

ON A COLLECTION OF PALINURID PHYLLOSOMAS FROM THE LACCADIVE SEAS*

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INTRODUCTION

THE research vessel *Kalava* made three cruises to the Laccadive Archipelago during 1958 and 1959 when a series of stations were operated, details of which have been given by Jones (1959). In addition to these, collections were also made during a cruise of I.N.S. *Junna* to the Laccadive waters in January 1959. Plankton collections made during these cruises contained, amongst other forms, several phyllosoma larvae belonging to different species of Palinurids and Scyllarids. The present report deals with the phyllosoma of Palinurids and an account of the Scyllarid phyllosomas and the Nisto stage of a *Scyllarus* will be published in due course.

Fifteen minute horizontal hauls were made simultaneously with a half metre organdie net and a one meter net with mosquito netting at the regular stations, whereas at the Anchor stations of *Kalava* the plankton nets were allowed to drift and collections were made every two hours (Fig. 1).

The authors wish to thank all those who have helped in the collection of plankton samples during the cruises and Shri. C. T. Rajan for sorting out the larvae. Thanks are likewise due to Shri. G. Raju for the phyllosomas obtained from the stomach of a tunny. The authors are also grateful to Dr. S. Jones, Chief Research Officer, Central Marine Fisheries Research Station for looking through the paper.

DESCRIPTION OF PHYLLOSOMAS

A nearly complete series of phyllosoma of what the authors are inclined to believe to be of *Panulirus penicillatus* Olivier has been obtained during these cruises. The series seems to be fairly connected excepting for one of the intermediate stages and one, or perhaps two, of the last stages before the phyllosoma metamorphoses into the puerulus. The other Palinurid phyllosomas collected during the cruises in the same area whose identity is not certain yet have been referred to in this account as species I, II and so on.

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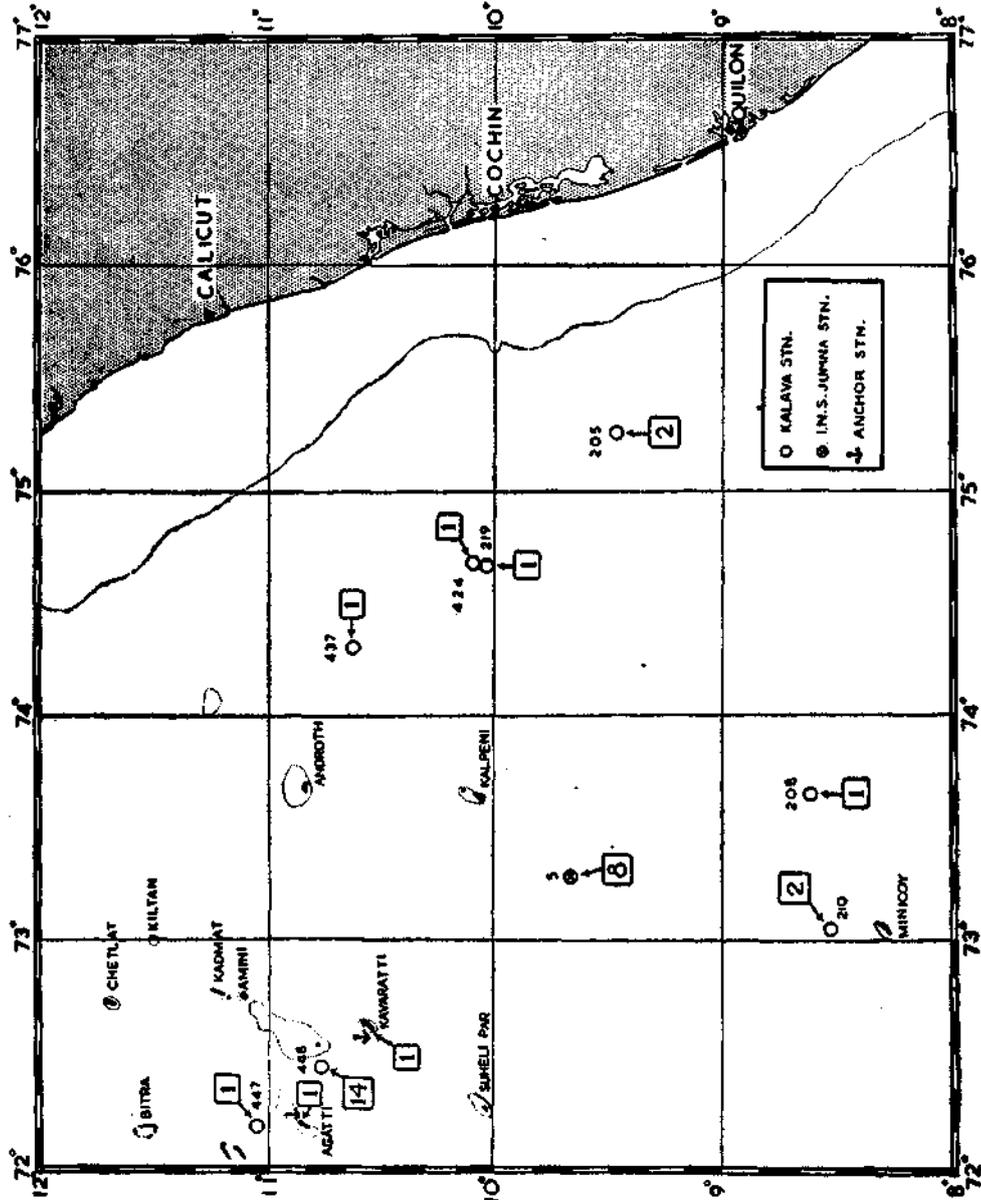


FIG. 1. The location of stations from which Palmarid phyllosomas were obtained. Numbers in boxes indicate the numbers of larvae collected at each station.

PHYLLOSOMA STAGES OF *Pamulirus penicillatus* OLIVIER

Stage I. (Fig. 2, A-D)

Station 448 : 29-4-1959 : 6 larvae 1.50 to 1.58 mm.

The length of the fore-body (cephalic shield) is about 1.3 times its width and the posterior border is obtusely pointed. The hind-body is nearly circular and is slightly

narrower than the fore-body. The eyes, as are usual with the first larva of other species of Palinurids, are large and not stalked. Antennule and the antenna are shorter than the eyes and each consists of a single segment. The second maxilla consists of two segments, the broader basal segment bears two small marginal spines and the smaller terminal segment has four long plumose setae. The first maxillipede is a rudimentary bud seen at the base of the second maxilla while the second maxillipede shows all the five segments but is without an exopod. Third maxillipede is a biramous appendage with a short setose exopod. Three pereopods are present of which the first and second have well developed exopods and long dactyls, whereas the exopod of the third pereopod is rudimentary and the dactyl is short. All the three legs possess a moderately long coxal spine on the ventral aspect. The abdomen is short with nearly parallel sides, terminating in a short fork and three setae on either side.

This larva generally resembles the first phyllosoma of the other Palinurids, viz., *Panulirus ornatus* and *P. burgeri*, described earlier by the authors (1957 and 1959 respectively). However, it may be distinguished from these two species by the difference in shape as well as the proportion of the cephalic shield. In the larvae of both *ornatus* and *burgeri* the length of the fore-body is almost equal to its width. Another important difference lies in the length of the dactyls of the first and second walking legs. These in relation to the corresponding propus segments indicate a much smaller proportion in the present larva than in *ornatus* and *burgeri*. The propus/dactyl values are 1.7 and 1.6 respectively for the first and second walking legs. The first larva of *penicillatus* also appears to be slightly longer than that of either of the two other species described earlier. Other minor differences in the position and number of setae are not being emphasised as their significance is not clear.

Stage II. (Fig. 3, A-D)

Station 208 : 20-2-1958 : 1 larva 2.21 mm.

The length/width relationship is nearly 1.43. The eyes have become stalked. There is no significant change in the appendages except that the exopod of third maxillipede shows more and well developed swimming setae, a reduction in the length of the dactyls of the two walking legs and a slight increase in the length of the exopod rudiment of the third pereopod. The forked end of the abdomen is less conspicuous while the presence of only two pairs of setae in this specimen seems to be caused by loss during either collection or preservation.

Stage III. (Fig. 4, A-D)

Station 5 : 7-1-1959 : 1 larva 3.20 mm.

