* in one of its most distinctive characters, *viz.*, in the occludent margin of the scutum not being arched or protuberant. Further, the internal umbonal tooth of the right-hand scutum is hardly stronger than that of the left-hand scutum. But as these characters vary even within the specimens of this locality, the form of the scutum in some of them approaching more to the typical form than is the case in others; there existing, moreover, a close resemblance in other regards between this and the typical form, no doubt was left as to the importance of this difference." (*Siboga-Exped.*, Mon. xxxia, Cirr. Ped., p. 2.)

Some of the Indian specimens I have examined (*e.g.*, those from Akyab) are typical examples of *L. anserifera*; others evidently agree with Hoek's specimens from Lombok. I also find, however, that in some specimens in which the scutum resembles that of *L. anserifera*, or that of *L. pectinata*, or has an intermediate character, the valves are nearly smooth. This is particularly noticeable in some of Professor Herdman's specimens from Ceylon, which I referred to *L. anatifa*, I still think rightly. Further, there is a considerable variation in the angle formed by the fork of the carina. In some specimens, moreover, which I assign to *L. anserifera* the upper extremity of the peduncle is clearly of an orange colour or (in specimens long preserved in bad spirit) at any rate paler than the lower part; but in others the dark coloration extends to the base of the peduncle, although the capitular membrane is always pale. Lastly, even the filamentous appendages exhibit a certain amount of variation in specimens agreeing in other characters. The upper pair of these appendages at the base of the first cirrus, as Darwin noticed, is frequently rudimentary in small individuals; in some of

my specimens not only these appendages but also the pair adjacent to them are short, consisting merely of short, rounded prominences, so that only one pair (that on the prosoma on each side) is fully developed. This pair, however, is always long and pointed. Darwin describes *L. pectinata* as having not more than one appendage on each side, but Gruvel says, "Appendices filamenteux, absent, ou seulement une paire de chaque côte." Probably Darwin is right; but it is safe to say, in any case, that the appendages of *L. pectinata* are never so well developed as those of at least one pair on each side in *L. anserifera*. The mouth parts of the former species are highly variable, and therefore no help may be expected so far as they are concerned in separating this species from *L. anserifera*.

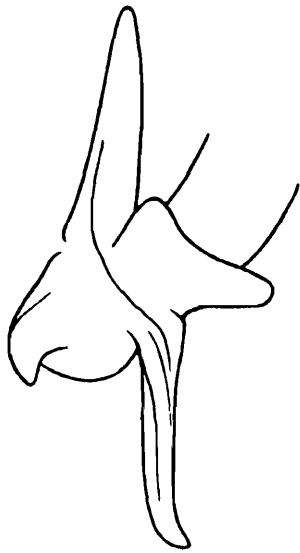


FIG. 2.—Lateral appendages of *Lepas anserifera*, $\times 8$, right side.

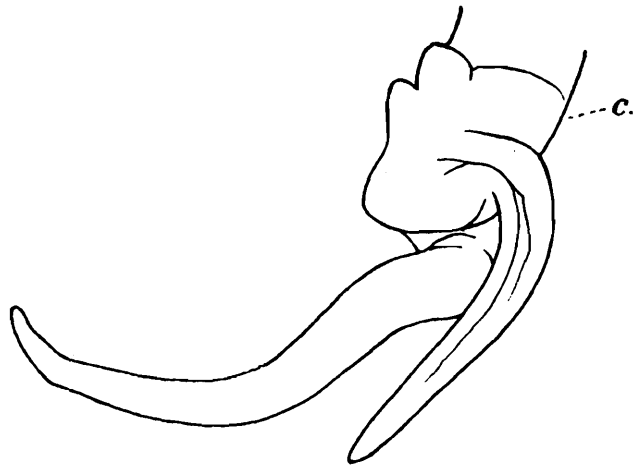


FIG. 3.—Lateral appendages of *Lepas anatifera* subsp. *indica*, $\times 8$, right side.

On the whole, in spite of the close resemblance between some Oriental specimens of *L. anserifera* and the typical *L. pectinata*, I am convinced that all the Indian specimens I have seen belong either to *L. anserifera* or *L. anatifera*. Most of them agree with the descriptions of the variety called *Pentalasmis dilata* by Leach, which Darwin was at first inclined to regard as a distinct species; but individuals intermediate between this and the typical form of *L. anserifera* occur not infrequently.

Since the bulk of this paper was written I have had an opportunity of examining large numbers of living specimens of the subgenus *Anatifa* on the Orissa coast. Two forms occurred in abundance, in one instance side by side on the same log of wood. The exact status of the Oriental race of *L. anserifera* seems to be more doubtful than ever. Possibly it is the ancestral form from which the *L. anserifera* of temperate climates and also *L. pectinata* have branched off in different directions. It is difficult, however, to call it by a special name as it includes many individuals, perhaps, indeed, a great majority, which it would be impossible to distinguish from

European or North American examples. I may also note that in European specimens of *L. pectinata* sent me by Professor Bouvier and identified as such by M. Gruvel I find considerable variation as regards the distance of the vertical ridge on the scutum from the occludent margin.

In any case it will be as well to give detailed descriptions of the two forms which occur together in the Bay of Bengal, basing these descriptions on an examination of fresh material, in which the characters are naturally better seen than in material that has been long in spirit. I see no reason to doubt that these two forms represent, respectively, the *L. anserifera* and *L. anatifera* of Linné; but those that represent the latter do not belong to the typical form of the species.

Lepas anserifera, Linné.

CAPITULUM broadly triangular, compressed; occludent margin sinuous, carinal margin curved. Valves thick, opaque, white, with strong radiating ridges and lines of growth, occupying the whole of the capitulum, covered by a delicate yellowish membrane, which is very liable to be rubbed off. *Tergum* almost quadrilateral, the apex being more or less definitely truncate; the occludent margin straight, slanting outwards; the scutal margin about three times as long as the occludent, without a strong tooth at the occludent angle. *Scutum* large, subtriangular, somewhat convex (especially at the base); nearly as broad at the base as long; the occludent margin boldly arched, forming the outer limit of a narrow (more or less), spindle-shaped area, of which the inner limit is formed by a bold vertical ridge on the valve; each scutum with an internal umbonal tooth, but the tooth on the right scutum always stouter than that on the left. *Carina* broad laterally, tapering above to a point, deeply concave within; produced below the base of the scutum and forming a prominent inwardly directed tooth, bearing two vertical branches, which meet one another at an angle greater than a right angle (or rather, would do so were not the angle rounded off); the dorsum plain or pectinated.

PEDUNCLE usually shorter than the capitulum, never much longer, cylindrical, without vertical ridges, variable in colour, being wholly deep orange in some individuals, wholly dark purple in others, mostly purple but orange at the capitular end in some.

The lining membrane of the capitulum dark purple, usually becoming orange at the edges of the aperture, so that the occludent margins of the terga and scuta appear of the latter colour. Body of the animal white, more or less deeply tinged with purple, with a dark purple streak along the dorsal surface. All the cirri dark purplish brown. The oral appendages covered with purple pigment cells. On the mandibles these form a conspicuous scalariform line parallel to the edge but at some distance from it. As a rule one of the lateral appendages on the prosoma is purple, while the others are white. The anal appendages are purplish brown.

CIRRI, etc.—The cirri are moderately long, not so boldly curved as in some species. Each joint bearing in front a broad band of soft hairs and a small bunch of short, stiff hairs at the apex behind. The two rami of the first cirri are unequal, the posterior

ramus reaching the base of the fourth joint from the tip of the anterior ramus; both rami are pointed and tapering, with the last few joints very small, the anterior ramus having about 16 and the posterior ramus about 14 joints, but those at the base being imperfectly differentiated in each case and variable in this respect. The anterior ramus of the second cirrus is slightly longer than the posterior but each has about 30 joints. The first cirrus is not very widely separated from the second. There are four lateral appendages on each prosoma, two being very much longer than the others (which are sometimes almost rudimentary), and two at the base of each first cirrus, one of them on each side being very long and delicate. The *penis* is not so long as the sixth cirrus; it is slender, tapering to a point, minutely annulated, densely covered with soft hairs of irregular length, especially on the distal half; there is a pencil of rather longer hairs at the tip. *Anal appendages* smooth, short, distinctly curved and claw-like.

MOUTH PARTS.—*Labrum* moderately prominent. *Maxilla* with a deep excavation near the upper margin, from which it is separated by several long stout spines, one of which is particularly well developed. Below the excavation are three steps of somewhat variable proportions, each bearing a double row of stout bristles. *Mandible* with six teeth including the inner angle, which is pointed but rather stout and bears a dense fringe of short bristles on both edges.

Lepas anatifera, Linné, subsp. *indica*, nov.

CAPITULUM compressed, subtriangular, the apex being somewhat truncate; the carinal margin arched, the occludent margin slightly sinuous. The valves thick, opaque, white, covered with a delicate, deep purple membrane arranged in sinuous parallel bars corresponding with the lines of growth. This membrane is easily rubbed off and soon loses its colour in spirit. When worn it often persists as a line of square spots in a series of small depressions running down the capitulum from near the umbo of the tergum to that of the scutum in a curved line and growing larger in the middle of the line than they are at the ends. The valves are separated from one another by lines of purple or purplish membrane, which are sometimes rather broad towards the base of the scutum. *Tergum* broadly truncate at the apex; the occludent margin straight, slanting outwards, produced into a tooth at its junction with the scutal margin; about one-fourth as long as the scutal margin; radiating ridges prominent, especially one running from the umbo to the occludent angle. *Scutum* quadrilateral (the scutal margin being distinct from the carinal margin), feebly convex even at the base; the surface almost smooth except for a vertical ridge, which bears the same relation to the occludent margin as the homologous ridge does in

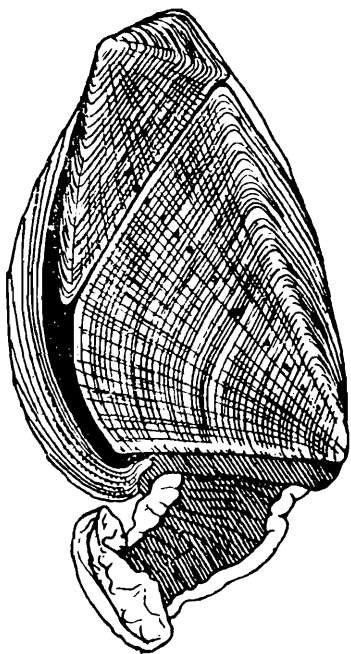


FIG. 4.—*Lepas anatifera* sub-sp. *indica*, $\times 2\frac{1}{2}$.

L. anserifera; not so broad at the base as long; internal umbonal tooth on the left scutum only; a prominent external basal ridge on both. *Carina* usually pectinate dorsally, otherwise as in *L. anserifera*.

PEDUNCLE shorter than capitulum, somewhat compressed, bearing a distinct pale vertical ridge on the occludent surface and two similar parallel ridges on the dorsal surface, variable in colour, generally deep purple slightly paler both at the base and the apex.

Lining membrane of the capitulum deep purple, not changing to orange on the sides of the aperture. Body lilac-purple; first, fifth and sixth cirri dark purple, the two latter brownish at the base; other cirri yellowish, with the anterior and posterior surfaces purple; anal appendages brown; mouth parts coloured as in *L. anserifera*; lateral appendages white.

CIRRI, etc.—Cirri much as in *L. anserifera*. *Penis* likewise. *Lateral appendages* only two on each side, one on the prosoma, the other at the base of the first cirrus, the latter being very long and delicate. *Anal appendages* as in *L. anserifera*.

MOUTH PARTS much like those of *L. anserifera*, but the inner angle of the mandible is more slender and has a much stouter fringe of bristles on the lower than on the upper margin.

Closely as this form appears to resemble some specimens of *L. anserifera* externally (*cf.* Pilsbry, *Bull. U. S. Nat. Mus.*, No. 60, pl. viii, fig. 3) I assign it to *L. anatifera*, mainly on the ground of the characters exhibited by its lateral appendages. It agrees as regards the markings on its terga and scuta with Darwin's var. A of the latter species, but differs in other respects, notably as regards the ridges on the peduncle, which seem to be a constant and characteristic feature. How far it is identical with the specimens in Prof. Herdman's collection from Ceylon I am not now in a position to say, as I only reserved one of these specimens, and that one an example in a bad state of preservation. At the time I examined Professor Herdman's collections, moreover, I had not had the same experience as regards the Lepadidæ as that which the examination of large numbers of specimens has since given me.

Subgenus DOSIMA, Gray.

The only species of this subgenus as yet known (*L. fascicularis*, Ellis and Solander) has not yet been taken in Indian seas but was obtained by the "Siboga" in the Malay Archipelago (whence it was also recorded by Darwin), and therefore may occur in our waters also. There are no Oriental specimens in the collection. I quote Darwin's description for convenience of reference:—

"Valves smooth, thin, transparent; carina rectangularly bent, with the lower part expanded into a flat oblong disk. Filaments five on each side; segments of the three posterior cirri with triangular brushes of spines."

The peduncle is often surrounded by a globular mass of dead vesicular substance, and several individuals are not infrequently joined together by means of a mass of the kind secreted by them in common.

Subgenus HYALOLEPAS, nov.

Lepas tenuivalvata (Annandale).

Dichelaspis tenuivalvata, Annandale, *Spolia Zeylanica*, iii, p. 193, figure (1906);
Lepas tenuivalvata, *id.*, in *Herdman's Report on the Marine Biology of Ceylon*
 (Roy. Soc.), pt. v, Cirripedia, p. 139 (1906).

The only known species of this subgenus was described in 1906 by myself as *Dichelaspis tenuivalvata*; in the same year (see synonymy above) I transferred it to the genus *Lepas*. The specimens were found attached to a sea-snake taken off the coast of Ceylon, and the species is evidently adapted to a pelagic life. I am now not at all sure that I was right in regarding the specimens as immature; in any case the lack of calcification exhibited by the valves is not due to immaturity.

Diagnosis—

CAPITULUM transparent, strongly compressed, flat on the surface; carinal margin rounded; occludent margin sinuous, slanting outwards from above; lower margin straight, horizontal; aperture large. Valves very imperfectly calcified, transparent, only the tergum and the upper part of the scutum and carina having a definite outline. *Carina* forked below, with two long basal branches, the distal parts of which disappear gradually without definite outline; the dorsal branch narrow, somewhat irregular in outline, often bearing a short tooth on the outer surface near the tip, which is situated nearer the apex than the base of the tergum; no ridge on the external surface. *Tergum* with the carinal and scutal margins nearly equal, each more than three times as long as the carinal margin; the apical angle rounded. *Scutum* separated narrowly from the tergum and carina, large but with only its tergal margin at all well defined, gradually disappearing towards the base of the capitulum, so that its lower limits cannot be detected exactly.

PEDUNCLE very short, less than a quarter as long as the capitulum, transparent, irregularly annulated.

CIRRI, etc.—First cirrus with both branches rather narrow, the posterior being shorter than the anterior by about four joints. The anterior branch with 14 joints, having the anterior margin of each joint nearly straight and the posterior margin boldly convex; the last six joints bear at the distal extremity of their posterior margin a pair of short spines; the distal joint terminates in a crown of longer and slenderer bristles, while the anterior margin of each joint bears a dense fringe of long hairs. The posterior ramus barely stouter than the anterior at the base; the distal joint ending in a fine bristle; the four penultimate joints bearing short spines on their distal extremity on and near the posterior margin, the number of these spines differing on the different joints and probably variable. Remaining cirri not very widely separated from the first pair, moderately long, slender; the distal joints (six to ten) each bearing several short spines at the distal extremity of the posterior margin, with a bunch of bristles at the tip of the last joint; the anterior margin of each joint with a dense fringe of bristles and hairs. *Anal appendages* each consisting of a single claw-

shaped joint, which bears on its posterior margin a series of very minute chitinous points; on the narrow, distal part of the appendage these become longer and are arranged in annular series; they are absent from the basal part of the anterior margin. *Penis* long and slender, rounded at the tip, indistinctly annulated in the middle, bearing numerous fine, scattered hairs. One filamentous appendage on each side.

MOUTH PARTS.—*Labrum* feebly or not at all bullate. *Outer maxilla* broad and short. The palp conical, with a dense fringe of rather short bristles on its outer margin. *Maxilla* with the free edge very broad, armed at the outer extremity with a single stout spine and two more slender spines of unequal length, which are followed by a deep, wide excavation; following this are two shallow excavations separated by rather wide prominences, the whole edge being armed with numerous bristles. *Mandible* with six teeth including the internal angle; the five innermost subequal, the external tooth being larger than, and rather widely separated from, the others; the whole of the sixth tooth, the outer margin of the fifth, fourth, third and second, and the excavation between the second and the external tooth, bearing very short spines.

The only known specimens of this species were taken on a sea-snake (*Hydrus platurus*) off the coast of Ceylon; some of them are now in the Colombo Museum, the remainder in Calcutta.

Genus CONCHODERMA, Olfers (1814).

Darwin defines this genus as follows:—

“Valves 2 to 5, minute, remote from each other; scuta with two or three lobes, with their umbones in the middle of the occludent margin; carina arched, upper and lower ends nearly alike.

“Filaments seated beneath the basal articulations of the first pair of cirri, and on the pedicels of four or five anterior pairs; mandibles with five teeth, finely pectinated; maxillæ step-formed; caudal appendages, none.”

The relations between *Conchoderma* and *Lepas* are comparable to those between *Dichelaspis* and *Pæcilasma*, but are much less close. Nothing that can be called an intermediate form is known, for the degeneration in the valves of *Lepas tenuivalvata* is of a wholly different kind from that which has taken place in *Conchoderma*, nor does the former lack caudal appendages or possess a large number of lateral filaments. Indeed, it would rather appear that the two genera were offshoots from a common stock than that one was an offshoot from the other.

The only known forms, according to the view adopted here, that can be distinguished as species are *C. virgatum* (Spengler) and *C. auritum* (Linn.). Both of these species are said by Darwin to be “mundane,” but I can find no definite record of the occurrence of *C. auritum* in the Indian Ocean, although it is apparently common in all parts of the Atlantic and Pacific.

Both species are commonly found attached to floating objects or pelagic animals, but *C. virgatum* also occurs at the bottom, both on inanimate objects and on crustacea.

Conchoderma virgatum (Spengler) (1790).

C. virgatum, Darwin, *Mon. Cirr.*, Lep., p. 146, pl. iii, fig. 2 (1851); Hoek, "Challenger" *Rep. Zool.*, vol. viii, Cirr., p. 55, pl. ii, figs. 13—15; Turner, *Trans. Roy. Soc. Edinburgh*, xli (ii), p. 430, pl. 1, fig. 3 (1905); Annandale, *Illustr. Zool. "Investigator," Crust. Ent.*, pl. v, figs. 2, 3 (1908).

C. hunteri, Darwin, *op. cit.*, p. 153, pl. iii, fig. 3; Stebbing, *Willey's Zool. Res.*, Crust., part v, p. 676; Borradaile, *Gardiner's Zool. Geograph. Laccadive and Maldive Arch.*, part i, p. 441.

CAPITULUM flattened, gradually blending into the peduncle; summit square or obtusely pointed. Membrane thin. Valves small, thin, sometimes imperfectly calcified, very variable in shape and in proportional length and, therefore, situated at variable distances from one another, but always remote and embedded in membrane. (Slightly modified from Darwin.)

Darwin recognized three species of this genus but acknowledged *C. hunteri* as distinct from *C. virgatum* with some doubt. Hoek was prepared to unite these two and to

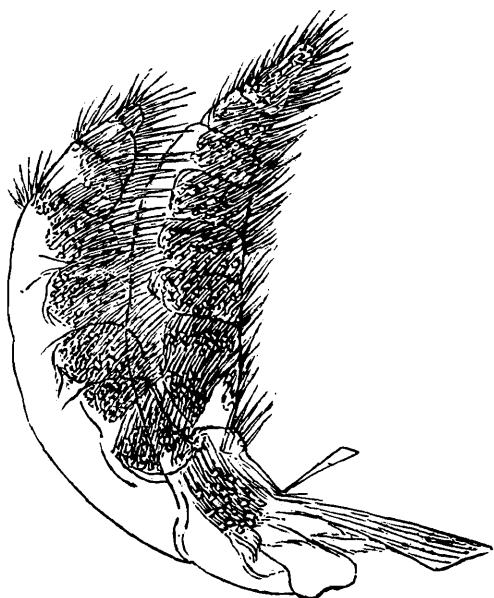


FIG. 5.—First cirrus of *Conchoderma virgatum* var. *hunteri*, $\times 16$.

recognize only *C. auritum*, a very distinct species, apart from *C. virgatum*. In this course I have followed Hoek, after examining a considerable number of specimens externally and dissecting several. The one constant difference between *C. virgatum* and *C. hunteri* is that of colour, and even this difference is not absolute. The species *C. virgatum* (*s. l.*) can be distinguished at once from *C. auritum* by the absence of the "ears" which form so conspicuous a feature of the capitulum of the latter. The membrane, too, is thinner and the lateral appendages have a different arrangement; for in *C. virgatum* there are none of these structures at the base of the second cirrus, while in *C. auritum* there are two in this position.

