THE LARVAL STAGES OF THREE STOMATOPOD CRUSTACEA (from the Red Sea)

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INTRODUCTION

The present work forms a part of a big programme launched, at the Marine Biological Station of the Institute of Oceanography at Al Ghardaqa, to get acquainted with the plankton of the Red Sea. As Crustacean larvae form a great part of the constituents of the temporary zooplankton, it has been deemed necessary to identify these larvae. Three Stomatopoda form the subject of this paper. Our knowledge of the postembryonic stages of crustaceans of this order in the Red Sea is unsatisfactory, only few stages were described by Gurney, 1937-1938. Identification of the planktonic larvae was achieved by rearing them in aquaria, through the successive stages until a stage is reached whose identification was possible, or larvae were obtained from ovigerous females of known species and these were reared and the stages were studied carefully and compared with corresponding ones obtained from the plankton. Where, artificial rearing fails to give all stages, resort was taken to the plankton to complete the stages. In this way, besides, the identification of the planktonic crustacean larvae, the study of metamorphosis in these animals was made possible.

HISTORICAL

Giesbrecht (1910) differentiated two types of larvae in the early stages of development of Stomatopoda, the pseudozoea and antizoea, the differences between the two types disappear in later stages. The antizoea hatches with biramous appendages on the first five thoracic segments. The abdomen is unsegmented or partly so. The setose pleopods are absent. The pseudozoea is hatched with the 1st. and 2nd. thoracic appendages only, and the 2nd. is in the form of a raptorial claw, both are without exopodites, and the abdomen is segmented and has functional pleopods. This larva develops into an erichthus or alima type.

Foxon (1932), gave a key for the genera of larval Stomatopoda. He remarked that « the characters of the larvae bear a very definite relation to those of the adults, the likeness to the adult becoming greater at each successive stage. The difference between alima and erichthus types is not fundamental as has been supposed but is really a minor generic modification ». He referred a larva to *Squilla lata* Brooks on the basis of similarities, between it and the adult, in number of teeth on the raptorial claw, the submedian carinae of the 6th. abdominal segment, and the telson and uropods.

Lebour (1940) trying to identify the stomatopod larvae in three tubes from Leopold expeditions, stated « the differences in the various alima larvae of different species of *Squilla* are often small and insignificant although one is able to separate them into groups».

Gurney 1937, described some larval stages of *Gonodactylus glabrous* Brooks. The 1st. stage which was obtained by hatching, gave the 2nd., and this died without giving the 3rd. stage. Resorting to the plankton to complete the stages, he confused between the third and the 4th., or his 3rd. stage might have belonged to another species. He missed the fifth, and was doubtful of the 6th.

Gurney (1946) offered an important key to the stomatopod larvae. Of the characters taken into consideration in the separation of larvae were, the shape of telson, the propodus of maxillipede II, the presence or absence and number of setose pleopods of the larva on hatching.

MATERIAL AND METHODS

Larvae were obtained from the plankton by the use of fine tow-nets of 129 M.P.I.. Artificial light was used to obtain phototactic larvae. In calm weather a lit strong electric bulb was lowered under the surface of the water. In about 15 minutes enough larvae collected round the light and appeared like a fine thin scum on the surface of the water which was then collected by the aid of the plankton net.

Ovigerous females were obtained from different habitats and kept in the aquaria until their eggs hatched in the laboratory. The hatched larvae were consequently transferred to flat-bottomed dishes, with fresh sea-water, where they were reared.

All drawings were made with the aid of the Camera Lucida. Only very fine details such as the setules on the plumose setae are added free hand. Fresh specimens are always dealt with, killed by 3% formalin, drawn and dissected just after killing. Glycerin was frequently used for mounting specimens.

REARING

Owing to the difficulty of keeping the larvae alive in the laboratory for more than a few days, most workers on the problem of metamorphosis in Crustacea resorted to the plankton to complete the larval stages. The difficulty in keeping these larvae alive, for a long time, is due to, firstly invading parasites, and secondly to insufficient food. For

the prevention of infection by parasites the following recommendations are made : I—The sea-water in the aquaria should be changed frequently, eg. twice daily. 2 — Dead larvae should be removed as soon as discovered. 3 — Proper food should be apportioned in appropriate, not too large amounts; after feeding, remnants of food are to be removed.

The following larval diets may be recommended.

(a) Plankton from which the larger animals had been removed.

(b) Eggs and larvae of Echinodermata and Mollusca.

(c) Powdered yolk of hen's eggs.

(d) The powder of a cake made up of 2 parts by volume of flour and I part of yolk

b and c proved to be the best diets.

Aeration and agitation of the water are effected by compressed air or by means of a water syphon. Each dish should contain only larvae of one species in a small number, as the greater the number of the larvae the greater the loss.

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LIST OF ABBREVIATIONS

Ab.	= Abdomen	Ep.	= epipodite
Ac. Sp.	=accessory spine	E. St.	= Eye Stalk
A. L. Sp.	= Antero lateral spine	Ex.	= Exopod
An.	= Antennule	F. L. Sp.	= Fronto-lateral spine
An.	= Antenna	G.	= Gill
B. P.	= Basipodial process	I. F.	= Inner flagellum
Ba.	= Basis	I. P.	= Inner process
B. Sp.	= Basal spine	Is.	= Ischium
Ba. L.	= Basal lobe		= Inner spine
Ba. J.	= Basal joint	L.	= Leg.
Ca.	= Carpace	L. Sp.	= Lateral spine
Car.	= Carpus	L. T. S.	= Last thoracic segment
Co.	= Coxa	Max.	= Maxillipede
Da.	= Dactylus	M. D. Sp.	= Middle dorsal spine
E.	= Eye	Me.	= Merus
En.	= Endopod	M. F.	= Middle flagellum

M. P.	= Molar process	Ro.	= Rostrum
M. P. Sp.	= Middle posterior spine	S.	= Segment
M. Sp.	= Intermediate spine	S. O. S.	= Supraorbitral spine
O. F.	= Outer flagellum	Sp.	= Spine
O. Sp.	= Outer spine	S. Sp.	= Submedian spine.
P. D. Sp.	= Posterior dorsal spine	Te.	= Telson
Pl.	= Pleopod	Th. Se.	= Thoracic segment
P. L. Sp.	= Posterior lateral spine	Ur.	= Uropod
Pp.	= Propodus	V. Ac. Sp.	= Ventral accessory spine
Pr.	= Protopodite	V. Sp.	= Ventral Spine
R. G.	= Rudimentary Gill	V. L. Sp.	= Ventrol Lateral spine

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FAMILY SQUILLIDAE

SQUILLA MASSAVENSIS KOSSMANN

All our larvae of this species were obtained from the plankton and moulting in the laboratory. The 1st. post-larval stage was obtained by moulting of the 9th. pelagic stage. A larva can be referred to its appropriate species by the Post-larval stage, although some characters may be still not well developed. We refer the following larvae to *S. massavensis* for the following reasons (from the 1st. 2 post-larval stages).

1. On the inner surface of the dactylus of the 2nd. maxillipede there are 6 spines, including that at the tip.

2. The protopodus of the 4th. maxillipede is longer than broad.

3. On the posterior edge of the 6th. abdominal somite there are 3 pairs of spines, one pair on the middle region and a pair on each side.

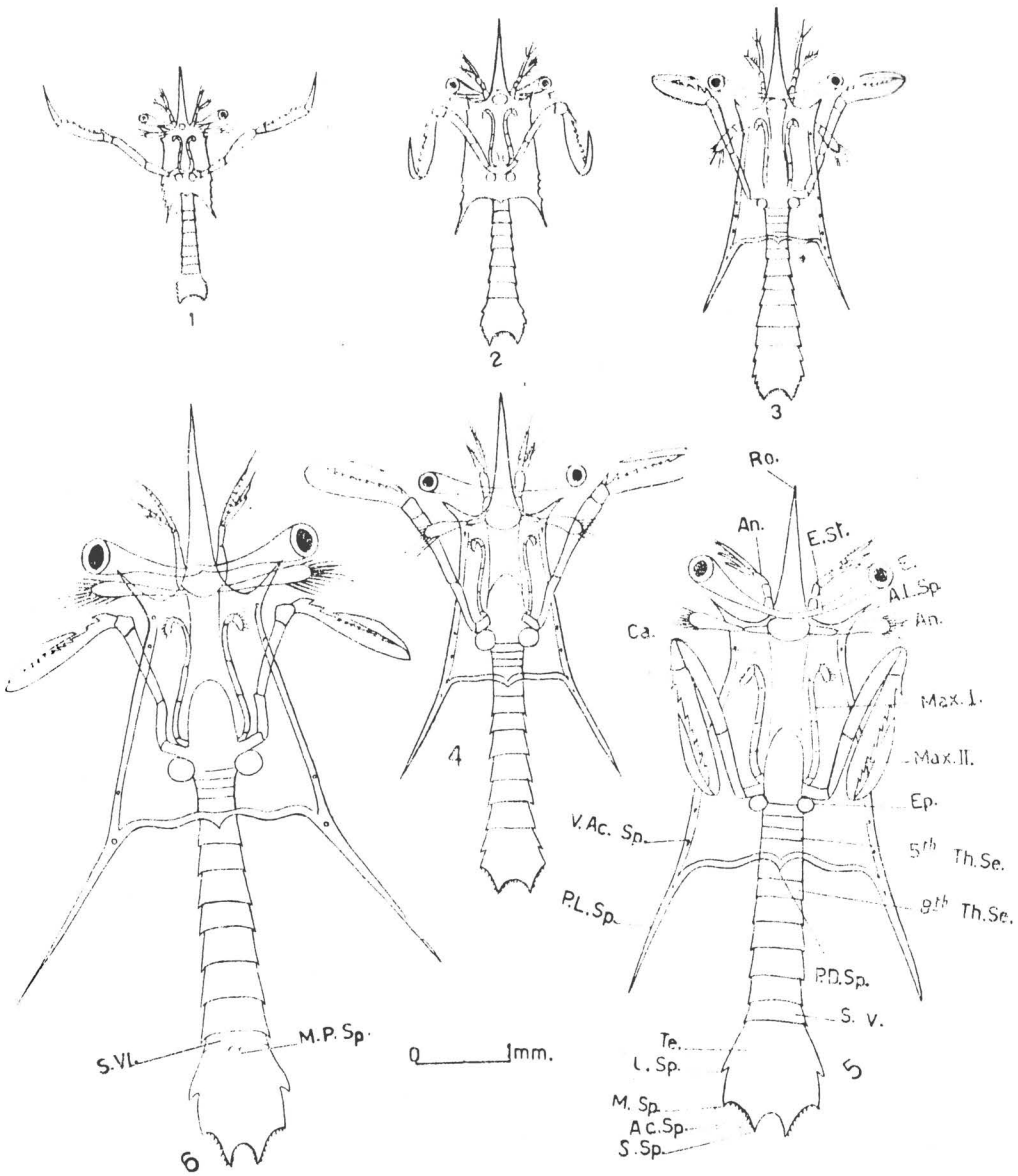
4. Between the intermediate and submedian spines, on one side of the telson there are 8 papillae carrying spines.

5. Between the two submedian spines there are 3+3 papillae with 5, 3, and 1 spines on the 1st. - 3rd. papillae, of each side, respectively. The innermost papilla is the broadest.

6. There are 9 outer spines on the exopod of the uropod.

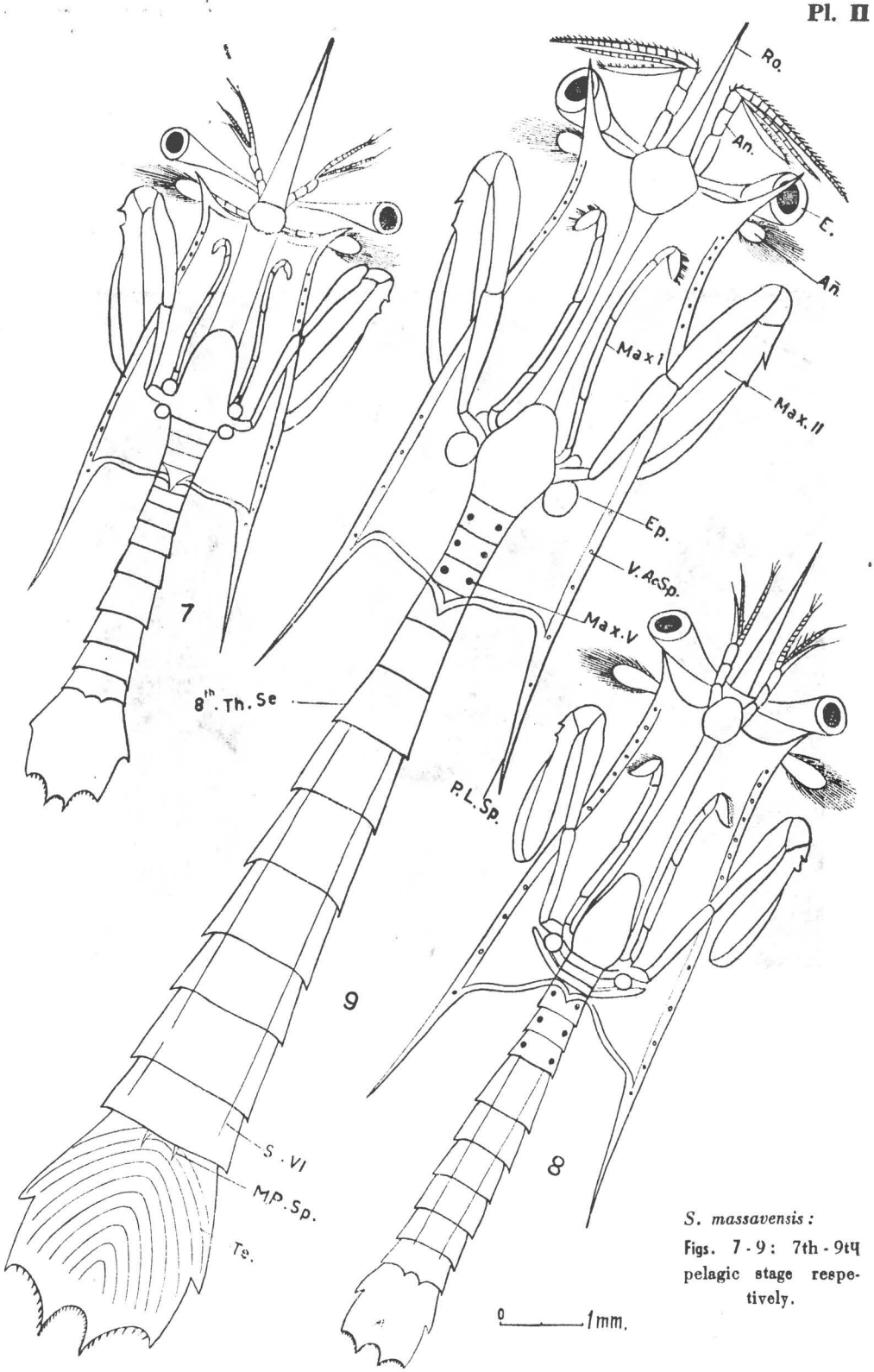
7. The inner spine of the basipodial process has a middle accessory outer spine.