The length/width proportion of the cephalic shield is 1.5 and the median prominence of the posterior margin is more pronounced. The hind-body continues to be narrower than the fore-body but is shorter than its own width. Both the antennule and the antenna have become longer although the antenna remains shorter than the antennule. Separation of these appendages from the margin of the cephalic shield is indicated by a faint segmentation. Other appendages remain almost unchanged, but the exopod of the third pereopod shows a few swimming setae. Rudiment of the fourth pereopod has appeared at the base of the abdomen while the abdomen itself shows no significant change.

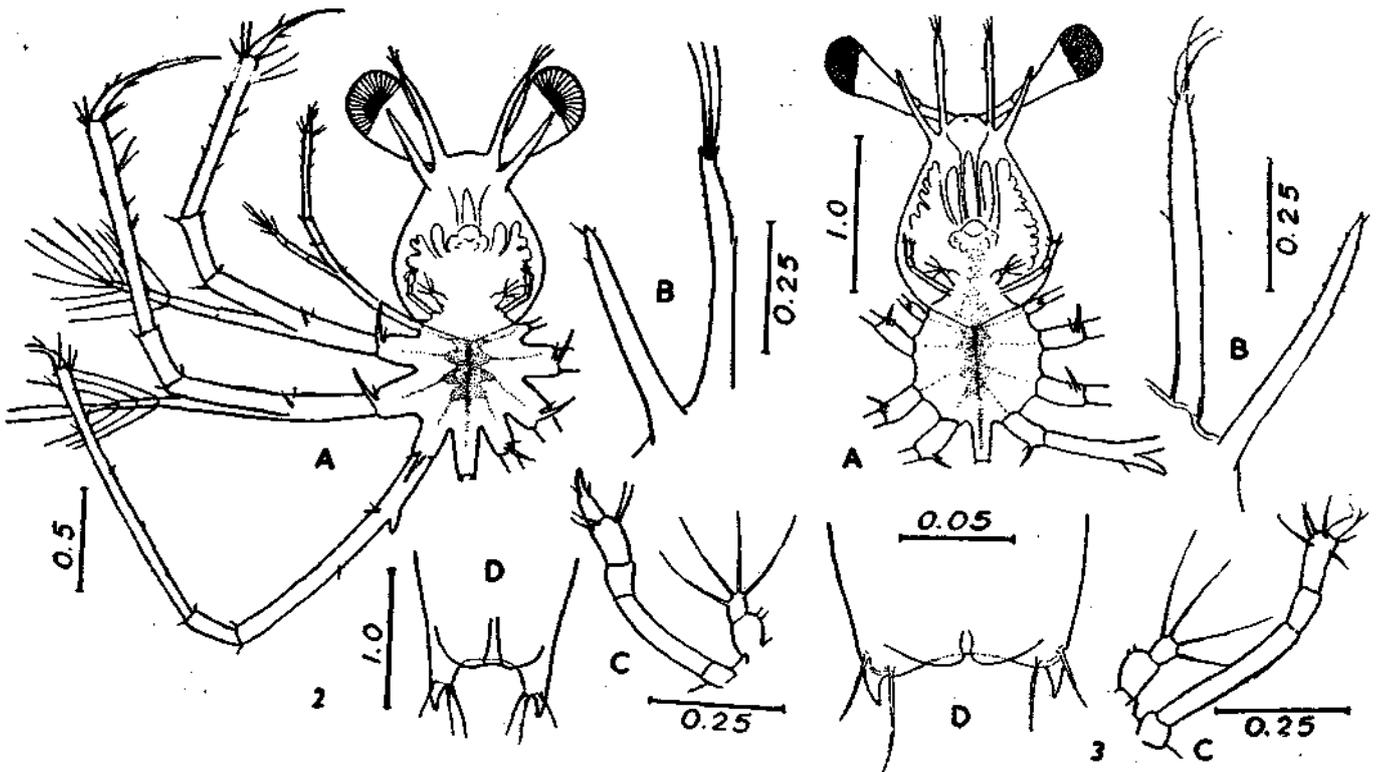


FIG. 2. Stage I.

FIG. 3. Stage II.

Figures 2 to 10 show stages of *Panulirus penicillatus* phyllosomas. In all the figures given in this paper, A is phyllosoma larva; B, antennule and antenna; C, second maxilla with first and second maxillipedes and D, abdomen. Magnifications indicated are in millimeters.

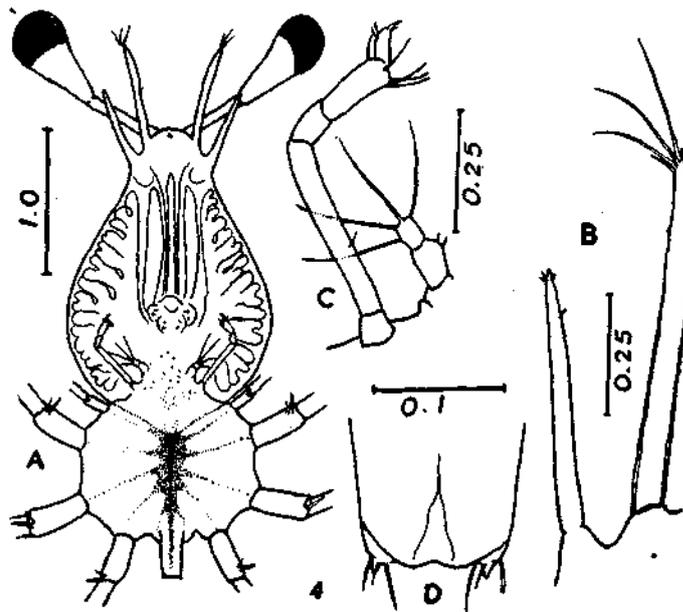


FIG. 4. Stage III.

Stage IV. (Fig. 5, A-D)

Station 5 : 7-1-1959 : 2 larvae 4.75 mm.

Station 424 : 6-4-1957 : 1 larva 5.00 mm.

Anchor station near Agatti : 29-4-1959 : 1 larva 3.75 mm.

Judged from the degree of development of the appendages all these larvae, despite their rather wide variation in size, seem to belong to the same stage. The shape and proportion of the cephalic shield remain almost unchanged from the previous stage. The antennule has developed a few more aesthetes, but is otherwise not very different from the earlier larva, whereas there is a noticeable increase in the length of the antenna which at this stage is slightly longer than the antennule. An enlargement of the terminal piece of the second maxilla has taken place and there are five long setae at its margin. The first maxillipede remains rudimentary, while the second and third maxillipedes remain the same as before. The second and third pereopods show an additional spine on the coxal segment more towards its dorsal side. The rudimentary fourth pereopod has grown into a short but biramous appendage and the fifth pereopod has also appeared at this stage as a small bud. Faint protuberances of the developing uropods are seen on the abdomen which otherwise remains unchanged.

Stage V. (Fig. 6, A-D)

Station 5 : 7-1-1959 : 2 larvae 6.50 mm. and 1 larva 6.20 mm.

The length of the larva has increased in this stage but the proportion of the shield remains unaltered. The hind-body is nearly as broad as the fore-body with a

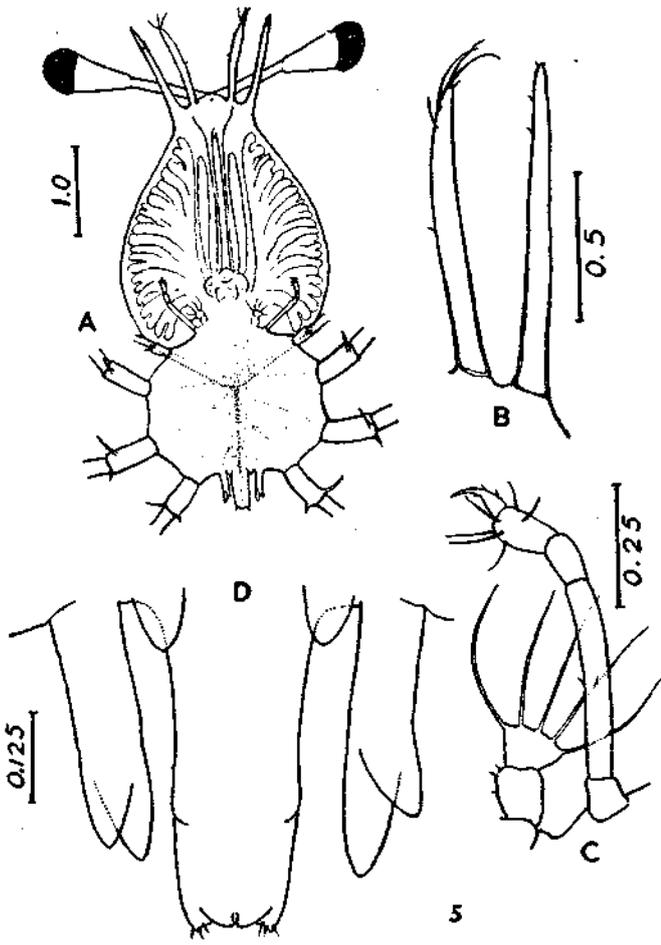


FIG. 5. Stage IV.

