

# AN ACCOUNT OF THE STOMATOPOD LARVAE OF THE MADRAS PLANKTON.\*

By K. H. ALIKUNHI.

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## INTRODUCTION.

It is well known that early authors, from Fabricius to Dana, including Leach, Latreille and Milne-Edwards, regarded the stomatopod larvae as adult animals and described them under generic names like *Alima*, *Erichthus*, etc. Different stages of the larvae of one and the same species were often described as distinct species and larvae of different species as stages of some one particular species, naturally resulting in much confusion and repetition. Even when the larval nature of these pelagic creatures was recognized, the authors, working mostly on preserved material, were not in a position to identify the larvae with their adults with any certainty, except on circumstantial evidence such as the comparative abundance or otherwise of the adult stomatopods occurring in the particular locality from which the larvae were collected. The limitations of this method are obvious; living usually in burrows and crevices at the bottom it is generally very difficult to make an exhaustive collection of the different species of stomatopods occurring in any particular locality, and larvae from neighbouring localities might get mingled by wind and wave action, with the result that even in relatively recent publications there are instances where larvae have been erroneously referred to the wrong species or even genus. It has been suggested (Brooks, 1886; Lebour, 1934, Foxon, 1939) that the only way out of this difficulty is, wherever possible, to rear the late planktonic larvae into post-larval forms which show a closer approximation to the adult features and are therefore easier to be properly identified than the pelagic larvae.

The decapod larvae from the Madras plankton have been exhaustively dealt with by Menon (1933, '37, '40) in a series of noteworthy contributions. In the present paper an attempt is made to deal with the stomatopod larvae also in a similar manner but with particular reference to establishing their specific identity. Successful endeavour has been made to rear the advanced larvae through metamorphosis and grow the post-larvae under laboratory conditions, so that, it has now been possible to refer almost all the common species of larvae occurring in the Madras plankton to their respective adults, on the best direct evidence. With proper attention, it has also been possible to rear the early post-larvae to the adult stage, in the laboratory aquaria. The habits of the larvae and post-larvae have already been detailed elsewhere (Alikunhi, 1950); while, the descriptive account of the early post-larvae, their growth and attainment of maturity will form the subject matter for a separate communication.

Specific identification in the majority of cases has been checked and confirmed after rearing the post-larvae to the adult stage. Since the identity of the larvae reared has now been positively established with their adults, it is not considered necessary to retain their larval names and I have accordingly used the adult names only. For the same reason, the final pelagic stage of each species is described in some detail and on a common plan to facilitate comparison between species. An attempt

has also been made to give the synonymy of the larvae described in this paper, but I do not claim that this attempt has been sufficiently exhaustive.

#### HISTORICAL RESUME.

The publication of Claus' classical account of the stomatopod larvae, in 1871, is rightly acknowledged as an important landmark in the study of the larval history of the group. Their larval nature and the lengthy metamorphosis they undergo before assuming the adult characters were first made known by this author. Since then important contributions on the subject have been made by various authors and numerous larval species described, with the result that at present the latter probably exceed the number of known adult species of stomatopods. The contributions of Faxon (1882), Brooks (1886, 1892), Bigelow (1894), Hansen (1895, 1926), Jurich (1904), Tattersall (1906), Lanchester (1903, 1906), Borradaile (1907), Giesbrecht (1910), Komai and Tung (1929), Foxon (1932, 1939) and Gurney (1937, 1946), amongst others, have added much useful descriptive material of the larval forms. In a recent contribution Gurney (1946), besides attempting to classify the larvae, has compiled a very useful list of the larval species so far known, as also an exhaustive annotated bibliography. However, the important aspect of correctly referring the numerous larval species to their respective adults still remains practically untouched. Foxon (1939) has remarked that description of unidentified *Alima* larvae is an unprofitable business and it is surprising to see that out of nearly 200 species and varieties of adult stomatopods and a similar or even larger number of larval species known at the present day, only ten species have been positively correlated with their larval forms, as follows :

##### *By hatching from egg.*

1. *Squilla mantis* (P. Mayer, 1877; Giesbrecht, 1910).
2. *S. oratoria* (Komai, 1924; Komai & Tung, 1929).
3. *Gonodactylus oerstedii*. (Brooks, 1892).
4. *G. glabrous*. (Gurney, 1937).

##### *By moulting to post-larvae.*

1. *Squilla empusa* (Faxon, 1882).
2. *S. quadridens*. (Bigelow, 1894).
3. *S. desmaresti*. (Giesbrecht, 1910).
4. *S. tricarinata*. (Gurney, 1946).
5. *Lysiosquilla excavatrix*; (Brooks, 1886).
6. *L. eusebia*. (Giesbrecht, 1910).

Of the two direct methods for identifying the larvae, that by hatching the eggs is comparatively more difficult than that by moulting, since it is often very difficult to secure the eggs. Gurney (1937) referring to *Gonodactylus* remarks about the extreme difficulty in getting the eggs 'since the animals live in burrows, commonly below the low tide marks, and the eggs are laid in burrows and not attached to the body' In the case of *Squilla* since the egg mass is usually carried by the female, it is easier to obtain the eggs but once in captivity the female casts away the egg mass which is soon attacked by ciliates, impeding further development (Nair, 1942). Also the early larvae are very fragile and only rarely undergo a moult in captivity (Brooks, 1886, Alikunhi, 1950). 'The late

pelagic larvae are generally common in tow-net catches and, being hardier than the early *Alima*, could be successfully reared in the laboratory aquaria. Identification of the numerous larvae is therefore more easily tackled by rearing the late pelagic larvae till they metamorphose into post-larvae in the laboratory. By carefully following the above method the writer has been able to identify 17 species of stomatopod larvae that generally occur off the Madras coast.

#### MATERIAL AND METHODS.

Material for the present paper consists of thousands of larvae collected from the Bay of Bengal, off the Madras coast, during the years 1936 to 1943. Collections were invariably made during the morning hours, using an ordinary catamaran and a bolting silk tow-net; the duration of the daily haul being about half an hour. The collections were generally brought to the laboratory by about 9 a.m. For purposes of rearing, the active larvae were immediately picked out and placed in dishes of fresh sea water. They were then sorted into different types by examination of individual specimens under the binoculars and each type was then kept in separate aquaria. Occasionally the larvae were fed on live plankton and at times they also readily took to minced meat of the mole crab, *Emerita asiatica*. Late larvae metamorphosed into post-larvae overnight, while slightly earlier stages remained in the aquaria for a few more days before undergoing metamorphosis. Smaller larvae ranging from minute pseudozoea and antizoea to early synzoea stages, though remained active in the aquaria for several days, could not be reared to the final pelagic stage. Even when constant circulation of water was maintained in the aquarium by a simple siphon arrangement and with live plankton introduced as food, the smaller larvae moulted but once and died within a day or two.

All the figures are camera lucida sketches, except fig. 8 which is a reconstruction from descriptions and dimensions of parts of the final pelagic larva that moulted in the laboratory into the post-larva. In making the diagrams the author has left out certain characters which are of dubious taxonomic significance.

#### OCCURRENCE.

Stomatopod larvae form an important constituent of the macroplankton of the Madras coast. They do not exhibit any marked seasonal abundance and early as well as advanced larvae are caught almost throughout the year. Dakin and Colefax (1940) also observed the same phenomenon in the Australian waters. While no observations were made either on the vertical distribution of the larvae or on their diurnal migrations, if any, in the surface waters, examination of the horizontal surface hauls, usually made in the morning, indicates only irregular fluctuations in their occurrence. Sometimes they were absent in the tow-net collections for a few days, only to appear soon in considerable numbers; they were, however, never absent continuously for long periods.

*Table I.—Stomatopod Larvae of the Madras Plankton: Analysis of tow-net catches made during 1936 to 1943.*

Year.	No. of collections examined.	No. of collections with larvae.	Total number of larvae.	Maximum No. per collection.	Month.
1936	34	14	166	66	Sep.
1937	33	16	278	162	Dec.
1938	34	26	772	118	Aug.
1939	51	35	1,219	195	Mar.
1940	43	33	1,729	270	Mar.
1941	71	52	3,383	432	Aug.
1942	90	74	4,117	354	Oct.
1943*	57	48	2,533	302	Jul.
7½ Years	413	298	14,197		

\*Till end of July.

As detailed in Table I a total number of 413 tow-net collections were examined. Out of these only 298 collections contained stomatopod larvae (early *Alima* and *Erichthoidina* larvae were not fully enumerated) which totalled 14,197. The maximum number of larvae per collection did not generally exceed 500 and during the period, 1936 to 1943, they were not observed to occur in any enormous swarms. The majority of larvae caught in the tow-net were of an advanced stage (Synzoea) of development. Earlier stages were remarkably few.

The relative abundance of the common species of larvae was also analysed from the collections, as indicated in Table II.

*Table II.—Stomatopod larvae of the Madras Plankton: Analysis of species in the tow-net catches made during 1936 to 1943.*

Species.	1936.	1937.	1938.	1939.	1940.	1941.	1942.	1943.	Total.
<i>Squilla nepa</i>	130	289	417	652	827	1,815	3,036	1,231	8,495
<i>S. holoschista</i>	3	7	202	274	585	1,233	368	767	3,409
<i>S. wood-masoni</i>	23	3	15	144	145	120	205	204	852
<i>S. interrupta</i>	..	2	6	11	4	20	32	39	114
<i>S. quinquentata.</i>	3	3	52	45	79	27	129	143	431
<i>S. gonypetes</i>	..	..	29	20	6	25	1	27	98
<i>S. raphidea</i>	..	2	3	8	1	2	24	8	48
<i>S. latreillei</i>	5	4	15	5	20	26	42	20	137
<i>S. boops</i>	..	..	3	13	8	2	16	8	50
<i>S. fasciata</i>	..	..	..	..	..	1	1	2	4
<i>S. scorpio</i>	..	..	..	..	2	..	..	1	3
<i>S. hieroglyphica</i>	..	..	..	..	..	..	..	1	1
<i>Squilla lata</i>	1	1	1	..	..	1	1	2	7
<i>Lysiosquilla maculata</i>	1	1	8	8	6	18	11	12	63
<i>L. multifasciata</i>	..	..	..	4	2	3	1	1	11
<i>L. acanthocarpus</i>	..	..	..	2	..	2	1	1	6
<i>L. tigrina</i>	..	..	..	1	..	..	..	1	2

*Squilla nepa* is, by far, the commonest species in the Madras plankton, representing more than half the total catches. *S. holoschista* accounts for a little less than one-fourth the total catch and is followed by *S. wood-masoni*, *S. quinquedentata*, *S. latreillei*, *S. interrupta*, *S. gonypetes*, *Lysiosquilla maculata* and *S. raphidea* in the order of abundance. Other species occur only in random catches; *S. hieroglyphica* being represented by a single specimen and *S. fasciata*, *S. scorpio* and *L. tigrina*, each by 2 to 4 specimens only, during the entire period of seven and a half years. It is interesting to note that the common species of adult stomatopods caught along the Madras coast are *S. nepa*, *S. holoschista*, *S. wood-masoni* and *S. raphidea*, in the order of abundance.

The occurrence of stomatopod larvae in relation to other plankton organisms is also very fluctuating. Generally, when swarms of such diverse forms like *Loimia medusa*, *Thalia democratica*, *Doliolum* sp. *Creseis acicula*, *Eirene malayensis*, *Noctiluca*, *Rhizosolenia*, etc. occur in the plankton the stomatopod larvae are either absent or rare. However, on certain occasions appreciable numbers of stomatopod larvae have been caught along with swarms of *Rhizosolenia* and *Thalia democratica*. Usually when stomatopod larvae abound in the tow-net catches, other plankton organisms have been observed to be poor, both in quality and quantity. Here again, exceptions are met with and appreciable numbers of stomatopod larvae have been caught when there were swarms of *Pleurobrachia globosa*, *Acetes erythraeus*, leptocephalus and post-larval fish, *Hybacodon* sp., etc. Unless more systematic collections are made no definite statements could be made regarding the ecological associations of these larvae. It may be mentioned in this connection that there is a common belief among fishermen that when stomatopod larvae occur in considerable numbers in any particular locality, fishing there will be generally poor.

#### DESCRIPTIVE ACCOUNT.

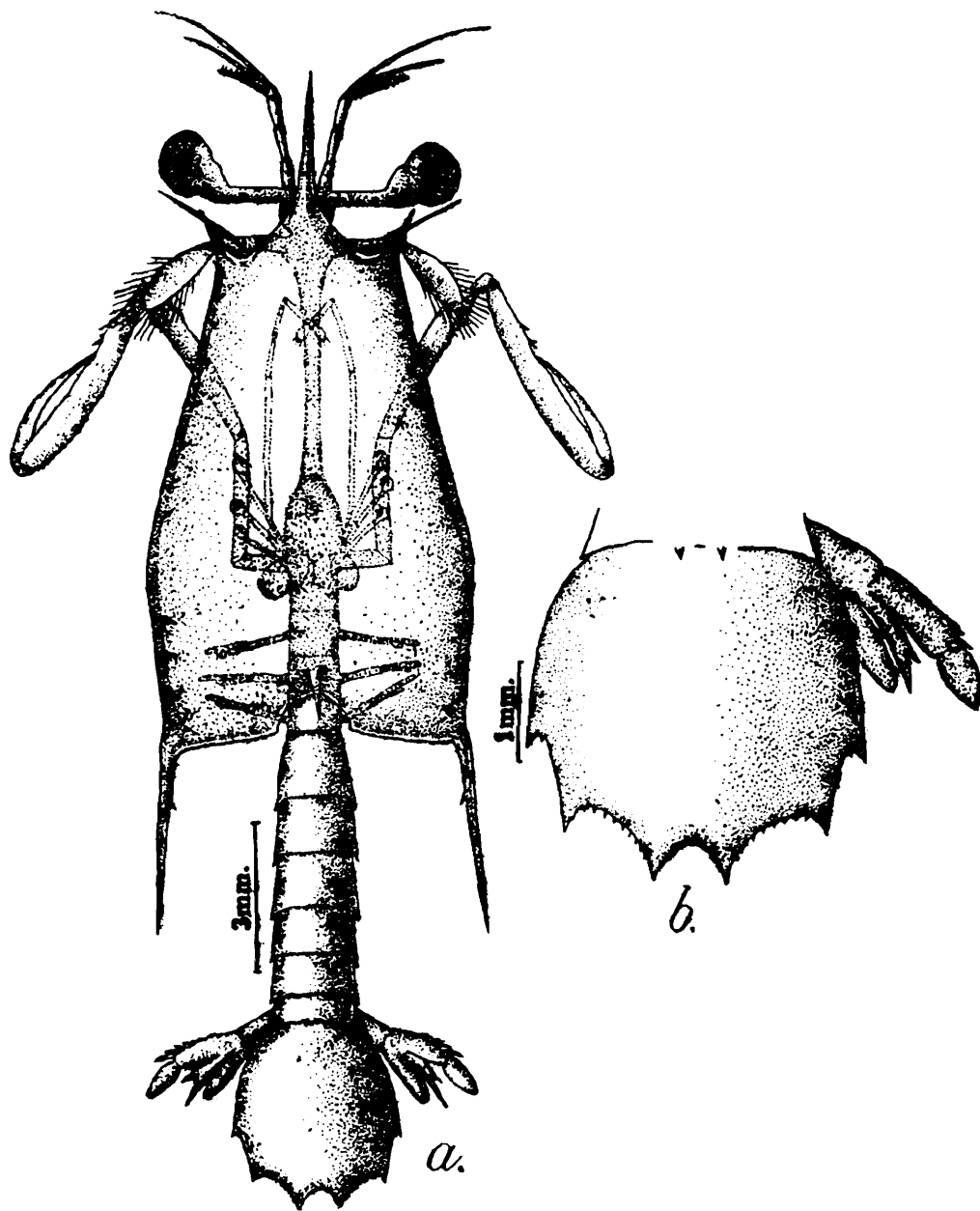
An intensive study of the stomatopod larvae of the Madras plankton was carried out from December, 1941 to August, 1943, when the numerous larvae collected were, as a routine, segregated into types and separately reared in the laboratory aquaria. The final pelagic larvae of the following seventeen species were successfully metamorphosed and the post-larvae of twelve of them reared to the adult stage:—

1. *Squilla nepa* Latreille (Bigelow).
2. *Squilla holoschista* Wood-Mason.
3. *Squilla wood-masoni* Kemp.
4. *Squilla interrupta* Wood-Mason.
5. *Squilla boops* Kemp.
6. *Squilla quinquedentata* Brooks.
7. *Squilla gonypetes* Wood-Mason.
8. *Squilla raphidea* Fabricius.
9. *Squilla latreillei* (Eydoux & Souleyet).
10. *Squilla fasciata* de Haan.
11. *Squilla hieroglyphica* Kemp.
12. *Squilla lata* Brooks.
13. *Lysiosquilla maculata* (Fabricius).
14. *Lysiosquilla sulcirostris* (Kemp).
15. *Lysiosquilla multifasciata* Wood-Mason.
16. *Lysiosquilla tigrina* Nobili.
17. *Lysiosquilla acanthocarpus* Miers.

In the succeeding pages detailed descriptions of the final pelagic larvae of these species are given. Descriptions of the larvae of *S. scorpio* Latreille which could not, unfortunately, be reared to metamorphosis, and notes on the early larvae of the different species picked out from the plankton are also included.

### **SQUILLA NEPA LATREILLE (Bigelow).**

*Final Pelagic Stage.* (Text-fig. 1).—It is represented in almost every collection in which stomatopod larvae are present. It is easily distinguished from the other species by its comparatively small size and



TEXT-FIG. 1.—*Squilla nepa* Latreille (Bigelow).

a. Final pelagic larva, 22.8 mm. long, dorsal view; b. Telson and right uropod of the same, magnified.

large carapace. The size at which it metamorphoses into the post-larva varies slightly, specimens 22 to 25 mm. long having been observed to moult into post-larvae.

Total length	..	..	22.8 mm.
Length of rostrum	..	..	2.8 mm.
Median length of carapace	..	..	10.0 mm.
Anterior breadth of carapace	..	..	3.2 mm.
Posterior breadth of carapace	..	..	6.1 mm.
Length of antero-lateral spine			0.9 mm.
Length of postero-lateral spine	..	..	3.5 mm.
Length of eye-stalk	..	..	1.1 mm.
Length of corneal portion of eye*	..	..	1.1 mm.
Length of telson	..	..	3.0 mm.
Breadth of telson	..	..	3.2 mm.

The carapace is comparatively large and extends over the anterior half of the last thoracic somite. The rostrum is slender and devoid of ventral spinules. The maximum breadth of carapace is almost double its anterior breadth. Its lateral margin is provided with 8+4 spinules, the first near the base of the antero-lateral spine, eighth at the level of the labrum and the last four nearer the postero-lateral corner. Each postero-lateral spine has a ventral spinule at one-third its length from base and is directed almost parallel to the margin of the abdominal segments, but usually tending to diverge slightly near the tip, which often reaches the level of the fourth abdominal segment, or rarely up to the fifth. The dorsal spine is shorter than the antero-lateral and is situated on an elevated prominence, a little in front of the posterior margin of carapace.

In the antennular peduncle the basal segment is longer than the other two which are equal in length. The second antennular flagellum carries 12 groups of sensory hairs. In the raptorial limb the peduncular segment is provided with a ventral spine, distally. The propodus has three stout spines at base and a series of pectinations on the margin. The dactylus does not have any free spine other than the terminal. The thoracic segments become gradually longer towards the last. Abdominal segments are broader than the thoracic and have their postero-lateral corners produced into acute spines. The sixth segment is broader than long and has a pair of sub-median dorsal spines. The marginal spines of telson are prominent (Text-fig. 1b.). There are 1 lateral, 9 intermediate and 14-15 sub-median denticles on each side. Uropods when directed backwards reach almost half way between the lateral and intermediate spines of telson. There may be 3 or 4 free spines on the outer aspect of the basal segment of the exopod. The ventral prolongation ends in two distal spines, of which, the tip of the inner, larger one reaches beyond the distal extremity of the endopodite.

*Earlier Stages of Larvae.*—The earliest stage obtained, that can be positively referred to this species measures 9.0 mm. in total length (Collection dated 4-2-1937; a second specimen 9.2 mm. long is also of

\* 'Corneal portion of eye' as used in this paper includes the entire eye proper excluding the stalk.



the same stage). As in the final pelagic stage, the carapace extends posteriorly across the middle of the last thoracic segment. Along the lateral margin of carapace there are 5+4 spinules of which the first, sixth and seventh are long and prominent, while the rest are rudimentary. Rostrum has a slight downward bend at the base. Postero-lateral spine, with a spinule near the base, has its tip reaching the level of the 4th abdominal segment. The antero-lateral and dorsal spines are long and pointed. The tip of antennular peduncle is markedly inferior to tip of rostrum. The second antennular flagellum has four groups of sensory hairs. Antennal endopodite is unsegmented. Thoracic limbs 3 to 5 are mere finger-like outgrowths, while no trace of the last three is visible. Pleura of the abdominal somites end in blunt points posteriorly. The sixth abdominal segment is not yet fully differentiated. The fifth pleopod is smaller than the rest. Telson is broad, with well developed marginal spines. There are 1 lateral, 8-9 intermediate and 13 sub-median denticles on each side. Uropods are only stump-like, bifid processes.

*Larva, 13.8 mm. long.*—In general appearance it resembles the final pelagic stage. Carapace has 8+4 spinules as in the latter. Antennular peduncle is slightly longer and 7 groups of sensory hairs have appeared on the second antennular flagellum. Antennal endopodite is 3-segmented and reaches just beyond the tip of peduncle. Thoracic limbs 3 to 5 are well developed ; while the last three are still rudimentary though bifid. The sixth abdominal segment has been differentiated and the pleura of the abdominal somites have become pointed posteriorly. In the telson the lateral spines are smaller than the rest ; the denticles number 1 lateral, 10 intermediate and 16 sub-median on each side. Uropod reaches half-way to the base of lateral spine of telson. Ventral prolongation of uropod is not yet clearly bifid. The exopod has one free spine.