Pl. I



S. massavensis :

Figs. 1 - 6 : 1st - 6th pelagic stages respectively



S. massavensis :
Figs. 7 - 9 : 7th - 9th pelagic stage respetively.

Pl. III

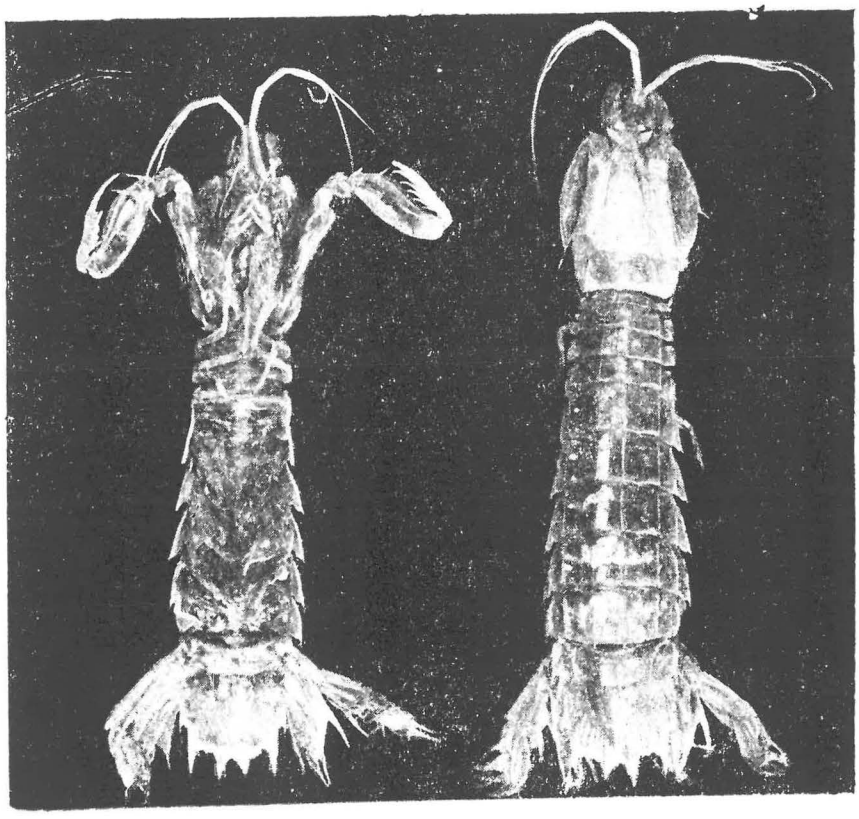
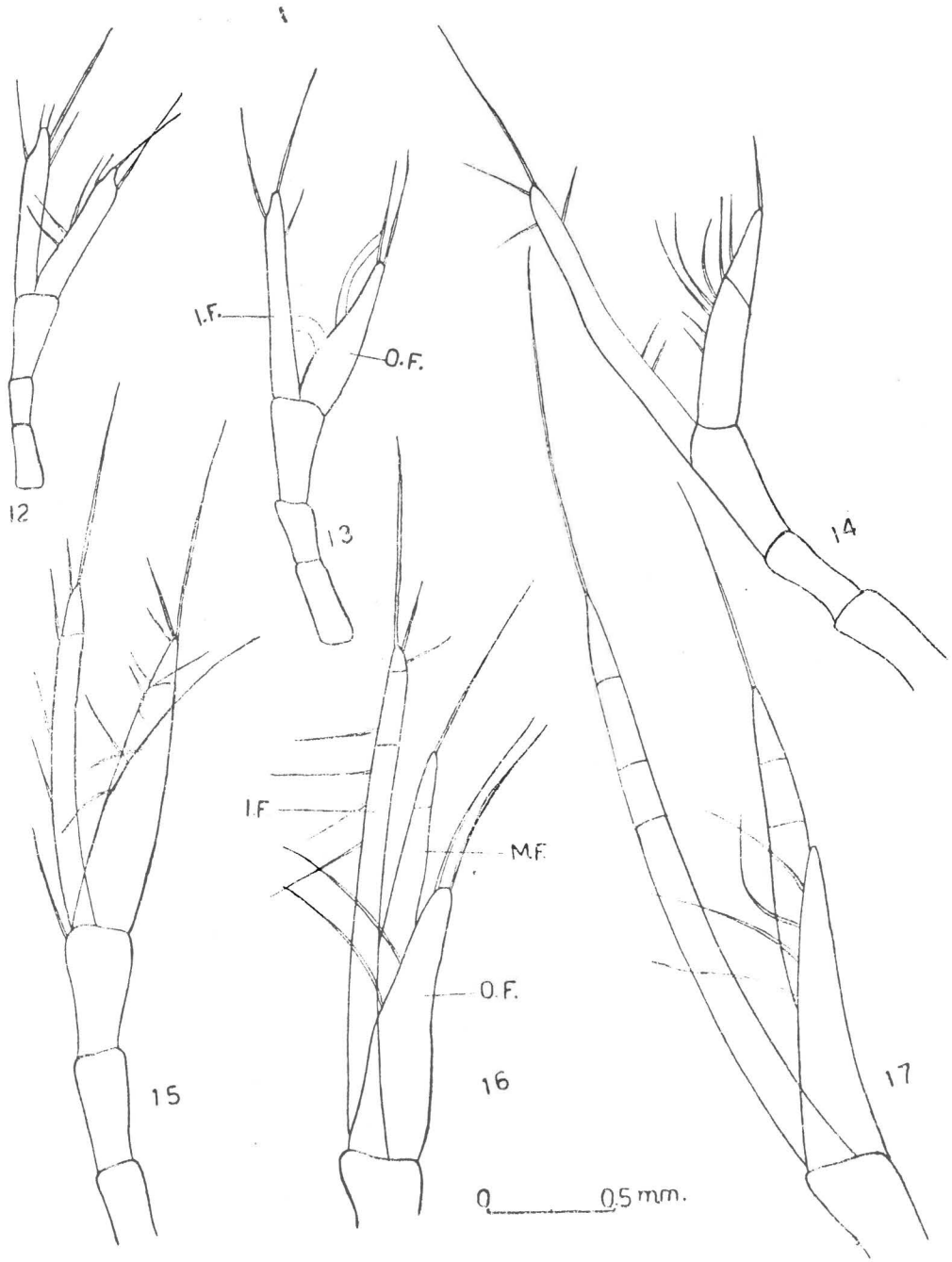


Fig. 10 : dorsal view, Fig. 11 : ventral view.

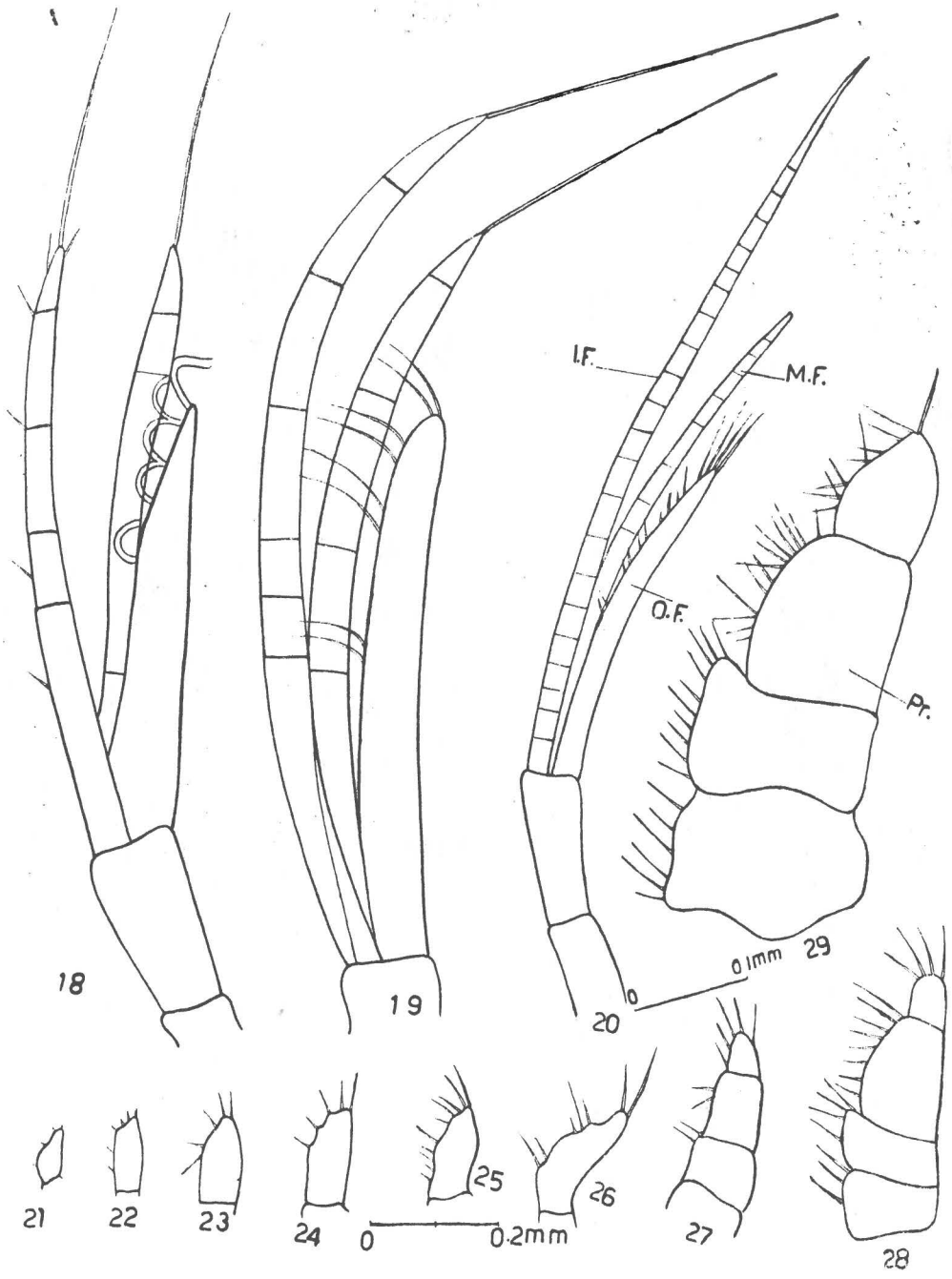
Adult male of S. *massavensis*.



S. massavensis :

Figs. 12 - 17 : Antennule of 1st - 6th pelagic stages respectively (Middle flagellum partly separated from the outer).

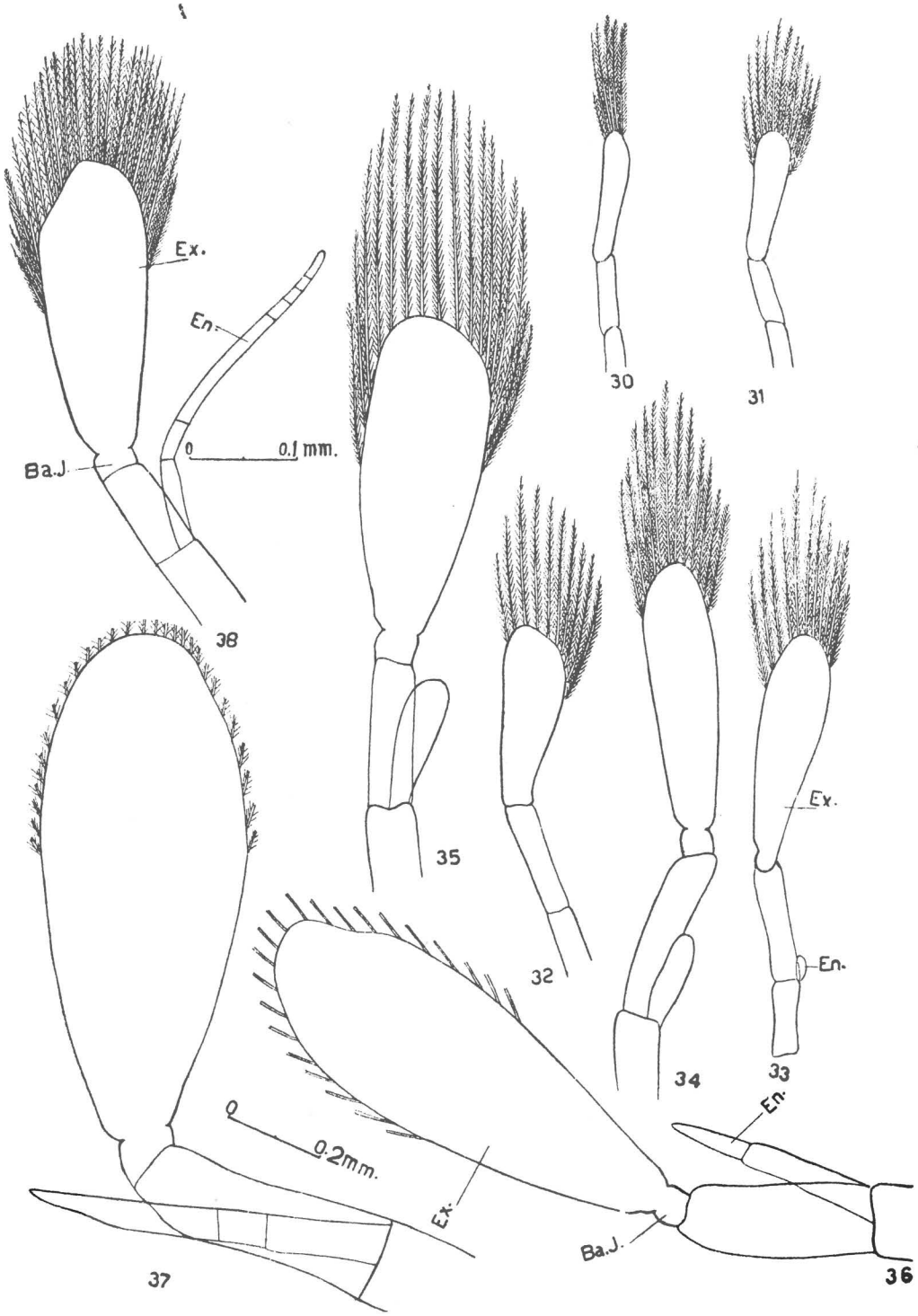
Pl. V



S. massavensis :

Figs. 18 - 20 : Antennule of 7th - 9th pelagic stages, respectively (Outer flagellum unsegmented and united with the middle at the base).

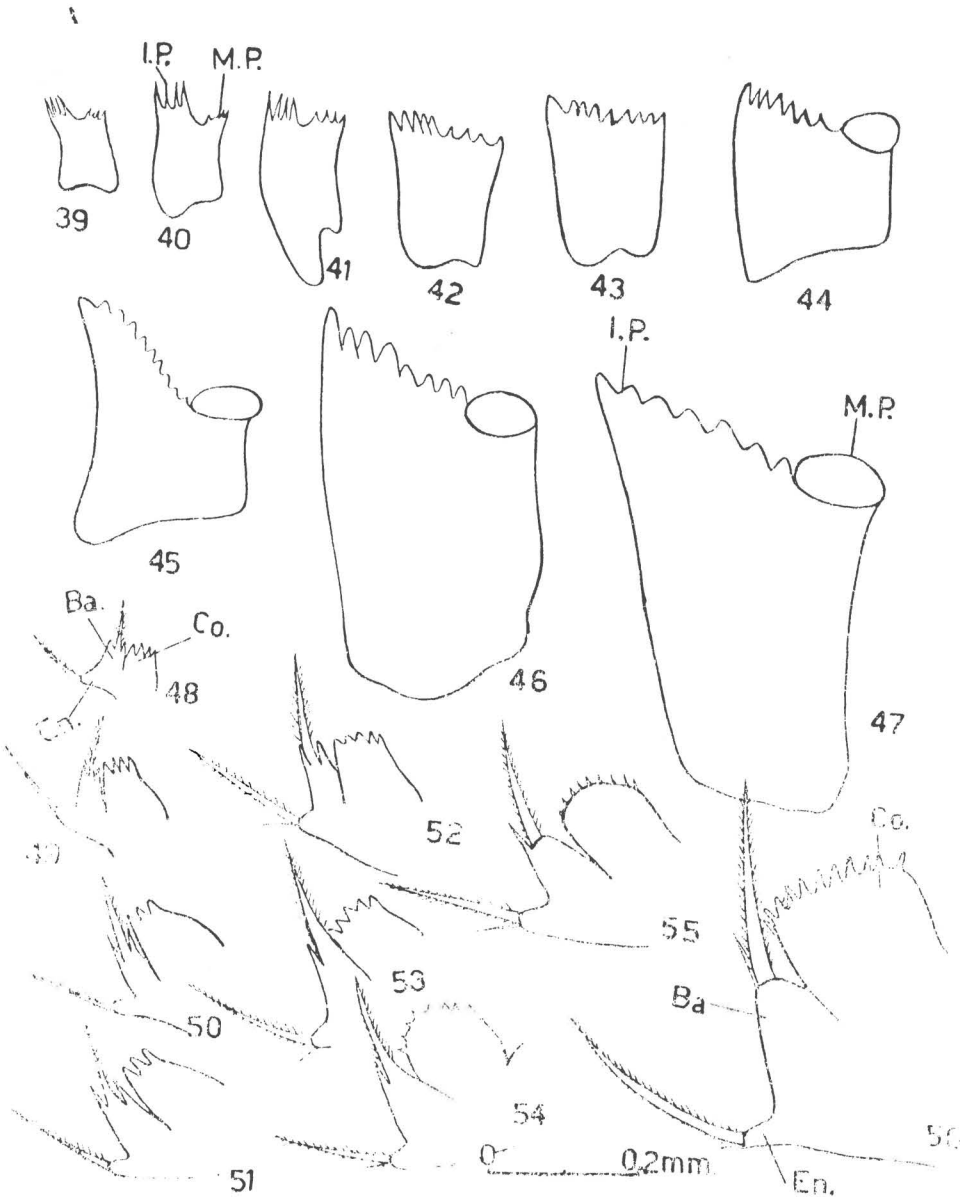
" 21 - 29 ; Maxilla of 1st - 9th pelagic stages, respectively, (Protopodite 4-segmented)



S. massavensis:

Figs. 30 - 38: **Antenna** of 1st - 9th pelagic stages, respectively, (Rudimentary endopod).