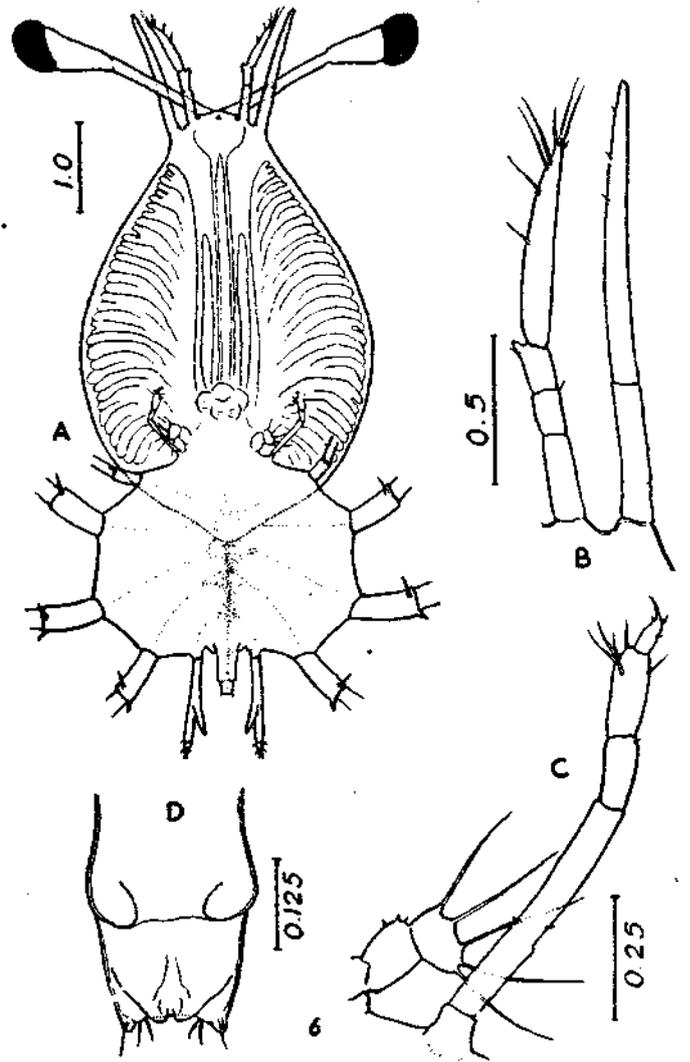


FIG. 6. Stage V.

almost straight posterior margin. The peduncle of the antennule is differentiated into three segments with a rudimentary endopod on the third segment. The antenna which projects slightly beyond the level of the antennule shows one distinct segment while another is indicated. The maxillae and other appendages remain more or less the same as in the earlier stage but a slight protuberance indicating the developing exopod of the second maxillipede is distinguishable. The additional coxal spines on both the second and third pereiopods continue to be present. Fourth pereiopod has grown twice as long as the abdomen but the exopod remains without swimming setae. The fifth pereiopod is still rudimentary while the uropod buds are more distinct than in the previous stage.

Stage VI. (Fig. 7, A-D)

Station 205 : 19-2-1958 : 1 larva 8.25 mm.

Station 5 : 7-1-1959 : 1 larva 9.25 mm.

Station 437 : 24-4-1959 : 1 larva 8.00 mm.

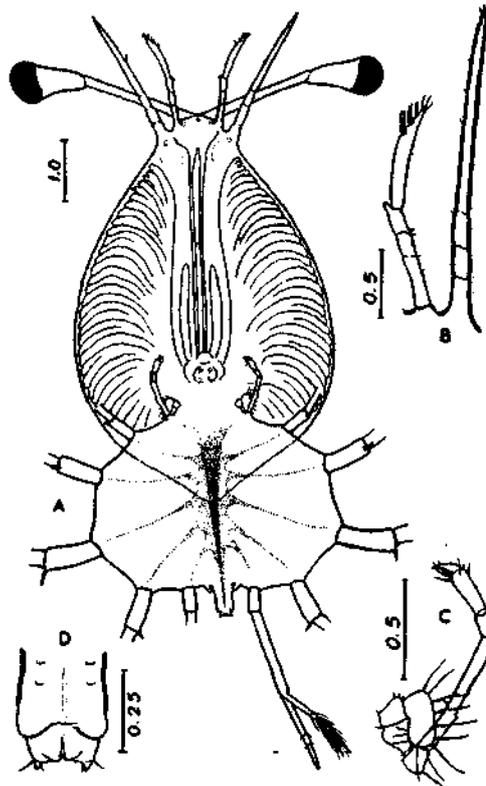


FIG. 7. Stage VI.

Despite the differences in length (8.00 to 9.25 mm.) and variations in some of the minor individual characteristics, the three larvae seem to belong to the same stage,

There is no change in the shape of the fore-body and its proportion from the previous stage; the hind-body also retains the same relative width. Excepting for the increase in the number of aesthetes of the antennular flagellum this appendage has no change, whereas the antennae have elongated further with the two segments of the peduncle clearly formed. The terminal segment of the second maxilla has enlarged and is leaf-like with an increase in the number of marginal setae. The projection on second maxillipede indicating the formation of the exopod is distinct in this stage. The only noticeable change in the pereopods, apart from the slight reduction in the length of the coxal spines, is the loss of the ventral coxal spines in the second and third pereopods. The fourth pereopod has grown further with indications of the segmentation and its exopod has become setose although the whole appendage has not attained the length of the other legs. The coxal segment of this leg seems to lack the spine at this stage. Fifth pereopod is only a rudimentary bud. Faint indications of the pleopods are seen on the abdomen while the uropods remain as low buds.

Stage VII. (Fig. 8, A-D)

Anchor Station outside Kavaratti lagoon : 25-2-1958 : 1 larva 10 mm.

Although there is no significant change in the length/width relationship of the fore-body, a slight widening of the anterior region is noticeable. This widening becomes more pronounced in the subsequent stages and leads to a change in the general shape of the cephalic shield. Similarly, the obtuse prominence on the posterior margin tends to disappear and the margin becomes more even. The endopod bud of the antennule is slightly more elongated than in the earlier larva. The other changes include a further flattening of the second maxilla and a shortening of the marginal setae, the growth of the exopod of the second maxillipede into a distinct bud, an increase in the length of the fourth and fifth pereopods and the greater prominence of the pleopods and the uropod rudiments. There is also some indication of a widening of the base of the abdomen although there is no noticeable increase in its length.

Stage VIII.

This stage seems to be wanting in this series as the characters of the next available larva indicate clearly a gap in the series.

Stage IX. (Fig. 9, A-D)

Station 205: 19-2-1958 : 1 larva 16.00 mm.

The length/width ratio of the fore-body is reduced to 1.3 and the posterior border is completely round. Besides an increase in the number of sensory hairs on the antennular flagellum and an increase in the length of the endopod both the antennule and the antenna are appreciably longer in the present larva compared to those in stage VII. Similarly, the eye stalk also has grown longer. The second maxilla is further flattened and its marginal setae short compared to those of the earlier stages. The rudiment of the first maxillipede has increased in size and the exopod of the second maxillipede has developed into a setose segment. Other changes include the development of a spine near the dorsal side on the coxal segment of the fourth pereopod, the fifth pereopod has grown to a three-segmented appendage, but without exopod. The most significant change is in the abdomen which is now more than 2 mm. long with clear segmentation, low biramous buds of the four pairs of pleopods and well formed uropods and telson. Both the uropods and the telson have an entire margin at this stage.