Larvae up to 16.5 mm. resemble the above stage in almost all details.

In specimens 17.5 mm. long, the antennular peduncle is only slightly inferior to the tip of rostrum ; while the second antennular flagellum carries 8 groups of sensory hairs. Antennal endopodite is longer, while the last three thoracic limbs are better developed than in the previous stage. Ventral prolongation of the uropod has the tip distinctly bifid, with the inner spine about double the size of the outer. Exopod of uropod has two free spines basally.

In the 18.5 mm. stage an additional group of sensory hairs appears on the antennular flagellum ; antennal endopodite reaches half way to the tip of squame and the uropod is better differentiated than in the previous stage.

When 21.5 mm. long, the larva very much resembles the final pelagic stage, but the antennular flagellum has only 10 groups of sensory hairs ; the peraeopods are shorter than in the final pelagic larva ; the exopod of uropod has still only 2 free spines ; while the inner spine of the ventral prolongation of uropod is thrice as long as the outer and has the tip reaching slightly beyond the tip of endopodite.

With the next moult the larva probably reaches the final pelagic stage.

*Remarks.*—Except in size, spinulation of carapace, shape of telson and certain other minor details, the larva shows close resemblance to the final pelagic stage of *S. holoschista* (p. 19), particularly in general appearance and to a great extent in the relative proportions of the various parts of the body. *S. nepa* and *S. holoschista* are very closely related and this is probably reflected in the close resemblance between their pelagic larvae.

While it is the commonest larva in the Madras plankton, it does not appear to have been described before. It, however, shows close resemblance to *Alima dilatata* (Hansen, 1895) and *Alima subtruncata* (Jurich, 1904), though on grounds of distribution these cannot be identical with the larva of *S. nepa*, the distribution of which is limited to the Indo-Pacific region. The larva ascribed to *A. subtruncata* by Komai and Tung (1929) from the Japanese seas, however, appears to be very distinct from Jurich's species and is markedly different from the larva of *S. nepa*, particularly in the form and spinulation of carapace. The *Alimerichthus* larva (15.52 mm. long) from the south Atlantic, figured by Brooks (1886) also has the broad, shield-like carapace characteristic of the larvae of *S. nepa* and *S. holoschista*. The size and stage of development of the larva figured by Brooks show that it is probably closely related to *S. nepa*, even though from the spinulation of carapace and on geographical considerations the two appear to be specifically distinct. Brooks has classified the above larva as *Alimerichthus*, but it does not possess features characteristic of that group of larvae. Lancheater's (1903) view that *Alimerichthus* sp. of Claus is identical with *Alimerichthus* larva of Brooks also does not appear to be correct.

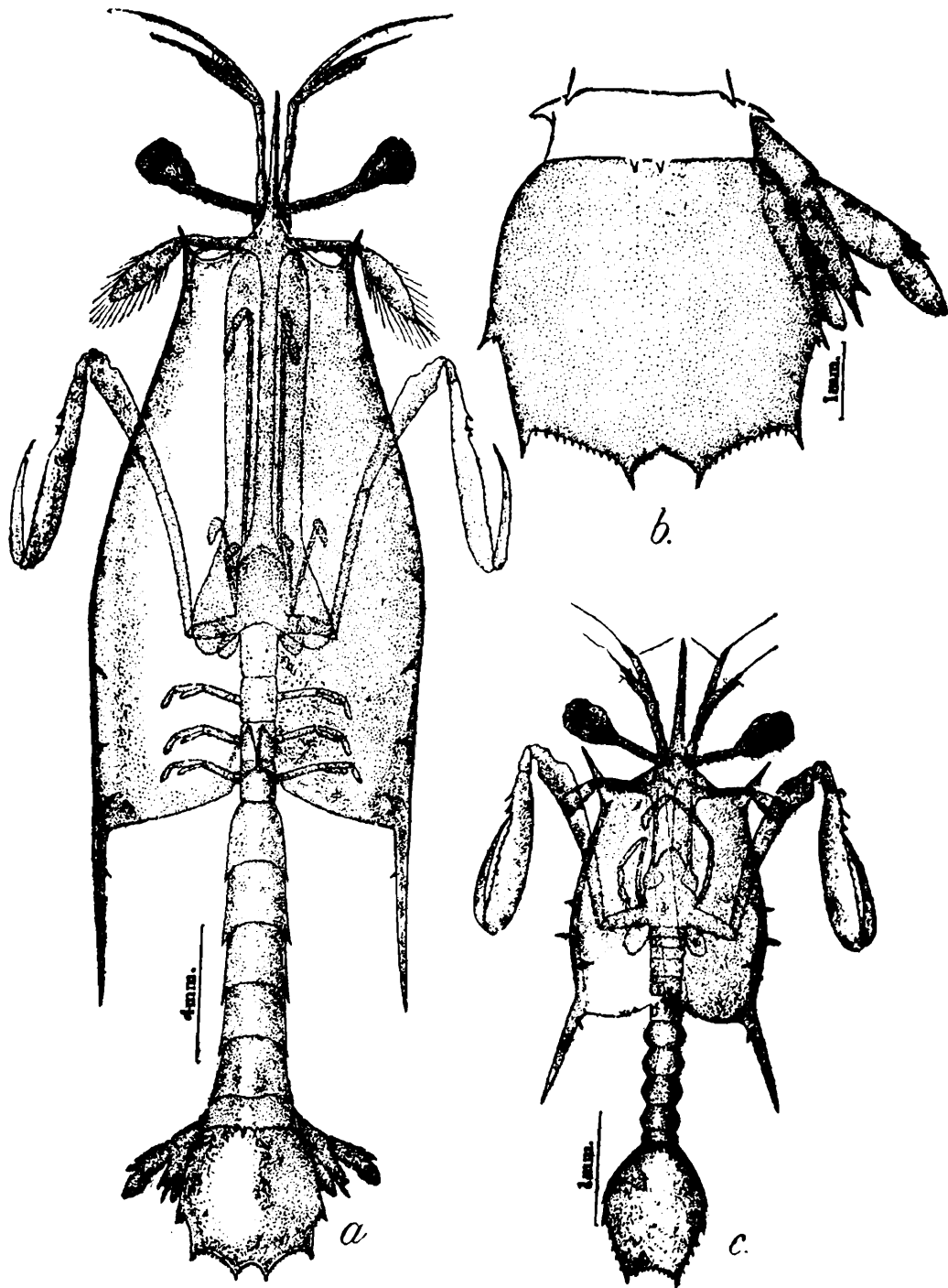
### SQUILLA HOLOSCHISTA Wood-Mason.

1837. *Alima laticauda*, Milne-Edwards, *Histoire Naturelle des Crustacea*, Paris, p. 507.  
 1837. *Alima laticauda*, Milne-Edwards, *Crustacea*, In Cuvier's *Regne Animal*, Paris, Pl. lvii, fig. 2.  
 1857. *Hyalopelta laticauda*, Guerin-Meneville, *Animaux asticules*, Paris, Crustacea, Stomatopodes, Pl. lix.  
 1871. *Alima*, Claus, *Abh. Ges. Wiss. Göttingen*, Pl. viii, fig. 31.  
 1871. *Alima laticauda*, Claus, *ibid.*, Pl. viii, fig. 32.

*Final pelagic stage.* (Text-fig. 2).—One of the largest and most conspicuous larvae secured in tow-net catches, the final pelagic larva of *S. holoschista* is easily recognized by its large size, very broad carapace and relatively slender abdominal segments.

Total length		34.5 mm.
Length of rostrum	..	4.3 mm.
Median length of carapace		15.3 mm.
Anterior breadth of carapace		4.8 mm.
Posterior breadth of carapace	..	9.0 mm.
Length of antero-lateral spine	..	1.2 mm.
Length of postero-lateral spine	..	5.5 mm.
Length of eye-stalk		2.4 mm.
Length of corneal portion of eye	..	2.0 mm.
Length of telson		4.3 mm.
Breadth of telson		3.8 mm.

The carapace is conspicuously broad and posteriorly covers the anterior half of the last thoracic somite dorsally. The rostrum is comparatively short and slender and is devoid of ventral spinules. The antero-lateral spines are short and almost equal to the dorsal spine which is situated on a prominence at the hind border. The maximum breadth of carapace (9.5 mm.) at about the level of the labrum, is almost twice its anterior breadth. The postero-lateral spines, each with a prominent ventral spinule at about one-fourth its length from the base, are directed almost parallel to the abdominal segments and reach the



TEXT-FIG. 2.—*Squilla holoschista* Wood—Mason.

a. Final pelagic larva, 34.5 mm. long, dorsal view; (rudimentary post-larval carapace is indicated as a median, long, narrow strip); b. Telson and right uropod of the same, magnified; c. Larva, 5.6 mm. long.

level of the fourth abdominal somite. There are 8+3 ventrally directed spinules on each lateral margin of carapace; the last three which are larger than the rest, being situated nearer the postero-lateral corner.

The tip of rostrum is superior to the tip of antennular peduncle, but often the two may be at the same level. The second antennular flagellum carries 15 groups of sensory hairs. The eye is comparatively small and slender, with a long stalk. The region between the antenna and the labrum is very much distended. The peduncular segment of the raptorial limb is provided with a stout ventrally directed distal spine. The raptorial propodus carries three stout spines and a series of pectinations. The dactylus is slender, falciform and without any free tooth other than the terminal. The last three thoracic segments are distinctly longer than broad. The abdominal segments are broader than the thoracic and have their pleura produced into acute spines posteriorly. The sixth abdominal segment is very short, about two and a half times as broad as long, with a pair of sub-median spines dorsally and with the lateral margin anteriorly produced into a stout ventrally directed spine. The marginal spines of telson are well developed (Fig. 2 b). The denticles number 1 lateral, 12 intermediate and 15-16 sub-medians on each side. The uropods when directed backwards reach half-way between the lateral and intermediate spines of telson. The basal segment of exopod carries 3 free spines on its outer aspect. The tip of the ventral prolongation reaches just beyond the tip of endopod and has two spines distally, the outer one being about half the length of the inner which has no prominence on its outer aspect.

*Earlier stages of Larvae.*—They seldom occur in the collections. A single specimen, probably in the second pelagic stage, is referable to this species (Text-fig. 2c.).

Total length	5.6 mm.
Length of rostrum	1.2 mm.
Median length of carapace	2.1 mm.
Anterior breadth of carapace	1.2 mm.
Posterior breadth of carapace	1.5 mm.
Length of postero-lateral spine	0.9 mm.
Length of telson	1.0 mm.
Breadth of telson	0.85 mm.

Carapace is large and extends posteriorly over the anterior half of the last thoracic segment. Rostrum is long and prominent and has no ventral spinules. Antero-lateral spines are acutely pointed; postero-laterals are shorter than the rostrum, divergent posteriorly and are provided each with a prominent spinule near the base. Tip of each postero-lateral spine reaches the level of the 4th abdominal segment. Lateral margin of carapace has 4 spinules, the first near the base of the antero-lateral spine, the 2nd and 3rd situated mid-way from either end, are long and project outward; while the fourth is directed ventrally. The tip of antennular peduncle reaches only half-way to tip of rostrum; second antennular flagellum has three groups of sensory hairs; the corneal portion of eye is slightly longer than the stalk; there is no trace of the antennal endopodite; raptorial propodus has three basal spines; the 3rd to the 8th thoracic appendages are not developed; sixth abdominal segment is not differentiated; postero-lateral corners of abdominal segments do not end in spines; 5th pleopod is in the form of

a bilobed rudiment; uropod is not indicated; telson is large and conspicuous; sub-median spines are almost double the size of the lateral or intermediate spines and denticles number 1 lateral, 4 intermediate and 5 or 6 sub-median on each side.

*Remarks.*—It is not certain that the early *Alima* described above, actually belongs to *S. holoschista*; the broad carapace and the relatively large size when compared with the stage of development being the only criteria on which the identification is based. This larva, however, largely resembles the 4.5 mm. long *Alima a* (Tattersall, 1906) from the gulf of manaar, the only difference being the possession of a median carina on the carapace in the latter. *Alima dilatata*, 4.7 mm. long, described by Hansen (1895) also appears to be identical with the Madras and Ceylon larvae. The young *Alima*, 3.3 mm. long, described by Gurney (1946) from Bermuda as *A. dilatata*, differs from the above specimens in the shape of telson and in the possession of an additional spinule on the margin of carapace.

Larvae younger to the final pelagic stage are not represented in the present collection. The final pelagic larva, though slightly smaller than the corresponding stage of *S. wood-masoni* in total length, is by far the most conspicuous stomatopod larva in the Madras plankton, mainly by virtue of its large, shield-like carapace. Claus's *Alima laticauda* from the Indian ocean appears to be identical with the final pelagic stage here described. It is of almost the same size as the latter. While I have not been able to compare the descriptions of *A. laticauda* given by Milne-Edwards (1837) and Guerin Meneville (1857), there seems to be little doubt that the larvae described by them are identical with *S. holoschista*. The 16 mm. long *Alima*, described by Claus (His Fig. 31), is also probably identical with *A. laticauda*, though representing an earlier stage than the final pelagic.

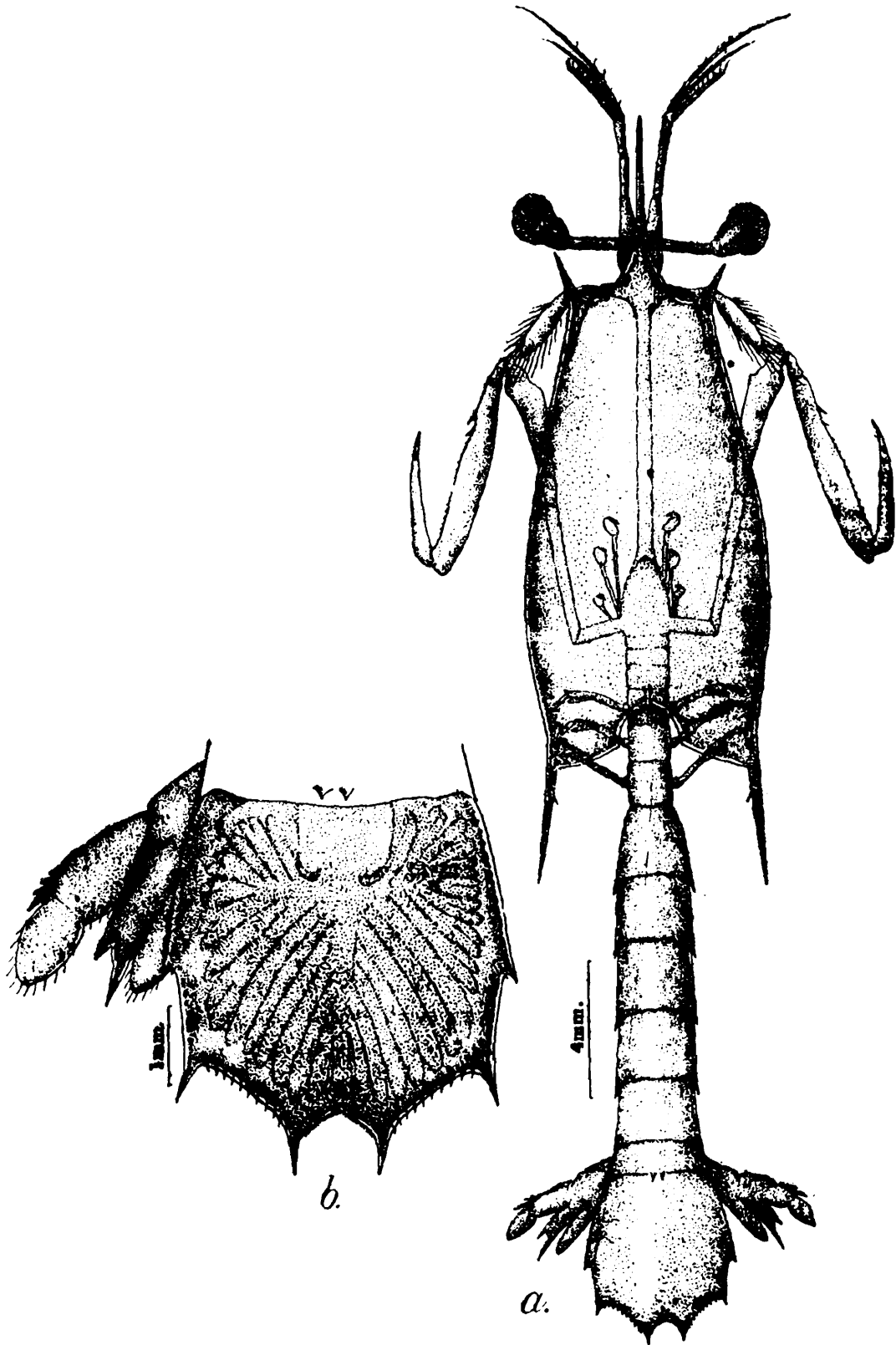
### SQUILLA WOOD-MASONI Kemp.

1871. *Alima emarginata*, Claus, *Abh. Ges. Wiss. Gottingen*, Pl. viii, fig. 33 (?)  
 1895. *Alima trivialis*, Hansen, *Ergeb. Plankt. Exped.*, Pl. viii, fig. 11.  
 1906. *Alima a*, Tattersall, *Rept. Pearl Oyster Fish. Lond.*, figs. 23, 24, 25.  
 1929. *Alima emarginata*, Komai & Tung, *Annot. Zool. Jap.*, Pl. v, figs. 16-22; Pl. vi, figs. 1-15; Pl. vii, figs. 1-3.  
 1932. *Alima emarginata*, Foxon, *Sci. Rept. Great Barrier Reef Exped.*

*Final Pelagic Stage* (Text-fig. 3).—The longest stomatopod larva in the Madras plankton, it is less frequently caught than the final pelagic larvae of *S. nepa* and *S. holoschista* from which it is easily distinguished by the large size and the relatively narrow carapace.

Total length	..	35.5 mm.
Length of rostrum	.. ..	4.5 mm.
Median length of carapace	.. ..	12.8 mm.
Anterior breadth of carapace	.. ..	4.3 mm.
Posterior breadth of carapace	.. ..	6.1 mm.
Length of antero-lateral spine	.. ..	1.6 mm.
Length of postero-lateral spine	.. ..	3.6 mm.
Length of eye-stalk	.. ..	1.7 mm.
Length of corneal portion of eye	.. ..	1.85 mm.
Length of telson	.. ..	4.3 mm.
Breadth of telson	.. ..	4.3 mm.

The carapace extends only upto the anterior portion of the sixth thoracic somite, leaving the last two segments exposed dorsally. The rostrum is prominent and without any ventral spinule. The antero-lateral spine is about twice the size of the dorsal spine which is placed on an elevation near the hind margin. The greatest breadth of carapace (7.0 mm.) at about the level of the labrum, is more than one and a half times its anterior breadth. The postero-lateral spine, not very divergent



TEXT FIG. 3.—*Squilla wood-masoni* Kemp.

*a.* Final pelagic larva, 35.5 mm. long, dorsal view; *b.* Telson and left uropod of the same, magnified.

posteriorly, carries a ventral spinule at about one-third its length from base and has the tip reaching the level of the hind border of the first abdominal segment. The lateral margin of carapace is provided with 12+4 spinules, the last 4 being near the postero-lateral angle.

The tip of rostrum and that of the antennular peduncle are usually situated at the same level. The second flagellum of the antennule carries 18 groups of sensory hairs. The eyes are comparatively large, the corneal portion being larger than the stalk, unlike the condition in *S. holoschista*. The peduncular joint of the raptorial limb carries a distal, ventrally directed, stout spine. The raptorial propodus has three stout spines proximally, besides pectinations on the inner margin. The dactylus has only the terminal tooth. The thoracic segments gradually become longer towards the last. The first four abdominal segments are almost as broad as long, while the last two are broader. The sixth segment carries a pair of dorsal sub-median spines and a pair of lateral, ventrally directed spines. The marginal spines of telson, particularly the sub-medians and intermediates, are long. The denticles number 1 lateral, 11 intermediate and 20-21 sub-median on each side. The tip of exopod of uropod, when directed backwards, reaches the base of intermediate spines of telson. It has 5 free spines on the outer aspect. The ventral prolongation of uropod is bifid, with the outer spine less than half the length of the inner which has an inconspicuous bulging on the outer basal aspect.

*Earlier stages of Larvae.*—Like *S. holoschista*, earlier stages of larvae of the present species also are very seldom caught. An early synzoea stage, 26 to 28.5 mm. long, is represented in the present collections by a few specimens. The carapace, as in the final pelagic larva, leaves the last two thoracic segments exposed. The lateral margin carries 10+4 spinules; the number in other specimens varying from 8 or 9+4. The second flagellum of antennule carries 14 groups of sensory hairs. Antennal endopodite reaches half-way to tip of squame. The last three thoracic legs are elongate and bifid but are shorter than in the final pelagic stage. The lateral spines of telson are short. Uropods are well differentiated.

*Remarks.*—The final pelagic larva shows close resemblance to *Alima emarginata* (Claus, 1871), even though the latter is about 9 mm. longer. *A. trivialis* (20.6 mm.; Hansen, 1895) also appears to be identical with *S. wood-masoni*, though it represents an earlier stage to the final pelagic. Komai and Tung (1929) have identified certain larvae from the Japanese seas as *A. emarginata*. The first two larvae of this series measure 52 and 44 mm. respectively in length, excluding rostrum and have the shape of carapace different from that of Claus's *A. emarginata*. These are obviously different from *S. wood-masoni*. Two other specimens ascribed to the same species by Komai and Tung, have a different carapace form; are smaller than the first two specimens (30 and 31 mm. long, including rostrum) and are probably identical with *S. wood-masoni*, though representing a slightly earlier stage than the final pelagic.