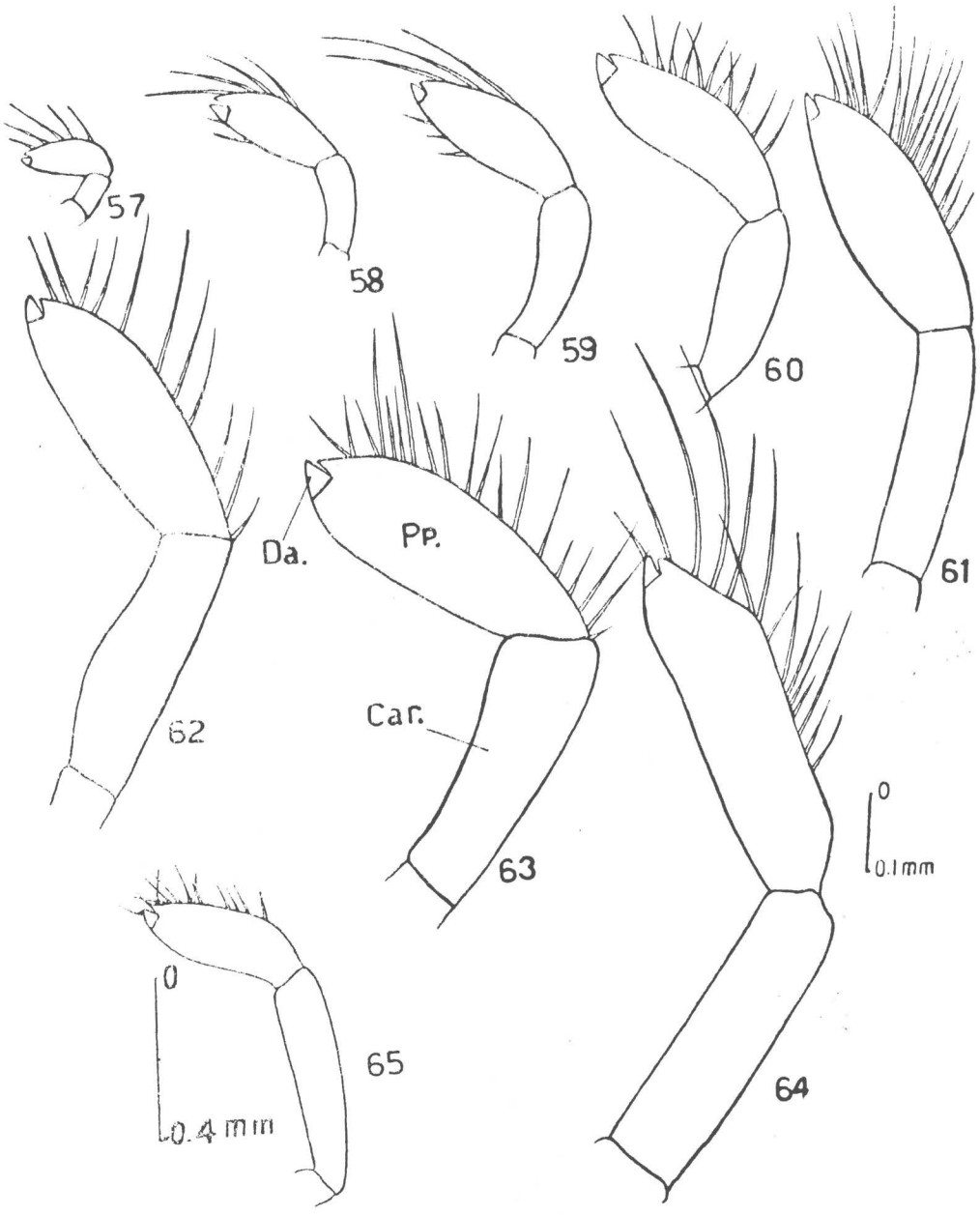
Pl. VII



S. massavensis :

Figs. 39 - 47 : Mandible of 1st - 9th pelagic stages, respectively.

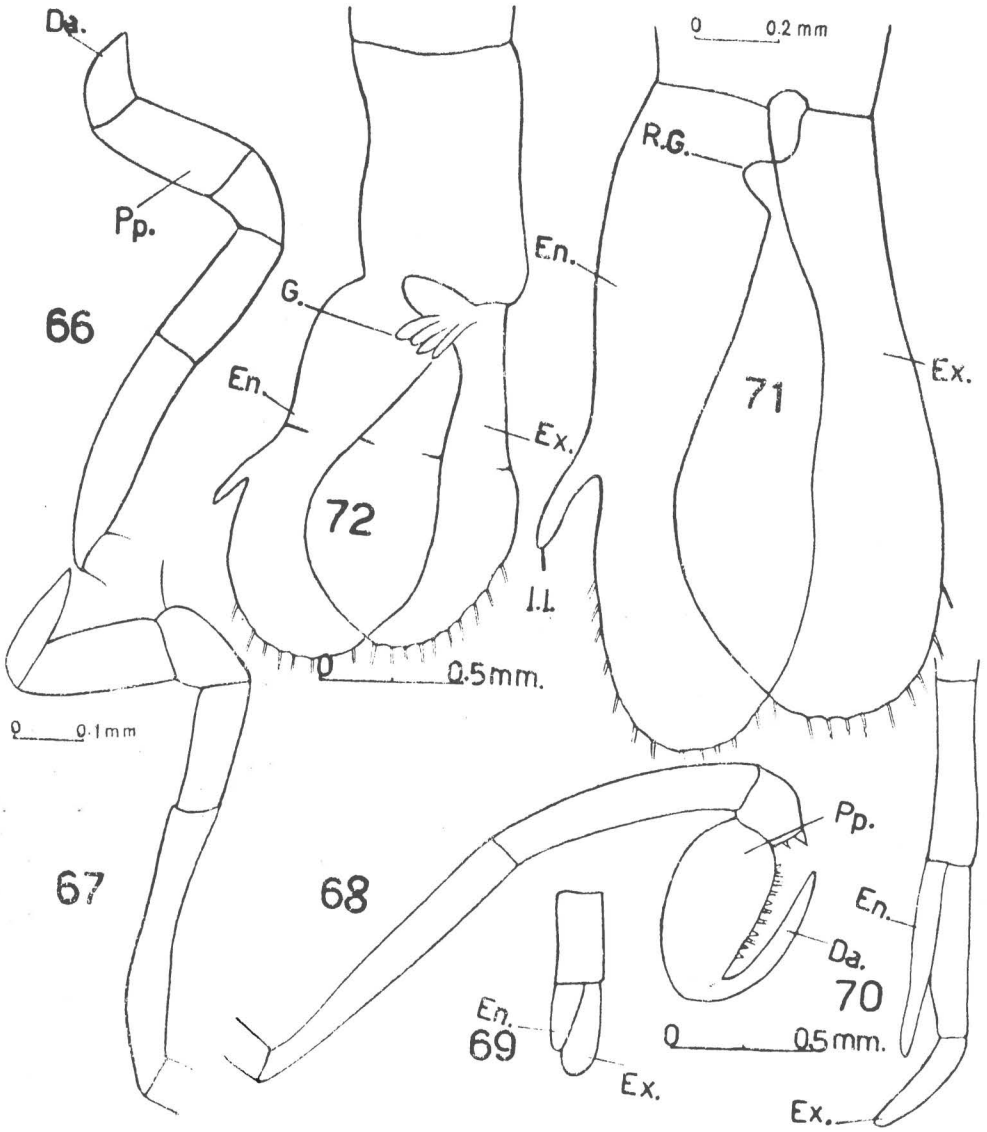
" 48 - 56 : Maxillule of 1st - 9th Pelagic stages, respectively.



S. massavensis :

Figs. 57 - 65 : Apical region of 1st. maxillipede of 1st - 5th pelagic stages, respectively.

Pl. IX

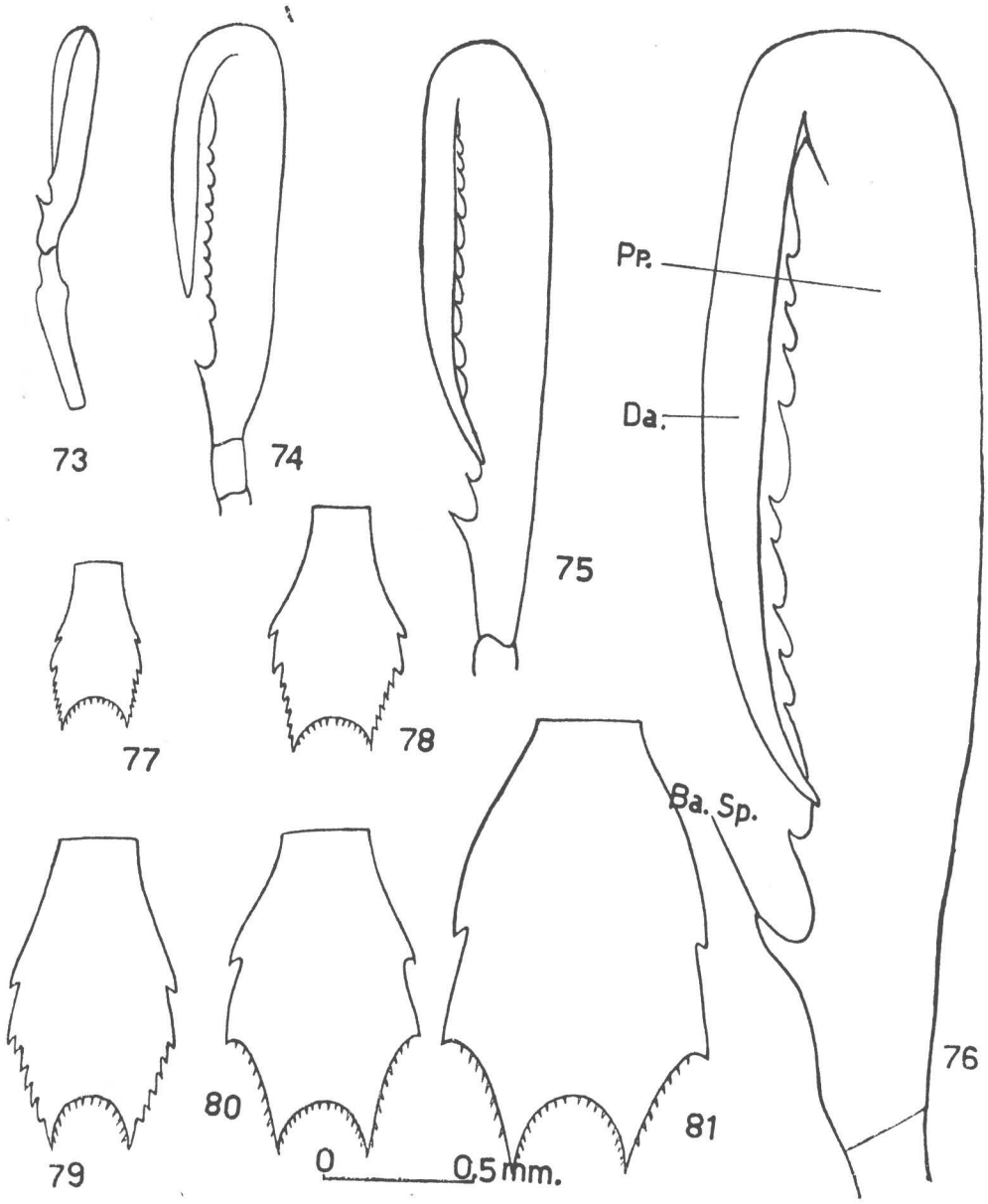


S. massavensis :

Figs. 66 - 68 : Third maxillipede of 7th. - 9th. pelagic stages, respectively.

69 - 70 : First leg of 8th. and 9th. pelagic stages respectively.

71 - 72 : Third pleopod of 8th. and 9th. pelagic stages respectively. (Rudimentary gill at the base of exopodite).

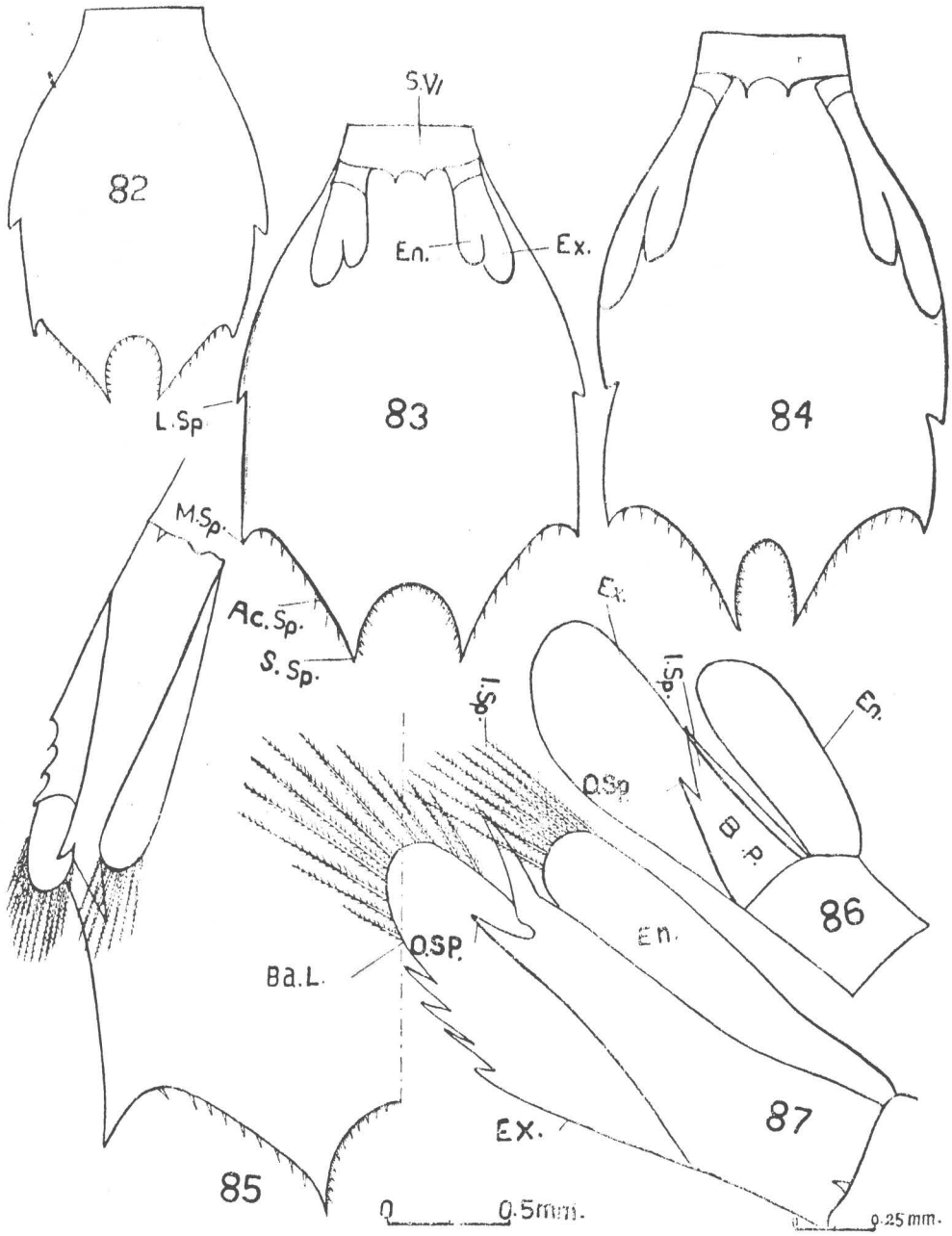


S. massavensis :

Figs. 73 - 76 : Last portion of 2nd maxillipede of 1st - 9th. pelagic stages, respectively.

" 77 - 81 : Telson of 1st - 5th pelagic stages, respectively.

Pl. XI



S. massavensis :

Figs 82 - 84 : Telson of 6th - 8th pelagic stages, respectively, (Rudimentary uropods).
" 85 : Half Telson of 9th pelagic stage. " " "
" 86 : Uropod of 8th " " (Basipodial process distinguished, exopodite and endopodite non-setose).
" 87 : Uropod of 9th pelagic stage (Spines on outer surface of exopodite present)

8. On the middle region of the telson there is a keel ending with a short spine.

9. A short spine is found under the lateral spine of the telson.

1st. Pelagic stage (fig. I., Pl. I):

The larva is totally transparent 2.4 mm. in length (rostrum included). The carapace is produced into a long ventrally smooth rostrum, exceeding the end of the antennular flagella. The antennular somite is provided with a ventral short spine which is absent from the occular. On each side of the frontal region of the carapace there is a fronto-lateral spine, a short distance below which there is a shorter ventro-lateral one. On the carapace, there are 3 lateral accessory spines on the posterior 1/3; 2 long spines at the bases of which are 2 ventral short ones on the postero-lateral angles. On the posterior part of the carapace there is a middle dorsal spine, directed upwards and backwards on the posterior part. The eyes are long-stalked. The antennular peduncle (fig. 12, Pl. IV) is 3 - jointed with an outer and a longer inner unsegmented flagellum on the apical joint. The outer flagellum is narrower at the apex and produced into a long apical, and has a long outer and 4 inner setae. The inner flagellum is provided with 2 apical short, 2 outer, (one long and one short) and one inner long setae. The endopod of the antenna (fig. 30, Pl. VI) is absent and the scale is oval and broad with 6 apical plumose setae. The molar and incisor processes of the mandible (fig. 39, Pl. VII) are distinguishable, each with 4 apical spines, those on the molar are shorter. 8 short buds with an apical long plumose seta represent the endopod of the maxillule (fig. 48, Pl. VII). The coxa has 4 apical short spines while the basis has a middle long plumose seta, an outer and an inner short ones. The protopodite of the maxilla (fig. 21, Pl. V) is neither segmented nor lobed and has 4 setae.

The propodus of the 1st. maxillipede (fig. 57, Pl. VIII) is longer than broad and ends in a pointed tip against which is reflected the dactylus. A short epipodite is found on the base of the maxillipede. The dactylus of the 2nd maxillipede (fig. 73, Pl. X) is reflected against the propodus giving the appendage the shape of the raptorial claw. There are 2 basal and a number of shorter spines on the inner surface of the propodus. Meropodial mero-ischial articulation is terminal. A long basal epipodite is distinct. The 6th. abdominal somite is fused with the telson, 4 pairs of pleopods are present on the 1st. four somites. An index interna is distinct on the endopod.

The telson (including the 6th abdominal somite) (fig. 77, Pl. X) is longer than broad, with 3 main spines on each side; lateral, intermediate

and submedian. Between the latter two spines are 5 small accessory ones, and between the two submedian there are 6+6 spinules.