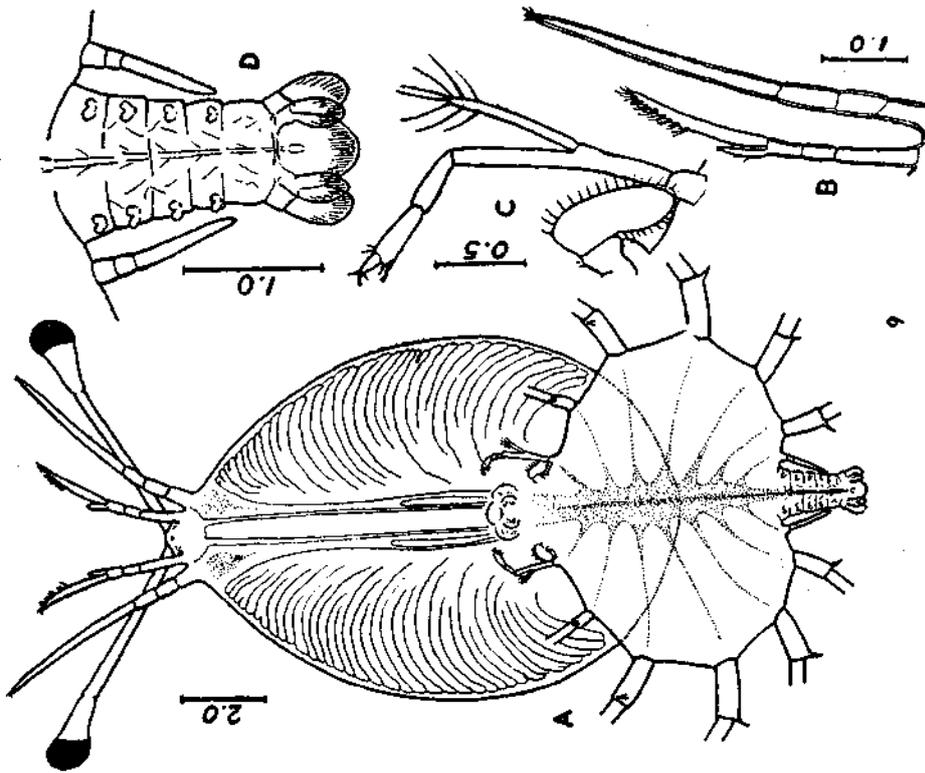


FIG. 9. Stage IX.

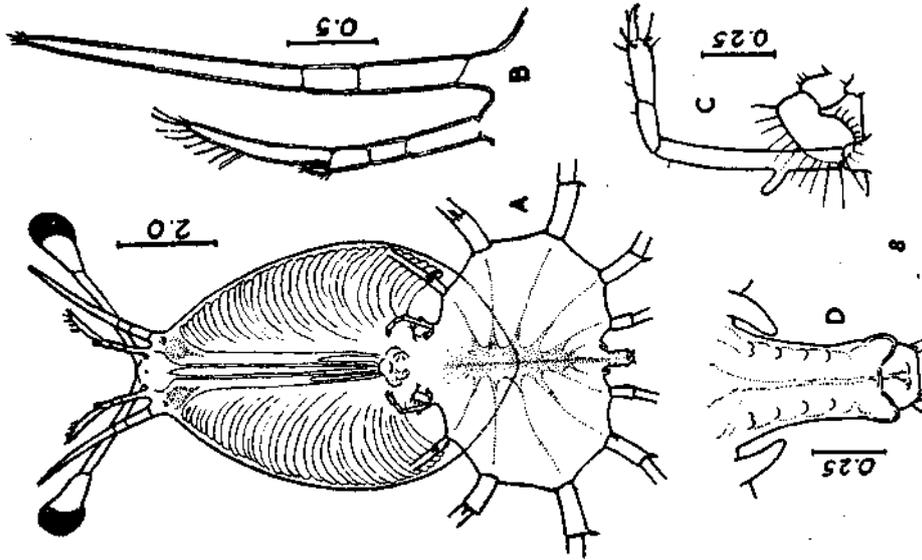


FIG. 8. Stage VII.

Stage X. (Fig. 10, A-D)

Station 210 : 23-2-1958 : 1 larva 19.25 mm.

Station 5 : 7-1-1959 : 1 larva 20.75 mm.

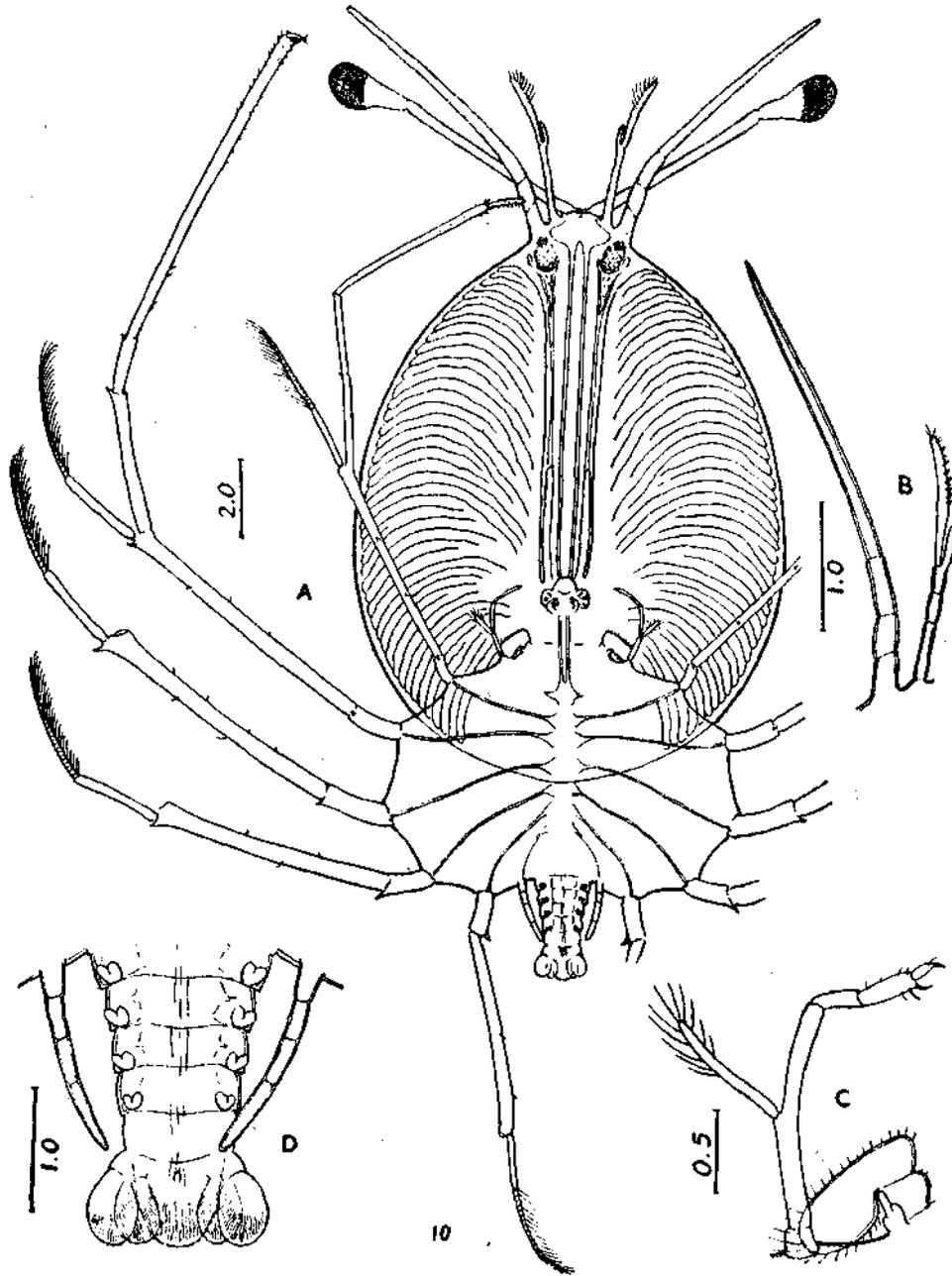


FIG. 10. Stage X,

The progressive increase in width of the anterior region of the shield through the earlier stages is more marked in this stage and the hind margin is completely rounded off so that the shape of the fore-body is more egg-shaped. The length/width proportion is between 1.34 and 1.38. The antenna is approximately twice the length of the antennule and is about 8 mm. long in the larva. The terminal segment of the second maxilla has become highly flattened and leaf-like; the first maxillipede which was hitherto only a bud has grown as shown in Fig. 10 C, whereas the changes in the second maxillipede are not appreciable. All the four pereopods show the coxal spines but these are relatively much smaller than in the earlier stages. Four segments have developed in the fifth pereopod which is only three-fourth the length of the abdomen. There is a slight increase in the length and width of the abdomen. It shows clearer segmentation and the pleopod buds are also distinctly raised and clefted. There is an indication of a tiny spine on the outer border of the external pair of uropods.