The 27 mm. long *Alima a* described by Tattersall (1906) also appears to belong to *S. wood-masoni*. Representing an earlier stage than the final pelagic, it agrees with the Madras form in the spinulation of carapace

and in the relative size considered with the stage of development attained. The earlier stage, 4.5 mm. long, ascribed to this species by Tattersall, has been shown to be probably the larva of *S. holoschista* (vide p. 21.)

*Squilla* sp. (*Alima emarginata*, Foxon, 1932) from the Great Barrier Reef is probably identical with *S. wood-masoni*; while the larva described as *A. emarginata* by Lanchester (1906) appears to belong to the closely related *S. interrupta* (vide p. 26).

*A. robusta* (Jurich, 1904) shows a vague general resemblance to the final pelagic larva of *S. wood-masoni*; but the indication of five teeth beneath the cuticle on the dactylus of the raptorial claw in the 28.7 mm. long specimen, probably shows that it belongs to a different species than *S. wood-masoni*.

### SQUILLA INTERRUPTA Wood-Mason.

1906. *Alima emarginata*, Lanchester, *Fascicule Malayensis*, Fig. 4.

*Final Pelagic Stage (Text-fig. 4).*—The larva is fairly large-sized and robust in appearance. Occasionally, considerable number of them is obtained along with some of the earlier stages also. The fairly large size, the comparatively narrow carapace and the large telson easily mark out this larva from the rest.

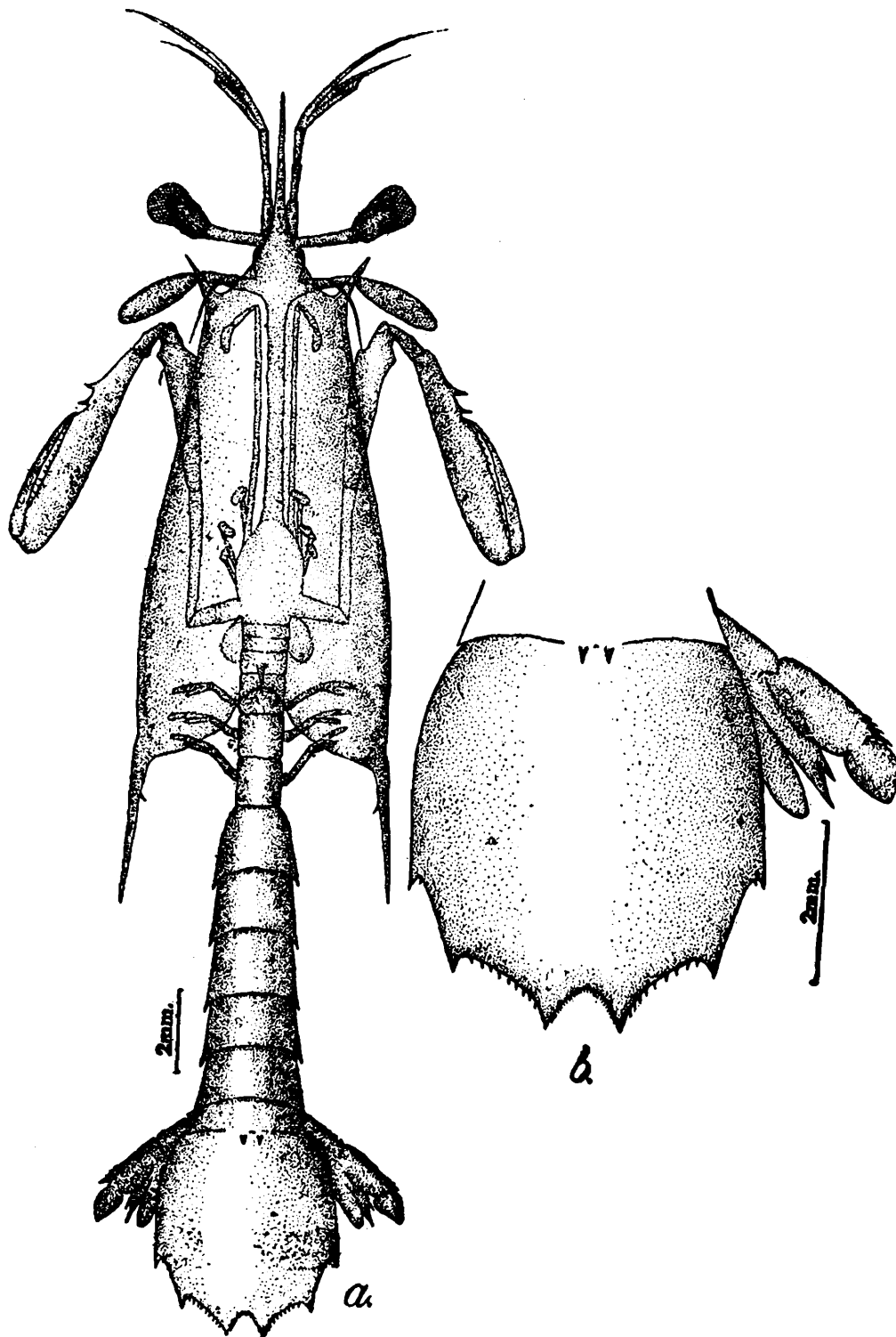
Total length	..	..	29.5 mm.
Length of rostrum	..	..	4.5 mm.
Median length of carapace	..	..	10.8 mm.
Anterior breadth of carapace	..	..	3.4 mm.
Posterior breadth of carapace	..	..	6.0 mm.
Length of antero-lateral spine	..	..	1.3 mm.
Length of postero-lateral spine	..	..	3.5 mm.
Length of eye-stalk	..	..	1.6 mm.
Length of corneal portion of eye	..	..	1.6 mm.
Length of telson	..	..	4.4 mm.
Breadth of telson	..	..	4.2 mm.

The carapace is comparatively long and narrow, and covers the anterior half of the 6th thoracic somite, leaving the last two fully exposed. The lateral margin of carapace bears 7+3 spinules. The rostrum is fairly long and is armed with 7 ventral spinules. The antero-lateral spines are acutely pointed and are longer than the dorsal spine. The postero-laterals do not diverge much posteriorly, each carries a ventral spinule at a point slightly in advance of one-third its length from the base and has the tip reaching the level of the anterior half of the second abdominal segment.

The tip of antennular peduncle is distinctly inferior to the rostral tip. Second antennular flagellum carries 15 groups of sensory hairs. The eye is not very conspicuous and the corneal portion is only equal to the stalk in length. The raptorial limb has a sharp spine on the distal end of the basal segment, ventrally. The propodus has three stout spines and a row of pectinations. The dactylus has no free tooth other than the terminal. The abdominal segments are more than one and a half times as broad as the thoracic and have their postero-lateral corners produced into acute spines. The segments are broader than long and



get gradually shorter towards the last which is about  $2\frac{1}{2}$  times as broad as long. It has a pair of sub-median spines and an additional spine at the postero-lateral margin directed ventrad. The telson is comparatively large and is longer than broad (Text-fig. 4b). The marginal spines are



TEXT-FIG. 4.—*Squilla interrupta* Wood-Mason.

*a.* Final pelagic larva, 29.5 mm. long, dorsal view; *b.* Telson and right uropod the same, magnified.

rather short and stout. The denticles number 1 lateral, 9-10 intermediate and 15-17 sub-median on each side. The uropod when directed backwards, reaches the base of the lateral spine of telson and has 4 free spines on the outer aspect of the basal segment of exopod. The ventral

prolongation is bifid, the inner spine being over double the size of the outer, without any noticeable tubercle on its outer aspect and with the tip just projecting beyond the distal end of the endopod.

*Earlier stages of Larvae.*—Two stages slightly earlier to the final pelagic are present in the collection. Both these, measuring 23.5 mm. and 26.0 mm. respectively in length, resemble the final pelagic larva with which they agree in almost all details except that the various structures are, as a whole, slightly less developed than in the final pelagic stage.

*Remarks.*—Lanchester (1906) referred a single *Alima* larva, 20 mm. long, collected off cape Patani, to *Alima emarginata*. The details of the spinulation of carapace and the figures given by Lanchester, however, indicate that the larva is different from Claus's *A. emarginata* which measured 44 mm. in length. Foxon (1932) commenting on Lanchester's larva stated that "Lanchester's figure is hardly typical, especially as regards the telson and the spinulation of the carapace" The conspicuous telson, the shape of carapace, ventrally armed rostrum and the 7+3 spinules on the lateral margin of carapace are all characteristic of the larva of *S. interrupta* and Lanchester's specimen is therefore referable to that species.

Lele (1937) has briefly reported that he has been able to note the successive stages of a pelagic *Alima* larva from the Bombay waters and trace the same to the adult form of *S. interrupta*. However, as no description of this larva has been available to me I am unable to comment further on this record.

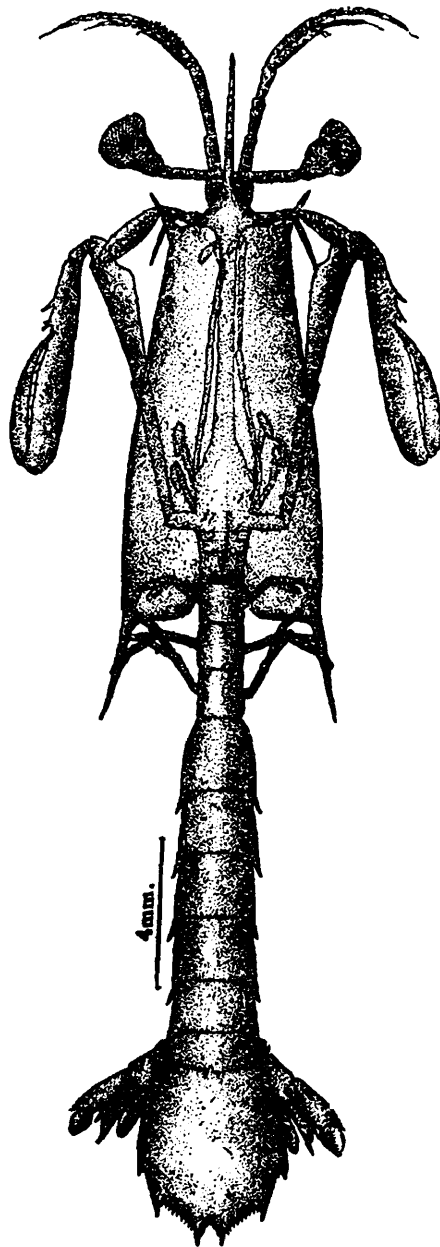
### SQUILLA BOOPS Kemp

*Final Pelagic Stage (Text-fig. 5).*—The larva comes up only rarely in the plankton catches. In the shape of carapace and in the number of its spinules it resembles *S. interrupta*, but the comparatively more slender build and the larger size make it easily distinguishable.

Total length	31.0 mm.
Length of rostrum	4.0 mm.
Median length of carapace	9.5 mm.
Anterior breadth of carapace	3.5 mm.
Posterior breadth of carapace	5.0 mm.
Length of antero-lateral spine	1.1 mm.
Length of postero-lateral spine	3.0 mm.
Length of eye-stalk	2.0 mm.
Length of corneal portion of eye	1.9 mm.
Length of telson	4.4 mm.
Breadth of telson	4.0 mm.

The carapace is long and narrow and leaves the last three thoracic segments fully exposed. Its lateral margin is provided with 7+3 spinules. The rostrum is long and slender and has a row of 6-7 ventral spinules, usually continued forwards as a series of fine tubercles. The antero-lateral spines are long and pointed, while the dorsal spine is short and inconspicuous. The postero-laterals are short and slender,

slightly divergent posteriorly, each with a ventral spinule at about  $\frac{1}{4}$  its length from base and have the tips reaching the level of the hind border of the last thoracic segment.



TEXT-FIG. 5.—Final pelagic larva of *Squilla boops* Komp, 31.0 mm. long, dorsal view.

The antennular peduncle is long and slender, with its tip slightly inferior to the rostral tip. The second flagellum of the antennule has 12 groups of sensory hairs. The basal joint of the raptorial limb carries a terminal ventral spine. The propodus has three stout spines and a row of pectinations. The dactylus has no free tooth besides the terminal but internally shows traces of five, including the terminal one. The last three thoracic somites are longer than broad. In the first five abdominal segments the postero-lateral corners are produced into long slender acute spines. In the sixth there is no such spine, but a pair of sub-median dorsal spines and an antero-lateral, ventrally directed spine on either side are present. The telson is longer than broad and has the

marginal spines well developed. The denticles number 1 lateral, 9 intermediate and 15—16 sub-median on each side. The tip of uropod when directed backwards reaches the lateral spine of telson. The exopod carries 3 to 5 free spines externally; the inner spine of the basal prolongation is more than double the size of the outer, has a prominent swelling or tubercle externally and has its tip projecting distinctly beyond that of the endopod.

*Earlier Stages of Larvae.*—A few early stages of the larvae are also present in the collection. The smallest of them, measuring 19 mm. in length, has the same general body form as in the final pelagic larva. However, the ventral spinules on the rostrum are rather inconspicuous, the second antennular flagellum carries only 6 groups of sensory hairs; the antennal flagellum is small and rudimentary, hardly reaching the tip of antennal peduncle; the last three thoracic limbs are only rudimentary, bifid stumps; and the uropod is just getting differentiated, with the tip reaching only upto  $\frac{1}{4}$  the distance to the base of lateral spine of telson; the exopod still unsegmented and without any clearly marked spine and the ventral prolongation stump-like with its tip which is not yet bifid, reaching only half way to the tip of endopod.

A specimen 21.0 mm. long, though generally resembling the above stage, has 7 groups of sensory hairs on the second antennular flagellum; the exopod on the uropod segmented and with one outer spine and the ventral prolongation just bifid at the tip which is still inferior to the tip of endopod.

In the 23 mm. stage the second antennular flagellum has 8 groups of sensory hairs; tip of antennal flagellum just projects beyond the tip of peduncle; peraeopods are longer and in the uropod the ventral prolongation has its tip still inferior to the tip of endopod.

When 25 to 27 mm. long, the second antennular flagellum bears 10 groups of sensory hairs; tip of uropod reaches half way to the lateral spine of telson; exopod still has only one free spine; the bifid tip of the ventral prolongation is at the same level as the tip of endopod and its inner, larger spine is devoid of the smooth swelling found in the final pelagic stage.

Apparently between the final pelagic stage and the one described above there is another intervening stage which is not represented in the present collection.

*Remarks.*—While this larva does not appear to have been described before, it shows some resemblance to the larva of *S. oratoria* (Komai & Tung, 1929) in general appearance; but the distinctly larger size, the shorter postero-lateral spines and the marginal spinulation of carapace are distinguishing features of the species.

### **SQUILLA QUINQUEDENTATA** Brooks

*Final Pelagic Stage (Text-fig. 6).*—The larvae are only occasionally caught and are not very abundant, though some of the earlier stages

also come up along with the final pelagic larvae. The very slender, frail body, with the short, narrow carapace is characteristic of the final pelagic larva.

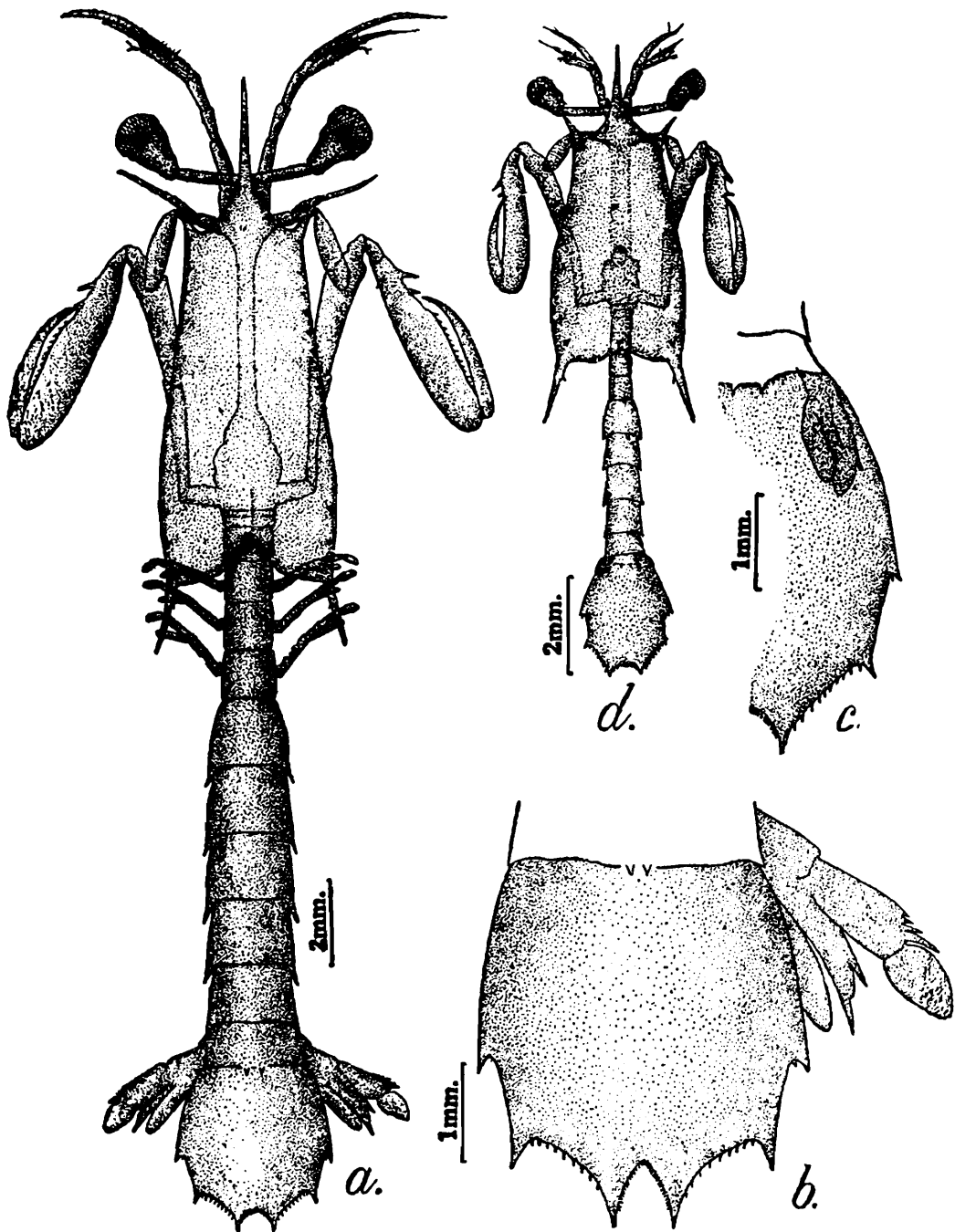
Total length .. .. .	27.4 mm.
Length of rostrum .. .. .	3.4 mm.
Median length of carapace .. .. .	8.4 mm.
Anterior breadth of carapace .. .. .	2.7 mm.
Posterior breadth of carapace .. .. .	4.0 mm.
Length of antero-lateral spine .. .. .	1.0 mm.
Length of postero-lateral spine .. .. .	2.5 mm.
Length of eye-stalk .. .. .	1.5 mm.
Length of corneal portion of eye .. .. .	1.6 mm.
Length of telson .. .. .	3.4 mm.
Breadth of telson .. .. .	3.4 mm.

The carapace extends over the posterior half of the fifth thoracic somite, the last three segments of the thorax remaining fully exposed dorsally (fig. 6a). The rostrum is long and slender and is armed with 8 ventral spinules, the last four of which being very minute. The antero-lateral spines are acutely pointed. The postero-laterals are short, slightly divergent posteriorly, with the tip of each reaching the level of the hind end of the last thoracic somite and each carrying a ventral spinule at about one-third its length from base. The dorsal spine is small and inconspicuous. The lateral margin of the narrow carapace bears 8+3 spinules, the last three being bigger than the rest and situated at longer intervals near the postero-lateral corner of carapace.

The tip of antennular peduncle is at the same level as, or slightly superior to, the tip of rostrum. The second antennular flagellum carries 11 groups of sensory hairs. The eyes are comparatively large, with the stalk slightly shorter than the corneal portion. Protopodite of the raptorial limb carries a ventrally directed distal spine. Propodus has the usual three spines and the series of pectinations. Dactylus has no free tooth other than the terminal. Third and fourth segments of the thorax are very short and the two together make only half the length of the fifth which is almost as long as broad. The sixth is as long as the preceding one but the last two are longer. Abdominal segments are broader than the thoracic, but get shorter gradually towards the sixth which is about twice as broad as long and has a stout ventro-laterally directed anterior spine on either side, besides a pair of sub-median dorsal spines. Telson is almost as broad as long and has the marginal spines rather elongated (Text-fig. 6b). Denticles number 1 lateral, 9-10 intermediate and 14 sub-median on each side. Uropods when directed backwards reach slightly beyond the lateral spines of telson. The basal segment of the exopod has 4-5 free spines. The ventral prolongation, as usual, is bifid at the tip, the outer of the two spines being smaller than half the length of the inner which has a smooth prominence on its outer aspect basally and has the tip just projecting beyond the distal extremity of the endopodite.

*Earlier Stages of Larvae.*—Earlier stages are fairly well represented in the collection and the earliest stage obtained that could be referred to this species measures about 7.5 mm. in total length.

*Larva, 7.5 mm. long.*—Carapace leaves the last two thoracic segments exposed dorsally. Tip of antennular peduncle is inferior to tip of rostrum. Lateral margin of carapace has only 5 spinules, one near the antero-lateral spine, two near the middle region at each margin and the other



TEXT-FIG. 6.—*Squilla quinquentata* Brooks.

a. Final pelagic larva, 29.4 mm. long, dorsal view ; b. Telson and right uropod of the same, magnified ; c. Right half of telson and right uropod of larva, 18.5 mm. long, magnified ; d. Larva, 13.0 mm. long, dorsal view.

two near the postero-lateral spine, all directed outwards. Tip of postero-lateral spine projects just beyond the hind border of the second abdominal segment.

