through slow ontogenetic increments in the valves, particularly in the basal arm of the scutum, at a rate greater than the rate of increase in the size of the capitulum. By this sort of differential development, partially armored juveniles become fully armored somewhat later in life than do related free-living species in which juveniles are essentially as fully armored as adults. The same process is seen to occur in Octolasmis tridens (Aurivillius), (Nilsson-Cantell, 1934), and in O. cor (Aurivillius), (Newman, 1960b). This process suggests that species in this family with the scutum split into two parts have descended from forms in which the valves were much reduced, the split-valve being a product of rearmament. This suggestion is believed to be quite plausible for it not only explains their somewhat aberrant form, but it also explains the vestige of a scutal suture seen in such species as Trilasmis eburneum Hinds and occasionally in T. crassum sensu Darwin (1851). These two species have apparently completed the rearmament process, the vestigial, fully-fused, non-functional suture testifying to a split-valve ancestry, being acquired through relatively unarmored forms living in protected environments.

This argument is contrary to the concept of the prototype of split-valve forms in which Pilsbry (1911) envisions a fully armored ancestral type with a split-valve already developed, becoming reduced in protected environments. The same argument is the reverse of that of Broch (1947), which is essentially Pilsbry's concept in more detail, without additional evidence. What Pilsbry and Broch fail to take into consideration is the functional aspect of the split-valve; that is, what purpose does it serve the barnacle, especially when the occludent arm is immovably fused to the basal arm? They also fail to consider what possible path selection might take to achieve such an unusual structural arrangement.

In fully armored species, without a split-valve, the scuta are hinged to one another as they are in nearly naked species of Octolasmis. In this way the valves can be opened and closed, and when closed, being fully approximate at their edges, they prevent crushing of the soft animal within. Forms with greatly reduced valves are relatively easy to crush, but they generally survive in environments where crushing is not likely to occur. If rearmament were gradually selected for, in response to more exposed conditions, the barnacle would still be subject to crushing until the valves became fully approximate. In such partially armored forms, this problem is overcome by a fusion of the hinge area of the basal scutal arms, which, being the strongest and overlying the body of the animal when withdrawn, offer fair protection. However, this necessitates having the occludent arms, each connected to a basal arm by an uncalcified ligament, free to be drawn together by the scutoral adductor muscle, closing the aperture. In this way, partially armored species are protected against crushing, yet retain the facility of closing. In exploiting more exposed environments, fuller armament being selected for, the valves would become fully approximate. Fusion of the basal scutal arms is no longer a requirement but actually a disadvantage, for the occludent arms must remain free of the basal arms in order to continue to close the aperture. This arrangement sacrifices a considerable degree of rigidity. In overcoming this final complication in rearmament, the fusion platforms could become transformed into a hinge, with the simultaneous fusion of the occludent arm to the basal arm of the scutum, leaving the vestigial suture mentioned above. Indeed, the peculiar hinge-like platforms of Trilasmis fissum (Darwin) and the peculiar hinge of T. eburneum Hinds are more readily understood as being derived in this way than from the ordinary hinge of more remote fully armored ancestral forms.

Following this explanation for the origin of the split scutal valve, it appears most likely that split-valve forms have descended from relatively naked ancestors inhabiting the gill chambers of decapod Crustacea (Plate 23). This is not as unlikely as it may at first appear, for it is a fact that relatively unarmored species which inhabit gills are often found occurring around the exhalant area of gill chambers and along the basal portions of the last maxillipeds of the host (Annandale, 1909). In this position they are at a disadvantage as regards mechanical injury, but they conceivably may be rewarded by fragments of food drifting away from the food being fed upon by the host. To this end a ctenopod feeding mechanism would be satisfactory, for barnacles could carry on normal setose feeding when not receiving food escaping the host. If the protection afforded by fuller armor were attained in forms tending to settle near the mouth field, there would be a better chance of survival. Thus, they could occupy positions further out on the mouth parts, closer to the new source of food. If the rather delicate feeding mechanism were gradually replaced with stouter clawed append-