Excepting for minor individual variations between the two larvae in their total length, length of the antenna and the segmentation of the exopod of the first maxillipede, both these resemble closely and therefore are regarded as belonging to the same stage. While this is the last stage obtained in the present series of collections, the nature of the antenna and the pleopods, and the lack of gills on the pereopods, in this stage seem to suggest the existence of possibly two more developmental stages before the larva could metamorphose into the puerulus. Comparing with the larval stages of *P. interruptus* given by Johnson (1956) the present larva corresponds with either stage IX or X. A summary of the distinguishing characters of the phyllosoma stages of *Panulirus penicillatus* described above is given in Table I.

The series of larvae now described has been tentatively assigned to the species *penicillatus*, because a preliminary survey of the Palinurids of the Laccadive Archipelago reveals that this is the most common species of this area and, out of all the species collected, such as *P. versicolor*, *P. burgeri*, *P. ornatus* and *P. penicillatus*, berried specimens of only the last species were obtained so far. These berried ones were collected during May and September, when they were quite common, but it is likely that they may be breeding at other times also as indicated by the occurrence of juveniles ranging in total length from 51.00 to 54.00 mm. in September in our collections. The larvae described above were obtained during the early part of the year, January to April, during which period alone collections were made in the area and so the distribution of larval stages at other times of the year is not known. It is certain that the larvae under discussion are not those of *burgeri* or *ornatus*, both of which have been described by the authors but it should be mentioned that there is no information at present on the larvae of *versicolor*.

An attempt was made to ascertain whether the various stages of growth described above belong to the same series and show the usual growth pattern. Figure 11 shows the growth curve based on the present larval stages and for comparison the lengths of the larval stages of *P. interruptus* given by Johnson (1956) are also indicated. There is close agreement between the growth pattern of these and the distribution of the points in the curve suggests beyond any reasonable doubt that the stages described here form one connected series.

Besides these fairly connected series in the development of what is considered as *P. penicillatus*, several other Palinurid larvae were also obtained from the same

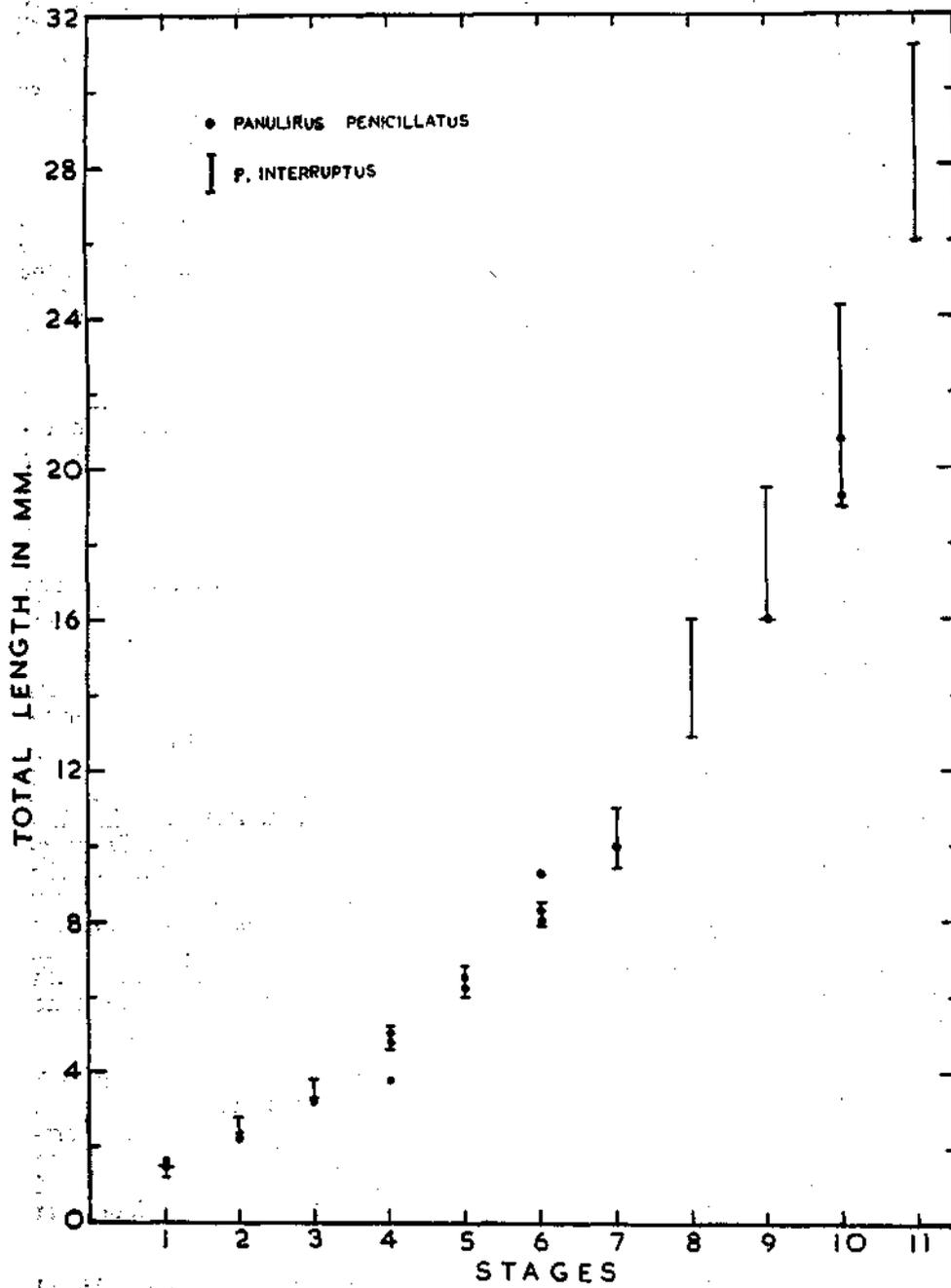


FIG. 11. The growth of the different stages of *P. penicillatus* phyllosomas compared to that of *P. interruptus*.

TABLE I
Summary of distinguishing characteristics of the phyllosoma stages of *Panulirus penicillatus*

Ser. No.	Probable stage	Length mm.	a1	a2	mx. 2	mxp. 1	mxp. 2	mxp. 3	P1	P2	P3	P4	P5	Pleopods	Uropods
1	I	1.50-1.58	1 seg.	1 seg. <a1	4 setose spines on last seg.	small bud	no ex.	setose ex. with v.c.s. small	setose ex. with v.c.s.	setose ex. with v.c.s.	rudimentary ex. with v.c.s.	O	O	O	O
2	II	2.21	same	same	same	same	same	same	same	same	same	O	O	O	O
3	III	3.20	same	same	same	same	same	same	same	same	ex. setose	bud	O	O	O
4	IV	3.75-5.00	same	1 seg. a1 = a2	slightly enlarged. 5-7 setose spines	same	same	same	same	same + d.c.s.	same + d.c.s.	biramous bud	bud	O	O
5	V	6.20-6.50	base 3 seg. en. small bud	>a1 2 or 3 seg.	same	same	same	same	same	same	same	ex. longer with a few setae	same	O	low buds
6	VI	8.00-9.25	same	3 seg. 4th indicated	further enlarged	same	same	same	same	v.c.s. disappears	v.c.s. disappears	4 seg. ex. setose	same	O	same
7	VII	10.00	en. longer	1.5 times a1	same	same	ex. 1 seg.	same	same	same	same	longer	1 seg.	low buds	same
8	VIII	NOT REPRESENTED IN THE COLLECTION													
9	IX	16.00	en. 1 seg.	4 seg.	large & flat	more prominent	ex. long & setose	same	same	same	same	same + d.c.s.	3 seg.	small cleft buds	biramous complete
10	X	19.25-20.75	same	2 times a1	same	3 lobed	same	same	same	same	same	same	4 seg.	raised cleft buds	same

a1 = antennule, a2 = antenna, d.c.s. = dorsal coxal spine, en. = endopod, ex. = exopod, mx.1 = first maxilla, mxp.1-3 = maxillipedes 1-3, P1-5 = Pereiopods 1-5, seg. = segment(s), v.c.s. = ventral coxal spine, O = wanting.

region on different occasions. Most of these belong to the first or early stages. On the basis of available information regarding the occurrence of adult lobsters in the area covered during this investigation, the authors have tentatively described the larvae as *Panulirus* sp. I, II, etc., except the last one which has been assigned to *Jasus lalandii*.