Second antennular flagellum carries 4 groups of sensory hairs. Antennal endopodite is bud-like and small ; third and fourth thoracic limbs are rudimentary ; appendages on segments 5 to 8 are absent ; the

fifth pair of pleopods are smaller than the rest ; uropod is only an unsegmented, small rudiment. Telson is large and long, with 1 lateral, 6 intermediate and 6 sub-median denticles on each side. Postero-lateral corners of the abdominal segments are not acutely pointed.

*Larva, 10.0 to 10.5 mm. long.*—Carapace as in the 7.6 mm. long larva, except that the antero-lateral spines are long and pointed, that the lateral margin of carapace has only 4 spinules and that the rostrum carries 5–6 ventral spinules.

Second antennular flagellum still has only 4 groups of sensory hairs. Antennal endopodite stops short of the tip of antennal peduncle. Thoracic segments 5 to 8 carry minute bud-like limb rudiments. Fifth pleopod is still small. Uropod is a small bifid outgrowth, while the telson is long and conspicuous, with the intermediate spines stouter than the sub-medians which are longer. Denticles number 1 lateral, 9 intermediate and 6 sub-median on each side.

*Larva, 13.0 mm. long (Text-fig. 6d).*—Carapace as in the 10.0 mm. long larva, but with 7+2 marginal spinules, the last 6 of which are extremely minute and with the tip of postero-lateral spines reaching only just beyond the last thoracic segment.

The second antennular flagellum has 5 groups of sensory hairs. Antennal endopodite is segmented, but the tip does not yet reach the peduncular tip. The last three maxillipeds are not fully differentiated, the last being still rudimentary. Rudiments of peraeopods are unsegmented. Fifth pleopod is smaller than the rest. Uropod is bifid but rudimentary. Telson is large, longer than broad and has 1 lateral, 9–10 intermediate and 9–10 sub-median denticles on each side.

*Larva, 14.5 to 15.5 mm. long.*—Carapace only partially covers the 6th thoracic somite ; 2+3 marginal spinules well developed ; the rest rudimentary ; rostrum with 3 or more ventral spinules.

Second antennular flagellum with 7 or 8 groups of sensory hairs ; antennal endopodite three-jointed, with the tip projecting beyond peduncular tip ; last three maxillipeds fully differentiated and directed forwards ; peraeopods rudimentary but bifid ; fifth pleopod as large as those in front ; tip of uropod when directed backwards reaches  $\frac{1}{3}$  the distance to the lateral spine of telson ; exopodite indistinctly segmented and with a rudimentary outer spine ; tip of ventral prolongation just bifid and reaches to  $\frac{2}{3}$  the length of endopod. Sub-median spines of telson are the longest and are acutely pointed. Denticles number 1 lateral, 10 intermediate and 12–13 sub-median on each side.

*Larva, 16.5 mm. long.*—Appendages are slightly better differentiated than in the previous stage.

*Larva, 18.5 to 19.0 mm. long (Text-fig. 6c).*—Carapace as in the 16.5 mm. long larva, but has 4–5 ventral spinules on rostrum and the lateral margin is provided with 8+3 spinules as in the final pelagic stage.

Second antennular flagellum has 8 or 9 groups of sensory hairs. Antennal endopodite is a trifle longer than in the 16.5 mm. long larva and so also are the peraeopods. Tip of uropod reaches to almost half

the distance to the lateral spine of telson. Tip of ventral prolongation is inferior to the tip of endopodite ; denticles as in the 16.5 mm. long larva.

*Larva, 21.0 to 22.3 mm. long.*—Carapace as in the final pelagic larva, except that the postero-lateral spines are a trifle longer. Second antennular flagellum has 10 groups of sensory hairs. Antennal endopodite reaches half way to tip of squame ; peraeopods are almost fully differentiated ; tip of uropod reaches more than half-way to the base of lateral spine of telson ; exopod has two free spines ; outer spine at the bifid tip of the ventral prolongation is about half the length of the inner, the tip of which reaches the endopod tip. Denticles on telson are as in the 19.0 mm. long larva.

The above larva is almost identical with the final pelagic stage in details, but probably, a further stage intervenes between it and the final pelagic stage.

*Remarks.*—As already mentioned the distinctly narrow carapace makes the larva appear very slender and frail and by this feature alone it is easily distinguished from the other species. Like *S. boops* this larva also does not appear to have been described before. In general appearance it closely resembles *Alima bigelowi* (Hansen, 1895). Bigelow (1894) observed a similar larva moult into *S. quadridens*. Lebour (1934) has described a similar, though different, larva from Asia Negros. These larvae, measuring only 15 to 16 mm. in length, are very much smaller than the final pelagic stage of *S. quinquedentata* and as such the resemblance between them is perhaps only superficial.

### SQUILLA GONYPETES Wood-Mason

1939. *Squilla (Alima) sp.* ("nepa" group), Foxon, *Sci. Rept. John Murray Exped.*, Fig. 1.

*Final Pelagic Stage (Text-fig. 7).*—Only a few specimens are obtained in the tow-net collections and that too very occasionally. They resemble the larvae of *S. quinquedentata* and are of almost the same size, but can be easily distinguished from them by the distinctly broader carapace and the long telson.

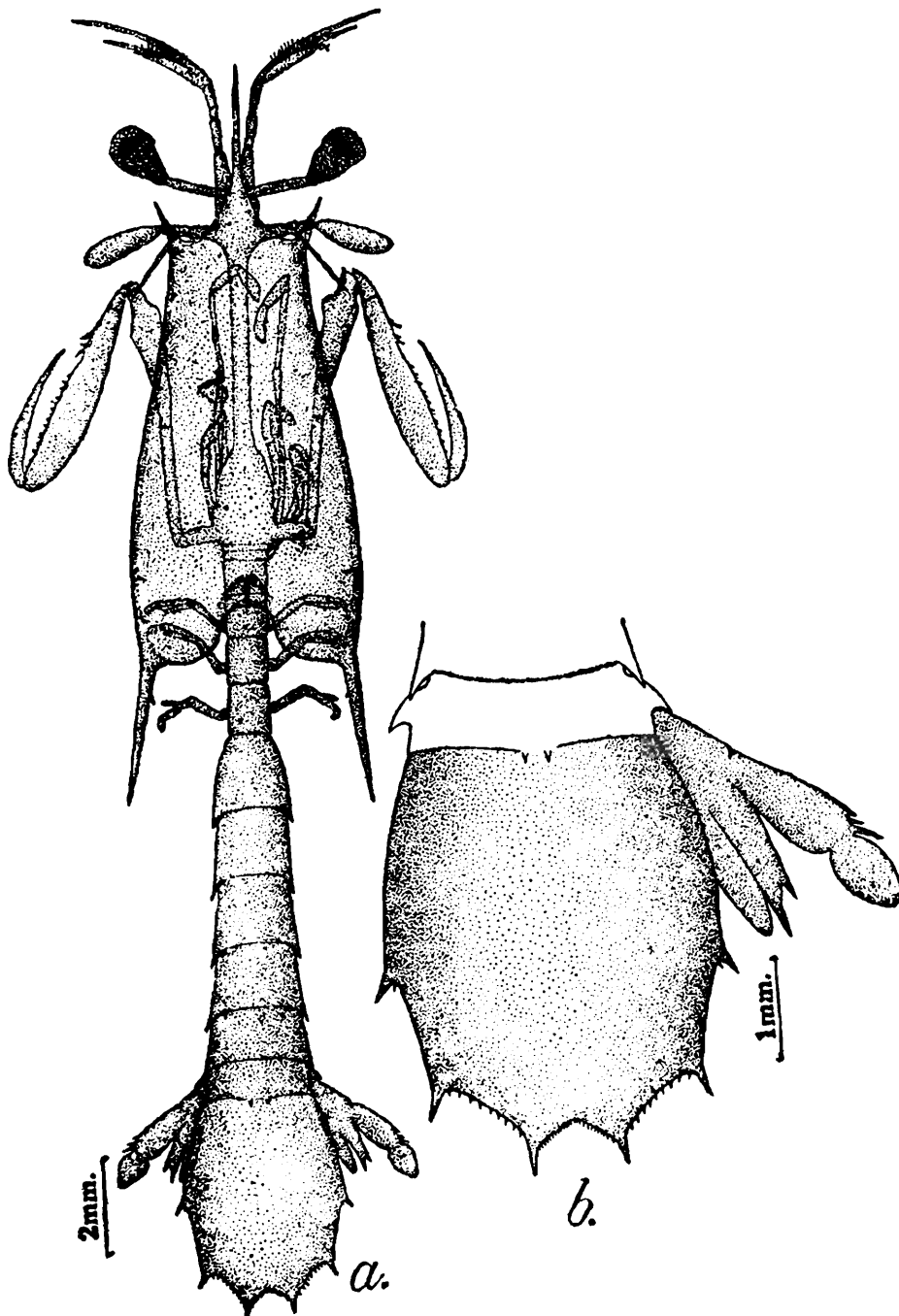
Total length .. .. .	27.0 mm.
Length of rostrum	3.2 mm.
Median length of carapace	8.5 mm.
Anterior breadth of carapace	2.9 mm.
Posterior breadth of carapace	4.7 mm.
Length of antero-lateral spine ..	1.1 mm.
Length of postero-lateral spine	3.0 mm.
Length of eye-stalk .. .. .	1.4 mm.
Length of corneal portion of eye .. .. .	1.4 mm.
Length of telson .. .. .	4.0 mm.
Breadth of telson .. .. .	3.3 mm.

Carapace posteriorly extends over the anterior part of the 6th thoracic segment. The greatest breadth of carapace (4.9 mm.) is at about the level of the 5th thoracic segment. The lateral margin is usually provided with 6+2 spinules but often an additional spinule may be present in front of the penultimate one. The rostrum is very slender and is devoid



of ventral spinules. The antero-lateral spines are acutely pointed and are longer than the dorsal spine which is very small and inconspicuous. The postero-lateral spine carries a ventral spinule at about  $\frac{1}{4}$  its length from the base, is slightly divergent posteriorly and has the tip reaching the level of the hind border of the first abdominal segment.

Peduncular segments of the antennule are long and slender, the basal one being the longest. Tip of the peduncle is inferior to the rostral tip and its second flagellum carries 12 groups of sensory hairs. Eyes are comparatively small, with the corneal portion being of almost the same length as the stalk. Raptorial limb has a peduncular spine; the propodus has three spines and a series of pectinations; while the



TEXT-FIG. 7.—*Squilla gonyptetes* Wood-Mason.

a. Final pelagic larva, 27.0 mm. long dorsal view; b. Telson and right uropod of the same, magnified.

dactylus has no free spine other than the terminal. Thoracic segments gradually become longer towards the last which is longer than broad. Abdominal segments are broader than the thoracic and become gradually shorter towards the last. The postero-lateral corners are produced into long, acute spines. The 6th somite is about  $2\frac{1}{2}$  times as broad as long and has a pair of sub-median dorsal spines and an additional pair of antero-lateral spines, directed ventrad. Telson is characteristically longer than broad (*Text-fig. 7b*). The marginal spines are long and slender. The denticles number 1 lateral, 9 intermediate and 13 sub-median on each side. The tip of uropod when directed backward reaches beyond the lateral spine of telson. The exopod has three free spines. The ventral prolongation is bifid, the outer spine being about half the size of the inner which has its tip projecting beyond the distal end of the endopod and has no prominence on its outer basal aspect.

*Remarks.*—The *Alima* sp. figured by Foxon (1939) from the Red Sea appears to be identical with the final pelagic stage of *S. gonypetes*. Foxon, however, does not give details of the spinulation of carapace; nor are these evident from his figure. The shape and proportion of carapace, structure of telson and uropods and size, however, are features in common with the Madras larva. In attempting to allocate the larva to the adult, Foxon suggested that it might belong to the “*nepa*” group and probably to *S. investigatoris*. The majority of his specimens were of an earlier stage than the final pelagic, unlike “the three rather damaged specimens” caught from the gulf of Oman and which showed indications of 5 spines on the raptorial claw. Foxon, therefore, pointed out that there is a chance that these larvae do not belong to the “*nepa*” group, but considered it most likely that another spine may be added on the dactylus at a subsequent moult. It seems fairly certain, as shown above, that Foxon was actually dealing with larvae of *S. gonypetes* which occurs in the same locality.

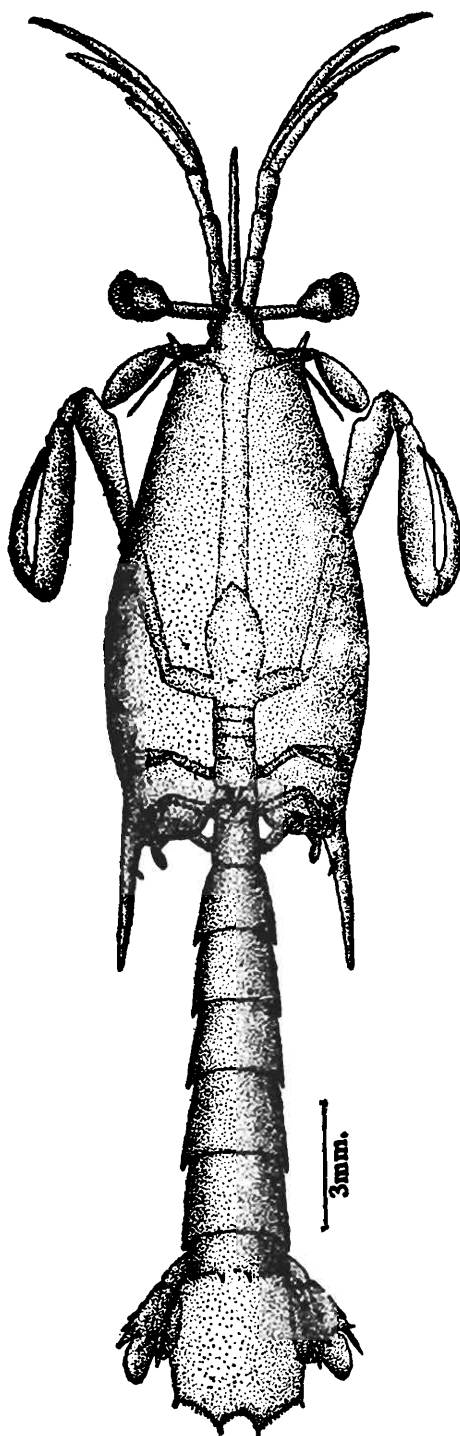
### SQUILLA HIEROGLYPHICA Kemp

1944. *Squilla (Alima) hieroglyphica*, Alikunhi, *Curr. Sci., Bangalore*, fig. a-d.

*Final Pelagic Stage (Text-fig. 8).*—A brief description of the final pelagic larva of this rare stomatopod, obtained from the plankton collected on 5-3-1943, has already been published (Alikunhi, 1944). While no other specimen was obtained during the present investigations, I have included in this report a complete figure of the final pelagic larva for the sake of comparison with those of the other species and easy identification. There is nothing to add to the description already given.

*Remarks.*—Of the typical, larger *Alima* larvae of the Madras plankton, the final pelagic stage of *S. hieroglyphica* is easily distinguished when alive by the characteristic pigmentation on the ‘Hands’ of the 3rd, 4th and 5th thoracic appendages. Unlike other species of the ‘*Quinquedentata*’ group, viz. ; *S. boops*, *S. quinquedentata* and *S. gonypetes*, this larva has a broader carapace which has a general resemblance to that of the final pelagic larva of *S. wood-masoni*.

The species appears to be very rare in the Madras waters.



TEXT-FIG. 8.—Final pelagic larva of *Squilla hieroglyphica* Kemp, 30.0 mm. long, dorsal view.

### **SQUILLA RAPHIDEA** (Fabricius)

1871. *Alimerichthus*, Claus, *Abh. Ges. Wiss. Gottingen*, pl. viii, fig. 30.
1903. *Alimerichthus pyramidalis*, Lanchester, *Fauna Geog. Maldives and Laccadive Archipelagoes*.
1932. *Alima pyramidalis*, Foxon, *Sci. Rept. Great Barrier Reef Exped.*
1939. *Alima multispinus* (Atypical form), Foxon, *Sci. Rept. John Murray Exped.*, Fig. 2b.

*Final Pelagic Stage (Text-fig. 9).*—A few specimens are occasionally brought up in the plankton catches. The relatively small size, the short, stout carapace and the broad abdominal segments are characteristic of the final pelagic larva.

Total length ..	18.1 mm.
Length of rostrum	2.2 mm.
Median length of carapace	6.5 mm.
Anterior breadth of carapace ..	3.3 mm.
Posterior breadth of carapace	5.8 mm.
Length of antero-lateral spine ..	1.0 mm.
Length of postero-lateral spine	2.1 mm.
Length of eye-stalk .. ..	1.4 mm.
Length of corneal portion of eye .. ..	1.8 mm.
Length of telson .. ..	2.6 mm.
Breadth of telson .. ..	3.1 mm.

The carapace is broad and covers all the thoracic somites posteriorly. Its lateral margin is provided with 4+3 spinules of which the first two, near the base of the antero-lateral spines are ventrally directed. The third one, larger than the foregoing two and situated just in front of the middle point of the lateral margin is directed ventro-laterally; while the fourth, situated a little behind the 3rd is much larger and is directed laterally. The last three spines are smaller, directed ventrad and nearer to the postero-lateral angle of the carapace. The rostrum is slender and carries a weak ventral spinule at about its middle point. The antero-lateral spine is almost equal to the dorsal spine which is acutely pointed. The postero-laterals are short and each has a ventral spinule a little in front of its middle point. They are slightly divergent posteriorly, with the tips reaching the level past the hind border of the second abdominal segment.

The tip of the antennular peduncle is inferior to the rostral tip and the second flagellum of the antennule carries 9 groups of sensory hairs. The eyes are conspicuous and are distinctly larger than the stalk. In the raptorial limb the basal segment does not possess a terminal spine. The propodus has three stout spines at the base, but the pectinations along the margin are few and there are some additional short hairs. The dactylus has no free tooth other than the terminal. Indications of seven to 9 spines are, however, visible through the skin. The third and fourth segments of the thorax are short, while the fifth is about double the size of the 4th. The last three thoracic somites are longer than the preceding ones and each is about three times as broad as long. The abdominal segments are broader than the thoracic, the sixth segment being about 4 times as broad as long. The postero-lateral corners of the abdominal segments, except the last one, end in acute spines. The last has a pair of sub-median spines and an additional stout spine on the lateral margin anteriorly, directed ventro-laterally backwards. The telson is very much broader than long and has the marginal spines fairly elongated. The sub-median space is wide. The denticles number 1 lateral, 13-14 intermediate and 19-20 sub-median on each side. The tip of uropod when directed backwards reaches half-way between the lateral and intermediate spines of telson. The basal segment of the

exopod carries 4 or 5 free spines. The terminal spines of the ventral prolongation of the uropod are unequal, the inner one being longer than double the length of the outer and has a distinct smooth prominence at the outer basal aspect.

Occasionally, besides the typical larva described above, a closely similar one with a larger carapace is also collected. Dimensions of one such specimen are given below :

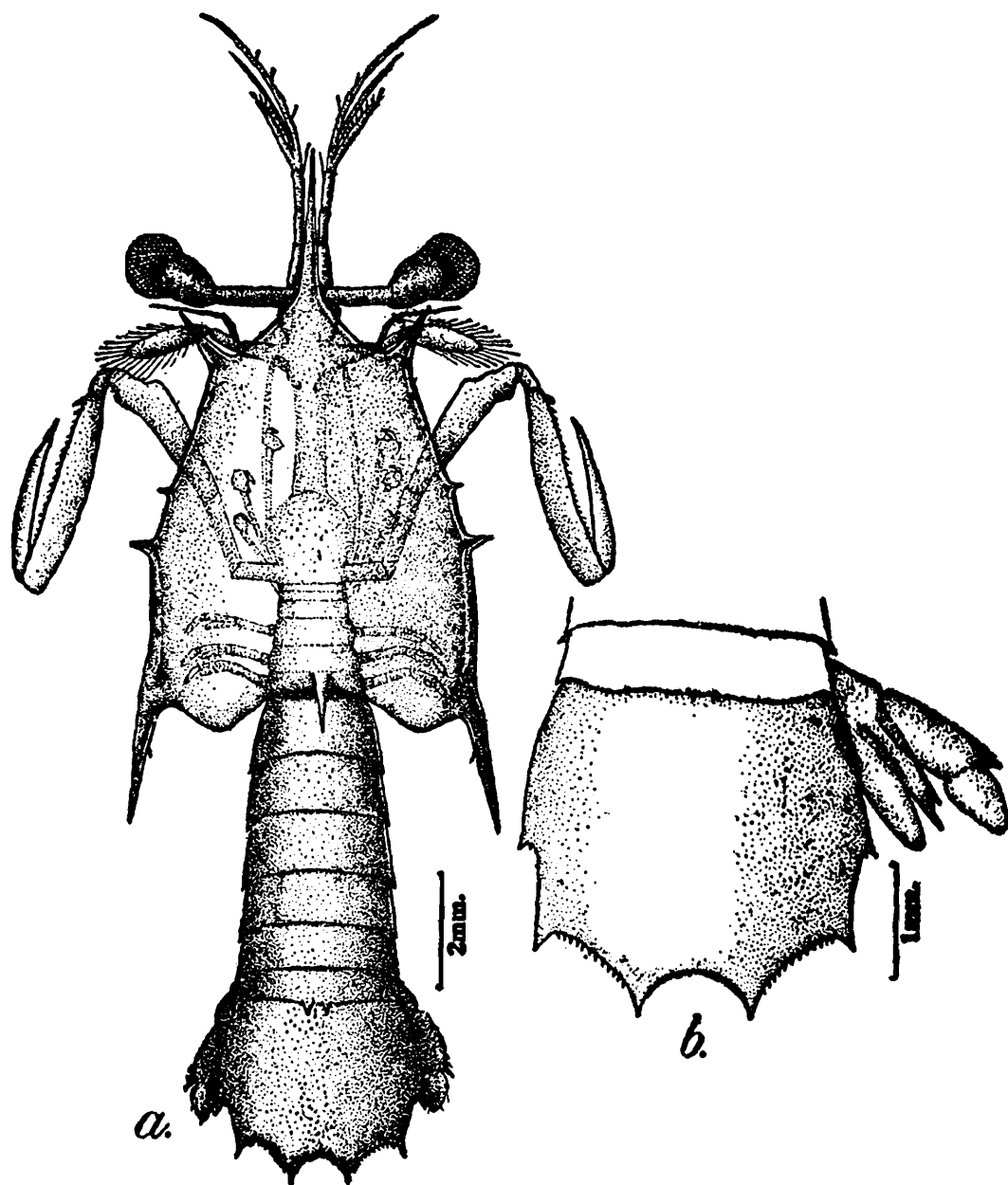
Total length	..	..	18.2 mm.
Length of rostrum	..	..	2.9 mm.
Median length of carapace	..	..	7.5 mm.
Anterior breadth of carapace	..	..	4.2 mm.
Posterior breadth of carapace	..	..	7.0 mm.
Length of postero-lateral spine			3.0 mm.
Length of antero-lateral spine		..	1.1 mm.
Length of eye-stalk	..	..	1.5 mm.
Length of corneal portion of eye		..	2.0 mm.
Length of telson			3.1 mm.
Breadth of telson			3.6 mm.