ages, the barnacle might be able to capture larger particles of food or even rasp directly at the food being manipulated by the host. It is a fact that most split-valve forms occur on the mouth parts, primarily the maxillipeds of macrurous forms, and it is a fact that where the ontogeny of these forms is known, the split-valve is seen to be acquired through slow onto-genetic increments and differential growth. It may be simply a coincidence that most species in this position also have very peculiar, strong, stout clawed cirri and unusually spiny mouth parts which appear poorly adapted to setose feeding, but I prefer to suggest that these structures are correlated with the unique habitat in which the barnacle, having descended from forms inhabiting gill chambers, has moved forward into the mouth field, enabling it to share the food of the host.

That such species are the descendants of more naked ancestors and have come to occupy such an unusual niche by an indirect route through the gill chambers of the host is suggested not only because it would explain the split-valve as a result of rearmament, but also because a more gradual transitional process could hardly be imagined in achieving such a remarkable and precarious position on the host and in attaining the highly modified feeding mechanism correlated with it.

Acknowledgment

Specimens of Octolasmis (Octolasmis), Trilasmis (Trilasmis), T. (Poecilasma), and Megalasma (Megalasma) studied in conjunction with this paper were obtained from a number of individuals to whom I am deeply indebted. The specimens originated from widely separated localities, and together they allow one to gain a fuller concept of the family than could otherwise be obtained. I am grateful to Dr. Thomas E. Bowman for the loan of specimens from the Caribbean, to Dr. Fenner A. Chace, Jr., for the loan of specimens from the Society Islands, to Dr. Cadet Hand for specimens from New Zealand and Australia, to Dr. Arthur G. Humes for specimens from the Caribbean, East Africa, and New Guinea, to Arnold Ross for specimens from the Caribbean, to Dr. H. G. Stubbings for specimens from West Africa, to Stephen A. Wainwright for specimens from Hawaii, to Dr. Huzio Utinomi for specimens from the Seto Inland Sea, and to Victor A. Zullo for specimens from Shoal Guyot, South East Pacific. I would also like to thank Dr. Hand for his reading and criticism of the manuscript.
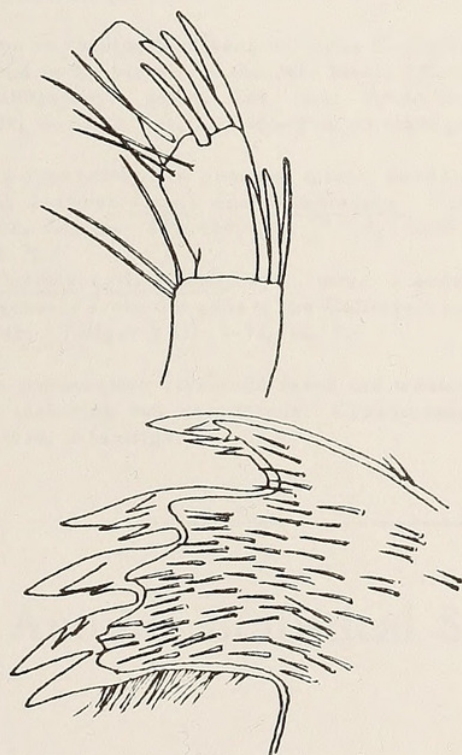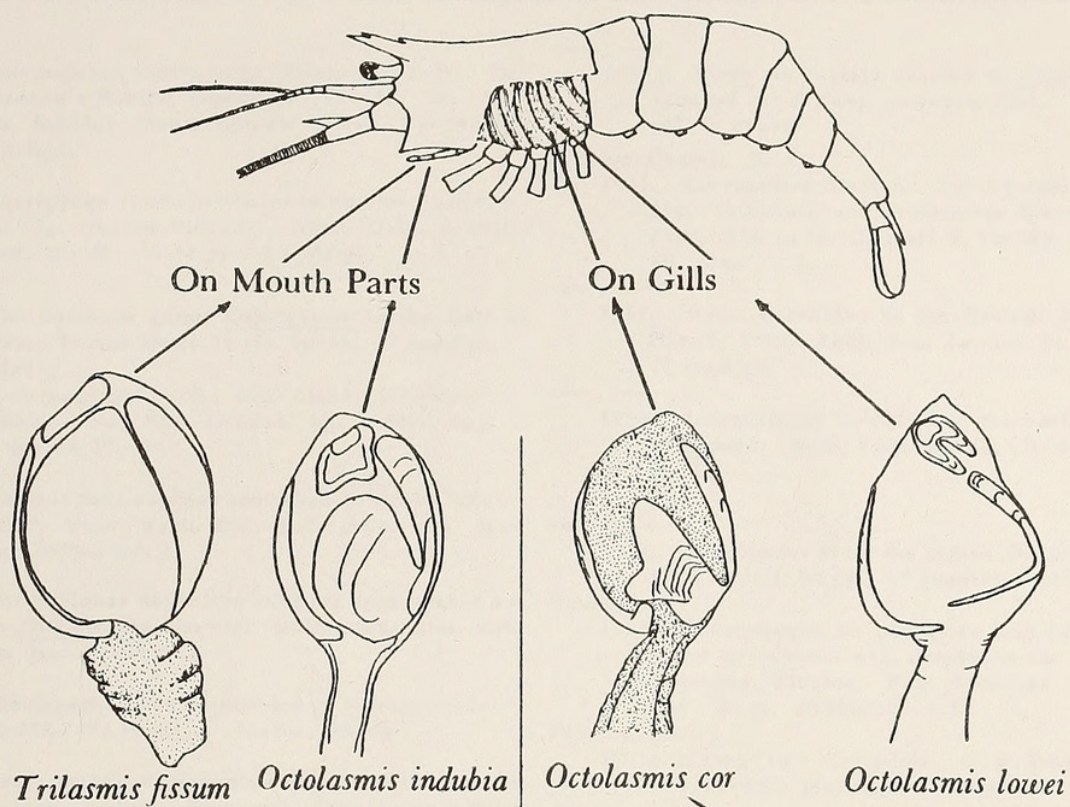
It is currently my wish to revise the family Poecilasmatidae and I solicit specimens from any quarter of the world for this purpose.
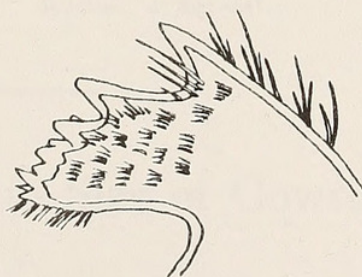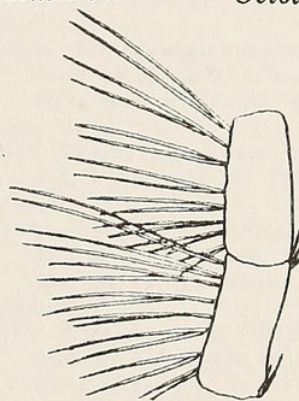
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Explanation of Plate 23