The main differences which led Darwin to recognize *C. hunteri* as distinct were "the almost rectangular manner in which the upper portion of the tergum is bent outwards and along the orifice of the sack, the narrowness of all the valves, and especially the lateral lobes of the scuta, and lastly, the greater curvature of the carina, which in some specimens runs up far between the terga." None of these characters are constant in the specimens I have examined. The tergum in some is straight, being broader at its occludent end than at its carinal; in others it is angularly bent as in Darwin's specimens; in a few it is absent. Similarly, the carina is almost straight in some specimens, strongly arched in others, sinuate in others. The scuta vary in size, in the degree to which they are calcified, and in the relative lengths of the three branches. The one constant character about them is that they are Y-shaped, never

approaching a triangle in outline. As regards colour, the smaller specimens from Sumatra, and all those from the Bay of Bengal that I have seen have been transparent, tinged with a vinous shade, and sometimes—by no means always—showing in certain lights feeble traces of darker vertical bars. The larger specimens from Sumatra, having a capitulum of a little more than 10 mm. in length, are of a deep purple colour, without markings, the peduncle being stained with violet-blue and the membrane being opaque owing to the accumulation of pigment in its internal layer. I should have been prepared to retain *C. hunteri* as a subspecies, as I did in the last number of the "Investigator" Illustrations, had it not been for the examination of several specimens from Sumatra, kindly sent me by Dr. van Kampen, and for the fact that the scutum is distinctly Y-shaped in a striped specimen from a ship from Brazil presented to the Indian Museum some years ago by Prof. E. Cornalia. This specimen is but little different as regards the terga and scuta from one from the mouth of the river Hughli I have recorded elsewhere (*Journ. Asiat. Soc. Bengal* (N. S.), vol. ii, p. 207, 1906) but is very much more distinctly striped. It is figured in the "Investigator" Illustrations, pl. v, fig. 2. Dr. van Kampen's large specimens are very dark and show no trace of stripes, but the whole series exhibits great variation as regards the terga and carina, the latter being wholly absent or represented by minute rudiments in several instances. The peduncle is much longer relatively in the small individuals than it is in the darker and larger ones.

There seems to be considerable variation as regards the mouth parts of *C. virgatum*. The mandible (fig. 6) is liable to be distorted, as one of Hoek's specimens of the



FIG. 6.—Mandible of *C. virgatum* var. *hunteri*, $\times 46$.

var. *chelonophilus* showed, and, apart from this, varies as to the pectination of the six teeth which, including the inner angle, are present in normal individuals. In one specimen I dissected I found that on one side the row of small, triangular projections that constitute the pectination was near the upper edge of each tooth, while on the other it was near the lower; in neither was it on the edge. The innermost tooth (inner angle) is very short and narrow, and may be either straight or project at an angle. The two teeth next it in my specimens are much shorter than the one next them on the other side. Darwin describes the maxilla (fig. 7) as having five steps on

the free edge. In my specimens the first step is a rather deep incisure, only bearing slender bristles at its base, while each of the others bears either six or eight stout spines arranged in two parallel rows; there are three stout spines external to the uppermost step, the outermost spine being the largest and the other two being parallel and not in line.

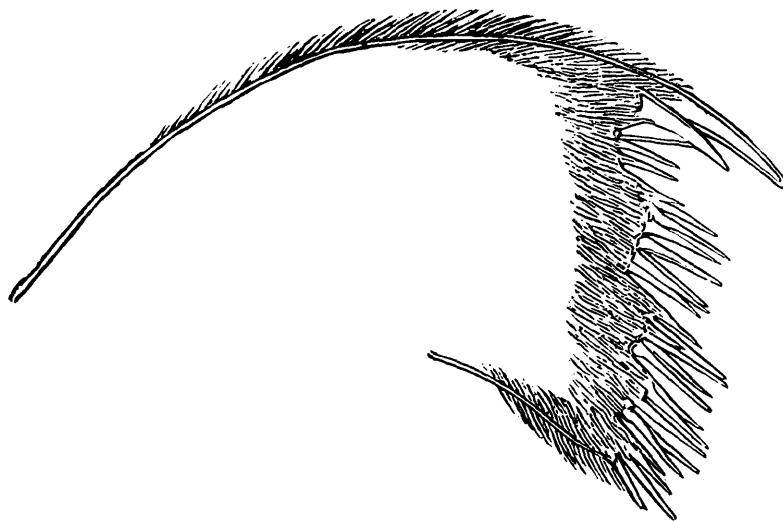


FIG. 7.—Maxilla of *C. virgatum* var. *hunteri*, $\times 50$.

The penis is long and stout, not minutely annulated, but with irregular transverse wrinkles on its distal half. The tip is obtusely pointed and bears a thin tuft of short hairs. The dorsal half of the proximal part bears numerous long, slender hairs, which make their appearance also on the ventral half towards the tip. The external surface is coloured of a faint and uniform vinous tinge, which pervades the whole of the animal's integument, including the mouth parts, and is due to the presence of innumerable very minute pigment cells.

Although, owing to the existence of intermediate forms, I do not consider it advisable to divide the species into subspecies or local races (see p. 68, *antea*), it must be acknowledged that it is possible to distinguish several varieties which have a certain stability. They may be recognized as follows:—

Var. I (typical form).—Capitulum square above, with well-defined vertical bars of a darker colour than the rest of the membrane. Scutum trilobed but not Y-shaped, the three lobes of equal length. Tergum somewhat sinuate.

Habitat.—Atlantic and Arctic Ocean, Pacific, Mediterranean.

Var. II (*intermedia*, nov.).—Tergal margin of the capitulum forming an angle considerably greater than a right angle with the carinal margin; stripes distinct. Tergum straight. Carina somewhat sinuate or angulate. Scutum Y-shaped; the lobe pointing towards the carina shorter than the other two.

Habitat.—On bottom of ship from Brazil (*Cornalia*).

Var. III (*Cineras hunteri*, Owen).—Upper part of capitulum not or barely angulate behind. Stripes obsolete or obsolescent. Tergum straight or nearly so. Carina usually arched. Scutum narrowly Y-shaped.

Habitat.—Indian Ocean, S. Pacific.

Var. IV (*Cineras olfersii*, Leach).—Summit of capitulum bluntly pointed; stripes present, but sometimes of a faint colour. Terga straight. Scutum tri- or quinquelobate, the three main lobes of equal or nearly equal length, meeting one another in such a way as to form two right angles, or one angle slightly greater than and one slightly less than a right angle.

Habitat.—Mediterranean, Atlantic.

The characters by which the form called *Cineras olfersii* by Leach is distinguished from the same author's var. *chelonophilus* appear from Hoek's description of the latter to be so variable (and certainly are so variable in the variety *hunteri*) that it seems to be impossible to separate the two even as varieties.

I have already (p. 68, *antea*) discussed the distribution¹ of the varieties of *C. virgatum*, but it may be as well to state in greater detail what is known as to the objects to which they commonly affix themselves. The typical form is common on ships' bottoms, on the skin of whales, and even of slow-moving fish (Darwin), on the copepod parasites of whales and fish (Turner); and still more so on the sessile barnacles (*Diadema*) commonly found attached to whales. The variety known as *chelonophilus* is stated by Darwin to be found on one species of turtle, viz., "*Testudo*" *caretta*, but several specimens are recorded as from *Chelone* sp., and the number actually examined by students of the Cirripedes appears to have been small. The variety *hunteri* has usually been taken on the sea-snake *Hydrus platurus*, but has also been found attached to a telegraph cable and to the carapace of a crab; the specimen from the mouth of the river Hughli, now in the collection of the Indian Museum, was apparently attached to a turtle. There does not, therefore, seem to be evidence that any of the varieties of the species is confined to one particular host. Although *Conchoderma virgatum* is reported to be a common species, the actual number of specimens recorded is by no means a large one.

Genus HETERALEPAS, Pilsbry (1907).

Capitulum naked or provided with a pair of ill-defined chitinous scuta, the capitular membrane greatly thickened and more or less wrinkled on the surface; the muscles of the peduncle extending upwards into the capitulum and forming a layer beneath the membrane. A single lateral appendage on each side, situated at the base of the first cirrus. Anal appendages long, multiarticulate. Mandibles usually with four teeth, the base of which bears numerous small spines; maxillæ excavated, their biting edge often irregular.

This genus is divided by Pilsbry into two subgenera in accordance with the structure of the fifth and sixth pairs of cirri. In the subgenus *Paralepas* the two rami of each of these appendages are approximately equal, while in the more typical forms the internal (posterior) rami are much reduced, being distinctly smaller and less well armed than the external (anterior) rami.

¹ Since this paper was in the press I have found a small example of the typical form of the species on the leg of a turtle (*Chelone imbricata*) from the Bay of Bengal.—May 3rd, 1909.

There can be little doubt that the degeneracy of these rami brings the subgenus into close relationship with the Alepadinæ, and it is noteworthy that the mandibles of the species of both subgenera show a certain approximation in form to those of the species of that degenerate subfamily. Degeneracy in the mandibles consists, however, very largely in a reduction in the number of their teeth, and it must be noted that a reduction of the kind takes place occasionally, as an individual peculiarity, in widely separated families. For instance, in some examples of *Pæcilasma minutum* two of the central teeth fuse together, as a rule only on one mandible; while in the specimen of *Scalpellum sociabile* which was first dissected the large outer tooth of both mandibles had completely disappeared, although in other specimens from the same locality since examined it has been found to be well developed.¹ However this may be, it seems clear that the genus *Heteralepas* (*sensu lato*) affords a link between the subfamilies Lepadinæ and Alepadinæ. It may be necessary later, however, as Pilsbry points out, to separate *Paralepas* from *Heteralepas* as a distinct genus.

Only two species of *Heteralepas* have been as yet recorded from Indian seas, one representing each subgenus. They are—

Heteralepas (*Paralepas*) *xenophoræ*, mihi,

and

Heteralepas (*Heteralepas*) *nicobarica*, sp. nov.

Subgenus PARALEPAS, Pilsbry.

Heteralepas (*Paralepas*) *xenophoræ* (Annandale).

Alepas xenophoræ, Annandale, *Ann. Mag. Nat. Hist.* (7), vol. xvii, p. 399 (1906); *Illustr. Zool. "Investigator,"* Crust. Ent., pl. ii, figs. 5, 5a, 5b; Hoek, *Siboga-Exped.*, Mon. xxxia, Cirr. Ped., p. 39.

CAPITULUM subtriangular, pointed at the apex, slightly inflated below the aperture (at the base of which there is a distinct constriction), marked with transverse striæ. Aperture slit-shaped, with barely protuberant lips, rather less than a third as long as the vertical length of the capitulum. No scuta.

PEDUNCLE stout, irregularly but finely annulated, longer than the capitulum.

CIRRI, etc.—Cirri short and feebly curved, with the pedicel long as compared with the rami. First cirrus widely separated from the second, each of its rami with five distinct joints, of which the proximal joint equals the sum of the others in length; the anterior ramus with a soft, easily broken cylindrical process at its tip; this ramus distinctly broader than the other and longer by one complete joint; the basal joint of each ramus broadly convex outwards on the posterior margin, the other joints having this margin nearly straight and the anterior margin more or less convex; each joint of both rami bearing a circle of stout feathered bristles round its distal extremity and each basal joint with a dense fringe of similar bristles running down both

¹ I have satisfied myself that this is so by re-examining my preparations of the type specimen, and by dissecting several others [see *Mem. Asiat. Soc. Bengal*, vol. i, p. 78, fig. 2 (1906)].

margins. The other cirri similarly armed except as regards the basal joints; the circle of bristles incomplete on all except the last few joints in each case. The two rami of the fifth and sixth cirri almost equal. *Anal appendages* long and slender, with about twelve joints, somewhat variable. *Penis* slender and rather short, very minutely and obscurely annulated, bearing a small number of fine, scattered hairs on the proximal part and a few rather coarse, short, flattened hairs on the distal; the whole organ tapering, but the extreme tip minutely blunt, the base contorted.

MOUTH PARTS.—*Labrum* moderate, not bullate. *Maxilla* with free edge slightly irregular; the outermost spine much larger than any of the others; a number of subequal spines arranged all along the edge, with a bunch of stout hairs near the inner end. *Mandible* with four teeth, the innermost with a short, sharp projection on its inner margin near the tip; the bases of all the teeth near together and on a wide arc; the tip of the innermost tooth sharply pointed, the remainder rather blunt; slender spines arranged in a semicircle parallel to the excavation between the third and fourth teeth, in a dense mass at the base of the first and second teeth and almost all over the innermost, forming a fringe on the inner border of the latter.

Length of capitulum	..	12 mm.
Breadth	„	10 „
Length of aperture		4 „
„ peduncle		7 „

HABITAT.—Off the S.-W. of India, 185 fathoms. Four specimens on shell of living *Xenophora pallida* (R.I.M.S. "Investigator").

Hoek (*loc. cit.*) was undoubtedly right in considering his *Alepas obliqua* from the Malay Archipelago as an ally of this species. My species appears, however, to be a stouter one and to exhibit distinct differences in the mouth parts, cirri, etc. Both species are interesting in that their cirri are short and almost straight, thus showing an approximation to the Alepadine type, although neither is pelagic.

Subgenus HETERALEPAS, Pilsbry.

Heteralepas (Heteralepas) nicobarica, sp. nov.

Alepas indica, Annandale (nec Gruvel), *Mem. Asiat. Soc. Bengal*, i, p. 83 (1906).

All the tissues delicate and transparent, with a slight yellowish tinge in spirit. External surface smooth or minutely wrinkled.

CAPITULUM indistinctly separated from the peduncle, slightly inflated, without scuta; the occludent margin nearly straight, the carinal margin rounded, bearing a very low crest with two small projections. Aperture about one-quarter as long as the vertical length of the capitulum, with short fringed lips and almost parallel sides.

PEDUNCLE several times as long as the capitulum in some specimens, not much longer than the capitulum in others, cylindrical, stout, expanding slightly at the base.

CIRRI, etc.—Cirri with a large number of joints, long and curved. First cirrus not very widely separated from the second, with the two rami subequal, each joint bearing a fringe of stout bristles across its anterior margin. Second cirrus much shorter

than the fourth. The fully developed rami of the posterior cirri armed like those of the first pair, except that on the greater number of the joints (all but the first few at the base) they bear only one transverse pair of bristles on each joint with a number of fine hairs between them; hairs at the tip of the joints behind few and short. The posterior rami of the fifth and sixth cirri very fine, having 17 and 15 joints respectively, while the anterior rami have a very large number; the hairs on the posterior rami short and extremely fine, confined to the tip of the distal joint (which is small and cylindrical) and to the distal end of the posterior margin of the last ten joints. *Anal appendages* very slender, consisting of about nine joints and extending slightly beyond the distal end of the pedicel of the sixth cirri; the bunch of hairs at the tip short and sparse. *Penis* moderately long and slender, cylindrical, pointed at the tip, minutely annulated, bearing a few scattered hairs on the surface and a bunch of similar hairs at the tip.

MOUTH PARTS.—*Mandibles* not bullate, bearing a sparse row of minute, rounded, chitinous teeth. *Maxillæ* narrow; the biting edge with a rather shallow incisure, at the base of which there is a small, conical projection; the outermost spine by far the largest. *Mandible* with five teeth, the inner angle being dichotomous; the outer tooth the largest, pectinate at its base on the inner margin, separated from the other teeth by a deep but not very broad incisure; second, third and fourth teeth subequal, the innermost tooth very small; second tooth pectinated at the base on the inner margin.

HABITAT.—Nicobar Islands, on floating wood (*de Roepstorff*). Ten specimens in rather bad condition.

This species bears a close external resemblance to Gruvel's figures of his *Alepas indica* from Singapore. It appears, however, to differ considerably from that species, with which I formerly confused it, in the structure of its cirri and mouth parts. The largest specimen I have seen measures 40 mm. in total length, but the peduncle in all is somewhat curved.

Subfamily PÆCILASMATINÆ.

Key to the Genera.

1. Valves fully calcified, covering the whole or nearly the whole of the capitulum.
 - (a) Carina not expanded laterally at the base *Pæcilasma*.
 - (b) Carina expanded laterally at the base *Megalasma*.
2. Valves more or less degenerate and separated from one another; at least one calcified valve as a rule present.
 - (a) Scutum split into two segments, which diverge from one another above, or reduced to a vertical linear rudiment *Dichelaspis*.

Genus PÆCILASMA, Darwin (1851).

Lepadidæ with 3, 5 or 7 fully calcified, approximate valves. The scutum broad, entire or split into two vertical segments, of which the occludent segment

is narrower than the carinal; umbo at the rostral angle. Tergum triangular or nearly so, absent in one species. Carina forked at the base or expanded into a more or less well-developed transverse disk, not expanded vertically; its apex reaching or extending for a short distance between the terga above; its umbo basal. Peduncle well developed, naked, or bearing small chitinous plates. Filamentous appendages absent; caudal appendages consisting of a single joint, cylindrical or laterally compressed, not claw-shaped, bearing at the tip a pencil of fine hairs. Mandibles with four or five (rarely six) teeth, inclined to be variable; maxillæ with the free edge straight or broken by a single incisure, not step-formed.

This genus is easily distinguished from *Lepas* by the structure of its anal appendages and maxillæ; it fades almost imperceptibly into *Dichelaspis*, from which it is only distinguished by the perfect development of its valves. From *Megalasma*, Hoek, it is distinguished by the shape of the carina at the base—a character which is perhaps of no more than subgeneric value.

Strictly speaking, as Darwin was well aware and as Pilsbry has recently pointed out, the name of the genus should be *Trilasmis*, for a species was described under that name by Hinds in 1844. The species (*T. eburnea*), however, was an aberrant one, and the name has so long been obsolete that to revive it would only cause confusion. I have therefore neglected to follow the strict laws of priority in this instance, retaining Hinds's name merely as that of a subgenus.

Four¹ Indian species of *Pæcilasma* are known; they may be distinguished as follows:—

Key to the Indian species of Pæcilasma.

- | | |
|---|----------------------|
| I. Valves complete; scutal margin of tergum straight. | |
| A. Carina narrow, truncated at the base | <i>P. kæmpferi.</i> |
| II. Scutum divided vertically; scutal margin of tergum straight. | |
| A. Tergum with the occludent and apical angles more or less rounded and the carinal angle truncate | .. <i>P. fissum.</i> |
| III. Scutum divided vertically; tergum present, its scutal margin excavated to correspond with the tip of the occludent margin of the scutum. | |
| A. Valves closely approximate; occludent margin of the scutum strongly curved | <i>P. minutum.</i> |
| IV Tergum absent; scutum inflated. | |
| A. Scutum with a strong internal tooth, not divided, but possessing a distinct vertical suture | <i>P. eburneum.</i> |

¹ The specimens identified as representing *P. gracile*, Hoek (*Rec. Ind. Mus.*, vol. i, p. 81 (1907)), are young examples of *Megalasma minus*, which, at an early stage, closely resembles *P. gracile* externally.

Each of these four species represents a distinct section of the genus, and there can be no difficulty in separating one from the other. Each, however, is represented (with the exception of *P. eburneum*) in other parts of the Indo-Pacific region by closely allied or racial forms, which must be separated, if they are really distinct, with the greatest care. On the whole I think it best to regard *P. eburneum* as the type of a distinct subgenus, for which the name *Trilasmis*, Hinds, is available.

Pæcilasma kæmpferi, *P. fissum* and *P. eburneum* all appear to have an extensive distribution. This is especially the case as regards the first, which occurs (either in the typical form or so modified as to constitute a local race) on both sides of the Atlantic, off the coast of Japan in the S. Pacific and in the Malay Archipelago, as well as in the Gulf of Manaar. *P. fissum* was originally described from the Philippines and has since been recorded from the Malay Archipelago and from several localities in the S. Pacific; while *P. eburneum* was first discovered at New Guinea and has since been found in other parts of the Malay Archipelago and in the Persian Gulf and the Red Sea. The original locality of *P. minutum* was Singapore; I have examined many specimens from the Bay of Bengal and the Arabian Sea.

The different species differ considerably as regards their bathymetric range. *P. kæmpferi* is a deep-sea form, probably to be found only below the 100-fathom line. *P. fissum* and *P. eburneum*, on the other hand, belong to the littoral fauna. *P. minutum* is abundant in the Arabian Sea at a depth of between 100 and 200 fathoms.

Several species of *Pæcilasma* show a preference for Echinoids, to the spines of which they are commonly found attached. This is the case as regards *P. eburneum*. I have noticed that all the specimens I have examined have been fixed to the spines on the oral surface of the host, in which position it is probable that stray fragments of the Echinoid's food are more easily obtained by the barnacle than if it were attached to spines on the anal or lateral surface.

P. kæmpferi and its local races are usually attached to the carapace of spiny crabs, but have also been found on sea-urchins; while *P. minutum* apparently adheres to any crustacean which it meets at the critical stage of its development. I have found it most commonly on the carapace of *Panulirus angulatus*, but have taken two specimens on the capitulum of *Pæcilasma kæmpferi*. I have also found specimens on the carapace and even in the gill-chambers—but there rarely—of several crabs.

The following table gives a statement of the distribution, etc., of the Indian species of the genus. I have dealt with these points in greater detail as regards the species of the genus *Dichelaspis*, as I have more information about them than I possess as regards those of the present genus. As a matter of convenience the two Indian species of *Megalasma* are included in the same table—a position which the similarity in structure and habits between the two genera abundantly justifies.

Distribution, etc., of Indian species of *Pœcilasma* and *Megalasma*.