Though hardly longer than the typical form, the larva appears much stouter and has the different parts also relatively bigger than in the typical form. When placed side by side and examined, the two larvae look very different, eventhough in the details of structure they do not differ so much. The spinulation of carapace is identical with that in the typical form, except that the laterally directed spine is perhaps a little stouter. The postero-lateral spines are long, almost parallel to the body and have their tips reaching the level of the hind border of the 4th abdominal segment. Telson is bigger than in the typical larva and has 1 lateral, 11 intermediate and 21 sub-median denticles on each side. The outer spine of the basal prolongation of the uropod is only about  $\frac{1}{2}$  the length of the inner. The second antennular flagellum carries 10 groups of sensory hairs. Eyes are slightly more rounded and large. In all other features the larva is identical with the typical one.

*Remarks.*—While the typical larva has been definitely correlated with *S. raphidea* by rearing the pelagic larvae into post-larvae, it is not yet certain whether the atypical form with the larger carapace, also belongs to the same species. The post-larva obtained by moult from one such larva more or less agrees with *S. raphidea*. However, since the early post-larvae in most cases do not show the full adult characters and since *S. raphidea* and *S. annendalei* are very closely related, it is a possibility that the atypical larva probably belongs to the latter species. This is, however, just a surmise which is not based on any positive evidence.

The final pelagic larva of *S. raphidea* appears to be identical with Claus's *Alimerichthus* sp. Claus's figure, however, shows only one laterally directed spinule on the margin of carapace ; but size, general appearance, shape and proportion of carapace and the clear indication of 8 spines on the dactylus of the raptorial claw are in agreement with the present larva.

Lanchester (1903) considers *Alimerichthus* sp. of Claus and Books as synonymous with his *A. pyramidalis*, which measured 17 mm. in length. While no figure is available for comparison and since details of the spinulation of carapace are also wanting it is not possible to state definitely whether this larva is identical with the Madras form; but from the description given the two appear to be identical.



TEXT-FIG. 9.—*Squilla raphidea* (Fabricius).

*a.* Final pelagic larva, 18.1 mm. long, dorsal view; *b.* Telson and right uropod of the same, magnified.

Foxon (1932) considers *A. pyramidalis* Lanchester, *A. unidens* Lanchester and *Alimerichthus a* Tattersall as belonging to a single species. He observes that the characters used by Lanchester and Tattersall to differentiate their species are subject to much variation. However, *A. unidens* has now been shown to be the final pelagic larva of *S. fasciata* (p. 50) and *Alimerichthus a*, the corresponding stage of *S. latreillei* (p. 47). That Foxon was dealing with a collection of species under the name *A. pyramidalis* is, therefore, obvious. Since larvae measuring 18 mm. in length are reported in this collection, it is likely that *S. raphidea* is also represented in it.

The atypical form of *Alima multispinous* described by Foxon (1939) also shows close similarity to the final pelagic larva of *S. raphidea*. Foxon observed that this atypical larva " appears to be that figured by Claus in his figure 30' But, like Claus's *Aimerichthus*, in this larva also only one laterally directed spinule is seen along the margin of carapace. Full details of the spinulation of carapace are not given by Foxon, nor are these evident from his figures. However, in size, general shape of carapace and indications of seven spines on the dactylus of raptorial claw Foxon's larva (atypical form) agrees with *S. (Alima) raphidea*. The typical specimens of *A. multispinus*, as figured by Foxon, have two lateral spinules on the carapace, but the shape of carapace is different from that in *S. (Alima) raphidea*. Also the raptorial dactylus of the former has 4 free teeth which is never the case in the final pelagic larva of *S. raphidea*.

Foxon, attempting to refer these larvae to their adults, pointed out that if the typical and atypical larvae are specifically distinct, they might belong to *S. raphidea* and *S. annendalei*. As already pointed out, while the atypical form is perhaps identical with *S. (Alima) raphidea*, the typical larva might well belong to the closely related *S. annendalei*.

Claus's *Erichthus multispinus* appears to be a very different species, probably not related to *S. raphidea*, even though it also possesses laterally directed spinules on the carapace. Borradaile's specimens are perhaps identical with the specimen figured by Claus. The shape and spinulation of carapace in *E. multispinus* is so characteristic that it is doubtful whether *A. multispinus* of Foxon has been rightly referred to that species.

### SQUILLA SCORPIO Latreille

1915. *Squilla (Alima) scorpis*, var. *immaculata*, Kemp, *Mem. Ind. Mus. Calcutta*; fig. 2g.

1929. *Squilla (Alima) oratoria*, Komai & Tung, *Annot. Zool. Jap.*, Pl. ii, figs. 1-26; pl. iii, figs. 7-17.

*Final Pelagic Stage (Text-fig. 10).*—Very rarely caught in the tow-net, this larva closely resembles the final pelagic stage of *S. fasciata*, but colouration, the characteristically long rostral and postero-lateral spines, the small spinule at the posterior margin of carapace and the absence of laterally directed spines on the margin are features that easily distinguish this larva. Dimensions of a single specimen (with rostrum broken near base) collected on 2-8-1940 are given below :

Total length excluding rostrum	...	...	...	9.2 mm.
Median length of carapace	...	...	...	3.1 mm.
Anterior breadth of carapace	...	...	...	1.7 mm.
Posterior breadth of carapace	...	...	...	2.9 mm.
Length of antero-lateral spine	...	...	...	0.7 mm.
Length of postero-lateral spine	...	...	...	3.3 mm.
Length of eye-stalk	...	...	...	1.0 mm.
Length of corneal portion of eye	...	...	...	1.4 mm.
Length of telson	...	...	...	1.03 mm.
Breadth of telson	...	...	...	1.04 mm.

The carapace is small and narrow and posteriorly extends over the anterior half of the 7th thoracic segment. The antero-lateral spines are acutely pointed and are longer than the dorsal spine. The lateral margin of carapace has 1+3 spinules. The postero-lateral spines are markedly divergent posteriorly; each has a ventral spinule at about  $\frac{1}{3}$  its length from base and has the tip reaching the level of the 4th abdominal segment. On the hind margin of carapace, between the postero-lateral and dorsal spines there is a characteristic small spinule.

The second antennular flagellum has 5 groups of sensory hairs. The raptorial dactylus has no free tooth other than the terminal; but clear indications of five teeth are visible beneath the skin. Postero-lateral corners of the abdominal segments are obtuse. The 6th abdominal segment has a pair of sub-median dorsal spines. The marginal spines of telson are well developed. The denticles number 1 lateral, 5 intermediate and 9 sub-median on each side. The uropod when directed backward reaches the base of the intermediate spine of telson. The exopodite of uropod has 3 free spines basally and shows indications of 3 more beneath the skin. The outer spine of the ventral prolongation of the uropod is half as long as the inner which has a very conspicuous basal swelling.

*Earlier Stages of Larvae.*—These are also equally rare as the final pelagic stage and only two specimens have been available for study.

*Larva, 5.1 mm. long.*—The rostrum and postero-lateral spines are very long and conspicuous; the two characteristic spinules at the hind margin of carapace are present; lateral margin has 1+3 spinules; carapace posteriorly covers all the thoracic segments; shape of carapace is the same as in the final pelagic stage, and tip of the postero-lateral spine reaches the level of the telson. Antennular peduncle is short. Antennal endopodite is bud-like and reaches half-way to the tip of antennal peduncle. Rudiments of the last three maxillipeds are present, but are small; peraeopods are not formed yet. Postero-lateral corners of the abdominal segments are not pointed. 5th pleopod is rudimentary. The 6th abdominal segment and the uropods are not differentiated. Telson is longer than broad, with wide sub-median space. There are 3 intermediate and 9 sub-median denticles on each side.

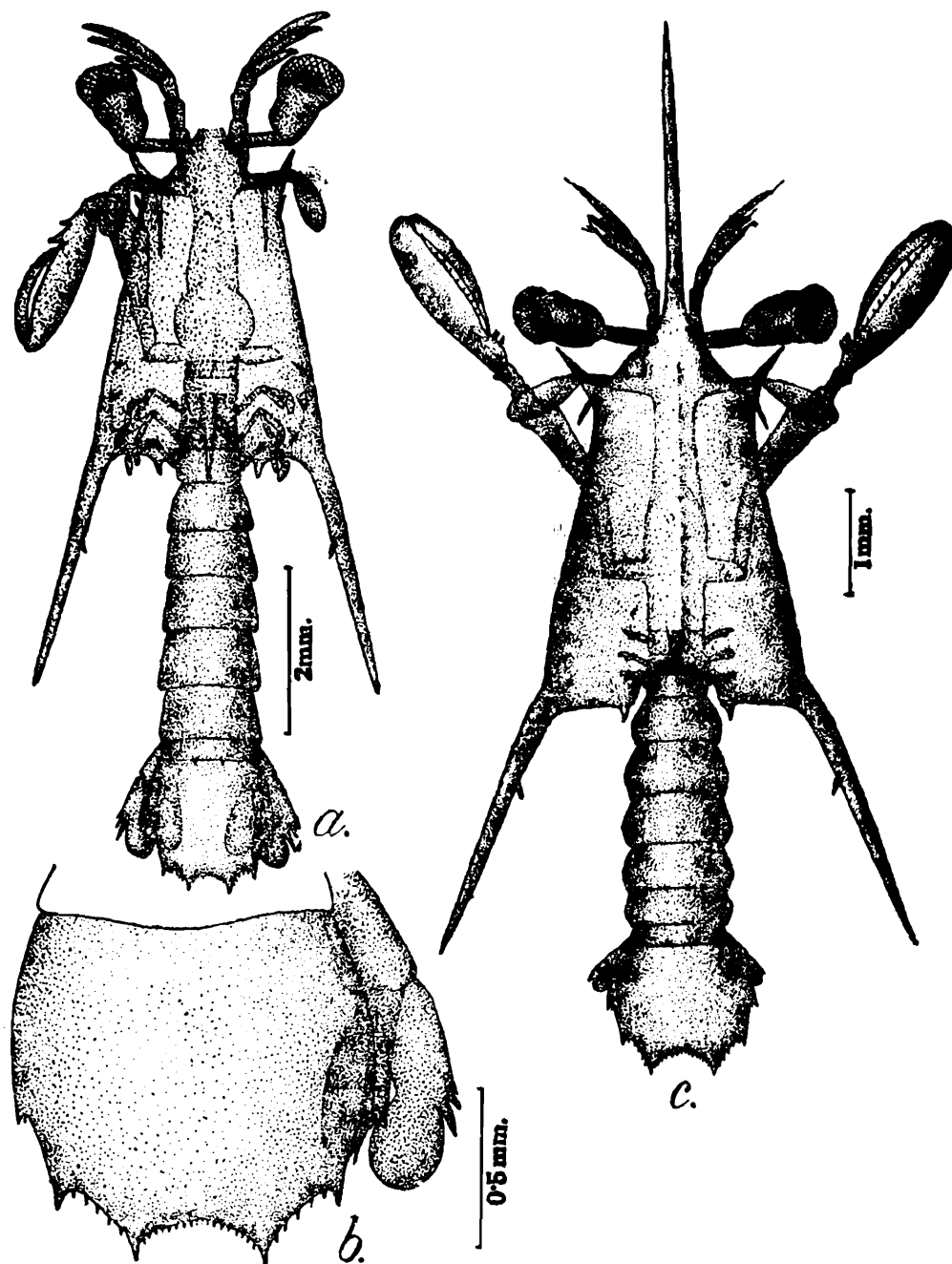
*Larva, 9.8 mm. long (Text-fig. 10c).*—Spines of carapace are longer than in the final pelagic stage. Carapace is narrow, almost triangular in outline and extends over the 7th thoracic somite. Rostrum is very long and has 3 large ventral spinules. Postero-lateral spines are greatly divergent posteriorly and each has the tip reaching the level of the base of telson. Second antennular flagellum has 3 groups of sensory hairs. Eyes are large. Antennal endopodite is segmented and reaches half-way to the tip of squame. Postero-lateral corners of abdominal segments do not end in spines. Uropods when directed backward do not reach the base of the lateral spines of telson. Exopod of uropod has only 1 free spine. The ventral prolongation is just bifid at the tip and is shorter than the endopod. Telson is almost as broad as long and has the sub-median space wide. Denticles number 1 lateral, 5 intermediate and 7-8 sub-median on each side.



*Colouration*.—In living specimens a conspicuous bright yellow spot at the mandibular region beneath the carapace and a still larger rosy patch of colour on the protopodite of the 3rd pleopod are characteristic. The latter patch is formed of an irregular spot of deep yellow, surrounded by a rose red area. Distal portions of rostrum and postero-lateral spines of carapace and the raptorial propodus and dactylus are also provided with a few bright yellow pigment granules.

*Remarks*.—The final pelagic larva could not be reared to undergo metamorphosis and as such positive evidence for correlating the larva to *S. scorpio* is lacking.

Kemp (1915) describes a series of larvae from the Chilka lake and refers them to *S. scorpio* var. *immaculata* on the ground that it is the



TEXT-FIG. 10.—*Squilla scorpio* Latreille.

a. Final pelagic larva, 9.1 mm. long (excluding rostrum), dorsal view ; b. Telson and right uropod of the same, magnified ; c. Larva, 9.8 mm. long, dorsal view.

commonest stomatopod in the lake. Judging from the nature of the uropods, Kemp's largest larva (11.5 to 12.0 mm.) is probably in an earlier stage than the final pelagic. The present larvae resemble Kemp's specimens in all essential features and undoubtedly belong to the same species. It is, however, seen that they differ from the Chilka specimens in the relatively longer rostrum and postero-lateral spines of carapace and in the possession of an additional spinule on the rostrum and on the lateral margin of carapace. Of the larvae figured by Kemp, the smallest specimen, represented in his figure 2g, shows remarkable resemblance to the present form and is probably identical with it. I had also occasion to examine two collections from the Chilka lake, dated 12-6-1948 and 16-7-1948 respectively, in which, besides the stages figured by Kemp, the final pelagic larvae and a few early *Alima* were also present.\* The final pelagic larva agrees in almost all details with the 11.5 to 12.0 mm. long larvae described by Kemp. Indications of five teeth on the dactylus of the raptorial claw are visible through the skin. The smallest specimen in the present Chilka Lake collections measured 5.2 mm. in total length. In none of these specimens the rostrum and postero-lateral spines are unusually long. The lateral margin of carapace invariably has only 1+2 spinules. On the other hand, all the larvae, including those the final pelagic stage, collected from Madras have the spines of carapace much longer than in the Chilka specimens and the lateral margin of carapace also has 1+3 spinules. Since the above differences are so constant I am inclined to believe that the Madras larvae and also the smallest larva figured by Kemp (as Fig. 2g) probably belong to *S. scorpio*; while the rest of the Chilka specimens belong to the variety *immaculata*.

In a valuable contribution Komai & Tung (1929) have described a series of larval stages which they ascribe to *S. oratoria*, even though no specimen undergoing metamorphosis has come under their observation. Conclusive proof that the larvae described belong to *S. oratoria* is, therefore, lacking, the identification being based merely on the comparative abundance of *S. oratoria* in the locality concerned (Tokyo Bay). Thus, the authors conclude that "the other species of the same genus known in the same locality, namely *S. fasciata*, *S. mikado* and *S. scorpio* being incomparably rarer, the chance that a given *Alima* larva belongs to any one of these species is evidently negligible" This, at best, is only a probability and a careful perusal of their paper shows that in the stages ascribed to *S. oratoria* the larvae of at least two different species have been mixed up. Stages 4, 5, 6 and 7 (specimens collected on July, 12, 1919), represented by figures 1 to 26 of plate ii and 7 to 17 of plate iii seem to belong to a very different species than the supposed *S. oratoria*. The authors themselves have referred to "some remarkable differences to be found between the specimens of stages 6 and 7 collected on July, 12, 1919 and those collected on August, 27, 1917" These larvae closely resemble Kemp's specimens from the Chilka lake and in all probability belong to *S. scorpio*, which also occurs in Tokyo bay. Even though Komai & Tung have not referred to Kemp's paper (1915), they have

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\* I am indebted to Mr. P. M. G. Menon for kindly placing these collections at my disposal.

observed in their specimens the characteristic spines at the hind margin of the carapace, mid-way between the zoea and the postero-lateral spines, which Kemp had already shown to be a unique feature of the larvae of *S. scorpio*.

### **SQUILLA LATREILLEI** (Eydoux & Souleyet)

1906. *Alimerichthus a*, Tattersall, *Rept. Pearl Oyster Fish.*, figs. 27-29.

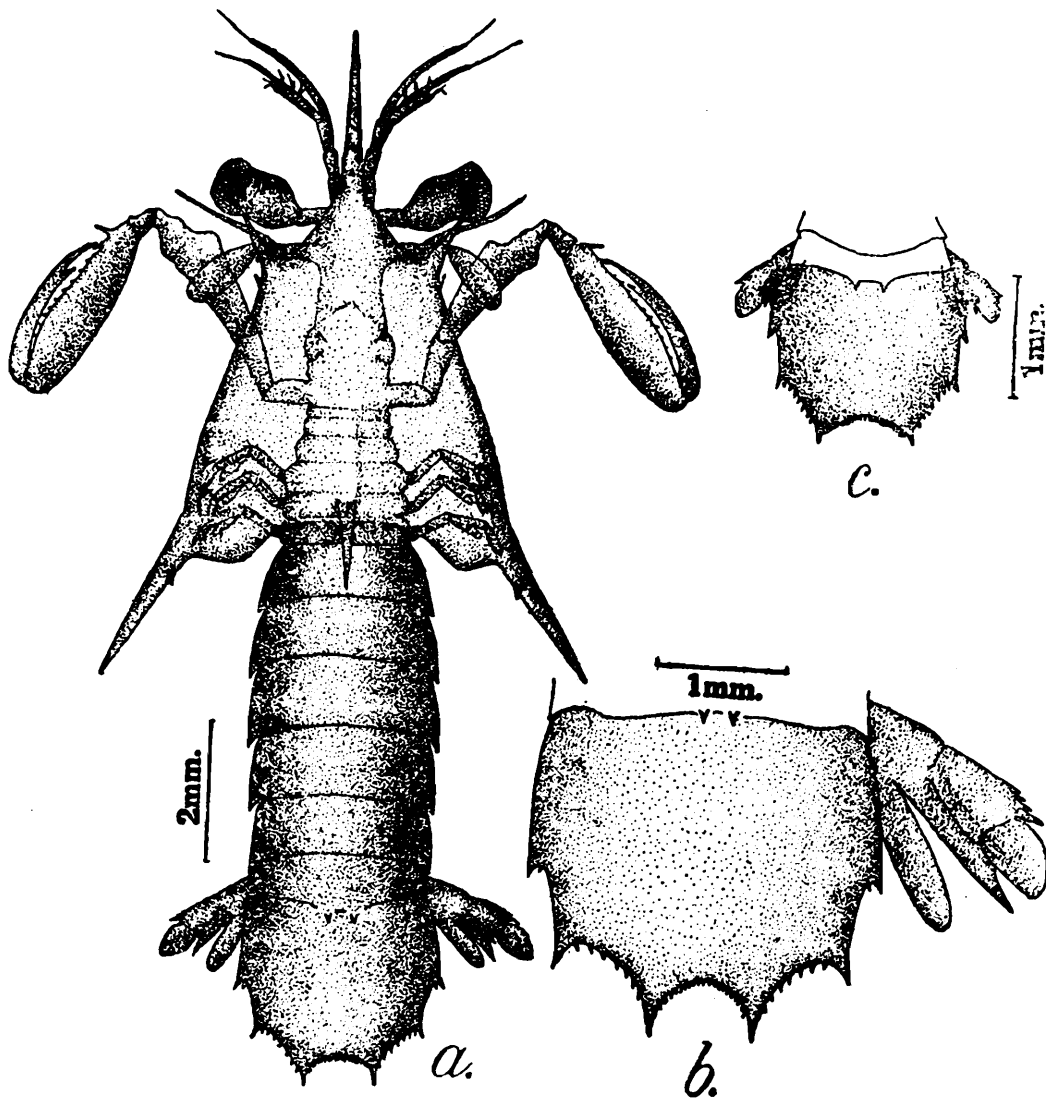
*Final Pelagic Larva* (Text-fig. 11).—The larva does not occur in large numbers and is only occasionally caught in the tow-net. The small size, the comparatively broad, triangular carapace and the thick robust appearance are features by which it could be easily distinguished from the larvae of other species. The length at the final pelagic stage varies slightly, specimens measuring 10.5 mm. to 13.0 mm. having been observed to undergo metamorphosis into post-larvae.