2nd. Pelagic Stage (fig. 2, Pl. I) :

The larva is 3.3 mm. in length. The carapace increases both in breadth and length, and the postero-lateral spines increase in length. The eyes are large and longer than the stalks. The outer flagellum of the antennule (fig. 13, Pl. IV) thins out towards the tip acquiring 2 apical long and 2+2 inner setae; the inner flagellum is long with a long apical, an inner long, and an outer short setae. The exopod of the antenna (fig. 31, Pl. VI) is provided with 11 plumose setae. The mandible (fig. 40, Pl. VII) increases both in length and breadth. The endopod of the maxillule (fig. 49, Pl. VII) grows in length and the apical plumose seta gets longer than in the 1st. stage. The protopod of the maxilla (fig. 22, Pl. V) is provided with 6 setae. The propodus of the 1st. maxillipede (fig. 58, Pl. VIII) is produced into 4 dorsal and 2 ventral simple setae. The ischium of the 2nd. maxillipede is shorter than the merus. There are papillae on the thoracic segments 3-5, representing maxillipedes 3-5. The 6-8 segments have no papillae, the carapace covers only as far as half of the 6th. thoracic segment. Abdomen and telson (fig. 78, Pl. X) are the same as in the 1st. stage.

3rd. Pelagic stage (fig. 3, Pl. I) :

The larva is 4 mm. in length. The short spines on the lateral surfaces of the carapace become ventral. The inner flagellum of the antennule (fig. 14, Pl. IV) is produced into one long and one short apical, 3 outer (2 at the base) and inner simple setae. The outer flagellum has an apical segment — with an apical and an inner setae — separated from the basal one, which has 6 inner setae and will probably be the apical region of the future middle flagellum.

Endopod of the antenna (fig. 32, Pl. VI) is not distinct, exopod is provided with 10-13 plumose setae. Mandible (fig. 41, Pl. VII) is the same as in the 2nd. stage. Coxa of maxillule (fig. 50, Pl. VII) has 3 apical spines, and the propodus of the maxilla (fig. 23, Pl. V) has 3 setae. There are 3 long setae on the dorsal surface of the propodus of the 1st maxillipede (fig. 59, Pl. VIII) and 3 short ones on the ventral surface. Second maxillipede (fig. 74, Pl. X) remains the same as in the 2nd. stage. The 5th. pleopod is rudimentary, biramous, but non-setose. Between the submedian spines of the telson (fig. 79, Pl. X) there are 7+7 spinules and between the intermediate and submedian spines there are 5 accessory ones.

4th. Pelagic stage (fig. 4, Pl. I) :

Length is 5.1 mm. There are 2 ventral accessory spines on each side of the posterior half of the carapace instead of 3 in the 3rd. stage. The outer flagellum of the antennule (fig. 15, Pl. IV) which can now be differentiated from the middle, though not yet separated, is provided with 5 long apical and inner setae. The middle has an apical segment with 3 apical setae, the outermost of which being the longest. On the intersegmental region, there are two inner short setae. The inner flagellum is long and acquires a 2nd. short segment with an outer long and an inner short apical setae. At the base of the inner flagellum, there is an inner long in addition to 3 inner short setae. A very minute papilla represents the future endopod of the antenna (fig. 33, Pl. VI), the exopod is provided with 11-15 plumose setae. The incisor process of the mandible (fig. 42, Pl. VII) is produced into 5 long teeth and the molar into 4 broad and short ones. Maxillule (fig. 51, Pl. VII) does not differ from that of 3rd. stage. The protopodite of the maxilla (fig. 24, Pl. V) is provided with 1+1+1+1 setae. The hand of the 1st. maxillipede (fig. 60, Pl. VIII) is more setose than before. The 2nd. maxillipede (fig. 75, Pl. X) is as in the 3rd. stage. The 5th. pair of pleopods is setose and shorter than the other pleopods. Between the intermediate and submedian spines of the telson (fig. 80, Pl. X) there are 9 short accessory spines, and between the two submedian spines there are 8+8 spinules.

5th. Pelagic stage (fig. 5, Pl. I) :

The larva is 6.7 mm. in length. The middle flagellum of the antennule (fig. 16, Pl. IV) is long with a long apical seta, while the outer is provided with 2 apical and 2 inner long setae, and the inner is 3-segmented with 7 setae. The exopod of the antenna (fig. 34, Pl. VI) is provided with 12-17 plumose setae. The mandible (fig. 43, Pl. VII) does not change from before. At the base of the apical plumose seta of the maxillular endopod (fig. 52, Pl. VII) there is a hair on the outer side. Coxa is provided with 5 short spines while the basis remains as before. Maxilla, 1st., 2nd. maxillipedes, and abdomen do not differ from the 4th. stage. Between the submedian spines there are 10+10 spinules.

6th. Pelagic Stage (fig. 6, Pl. I) :

The larva is 7.8 mm. in length. An additional accessory spine appears on the antero-lateral region of the carapace, while postero-lateral spine increases in length. The middle antennular flagellum (fig. 17, Pl. IV) acquires a 3rd. segment. The apical segment is provided with a long seta, and the outer flagellum with 4 long broad inner setae. The

inner flagellum is long and 4-jointed, the basal joint being the largest. The antennal endopod (fig. 35, Pl. VI) is still unjointed, reaching the base of the exopod which is provided with 17 plumose setae. The exopod acquires a basal joint. The incisor process (fig. 44, Pl. VII) is produced into 7 apical teeth, while the molar is a hard roundish plate, without teeth or ridges. The maxillular coxa (fig. 53, Pl. VII) has 5 apical spines and the basis a long apical plumose and a short outer setae, the inner short seta of the early stages is lost. Three lobules of the maxilla (fig. 26, Pl. V) are distinct with 2+3+2 apical setae.

1st. and 2nd. maxillipedes are as in the 5th. stage, but the 3rd.-5th. maxillipedes are more conspicuous; and the 6th.-8th. limbs are rudimentary. The 6th. abdominal somite is partially separated from the telson. Between the intermediate and submedian spines of the telson (fig. 82, Pl. XI) there are 8 short ones on each side. The region between the two submedian spines becomes narrower, and the concavity increases.

7th. Pelagic stage (fig. 7, Pl. II) :

The larva is 9.8 mm. in length. Below the fronto-lateral spine of the carapace there are 4 minute accessory ventral ones. Posteriorly the lateral surface of the carapace is provided with 4 ventral short accessory spines and a 5th. at the base of the postero-lateral spine. The postero-lateral spines increase greatly in length. The rostrum is long and still smooth ventrally. The outer flagellum of the antennule (fig. 18, Pl. V) has 2+2+2+2+2+2 setae. The middle flagellum is longer and has a basal short segment, the 4th. segment is provided with an apical long seta. The inner flagellum is long 5-jointed and has 7 apical, and inner setae, the apical is the longest. A 2nd. narrow apical segment is acquired by the antennal endopod (fig. 36, Pl. VI). The exopod is broad and provided with 21 plumose setae. The incisor process (fig. 45, Pl. VII) is provided with 10 teeth. The coxopod of the maxillule (fig. 54, Pl. VII) increases greatly in breadth and is provided with 8 apical spines. The protopodite of the maxilla (fig. 27, Pl. V) is divided into 4 segments : the 1st. is non-setose, the 2nd. has one and the 3rd. 2, and the 4th. 5 setae. One seta is present on the inter-segmental region between the 2nd. and 3rd. segments. 1st. and 2nd. maxillipedes are as in the previous stage, but the hand of the 1st. is more setose. The endopod in each of the 3rd.-5th. maxillipedes (fig. 66, Pl. IX) is 6-segmented, and the exopod is absent. The apical segment of the endopod is short, pointed and not reflected against the penultimate joint. The legs become biramous, but the rami are short and non-setose. The 6th. abdominal somite is totally separated from the telson. The pleurae of the segments have postero-lateral ridges. The 5th. pair of pleopods are longer and

more setose than in the 6th. stage. The 6th. abdominal somite has two short postero-median spines, extending over the basal portion of the telson. The uropods (fig. 83, Pl. XI) are rudimentary with short non-setose exopod and endopod and, between the two submedian there are 10+10 spinules, secondary ones are also found in between.

8th. Pelagic stage (fig. 8, Pl. II) :

The larva is 11 mm. in length. The 1st. thoracic somites are not covered by the carapace. The 7-segmented antennular inner flagellum (fig. 19, Pl. V) has a seta on the apical segment. The outer flagellum has 2+2+2+2 inner and apical setae and is not totally separated from the middle which has a long seta on the apex of the 5th. segment. The endopod of the antenna (fig. 37, Pl. VI) is 3-jointed, the middle joint being the shortest and the apical the longest. The exopod is provided with 29 plumose setae. The incisor process (fig. 46, Pl. VII) is produced into 8 teeth. The coxa of the maxillule (fig. 55, Pl. VII) is provided with 9 apical spines. The 2nd. segment of the maxillar protopodite (fig. 28, Pl. V) is the longest. The 4 segments are provided with 4+8+4+4 setae. There is a hook on the basal segment of the 2nd. maxillipede. The dactylus in each of the 3rd.-5th. maxillipedes (fig. 67, Pl. IX) is pointed and somewhat bent against the propodus. The exopods of the legs are longer than the endopods. A bud on the base of the exopod of the pleopod, that represents the begining of the formation oft he branchial organ, can now be distinguished. The exopod and endopod of the uropod (fig. 86, Pl. XI) are non-setose and longer than in the 7th. stage. The basipodial process is developed with an outer short and an inner long spines. The spinular formula is 11+11, a number of secondary spinules is found between the primary ones.

9th. Pelagic Stage (fig. 9, Pl. II) :

The length is 17.4 mms. The rostrum is shorter, and the last 3 thoracic segments are not covered by the carapace. The inner antennular flagellum (fig. 20, Pl. V) is very long, and multi-segmented with a great number of minute inner hairs. The apical segment is produced into a short apical spine. The middle flagellum is 9-segmented and spineless, but the inner surface is covered with minute hairs. The outer flagellum is long with 4+2+2+2+2+2 inner setae. The antennular endopod (fig. 38, Pl. VI) is 7-jointed, but not reaching the tip of the exopod. The incisor process of the mandible (fig. 47, Pl. VII) is produced into 7 teeth. The coxa of the maxillule (fig. 56, Pl. VII) is twice as broad as the basis, provided with 12 apical spines. Maxilla, 1st. and 2nd. maxillipedes do not differ in structure from the 8th. stage. The dactylus

in each of the 3rd.-5th. maxillipedes (fig. 68, Pl. IX) is totally reflected against the propodus. It has a smooth inner surface, while the propodus carries 4 spines and a number of short setae. The propodus of each maxillipede is longer than broad. On the carpus there are two spines. The 5 pairs of maxillipedes possess epipodites. The exopod of the leg (fig. 70, Pl. IX) is 2-jointed. The 5 pairs of pleopods (fig. 72, Pl. IX) are branchiate. The branchial organ becomes 4-branched. Exopod and endopod of the pleopod are 2-jointed. Carinae are not obvious, but two lateral lines are distinguished. Telson (fig. 85, Pl. XI) and uropods (fig. 87, Pl. XI) are well formed. The exopod is provided with 4 spines on its basal half and has a setose lobe at the apex having 10-15 plumose setae. The outer spine of the basipodial process increases in length but is shorter than the inner spine. At the base of the last spine there is an outer short ridge indicating the origin of a future spine. The endopod is shorter than the exopod with 7 plumose setae. The telson is longer than broad. On the dorsal surface of the basipodite there is a short dorsal spine.

SQUILLA SP.

All the stages of this species were procured from the plankton. Unfortunately, specific identification was not possible as so far we have not been able to obtain the post-larval stage. However, this species is included for comparison with the other two species.

1st. Pelagic Stage (fig. I Pl. XII) :

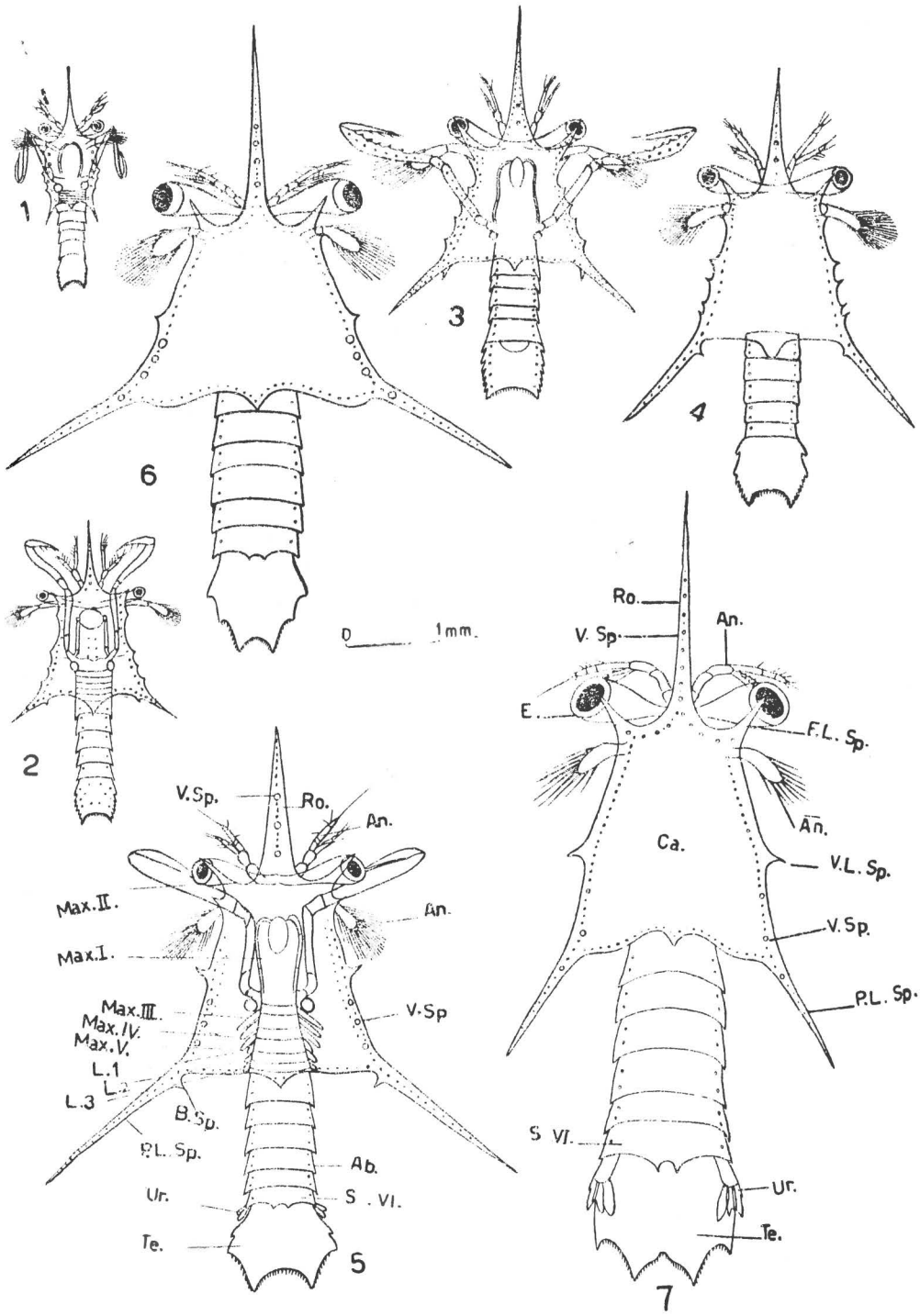
The larva is 2.3 mms. in length (rostrum included). The pleopods have red bases, the carapace is ornamented with grey pigment along its lateral sides and extends along the dorsal surface of the rostrum, maxillipedes II, and abdomen. The rostrum extends beyond the length of the antennular flagella. There are neither antennular nor occular ventral spine. The two antero-lateral spines are present, under each of which there is a small lateral ridge or accessory spine. The postero-lateral spines are long and have 2 ventral spinules on their basal half. The lateral surface of the posterior half of the carapace is provided with 3 lateral accessory spines. Eyes are large with conspicuous stalks shorter than themselves. The 2nd. joint of the two-jointed inner antennular flagellum (fig. 8, Pl. XIII) is narrower and shorter, and provided with a long apical seta. On the inter-segmental region from the outer side there is a long seta. The outer flagellum is little shorter than the inner, unsegmented and provided with 2 apical long and 2 inner short setae.

The exopod of the antenna (fig. 15, Pl. XIV) is produced into 8 plumose setae. The incisor process has 3 apical spines while the molar has 4; a deep gap is found between the two processes. Maxillular endopod (fig. 29, Pl. XV) is short with an apical plumose seta. The coxa is broader than the basis and provided with 3 apical spines. The basis has an apical middle long plumose seta on each side of which is a short one. The maxillar protopodite (fig. 36, Pl. XV) is not lobed and is produced into 7 setae. The dactylus of the 1st. maxillipede (fig. 43, Pl. XVI) is claw shaped and reflected against the pointed tip of the propodus which is provided with 5-8 setae. An epipodite is present. The dactylus of the 2nd. maxillipede (fig. 50, Pl. XVI) forms the raptorial claw with the propodus. The inner surfaces of both the dactylus and propodus are provided with minute ridges. A large epipodite is present at the base of the appendage. All the thoracic segments are obvious, and covered by, but free from, the carapace. Antennular and occular segments are distinct and are movable against each other. The 6th. abdominal somite is fused with the telson. The pleurae of the somites have postero-lateral minute ridges. The fifth pair of pleopods is absent. The index interna on the endopod is distinct. The telson with the fused 6th. abdominal somite is longer than broad, with a slightly concave posterior edge, and 6 equal spines on each side, and 2 long postero-lateral spines 6+6 minute spinules, in between.