1909.]

N. ANNANDALE: *The Indian Cirripedia Pedunculata.*

Name of Species.	Localities.	Hosts.	Bathymetric Distribution.
<i>Pœcilasma kæmpferi</i> , Darwin (with local races).	PACIFIC: Japan (<i>Darwin, Weltner, Pilsbry</i>); Sandwich Islands (<i>Pilsbry</i>). MALAY ARCHIPELAGO: Lat. 5° S., Long. 132° E. (<i>Hoek</i>). BAY OF BENGAL: Gulf of Manaar. EAST ATLANTIC: Madeira (<i>Darwin</i>); off C. Bojador (<i>Gruvel</i>); C. Verde Islands. WEST ATLANTIC: Off New Jersey (<i>Pils- bry</i>); off C. Florida (<i>Pilsbry</i>).	DECAPOD CRUSTACEA: <i>Inachus kæmpferi, Echinoplax pungens, Eupagurus politus, (?) Lithodes agassizii, Scyrumathia carpen- terii, Eumunida picta, Geryon quinquedens, G. affinis, Cyrtomaia smithi, Lumbrus stellatus.</i> ECHINODERMA: <i>Dorocidaris pa- pillata.</i>	163 and 101 fathoms (Malay Archi- pelago, <i>Hoek</i>); 185 fathoms (G. of Manaar); 125—430 fathoms (E. Atlantic, <i>Gruvel</i>); 170 and 1,120 fathoms (W. Atlantic, <i>Pils- bry</i>); 164—338 fathoms (S. Paci- fic, <i>Pilsbry</i>).
<i>Pœcilasma fissum</i> , Darwin ..	PACIFIC: Bonol, Philippines (<i>Darwin</i>); New Caledonia (<i>Fischer</i>); Port Jackson (<i>Whitelegge</i>); Jaluit (<i>Weltner</i>); Honolulu (<i>Schaunsland</i>). MALAY ARCHIPELAGO: Lat. 5° S., Long. 132° E.; Lat. 7° S., Long. 115° E. (<i>Hoek</i>). BAY OF BENGAL: Andamans (<i>Blanford</i>).	DECAPOD CRUSTACEA: <i>Palinurus</i> sp. (<i>Weltner, Hoek</i>); "Spinose crab" (<i>Darwin</i>).	Low water (<i>Darwin</i>). Apparently littoral.
<i>Pœcilasma minutum</i> , Gruvel ..	MALAYA: Singapore (<i>Gruvel</i>). ARABIAN SEA: Lat. 7° N., Long. 77° E.; Lat. 17° N., Long. 57° E. BAY OF BENGAL: Lat. 11° N., Long. 92° E.; Gulf of Manaar.	DECAPOD CRUSTACEA: <i>Panulirus angulatus, Paralia alcockii, Ho- mola megalops.</i> (Generally ex- ternal, occasionally at entrance to gill-chamber.) CIRRIPEDE CRUSTACEA: Capitu- lum of <i>Pœcilasma kæmpferi</i> ; pe- duncle of <i>Alepus indica</i> .	143 fathoms; between 156 and 200 fathoms; between 180 and 220 fathoms; 185 fathoms.
<i>Pœcilasma eburneum</i> (Hinds) ..	MALAY ARCHIPELAGO: New Guinea (<i>Hinds</i>); Street Molo (<i>Hoek</i>); Borneo Bank (<i>Hoek</i>); off Sumatra (<i>van Kampen</i>). PERSIAN GULF (<i>Lloyd</i>). RED SEA (<i>Weltner</i>).	ECHINODERMA: Spines of <i>Echi- nus</i> spp., <i>Cidaris bispinosa</i> and other Echinoids.	Littoral zone; 48 fathoms (Persian Gulf); 13-14 fathoms (Sumatra).
<i>Megalasma minus</i> , Annandale. Syn. <i>M. lineatum</i> , Hoek.	BAY OF BENGAL: Andaman Sea; off S. India. ARABIAN SEA: W. of Laccadive Islands. MALAY ARCHIPELAGO: Lat. 5° 3' S., Long. 119° E. (<i>Hoek</i>).	ECHINODERMA: <i>Goniocidaris flori- gera</i> (<i>Hoek</i>); various Cidaridæ. PORIFERA: <i>Pheronema raphanus</i> .	200—500 fathoms (Indian seas); 67 fathoms (<i>Hoek</i>).
<i>Megalasma carino-dentatum</i> , Weltner.	BAY OF BENGAL: Lat. 11° N., Long. 88° E.	PORIFERA: <i>Hyalonema masoni</i> .	1,748 fathoms.

Subgenus PÆCILASMA, Darwin.

Pæcilasma kæmpferi, Darwin.

P. kæmpferi, Darwin, *Mon. Cirr.*, Lep., p. 102, pl. ii, fig. 1; Gruvel, *Zool. Travailleur et Talisman*, Cirrhipèdes, p. 46, pl. iv, fig. 1; Weltner, *Archiv. f. Naturg.*, 1897 (i), p. 243; Pilsbry, *Bull. Bureau of Fisheries*, vol. xxvi (1907), p. 183, and *Bull. U. S. Nat. Mus.*, No. 60, p. 84, pl. vi, figs. 1—5, 13 and 14; Annandale, *Illustr. Zool. "Investigator," Crust. Ent.*, pl. iii, fig. 1.

P. aurantium, Darwin, *op. cit.*, p. 105, pl. ii, fig. 2; Hoek, *Siboga-Exped.*, Mon. xxxia, *Cirr. Ped.*, p. 7.

P. dubium, Hoek, *op. cit.*, p. 6, pl. i, figs. 2—4, pl. x, figs. 1a—d.

CAPITULUM more or less narrowly ovate; the carinal margin much more strongly arched than the occludent margin; apex pointed, valves five, stout, closely approximate. *Tergum* triangular; the carinal angle slightly truncated, the others sharp; the scutal margin straight. *Carina* arched, ending in a very small and imperfect disk at the base, tapering above, almost of the same width throughout or widest at the base; above extending a short distance between the terga. *Scutum* entire, much longer than broad, with a more or less distinct ridge running down it near the occludent margin; internal umbonal teeth feebly developed or strong.

PEDUNCLE slender, variable in length, ringed, naked.

CIRRI, etc.—Rami of first cirrus nearly equal; second cirrus widely separated from first. *Anal appendages* about $\frac{1}{3}$ length of the pedicel of the sixth cirrus, with bristles at the tip and down the whole of the posterior margin. *Penis* long, stout, hairy.

MOUTH PARTS.—*Mandibles* variable. *Maxilla* has "two large upper spines, the edge deeply notched below them, sparsely spiny in the notch. It then protrudes and is rather closely set with spines" (Pilsbry).

Several forms have been described which seem to be subspecies or local races of *P. kæmpferi*. The Indian specimens I have examined do not quite agree with any figure I have seen. Unfortunately I have only been able to examine six individuals from any Oriental locality. All of them were taken in the Gulf of Manaar on the shell of a "spinose crab" (*Echinoplax pungens*) at a depth of nearly 500 fathoms. They come nearest to the form recently described by Hoek as *P. dubium*, but their carina is intermediate between that of this form and that of the specimen figured by Darwin. Pilsbry's figure, however, of the carina of a Japanese specimen does not altogether agree with Darwin's, although the latter's specimen was also from Japan. In my specimens the occludent margin projects less beyond the vertical ridge on the scutum than it does in Hoek's figure, but a little more than it does in Darwin's. On the whole, I think that it is possible to distinguish five local races of the species, and that they may be distinguished as follows:—

Race I (typical form).—A single vertical ridge on the scutum. Occludent margin of the scutum projecting very little beyond the vertical ridge, evenly curved;

maximum length of scutum to maximum breadth about as 5 to 3. Carina of almost the same width throughout when viewed laterally.

Habitat.—Japan and S. Pacific.

Race II (*P. dubium*, Hoek).—A single vertical ridge on the scutum. Occludent margin of scutum regularly curved but separated from the vertical ridge by a more or less considerable interval; maximum length of the scutum to maximum breadth about as 2 to 1. Carina tapering from below upwards when viewed from the side.

Habitat.—Seas of India (Gulf of Manaar) and the Malay Archipelago.

Race III (*P. aurantia*, Darwin).—A single vertical ridge on the scutum. Occludent margin of the scutum protuberant and irregularly curved; the greatest length of the scutum to the greatest breadth about as 12 to 7. Carina broadest at the base when viewed from the side. Concentric striæ on the valves less marked than in the other forms; valves more or less yellowish.

Habitat.—E. Atlantic, off W. Coast of Africa.

Race IV (*P. kæmpferi litum*, Pilsbry).—Very close to the last, from which it is distinguished mainly by the greater protuberance of the occludent margin of the scutum. Perhaps it should not be considered distinct.

Habitat.—W. Atlantic, off the coast of Florida.

Race V (*P. kæmpferi novæangliæ*, Pilsbry).—Curve of the occludent margin of the scutum regular, but separated by a considerable distance from the vertical ridge, which is very distinct. There is a second vertical ridge on the valve, less distinct than the first and approaching it at an angle. Carina very slightly wider at the base than above when viewed from the side.

Habitat.—W. Atlantic, off the coast of New Jersey.

In drawing up this table I have been obliged to depend very largely on the figures published by Darwin, Gruvel, Hoek and Pilsbry, but, apart from the specimens from the Gulf of Manaar, I have examined a small individual of the New England race which I found on the carapace of a crab (*Geryon quinquedens*) from off Martha's Vineyard, New Jersey, and a number of specimens of the race *aurantia* which have been sent me by Prof. Bouvier and were originally attached to the type specimens of *Geryon affinis*. Even before consulting Pilsbry's paper I had no difficulty in identifying the New Jersey specimen as representing a form of *P. kæmpferi*. There can be no object, I think, in separating the Indian from the Malayan race, at any rate until more examples of the form have been examined; in drawing up the definition of Race II I have made use of my examination of the specimens from the Gulf of Manaar as well as Hoek's description and figures. The length of the stalk is so variable a character in other species of the genus that I have not alluded to it. In *P. minutum* I find that while the stalk is usually short, about one individual in fifty has it of several times the normal length. One of the specimens of *P. kæmpferi* from the Gulf of Manaar is figured in the last part of the "Investigator" Illustrations (*tab. cit. supra*).

Pæcilasma fissum, Darwin.

P. fissa, Darwin, *Mon. Cirr.*, Lep., p. 109, pl. ii, fig. 4 (1851).

P. fissum, Hoek, *Siboga-Exped.*, Mon. xxxia, *Cirr. Ped.*, p. 8, pl. x, figs. 2—5 (1907); *Annandale, Illustr. Zool.* "Investigator," Crust. Ent., pl. iii, fig. 8.

P. amygdalum, Aurivillius, "Stud. ü. Cirr.," *K. Svensk. Vet.-Ak. Handl.*, xxvi, No. 7, p. 10 (1894).

? *P. lenticula*, *id.*, *ibid.*, p. 12.

CAPITULUM ovoid, narrowly rounded above, the carinal margin somewhat more boldly and more regularly arched than the occludent; valves not in close contact with one another. *Scutum* divided, the two segments often diverging to some slight extent above, the occludent segment narrow, especially so in its lower half, its upper extremity more or less pointed; carinal segment broad, slightly inflated, its anterior border almost straight, its tergal and carinal borders forming an almost uninterrupted curve. *Carina* reaching the basal angle of the tergum above, forming a very small transverse disk at the base, which is concealed beneath the cuticle; no definite dorsal or lateral ridges. *Tergum* subtriangular, the apex being more or less rounded; the occludent, and sometimes the carinal angle also rounded.

PEDUNCLE short, irregularly annulated, often ornamented with small spines or plates.

CIRRI, etc.—"Cirri of the first pair . . . have unequal rami of respectively 6 and 9 segments. These segments are broad, short, quadrangular, bearing at the extremity a transverse row of numerous spines, which are longer than the segments themselves." "Cirri of the second to sixth pair . . . have rather short pedicels and also short rami of 11 and 12 segments. . . what is especially characteristic for this species is, that the pairs of spines which as a rule in other Cirripeds are seen at the anterior faces of the segments of the cirri are totally wanting" (Hoek).

MOUTH PARTS.—"Labrum with a row of about 24 small teeth, standing close together; at each side the five or six outer ones are sharply pointed, the dozen in the middle being rather blunt. Palpi small, conical, with about five longer hairs at the tip and a few smaller ones along its inner side."

"According to Darwin the fourth tooth of the mandible is pectinated. I found a small tooth on the inner edges of the second and third teeth, one on the outer edge of the fourth tooth and also one on the edge of the inferior angle."

"The *maxillæ* were unknown to Darwin. The upper part. . . is furnished with three spines: two claw-like and the third rather straight and more delicate;

Under the upper part there is a deep notch, on the inferior margin of which two minute hairs are planted. The inferior part of the edge of the maxilla is much produced and bears about ten unequally stout spines. Of these the one placed about the middle is by far the strongest" (Hoek).

The species appears to be rare though widely distributed. Darwin examined a single specimen (dried) from the Philippines, Hoek found a large number on a "*Palinurus*" taken at Ternate, and others have been recorded by Weltner. The only

specimen in the Indian Museum was taken at the Andamans by the late Dr. W. T. Blanford and is figured in the "Investigator" Illustrations. It is probably immature. As we have only one small specimen I have quoted largely from Hoek in the description of the species.

Pæcilasma minutum, Gruvel.

P. minutum, Gruvel, *Trans. Linn. Soc.* (2), vol. viii, p. 288, pl. xxiv, fig. 5 (1902), *Mon. Cirr.*, p. 120, fig. 138 (1905).

CAPITULUM somewhat broadly ovate, pointed above, varying in proportions considerably. Valves six, delicate and translucent, not very closely approximate above. *Tergum* triangular, the anterior part of the scutal margin deeply excavated to receive the apex of the occludent segment of the scutum, the umbo surrounded by an opaque, sculptured area. *Carina* narrow, not reaching the level of the apex of the carinal segment of the scutum above, broadening out slightly at the base and concave on the sides, terminating in a broadly oval transverse disk below, generally with a distinct dorsal ridge, and sometimes with a subterminal tooth above. *Scutum* split into two segments, with an opaque sculptured area surrounding the umbo at the base; the occludent segment much broader above than at the base, bluntly pointed or rounded when in contact with the tergum, the arc of the inner edge having a wider radius than that of the occludent margin; the carinal segment broad, convex outwards, without vertical ridges, its tergal margin straight, the carinal margin broadly arched, the basal margin not distinctly marked off from the carinal, the occludent margin corresponding with the inner margin of the occludent segment, with which it is in close contact.

PEDUNCLE very variable, often short and thick, sometimes longer than the capitulum and relatively slender, bearing numerous little round, yellowish chitinous plates, which are sometimes minute and inconspicuous.

CIRRI, etc.—First cirrus widely separated from the second, by no means broad, the anterior ramus reaching nearly to the tip of the penultimate joint of the posterior, the two distal joints of each ramus bearing a terminal circle of stout bristles and an anterior fringe of similar bristles, which is extended down the margin of the next one or two joints and disappears gradually towards the base of the ramus. Other cirri long and slender, bearing on their anterior margin numerous long, slender hairs, and at the distal extremity of the posterior margin of each joint a sparse bunch of similar hairs. *Anal appendages* slender, of variable length, falling short of, reaching or passing the basal joint of the sixth cirri, bearing at the tip a number of very long bristles, which extend a short distance down the posterior margin. *Penis* slender, moderately long, minutely annulated, pointed, bearing a short process on the dorsal surface near the tip and a few scattered hairs near the base.

MOUTH PARTS.—*Labrum* not bullate, bearing a row of minute equal, triangular teeth. *Outer maxilla* long and moderately broad, spatulate, bluntly rounded at the tip, bearing a row of short, stout spines on the distal third of the external surface. The palpi short, bluntly pointed, bearing a somewhat sparse fringe of stiff

hairs. *Maxilla* very large, deeply excavated, the excavation being narrow and much nearer the outer than the inner margin; three stout spines external to the excavation, internal to it five or six rather slender spines and a number of fine hairs; internal margin broadly serrated, hairy. *Mandible* normally with five teeth, including the inner angle, but this angle often dichotomous and the two teeth next it sometimes fused together, so that there might be either four or six teeth altogether; the two mandibles of the same individual not always symmetrical, the outer tooth much larger than and widely separated from the others; the inner margin pectinate.

This species, which was originally described from a single young individual, is a very variable one. I have dissected about a dozen individuals and examined over a hundred more externally. The three outlines in plate vii (figs. 5—7) illustrate the manner of variation of the valves; fig. 5 represents a very old individual and fig. 6 a young one.

A near relationship evidently exists between this species and Hoek's *P. excavatum*, from which it is easily distinguished by the shape of the occludent segment of the scutum. Both forms exhibit a marked similarity in their anatomy to the less degenerate species of *Dichelaspis* such as *D. tridens*.

Subgenus TRILASMIS, Hinds (1844).

On the whole I think it advisable to regard Hind's *Trilasmis eburnea* as a type of a subgenus. Its peculiarities are so marked that it might even be justifiable to regard it as the type of a distinct genus. Hoek (1907) has, however, recently described a new species (*Pæcilasma obliquum*) which is to some extent intermediate between *Trilasmis eburnea* and the more typical members of the genus *Pæcilasma*. In any case *Trilasmis*, in which Hoek's *Pæcilasma obliquum* should be included, may be defined as follows:

Species of *Pæcilasma* in which the tergum is absent or quite rudimentary and in which the scutum is greatly developed and covers almost the whole of the capitulum.

Pæcilasma (Trilasmis) eburneum, Hinds.

CAPITULUM ovoid, broadly rounded above, the base pointed towards the occludent margin; external surface of the valves smooth. *Tergum* entirely absent. *Scutum* occupying almost the entire surface of the capitulum, ovoid, pointed at the base, inflated, not divided but having a distinct vertical suture not far from the occludent margin. *Carina* short, arched, broad laterally, concave internally, terminating at the base in a broad subquadrangular or circular disk directed downwards and inwards; a conspicuous ridge running down the valve on either side near its scutal margin and becoming more pronounced in the region of the disk.

PEDUNCLE very short, placed obliquely as regards the capitulum.

CIRRI, etc.—First pair of cirri widely separated from second, with the rami slender, subequal, each with about 10 joints, which are imperfectly developed at the base. The other cirri rather short, curved, the bunches of hairs on the posterior margin of

the joints long and well developed. *Anal appendages* uniarticulate, cylindrical, rather stout, rounded at the tip, which bears a bunch of bristles shorter than the appendage. *Penis* short, pointed, slender.

MOUTH PARTS.—*Labrum* with very small chitinous teeth, which become almost granular in the middle of the row. *Outer maxilla* very broad, truncated, subquad-rangular, bearing numerous rather short and slender hairs on its inner surface. *Maxilla* excavated, bearing three stout spines external to the notch; the edge internal to the main notch somewhat irregularly sinuated or serrated, sometimes with a second notch not very much more shallow than the outer one; the spines on the internal part of the edge very stout; the greater part of the maxilla covered with fine, short hairs. *Mandible* bearing five teeth, the internal angle being dichotomous; the innermost tooth more or less spine-like; the notches between the teeth with their edges more or less irregular, but not definitely serrated or pectinate; the greater part of the mandible covered with fine, scattered hairs.

The largest specimen of the species that I have seen has a capitulum 6 mm. in vertical length and 4.5 mm. in greatest transverse diameter.

Pæcilasma eburneum is evidently a shallow-water species, although not exactly littoral. It has only once been taken by the "Investigator," so far as I can discover, but on that occasion in considerable numbers. I have not, however, been able to examine many of the Indian Echinoidea to which barnacles might be expected to be attached, the greater part of the "Investigator" collection being in the hands of a specialist abroad.

Genus MEGALASMA, Hoek (1883).

Distinguished from *Pæcilasma* by its extremely broad carina, which is expanded laterally but does not form a transverse disk at the base. Valves heavy and fully calcified, the scutum entire. Peduncle invariably short.

This genus was created by Hoek in 1883 for the reception of a single species (*M. striatum*) and has recently (1907) been much extended by Pilsbry, who has not only described several new species but has also included several others previously ascribed to *Pæcilasma*. The latter species constitute in his opinion a subgenus of *Megalasma* which he has called *Glyptelasma*; they agree with the species of *Megalasma* in the lateral expansion of their carinæ but differ in the position of the umbo of the scutum, which in the more typical forms of the genus has rotated through an angle of 90° and taken up a position in line with the occludent margin, while in the species included in Pilsbry's subgenus, as well as those left in *Pæcilasma*, the umbo is situated at some distance from the margin of the capitulum.

It is certainly very difficult to separate the species of *Glyptelasma* from those of the typical *Megalasma*. Young individuals of *M. minus*, which is as typical a form as any, sometimes approach very closely to the subgenus, resembling *Megalasma* (*Glyptelasma*) *gracile* in outlines with sufficient exactitude to deceive me as to their correct diagnosis. No true species of *Glyptelasma*, however, has been reported from Indian seas.

There is unfortunately some confusion as to the species of *Megalasma* which occur in Indian seas. In 1894 Weltner described a form to which he gave the name *Megalasma carino-dentatum*. In preparing his diagnosis he had before him a single specimen from the "Investigator" collections. The specimen was returned to the Indian Museum but was apparently overlooked when the collection of which it formed a part was unpacked. I have been unable to trace it and have little doubt that it has perished. Pilsbry has recently (1907) suggested that this specimen, which it is impossible any longer to re-examine, was an abnormal one.