Total length ...	...	...	...	...	12.6 mm.
Length of rostrum ...	...	...	...	...	2.6 mm.
Median length of carapace	...	...	...	...	3.2 mm.
Anterior breadth of carapace	...	...	...	...	2.0 mm.
Posterior breadth of carapace	...	...	...	...	4.0 mm.
Length of postero-lateral spine	...	...	...	...	2.0 mm.
Length of dorsal spine ...	...	...	...	...	0.9 mm.
Length of corneal portion of eye	...	...	...	...	1.1 mm.
Length of telson ...	...	...	...	...	2.4 mm.
Breadth of telson ...	...	...	...	...	2.8 mm.

The carapace is small and approaches a triangle in outline. Posteriorly it extends over the 7th thoracic segment. It is characterised by a median dorsal carina which terminates posteriorly in the conspicuous dorsal spine situated on a prominent elevation at the hind margin of carapace. The lateral, in-turned margin of carapace has only three spinules; the first of which situated at the base of the antero-lateral spine is fairly prominent and ventro-laterally directed; while the other two are situated nearer the postero-lateral corner. The rostrum is long and stout and has 2 or 3 prominent ventral spinules. The antero-lateral spines are short and stout and are only a little longer than half the length of the prominent dorsal spine. The postero-lateral spines are highly divergent posteriorly, each has a ventral spinule at about  $\frac{1}{4}$  its length from the base and has the tip reaching the level of the hind border of the third abdominal segment.

The tip of antennular peduncle is far inferior to the rostral tip. The second flagellum of the antennule carries only 4 groups of sensory hairs. The eyes are comparatively large, with short stalk. Unlike species of the "nepa" and "quinquedentata" groups, in the final pelagic larva the region between the antenna and the labrum is not very much telescoped. The raptorial propodus is fairly thick; has three stout basal spines and a row of pectinations. The dactylus has an additional free tooth besides the terminal; but occasionally a second one may also be present. The thoracic and abdominal segments are very much broader

than long. The postero-lateral corners of the first five abdominal segments are produced into spines; while the 6th segment has a pair of sub-median dorsal spines and a pair of ventrally directed stout spines anteriorly. The sub-median spines of telson are long. The denticles number 1 lateral, 7 or 8 intermediate and 17 to 19 sub-median on each side. The tip of uropod when directed backwards reaches half-way between the lateral and intermediate spines of telson. The exopod carries 3 free spines, while the inner spine of the ventral prolongation is about twice the length of the outer and has a smooth prominence externally.



TEXT-FIG. 11.—*Squilla latreillei* (Eydoux and Souleyet).

a. Final pelagic larva, 12.6 mm. long, dorsal view; b. Telson and right uropod of the same, magnified; c. Telson and uropods of larva 8.5 mm. long.

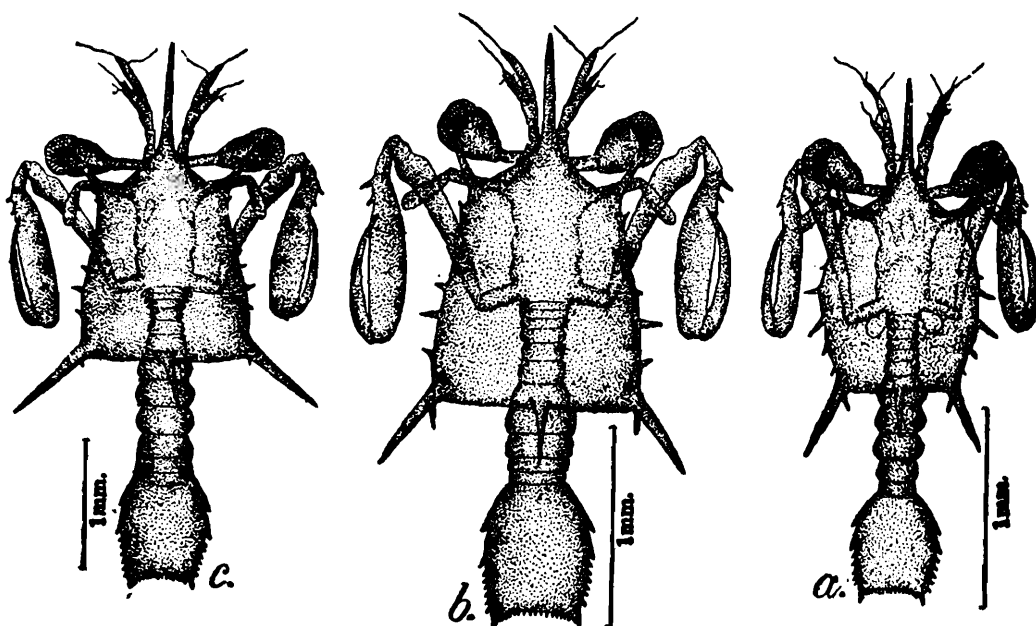
**Colouration.**—A general tinge of greenish yellow, due to scattered chromatophores on the margin of carapace gives the larva a beautiful appearance in the living or freshly preserved condition. The mandibular region and the basal segment of the 4th pleopod appear as conspicuous golden yellow spots to the naked eye. The basal segment of all the pleopods has a less conspicuous patch of red, and the propodus of the raptorial claw is also provided with a few yellow chromatophores. The colouration is less conspicuous in the earlier stages, but the patches on the 4th pleopod and the mandibular region are developed even at a very early stage.

*Earlier Stages of Larvae*.—A complete series of larval stages, each represented by several specimens, have been available for study.

*Stage 1, 2.4 mm. to 2.7 mm. long* (Text-fig. 12a).—Minute, extremely slender and with large eyes, this early *Alima* has the carapace posteriorly extending over the middle portion of the first abdominal segment. The breadth of carapace between the postero-lateral spines is almost equal to that between the antero-lateral spines; the lateral margin is smoothly convex. Rostrum is longer than the postero-lateral spines; while the two acutely pointed antero-lateral spines are shorter than the zoea spine. Postero-lateral spines are divergent posteriorly; each has a prominent ventral spinule near the base and has the tip reaching the level of the 3rd abdominal segment. Lateral margin of carapace has 6 spinules, all directed laterally. The second spinule is extremely minute; while the 3rd and 4th, situated at about the middle point of the lateral margin are large and conspicuous.

The antennular peduncle is short; the second flagellum has only 2 groups of sensory hairs; there is no endopodite on the antenna; thoracic appendages behind the raptorial limb have not appeared; there are only 4 pairs of pleopods; the fifth pleopod, the sixth abdominal segment and uropods are not developed; telson is longer than broad, with wide sub-median space and the denticles on telson number 5 intermediate and 8 sub-median on each side.

*Stage 2, 2.8 mm. to 4.0 mm. long*, (Text-fig. 12b.)—The shape of carapace has changed, its greatest breadth being between the postero-lateral spines. The antero-lateral spines are almost equal to the zoea spine in length. There are only 5 spinules along the lateral margin of carapace; the second spinule seen in the previous stage having disappeared. The last spinule is directed ventrad. Postero-lateral spines are conspicuously divergent posteriorly and each has a very conspicuous ventral spinule basally. In other features the larva agrees with the previous stage.



TEXT-FIG. 12.—*Squilla latreillei* (Eydoux and Souleyet).

a. Larva, 2.6 mm. long, dorsal view; b. Larva, 3.0 mm. long; c. Larva, 4.2 mm long.

*Stage 3, 4.1 to 5.0 mm. long* (Text-fig. 12c).—Very similar to the previous stage. Two ventral spinules have appeared on the rostrum. Rudiment of antennal endopodite has appeared. Maxillipeds 3 to 5 are indicated by minute stump-like rudiments; the 5th being the smallest. The 5th pleopod has appeared as a small bifid structure. The 6th abdominal segment is just indicated, but not fully differentiated. There is no indication of the uropods; while two extremely minute sub-median dorsal spines have appeared on the rudimentary 6th abdominal segment.

*Stage 4, 5.1 to 5.9 mm. long* (Text-fig. 13a).—Carapace is almost triangular in shape; the marginal spines excepting the antero-laterals are conspicuously large; the lateral margin is flexed inwards. There are only 3 marginal spinules on carapace, all directed ventrad. Antennal endopodite is blunt, stump-like and unsegmented. The last three thoracic appendages (peraeopods) are indicated. Postero-lateral corners of the first four abdominal segments are rounded. Those of the 5th are sub-acutely pointed. 5th pleopod is smaller than the rest. The 6th abdominal segment is better differentiated than in the previous stage and rudiments of uropods are also indicated. The shape of telson has not changed.

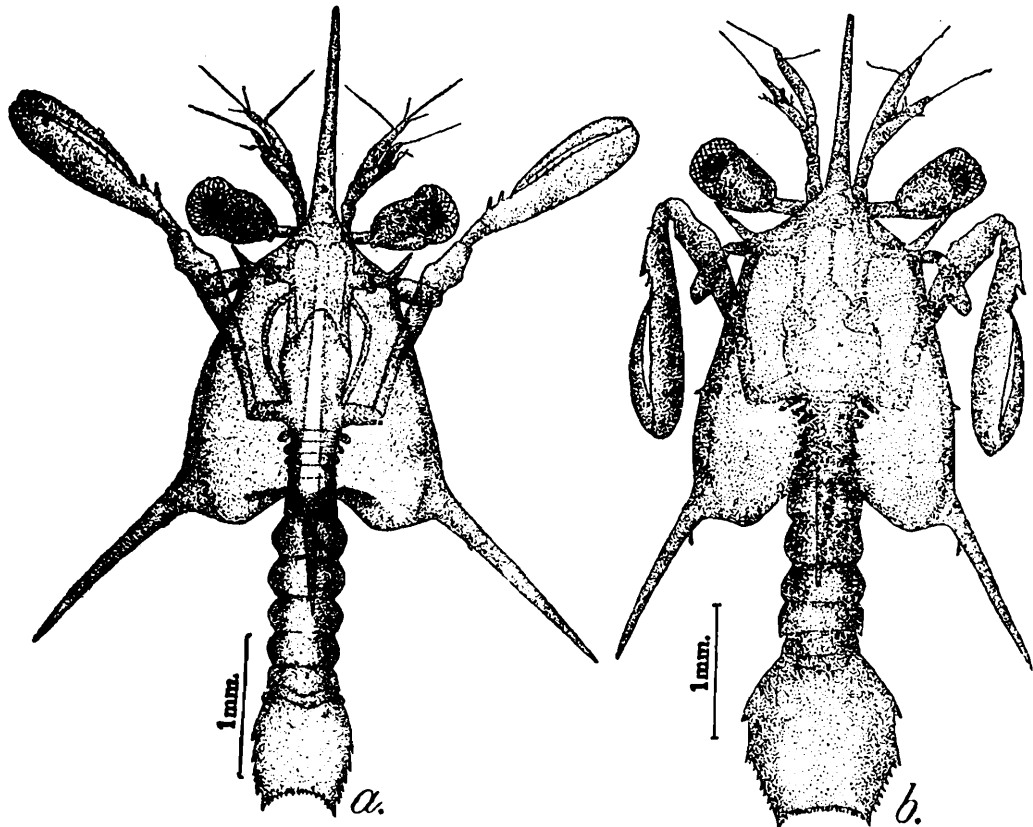
*Stage 5, 6.0 to 6.5 mm. long* (Text-fig. 13b).—Spines of the carapace are not so conspicuous as in the previous stage. Lateral margin has 1+2 spinules, but occasionally an additional minute spinule may be present a little in front of the second. Rudiments of the last three maxillipeds are short and finger-like. Peraeopods are rudimentary and bud-like, the third being the longest. Postero-lateral corners of the 4th and 5th abdominal segments are pointed. Sub-median spines on the 6th segment are more prominent. Rudiments of uropods are unsegmented. Shape of telson has changed. Denticles number 7 or 8 intermediate and 13 or 14 sub-median on each side.

*Stage 6, 6.6 to 7.8 mm.*—Resembles the previous stage in general appearance. Antennal endopodite is elongated and reaches to the tip of the antennal peduncle, or sometimes even projects a little beyond. The third to the fifth maxillipeds are better differentiated and are getting directed forwards. Peraeopods are more elongated. Ventral prolongation of the uropod is indicated.

*Stage 7, 7.9 to 9.5 mm.* (Text-fig. 11c).—Shape of carapace approximates to that of the final pelagic larva. All the thoracic segments are covered by the carapace. Rostrum has three spinules ventrally. Antennal endopodite reaches half-way to the tip of squame. Raptorial dactylus has one free spine besides the terminal. The second flagellum of the antennule has 4 groups of sensory hairs. Maxillipeds are all well developed. Peraeopods are still short but are bifid and fully segmented. Abdominal segments are very broad and have the postero-lateral corners sub-acutely pointed. Telson has 1 lateral, 6—7 intermediate and 15 sub-median denticles on each side. Uropods when directed backwards hardly reach the base of the lateral spines of telson. Exopod has one free spine. Ventral prolongation is insipiently bifid and is pointed at the tip.

With the subsequent moult the larva probably enters the final pelagic stage.

*Remarks.*—The final pelagic larva appears to be identical with *Alimerichthus a* of Tattersall (1906) and agrees with the latter in almost all features. Foxon (1932) however, considered Tattersall's species as synonymous with Lanchester's (1903) *Alimerichthus pyramidalis* and *A. unidens*. Describing *Alimerichthus a* Tattersall clearly stated that the prominent ventro-lateral spines on the carapace midway between the antero- and postero-lateral spines, as seen in *A. pyramidalis* and *A.*



TEXT-FIG. 13.—*Squilla latreillei* (Eydoux and Souleyet).

a. Larva, 5.6 mm. long, dorsal view; b. Larva, 6.1 mm. long, dorsal view.

*unidens* is absent in his species. Foxon, however, was of the opinion that the above feature and the small size of the larva considered along with the stage of development, were not sufficient to justify creation of a new species for its reception. As already mentioned (*vide S. raphidea*), these two larvae which are distinguished from each other only by differences in the spinulation of the carapace, size at the final pelagic stage and the presence or absence of free spines on the dactylus of the raptorial claw, have now been shown to belong to two very distinct adult species. Foxon's contention that the above features are not of importance, cannot, therefore, be supported. Formation of free spines, other than the terminal, on the dactylus of the raptorial limb in the pelagic larvae, is characteristic of only certain species, in each of which constant specific differences are noticeable. The very close resemblance between the pelagic larvae of the different species dealt with in the present report and the simple features by which they could always be distinguished from one another, on the other hand leads one to a conclusion that is almost opposite the one expressed by Foxon.

### SQUILLA FASCIATA DE HAAN

1903. *Alimerichthus unidens*, Lanchester, *Fauna and Geogr. Maldives and Laccadives Archi.*  
 1906. *Alimerichthus unidens*, Tattersall, *Rept. Pearl Oyster Fish.*  
 1907. *Alima spinigera*, Borradaile, *Trans. Linn. Soc. Zool. Lond.*, p. 215, fig. 4.  
 1934. *Alima spinigera*, Lebour, *Res. Sci. Voy. Indes Orient. Neerl. Prince Leopold de Belgique*, p. 12, figs. 1-2.

*Final Pelagic Stage* (Text-fig. 14).—In general appearance the larva closely resembles the corresponding stage of *S. latreillei*, but is easily distinguished from it by the ventro-lateral spines projecting from the lateral margin of carapace. It is generally very rare and during the period of the present investigations only two live specimens have been available for observation.

Total length .. .. .	14.5 mm.
Length of rostrum .. .	3.3 mm.
Median length of carapace	3.8 mm.
Anterior breadth of carapace	2.1 mm.
Posterior breadth of carapace .. .	3.5 mm.
Length of postero-lateral spine .. .	2.8 mm.
Length of dorsal spine	1.0 mm.
Length of eye-stalk .. .	1.3 mm.
Length of corneal portion of eye .. .	1.4 mm.
Length of telson	2.4 mm.
Breadth of telson .. .	2.5 mm.

The carapace is comparatively small and narrow and posteriorly leaves the last two thoracic segments exposed. The lateral margin has 4 spinules, the first situated some distance behind the base of the antero-lateral spine, the second which is long and laterally directed, is almost mid-way between the antero- and postero-lateral spines, while the last two are nearer the postero-lateral spines. The rostrum has 3 prominent ventral spinules and a row of minute denticles. The antero-lateral spines are short and are less than half as long as the dorsal spine which is acutely pointed and conspicuous. The postero-lateral spine is provided with a ventral spinule at about  $\frac{1}{3}$  its length from the base, diverges posteriorly and has the tip reaching the level of the middle portion of the 3rd abdominal segment.

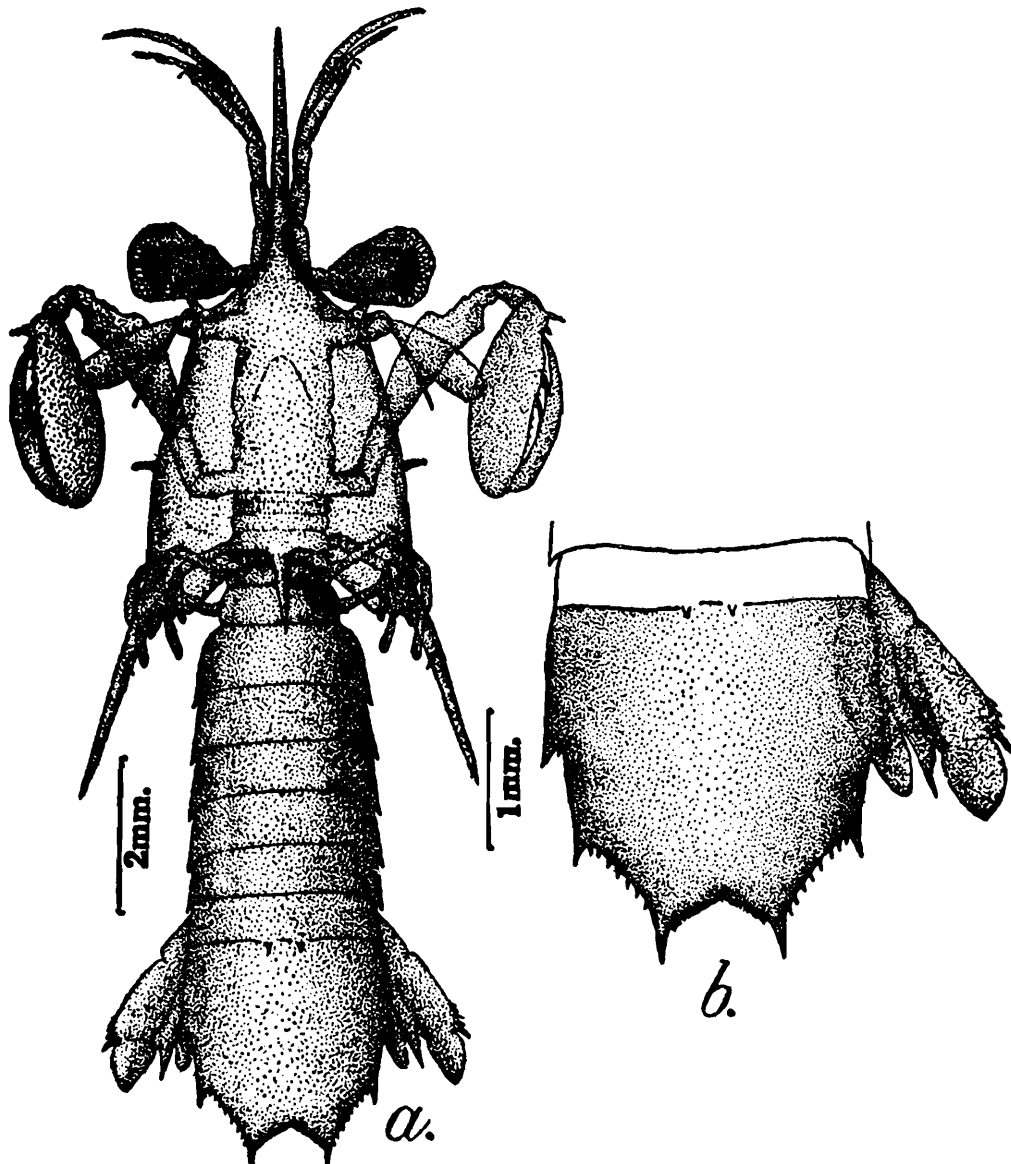
The tip of antennular peduncle is far inferior to that of the rostrum. The second flagellum carries only 6 groups of sensory hairs. The eyes are comparatively large with short stalks. Peduncular segment of the raptorial limb is without any spine. Raptorial propodus is rather inflated and broad and has two stout spines; one very short, and a series of pectinations. The dactylus has three free teeth including the terminal. The thoracic and abdominal segments are characteristically broad. Postero-lateral corners of the abdominal segments end in short, acute spines; while, there is a pair of sub-median dorsal spines on the 6th. Telson is a little broader than long, and has the marginal spines, particularly the sub-medians, long. The denticles number 1 lateral, 8 intermediate and 19 sub-median on each side. The uropod when directed backwards, reaches half-way to the base of the intermediate spine of telson. The basal segment of the exopod carries 5 free spines; the ventra



prolongation is deeply bifid, with the outer spine fully half the length of the inner which has a smooth basal swelling and has the tip projecting beyond that of the endopod.

*Colouration.*—A characteristic feature of the larva is its colouration, by which alone, in the fresh condition, it can be easily distinguished from others. There is a uniform row of yellow chromatophores along the margin of carapace. The mandibles appear golden yellow to the unaided eye. In the raptorial limb, the distal portions of the merus and the propodus have a large number of yellow chromatophores, but there is also a conspicuous patch of dark yellow colour over the proximal part of the propodus. The dactylus is of a uniform rose-red colour. The distal end of the protopodite of all the pleopods is tinged rose red, but this colour increases from the first to the last, that on the 4th and the 5th pleopods being the most prominent.