2nd. Pelagic Stage (fig. 2, Pl. XII) :

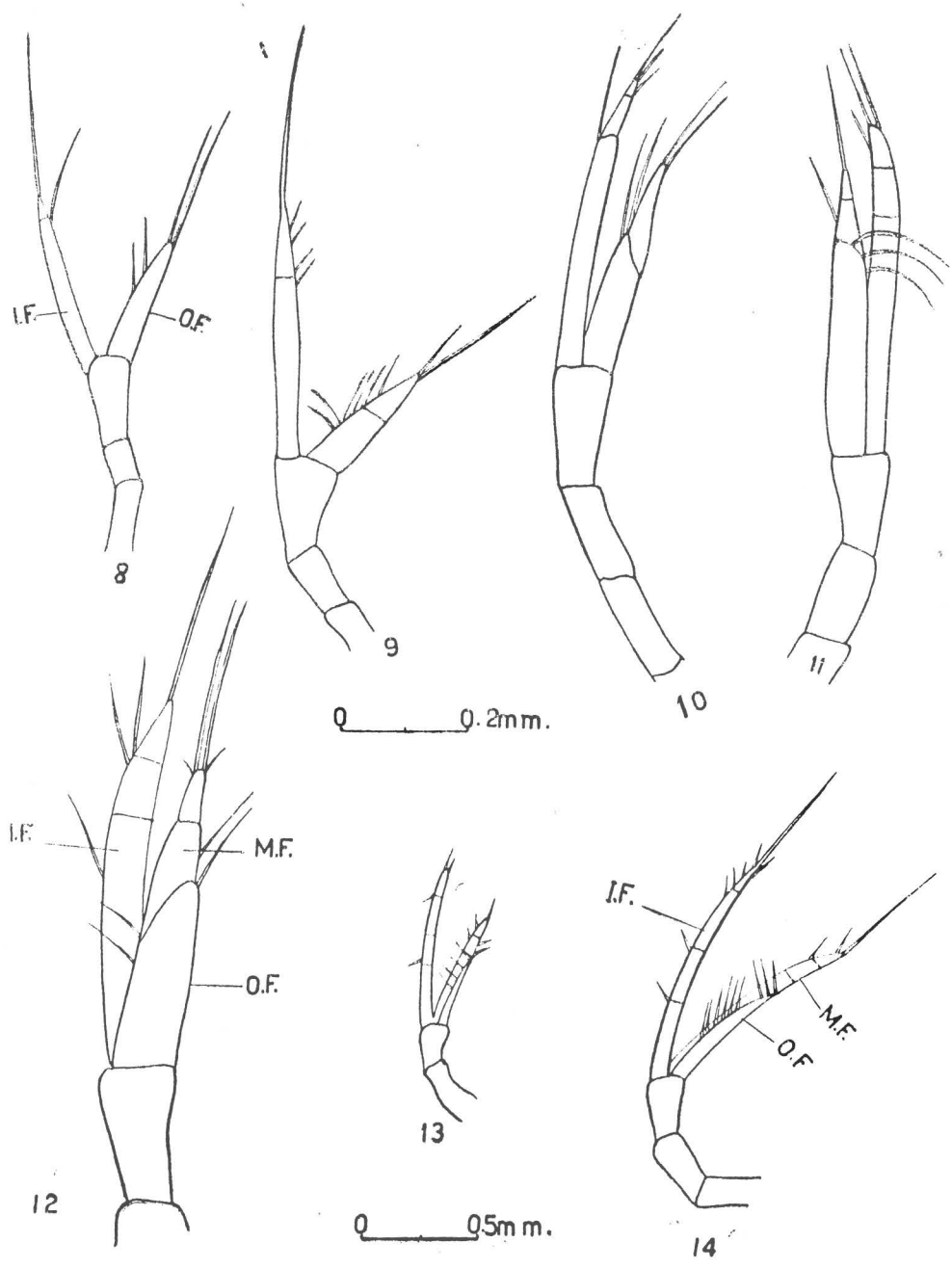
The larva is 3.3 mm. in length. The apical segment of the inner antennular flagellum (fig. 9, Pl. XIII) is provided with a long apical seta, and there are 2+2 short setae on the outer surface a short distance below. The outer flagellum acquires another segment at the apex. The apical joint — the future apical portion of the middle flagellum — is provided with two apical setae. On the inner surface of this joint there are two inner setae. The inner surface of the basal joint is provided with 2+2 inner setae. The antennal scale (fig. 16, Pl. XIV) is produced into 13 plumose setae. The molar process (fig. 23, Pl. XV) is shorter than the incisor, each carries 4 apical spines. The maxillular basis (fig. 30, Pl. XV) has two outer long and an inner short setae, the middle is plumose. The maxillar protopodite (fig. 37, Pl. XV) is produced into 7 setae. The propodus of the 1st. maxillipede (fig. 44, Pl. XVI) is longer than broad, with 5 dorsal and 4 ventral setae. On the inner surface of the propodus of the 2nd. maxillipede (fig. 51, Pl. XVI) there are two long basal outer spines, the outermost is the longest. The portion of the propodus under the dactylus is provided with 8 minute ridges. The inner surface of the dactylus is produced into a number of minute ridges.

Pl. XII



Squilla sp.

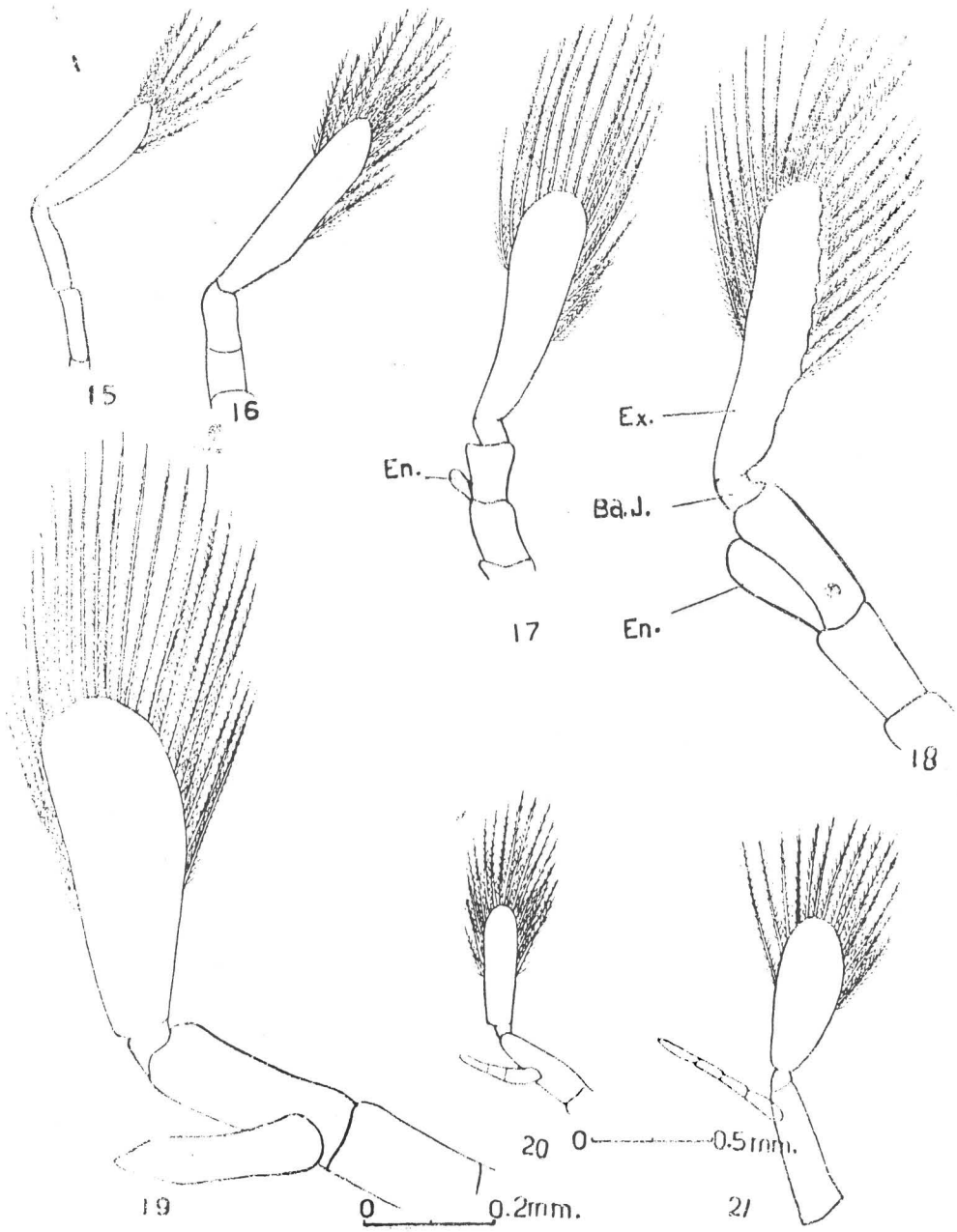
Figs. 1 - 7 : 1st. - 7th. pelagic stages, respectively.



Squilla : sp.

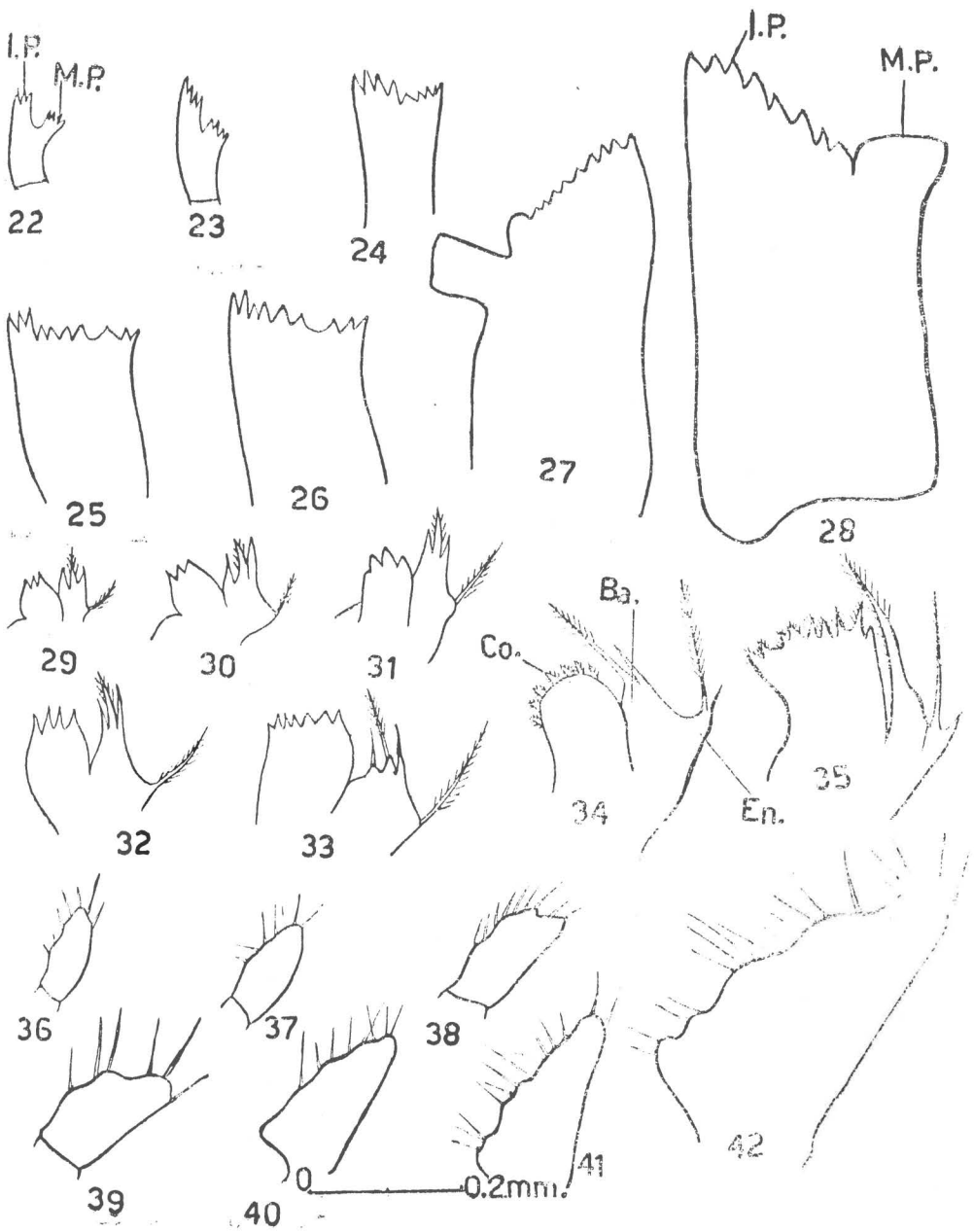
Figs. 8 - 14 : Antennule of 1st. - 7th. pelagic stages, respectively.

Pl. XIV



Squilla sp. :

figs. 15–21 : Antenna of 1st.–7th. pelagic stages, respectively (Rudimentary endopod).



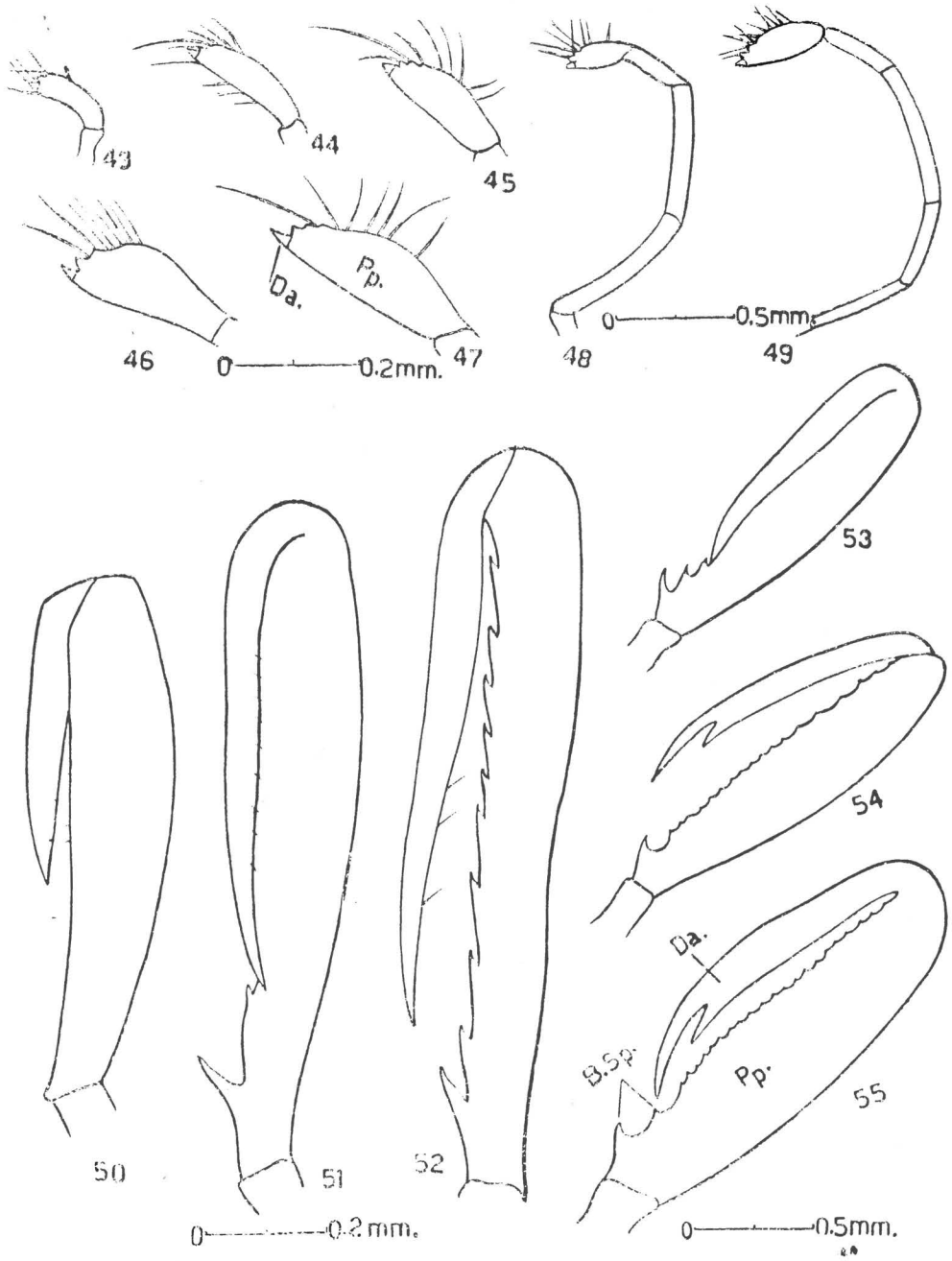
Squilla sp. :

Figs. 22 - 28 : Mandible of 1st. - 7th. pelagic stages, respectively.