A second form was described by myself in 1906 as *Megalasma striatum* subsp. *minus* and by Hoek in 1907 as *Megalasma lineatum*. Hoek, after seeing the figure of my subspecies in the "Investigator" Illustrations, acknowledged that *M. lineatum* was a synonym, and Pilsbry has recently redescribed the form, showing that it should rank as a distinct species. *M. minus* may therefore be considered a well established species, if it is distinct from *M. carino-dentatum*. The distinctive characters of the latter were its reduced terga and toothed carina. I have examined over sixty specimens of *M. minus* and have found none with a toothed carina; but the relative size of the tergum varies considerably in this series and a tooth occurs on the carina on a small proportion of individuals of some species of *Pæcilasma* (e.g., *P. minutum*, see fig. 5, pl. vii).

For these reasons, in the absence of a specimen of *M. carino-dentatum*, I think it will be best to regard the species as a doubtful one.

Megalasma carino-dentatum, Weltner (*species dubia*).

M. carino-dentatum, Weltner, Sitz. Ber. Ges. Naturf. Freunde, 1894, p. 84.

Exhibiting the characters of the genus; the carina with a distinct tooth near its upper extremity; terga reduced.

Attached to the filamentous spicules of the Hexactinellid sponge *Hyalonema masoni*, Bay of Bengal at a great depth.

Megalasma minus, Annandale.

M. striatum subsp. *minus*, Annandale, Ann. Mag. Nat. Hist. (7), vol. xvii, p. 399 (1906); *Illustr. Zool. "Investigator,"* Crust. Ent., pl. i, fig. 8 (1907); *M. minus*, Pilsbry, Proc. A. Nat. Sci. Philadelphia, lix, p. 409, figs. 1, 3, 4, 6 (1907).

M. lineatum, Hoek, Siboga-Exped., Mon. xxxia, Cirr. Ped., p. 31, pl. iv, figs. 1—8 (1907).

CAPITULUM.—*Carina* reaching posterior angle of the tergum above, where it is distinctly pointed, with a regular series of Λ -shaped ridges on the dorsal surface; the lateral surfaces strongly ridged vertically, the lateral basal margin frequently irregular. *Tergum* subtriangular, the posterior angle narrowly truncate or irregularly sinuous; the occludent margin barely $\frac{1}{3}$ as long as scutal margin; scutal and superior margins equal; a distinct internal tooth near the scutal margin a short distance

from the occludent. *Scutum* not much inflated, its vertical length about six times the length of the occludent margin of the tergum; external surface bearing a single well-marked semicircular ridge, which extends from near the umbo on the occludent margin to the point where the carina, tergum and scutum meet; a strong umbonal tooth on both scuta.

PEDUNCLE relatively stout, very short.

CIRRI, etc.—First cirrus widely separated from second; its anterior ramus reaching the distal extremity of the penultimate joint of the posterior ramus; rami with eight or nine joints, slender with both margins spinose. Other cirri normal, with well-developed anterior fringes and posterior bunches of bristles; the number of bristles in each of the latter being variable. *Anal appendages* short, uniarticulate, truncated, bearing a row of short bristles at the tip. *Penis* moderately long, slender, bearing numerous fine scattered hairs on its surface and a somewhat less sparse bunch of similar hairs at the tip.

MOUTH PARTS somewhat variable, as in most species of *Pæcilasma* and *Megalasma*. *Labrum* bullate, with a row of small triangular teeth. *Maxilla* with the biting edge forming a }-like outline, the excavation being deep and rounded and having its inner margin with a curved and gradual slope; three stout spines external to the excavation, several fine hairs at its base and about twelve slender spines on its inner margin and internal to it. *Mandible* with four or five teeth, the innermost tooth, when five are present, being narrow and spine-like; the greater part of the mandible covered with minute bristles arranged in small transverse rows of three or four bristles each.

This species is common in the deeper parts of the Bay of Bengal and has recently been found in the Malay Archipelago. Pilsbry has described a very similar form from the S. Pacific under the name *Pæcilasma bellum*¹ and later² has published an elaborate comparison between this species and *Megalasma minus*. Undoubtedly differences exist between these two forms, and I find that most, though not all, of the differences noted by Pilsbry are constant. Moreover, I owe to his kindness the opportunity of examining a specimen of *M. bellum*. I do not think, however, that the two forms should be regarded as specifically distinct, for they seem to me to be merely local races, differing from one another in minute and comparatively unimportant characters. The following table will serve to distinguish them from one another, but I should not be surprised to find that other "species" in the genus should (if my views as to what constitutes a subspecies be correct) be regarded as subspecies of *M. minus*.

Megalasma minus.

Race I (typical form).—Vertical length of scutum at least twice the greatest transverse diameter.

Race II (*Megalasma bellum*, Pilsbry).—Vertical length of scutum less than twice the greatest transverse diameter.

¹ *Bull. Bur. Fisheries*, xxvi, p. 183, pl. iv, fig. 6 (Washington, 1907).

² *Proc. Acad. Nat. Sci. Philadelphia*, lix, p. 409 (1907). The first paper was written some time before publication.

There are small differences in the other valves and in the cirri, but the relative width of the scutum affords the easiest means of distinguishing between the two races.

Genus DICHELASPIS, Darwin (1851).

Closely allied to *Pæcilasma*, from which its species may be recognized by the imperfect development of their valves. These are never closely approximate. Scutum never entire unless it is reduced to a mere rudiment, otherwise consisting of two distinct segments or of two or even three branches united at the base. Tergum as a rule with the scutal margin excavated to correspond with the tip of the occludent segment or branch of the scutum, often much reduced, sometimes absent. Carina simple and linear, forked at the base, or expanded into a more or less well-developed transverse disk, occasionally absent in some species.

When Darwin wrote his incomparable "Monograph" he experienced no great difficulty in separating this genus from *Pæcilasma*, although he fully realised their close relationship. Intermediate forms were not then known to exist. Several such forms have, however, now been discovered and there is no longer any morphological justification for the separation. I retain the two genera as a matter of convenience, for together they would be of a somewhat unwieldy character. As Pilsbry has recently pointed out, however, the name of those species which have imperfect valves should, if the laws of priority were strictly followed, be *Octolasmis*, for Gray described *Octolasmis warwickii* in 1825. Darwin was aware of the fact and changed the name because it was inappropriate—a course that would not nowadays be considered correct. To revive the earlier name, nevertheless, would only cause confusion, for it has long been obsolete.

The nomenclature of the Oriental species of the genus is at present in some confusion owing to the large number of names that have been given to variable species. Fortunately I have been able to examine considerable series, consisting in most cases of over a hundred specimens, of all the species known to exist in Indian seas. I have therefore been able to revise their synonymy with some confidence, although not without prolonged deliberation in each case. In spite of the large number of specimens examined, I have been forced to describe two species as new and to recognize eight already described as distinct. One of these eight has only been recorded hitherto from the North Atlantic.

Key to the Indian species of Dichelaspis.

- I. Tergum large, triangular or nearly so.
 - A. Carina expanded into a large transverse disk at the base.
 - a. Two segments of the scutum close to one another.
Capitulum nearly as broad as long *D. tridens.*
 - B. Carina neither forked at the base nor expanded into a regular disk.
 - b. Capitulum nearly twice as long as broad *D. bathynomi.*

- II. Valves more or less rudimentary. Tergum much reduced.
- A. Tergum¹ shaped like an axe with the shaft pointing towards the carina in a slanting direction.
- a. Carinal segment of scutum triangular. Carina divided transversely near the base *D. warwickii.*
- a¹. Carinal branch of scutum linear. Carina entire *D. grayii.*
- B. Tergum saddle-shaped, vertically elongate, or (occasionally) square.
- b. Carinal segment of scutum triangular; occludent segment linear or almost so *D. geryonophila.*
- b' Scutum consisting of three linear branches, one horizontal and two vertical; tergum subtriangular but vertical. *D. rhinoceros.*
- b'' Scutum consisting of two linear branches which meet one another at an angle less than a right angle; the lower branch passing above and almost parallel to the basal branch of the carina *D. sinuata.*
- C. Tergum star-shaped.
- c. Scutum consisting of two linear branches meeting one another at an angle, the lower branch shorter and narrower than the upper *D. stella.*
- D. Valves much reduced. Tergum absent or represented by an amorphous chitinous patch.
- d. Carina forked at its base; the basal branches directed upwards in a slanting direction *D. cor.*
- d'. Carina sometimes absent, its base either simple or forked, the basal branched, when they are developed, horizontal *D. angulata.*

The different species of *Dichelaspis* differ so much from one another as regards the shape of the valves that it is not surprising that attempts have been made to divide the genus. In 1869 Macdonald described *D. neptuni* as *Paradalepas neptuni*, in a paper entitled "On an apparently new genus of minute parasitic Cirripedes" (*P.Z.S.*, 1869, p. 440), while in 1894 Stebbing introduced a new genus for the form he called *Trichelaspis forresti* (*Ann. Mag. Nat. Hist.*, xiii, p. 443). The latter was believed to be distinguished from all other species of *Dichelaspis* by the fact that it had three branches to the scutum. Gruvel, however, has since pointed out that this character is not constant even in individuals of Stebbing's species; it is even more marked in one of my new species, *D. rhinoceros*, so called from the resemblance in outline between its scutum and the top of the head and the horns of a two-horned rhinoceros. There does not seem to be any justification for the separation either of these

¹ In the var. *pernuda* of *D. grayii* the tergum is absent. This species may be recognized by the great length of the caudal appendages, which are from $\frac{1}{3}$ to $\frac{1}{2}$ as long as the sixth cirri.

species or of *D. neptuni* from the genus *Dichelaspis*. *D. neptuni* is closely related to *D. sinuata*, of which it may be a local race or even a chance variety.

Hoek, in his recent account of the Pedunculate Cirripedes of the "Siboga," divides the genus into seven sections, much on the same principles as those adopted in my key, which will serve to distinguish the Indian species not only from one another but from most other forms. There are, however, a few points that I have been obliged to leave in doubt when preparing it. They may be noted here. I put them in the form of questions as follows:—

- (1) Is *D. sinuata* merely a local race of *D. lowei*, Darwin? Except as regards size (which is not a reliable specific character in the genus owing to the fact that few individuals reach the maximum dimensions they appear to be capable of attaining) the difference between these two forms lies mainly in outline, and this is not only a variable character in the softer Lepadidæ, but also one liable to be altered by bad or prolonged preservation.
- (2) Is *D. sinuata* distinct from the Japanese *D. aymonini*, Lesson? So far as external characters go, I have examined intermediate specimens.
- (3) Is *D. mülleri*, Coker, distinct from *D. lowei*? The two are certainly very similar, but I have not seen either.
- (4) Are Stebbing's *D. hoeki* and *D. antiquæ* distinct from one another? The external differences between them are certainly smaller than those which separate the extreme forms of *D. tridens*, a species belonging to the same section of the genus.

The following table shows the geographical distribution, bathymetrical range and hosts of the Indian species of *Dichelaspis*, so far as these elements in their biology have been ascertained. It will be noted that all the species are parasitic, or at least commensal, in habits, but that the degree to which they are so varies considerably, some attaching themselves to the exterior of their host, others penetrating within its gill-chamber.

An examination of the table shows that, with one exception, the Indian representatives of the genus habitually affix themselves on settling down in life to the body of some hard-shelled crustacean. The one exception is *D. grayii* which, so far, has always been found on the skin of sea-snakes. As regards the species of *Dichelaspis* commonly found on crustacea it will be seen that at least two have been found occasionally on the shells of echinoids, and that one (*D. warwickii*) sometimes fixes itself to the shells of living molluscs, to the skin of sea-snakes and even to that of fish. As regards the crustacean hosts of the genus, there is abundant evidence that the majority of the barnacles prefer a hard-shelled decapod but are not particular as to its family. Decapods are of course by far the commonest crustaceans of a considerable size and with hard shells; it is noteworthy that I have not found a single barnacle of any genus attached to the carapace, limbs or gills of any of the soft-shelled prawns dredged by the "Investigator" or purchased in the Indian markets. Probably these decapods cast their skin

too frequently for them to be suitable hosts. Apart from soft-shelled forms, *D. warwickii* apparently affects any decapod from shallow water or the surface of the sea that it happens to meet at the critical moment in its existence at which the larva must become sedentary. It is equally common on crabs like *Doclea ovis* that hug the bottom, on crabs like *Neptunus pelagicus* that swim on the surface, and on lobsters such as *Panulirus fasciatus*. *D. angulata*, *D. sinuata*, and perhaps to a less extent *D. cor*, are also somewhat catholic in their tastes, but, so far as is known, only choose decapod hosts and are usually found on pelagic species. As they are almost invariably found in the gill-chamber of the crabs and lobsters they honour with their company, it is improbable that hosts without gill-chambers attract them. *D. bathynomi*, on the other hand, has only been found on the pleopods and uropods of the largest of known Isopods, viz., *Bathynomus giganteus*—a species with a hard shell and sometimes as much as ten inches long. *D. rhinoceros* and *D. stella* have each been taken on one occasion only. It is therefore impossible to say anything as regards their choice of hosts with confidence; both were found in the gill-chambers of bottom-haunting decapods. The case of *D. geryonophila* is very remarkable. It is apparently not uncommon on the gills of a certain crab (*Geryon quinquedens*) frequently obtained from deep water off the coast of New Jersey in North America. A single individual of an allied crab (*G. affinis*) has been obtained in Indian seas, representing a species originally captured near the Azores. I have examined both this specimen and one of the American species; round the entrance to the gill-chamber of both I found the barnacle in large numbers, the Indian examples agreeing so closely with the American ones that it is impossible even to regard them as representing a specialized local race. *Dichelaspis geryonophila*, up to the present time, has, therefore, only been taken with crabs of the genus *Geryon*, and with them only in the western part of the North Atlantic and in the Laccadive Sea.

As regards the position on or in the body of their host assumed by barnacles of this genus, it is possible to divide them roughly into two categories, (1) those that attach themselves to the external surface and (2) those that penetrate into the gill-chamber. To some extent it may be said that the latter are more degenerate as regards their shell than the former. In both respects, however—that is to say, both as regards habit and as regards structure—there are intermediate stages. *D. grayii* belongs to the first category, but in its transparent integument and minute valves resembles those species which frequent the gill-chambers of crabs. *D. grayii*, however, is the most thoroughly pelagic species of the genus as yet known, and in many groups of the animal kingdom a pelagic life is associated with transparency and softness of the tissues; *Lepas tenuivalvata*, in which the shape of the tergum and scutum, so far as it is ascertainable, remains typical of the genus *Lepas*, exemplifies this fact by the transparency and lack of calcium of its shell. *D. warwickii* is generally found on the external surface of its host, but on two occasions I have found small, colourless specimens of the species in the gill-chamber. Few species vary more than this one as regards the colour of the membrane of their capitulum and the degree to which their valves are calcified. The examination of hundreds of specimens has

convinced me that the darkest and hardest individuals are usually those which are attached to crabs or lobsters from the bottom, but there are exceptions to this rule. *D. sinuata* and *D. angulata* appear to be exclusively internal commensals. Their valves are more degenerate than those of any other species and their membrane is as a rule quite transparent. *D. cor* which is usually less transparent and has rather less degenerate valves, is most often an internal commensal also; but in one instance I found large numbers of this species attached to the posterior limbs as well as the gills of a crab. *D. bathynomi* is technically an external species, but the pleopods of *Bathynomus* are well protected by the shell which overhangs them, so that the barnacles have, so to speak, a roof over their heads. I have, however, also found a few examples of the barnacle attached to the extremity of the uropods, a much more exposed situation, and although *D. bathynomus* exhibits considerable variation as regards the extent of its valves, I have not been able to detect any difference in this respect between the individuals attached to the uropods and those fixed to the pleopods. *D. tridens*, a form allied to *D. bathynomi* and like it belonging to the section of the genus in which the valves are least degenerate, is found most commonly on the mouth parts of its host or round the external margin of the entrance to the gill-chamber. It also occurs not uncommonly on the gills. All the external specimens of this species I have examined have had the valves more opaque than those of specimens from the gills; but I cannot correlate the relative extent of the valves and membrane on the surface of the capitulum with any variation in habit. *D. geryonophila* is found both in the gill-chamber and at its external opening, clustering round the aperture at the base of the chelæ.

It is not uncommon to find more than one species on the same host. For example, *D. tridens* and *D. warwickii* are frequently found together, while I have discovered *D. angulata* and *D. sinuata* on the gills of the same crab on more than one occasion.

As regards the geographical distribution of the Indian species of *Dichelaspis* little of a definite nature can be said with confidence, for few specimens of most of them have as yet been reported by students of the Cirripedes in other countries. When the internal as well as the external characters of their decapod hosts are investigated, there can be little doubt that many specimens of the internal forms will be found to exist in museums. Almost every marine crab sold for food in the markets of Bengal harbours *D. cor* or *D. angulata* in its gill-chamber, and there is no reason to think that Bengali crabs are peculiar in this respect. Unfortunately, in these days of intense specialization, the student of the decapods frequently takes no interest in the Cirripedes. I cannot doubt that the majority of the representatives of the genus *Dichelaspis* obtained by the scientific expeditions that have visited tropical seas have never been recorded in their reports.

However this may be, one point is clear as regards the Indian species, *viz.*, that a large proportion of them have a considerable range in the northern part of the Indian Ocean, sometimes extending into the Pacific. *D. warwickii*, by far the most abundant shallow-water external form in the Bay of Bengal, extends from the Persian Gulf to the China Sea; *D. sinuata*, a common species in the gill-chamber of

shallow-water crabs, from the Gulf of Suez to Java, perhaps to Japan; *D. cor*, also common, from the East Coast of Africa to Java and Sumatra; *D. angulata* from the Persian Gulf to Java; *D. tridens* from the Bay of Bengal to the Philippines. The only Indian species as yet reported from the Atlantic is a deep-sea form, namely, *D. geryonophila*; but the shallow-water species *D. sinuata* is closely allied to *D. lowei* from Madeira and *D. mülleri* from the Atlantic Coast of North America, if it is not actually identical with them, while *D. rhinoceros* is probably the Oriental representative of the North American *D. forrestii*. *D. bathynomi* and *D. stella* have as yet only been found in Indian seas, the latter on one occasion, the former in several rather widely separated localities; the host of *D. bathynomi*, *Bathynomus giganteus*, also occurs in the Caribbean Sea, but there is no evidence that the barnacle accompanies it in its American habitat.

As regards the vertical range of the species of this genus it is clear that they may be divided roughly into two sections, one only occurring at considerable depths (about 100 fathoms and over), the other only in shallow water and on the surface; but there are several exceptions to this rule; nor does it appear to be possible in most instances to make a distinction between pelagic and littoral forms. Few species have been taken at a greater depth than 200 fathoms. In Indian seas *D. bathynomi* ranges from 180 to about 500 fathoms, while *D. geryonophila* (which has been taken at still greater depths in the Atlantic) has been obtained by the "Investigator" from a depth of between 200 and 300 fathoms in the neighbourhood of the Laccadive Islands. Probably these two forms do not occur at a depth of much less than 200 fathoms. *D. tridens* and *D. sinuata*, however, extend from the littoral zone to a depth approaching or greater than 100 fathoms; *D. stella* was taken at one of 180 fathoms and *D. rhinoceros* between 60 and 100 fathoms. The remaining species appear to be confined to shallow water and to the surface.

In his recent account of the Pedunculate Cirripedes of the "Siboga" Expedition Hoek notes that the only deep-sea species (*D. welleri*) taken by that expedition is the largest species of the genus known, having a capitulum about 12 mm. in greatest length. I have, however, examined several specimens of *D. warwickii* with a capitulum about 10 mm. long and one with it over 11 mm. long, while the smallest species of the genus with which I am acquainted are *D. stella* and *D. rhinoceros*, both from considerable depths. There can be no doubt, therefore, that the deep-sea species are not always larger than those from shallow water; but there is undoubtedly some connection between the size both of individuals and of species and their habitat; those species found within the confined space of the gill-chamber of a decapod are, for instance, always small. Even in the case of external species, however, it is rare for individuals to attain their full dimensions, probably because their host gets rid of them periodically by casting its skin; the great majority of the specimens of *D. warwickii* I have examined have been less than 5 mm. long.