Panulirus sp. I. (Fig. 12, A-D)

Station 447 : 28-4-1959 : 1 larva 1.60 mm.

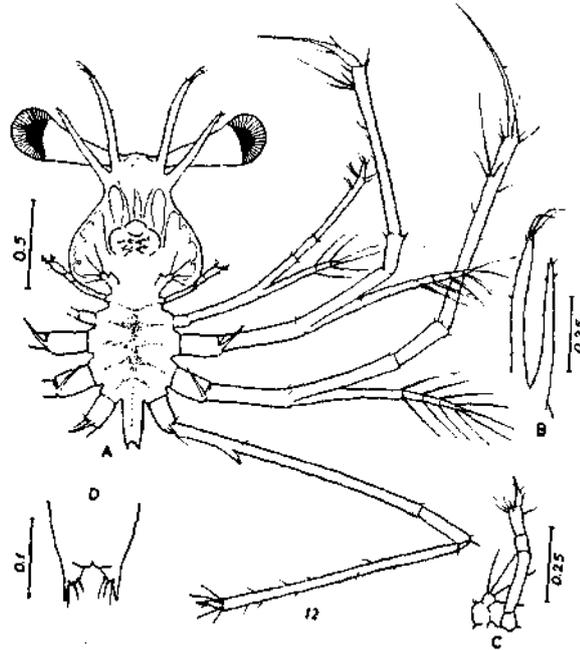


FIG. 12. Phyllosoma Stage I of *Panulirus* sp. I.

This larva belongs to the first stage as can be seen from the nature of the eyes, the long claws (dactyl) of the first and second pereopods, as well as the rudimentary exopod of the third pereopod. While the difference in the shape of the fore-body from that of *P. penicillatus* is evident from the figure, its general resemblance to that of the larva of *P. ornatus* and *P. burgeri* is also apparent. Posteriorly the shield hardly extends beyond the level of the base of the second maxillipede. The antennule and antenna are nearly equal in length and each consists of only one segment. The eyes are large, as is usual at this stage, and devoid of a basal stalk-like differentiation. The second maxilla bears four long setae on its end segment while the basal segment has two short spines on its inner margin. The first maxillipede is a tiny rudiment. The second maxillipede shows the usual structure with five segments. The third maxillipede is long and well developed with an exopod as in most Palinurid larvae. Three walking legs are present in this stage, the first two with long terminal claws and well formed exopods. The proportions of the length of the claw and the last segment of the first and second pereopods are 1.64 and 1.30 (propus/dactyl) and thus show considerable

difference from the larvae of either *P. ornatus* or *P. burgeri* described earlier by the authors (1957 and 1959). The third pereopod has only rudimentary exopod as can be seen in Fig. 12A. All the three pereopods are provided with a long coxal spine on the ventral aspect. The fourth walking leg is absent in this stage even as a rudiment. The abdomen has nearly parallel sides and terminates in two pointed tips, each with three simple setae.

Panulirus sp. II. (Fig. 13, A-D)

Station 448 : 29-4-1959 : 3 larvae 1.49 mm.

All the three larvae represent the first stage of a Palinurid. Compared to the larva of *Panulirus* sp. I, these are slightly smaller, the shape of the fore-body is somewhat different and the eyes seem smaller in proportion to the body. Similarly the length of the claw in the first and second pereopods in relation to the propus of the corresponding legs is comparatively shorter in this larva. Another significant difference seems to be the presence of a spine at the distal end of the basipod closely adjacent to the exopod of each of the first three pairs of pereopods, whereas the long coxal spines on the leg is a common feature for both the larvae. Johnson (1956) has pointed out the presence of a strong spine at a similar position on the walking legs of the first larva of *P. gracilis* and considers this as distinguishing character enabling its separation from *P. interruptus*. Although there is some agreement between the larva obtained in the present collection and that of *P. gracilis* in the shape of the cephalic shield and appendages, the propus/dactyl proportion (as shown in Fig. 22, Johnson 1956) seems to be widely different. Besides, *P. gracilis* which is common in the Californian coast has not so far been recorded from the Indo-African region and therefore the possibility of the present larva belonging to *P. gracilis* will have to be ruled out.

Panulirus sp. III. (Fig. 14, A-D)

Station 219 : 1-3-1958 : 1 larva 5.00 mm.

The phyllosoma has an elongated cephalic shield emphasised by the narrowness of the anterior region and a nearly acute posterior border as in the figure. The length/width proportion of the shield is about 1.7. The thoracic region is slightly wider than the shield. This larva appears to belong to stage III or IV in a series considering the development of the appendages, particularly the antennae and the pereopods. The eyes are provided with long stalk. The antennules and antennae are unique in this larva while these appendages indicate some advance in their development from the early stages, particularly by their segmentation and development of aesthetes in the antennule their comparative length is peculiar. In most other Palinurid larvae the antenna shows a tendency to grow longer than the antennule as development progresses. Comparing this with the corresponding stage of *P. penicillatus* (Figs. 4 and 5) we find that in the present instance the antennule is still longer than the antenna and it also shows the rudiment of the endopod appearing on the third segment. Another noticeable feature is the long second maxillipede of the larva compared to that of other Palinurid phyllosomas. The second maxilla, the rudimentary first maxillipede and the second maxillipede are shown in Fig. 14C. The third maxillipede is typically biramous. First, second and third pereopods are fully formed and have each a coxal spine on the ventral side, but have no spine on the second segment at the articulation of the exopod. The fourth pereopod is present as a three jointed appendage with a rudimentary but segmented exopod, while the fifth pereopod appears as a small

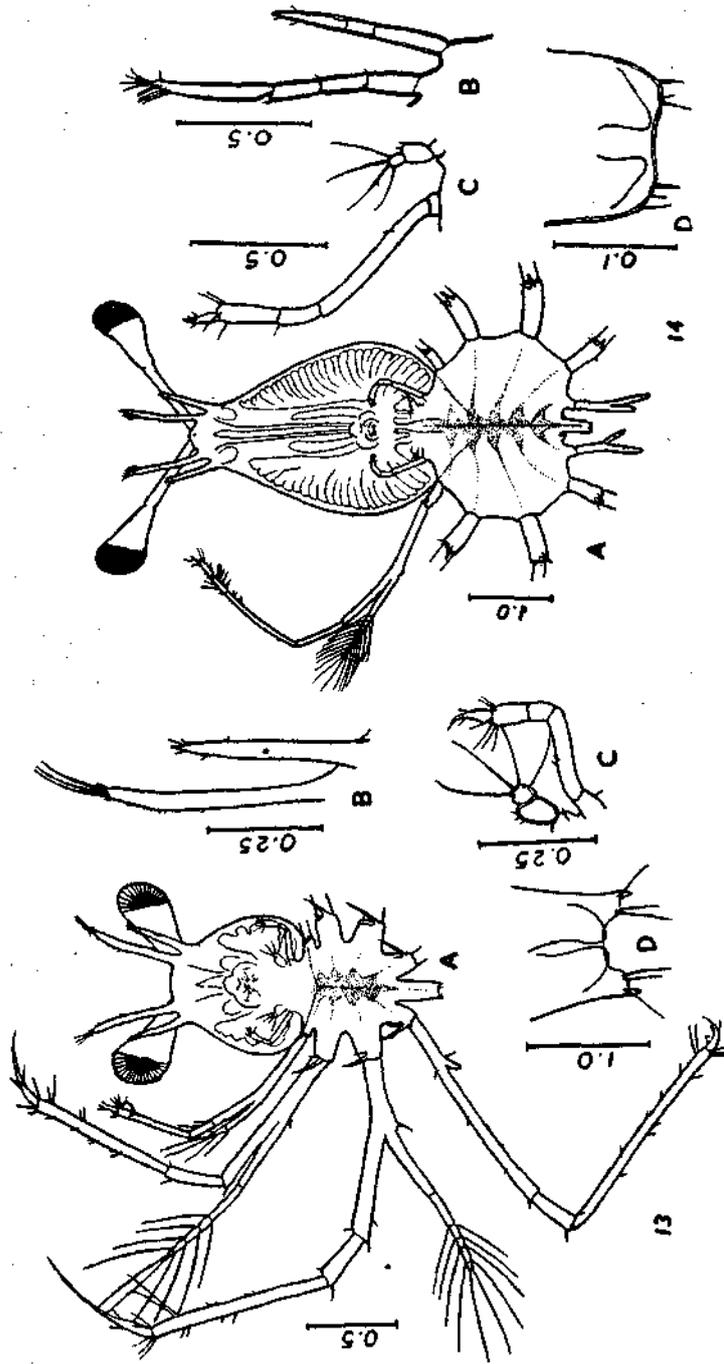


FIG. 13. Phylosoma Stage I of *Panaitirus* sp. II.