" 29 - 35 : Maxillule of 1st. - 7th. pelagic stages, respectively.

" 36 - 42 : Maxilla of 1st. - 7th. pelagic stages, respectively.

Pl. XVI

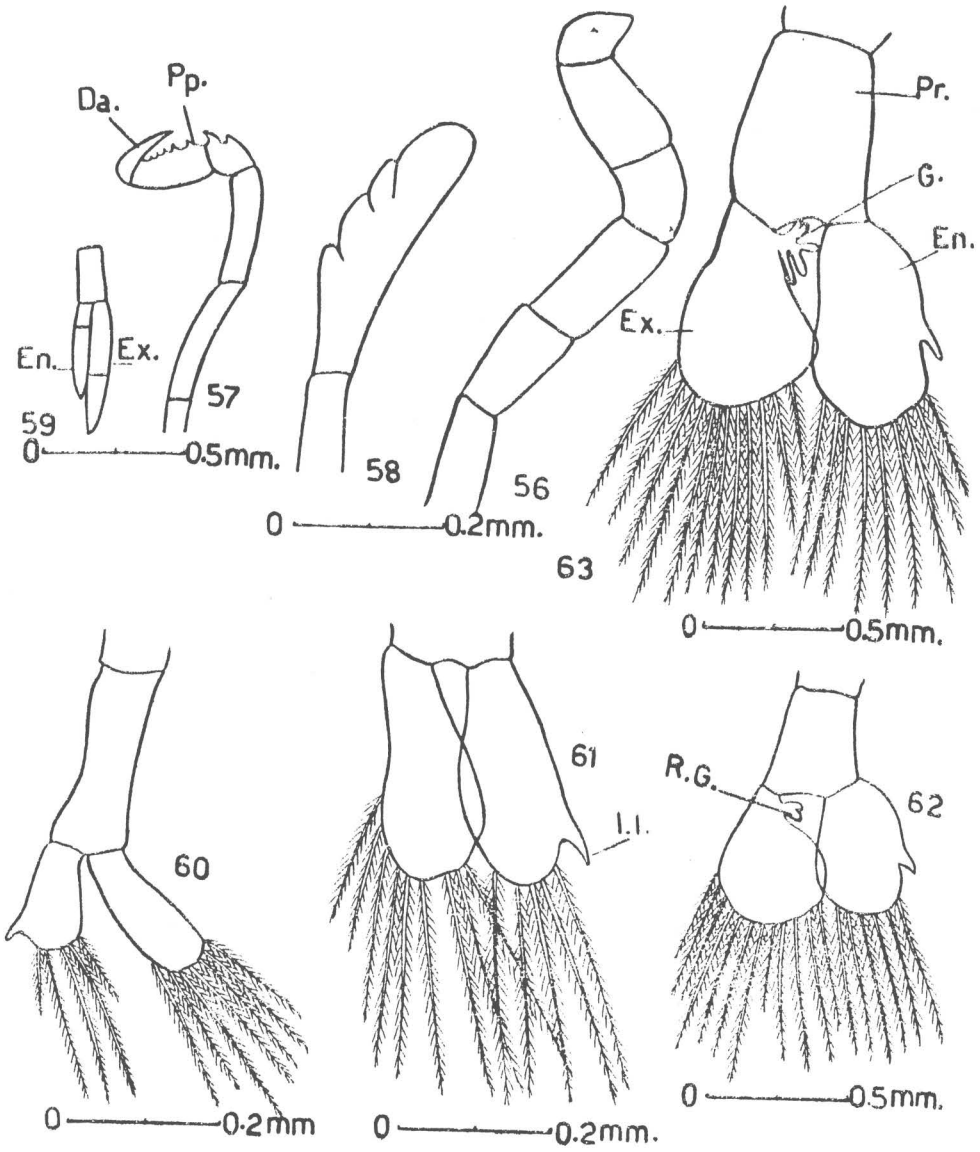


Squilla sp. :

Figs. 43 - 47 : Last portion of 1st. maxillipede of 1st. - 5th. pelagic stages, respectively.

" 48 and 49 : First maxillipede of 6th. and 7th. pelagic stages, respectively

" 50 - 55 : Last portion of 2nd. maxillipede of 1st., 2nd., 3rd., 5th., 6th., and 7th. pelagic stages, respectively.

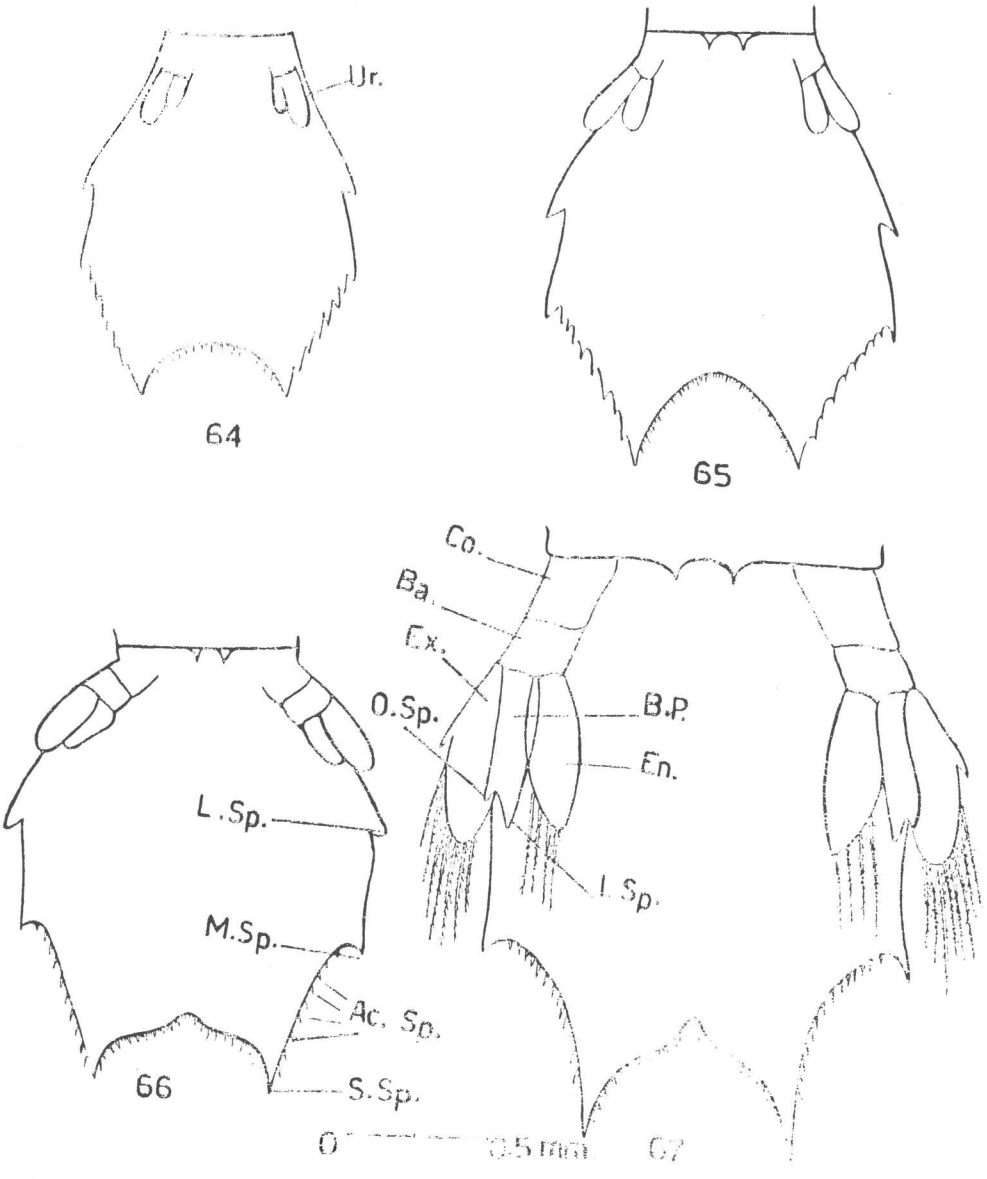


Squilla sp. :

Figs. 56 and 57 : Third maxillipede of 6th. and 7th. plagic stages

" 58 and 59 : First leg of 6th. and 7th. pelagic stages.

" 60 - 63 : Fourth pleoped of 1st. - 7th. pelagic stages, respectively (Rudimentary gill).



Squilla sp. :

Figs. 64 - 67 : Telson of 4th. - 7th. pelagic stages, respectively (Rudimentary uropods).

The abdomen is similar in structure to that of the 1st. stage. On the hind margin of the telson, between the two submedian spines are 8+8 spinules.

3rd. Pelagic stage (fig. 3, Pl. XII) :

The larva is 4 mm. in length. The rostrum gets longer and has two ventral minute spines. The inner antennular flagellum (fig. 10, Pl. XIII) is 3-jointed, the apical joint is the narrowest and smallest and provided with 3 apical and outer setae. On the inner side of the inter-segmental region, between the 1st. and 2nd. joints, there is a longer seta. There are 2 apical setae on the apex of the 2nd. segment of the flagellum, and two inner setae on the inner surface of the basal segment. A rudimentary antennal endopod (fig. 17, Pl. IV) is developed. The gap between the 5-toothed molar and 4-toothed incisor processes (fig. 24, Pl. XV) is narrow. The maxillular basis (fig. 31, Pl. XV) has a long middle plumose seta. The apical plumose seta on the endopod gains in length over the 2nd. stage. The coxa is provided with 3 apical spines. Maxilla, 1st. and 2nd. maxillipides are nearly similar in structure to those of the 2nd. stage. Maxillipedes 3-5 and 6th.-8th. thoracic appendages are rudimentary. The 5th. pleopod is rudimentary and non-setose. The telson is still the same as in the 2nd stage.

4th. Pelagic Stage (fig. 4, Pl. XII) :

Length is 4.5 mm. The 2-segmented middle flagellum of the antennule (fig. 11, Pl. XIII) is partially separated from the outer and has one apical and one outer long seta. The outer flagellum is 3-jointed with 2 apical and one outer short setae on the last segment. The antennal endopod (fig. 18, Pl. XIV) is unsegmented but has become longer and the exopod has developed a basal joint and 20-25 plumose setae. The incisor process (fig. 25, Pl. XV) has 7 spines of which the inner 3 are the largest, and the molar process is provided with 3 shorter spines. The maxillular coxa (fig. 32, Pl. XV) is broader and larger than the basis. The former is provided with 4 apical spines. Maxilla, 1st. and 2nd. maxillipedes do not differ from those of the 3rd. stage. The 5th. pleopod becomes setose but is shorter than the others. Two posterior middle spines are found on the hind region of the 6th. abdominal somite, which is partially separated from the telson. The uropods are rudimentary (fig. 64, Pl. XVIII) biramous appendages in which the exopod is longer than the endopod and both are non-setose. The spines on the sides of the telson are differentiated also into, lateral, intermediate, and submedian, with 6 accessory spines on each side of the telson between

the intermediate and submedian spines. 9+9 spinules—with still shorter ones in between — lie between the submedian spines.

5th. Pelagic Stage (fig. 5, Pl. XII) :

The larva is 5.7 mm. in length. The rostrum gains both in length and breadth, with 3 ventral spines and 5 accessory ventro-lateral ones. The outer antennular flagellum (fig. 12, Pl. XIII) is unsegmented with one apical and two inner setae. The middle is 2-segmented, the apical segment being produced into 2 long apical setae+2 hairs. The inner flagellum is 3-segmented with an apical and 3 inner setae. The antennal endopod (fig. 19, Pl. XIV) is unsegmented.

The mandibular incisor process (fig. 26, Pl. XV) has 6 apical spines while the molar is provided with 3. The maxillular coxa (fig. 33, Pl. XV) which is longer and broader than the basis, has 7 apical spines, otherwise similar to the 4th. stage. Maxilla, 1st. and 2nd. maxillipedes do not differ in structure from those of the 4th stage. Each of the 3rd. to 5th. maxillipedes has a 5-jointed stem. The legs increase in length but still uniramous. The 6th. abdominal somite separates totally from the telson, which (fig. 65, Pl. XVIII) is nearly as broad as long. Between the intermediate and submedian spines there are 8 accessory ones. The hind edge of the telson is provided with 9+9 spinules, secondary ones are also found.

6th. Peagic Stage (fig. 6, Pl. XII) :

The larva is 6.5 mm. in length. The long rostrum is produced into 4 ventral spines. On the lateral surface of the carapace spines are the same as in the 5th. stage. The outer and middle antennular flagella (fig. 13, Pl. XIII) are fused at their bases. The outer is provided with 1+1+1+1 inner setae, and the middle is 2-jointed, the 2nd. joint with one apical and one inner setae, and the basal joint is long and provided with an outer and an inner setae near the inter-segmental region. The inner flagellum is 4-jointed; with 2 short apical setae on the 4th. joint, one on the 2nd., and an inner one between the 3rd. and 4th. segments. The antennal endopod (fig. 20, Pl. XIV) is 3-jointed, the 3rd. joint is non-setose; the exopod is produced into 17-20 plumose setae, and the molar process (fig. 27, Pl. XV) is roundish and non-spinous. The maxillular coxa (fig. 34, Pl. XV) is provided with 7 plumose spines, and the basis is produced into an inner long and an outer short setae on its apex. The protopodite of the maxilla (fig. 41, Pl. XV) is produced into 4 lobules (not separated) with 2+4+4+3 setae. The dactylus of the 2nd. maxillipede (fig. 54, Pl. XVI) is provided with two inner apical spines (including that at the tip). Each of the 3rd.-5th. maxillipedes

(fig. 56, Pl. XVII) becomes 6-segmented, with the dactylus slightly bent against the propodus. The legs (fig. 58, Pl. XVII) increase in length but are still uniramous. The inner basal portion of the exopodite are ach pleopod (fig. 62, Pl. XVII) is produced into a bifid bud which represents the origin of the branchial organ. The endopod is provided with 8-10, and the exopod with 12-15 plumose setae. Between the intermediate and submedian spines of the telson (fig. 66, Pl. XVIII) there are 10 accessory ones and between the two submedian spines there are 12+12 spinules between which there are still shorter ones. The exopod and endopod of the uropod are longer than before but non-setose and the basipodial process is rudimentary.

7th. Pelagic Stage (fig. 7, Pl. XII) :

The larva is 8.5 mm. in length. The long and broad rostrum is provided with 8 ventral spines. The postero-lateral spines increase in length reaching the 4th. abdominal somite. The outer antennular flagellum (fig. 14, Pl. XIII) is unsegmented with 3+6 inner setae; the middle is 3-jointed with one apical and two inner setae, the inner flagellum is 4-jointed with 3 apical (the middle the longest) and 5 inner short setae. The antennal endopod (fig. 21, Pl. XIV) is 4-jointed and shorter than the exopod which is produced into 13-17 plumose setae. The incisor process (fig. 28, Pl. XV) is produced into 8 spines. The maxillular coxa (fig. 35, Pl. XV) is produced into 9 apical plumose setae, and is about 3 times longer and broader than the basis, on which there is only one long apical plumose seta. Maxilla, 1st. and 2nd. maxillipedes are as in the 6th. stage. The propodus of each of the 3rd.-5th. maxillipedes (fig. 57, Pl. XVII) is longer than broad with the inner surface thrown into 5 short ridges. The dactylus is reflected against the propodus. On the dorsal surface of the coxa there are two spines. Epipodites are clear on the bases of the first four maxillipedes only. The exopod and endopod of each leg (fig. 59, Pl. XVII) are non-setose, and each is 1-segmented; the former is longer. The uropods of the telson (fig. 67, Pl. XVIII) are completely developed. The exopod is provided with an outer spine and 8-10 plumose setae. The endopod is produced into 4 plumose setae. The basipodial process bifurcates on the apex into an inner long and an outer short spines. Both the endopod and basipodial process are shorter than the exopod. Between the intermediate and submedian spines there are 14 accessory ones, and between the two submedian there are 14+14 primary and a number of secondary spinules.

GONODACTYLUS GLABROUS

(Brooks (fig. 7, Pl. XX) :

This species is common near the Station, living among coral branches, in the crevices between coral rocks and underneath stones. When disturbed they escape with great speed, snapping their raptorial claws in defense. Snapping is accompanied by a characteristic noise and may cause an acute pain or inflict a wound to the intruder. In the breeding season, females are commonly seen carrying their balls of eggs between the 3rd.-5th. maxillipedes. If an individual loses its ball, it will run to and fro in search of it, until it finds it when, it will take the ball and run about with great agility. When hungry, the animal may eat its own eggs. Occasionally the parent stretches the ball from the sides between its maxillipedes, the ball then appears to be elastic. The egg-ball is actually a cup-like structure, made up of two contiguous layers and a narrow opening recalling the shape of a gastrula. The eggs are nearly spherical each 0.80 mm. in diameter, greenish or brownish in colour, becoming transparent, and 0.83 mm. in diameter, when about to hatch.

The eggs hatched into the 1st. stage on 20th. April 1952 and on the 22nd. the 2nd. stage was given, that changed into the 3rd. on 26th. On 2nd. May the 4th. stage was obtained, which gave the 5th. stage on 10th. May. The 6th. stage was obtained from a 5th. from the plankton.