The influence which the species of *Dichelaspis* exert on their hosts, if they exert any influence at all, is a point worth considering but still in need of investigation. Unfortunately the only species of the genus I have seen alive are *D. angulata*,

D. warwickii and *D. grayii*, all of which live for a considerable time after their host has been removed from the water. There is no evidence that even the internal species are detrimental to any appreciable extent to the crustacean in whose gill-chamber they live. Possibly they may even be to some slight extent beneficial in aiding respiration by the movements of their cirri and by eliminating organisms which, if not actually the producers of disease, would be out of place in the breathing apparatus of any animal; for their alimentary canal is usually crammed with diatoms, foraminifera and other protophyta and protozoa. The weight of the large numbers of external barnacles, mostly belonging to this genus, which some comparatively small decapods have to bear must be a strain upon them, and pelagic species such as those of *Neptunus* must be somewhat hampered in swimming by the tassel-like masses of *D. warwickii* adhering to their swimming legs and to the sides of their carapace. I have seen more than 600 specimens of *D. grayii* attached to a single snake, and the number of individuals of *D. warwickii* attached to a single crab is often almost as great. It is probable, however, that soon after the barnacles have attained such numbers the crab or lobster or snake casts its skin, for when such masses are present they obviously include barnacles of several generations and only a few are of full size. In the case of bottom-haunting crabs, moreover, it is by no means improbable that the barnacles aid them in concealing themselves. In the Colombo Museum there is a specimen of *Dorippe dorsipes* in which the whole of the posterior part of the carapace and the base of the posterior limbs are concealed by the masses of *D. warwickii* which cluster upon them. It is well known that the crabs of this genus frequently bear upon their back, by means of limbs apparently modified for the purpose, a gastropod operculum or some similar object to which an actinian is attached. In the case of the Colombo specimen the barnacles completely take the place of this peculiar buckler, and the crab would have probably found it impossible to hold any thin object in the usual position, had there been any necessity for it to do so.

For these reasons it is impossible to class the species of *Dichelaspis* as actual parasites.

Distribution, etc., of Indian species of *Dichelaspis*.

1909.]

N. ANNANDALE: *The Indian Cirripedia Pedunculata.*

Name of Species.	Localities.	Hosts.	Bathymetric Range.
<p><i>Dichelaspis tridens</i> (Aurivillius). Syn. <i>D. occlusa</i>, Lanchester.</p>	<p>PACIFIC OCEAN: Philippines (<i>Aurivillius</i>). GULF OF SIAM: Kelantan and Trengannu, Malay Peninsula (<i>Lanchester</i>). STRAITS OF MALACCA: N. Sumatra (<i>van Kampen</i>). BAY OF BENGAL: Balasore Bay, Orissa coast.</p>	<p>DECAPOD CRUSTACEA: Mouth parts of <i>Thenus orientalis</i>; gills of <i>Callapa exanthematos</i>; base of chelæ and entrance to gill-chambers of <i>Xantho scaberrimus</i>; on <i>Macrophthalmus tomentosus</i> (<i>Aurivillius</i>).</p>	<p>Littoral zone; between 91 and 112 fathoms.</p>
<p><i>Dichelaspis bathynomi</i>, Annandale.</p>	<p>BAY OF BENGAL: Off Ceylon; off Pegu. ARABIAN SEA: Lat. 15° 55' N., Long. 52° 38' E.</p>	<p>ISOPOD CRUSTACEAN: Pleopods of <i>Bathynomus giganteus</i>.</p>	<p>195 fathoms; between 225 and 594 fathoms; 585 fathoms.</p>
<p><i>Dichelaspis warwickii</i> (Gray).¹ Syn. <i>D. equina</i>, Lanchester.</p>	<p>CHINA SEA (<i>Darwin</i>). MALAY ARCHIPELAGO: Borneo (<i>Darwin, Aurivillius</i>); Java, Sumatra (<i>van Kampen</i>). GULF OF SIAM: Trengannu or Kelantan, Malay Peninsula (<i>Lanchester</i>). BAY OF BENGAL: Orissa, Madras, Ceylon, Chittagong, Arakan, Estuary of Ganges. ARABIAN SEA: Laccadives or Maldives (<i>Borradaile</i>); N. end of Persian Gulf.</p>	<p>DECAPOD CRUSTACEA: Mouth parts, limbs and carapace of <i>Thenus orientalis</i>, <i>Panulirus</i> spp., <i>Doclea ovis</i>, <i>Doclea japonica</i>, <i>Doclea hybrida</i>, <i>Egeria</i> spp., <i>Arcania septemspinosa</i>, <i>Neptunus gladiator</i>, <i>N. pelagicus</i>, <i>Goniosoma</i> spp., <i>Dorippe dorsipes</i>, etc. MOLLUSCA: Living shell of <i>Murex</i> sp., and of "mussels." REPTILIA: Skin of <i>Hydrus platurus</i>. FISH: Back of <i>Serranus lanceolatus</i>.</p>	<p>Littoral zone, probably not extending below 40 fathoms; pelagic.</p>
<p><i>Dichelaspis grayii</i>, Darwin. Syn. <i>D. pellucida</i>, Darwin.</p>	<p>INDIAN OCEAN (<i>Darwin</i>). BAY OF BENGAL: Mergui, Arakan, Andamans, Ceylon, Madras, Orissa. ARABIAN SEA: Travancore coast.</p>	<p>REPTILIA (Ophidia): <i>Hydrus platurus</i>, <i>Distira robusta</i>, <i>D. viperina</i>, <i>Hydrophis spiralis</i>, <i>H. gracilis</i>, <i>H. fasciatus</i>, <i>Enhydrina valakadien</i>.</p>	<p>Pelagic.</p>

¹ I have recently found small specimens of this species attached to a living Antipatharian dredged from a depth of between 24 and 30 fathoms off the Madras coast.—June 21st, 1909.

Distribution, etc., of Indian species of *Dichelaspis*—concl'd.

Name of Species.	Localities.	Hosts.	Bathymetric Range.
<i>Dichelaspis geryonophila</i> , Pilsbry.	N. ATLANTIC : Martha's Vineyard, off New Jersey, N. America. ARABIAN SEA : Near Laccadive Islands.	DECAPOD CRUSTACEA : <i>Geryon quinquedens</i> (N. America); <i>Geryon affinis</i> (Laccadive Sea).	435—1,043 fathoms (<i>Pilsbry</i>); 328 fathoms (N. America); between 224 and 284 fathoms (Laccadive Sea).
<i>Dichelaspis rhinoceros</i> , sp. nov.	BAY OF BENGAL.	DECAPOD CRUSTACEA : Gills of <i>Encephaloides armstrongii</i> .	60—100 fathoms.
<i>Dichelaspis sinuata</i> , Aurivillius Syn. <i>D. trigona</i> , Aurivillius. ,, <i>D. vaillanti</i> , Gruvel.	RED SEA : Suez (<i>Gruvel</i>). PERSIAN GULF : N. end (<i>Lloyd</i>). BAY OF BENGAL : Andamans. MALAY ARCHIPELAGO : *Java (<i>Aurivillius</i>); Sumatra (<i>van Kampen</i>).	DECAPOD CRUSTACEA : <i>Panulirus</i> spp., <i>Neptunus pelagicus</i> (always in gill-chambers), <i>Echinoplax pungens</i> (gills).	Littoral and pelagic; once between 130 and 250 fathoms.
<i>Dichelaspis stella</i> , sp. nov.	BAY OF BENGAL.	DECAPOD CRUSTACEA : <i>Homola megalops</i> (gills).	180 fathoms.
<i>Dichelaspis cor</i> , Aurivillius. Syn. <i>D. maindroni</i> , Gruvel. ,, <i>D. coutierii</i> , Gruvel.	E. AFRICA : Port Natal (<i>Aurivillius</i>); Obok, Djibouti, French Somaliland (<i>Gruvel</i>). PERSIAN GULF : Muscat (<i>Gruvel</i>). ARABIAN SEA : Karachi. BAY OF BENGAL : Mouth of River Hughli; Salt Lakes, near Calcutta; Balasore Bay, Orissa coast; Rangoon River, Pegu; Pondicherry (<i>Gruvel</i>). MALAY ARCHIPELAGO : Java (<i>Aurivillius</i>); Sumatra (<i>Gruvel</i>).	DECAPOD CRUSTACEA : Gills of <i>Panulirus</i> sp. (<i>Gruvel</i>) and of <i>Scylla serrata</i> .	Estuarine. ? Pelagic.
<i>Dichelaspis angulata</i> , Aurivillius. Syn. <i>D. aperta</i> , Aurivillius. ,, <i>D. cuneata</i> , Aurivillius. ,, <i>D. bullata</i> , Aurivillius. ,, <i>D. transversa</i> , Annandale.	BAY OF BENGAL : Orissa coast. ARABIAN SEA : Bombay (<i>Imms</i>). PERSIAN GULF : N. end (<i>Lloyd</i>). MALAY ARCHIPELAGO : Java (<i>Aurivillius</i>); Sumatra (<i>van Kampen</i>).	DECAPOD CRUSTACEA : Gills of <i>Panulirus</i> spp., <i>Neptunus pelagicus</i> , <i>N. sanguinolentus</i> , <i>Goniosoma crucifer</i> .	Littoral and pelagic.

Dichelaspis tridens (Aurivillius).

Pœcilasma tridens, Aurivillius, "Studien über Cirripeden," *Kongl. Sv. Vet. Akad.*

Handl., xxvi, No. 7, p. 14, pl. i, fig. 13; pl. vi, fig. 12; pl. viii, figs. 13, 29.

Dichelaspis occlusa, Lanchester, "Crustacea of the 'Skeat Expedition,'" *Proc.*

Zool. Soc. Lond., 1902 (ii), p. 373, pl. xxxv, figs. 6—6c.

CAPITULUM laterally compressed, oval, produced into a more or less distinct rounded projection in front of the tergum. Valves well developed, calcified, more or less opaque. *Carina* broadly, regularly curved, expanded at the base into a well-developed transverse disk, somewhat concave externally in this region, with a broad, flat, inferior margin, which is co-terminous with the lateral surface above; a low dorsal ridge generally running the whole length of the valve; the apex situated at a point about half the distance between the carinal angle and the umbo of the tergum, from the carinal margin of which the carina is often by no means widely separated. *Tergum* irregularly triangular, with two distinct excavations on its scutal margin; its breadth more than twice its greatest height; the umbo situated on or near the margin of the capitulum; the occludent margin irregularly curved, diverging from the edge of the capitulum, with which it is in contact only at the umbo. *Scutum* consisting of two segments, both approximating to the tergum above; the occludent segment sickle-shaped, with the tip at the base and the upper extremity pointed or truncated, extending considerably above the highest point of the tergal margin of the carinal segment; the carinal segment approximating closely to the occludent, with which it is sometimes in contact above, sometimes almost quadrangular, narrowly separated from the carina behind and almost in contact with the tergum above, sometimes separated from the tergum and carina by a considerable extent of membrane and nearly triangular, the tergal margin sinuate, the carinal almost straight.

PEDUNCLE as a rule short and stout, sometimes long and moderately slender, ringed or smooth, covered with minute chitinous points, which often give it a deep yellow colour.

CIRRI, etc.—First cirrus short and slender, the two branches subequal, each with six joints. The three distal joints of each bearing at their distal extremity a complete circle of long, stout bristles, the third joint from the base a similar but incomplete circle; a fringe of similar bristles on the distal half of the anterior edge of the fifth and sixth joints and the distal quarter of the anterior edge of fourth joint; the fringe on the posterior edge of both branches consisting of fine hairs. The remaining cirri slender and rather short, very widely separated from the first pair, each joint bearing, on its anterior edge, a double fringe of long, closely-set hairs, and a bunch of rather stouter hairs at the tip of the joint behind. *Anal appendages* somewhat variable in length, usually reaching the tip of the pedicel of the sixth cirrus, bearing a pencil of long hairs at the tip and on the distal half or third of the posterior edge. *Penis* long and tapering, minutely and regularly ringed, with a few short, scattered hairs, chiefly on the dorsal surface, and a bunch of longer hairs at the tip.

MOUTH PARTS.—*Outer maxillæ* very broad, almost quadrangular, with a fringe of hairs at the extremity. Palp broadly conical, with a few fine hairs on the dorsal edge and a bunch of stouter ones at the tip. *Maxilla* with a shallow and narrow incisure on its free edge, bearing externally to the incisure three stout spines, of which the outermost is the stoutest; at the base and on the inner edge of the incisure several bristles, and internally to it about ten to twelve spines of different lengths, the first or second and the last being the stoutest; the ventral edge fringed with fine hairs. *Mandibles* normally with five teeth, the two innermost of which (inner angle) are close together, while the outermost, which is much stouter than the others, is widely separated from them; the two innermost teeth covered with fine, short hairs. *Labrum* feebly bullate, apparently without chitinous teeth.

The anatomy of this species closely resembles that of *Pæcilasma minutum* in several respects, but differs in others, notably as regards the maxillæ. The carina resembles that of *P. excavatum* and *P. dubium*. My description is not so different from Lanchester's as it might seem to be on casual inspection, but, having examined a large number of specimens from different hosts and different localities, I have been able to note a considerable amount of variation, especially as regards the development of the valves. Lanchester, in dealing with the mouth parts, has obviously called that end of the free edge I have called inner, outer, and *vice versâ*. The whole of the free edge internal to the incisure is on a higher level than the base of the incisure, which is very shallow, but also than the base of the three stout spines external to it. These spines are a feature common to a good many species both of *Pæcilasma* and of *Dichelaspis*, the two inner ones being parallel to one another—not arranged in a linear series.

At first, when dealing with the specimens of this species, I thought that they represented two distinct species or varieties; but, with the whole series before me, including a number from Sumatra which Dr. van Kampen has been kind enough to send me, I find it impossible to discover a definite break at any point. The two individuals figured represent the extreme forms that the species assumes, while the one figured by Lanchester was intermediate in some points. The exact outline of the capitulum is a variable character, and so is the appearance of the valves, which are translucent in some specimens and opaque in others. A common feature is a white vertical bar, often very indistinct, on the capitulum near the upper part of the occludent margin.

Aurivillius's *Pæcilasma tridens* was evidently a young example of the species. The length of the peduncle is a variable character, although I have only seen it quite so long in one specimen as it appears to have been in the type of *P. tridens*. Aurivillius says that the mandible has no incisure, but in my specimens the incisure is often so shallow that it may very easily be overlooked. I hesitated, however, to sink Lanchester's name as a synonym without seeing specimens from the Philippines, until I found a young specimen from the Orissa coast agreeing in every respect with Aurivillius's figures and accompanied by others resembling those of Lanchester.

D. tridens is apparently not uncommon in the seas of Sumatra and the Malay Peninsula, but it is not very often met with in Indian seas. It appears to prefer as hosts crustacea such as *Thenus orientalis* which habitually live in rather shallow water but are also found at a depth of between 100 and 200 fathoms. As a rule it clusters on the mouth parts of its host and round the entrance to the gill-chambers or the base of the chelæ. Occasionally, however, it also adheres to the gills themselves and the membrane that covers them above.

Like most species of its habits, *D. tridens* is small. In large adults containing eggs the capitulum measures about 3.5×2.5 mm., and the peduncle is usually shorter than the capitulum. As a rule young individuals have the capitulum relatively narrower and the peduncle longer and more slender. I have found eggs, however, in the shells of individuals which had these characters. The peduncle varies considerably in length even in the larger specimens, and is smooth in some, annulated in others; the development of the chitinous points with which it is beset is also a variable character; for in some large individuals they are minute, colourless and almost invisible, while in others they are much larger and have a deep yellow colour.

Dichelaspis bathynomi, Annandale.

D. bathynomi, Annandale, *Ann. Mag. Nat. Hist.* (7), vol. xviii, p. 45 (1906); *Illustr. Zool. "Investigator,"* Crust. Ent., pl. v, fig. 1.

CAPITULUM regularly and somewhat narrowly ovoid, pointed above, rounded at the base, compressed, covered by the valves to a variable extent; the outlines of the five primitive valves and their lines of growth always distinct; the calcified valves more or less hyaline, with an opaque area at the umbo. *Dorsum* large, subtriangular; its umbo situated close to the carinal margin of the capitulum, its superior margin more or less curved and forming a continuous line with the carinal margin; rostral and carinal angles acute; the scutal margin almost straight or excavated to correspond with the tip of the occludent segment of the scutum. *Scutum* in two segments, which diverge above to a variable extent; the occludent segment rounded or truncate at the apex (at which point it is in contact with the dorsum), pointed at the base, regularly arched; carinal segment variable in outline and extent, subtriangular or triangular, not reaching so high above as the occludent segment. *Carina* rather short, of variable lateral width, with more or less defined lateral ridges, expanding at the base into a transverse disk, which is much smaller than that of the carina of *D. tridens*.

PEDUNCLE fairly slender, cylindrical, of variable length, covered with small, chitinous tubercles which vary in size and colour.

CIRRI, etc.—First pair of cirri somewhat widely separated from second, resembling those of *D. tridens*, to which the species is closely related as regards its anatomy generally. *Anal appendages* uniarticulate, rather slender, bluntly pointed, bearing a short fringe of long bristles on the posterior margin of the extremity only. *Penis* of variable length, slender, pointed, covered with closely set rings of minute

chitinous teeth and bearing a bunch of soft, delicate processes at the tip; one of these processes sometimes longer than the others.

MOUTH PARTS.—*Labrum* bullate, bearing a row of small conical teeth, which increase gradually in size from within outwards; at the outermost rim of the circle the row is double for about five teeth. Palpi short, conical, bearing long hairs on the dorsal surface. *Maxilla* with a deep and rather narrow excavation, the inner edge of which bears two or three stout hairs; three very long and stout external bristles, one of which is almost a tooth; the inner bristles short and fine, generally subequal. *Mandible* with five teeth; its inner arm narrow and elongated.

In large specimens the length of the capitulum is from 6 to 8 mm.

Two varieties of this very variable species may be distinguished as follows. Intermediate forms occur, however, although the gradation is slightly abrupt:—

Var. I (typical form)—

Carinal margin of the scutum widely separated from the carina, towards which it is concave. Carina laterally narrow.

Var. II (*perfidiosa*, nov.)—

Carinal margin of scutum in contact with the carina for a considerable part of its length, convex towards the carina. Carina much broader laterally than in the typical form.

I was at first inclined to regard these two forms as distinct species, although they were found together; but on comparing adult specimens of both I became convinced that they were only varieties. There does not seem to be any constant anatomical difference between them, although both are very variable as regards the cirri, penis, etc.

Dichelaspis bathynomi has only been found in association with the deep-sea Isopod *Bathynomus giganteus*, on the pleopods of which it is always, so far as my experience goes, abundant. There are large numbers of Decapod crustacea in the Museum collections from the same parts of the Bay of Bengal and the Arabian Sea as those in which *Bathynomus* has been taken, but I have been unable to find on them a single example of *D. bathynomi*.

Dichelaspis warwickii (Gray).

D. warwickii, Darwin, *Mon. Cirr.*, Lep., p. 120, pl. ii, figs. 6, 6a, 6b; C. W. Aurivillius, "Stud. ii. Cirr.," *Kongl. Sv. Vet. Akad. Handl.*, xxvi, No. 7, p. 15, pl. viii, figs. 26, 27.

D. equina, Lanchester, *Proc. Zool. Soc. Lond.*, 1902 (ii), p. 385, pl. xxxv, figs. 7, 7a—d; Annandale, in *Herdman's Pearl Oyster Fisheries* (Roy. Soc.), part v, p. 139, fig. 2; *Illustr. Zool. "Investigator,"* Crust. Ent., pl. v, figs. 4—6.

CAPITULUM irregularly ovoid, the occludent margin being nearly straight and vertical, the carinal margin broadly arched; the apex rounded or bluntly pointed; the membrane translucent or opaque, often very thick, white or orange-colour, occasionally

deep purple in very large specimens, often with the outlines of the five primitive valves well marked upon it; the calcified valves covering about half the surface but widely separated from one another, more or less fully calcified, translucent or opaque. *Tergum* shaped like an axe or a horse's head and neck, the handle of the axe (or neck of the horse) stout, slanting downwards towards the scutal margin of the carina, which it does not nearly reach; a considerable vertical depression usually present on the anterior part of the valve. *Carina* extending upwards far above the carinal angle of the tergum, usually rather broad, with a broad irregular dorsal ridge on the basal third or quarter, split transversely into two plates (the upper of which is devoid of a special centre of calcification) through this ridge; the basal branch well-developed, running parallel to and below the basal margin of the scutum, deeply buried, terminating in a large, broad, oval, flat transverse disk, the lateral margins of which usually bear conspicuous ridges; the edge of the disk more or less notched and irregular, as the whole margin of the lower part of the valve also frequently is. *Scutum* with two branches or segments, the separation being incomplete in some specimens; the occludent margin nearly straight, cone-shaped, slanting outwards from above, its apex separated from the scutal margin of the tergum but corresponding with the deep excavation therein; carinal segment much shorter than the occludent subtriangular, the upper angle usually being rounded and the carinal margin more or less concave.

PEDUNCLE cylindrical or compressed, usually smooth, tapering towards the base, moderately stout, naked or with minute chitinous points.

CIRRI, etc.—First pair of cirri, in the natural position, not far removed from second, but remote if the animal be stretched out, from $\frac{1}{2}$ to $\frac{2}{3}$ as long; the anterior ramus slightly shorter than the posterior, but of the same width; each ramus with six distinct joints, which are subrectangular towards the base and oval near the apex; each joint well encircled by bristles. Second cirrus with the anterior ramus slightly shorter than the posterior, its bristles (as those of the cirri posterior to it) well developed but more slender than those on the first cirrus; the anterior margin of the segments distinctly convex, while in the third to sixth cirri it is almost straight, projecting outwards at the apex of the segment and slanting in towards the base. The cirri as a whole rather feebly curved. *Anal appendages* slender, rounded at the tip (which usually bears a bunch of long hairs), very variable in length, curving outwards from the base. *Penis* of moderate length, rather slender, tapering, covered with scattered hairs and more or less distinctly annulated, bearing at the tip a bunch of less sparse hairs and a delicate process, which is apparently retractile.