Schematic drawing indicating certain types of barnacles associated with gills and mouth parts of decapod crustacea. From right to left: *Octolasmis lowei* (DARWIN), usually on "soft" gills of macrurans, and *Octolasmis cor* (AURIVILLIUS), usually on the "hard" gilled brachyuran, *Scylla serrata* (FORSKÅL); *Octolasmis indubia* NEWMAN, spec. nov. and *Trilasmis fissum* (DARWIN), both usually on last maxillipeds of macrura. While acanthopod types are quite location-specific, lasiopod and ctenopod types are not, their degree of armament apparently determining where they will survive. The lasiopod type (PILSBRY, 1911) is an intermediate condition between ctenopod and acanthopod types. Split-valve forms can be acanthopod, lasiopod or ctenopod, while unarmored forms are always ctenopod as are armored forms that do not have a split-valve ancestry.

On Mouth Parts   On Gills

Trilasmis fissum   *Octolasmis indubia*   *Octolasmis cor*   *Octolasmis lowei*

Acanthopod Types   Ctenopod Types

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Another Statistical Study in Size of Cowries

by

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The length of the shells of each cowry species varies considerably, even in specimens coming from a limited area. The frequencies of the classes, distributed according to a binomial curve, show a positive skewing so that the summit of the curve approaches nearer to the class of the smallest shell than to that of the largest specimen.