1st. Propelagic Stage (fig. 1, Pl. XIX) :

As mentioned by Gurney (1937 b), the larva moults before hatching. It is 2.5 mm. in length, transparent with a large yellowish or greenish mass of yolk, occupying a large proportion of the head and thorax. The carapace is longer than broad, produced into a short rostrum in front, reaching up to the end of the 1st. segment of the antennular peduncle. The lateral surfaces of the carapace are smooth, without spines or ridges, but the postero-lateral angles are produced into two short spines. There is also a median posterior spine. The eyes are large and sessile. The antennular peduncle is 3-jointed, the apical joint giving rise to an unsegmented outer flagellum with two inner short hairs, and a longer and more slender inner flagellum with a distinct apical short segment, and an apical long, an outer, and an inner short setae. The antennal scale is broad and oval with about 7 plumose setae. Mandible, maxillule, and maxilla are rudimentary as the larva does not feed freely. The 1st. maxillipede (Fig. 31, Pl. XXII) is 5-segmented, with a non-setose apical segment. An epipodite is found at the base of the 2nd. maxillipede.

The dactylus (Fig. 13, Pl. XXI) is bent inwards but not reflected against the propodus. The 3rd. - 5th. thoracic somites carry papillae representing the 3rd. to 5th. maxillipedes. The 6th.-8th. somites are without such papillae. The 6th. abdominal somite is fused with the telson. The somites are produced into postero-lateral ridges. Pleopods are well developed in this stage, 5 pairs are distinguished on the 1st. to 5th. somite, with 4 - 6 plumose setae on the exopod and 4 on the endopodite of each pleopod.

The telson (Fig. 45, Pl. XXIII) is longer than broad with 3 pairs of lateral spines. On the postero-lateral angles there are two spines with 12+12 shorter spines in between.

2nd. Propelgic Stage (Fig. 2, Pl. XIX) :

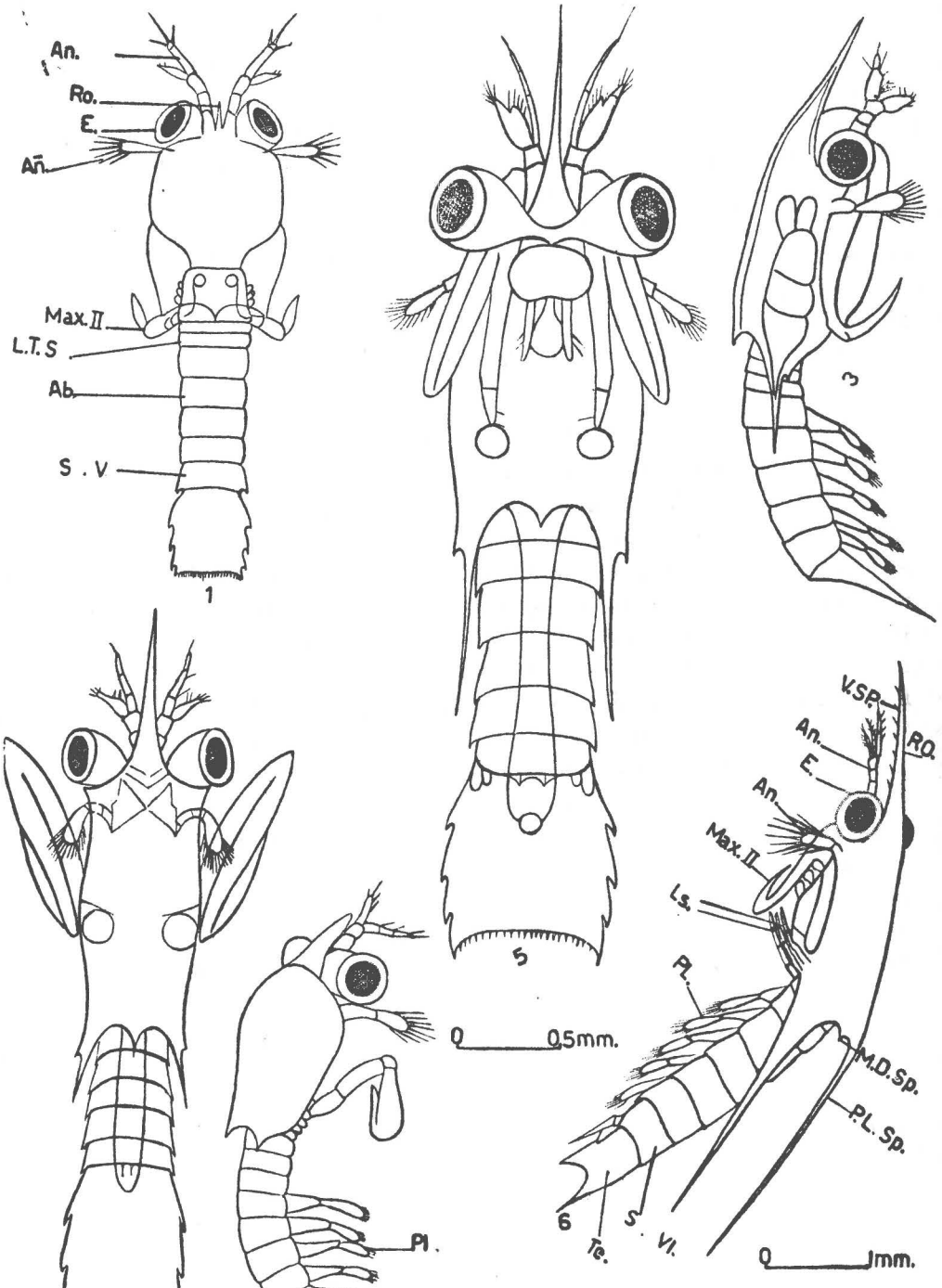
The larva is 2.9 mm. long. The mass of yolk on the head and thorax is partly consumed. Rostrum increases in length, reaching the end of the antennular peduncle. The middle, posterior and postero-lateral spines are larger than in the 1st. stage, a minute supra-orbitral spine can be distinguished. The eyes acquire short stalks. The outer antennular flagellum is provided with more setae and the inner — which is 3-segmented — has 3 short outer and one long apical setae. The antennal scale (Fig. 37, Pl. XXIII) has 10-14 setae, the endopod is absent, and the mandible is still rudimentary.

Neither the exopod nor the endopod of the maxillule (Fig. 21, Pl. XXII) are devloped. The protopodite is thrown into two lobes, the coxa is provided with 3 papillae and a spine on its apex. The basis is produced into 3 papillae and a spine. The maxillar protopodite (Fig. 26, Pl. XXII) is unsegmented and provided with 2+2+2+2 setae on 4 lobules. The ultimate segment of the 1st. maxillipede (Fig. 32, Pl. XXII) is cleft. The dactylus of the 2nd. maxillipede (Fig. 13, Pl. XXI) is reflected against the propodus and both have smooth inner surfaces. The 6th. abdominal somite is still fused with the telson, which shows no change. Pleopods are more setose than in the 1st. stage.

3rd. Propelagic Stage (Fig. 3, Pl. XIX) :

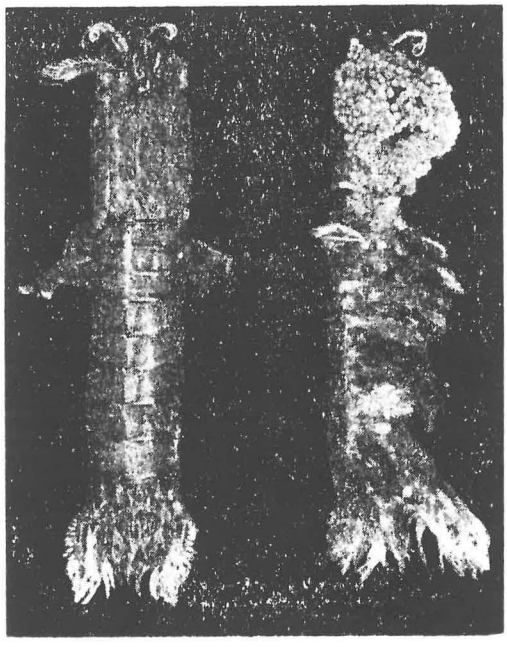
This is still a propelagic stage as opposed to Gurney's view (1957 b). What Gurney obtained was the 4th. and not the 3rd. stage. The larva is 3.5 mm. in length. The mass of yolk is still present but more reduced. The rostrum gains in length reaching the end of the inner antennular flagellum. The postero-lateral spines increase in length, and each is provided with a minute ventral spine on its base. The stalk of the eye

Pl. XIX



G. glabrous :

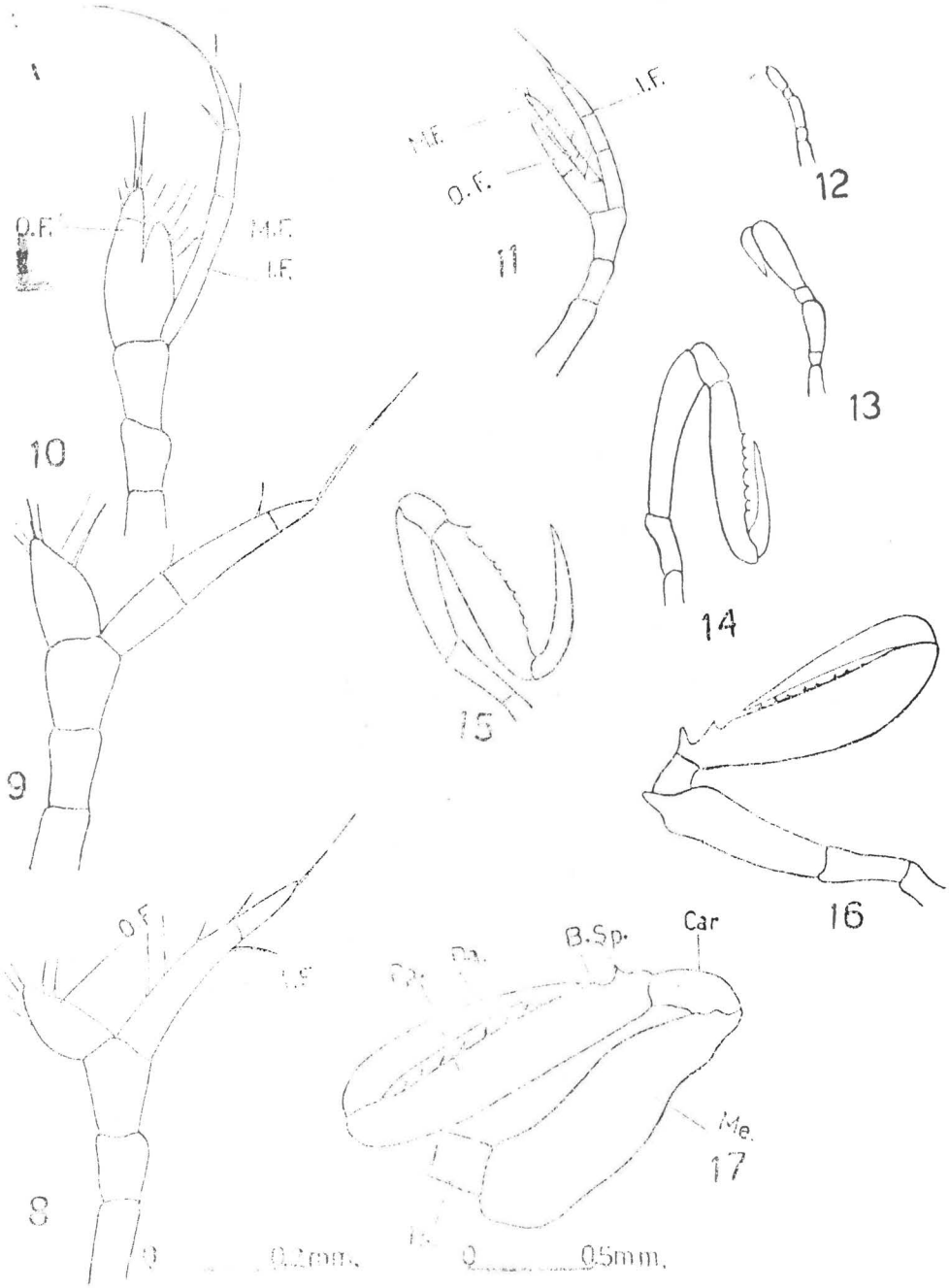
Figs. 1 - 6 : 1st. - 6th. larval stages, respectively.



G. glabrous :

Fig. 7 : (*a*) - Photo. of adult male X 1.25, dorsal view.

(*b*) . « « ovigerous female « X 1.25, ventral view (egg mass between maxillipedes).

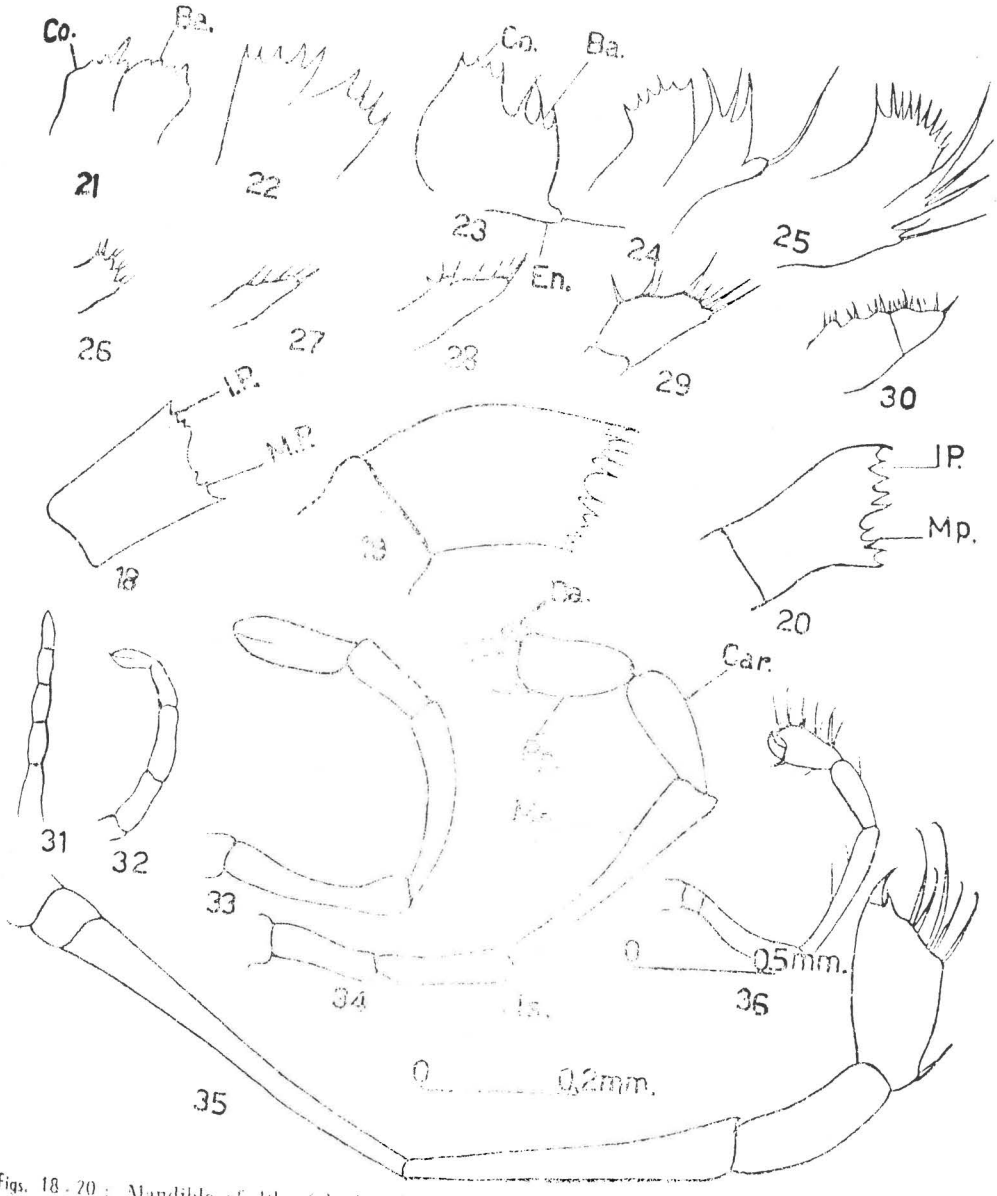


G. glabrous :

Figs. 8 - 11 : Antennule of 3rd. - 6th. larval stages, respectively (Segmented outer flagellum)