MOUTH PARTS.—*Labrum* bullate, with a row of comparatively large teeth. Palp short and stout, with long hairs at the tip. *Mandible* with four or five teeth, the fifth being small and blunt when present. *Maxilla* with a deep incisure, closely resembling the maxilla of *D. bathynomi*.

The capitulum occasionally reaches a length of at least 11.5 mm.

This is another variable species, probably recognized as such only owing to the fact that large numbers of specimens have been examined. It is by far the commonest

Pedunculate (except perhaps *Lepas anserifera*) in the shallow parts of the Indian seas, and hundreds of specimens have passed through my hands; there are certainly at least 1,000 in the Museum collection. Curiously enough, the one character I find constant has caused confusion as regards the species, *viz.*, the separation of the carina into two parts by a transverse fissure near the base. Neither Gray nor Darwin recorded this character, which is by no means clear in shrunken specimens; but Aurivillius noted it in specimens from the China Sea as well as from the Malay Archipelago. Dr. W. T. Calman of the British Museum has kindly sent me the following note:—"All our specimens labelled *Dichelaspis warwickii* have the carina divided horizontally as in the specimens of *D. equina* which you send. They are unfortunately far from numerous and they do not appear to include Gray's types (unless these are among some old specimens of which the localities have been lost), but they do include one tablet with half a dozen dry specimens labelled *D. warwickii*, var. in Darwin's handwriting." The transverse fission of the carina is a varietal character in *Dichelaspis geryonophila*, and it is of course possible that a race or variety of *D. warwickii* may occur in which it is absent. If this be so, this race or variety would be the typical form, while the common Indian form would become "subsp." or "var *equina*."

Dichelaspis geryonophila (Pilsbry).

Octolasmis geryonophila, Pilsbry, *Bull. U. S. Nat. Museum*, No. 60, p. 94, figs. 32a, b (1907).

CAPITULUM ovoid or triangular, variable in relative transverse diameter, laterally compressed, bearing five widely separated valves and usually marked on the surface with fine serrated ridges representing more or less completely the five primitive valves and their lines of growth. Membrane more or less opaque, colourless or tinged with orange. *Carina* forked at the base, the length of the basal branches being variable; the vertical branch moderately broad, often of irregular outline, reaching above the level of the base of the tergum; dorsal surface with a rounded ridge on the lower part, inner surface with a deep pit near the base. *Tergum* small, irregularly saddle-shaped, often having the outline of a bird's head with the beak pointing to the aperture. *Scutum* consisting of two branches or segments sloping towards one another; the lower branch triangular, shorter and usually broader than the upper, which is sharply pointed above and directed towards the concavity in the tergum, from which it is often widely separated.

PEDUNCLE naked, often longer than the capitulum, broader at the base than above, irregularly annulated.

CIRRI, etc.—First cirrus slender and rather short, its anterior ramus similar to the posterior one but shorter by about half the length of the distal joint of the latter; the distal joint of each ramus bearing near its tip a circle of stiff, sharply pointed spines and terminating in a bunch of fine hairs: all the joints densely fringed anteriorly. Other cirri widely separated from the first, rather short, slender, pointed, densely fringed. *Anal appendages* not quite reaching the junction of the two branches

of the sixth cirri, slender, slightly spatulate, rounded at the tip, which bears a pencil of stout hairs, some of which are considerably longer than the appendage itself: the upper third of the posterior edge bearing similar hairs. *Penis* slender, abruptly pointed at the tip, moderately long, clothed with closely set rings of minute spines and bearing a few scattered hairs.

MOUTH PARTS.—*Labrum* broad, bearing a row of short, rather stout teeth. Palpi short, slender, bearing a pencil of long hairs at the tip. *Outer maxillæ* broadly oval, densely fringed. *Maxillæ* with a broad, rather shallow, pointed incisure near the outer edge, which is armed with a long, slender spine; between this and the incisure two or three more slender spines of varying length; a long slender spine immediately on the other side of the incisure followed by several others (usually six) of varying lengths; the inner edge of the appendage irregularly serrated and bearing a fringe of fine hairs. *Mandibles* bearing five teeth, the outermost of which is by far the largest and is separated widely from the rest; the fourth tooth short and often blunt, the fifth slender and rather long; the four inner teeth and the part of the appendage adjacent to them clothed with minute spines; the inner edge of the appendage bearing a fringe of fine hairs.

I have examined some twenty specimens of this species from the entrance to the gill-chambers of two deep-sea crabs.

Specimens.

$\frac{5637}{10}$ Gill-chambers of *Geryon affinis*. Stat. 248 (Lat. 8° 37' N., Long. 75° 37' 30" E., Laccadive Sea), between 224 and 284 fathoms. (S.S. "Investigator.")

$\frac{5638}{10}$ Gill-chambers of *Geryon quinquedens*. "Martha's Vineyard" (off coast of New Jersey, U. S. A.), 328 fathoms. (Smithsonian Institution.)

Remarks—

This species is variable as regards the exact form of its valves, the colour of the membrane, the relative lengths of the capitulum and peduncle, and the proportions of the latter. The lower branch of the scutum is sometimes broadly triangular, occasionally almost linear, the outline of the tergum differs greatly in different individuals and the carina sometimes ends practically at its lowest point and is sometimes produced into horizontal branches, which may underly the extremity of the basal branches of the scutum. The specimens from *Geryon quinquedens* have a deep orange colour and are very opaque, while those from *G. affinis* are colourless and much more translucent. In all, the valves are yellowish and apparently contain a large proportion of chitin. Speaking generally, I may say that both the peduncle and the capitulum are more slender in older than in young individuals, in which the former is often somewhat narrowly oval, while in older (or at any rate larger) examples it is broadly triangular. Even the narrow, oval individuals, however, often bear ova. There is one character shown by some individuals among those from *Geryon quinquedens* (*viz.*, the transverse fission of the carina) which seems to justify them being considered a distinct variety, for which the name *var. fissicarina* is proposed.

The above description and notes were drawn up before I realized that I was dealing with specimens both from the Atlantic and from the Indian Ocean, or that the species had already been described; for it was only on looking up the localities of the crabs in the Museum register and referring to Pilsbry's paper on the Cirripedes of the U. S. National Museum that I discovered these facts. On doing so I re-examined the specimens with the greatest care, to see whether I had overlooked any difference between the two races, and also dissected two more specimens from each lot with the same end in view. One character made it easy to distinguish the individuals found on the American crab (*Geryon quinquedens*) from those on its Indian ally *G. affinis*, namely, their colour; for the former were tinged with orange, the latter white. In itself this is not an important matter, for if two lots of specimens of the common oriental species *Dichelaspis warwickii* from different crabs from the same locality be examined, they will often be found to differ in colour. The appendages, penis and mouth parts of the two lots of specimens of *D. geryonophila* agree closely. I cannot, therefore, separate the one from the other.

The occurrence of any species of the genus on allied species of crabs so widely separated in habitat is an extremely interesting fact, and, so far as I am aware, as yet one without parallel. The American specimens in this Museum are from the same locality as those on which the species was founded. Regarding it its author says, "It is an abundant species, only known from the gill cavity of the crab *Geryon quinquedens*, and taken only in a rather small area off the continental slope east of New Jersey, in 435 to 1,043 fathoms." So far as I am aware, only one specimen of *Geryon affinis* is known from Indian seas,¹ and I am pretty sure that this is the only crab in our collection to which the barnacle is attached.

Dichelaspis grayii, Darwin.

D. grayii, Darwin, *Mon. Cirr.*, Lep., p. 123, pl. ii, fig. 9 (1851).

D. pellucida, Darwin, *op. cit.*, p. 125, pl. ii, fig. 7; Hoek, *Journ. Linn. Soc. London*, xxi (Anderson's "Fauna of Mergui"), p. 154, pl. xiii (1889); Annandale in Herdman's *Report on the Ceylon Pearl Fisheries* (Roy. Soc., London), pt. v, p. 140, figs. 1, 1a, 1b (1906); *Illustr. Zool. "Investigator,"* Crust. Ent., pl. iv, figs. 2, 3 (1908).

All the tissues very transparent²; no cuticular plates or spines on the surface.

CAPITULUM bonnet-shaped, compressed; the carinal margin irregularly curved, the basal half being much more boldly arched than the upper half; the occludent margin sinuous. Five narrow, widely separated valves, which vary considerably as

¹ This crab was originally taken by the "Hirondelle" Expedition off the Azores and was described by Milne Edwards and Bouvier in their account of the Decapod crustacea of that expedition. Thanks to the kindness of Prof. Bouvier and H. S. H. the Prince of Monaco, I have been able to examine barnacles attached to Atlantic specimens. They were all specimens of *Pæcilasma kæmpferi* subsp. *aurantia*.

² In life they have a pale vinous tint, which varies in intensity in individuals living in the same snake and disappears very rapidly on spirit or formalin.

regards the amount of calcium salts they contain, present in the typical form. *Carina* linear, arched (often irregularly), elbowed at the base but not forked, the basal branch running parallel to and some little distance below the basal branch of the scutum. *Scutum* consisting of two narrow branches which meet one another practically at a right angle; the vertical branch broader and longer than the basal one, diverging somewhat from the occludent margin of the capitulum above, pointed apically. *Tergum* shaped like an axe with a somewhat slender handle, somewhat variable in exact outline, very widely separated from the carina.

PEDUNCLE as a rule longer than the capitulum, cylindrical, slender, very soft.

CIRRI, etc.—Cirri rather short, not strongly curved; pedicels long, in the second pair equalling about one-fourth the length of the rami, which are practically equal. The posterior cirri armed with a double row of moderately strong bristles down the anterior margin and with small bunches of delicate, short hairs at the distal end of the last four or five joints posteriorly. First cirrus with the two rami subequal; the distal joint in each bearing two circles of stout bristles and all the other joints bearing several somewhat irregular circles of similar but slighter bristles. *Anal appendages* very long and slender, one-third to half as long as the sixth cirri, without joints or with five or six more or less perfectly differentiated, ending in a bunch of short hairs of different lengths and with a few scattered hairs on the posterior margin. *Penis* short and stout, minutely ringed with circles of very minute chitinous processes, pointed, somewhat curved at the tip, bearing scattered hairs all over and sometimes a long flagellum on the dorsal surface.

MOUTH PARTS.—*Labrum* more or less bullate, armed above with a row of fine, minutely pointed teeth. Palpi blunt, sparsely hairy. *Outer maxilla* broadly and regularly oval (except as regards the base), covered with scattered hairs externally. *Maxilla* deeply excavated; three long stout bristles external to the excavation; the edge internal to it somewhat sinuous, bearing several short stout bristles and some smaller ones of different sizes; a single slender bristle as a rule present at the base of the excavation; the body of the mandible covered with short hairs, most of which are arranged in pairs transversely. *Mandible* narrow, with five teeth; the innermost very small and close to the fourth; the base of the large outer tooth bearing a few scattered hairs; the inner arm, which bears the four inner teeth, covered with hairs arranged as on the maxilla.

Large specimens measure about 5 mm. in capitular length.

Var. *pernuda*, nov.

Valves completely or almost absent; no trace of the tergum; the scutum, if present, represented only by the vertical branch, which is devoid of calcareous salts and barely even chitinized; the carina absent. The original five valves of the Lepadidæ are sometimes represented in outline on the capitulum with their lines of growth.

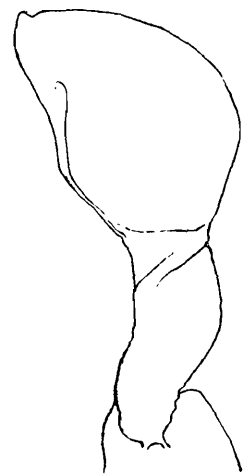


FIG. 8.—*Dichelaspis grayii* var. *pernuda*, $\times 8$.

Dichelaspis grayii is common on the sea-snakes of Indian seas and I have been able to examine over 800 specimens in all. This series exhibits every gradation between the typical form and *D. pellucida*, of which Darwin said, "I should not be much surprised if the present form were to turn out to be a mere variety" [of *D. grayii*].

The variety described above as var. *pernuda* is, however, a most remarkable form. I have found it in considerable numbers on three sea-snakes from different localities, always by itself so far as other cirripedes were concerned. A careful comparison of cirri, mouth parts, etc., with those of specimens of the typical form of the species shows no constant difference, while Darwin's description of these organs fits more exactly to one specimen of the variety than to any individual of the typical form I have dissected. The long anal appendages, which in some specimens of the typical form are distinctly segmented, are particularly characteristic of the

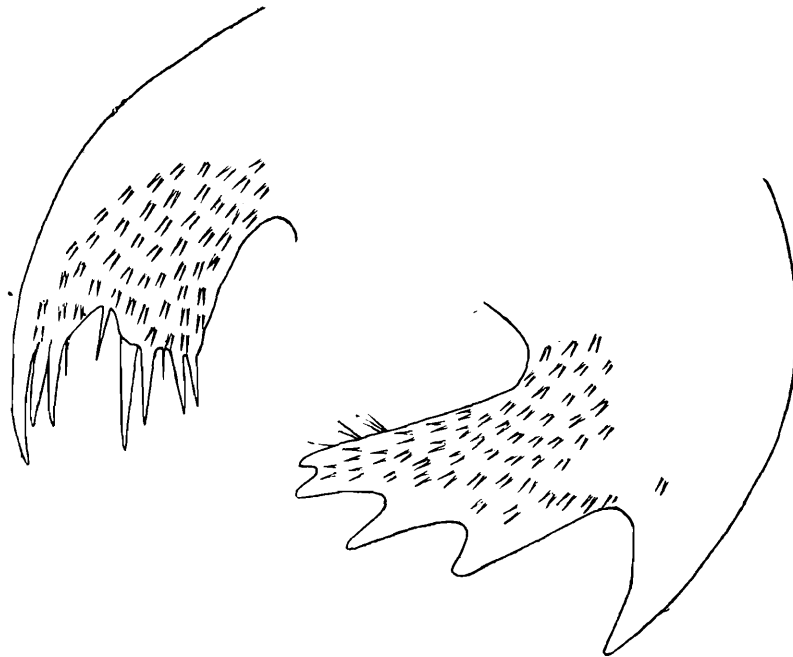


FIG. 9.—Mandible and maxilla of *D. grayii* var. *pernuda*, $\times 240$.

species, although their exact relative length is variable, while the arrangement of the armature and ornamentation of the mouth parts also affords a sufficient means of diagnosis.

The new variety affords another link between three subfamilies of the Lepadidæ (*i.e.*, the Lepadinæ, the Pœcilasmatinæ and the Alepadinæ). The nakedness of the capitulum and its lack of a muscular layer may be only an adaptive resemblance to the genus *Alepas*, from which the well-developed cirri at once distinguish it. The absence of a muscular layer and of lateral appendages separates it from *Heteralepas*, to which, however, it exhibits a certain resemblance as regards the anal appendages and mouth parts. Both the variety and the typical form of the species, moreover, differ as regards these structures from most other species of *Dichelaspis*; but it is impossible to separate them from that genus.

Dichelaspis stella, sp. nov.

Minute, transparent, the valves occupying a small part of the area of the capitulum.



FIG. 10.—*D. stella*,
x c. 27, with the tergum
of a second specimen.

CAPITULUM laterally compressed, with the occludent margin almost straight and vertical and the carinal margin strongly arched; with four delicate, brittle valves; a considerable area of apparently reticulate structure surrounding the umbo of each valve. *Carina* linear, arched, extending more than half way up the capitulum, forked at the base, the two branches of which are variable in length, widely separated, almost parallel to one another and, in another plane, to the basal branch of the scutum. *Tergum* small, in the shape of a four-rayed star, the uppermost ray of which is usually shorter than the other three, while the lowest is longer. *Scutum* consisting of two sublinear branches which almost form a right angle, one being horizontal, the other vertical; the vertical branch considerably longer and broader than the other.

PEDUNCLE naked, generally longer than the capitulum, smooth, slender, very transparent.

CIRRI, etc.—First cirrus narrowly separated from second, with both rami slender; the anterior ramus slightly broader than the posterior, and shorter by one joint; the distal joint of each bearing at its tip a circle of long, stout spines. Remaining cirri long and slender, bearing numerous very long, slender hairs on the anterior margin of each joint and at the tip of the distal joint. *Anal appendages* short, slender, barely reaching the distal end of the basal joint of the sixth cirrus, bearing at their tip a bunch of long, fine hairs, some of which are several times as long as the appendage; the posterior margin entirely bare. *Penis* long and slender, apparently naked.

MOUTH PARTS.—*Labrum* not bullate, with a row of minute, triangular, equal teeth round its dorsal margin. *Palp* short, somewhat claw-shaped, bearing a fine pencil of long hairs at its tip. *Outer maxilla* short and broad. *Maxilla* with a somewhat narrow and shallow incisure about the middle of its biting edge; external to the incisure three stout spines, of which the outermost is the stoutest; internal to it about half-a-dozen more.

This is a very small species, the capitulum in all that I have seen being less than 2 mm. in length. There is only one set of specimens in the Museum, however, and it consists only of ten individuals, all of which were found on the gills of a single crab. Possibly they are immature, for none of them contain eggs. The species is evidently rare.

Dichelaspis rhinoceros, sp. nov.

Minute, transparent, with five translucent, brittle valves; the scutum with three branches; the membrane thin.

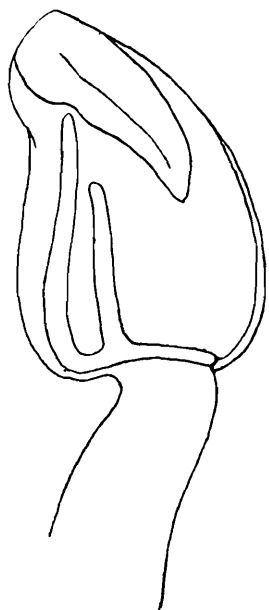


FIG. II.—*D. rhinoceros*, × 23.

CAPITULUM broadly ovate, compressed; the upper part of the occludent margin more or less lobate; the base rounded. *Carina* moderately narrow, concave internally, arched, expanded at the base into a short oval disk, which is imbedded in the membrane and lies parallel to the base of the capitulum; the lateral faces at the base concave, with a distinct ridge above on the sides of the inner margin. *Tergum* relatively large, subtriangular, almost vertical, the umbo facing the dorsal edge of the capitulum; the carinal margin curved, the scutal margin with two deep, broad excavations, of which the one corresponding to the occludent segment of the scutum is the narrower. *Scutum* with a basal transverse branch from which two vertical branches arise close together; the occludent branch usually narrower and longer than the carinal one; both vertical branches widely separated from the carina, their bases curved, *not* angular; the basal transverse branch extending almost to the carinal margin of the capitulum and overlapping the basal disk of the carina at either side.

PEDUNCLE usually short, bearing rings of very minute chitinous plates.

CIRRI, etc.—Posterior cirri slender, moderately short, not much curved; the bristles on their anterior margin slender but stiff, definitely arranged in a double vertical row, consisting of from five to eight pairs of bristles on each segment; the posterior terminal bunches of bristles well developed even on the proximal joints of the rami. First pair of cirri not widely separated from the others, at least three-quarters as long as the second, slender, with long pedicels; the rami subequal. *Anal appendages* long and slender, reaching considerably beyond the distal end of the pedicel of the sixth cirri, narrowly rounded at the tip, bearing a row of long bristles, some of which are longer than the appendage, on the external end of the posterior margin and the tip. *Penis* moderately long, slender, pointed, not distinctly annulated.

MOUTH PARTS.—*Labrum* bullate. Palpi broadly conical, large, bearing a few short bristles at the tip. *Outer maxilla* broadly oval, almost truncate; its external surface covered with long delicate bristles. *Maxilla* with a deep but narrow excavation. *Mandible* small, the outer tooth not very large or very widely separated from the others, which are small and usually number four including the inner angle.

A very small species, the capitulum of adults which contain eggs measuring only about 2 mm. in length.

This species was found on the gills of several specimens of the crab *Encephaloides armstrongii* dredged in the Bay of Bengal at a depth of between 65 and 93 fathoms. It does not appear to be a common species. The shape of the scutum, with its three branches, resembles that of *D. forrestii* (Stebbing) from the Coast of Florida and the West Indies. Apart from anatomical differences, however, the tergum occupies a much greater part of the surface of the capitulum in the Indian than in the Atlantic species.

Dichelaspis cor, Aurivillius.

- D. cor*, Aurivillius, "Stud. ü. Cirr.," *Kongl. Sv. Vet. Akad. Handl.*, xxvi, No. 7, p. 20, figs. 1, 2 (1894).
- D. maindroni*, Gruvel, *Mono. Arch Mus. Paris* (4), iv, p. 282, pl. iv, figs. 21—27, pl. i, figs. 15, 16 (1902).
- D. coutierei*, *id.*, *ibid.*, p. 289, pl. iv, figs. 28—32; Annandale, *Illustr. Zool. "Investigator,"* Crust. Ent., pl. iv, figs. 4, 5 (1908).

CAPITULUM heart-shaped, pointed above, gradually rounded at the base, with or without the lines of growth marked on the surface, transparent or translucent; the surface often covered with minute, chitinous points; the membrane thick. Valves three, sometimes five, narrow but stout. No definite *tergum*, which is sometimes represented, however, by an amorphous chitinous plate. *Carina* narrow, usually curved, with transverse basal branches, which are turned upwards towards the scutum; the inner part of the lateral faces usually concave. *Scutum* with two branches or segments, which are sometimes quite distinct from one another; the occludent branch or segment narrow, close to the occludent margin of the capitulum, sometimes expanded and truncated at the tip, sometimes pointed, extending along the occludent margin of the capitulum for the greater part of the length of the latter; basal branch or segment slanting inwards and upwards, narrow and pointed or expanded at the tip and truncated, its base more or less triangular.