*Earlier stages of Larvae.*—A single specimen (Collection dated 13-3-1943), 9.5 long, has been available for study. It has the same general appearance as the final pelagic larva, with the characteristic laterally



TEXT-FIG. 14.—*Squilla fasciata* De Haan.

a. Final pelagic larva, 14.1 mm. long, dorsal view; b. Telson and right uropod of the same, magnified.

directed spinule on the carapace. The rostrum however, has 5 ventral spinules. The second antennular flagellum has only 5 groups of sensory hairs. The antennal endopodite reaches only half-way to the tip of squame. Raptorial dactylus has only one free spine other than the terminal. The uropod when directed backward reaches only  $\frac{1}{2}$  the distance to the base of the lateral spine of telson. Exopod has only a single free spine. Tip of the ventral prolongation is bifid but is inferior to the tip of endopod.

*Remarks.*—While Lanchester (1903) does not give any figure of his *Alimerichthus unidens*, it is fairly clear from his descriptive account that his larva is identical with that of *S. fasciata*. Lanchester's specimen measured 12.5 mm. in length and with only a single spine other than the terminal on the raptorial dactylus, it was probably in an earlier stage than the final pelagic. Tattersall's specimens (1906) from Ceylon also represent stages earlier to the final pelagic.

The final pelagic larva also shows close resemblance to Borradaile's *Alima spinigera* and is probably identical with it. Borradaile's specimens measured 16.5 and 12.5 mm. respectively in length and were taken at Wasin, British East Africa. The only point of difference, however, seems to be in the shape of telson. Telson is distinctly longer than in the East African specimens and has the intermediate spines rather short and comparatively inconspicuous.

Lebour (1934) has referred a larva, 13 mm. long, from North New Guinea, to *Alima spinigera*. This larva, though closely resembling Borradaile's specimens, shows a somewhat broader carapace, with no ventral spinule near the base of the antero-lateral spine and with three teeth behind "the central tooth sticking out from the lateral margin"; has the postero-lateral corners of the abdominal segments represented as ending smoothly and has the telson characteristically broad or almost rectangular with the intermediate spines very long and highly conspicuous. Though it resembles the East African form in the unusual size of the intermediate spines, the shape of telson is noticeably different in the two forms and Lebour's specimen might well belong to a different species.

### SQUILLA LATA Brooks

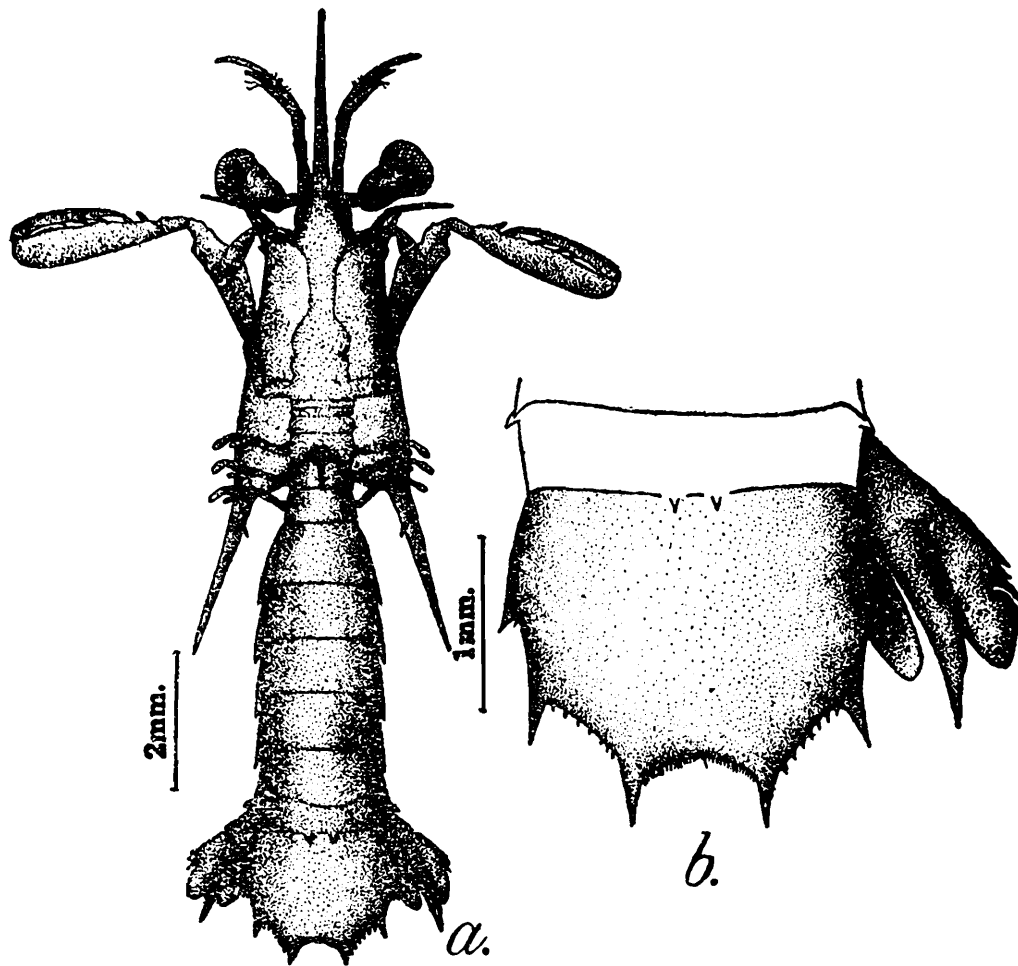
1932. *Alima* sp., Foxon, *Sci. Rept. Great Barrier Reef Exped.*, figs. 2-3.

1946. *Alima bermudensis*, Gurney, *Proc. Zool. Soc. Lond.*, fig. 6.

*Final Pelagic Stage* (Text-fig. 15).—Rather rare in the tow-net collections, this larva is easily distinguished from *S. latreillei* and *S. fasciata* by the relatively more slender appearance of the body and the very narrow carapace. The largest specimen obtained measured 13.5 mm. in total length.

Total Length	..	..	..	..	13.5 mm.
Length of rostrum	..			..	2.6 mm.
Median length of carapace		..		..	3.9 mm.
Anterior breadth of carapace		..		..	1.7 mm.
Posterior breadth of carapace		..		..	2.5 mm.
Length of antero-lateral spine		..	..	..	0.6 mm.
Length of postero-lateral spine		..	..	..	2.5 mm.
Length of eye-stalk	..	..	..	..	0.5 mm.
Length of corneal portion of eye	..	..	..	..	1.1 mm.
Length of telson	..	..	..	..	1.6 mm.
Breadth of telson	..	..	..	..	2.2 mm.

The carapace is small and narrow and leaves the last two thoracic segments exposed dorsally. In certain specimens the carapace extends over the anterior half of the seventh thoracic segment. The lateral margin of carapace carries only 3 spinules, one at the base of the antero-lateral spine, directed ventro-laterally, while the other two situated



TEXT-FIG. 15.—*Squilla lata* Brooks.

*a.* Final pelagic larva, 13.5 mm. long, dorsal view; *b.* Telson and right uropod of the same, magnified.

near the postero-lateral corner are directed ventrad. The rostrum is longer than the postero-lateral spines and is armed with 4 large spinules ventrally. The antero-lateral spines are short, pointed and smaller than the median dorsal spine which is mounted on a small prominence near the hind border. The postero-laterals are slightly divergent posteriorly and have their tips reaching the level of the hind border of the second abdominal segment and sometimes even beyond. Each such spine carries a ventral spinule at about  $\frac{1}{4}$  its length from the base.

The tip of antennular peduncle hardly reaches half-way to the tip of rostrum. The second antennular flagellum carries 5 groups of sensory hairs. The eyes are comparatively large, each mounted on a short stalk which is about half the median length of the corneal portion of the eye. The raptorial propodus has three spines proximally, the first of which is very much larger than the rest. The dactylus carries four free spines including the terminal; while indications of two more are clearly visible through the larval skin. The last three thoracic segments

are almost twice as broad as long. The abdominal segments are about 1.5 to 1.8 times as broad as the thoracic segments and have their postero-lateral corners produced into acute spines. A pair of sub-median spines is present on the sixth abdominal segment dorsally ; while the antero-lateral corners of the same segment are produced into a pair of stout spines directed ventrally backwards. The intermediate and sub-median spines of telson are long and pointed. The denticles number 1 lateral, 6-7 intermediate and 19 to 21 sub-median on each side. The tip of the uropod when directed backward reaches slightly beyond the level of the intermediate spines of telson. The exopod carries four free spines externally ; the outer process of the ventral prolongation is very small, about  $\frac{1}{5}$  the length of the inner which has a prominent smooth swelling externally.

*Earlier Stages of Larvae.*—An almost complete series of larval stages ; from the early *Alima* onwards is represented in the present collection.

*Larva, 2.0 mm. to 2.6 mm. long* (Text fig. 16a).—Extremely frail and almost transparent, this minute *Alima* is not uncommon in the tow-net catches. While it resembles the corresponding stage of *S. latreillei*, it differs from the latter in the following features :—

1. Carapace is rather small and leaves the last two thoracic segments exposed dorsally ;
2. Lateral margin of carapace bears only 4 spinules ;
3. Zoea spine is very small ;
4. Eyes are relatively small ; and
5. Telson is distinctly longer than broad and has only four intermediate denticles.

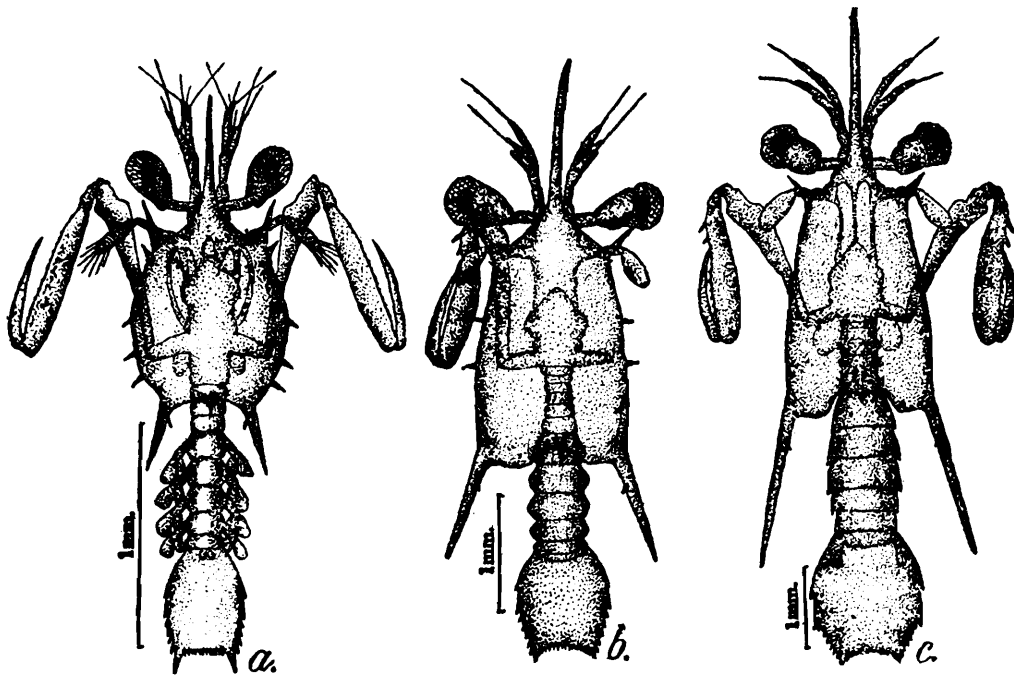
*Larva, 4.2 mm. long.*—Carapace is small and narrow and extends over the anterior half of the first abdominal segment. The rostrum is longer than the postero-lateral spines and is armed with 2 spinules ventrally. Antero-lateral spines are longer than the zoea spine. Lateral margin of carapace has 5 spinules, one a little behind the base of the antero-lateral spine, the 2nd and 3rd, projecting ventro-laterally at about the middle of the lateral margin, and the last two near the postero-lateral corner. Tip of the postero-lateral spine reaches the level of the last abdominal segment or even upto the telson, and carries a ventral spinule at about  $\frac{1}{4}$ th its length from base. Tip of the antennular flagellum is far inferior to the tip of rostrum. The second antennular flagellum has three groups of sensory hairs. Antennal endopodite is just indicated as a smooth outpushing. Thoracic appendages behind the raptorial claw are not developed. The fifth pleopod is rudimentary. Uropods are not developed. Denticles on telson number 4 intermediate and 7 or 8 sub-median on each side.

*Larva, 5.1 mm. long* (Text-fig. 16b).—Resembles the previous stage in general appearance. The following additional features are noticeable.

Antennal endopodite is knob-like and unsegmented ; minute rudiments of the last three maxillipeds are visible ; postero-lateral corners of the abdominal segments do not end in acute points ; the sixth abdominal segment is not fully differentiated from the telson ; uropods are

small, unsegmented and stump-like ; fifth pleopod is rudimentary ; telson is longer than broad ; sub-median spines are longer than the intermediate ; denticles number 5 intermediate and 7 or 8 sub-median on each side.

*Larva, 6.5 mm. long.*—Similar in appearance to the previous stage. Rostrum has two large ventral spinules. Of the marginal spinules of carapace, the 2nd one is very small, while the third alone now projects ventro-laterally. The antennular flagellum has a rudimentary 4th group of sensory hairs. Antennal endopodite does not yet reach the tip of the antennal peduncle. The last three maxillipeds are still rudimentary. Peraeopods are just indicated. Uropod is rudimentary, but bifid.



TEXT-FIG. 16.—*Squilla lata* Brooks.

a. Larva, 2.6 mm. long, dorsal view ; b. Larva, 5.1 mm. long ; c. Larva, 8.6 mm. long.

*Larva, 8.6 mm. long* (Text-fig. 16c).—The carapace extends over the anterior half of the last thoracic segment. Tip of the postero-lateral spine reaches the level of the last abdominal segment. Marginal spinules of carapace number only 1+2, the second and third spinules seen in the earlier stages having disappeared. Even in the 6.5 mm. stage the tendency for suppression of these spinules was apparent, when the second spinule appeared much smaller than what it was in the previous stage. The second antennal flagellum has 4 groups of sensory hairs. Antennal endopodite reaches the tip of the antennal peduncle. Postero-lateral corners of the abdominal segments are sub-acutely pointed. Peraeopods are rudimentary, though segmented. Denticles on telson number 1 lateral, 6 intermediate and 14 sub-median on each side. Uropod when directed backwards hardly reaches  $\frac{2}{3}$  the distance to the base of the lateral spine of telson. The exopodite carries one rudimentary spine. The ventral prolongation of the uropod is not yet bifid at the tip.

*Larva, 9.5 to 10.6 mm. long.*—Closely similar to the 8.6 mm. long larva, but the more advanced stage of differentiation has resulted in the following points of difference:—

The second flagellum of the antennule carries 5 groups of sensory hairs.

The raptorial dactylus carries one additional free spine besides the terminal.

Peraeopods are finger-like, bifid structures.

Postero-lateral corners of abdominal segments are pointed.

Denticles on telson number 1 lateral, 6 intermediate and 17 sub-median on each side.

Uropod when directed backwards reaches slightly beyond the base of the lateral spine of telson.

Ventral prolongation of the uropod is bifid at the tip, but the outer spine is extremely minute, while the larger inner one has no distinct basal swelling externally.

*Larva, 12.6 mm. long.*—Shows the following features owing to further differentiation of structure:—

Raptorial dactylus has three free spines, including the terminal.

Uropod when directed backwards reaches the level of the intermediate spines of telson.

Exopod of the uropod has 2 free spines and the inner spine of the ventral prolongation has a smooth basal swelling.

In most other features the larva resembles the final pelagic stage.

*Remarks.*—In size and general appearance the larva resembles the final pelagic stage of *S. latreillei* and *S. fasciata* from which, however, it is easily distinguished by the very narrow carapace.

Foxon (1932) has described an *Alima* larva from the Great Barrier Reef and has suggested that it belongs to *Squilla lata*. This larva closely resembles the one described above, but differs from it in the following points.—

- i. Larger size; 16 to 18 mm.
- ii. The last three segments of the thorax are exposed dorsally (In the figure only the last two segments are seen exposed).
- iii. Lateral margin of carapace bears 1 + 3 spinules, which are represented in the figure as directed ventro-laterally.
- iv. Exopodite of the uropod has six free spines (Only 5 shown in the figure).
- v. The carapace appears a trifle narrower.

Of these, size at the final pelagic stage and the spinulation of carapace are important features that probably indicate that Foxon's larva is not, perhaps, specifically identical with the Madras form. The former should then be referred to some very closely related species like *S. gilesi*.

Foxon refers his larva to *S. lata* on the strength of the following features:—

1. Six teeth on the dactylus of the raptorial claw ;
2. Only the sub-median carinae of the 6th abdominal segment end in spines ; and
3. The similarities seen in the telson and in the uropods.

In the pelagic larvae the carination of the abdominal segments, so characteristic of the adult species, is almost invariably suppressed. A pair of sub-median dorsal spines on the sixth abdominal segment is developed in all advanced larvae of the *Alima* and the *Alimerichthus* types, but these spines are not connected with any carina. In Foxon's figure also no carina is shown connected with the sub-median spines. Such a feature cannot therefore, be of any significance when attempting to allocate the larvae to adult species.

The early post-larva obtained by moult from the final pelagic larva had prominent serrations along the inner aspect of the ventral prolongation of the uropod as in the adult *S. lata*. It is possible that the differences pointed out are really of specific value and that the larva described by Foxon probably belongs to the allied species *S. gilesi*.

*Alima bermudensis* described by Gurney (1946) shows close resemblance to the corresponding stage of *S. lata* described above and appears to be identical with the latter.

### LYSIOSQUILLA MACULATA (Fabricius)

*Final Pelagic Stage* (Text-fig. 17).—Not very common in the plankton, the larvae come up only occasionally in the tow-net catches. They are very active and are easily distinguished by their moderately large size, the characteristically stout build and the more or less opaque body. If disturbed while swimming, the larva readily folds its abdomen completely below the thorax and quietly falls down to the bottom, the whole body being then completely placed in between the lateral downward extensions of the shield-like carapace which thus forms an efficient armour against enemies. On fixation also the specimens generally assume the above posture if they are not kept properly stretched.

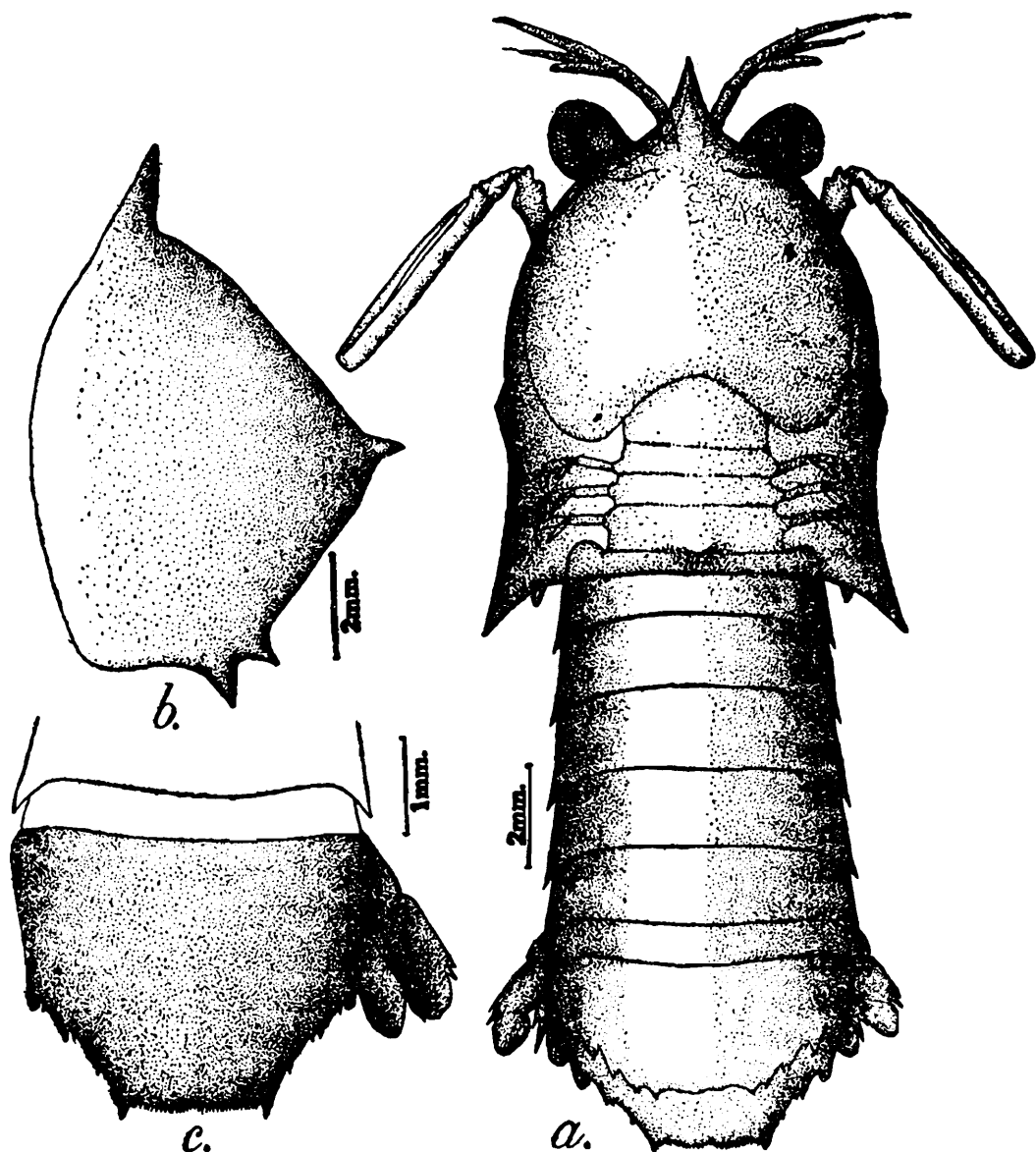
Total length .. .. .	23.5 mm.
Length of rostrum .. .. .	1.2 mm.
Median length of carapace .. .. .	9.5 mm.
Breadth of carapace at the middle .. .. .	7.0 mm.
Breadth of carapace at the base of postero-lateral spines .. .. .	8.0 mm.
Length of corneal portion of eye .. .. .	2.1 mm.
Length of telson .. .. .	4.2 mm.
Breadth of telson .. .. .	5.8 mm.