FIG. 14. Phylosoma Stage III or IV of *Panaitirus* sp. III.

bud. The abdomen itself is short and has parallel sides with truncate end bearing three pairs of setae (Fig. 14D).

Panulirus sp. IV. (Fig. 15, A-D)

Station 210 : 23-2-1958 : 1 larva 11.00 mm.

The resemblance between this larva and the earlier one is striking. The shield is highly elongated with a length/width proportion of 1.71, although in this specimen the broadest portion of the shield is more or less at the middle region. The posterior border of the shield also shows an acute margin and covers nearly half the length of the thoracic region. The hind-body is much broader than long, and is more than 1.2 times the breadth of the fore-body. The eyes are provided with long stalk. Antennule which has three distinct basal segments and a small endopod, is longer than the antenna. The antenna also indicates clear segmentation. The second maxilla consists of only one segment, with two small marginal spines, the first maxillipede remains as a tiny bud while the long second maxillipede shows a faint rudimentary projection of the developing exopod. The third maxillipede is biramous with a well developed setose exopod. Pleopods 1 to 4 seem to be fully formed although their endopods are broken off in the specimen during collections. One important point seems to be the absence of coxal spines in these legs. The fifth pereopod remains as a tiny bud projecting from the margin of the hind-body, but far removed from the base of the abdomen. The abdomen is very small and is only a little over 0.5 mm. long projecting from a deep depression of the posterior margin of the hind-body. Setae are present at the end of the abdomen and two low buds of the uropod are seen.

Although in general this larva has a resemblance to the one described as *Panulirus* sp. III the authors are inclined to consider the present one as belonging to yet another species. The reasons are : (1) the absence of coxal spines. There is usually a reduction in the length of these spines as development advances but the complete disappearance has not been noticed in any species so far, (2) the form and size of the abdomen compared to similar stages of other *Panulirus* species, and (3) the position of the fifth pereopods. The larvae shows some resemblance to the one described by Gurney (1936) as *Panulirus B*, stage V?, 7.7 mm.

Panulirus sp. V. (Fig. 16, A-D)

This phyllosoma was found in the stomach contents of a tunny, *Katsuwonus pelamis*, caught near Minicoy on 10-3-1959, and consequently it was partly damaged with the pereopods and the antennal flagellum broken or lost. But still the eyes, the fore- and hind-bodies, maxillipedes and abdominal region were intact and it seems evident from the nature of the third maxillipedes, antennae, etc., that this larva belongs to Palinuridae. The phyllosoma measures 38.00 mm., the largest obtained by the authors so far from Indian waters. The shield is roughly rectangular in outline (Fig. 16A) and its hind border has an obtuse median projection. The hind-body is much narrower than the fore-body which is about $\frac{2}{3}$ its width. Antennule shows three basal segments and a fairly well developed flagellum. The antenna also shows distinct basal segments with a few short spines on them while the flagellum seems to have been broken off. The second maxilla has a flat leaf-like terminal segment with long marginal setae and a few spines on the inner angle of the basal segment. The first maxillipede appears to have two segments, a slender piece attached to a broader basal segment which

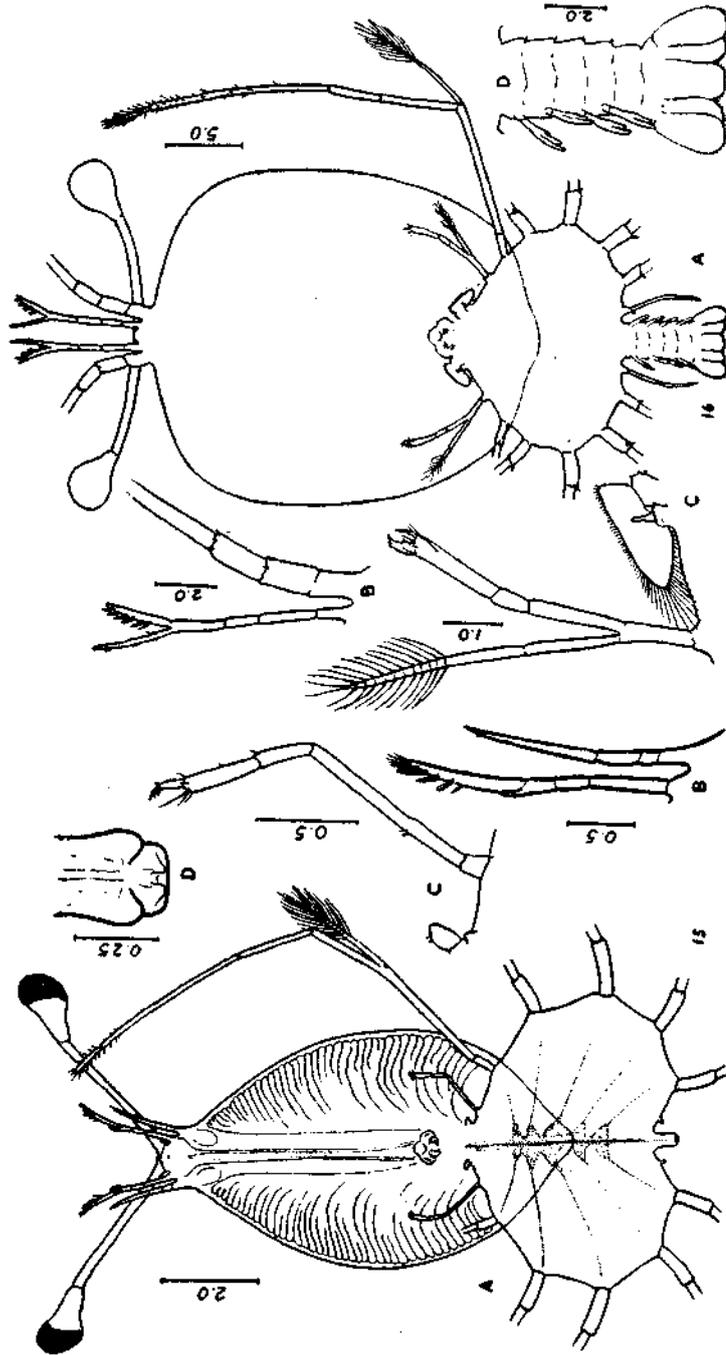


FIG. 15. Phyllosoma of *Pamphirus* sp. IV.

FIG. 16. Phyllosoma last stage (?) of *Pamphirus* sp. V.

has a pair of small spines. The second and third maxillipedes possess a well developed setose exopod. The coxal segment of all the pereopods show a short spine. The fifth pereopod, although shorter than the abdomen and not fully formed, shows indications of the five segments, but is without an exopod. Abdomen is well developed with five segments and the four pleopods. The pleopods are elongated and flattened structures showing somewhat clear demarcation into a basal segment to which are attached the exo- and an endo-pod segments with a small spine-like process on the inner margin of the endopod (rudiment of the appendix interna) Fig. 16D. Both the uropods and the telson possess small spines at their border.

The stomach contents of the same fish included six more phyllosomas but in a more digested condition. The larva described here shows some similarity with the last larval stage of *Palinurus* sp., 50 mm. described by Gurney (1936, p. 403).

Panulirus sp. VI. (Fig. 17, A-D)

Station 448 : 29-4-1959 : 3 larvae each 2.00 mm.