PEDUNCLE usually longer than the capitulum, with or without chitinous points, not or barely annulated.

CIRRI, etc.—First pair of cirri close to the second or separated from it, very short as a rule, but variable in this respect. All the cirri stout and rather short. The rami of the first pair subequal, rather broad, barely longer than the pedicel, the joints profusely covered with stout hairs. The posterior bunches of hairs well developed on the posterior cirri. *Anal appendages* variable in length and armature, laterally compressed, rounded at the apex, bearing a dense apical fringe of hairs, which extends down the posterior margin to a different degree in different individuals. *Penis* usually very stout, pointed, with the apex retroverted. In some individuals, however, which are perhaps immature, it is slender, and straight at the extremity.

MOUTH PARTS.—*Labrum* prominent but not bullate, without a row of chitinous teeth above but minutely ornamented with chitinous points in some individuals. Palp rather stout, bluntly pointed, bearing on the dorsal surface at the tip a fringe of stout hairs and along the whole of the dorsal margin a more sparse fringe of similar hairs. *Mandible* with five or six teeth (including the inner angle); all the teeth short and proportionately broad at the base; the first not much larger than and by no means widely separated from the second; the second, third, fourth and fifth subequal; the extra teeth, when present, smaller than the others, situated at the base of the fifth; a small projection also present at the base of the fourth; the greater part of the mandible covered with short, fine hairs. *Maxilla* without a definite excavation although there is sometimes a very faint concavity between the first three

outer spines, which are unusually stout, and the inner ones; these latter also very stout, numbering about six, arranged in a double row with fine hairs interspersed.

Exceptionally large specimens have a capitulum about 4 mm. long, but it is more commonly from 2 to 3 mm. long even in individuals bearing eggs. A common species on *Scylla serrata* in Indian estuaries.

Gruvel separates his *Dichelaspis maindroni* from *D. cor* on the following characters:—(1) difference in shape of the upper part of the capitulum, (2) absence of any trace of the terga, (3) absence of lines on the external surface of the capitulum, (4) small differences in the cirri, mouth parts and anal appendages. The first of these is not only a variable character but one peculiarly liable to be obscured by different methods of preservation; the second is a character not constant either in this species or in others allied to it; the same remark applies to the third, while those included under the fourth heading are discussed so briefly by Aurivillius in his original description of *D. cor* that it is not possible to make a detailed comparison. I can only say that I have found the cirri, etc., extremely variable even among individuals resembling one another externally. The parallel lines on the external surface of the capitulum in some individuals clearly represent the outlines of the original five valves, in others they are confined to the upper part of the capitulum, in others they can just be traced at a few points, while in others they are quite absent.

Gruvel distinguished three varieties, which, for very sound reasons, he refused to recognize as distinct species. They are characterized as follows:—

Var. A has the extremity of the basal branch of the scutum truncate and expanded and the occludent branch considerably broader in the middle than at the base. The extremity of the basal branch of the carina is also expanded and truncate.

Var. B has the same features to a less strongly marked extent, except that the occludent branch of the scutum is barely broader in the middle than at the base.

Var. C has all the valves linear, without expansions at the extremity of any.

The three varieties occur in the Bay of Bengal, but var. A is commoner than the others and is often the only one found on the gills of a crab, although the three, with intermediate stages, sometimes occur together. The degree to which chitinous points are developed on the external surface of the capitulum and peduncle is very variable.

By the kindness of Professor Bouvier I have been able to examine co-types of Gruvel's three varieties. Too much stress must not be laid on the differences between them, for many intermediate forms occur. Also by the kindness of the same zoologist, I have received co-types of Gruvel's *D. coutierei*, which I had long suspected to be a variety of *D. maindroni* founded on specimens in which the penis was not fully developed. An examination of the co-types confirms me in this view, for they all appear to be immature. The parallel and transverse chitinous bars on the capitulum are not so conspicuous in any of the specimens I have seen as they appear to be in Gruvel's

figure but exist as slightly raised linear ridges marking the limits of the original five valves. I would therefore regard the form at most as a variety of *D. cor*.

Dichelaspis sinuata, Aurivillius.

D. sinuata, Aurivillius, *op. cit.*, p. 17, figs. 2—5.

D. trigona, *id.*, *ibid.*, p. 19, pl. ii, fig. 8.

D. vaillantii, Gruvel, *op. cit.*, p. 279, pl. xiv, figs. 5—13; Annandale, *Illustr. Zool. "Investigator,"* Crust. Ent., pl. iv, fig. 6.

Small, more or less transparent; the scuta and carina linear; a pair of calcified terga present; chitinous points absent on the external surface, or very minute.

CAPITULUM somewhat variable in shape, more or less globose, usually having a distinct lobe on the upper extremity of the occludent margin; both edges arched. *Tergum* small, saddle-shaped or vertically elongate, occasionally almost square, fully calcified. *Scutum* imperfectly calcified as a rule, consisting of two more or less elongated, slender branches, which meet together at a point considerably removed from the base of the capitulum (in well-preserved specimens), the basal branch being nearly transverse and the occludent branch sloping towards it in such a way that the resultant angle would be less than a right angle if it were not rounded off; the two branches equal or nearly equal in length, pointed at the tip. *Carina* sometimes reduced to a mere rudiment of a narrowly triangular outline and only occupying a very small part of the dorsal border of the capitulum, more commonly longer and produced at the base into a pair of branches, which are long and slender in some individuals and barely represented even by minute rudiments in others.

PEDUNCLE generally longer than the capitulum, but sometimes much shorter.

CIRRI, etc.—Cirri short, slender and by no means strongly curved. The first pair not so widely separated from the second as in some species, very short, subequal, without stout spines, but profusely covered with delicate hairs. *Anal appendages* slender, reaching beyond the apex of the pedicel of the sixth cirri, compressed, rounded at the tip, which bears a double row of some five to seven moderately long hairs; these extend a short distance down the posterior margin. *Penis* slender, not very long, the tip very fine, ending in a bunch of fine hairs, not retroverted.

MOUTH PARTS.—*Labrum* more or less bullate, with about twelve minute, round, blunt teeth on the upper surface. Palp conical, bluntly pointed, long, covered with fine hairs and bearing six or seven irregularly placed pairs of stout bristles on and near the tip. *Outer maxilla* broad, almost heart-shaped, with a fringe of fairly stout hairs on the dorsal surface. *Maxilla* without or with a very faint incisure; the bristles not so stout as in *D. cor* and showing greater differences in size. *Mandible* with five teeth in addition to the inner angle, but with the inner angle either blunt or divided up more or less regularly into two smaller teeth; the fifth tooth small and blunt; none of the teeth very long; the first by no means widely separated from the others.

The capitulum of the largest specimens measures less than 3 mm. in length.

The series in the Indian Museum, which is a large one (including specimens from the Persian Gulf, the Bay of Bengal and the seas of Sumatra and Java) exhibits every gradation, so far as external characters are concerned, between the three forms I have regarded as synonymous. Many of the Malayan specimens, moreover, agree closely with Gruvel's description of *D. vaillanti*. The nature of the variation exhibited within the limits of the species as a whole is precisely similar to that exhibited by *D. angulata*, of which I have examined an even larger series. I propose to discuss the question at considerable length in connection with the latter species, and it is unnecessary to do so twice over.

Dichelaspis angulata, Aurivillius.

- D. angulata*, *Aurivillius, op. cit.*, p. 22, pl. ii, figs. 9—11, pl. viii, figs. 15, 24 (1894).
D. aperta, *id., ibid.*, p. 24, pl. i, figs. 14—16.
D. cuneata, *id., ibid.*, p. 25, pl. i, figs. 17—19.
D. bullata, *id., ibid.*, p. 26, pl. ii, figs. 12, 13; pl. vi, figs. 10, 11; pl. viii, figs. 19, 25.
D. transversa, *Annandale, Ann. Mag. Nat. Hist.* (7), vol. xviii, p. 44, figs. 1, 1a.

Minute, more or less transparent, colourless; all the valves linear; no tergum; the external surface naked or covered with small chitinous points.

CAPITULUM rounded, more or less bullate, with prominent lobes above the aperture, which is sometimes transverse. *Tergum* absent as a calcified plate, but often represented by an amorphous chitinous patch, which is sometimes conspicuous owing to its yellow colour. *Carina* sometimes absent, when present of variable size and shape, often quite rudimentary, sometimes forked at the base; the basal branches never stout and never turned upwards. *Scutum* very variable, sometimes fully calcified, forming a crescentic bar, often sinuous, occasionally angular, the lower extremity sometimes produced into a fine, imperfectly calcified basal branch, which is occasionally separated from the vertical one; the length of the basal branch, when it is present, very variable.

PEDUNCLE variable in length, sometimes long, slender and cylindrical, sometimes short and stout, much broader at the base than at its junction with the capitulum.

CIRRI, etc.—Cirri moderately long, curved; the hairs on their anterior margin, which is markedly convex in each joint, long, becoming shorter towards the base of each joint than they are at the apex, arranged on each joint in two vertical rows of about seven hairs each. First pair of cirri short, not very widely separated from the second; the anterior ramus slightly shorter than the posterior, each ramus bearing a circle of moderately stout bristles at the tip of the distal joint and otherwise profusely covered with hairs. *Anal appendages* moderately broad, compressed, reaching at least as far as the apex of the pedicel of the sixth cirri, bearing a dense tuft of moderately long hairs on the tip and several groups of stouter and shorter ones on the posterior

edge of the distal half; an imperfect separation into two joints sometimes visible. *Penis* stout and short; the proximal two-thirds covered with minute denticle-like chitinous teeth and bearing scattered hairs, devoid of annulation; the distal third closely and distinctly ringed, bearing a comparatively small number of scattered chitinous teeth, each with three comparatively long processes arising from a flat basis; the central process longer and more slender than those on either side; a tuft of short flattened hairs at the extreme apex of the organ, which is not retroverted, and a short flagellum.

MOUTH PARTS.—*Labrum* by no means bullate, bearing a tuft of short, fine hairs at the distal extremity. Palp bluntly conical, bearing a terminal bunch of stout hairs. *Outer maxilla* subquadrate, very broad; the distal margin sinuous; a fringe of stout hairs running all round the edge, but shorter on the distal margin than on the dorsal and ventral margins. *Maxilla* without an incisure, bearing a double row of stout bristles, which decrease in size gradually from above downwards and are interspersed with finer hairs; the body of the maxilla bearing several transverse rows of rather stout short hairs. *Mandible* with five teeth (including the inner angle, which is sometimes bifid); all the teeth rather short, not very widely separated from one another; the body of the mandible covered to a great extent with moderately slender, short hairs.

The capitulum of ovigerous individuals rarely measures more than 2 mm in length.

The external characters of this species are even more variable than is the case in *D. sinuata*, the variation being of a similar nature but extending further in the direction of reduction of the valves. The different forms that have been described as distinct species and to which reference is made in the synonymy printed above the description of the species, have been separated from one another mainly, but not solely, on external characters, and it will, therefore, be well to preface a discussion upon them by a brief statement as to the external differences which were believed to separate them.

(1) *D. bullata*, Aurivillius, had no carina or tergum; the scutum was somewhat sinuous but not angulate; the aperture was obliquely vertical, short, broader below than above; the capitulum was pointed above.

(2) *D. transversa*, Annandale, had a small linear or narrowly triangular carina; the tergum was absent or represented by a shapeless chitinous mass; the scutum was sinuous or almost angulate; the aperture was transverse or nearly so; the capitulum was produced above into a broad, rounded lobe.

(3) *D. angulata*, Aurivillius, had a linear carina with a broadly triangular base; there was no tergum; the scutum consisted of two branches meeting at an angle greater than a right angle, the uppermost being the longer and broader of the two; the aperture was almost vertical, narrow and slit-shaped; the capitulum was rounded above with a small lobe.

(4) *D. aperta*, Aurivillius, had a linear carina with a triangular base the lateral angles of which were produced into distinct branches; there was no tergum; the

scutum was somewhat L-shaped, but the angle at which the two branches met was rounded off; the aperture was vertical and broadly patent above; the capitulum was pointed at the apex, without a lobe.

(5) *D. cuneata* differed from *D. aperta* in that the scutum was divided a little above the point at which the two branches met and the aperture was not so patent.

Differences in the length of the peduncle I have not noticed, as this is a variable feature in all the species of the genus I have examined. The shape of the capitulum in species so soft and so liable to be distorted by alcohol as *D. sinuata* cannot be regarded as a reliable character on which to found specific diagnosis and is, as a matter of fact, extremely variable even in well-preserved specimens which otherwise resemble one another. The same is true of the exact direction of the aperture, the shape of which can apparently be altered at will by the living animal. As regards the latter point, moreover, all Aurivillius's figures seem to me to be incorrect in one particular, *viz.*, in the position assigned to the lower extremity of the opening. In his representations of *D. aperta*, *D. cuneata* and *D. bullata* this point is shown as considerably above the inferior extremity of the scuta, while in that of *D. angulata* the whole of the aperture appears to be confined to the space included between the scuta in their inferior half. In all the individuals I have examined it is possible, although often with difficulty, to see that the aperture extends from a point between the bases of the scuta nearly to the upper extremity of the capitulum. Frequently the lips are closely adpressed in the lower half of the opening, and occasionally this is the case both above and below the middle third. In transparent specimens it is difficult to see the separation between the lips when they are pressed together, but no such difficulty exists as regards specimens which are naturally somewhat opaque or have been stained by some suitable reagent such as borax carmine or hæmatoxylin.

The translucency of the capitulum and peduncle is a variable feature in this species as in many others, and so also is the development of chitinous points on the cuticle. Some individuals are quite transparent even after preservation in spirit, so that it is possible to examine their structure under the microscope without treating them with any special reagent. Others are much more opaque. Some have their whole external surface covered with small round chitinous tubercles of a deep yellow colour, while in others these points, although probably never altogether absent, can only be detected with great difficulty. The general opacity or translucency of the integument does not depend upon the degree of development of these tubercles, but is due to something inherent in the structure of the mantle and other parts of the animal.

The degree to which the valves are developed in different individuals or varieties of the species, is a character not devoid of a certain kind of consistency although by no means reliable as a means of diagnosis. My chief reason for considering the form I described as *Dichelaspis transversa* distinct from Aurivillius's *D. bullata* was the fact that all the specimens I had examined at the time the former was described possessed a carina. In the large series of specimens now before me, however, there are individuals with no carina, others in which a minute, needle-shaped calcareous body can

be detected with the aid of a high power of the microscope, others in which this body can just be seen with a hand lens, others in which it is larger and definitely though narrowly triangular, and others again in which the base is broadened out so as to form a second triangle; in a few the lateral angles of this triangle are lengthened into short branches. So far as the carina is concerned, the only point at which a break occurs in the series is the one at which it is possible to distinguish the base as a triangle; but this break is a very small one.

In some specimens it is possible to distinguish near the apex of the capitulum a chitinous structure of a yellowish colour which obviously represents the tergum. It never has a definite outline but fades imperceptibly into the surrounding membrane. In many individuals it is quite absent and in others it is only faintly indicated.

The scutum in its simplest form is a narrowly linear, sinuous structure at the side of the aperture. Often the two scuta of an individual differ in length. In a large proportion of the individuals I have examined a short piece of the lower end of the valve forms an angle with the slanting or transverse portion at the side of the aperture. In a few specimens this lower branch of the scutum has a more considerable length, and in one specimen it is completely separated from the upper branch. In several the upper branch is noticeably broader than the lower one, but this is a rare occurrence. The angle at which the two branches meet is generally greater than a right angle, but in several of my specimens it is less.

The next question to be answered is, how far are the differences in one valve correlated with those in the others? Speaking generally, I may say that the development of the lower branch of the scutum corresponds, as a rule, with that of the basal branches of the carina. But this rule is not without exceptions, for the specimen in the Museum in which the basal branch of the scutum is best developed possesses a carina that is small and narrowly triangular as a whole. I have not seen an individual without a carina, however, in which the basal branches of the carina were apparent. The absence or presence of a chitinous tergum is not a character that can be correlated with any other.

External characters are not the only ones on which *D. angulata*, *D. aperta*, *D. cuneata*, *D. bullata* and *D. transversa* were originally separated from one another. Aurivillius lays considerable stress on the length of the anal appendages relative to the joints of the protopodite of the sixth cirrus, and also on the number of teeth on the mandible. He shows himself, however, that the former is a variable character in another species of the genus, namely, *D. warwickii* (*op. cit.*, pl. 8, figs. 20, 21), and I do not find it constant in any species of *Dichelaspis* or *Pæcilasma* of which I have been able to examine more than one or two examples. In these genera, moreover, the number of teeth on the mandible is frequently variable, sometimes being different on the two mandibles of one individual. This fact has been recognized in the published descriptions of some species and ignored in those of others, probably because the description is often based on the examination (or at any rate the dissection) of a single specimen. C. W. Aurivillius's descriptions of the cirri, etc., are very short, so that it is difficult to regard them as a basis for comparison; while he rarely mentions the penis. The

second of these facts is unfortunate, but it is perhaps as well that too much stress should not be laid on the cirri, at any rate in minute species, for these can only be examined properly in such species under a high power of the microscope and in conditions which render distortion and breakages difficult to avoid.

The soft parts of the three allied species *D. cor*, *D. sinuata* and *D. angulata* exhibit a close general similarity, but afford sound means of diagnosis as regards particular organs. In fully adult individuals the characters of the penis especially appear to be fairly constant. In *D. sinuata* this organ is comparatively slender, while in *D. cor* and *D. angulata* it is very stout. As regards the two latter species the curious three-pronged chitinous structures on the distal part of the organ in *D. angulata* afford a ready means of separation. The arrangement of the hairs on the anal appendages, moreover, although it is by no means constant, differs much more widely in the separate species than it does among the individuals of any one of them. In *D. cor* there is a dense apical tuft extending some distance down the posterior margin as an uninterrupted fringe; in *D. sinuata* there is no definite tuft at the tip, but the distal edge of the organ bears a regular double row of some six or seven hairs (or rather some twelve or fourteen, if both series are considered), which only extends a short distance down the posterior margin, while in *D. angulata* there is, as in *D. cor*, a definite apical tuft extending down the appendages behind as a fringe, but this fringe is interrupted at one or more points. Differences in the maxillæ, mandibles and other mouth parts also exist, but are less reliable.

APPENDIX.

LIST OF THE LEPADIDÆ IN THE COLLECTION OF THE
INDIAN MUSEUM.

[Except when it is otherwise stated, each number refers to several or many individuals. The names of forms not recorded from the seas of British India and Ceylon are enclosed in square brackets.]

Family LEPADIDÆ.

Subfamily OXYNASPIDINÆ.

Genus *Oxynaspis*, Darwin.*Oxynaspis celata*, Darwin.

O. celata, Darwin, *Mon. Cirr.*, Lep., p. 134.

Subsp. *indica*, Annandale.

$\frac{5757}{10}$.	TYPES. (On Antipatharian.)	Off Akyab,	
	Arrakan coast: 17 fathoms		Bengal Fisheries.
$\frac{5774}{10}$.	Off Akyab: 17 fathoms		„
$\frac{5776}{10}$.	Off Orissa: 20 fathoms		„
$\frac{5785}{10}$.	Off Ganjam coast: 24—30 fathoms.	One specimen	„

Subfamily LEPADINÆ.

Genus *Lepas*, Linné.

Subgenus ANATIFA, Brugière.

Lepas anserifera, Linné.

445.	Port Blair, Andamans	J Wood-Mason, Esq.
619.	Andamans	„
$\frac{1845-6}{7}$.	Station 94: 15—17 fathoms	Marine Survey.
$\frac{7932}{9}$.	Sandheads, Hughli River	Commander, Pilot Brig.
$\frac{1475-6}{10}$.	North Andaman Island	Marine Survey.
$\frac{5045}{10}$.	Akyab	?
$\frac{5111}{10}$.	Colombo	Colombo Museum.
$\frac{5427}{10}$.	Batavia, Java	Dr. P. N. van Kampen.
$\frac{5428-5627}{10}$.	Puri, Orissa	Mr. C. A. Paiva.
$\frac{5753}{10}$.	Sabang Bay, N. Sumatra	Dr. P. N. van Kampen.
$\frac{5772}{10}$.	Puri beach, Orissa coast	Dr. N. Annandale.
$\frac{5793}{10}$.	(On buoy.) Off Ganjam coast	Dr. J. T. Jenkins.
$\frac{5824}{10}$.	St. Croix, West Indies	Prof. H. J. Hansen.

Lepas anatifera, Linné.

L. anatifera, Darwin, Mon. Cirr., Lep., p. 73.

$\frac{7845}{6}$.	Greenland	Stockholm Museum.
$\frac{5048}{9}$.	German Ocean	Asiat. Soc. Bengal.
$\frac{1015}{10}$.	Plymouth, England	Purchased.
$\frac{5763}{10}$.	Havre, France	Paris Museum (Prof. Bouvier).
$\frac{5799}{10}$.	Gulf of Naples	Dr. R. Dohrn.
$\frac{5823}{10}$.	Lat. 58° N., Long. 25° W	Prof. H. J Hansen.