These usual features may be illustrated by 1'555 Luria isabella (Linnaeus) coming from the beach of Tjilaut Eureun, South Java, the length of which varies from 15 to 40 mm. in adult shells. In the following table the size has been reduced to classes of 3 mm. (e. g., 15 = 13.5 to 16.5 mm.); the number of specimens belonging to every class has been expressed in percent of 1'555 (the sign 0 indicates less than 0.5 percent; the sign o expresses less than 0.1 percent):

16	19	22	25	28	31	34	37	40	mm.
1	17	30	26	17	7	1	0	o	%

The sum of shells coming from the whole area of distribution of a species supplies a similar curve, if the numbers of specimens preserved at each locality are rather similar. Thus, e. g., the distribution of 8'169 Monetaria annulus coming from 425 localities between Natal and Polynesia is as follows:

10	13	16	19	22	25	28	31	34	mm.
0	10	33	32	17	6	1	0	o	%

The minimum length is 10.3 mm., the maximum 33.7 mm.; ninety percent of these shells vary from 14 to 24 mm. only.

The differences in size observed in various populations can be environmental or racial. The local modifications may be caused by the depth of the sea in which the population lives, by differences in the motion of the sea or in the quantity and quality of food: so we learned from the collections carefully made by R. S. Benton that most specimens living on the coral reefs of Mombasa Island are distinctly smaller than the specimens of the same species collected among the sea weed on a sandy and muddy bottom at Shimoni a few miles off. In the same way, Barry Wilson stated (personal communication) that in Geographe Bay the adult specimens of Zoila friendii (Gray) collected between Quindalup and Dunsborough (about a mile apart) are stunted: they live "in an enclosed area in only three to six feet of water cut off from the deeper water offshore by a wide and very shallow sand bar." He has "never seen a small adult specimen outside the bank, nor a large specimen inside the bank". He suspects "the difference may be a physiological one" (quoted from Wilson's letter, dated 6th February, 1959). Therefore, the curve of variation in 79 Z. friendii (the Eastern vercoi Schilder in-

cluded) shows two summits:

40	50	60	70	80	90	100	mm.
2.5	14	9	29	24	19	2.5	%

There are, however, also racial differences in size, if the average length of most populations living in a continuous large region significantly differs from the usual size observed in other parts of the world. Thus, in my previous statistical study, published in The Veliger (Schilder, 1961), I have shown that in Mauritia arabica (Linnaeus), the South Western* race immanis Schilder-Schilder distinctly differs by its larger size from M. arabica living between Ceylon and the Pacific, though the limits of variation overlap; this fact may be illustrated by the following table, in which the size of 2'140 M. arabica and 86 M. immanis has been expressed in percent:

20	30	40	50	60	70	80	90	mm.
arabica:								
o	13	46	29	10	2	o	-	%
immanis:								
-	-	-	3	27	41	24	5	%

Similar differences may be observed in Erosaria lamarckii (Gray): the subspecies redimita (Melvill) with purely white spots lives in the Indian Ocean from Mauritius and Karachi to Penang, while the Western E. lamarckii with the larger spots distinctly ocellated occupies the area between Natal, Kenya, and Madagascar. The following table illustrates the variability in size of 127 E. l. redimita (including the specimens published by Griffiths, 1956) and 112 E. l. lamarckii, expressed in percent:

20	25	30	35	40	45	50	mm.
E. l. redimita:							
1	21	46	27	5	-	-	%
E. l. lamarckii:							
-	1	9	30	34	24	2	%
Port Reitz:							
2	9	48	34	6	1	-	%

The last line indicates the percentage of 124 specimens collected in a restricted area at

*In The Veliger, vol. 4, p. 17, left line 12, erroneously has been said "South Eastern".

Schilder, F. A. 1961. "Another statistical study in size of cowries." *The veliger* 4, 107–112.