These larvae differ from all the hitherto described phyllosomas from the Indian waters. The characters of the larva suggest clearly that it is the first in a series of phyllosoma stages. The width of the cephalic shield is the same as its length. The hind-body is only half as broad as the fore-body. The most striking character is their antenna which, unlike in other Palinurid larvae described earlier, is a biramous appendage. The endopod is slightly longer than the exopod and possesses a few processes more or less in the form of a forked tip. The second maxilla consists of two segments. The basal one has three pairs of short marginal spines and the terminal segment is slightly flattened and provided with five plumose setae. The first maxillipede is a rudimentary bud as in other larvae but provided with one or two small terminal setae. The second maxillipede is uniramous while the third maxillipede is biramous with well developed swimming setae. Unlike the early larvae of other Palinurids the first and second pereopods do not have the long curved dactyls. The dactyls in all the three pereopods are short and claw-like. The third pereopod shows the rudimentary exopod. The third maxillipede as well as the three fully developed pereopods possess a coxal spine of moderate length. The fourth pereopod is seen as a small bud closely apposed to the base of the abdomen. The abdomen is almost 0.4 mm. long, narrow, slightly tapering towards the tip and terminates in a shallow fork with a pair of short setae.

Feliciano (1956) has shown the presence of distinct biramous antennae in the prenaupliosoma stage of *Panulirus argus*. The persistence of this character in the first stage of some of the other species of *Panulirus* larvae is a possibility that cannot be completely ruled out as it does in the case of *Jasus lalandii* whose larval history is known (Von Bonde, 1936), and to which the present form bears some resemblance. Although the biramous nature of the antenna in this larva does not conform to the general classification of the phyllosoma larvae by Gurney (1936), still the authors are inclined to consider the present form as that of a species of *Panulirus*.

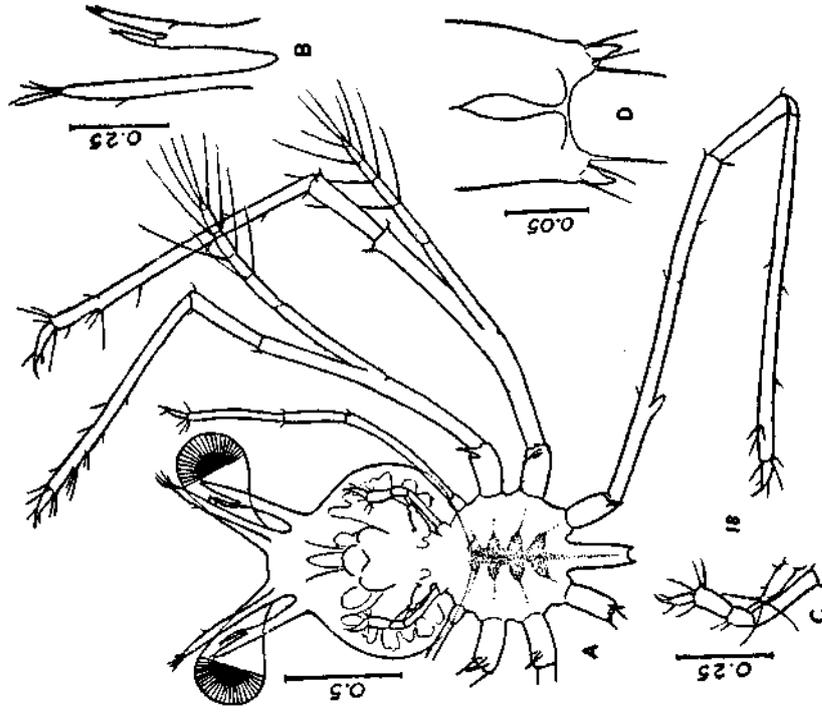


FIG. 18. Phyllosoma stage I of *Jasus latandii*.

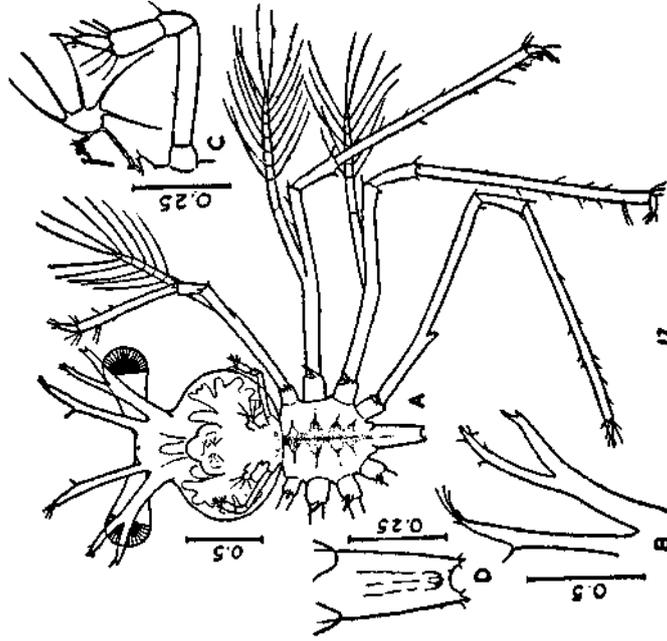


FIG. 17. Phyllosoma stage I of *Panulirus* sp. VI.

Jasus lalandii (Milne Edwards) Ortman (Fig. 18, A-D)

Station 448 : 29-4-1959 : 2 larvae each 1.5 mm.

From the figure it may be seen that this larva also belongs to the first phyllosoma stage and possesses biramous antenna. The length/width ratio of the cephalic shield is almost 1. The hind-body is about $\frac{3}{4}$ the fore-body in width. The eyes are not stalked and the antennule is simple. The antenna is shorter than the antennule. The endopod of the antenna is marked off into a segment and is shorter than the exopod which also shows the indication of segmentation and terminates in two spines. The second maxilla has a somewhat elongated basal segment and a small terminal segment with four plumose setae. The first maxillipede is not seen even as a rudiment, whereas the second maxillipede is well developed. The third maxillipede does not show an exopod and the first and second pereopods are fully developed possessing only short dactyls as in the larvae of *J. lalandii* described by the earlier authors. The third pereopod shows the rudimentary exopod while the fourth is not present even as buds. All the three pereopods possess a moderately long coxal spine. Abdomen is relatively short in the larva and is only about 0.25 mm. long, with parallel sides. There are three long setae on each posterior corner.

The first phyllosoma of the eastern form of *J. lalandii* has been described by Thompson, Anderson and Archey as cited by Gurney (1936) and of the South African form by Gilchrist (1916). Von Bonde (1936) described the development of the larvae. In both these forms the antenna is large and biramous. The present larvae agree closely with those described by these authors, except for the slight difference in the total length (0.2 mm.) from the one described by Gilchrist. Lebour (1950) described a similar larva as of a species of *Scyllarides* but since the earlier authors' descriptions are based on larvae hatched in the laboratory, the phyllosoma described here is considered as that of *J. lalandii*. *Jasus lalandii* has not been recorded from the Indian waters. The genus is reported to be restricted to the Southern Hemisphere (Barnard, 1950), extending northwards almost up to the Tropic of Capricorn (Gruevel, 1911). According to Sheard (1949) this species tends to avoid waters of consistently higher temperature (18°C . and upwards), particularly at the time of moulting, mating and during 'berry' periods and that the genus is confined to the cooler neritic waters of the Southern Hemisphere. In view of these remarks the occurrence of the first phyllosoma stage as far north as $10^{\circ} 46'$ is significant and interesting. It is unlikely that these early stages could have been carried all the way into this area from the known northern distribution limit of the adults. Further, it may be mentioned here that the maximum concentration of phyllosomas was recorded at station No. 448 all of which were in the first stage suggesting the greater possibility of these larvae being released in the vicinity. In the region where these larvae have been recorded, the temperature at the surface at the time of collection was 30.90°C . decreasing to 19.65°C . at 150 m. and to 14.84°C . at 200 m. Since the temperature can be as low as about 15°C within the neritic zone of this area, the adults could very well find suitable temperature range here. Therefore, the chances of the occurrence of *Jasus* in the Northern Hemisphere also somewhere in the neighbourhood of these islands cannot be overlooked.

SUMMARY

The paper describes the Palinurid phyllosomas collected by the research vessel *Kalava* and I.N.S. *Jumna* during their cruises between the west coast and the Laccadive Archipelago in 1958 and 1959. The collections include a fairly connected series in the development of *Panulirus penicillatus*, first phyllosoma stage of *Jasus lalandii* and the larvae of six other species of *Panulirus*. The significance of the occurrence of *J. lalandii* in the area of investigation has been briefly discussed.

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