Subsp. *indica*, Annandale.

$\frac{5773}{10}$.	TYPES. Puri beach, Orissa	Dr. N. Annandale.
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[*Lepas hillii*, Leach.]

L. hillii, Darwin, op. cit., p. 77.

$\frac{5046}{10}$.	On ship from Brazil	Prof. E. Cornalia.
$\frac{5047}{10}$.	St. Andrews, Scotland	Prof. McIntosh.
$\frac{5825}{10}$.	Copenhagen. On ship from West Indies	Prof. H. J. Hansen.

[*Lepas pectinata*, Spengler.]

L. pectinata, Darwin, op. cit., p. 86.

$\frac{8498}{6}$.	Hongkong	Sur.-Genl. R. Hungerford.
$\frac{5759}{10}$.	Mediterranean coast	Paris Museum (Prof. Bouvier).
$\frac{5789}{10}$.	Gulf of Naples	Dr. R. Dohrn.
$\frac{5826}{10}$.		Prof. H. J Hansen.

Subgenus DOSIMA, Gray.

[*Lepas fascicularis*, Ellis & Sol.]

L. fascicularis, Darwin, op. cit., p. 92.

$\frac{5761}{10}$.	La Rochelle, France	Paris Museum (Prof. Bouvier).
$\frac{5822}{10}$.	Lat. 36° 50' N., Long. 21° W	Prof. H. J Hansen.

Subgenus HYALOLEPAS, Annandale.

Lepas tenuivalvata (Annandale).

$\frac{5109-10}{10}$.	TYPES. Ceylon	Colombo Museum.
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Genus **Conchoderma**, Olfers.*Conchoderma virgatum* (Spengler).*C. virgata*, Darwin, *op. cit.*, p. 146.

- | | | |
|-------------|--|-------------------------------|
| 5760.
10 | Cape of Good Hope, S. Africa | Paris Museum (Prof. Bouvier). |
| 5796.
10 | Gulf of Naples | Dr. R. Dohrn. |
| 5794.
10 | (On <i>Chelone imbricata</i> .) Off Ganjam coast | Bengal Fisheries. |
| 5829.
10 | Copenhagen. On ship from W. Indies | Prof. H. J. Hansen. |

[Var. *intermedia*, Annandale.]

- | | | |
|-------------|----------------------------|--------------------|
| 5030.
10 | TYPE. On ship from Brazil. | Prof. E. Cornalia. |
|-------------|----------------------------|--------------------|

Var. *hunteri*, Owen.

- | | | |
|-------------|--|---|
| 5092.
10 | Sandheads, Hughli River. One specimen | Commander, Pilot Brig. |
| 5141.
10 | (From <i>Hydrus platurus</i> .) Ceylon. | British Museum (coll. E. E. Green, Esq.). |
| 5216.
10 | (On <i>Hydrus platurus</i> .) Port Blair, Andamans | Major A. R. Anderson, I.M.S. |
| 5683.
10 | (On crab.) Kroëng-Raja Bay, Sumatra | Dr. P. N. van Kampen. |
| 5800.
10 | (On buoy.) Off Ganjam coast | Dr. J. T. Jenkins. |

[*Conchoderma auritum* (Linné).]*C. aurita*, Darwin, *op. cit.*, p. 146.

- | | | |
|-------------|---|---------------------|
| 7907.
10 | (On <i>Coronula diadema</i> (Linné).) Vadso, Sweden | Stockholm Museum. |
| 5797.
10 | Gulf of Naples | Dr. R. Dohrn. |
| 5831.
10 | (On <i>Coronula diadema</i> .) Greenland | Prof. H. J. Hansen. |

Genus **Heteralepas**, Pilsbry.

Subgenus PARALEPAS, Pilsbry.

Heteralepas xenophora (Annandale).

- | | | |
|-------------|---|---------------|
| 5037.
10 | TYPES. (On shell of <i>Xenophora pallida</i> .)
Station 233: 185 fathoms | Marine Survey |
|-------------|---|---------------|

Heteralepas minuta (Philippi).*Alepas minuta*, Philippi, *Enumeratio Mollusc. Siciliae*, 1836, Tab. xii, fig. 23.

- | | | |
|-------------|----------------|---------------|
| 5787.
10 | Gulf of Naples | Dr. R. Dohrn. |
|-------------|----------------|---------------|

Subgenus HETERALEPAS, Pilsbry.

Heteralepas nicobarica, Annandale.

$\frac{5033}{10}$. TYPES. Nicobars F. A. de Roepstorff, Esq.

[*Heteralepas gigas* (Annandale).]

Alepas gigas, Annandale, *Mem. Asiat. Soc. Bengal*, vol. i, p. 80.

$\frac{8418}{6}$. TYPE. Bali Straits, Malay Archipelago Eastern Telegraph Co.

[*Heteralepas cygnus*, Pilsbry.]

H. cygnus, Pilsbry, *Bull. U. S. Nat. Mus.*, No. 60, p. 101.

$\frac{5756}{10}$. Locality unknown, probably West Indies Roy. Scottish Museum.

[*Heteralepas lankesteri* (Gruvel).]

Alepas lankesteri, Gruvel, *Ann. Mag. Nat. Hist.* (7), vol. vi, p. 195.

$\frac{5232}{10}$. CO-TYPES. Mona Channel, West Indies: 814 fathoms British Museum.

[*Heteralepas malayana* (Annandale).]

Alepas malayana, Annandale, *Mem. Asiat. Soc. Bengal*, i, p. 81.

$\frac{2762}{7}$. TYPE. Gaspar Straits: 30 fathoms Capt. F. Worsley.

[*Heteralepas belli* (Gruvel).]

Alepas belli, Gruvel, *Trans. Linn. Soc.* (2), vol. viii, p. 278.

$\frac{5233}{10}$. CO-TYPES. Off coast of Cuba British Museum.

Subfamily PÆCILASMATINÆ.

Genus Pœcilasma, Darwin.

Subgenus PÆCILASMA, Darwin.

Pœcilasma kæmpferi, Darwin.

Pœcilasma kæmpferi, Darwin, *op. cit.*, p. 102.

Subsp. *dubia*, Hoek.

$\frac{5026}{10}$. (On *Echinoplax pungens*.) Station 233: 185 fathoms Marine Survey.

[Subsp. *aurantia*, Darwin.]*Pæcilasma aurantia*, Darwin, *op. cit.*, p. 105. $\frac{5728}{10}$. (On *Geryon affinis*.) Cape Verde Islands, W.

Africa : 692 metres

H. S. H. The Prince of
Monaco.[Subsp. *novæ-angliæ*, Pilsbry.]*Pæcilasma kæmpferi novæ-angliæ*, Pilsbry, *op. cit.*, p. 85. $\frac{5650}{10}$. (On *Geryon quinquedens*.) Martha's Vineyard,

N. J. : 328 fathoms. One specimen

Smithsonian Institution.

Pæcilasma fissum, Darwin. $\frac{5039}{10}$. Andamans. One specimen

Dr. W. T. Blanford.

Pæcilasma minutum, Gruvel. $\frac{5849}{10}$. (On *Panulirus angulatus*.) Station 257 : 143
fathoms

Marine Survey:

 $\frac{5635}{10}$. (On *Paralia alcocki*.) Station 356 : 156—200
fathoms

,,

 $\frac{5645}{10}$. (On *Homola megalops*.) Station 115 : 188—220
fathoms

,,

 $\frac{5666}{10}$. (On capitulum of *Pæcilasma kæmpferi* subsp.
dubia from *Echinoplax pungens*.) Station
233 : 185 fathoms. One specimen

,,

Subgenus TRILASMIS.

Pæcilasma eburneum (Hinds). $\frac{5377}{10}$, $\frac{5644}{10}$. (On irregular Echinoidea.) Station 291 :
48-49 fathoms

Marine Survey.

 $\frac{5725}{10}$. (On Echinoid.) Lat. 0° 14' N., Long. 104° 4'
E. : 13—16 fathoms. One specimen

Dr. P. N. van Kampen.

Genus **Megalasma**, Hoek.

Subgenus MEGALASMA, Hoek.

Megalasma carino-dentatum, Weltner.

TYPE LOST.

Megalasma minus, Annandale. $\frac{8587}{6}$. Andamans, off Port Blair

Marine Survey.

 $\frac{3074}{7}$. Port Blair, Andamans

J. Wood-Mason, Esq.

$\frac{942}{10}$	Station 196 : 484 fathoms	Marine Survey.
$\frac{4927}{10}$	TYPES. Station 333 : 401 fathoms	„
$\frac{5031}{10}$	„ 197 : 406 „	„
$\frac{5376}{10}$	„ 248 : 224—284 fathoms	„
$\frac{5640}{10}$	(On irregular Echinoid.) Station 248 : 224—284 fathoms	„

[Subsp. *bellum*, Pilsbry.]

Megalasma bellum, Pilsbry, *Bull. Bur. Fisheries* (U. S. A.), xxvi, p. 183.

$\frac{5382}{10}$. Hawaiian Islands Dr. H. A. Pilsbry.

Subgenus GLYPTELASMA, Pilsbry.

[*Megalasma carinatum* (Hoek).]

Poecilasma carinatum, Hoek, "Challenger" Reports, vol. viii, Cirr., p. 44.

$\frac{5234}{10}$. CO-TYPES. Off coast of Cuba British Museum (H.M.S.
"Challenger").

[*Megalasma gracilius*, Pilsbry.]

M. gracile gracilius, Pilsbry, *op. cit.*, p. 88.

M. gracilius, *id.*, *Proc. Acad. Nat. Sci. Philadelphia*, Sep. 1907, p. 414.

$\frac{5754}{10}$. (From capitulum of *Scalpellum giganteum*.)
Atlantic Cable, West Indies Roy. Scottish Museum.

$\frac{5755}{10}$. (From capitulum and peduncle of *Heteralepas cygnus*.) Locality unknown, probably
West Indies „ „

Genus *Dichelaspis*, Darwin.

Dichelaspis tridens (Aurivillius).

$\frac{5684}{10}$. (From gills of *Thenus orientalis*.) Lat. 3° 58'
N., Long. 98° 47' E. : 15—17 fathoms Dr. P. N. van Kampen.

$\frac{5685}{10}$. (From gills of *Thenus orientalis*.) North,
coast of Achin, Sumatra „

$\frac{5655}{10}$, $\frac{5722}{10}$. (On *Xantho scaberrimus*.) Balasore Bay,
Bengal coast Bengal Fisheries.

$\frac{5658}{10}$. (From gills of *Calappa exanthematosa*.) Bay
of Bengal : 91—112 fathoms Marine Survey.

$\frac{5721}{10}$. (On *Thenus orientalis*.) Lat. 0° 14' N., Long.
104° 4' E. : 13—16 fathoms Dr. P. N. van Kampen.

$\frac{5751}{10}$. (From gills of *Thenus orientalis*.) Orissa coast Bengal Fisheries.

Dichelaspis bathynomi, Annandale.

- $\frac{5203}{10}$. TYPES. (From *Bathynomus giganteus*.) Station 357 : 555 fathoms Marine Survey.
 $\frac{5662-3}{10}$. (From *Bathynomus giganteus*.) Station 373 : 185 fathoms ,,
 $\frac{5657}{10}$. (From *Bathynomus giganteus*.) Off Ceylon : 225—594 fathoms ,,

Var. *perfidiosa*, Annandale.

- $\frac{5765}{10}$. TYPES. (From *Bathynomus giganteus*.) Station 373 : 185 fathoms ,,

Dichelaspis warwickii (Gray).

- $\frac{5094}{10}$. South coast of Ceylon Colombo Museum.
 $\frac{5631}{10}$. (On *Goniosoma* sp.) N. end of Persian Gulf. Marine Survey.
 $\frac{5632}{10}$. (On *Panulirus* sp.) Off Orissa coast Bengal Fisheries.
 $\frac{5641}{10}$. (, , ,) Puri, Orissa B. L. Chaudhuri, Esq.
 $\frac{5642}{10}$. (On *Thenus orientalis*.) Mouth of Hughli River Bengal Fisheries.
 $\frac{5643}{10}$. (On *Murex* shell.) Bay of Bengal ,,
 $\frac{5649}{10}$. (On *Doclea japonica*.) Sandheads Pilot Milner.
 $\frac{5631}{10}$. (On *Doclea hybrida*.) E. coast of India Marine Survey.
 $\frac{5652}{10}$, $\frac{5723}{10}$. (On *Xantho scaberrimus*.) Balasore Bay, Bengal coast Bengal Fisheries.
 $\frac{5656}{10}$. (From crabs.) Balasore Bay, Bengal coast ,,
 $\frac{5675}{10}$. Lat. 3° 40' N., Long. 99° 10' E. : 16—18 fathoms Dr. P. N. van Kampen.
 $\frac{5676}{10}$. (On crab.) Lat. 1° 35' S., Long. 104° 35' E. : 6—8 fathoms ,,
 $\frac{5677}{10}$. (From gills of *Thenus orientalis*.) North coast of Achin, Sumatra ,,
 $\frac{5678}{10}$. (On crabs.) Lat. 0° 14' N., Long. 104° 4' E. : 13—16 fathoms ,,
 $\frac{5679}{10}$. (On crabs.) Lat. 5° 8' N., Long. 100° 11' E. : 11 fathoms ,,
 $\frac{5680}{10}$. (On crabs.) Off Obhlet, Achin, Sumatra : 16—18 fathoms ,,
 $\frac{5681}{10}$. (On *Scyllarus* sp.) Lat. 0° 14' N., Long. 104° 4' E. : 13—16 fathoms ,,
 $\frac{5720}{10}$. (On *Thenus orientalis*.) Lat. 0° 14' N., Long. 104° 4' E. : 13—16 fathoms ,,
 $\frac{5752}{10}$. (On *Thenus orientalis*.) Orissa coast Bengal Fisheries.

- $\frac{5059}{10}$. (On *Doclea ovis*.) Orissa coast Marine Survey.
 $\frac{5724}{10}$. (On *Goniosoma crucifera*.) Puri, Orissa Bengal Fisheries.
 $\frac{5766}{10}$. (On back of large specimen of *Serranus lanceolatus*.) Off entrance to the Eastern Channel, mouth of River Hughli Dr. J Travis Jenkins.
 $\frac{5767}{10}$. (On *Neptunus sanguinolentus*.) Puri beach, Orissa coast Dr. N. Annandale.
 $\frac{5827}{10}$. (On *Dorippe*.) Eastern Asia Prof. H. J Hansen.

Dichelaspis geryonophila (Pilsbry).

- $\frac{5637}{10}$. (On *Geryon affinis*.) Station 248: 224—284 fathoms Marine Survey.
 $\frac{5638}{10}$. (On *Geryon quinquedens*.) Martha's Vineyard, N. J : 328 fathoms .. Smithsonian Institution.

Var. *fissicarina*, Annandale.

- $\frac{5798}{10}$. TYPES. (On *Geryon quinquedens*.) Martha's Vineyard, N. J : 328 fathoms Smithsonian Institution.

Dichelaspis grayii, Darwin.

- $\frac{5028}{10}$. (On *Enhydrina* sp.) Lower Burma Marine Survey.
 $\frac{5041}{10}$. (On *Hydrophis* sp.) Mergui Dr. J Anderson.
 $\frac{5064}{10}$. (On *Distira robusta*.) South Arcot ?
 $\frac{5743}{10}$. (On *Hydrophis spiralis*.) Trivandrum, Travancore State Trivandrum Museum.
 $\frac{5768}{10}$. (On *Hydrophis gracilis*.) Madras Dr. J R. Henderson.
 $\frac{5769}{10}$. (On *Hydrophis fasciatus*.) Puri beach, Orissa coast Dr. N. Annandale.
 $\frac{5770}{10}$. (On *Distira robusta*.) Puri beach, Orissa coast ..
 $\frac{5771}{10}$. (On *Enhydrina valakadien*.) Puri beach, Orissa coast ..

Var. *pernuda*, Annandale.

- $\frac{5747}{10}$. (On *Hydrophis* sp.) Madras coast Madras Museum.
 $\frac{5748}{10}$. TYPES. (On *Enhydrina valakadien*.) Madras coast ..
 $\frac{5749}{10}$. (On *Distira viperina*.) Puri Dr. J Travis Jenkins.

Dichelaspis stella, Annandale.

- $\frac{5636}{10}$. TYPES. (From gills of *Homola megalops*.) Stations 115 and 235 : 188—419 fathoms Marine Survey.

Dichelaspis rhinoceros, Annandale.

- $\frac{5689}{10}$. TYPES. (From gills of *Encephaloides armstrongii*.) Bay of Bengal: 93 fathoms Marine Survey.

Dichelaspis cor, Aurivillius.

- $\frac{5689}{10}$. (On crab.) Kroëng-Raja Bay, Achin, Sumatra Dr. P. N. van Kampen.
 $\frac{5667}{10}$. (From *Scylla serrata*.) Rangoon River Dr. N. Annandale.
 $\frac{5648}{10}$. (" " ") Karachi Messrs. Hume and Day.
 $\frac{5241}{10}$. (" " ") Ganges delta Purchased in Calcutta Market.
 $\frac{5750}{10}$. (From gills of *Scylla serrata*.) Balasore Bay, Bengal coast Bengal Fisheries.
 $\frac{5762}{10}$. CO-TYPES of *D. maindroni*, Gruvel, vars. A and B. Karachi Paris Museum (Prof. Bouvier).
 $\frac{5764}{10}$. " " " " var. C " "
- Var. *coutierei*, Gruvel.
 $\frac{5758}{10}$. CO-TYPES of *D. coutierei*, Gruvel. Djibouti, French Somaliland "

Dichelaspis sinuata, Aurivillius.

- $\frac{5199}{10}$. (From gills of *Neptunus pelagicus*.) North end of Persian Gulf Marine Survey.
 $\frac{5672}{10}$. (From gills of *Thenus orientalis*.) North of Achin, Sumatra Dr. P. N. van Kampen.
 $\frac{5673}{10}$. (On *Thenus orientalis*.) Lat. 3° 40' N., Long. 99° 10' E.: 16—18 fathoms "
 $\frac{5674}{10}$. (From gills of *Thenus orientalis*.) Lat. 3° 58' N. Long. 98° 47' E.: 15—17 fathoms. "
 $\frac{5719}{10}$. (On *Xantho scaberrimus*.) Balasore Bay, Bengal coast Bengal Fisheries.
 $\frac{5821}{10}$. (From gills of *Echinoplax pungens*.) Andaman Sea: 130—250 fathoms Marine Survey.

[*Dichelaspis darwini*, Filippi.]

- $\frac{5828}{10}$. (On gills of *Lupea*.) Prof. H. J. Hansen.

Dichelaspis angulata, Aurivillius.

- $\frac{5744}{10}$. (From gills of *Goniosoma crucifera*.) Orissa coast Bengal Fisheries.

LIST OF INDIAN MARINE STATIONS REFERRED TO IN THIS PAPER.

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No. of Station.	Date.	Position.	Depth in fathoms.	Bottom temperature.	Nature of bottom.	Species taken.
94	28-ii-90	Off Vizagapatam coast	15—17	..	Hard sand, etc.	<i>Lepas anserifera</i> , probably from surface.
115	9-xii-90	11° 31' 40" N., 92° 46' 40" E.	188—220	56° F.	Green mud.	{ <i>Pæcilasma minutum</i> . { <i>Dichelaspis stella</i> .
196	16-i-95	12° 54' 30" N., 72° 22' 0" E.	484	48·25° F.	Grey ooze and globigerina ooze.	<i>Megalasma minus</i> .
197	20-i-95	9° 34' 57" N., 75° 36' 30" E.	406	48° F.	Green mud.	<i>Megalasma minus</i> .
233	6-xii-97	13° 17' 15" N., 93° 10' 0" E.	185	53·5° F.	Sand.	{ <i>Heteralepas xenophora</i> . { <i>Pæcilasma kæmpferi</i> subsp. <i>dubia</i> . { <i>Pæcilasma minutum</i> .
235	8-iv-98	14° 13' 0" N., 93° 40' 0" E.	370—419	...	Grey mud.	<i>Dichelaspis stella</i> .
248	17-x-98	8° 37' 0" N., 75° 37' 30" E.	224—284	52—54° F.	Sand.	{ <i>Megalasma minus</i> . { <i>Dichelaspis geryonophila</i> .
257	22-iv-99	7° 15' 0" N., 77° 46' 0" E.	143		Sand.	<i>Pæcilasma minutum</i> .
291	1-xi-01	26° 22' 0" N., 56° 10' 0" E.	48—49		Mud.	<i>Pæcilasma eburneum</i> .
333	19-iv-04	6° 31' 0" N., 79° 38' 0" E.	401		Soft green mud.	<i>Megalasma minus</i> .
356	16-xii-05	17° 59' 0" N., 57° 22' 30" E.	156—200	58° F.	Green mud.	<i>Pæcilasma minutum</i> .
357	17-xii-05	16° 51' 0" N., 54° 55' 0" E.	555	48° F.	Green mud.	<i>Dichelaspis bathynomi</i> .
373	19-xii-06	15° 59' 10" N., 93° 39' 45" E.	195	52·4° F.	Soft green mud, rocks, etc.	<i>Dichelaspis bathynomi</i> .