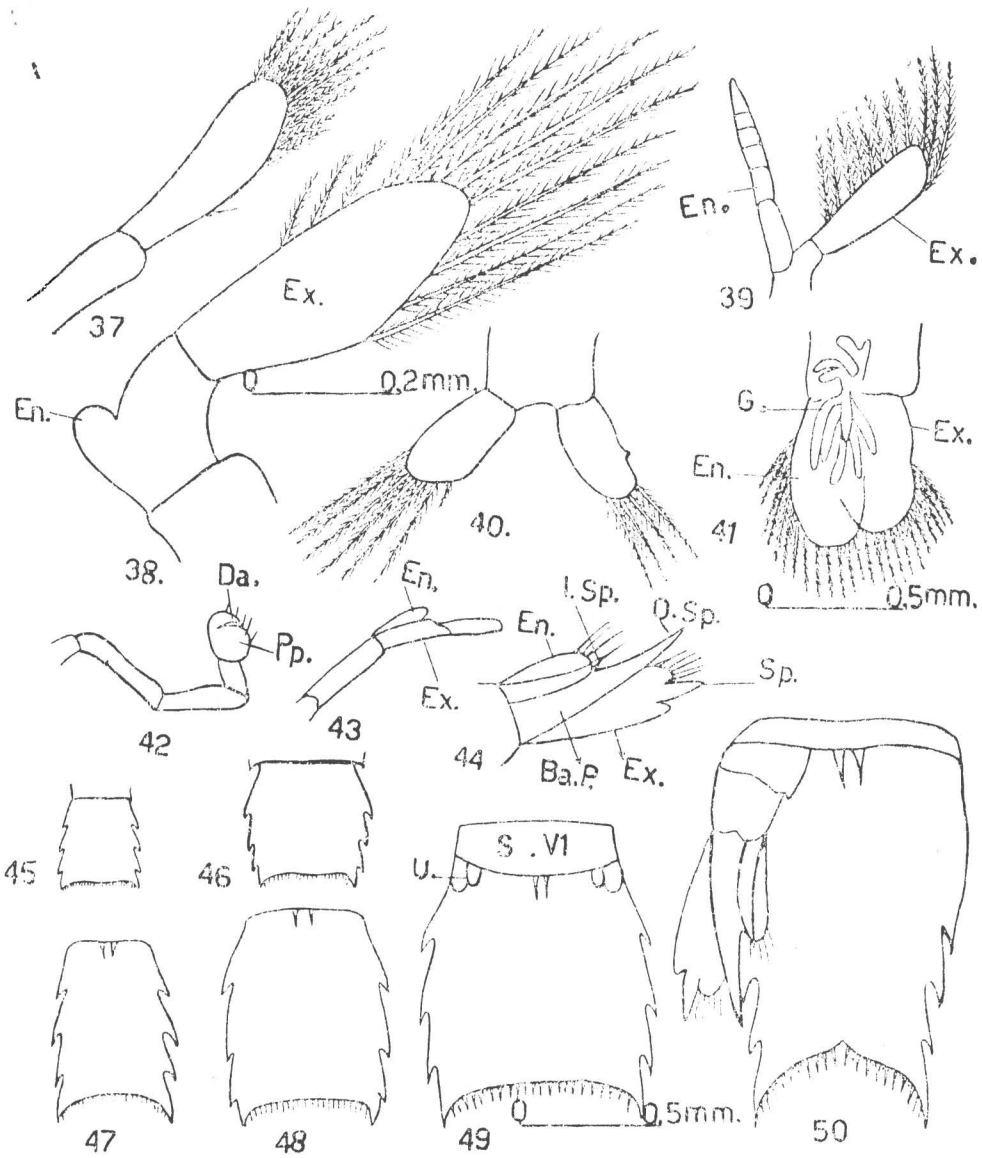
" 12 : Second maxilliped of 1st. larval stage (Dactylus not reflected against protopodite).

13-17 : ♂ . 2nd. - 6th. larval stages, respectively (Merus swollen at the base and ischium united to inner surface of merus).



Figs. 18 - 20 : Mandible of 4th. - 6th. larval stages, respectively.
" 21 - 25 : Maxillule of 2nd. - 6th. larval stages, respectively. (Endopod developed).
" 26 - 30 : Maxilla of 2nd. - 6th. larval stages, respectively.
" 31 - 36 : First maxillipede of 1st - 6th. larval stages, respectively.

Pl. XXIII



G. glabrous :

Figs. 37 - 39 : Antenna of 2nd., 5th. and 6th. larval stages, respectively.
" 40 and 41 : Third pleoped of 2nd. and 6th. larval stages.
" 41 : " " " 6th.
" 42 : Third maxillipede of 6th. larval stage.
" 43 : First leg of 6th. larval stage.
" 44 : Uropod of 6th. larval stage (Outer spine of basipodial process longer than inner).
" 45 - 50 : Telson of 1st. - 6th. larval stages respectively (Rudimentary uropod).

gets longer. The inner antennular flagellum (Fig. 8, Pl. XXI) is 3-jointed with an apical long, an inner and four outer setae. The outer flagellum is unsegmented with 6 apical, outer and inner setae. The antennal scale is provided with 12-15 plumose setae. The mandible is still rudimentary. The maxillular coxa (Fig. 22, Pl. XXII) carries 5 and the basis 4 apical spines. The maxillar protopodite (Fig. 27, Pl. XXII) is unsegmented with 5 setae; the lobules of the 2nd. stage are no longer distinguishable. First maxillipede (Fig. 33, Pl. XXII) is similar to that of the 2nd. stage. The inner surface of the dactylus of the 2nd. maxillipede (Fig. 14, Pl. XXI) is smooth while that of the propodus is provided with 7 short spines. The pleopods are more setose than before. The 6th. abdominal somite has two median minute spines on its hind region. This somite is partially separated from the telson which has 13 + 13 short spines on its hind region.

1st. Pelagic Stage (Fig. 4, Pl. XIX) :

The larva is 4.2 mm. long. The amount of yolk reserve has been totally consumed and this is the 1st. actual pelagic stage. The rostrum is greatly elongated extending beyond the antennular flagella, and has 3 spines on the ventral surface. Both the postero-lateral and supra-orbital spines increase in length. Eyes are large and the stalks are larger. The outer antennular flagellum (Fig. 9, Pl. XXI) is nearly half as long as the inner. There are two long inner and 4 short apical setae. The inner flagellum is 3- jointed, the 3rd. joint is provided with a long apical seta, and the 2nd. joint — which is the longest — has a short upper and a longer outer setae.

The antennal endopod is represented by a short papilla. The cutting edge of the mandible (Fig. 18, Pl. XXII) is produced into an incisor process, with 4, and a molar with 3, teeth. The maxillular palp (Fig. 23, Pl. XXII) is developed with 4 apical short spines and the basis with 3 apical setae. Maxilla (Fig. 28, Pl. XXII) is similar to that of the 3rd. stage. An epipodite is developed at the base of the 1st. maxillipede (Fig. 34, Pl. XXII).

The dactylus is in the form of a claw, the propodus is expanded with 5 hooked setae. The 2nd. maxillipede (Fig. 15, Pl. XXI) has the base of the merus attached to the apex of the ischium. There are 2 outer basal spines and a number of shorter ones on the inner surface of the propodus. The 3rd.-5th. maxillipedes increase in length. The legs can be differentiated in the form of short papillae on the last 3 thoracic segments. The 6th. abdominal somite is totally separated from the telson.

2nd. Pelagic Stage : (Fig. 5, Pl. XIX)2:

The larva is 4.5 mm. in length. The rostrum is produced into 5 ventral spines. The postero-lateral spines are so long that they reach the middle of the 5th. abdominal somite. The 3rd. segment of the inner antennular flagellum (Fig. 10, Pl. XXI) has a long and a short apical setae, and an inner short basal seta. The outer flagellum has a middle cleft dividing it into, an outer 2-jointed flagellum with 3 apical and 2 outer setae on the 2nd. segment, and an inner seta on the inter-segmental region. The middle flagellum has 4 apical and inner nearly equal setae. The antennal endopod (Fig. 38, Pl. XXIII) is in the form of a short bud. The incisor process (Fig. 19, Pl. XXII) is produced into 5 long spines, and the molar is provided with 6. In between the two processes there is a narrow gap. The maxillular endopod (Fig. 24, Pl. XXII) increases in length and has a long apical seta. The coxa is provided with 6 apical short spines, while the basis has 3 long apical setae, nearly equal in size. Both coxa and basis decrease in size in this stage. The lobules of the maxillar protopodite (Fig. 29, Pl. XXII) are not clear but there are 8 setae in 3 groups of 5, 2, and 1, representing 3 lobules.

1st. and 2nd. maxillipedes do not differ in structure from those of the 1st. pelagic stage. The 3rd.-5th. maxillipedes are longer and 5-segmented. The legs are longer than in the 4th. stage, but they are uniramous. The pleopods are more setose and a rudiment of gill is found on the base of the exopod, to the inner side. From the hind region of the telson, on the sides of the 6th. abdominal somite the uropods originate, each in the form of two short rods, representing the exopod and endopod arising from unsegmented protopodite. The telson (Fig. 49, Pl. XXIII) is longer than broad with 11+11 short main spines, on the hind region, and between them are secondary shorter spines.

3rd. Pelagic Stage (Fig. 6, Pl. XIX) :

The larva attains a length of 6.7 mm. The rostrum is long with 7 ventral spines. The middle and outer antennular flagella (Fig. 11, Pl. XXI) are fused at the bases, the outer is 3-jointed with 4+2+3+1 apical and inner setae, and the middle is 2-segmented with 3+2+2+2 apical and inner short setae. The inner flagellum is 4-jointed with 2 short inner setae on the 1st. joint, 1 inner on each of the 2nd. and 3rd, 2 short on the inter-segmental region between the 3rd. and 4th., and 1 long apical on the 4th. joint. The antennal endopod (Fig. 39, Pl. XXIII) becomes a little longer than the scale and is 6-segmented; the basal segment is the longest. The incisor process (Fig. 20, Pl. XXIII) is produced into 5 and the molar into 4 apical spines. The maxillular coxa

(Fig. 25, Pl. XXII) is produced into 10 apical spines. The basis which is narrower than the coxa is provided with 3 apical setae; the innermost is the longest. The endopod has an inner short and an outer long apical setae. The maxillar protopodite (Fig. 30, Pl. XXII) is divided into 2 segments, the proximal segment is produced into 2 lobules with 4+4, and the distal into 3 lobules with 4+2+3 setae. The propodus of the 1st. maxillipede (Fig. 36, Pl. XXII) is broad with 5 groups of hooked setae; each group consists of two setae. The dactylus of the 2nd. maxillipede (Fig. 17, Pl. XXI) is smooth ventrally, wider at the base than at the apex. The spines on the inner surface of the propodus decrease in number. The ischium is untied to the inner surface of the merus which is swollen at the base. The 3rd., 4th. and 5th. maxillipedes (Fig. 42, Pl. XXIII) are fully developed, the 1st. pair is a little longer than the others. The three pairs are similar in structure, all have prehensile hands, each hand is as broad as long. The dactylus is bent against the propodus and no spines are found on the inner surfaces of both, but minute hairs cover them. There are 5 pairs of epipodites on the bases of the maxillipedes. Legs (Fig. 43, Pl. XXIII) are similar in structure, each consists of an endopod shorter than the exopod which is 2-segmented and non-setose. The pleopods (Fig. 41, Pl. XXIII) are longer, setose and provided with branched gills. The telson (Fig. 50, Pl. XXII) is narrow on its hind sharply concave margin. The uropod has a 2-segmented protopodite, an exopod with an outer long spine and an apical setose lobe, with 5 setae, a basipodial process, with a long outer and short inner spines, and the endopod with 4 apical setae. The hind margin of the telson has 10+10 spines and a number of short minute secondary ones.

CONCLUSIONS

I. The terga of the thoracic and abdominal somites are free from the carapace. The antennular and occular segments are not covered by the carapace, but are overlain by the rostrum in the Pelagic stages of *Squilla massavensis* Kossman or in *S. mantis* Giesbrecht 1910. The carapace covers all the thoracic segments in Squilla sp. and *Conodactylus glabrous* Brooks, but remains short of the posterior three thoracic segments in later larval stages of *S. massavensis*. The carapace in *Stomatopoda* is characterised by a high supply of spines of which the main are, the rostral, the two antero-lateral (supra-orbitral in *Conodactylus glabrous*), two postero-lateral and one middle postero-dorsal. Between

the antero-lateral and postero-lateral spines, there are accessory ventro-lateral or ventral spines which are absent from the carapace of *G. glabrous*. The number of these accessory spines differs with the species and stages of development of the same species.

2. The 6th. abdominal somite is fused with the telson in early stages separating later, in all the studied species. The somites are smooth except for the presence of postero-median spines in later larval stages.

3. The telson is either longer than broad as in *Squilla massavensis* and *Gonodactylus glabrous* or nearly as broad as long, as in *Squilla Sp.* In *G. glabrous* there are 3 lateral spines on each side, and the posterior angles are produced into 2 spines between which there is a number of short ones that decrease in the last stage. In *S. massavensis* and *Squilla Sp.* the telson is povided with 3 spines on each side. Between the intermediate and submedian spines there is a number of accessory ones, greater in *Squilla sp.* than in *S. massavensis*. Between the submedian spines, there are short ones between which develop secondary spinules in later stages.

4. The basipodial process of the uropod is developed in the last two larval stages attaining an inner long and an outer short spine at its apex in *S. massavensis* and *Squilla sp.*; in the former the inner spine has an apical outer ridge. The exopod is provided with one or more outer spines and a basal setose lobe. Usually the endopod is shorter than the exopod. In *G. glabrous* development of the basipodial process is abrupt in the 6th. stage, the outer spine of the process is longer than the inner.

5. In the stomatopod larvae, the antennular peduncle is 3-jointed from the 1st. stage. Two flagella are found in the 1st. stage, later, a middle flagellum separates distally from the outer but remains fused at the base. The outer flagellum is short and remains unjointed in the last stage of *S. massavensis* and *Squilla sp.* but 3-segmented in *G. glabrous*.

6. There is a delay in the papearance of the antennal endopod, which in *S. massavensis* and *Squilla sp.* is rudimentary in the 4th. and 3rd. stages and increases in length towards the last stage, but remains shorter than the exopod. In *G. glabrous*, the endopod, in the last stage, is a little longer than the exopod.

7. The two mandibular processes are separated from each other and the palp does not appear in larval stages.

8. The maxillular endopod is short with an apical seta, which may be plumose or not. The number of setae or spines on the coxa increases towards the last stage.

9. Both the maxillar exopod and endopod are absent. The protopodite is either segmented or not. This type of maxilla is homologus to that of the Euphausiacea.

10. The 1st. maxillipede of *Gonodactylus glabrous* is 5-segmented in the 1st. propelagic stage, 6-jointed in other stages. The propodus of the 1st. maxillipede is longer than broad and the dactylus is claw-shaped and reflected against the propodus; an epipodite is developed at the base of the appendage. The 2nd. maxillipede has the characteristic shape of the raptorial claw of *Mantis*. The dactylus is not reflected against the propodus in the 1st. propelagic stage as in *G. glabrous*. It is either smooth internally as in *S. massavensis* and *G. glabrous*. or may be spiny as in *Squilla sp.* In the last larval stage the base of the merus is joined to the apex of the ischium in *S. massavensis* or the ischium is joined to the inner surface of the merus which is swollen at the base in *G. glabrous*.

The 3rd.-5th. maxillipedes are rudimentary in the 1st. stage and develop gradually towards the last stage. Either all maxillipedes are provided with epipodites as in *S. massavensis* or only the 3rd. and 4th. as in *Squilla sp.* the anterior 5 pairs of thoracic appendages in Stomatopoda larvae may be biramous and setose, as in the antizoea of the Lysiosquillinae, and they are natarory in function as the setose pleopods are absent in this stage. So by the nature of the thoracic appendages one differentiates between two types of stomatopod larvae, the antizoea and the pseudozaea. The latter hatches with the 1st. and 2nd. maxillipedes only, the 2nd. being in the form of a raptorial claw and both are without exopods. There are only 3 pairs of biramus and non-setose legs on the 6th.-8th. thoracic segments, which appear later in development.

11. The antizoea of Lysiosquillinae has no pleopods, although Gurney 1937 described one type with 5 pairs and the present authors came across the same type again. The alima larva has 4 and the erichthus 5 pairs of pleopods, in which the plumose setae increase in number towards the last stage.

SUMMARY

As a part of a big programme for the study of the temperary plankton of the Red Sea, the complete series of larval stages of *Squilla massavensis*, *Squilla sp.* and *Gonodactylus glabrous* are described. Larvae were obtained mainly by hatching eggs of ovigerous females, as well as from the plankton, and were reared in aquaria to give the consecutive stages. The larvae referred to as *Squilla sp.* were obtained from the plankton

and the post-larval stage was not procured; specific identification was not possible. 9 pelagic larval stages of *S. massavensis* and 7 pelagic stages of *Squilla sp.* are described. *Gonodactylus glabrous* passes through 3 propelagic followed by 3 pelagic larval stages, all of which are described. Larvae were dissected for study and camera lucida illustrations of whole larvae, as well as of dissected parts are given.

REFERENCES

Foxon, G. E. H., . 1932 : Report on Stomatopod larvae, Cumacea and Cladocera. Great Barrier Reef Expedition, Vol. 4, pp. 375-398, 10 Figs.

Giesbrecht, W., . . 1910 : Fauna und Flora des Golfes von Neapel. XXIII, I, Stomatopoden, pp. 1-239, Mit 12 Figuren im Text und II Tafeln.

Gurney, R, . . . 1937, Notes on some decapod and Stomatopod Crustacea from the Red Sea, II-V Proc. Zool. Soc. London. Ser B, Vol. 107 pp. 319-336, 107 figs.

„ „ . . . . 1946 : Notes on some stomatopod larvae. Proc. Zool. Soc. London, Vol. 116, Part. I; pp. 133-175, 14 figs.

Lebour, M. V., . . 1934 : Stomatopod larvae. Resultats scientifiques du voyage aux Indes orientales Neerlandaises de LL. AA. RR. Le Prince et la Princesse leopold de Belgique, Vol. III, Fascicule 16, pp. 11-17, 5 figs.