The carapace is a conspicuous strong shield, extending posteriorly over the middle of the first abdominal segment. Its lateral margins are produced deeply ventrad and on either side end in a conspicuous stout spine in the middle region (Text-fig. 17*b*). The rostrum is very short and stout and is unarmed ventrally. The antero-lateral spines are wanting. The postero-laterals are very short, posteriorly reaching only upto the level of the hind border of the first abdominal segment. The 'Zoea' spine is present but in the majority of specimens it is represented only by a smooth, stump-like prominence, though in others it is in the form of a small, short, acutely pointed spine. The lateral margin of carapace has only a single spinule at the base of the postero-lateral spine, besides the stout spine mentioned above.

The antennular peduncle is short and reaches only upto the tip of rostrum. The second flagellum of the antennule has 12 groups of sensory hairs. The raptorial claw is long and relatively slender. The propodus is long and narrow and has no stout spines at its outer basal aspect. The row of pectinations on the surface facing the dactylus is thin and the pectinations alternate with slender hairs. The dactylus has no free spines other than the terminal. The last three thoracic segments are very short, the 6th being about 6 times and the 8th over

3 times as broad as long. The abdominal region is highly depressed and flat, giving the body a remarkably stout appearance. Each segment is about 4 times as broad as long and has the postero-lateral angles produced into stout, acute spines. The last abdominal segment is extremely short and has the postero-lateral corners smooth. The telson is distinctly broader than long and has the intermediate marginal spines rather short. The laterals and sub-medians are stout, the tip of the former being often curved inwards. The sub-median space is only a little over  $\frac{1}{3}$  the greatest breadth of telson. The denticles number 1 lateral, 2 intermediate and 14 to 18 sub-median on each side. Between adjacent sub-median denticles there are usually 3 to 6 minute denticles. The uropod when laid backwards almost reaches the level of the lateral spines of telson. The exopod usually carries 2 free spines. The ventral prolongation is bifid distally; with the outer spine smaller than half the length of the inner which just reaches the level of the distal extremity of the endopodite.

*Remarks.*—*Lysierichthys duvaucellii* (Guerin) has been generally supposed to be the pelagic larva of the widely distributed species,



TEXT-FIG. 17.—*Lysiosquilla maculata* (Fabricius).

a. Final pelagic larva, 23.5 mm. long, dorsal view; b. Side view of carapace of the same; c. Telson and right uropod of the same, magnified.



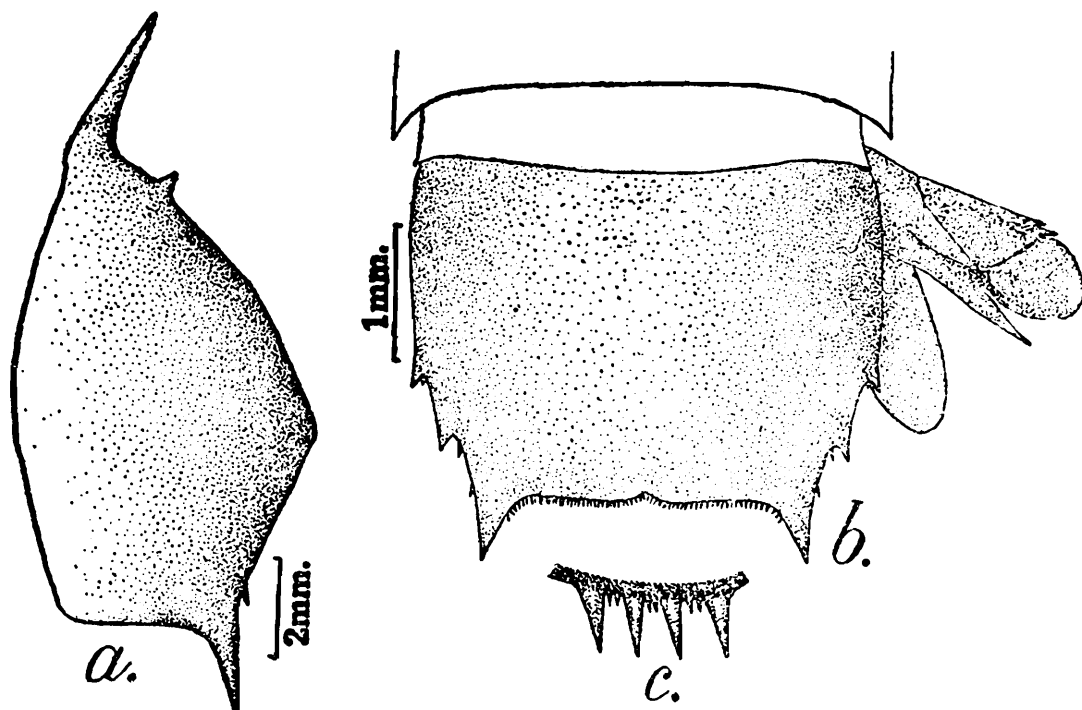
*Lysiosquilla maculata*. Brooks (1886) arrived at this assumption by the presence, in one of his larvae, of pigment bands characteristic of the adult. Size, distribution and the number of teeth on the dactylus of the raptorial claw led Hansen (1926) to arrive at the same conclusion as Brooks. However, a critical analysis of the material ascribed to this species by different authors clearly indicates that more than one species have been mixed up under the specific name *Lysierichthus duvaucellii*. Brooks's specimens have comparatively large carapace, with well developed antero-lateral and zoea spines. But in some of his specimens the zoea spine was absent and Tattersall (1906) suggested that Brooks might have been dealing with two different species. Borradaile (1907) also found the zoea and antero-lateral spines variable in his specimens. In Jurich's larva (1904) the carapace is comparatively longer, covers the first three abdominal segments posteriorly, has the antero-lateral and zoea spines well developed and the postero-laterals are long and acutely pointed, reaching the level of the proximal part of telson. Hansen (*loc. cit.*) observed that some of his specimens, measuring 27 mm. in length were actually of a more advanced stage of development than his largest specimen which measured 40 mm. in length. Tattersall (*loc. cit.*) doubted whether all the larvae referred to this 'distinct and rather remarkable species' by various authors really belonged to a single species and pointed out that Brooks's and Jurich's specimens might well belong to a different but closely related species than his Ceylon larva. The marked disparity in size in Hansen's specimens is hardly to be expected in a single species and it is quite probable that Hansen was also dealing with two distinct species which alone will explain the earlier stage of development of the longer larvae. Even though the actual length of Claus's (1871) *Erichthus duvaucellii* is not known Tattersall is almost certain that it is identical with the Ceylon larvae which measured 22 mm. in length, excluding the rostrum, *i.e.*, almost the same length as the Madras form. It may, however, be noted that *L. duvaucellii* was originally recorded from the Bay of Bengal (Guerin, 1857). The present observations, however, clearly show that the larva that has been successfully metamorphosed and reared into *Lysiosquilla maculata* is very distinctly different from *L. duvaucellii*. The thick, shield-like carapace, with short, stout rostrum and postero-lateral spines, the small or obsolete dorsal spine, the absence of antero-lateral spines and the rather pointed telson with relatively narrow sub-median space are important features in which the final pelagic larva of *L. maculata* differs from *L. duvaucellii*. In the nature of the telson and the spinulation of carapace *Erichthus duvaucellii* of Claus differs from the present larva which, in the same features, indeed differs from all the larvae so far described as *L. duvaucellii*.

#### LYSIOQUILLA SULCIROSTRIS (Kemp)

1837. *Erichthus duvaucellii*, Milne-Edwards, *Hist. Nat. Crust. Paris*, p. 505.  
 1857. *Erichthus duvaucellii*, Guerin-Meneville, *Animaux Asticules, Crustacees Stomatopodes*.  
 1871. *Erichthus duvaucellii*, Claus, *Abh. Ges. Wiss. Gottingen*, pl. iv, fig. 16  
 1906. *Lysierichthus duvaucellii*, Tattersall, *Rept. Pearl Oyster Fish*.  
 1939. *Lysiosquilla (Lysierichthus) maculata*, Foxon, *Sci. Rpt. John Murray Exped.*

*Final Pelagic Stage* (Text-fig. 18).—Very closely resembling the corresponding stage of *L. maculata*, in size and appearance, it is easily mistaken for the larva of the latter species. A single specimen obtained from plankton collection dated 17th September 1942 was reared in the laboratory through metamorphosis and the post-larva survived for about 80 days in the aquarium tank. Owing to certain very distinct features of the larva, particularly in the carapace and telson and since the early post-larva and the adult are found to differ from *L. maculata* in certain very important features other than those listed by Kemp (1913), and which I consider to be of specific importance, I have thought it fit to raise Kemp's variety *sulcirostris* to specific rank. A detailed account of the species *L. sulcirostris* will be included in a subsequent report which will deal with the growth of post-larval stomatopods.

In the final pelagic larva the carapace appears slightly larger than in *L. maculata*. The rostrum is much longer than in the latter. Antero-lateral spines are present, but the zoea spine is wanting. Postero-lateral spine is a little over half the length of the rostrum. The lateral margin of carapace on either side is produced downwards as in *L. maculata* but does not end in an acute spine. Near the base of the postero-lateral spine there is a stout spinule. The telson is broader than long and has the sub-median space very wide and conspicuous. The denticles number 1 lateral, 2 intermediate and 20-21 submedian on each side. In other respects the larva is almost identical with the corresponding stage of *L. maculata*.



TEXT-FIG. 18.—*Lysiosquilla sulcirostris* (Kemp).

*a.* Side view of carapace of final pelagic larva ; *b.* Telson and right uropod of the same, magnified ; *c.* Sub-median denticles of telson of the same, highly magnified.

*Remarks.*—The larva though very closely resembling the final pelagic stage of *L. maculata* differs from the latter in the following features :—

1. Longer rostrum and postero-lateral spines of carapace.
2. Presence of antero-lateral spines.
3. Absence of zoea spine.
4. Lateral downward extension of carapace not ending in acute spines.
5. Wide sub-median space.

The final pelagic larva appears to agree in all essential features with *Erichthus duvaucellii* of Claus (His fig. 16) the length of which, as pointed out by Tattersall, is not known. In the latter, however, the zoea spine is present, though varying in size (See Claus's Figs. 16 A and B) and the lateral ventral extension of carapace also ends in spine, the acuteness of which also is perhaps variable as seen from the above figures. The Ceylon larva (Tattersall, 1906) is also probably identical with the Madras specimen and so are probably the larvae referred to *L. duvaucellii* by Foxon (1939). Certain very early larvae which he found identical with *Erichthoidina armata* (Claus, 1871, Fig. 3) have also been referred to this species by him. In view of the presence of the characteristic ventrally directed spine at the lateral margin of carapace in *E. armata*, it appears that Foxon was right in referring this larva to *L. duvaucellii*. As already pointed out, more than one species appear to be mixed up in the larvae ascribed to *L. duvaucellii* by Brooks, Jurich and Hansen. In appearance and proportion of carapace Jurich's larva seems to be very different from *E. duvaucellii* of Claus ; while Hansen's 40 mm. long larva must necessarily belong to a different adult species than *L. sulcirostris*. There is thus confusion still about the identity of the larvae referred to *L. duvaucellii* and since accurate detailed description of several important features are wanting and since the larvae have not been figured in some of the records, there appears to be little hope in clearing this confusion except by rearing the planktonic larvae from the concerned localities to the post-larval stage.

#### LYSIOSQUILLA MULTIFASCIATA Wood-Mason.

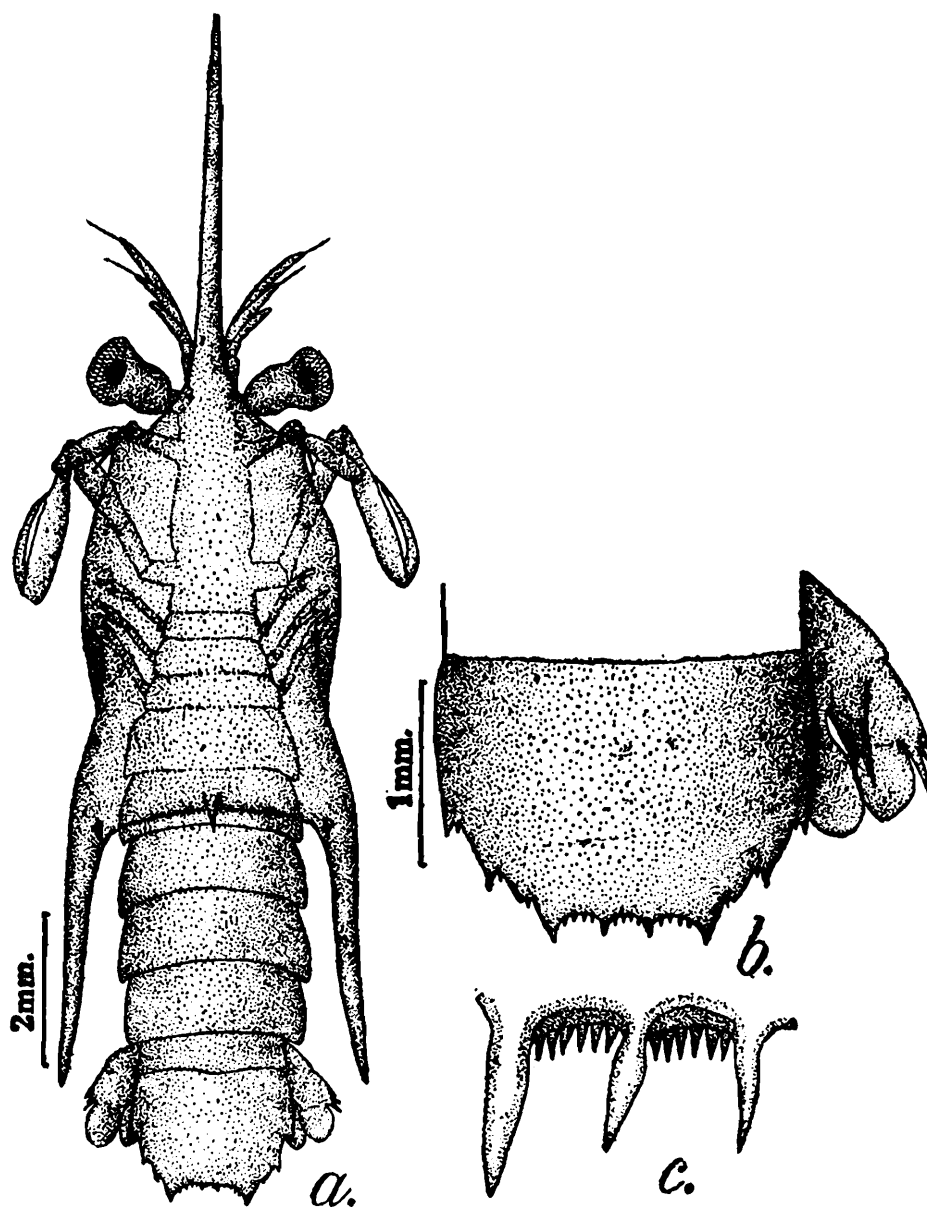
1929. *Lysierichthus* sp., Komai & Tung, *Annot. Zool. Jap.*, pl. vii, figs. 13-19, pl. viii, figs. 1-9.
1871. *Erichthoidina brevispinosa*, Claus, *Abh. Ges. Wiss. Gottingen*, pl. i, fig. 4, pl. ii, fig. 5.
1946. *Erichthoidina brevispinosa*, Gurney, *Proc. Zool. Soc.*, fig. 9.

*Final Pelagic Stage* (Text-fig. 19).—Rarely obtained in the plankton catches, the larva is much smaller than the two foregoing species, *L. maculata* and *L. sulcirostris* and can be easily distinguished from them by the characteristically long rostrum and postero-lateral spines of the narrow carapace.

Total length	..	..	..	..	15.0 mm.
Length of rostrum	..	..	..	..	5.0 mm.
Median length of carapace	..	..	..	..	5.3 mm.
Anterior breadth of carapace	..	..	..	..	2.3 mm.
Posterior breadth of carapace	..	..	..	..	3.2 mm.
Length of postero-lateral spine	..	..	..	..	3.5 mm.
Length of eye ; corneal portion	..	..	..	..	1.1 mm.
Length of telson	..	..	..	..	1.4 mm.
Breadth of telson	..	..	..	..	2.1 mm.

The carapace is long and narrow and posteriorly extends over the middle of the second abdominal segment. The lateral margin is deeply flexed ventrally and has only a single spinule near the base of the postero-lateral spine. The rostrum is long and stout, almost equal to the median length of carapace and has 3 or 4 ventral spinules. The antero-lateral spines are short. The zoea spine is usually of the same size as the antero-lateral, but in certain specimens it may be a little longer. The postero-laterals are long and stout, directed very nearly parallel to the body and have their tips reaching the level of the junction between the last abdominal segment and the telson.

The antennular peduncle is very short and the flagellar tips do not reach the middle of the rostrum. The second flagellum carries only 4 groups of sensory hairs. The eyes are conspicuous, each mounted on a stalk which is only about half the length of the corneal portion. The raptorial limb is small and slender, the propodus has no stout spines at the proximal region and the pectinations are very small and almost



TEXT-FIG. 19.—*Lysiosquilla multifasciata* Wood-Mason.

a. Final pelagic larva, 15.0 mm. long, dorsal view ; b. Telson and right uropod of the same, magnified ; c. Sub-median denticles of telson of the same, highly magnified.

alternating with long hair-like processes. The dactylus has no free teeth besides the terminal one. The thoracic segments become gradually longer from the 6th to the last which itself is about  $3\frac{1}{2}$  times as broad as long. The abdominal segments are all broader than long and have their postero-lateral corners smooth. The telson is distinctly broader than long and has the lateral and intermediate spines rather small ; while the sub-medians are long and stout. The denticles number 1 lateral, 2 intermediate and 7 sub-median on each side. The 5th sub-median denticle from either side is distinctly longer than the rest, with the result that the sub-median space is divided into 3 sections, each with 4 denticles. Between adjacent sub-median denticles there are 6 to 8 minute serrations. The inner aspects of the lateral and intermediate spines are also serrated. The uropod when directed backwards reaches mid-way between the lateral and intermediate spines of telson. The exopod carries 3 free spines. The outer spine of the basal prolongation of uropod is distinctly longer than the inner.

*Remarks.*—The number and arrangement of the sub-median denticles (4-1-4-1-4) of telson and the larger size of the outer spine of the ventral prolongation of uropod are important features that make identification of this species from allied *Lysierichthii* easy.

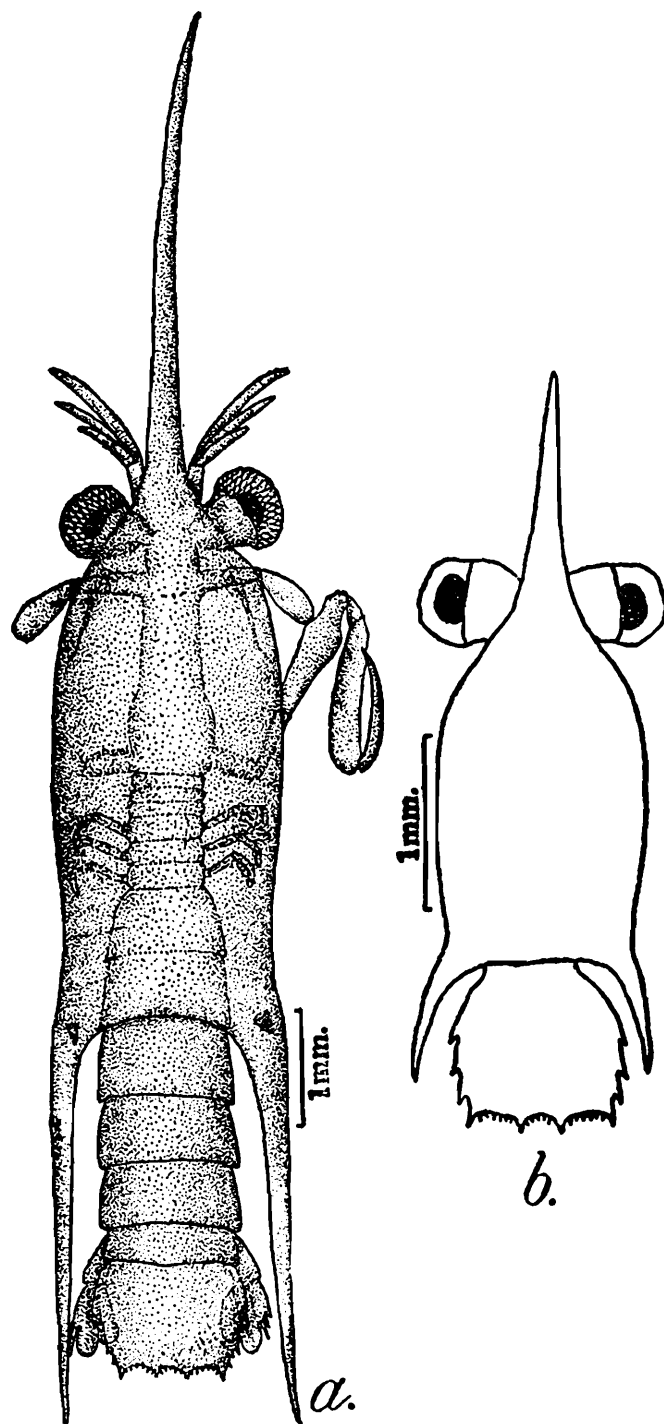
Komai and Tung (1929) describe a species of *Lysierichthus* from Seto and suggest that it is the larva of *L. multifasciata* since it is “ the only adult species of *Lysiosquilla* known in the vicinity of Seto ” and since it is “ the commonest of all the *Lysiosquillae* occurring in the Japanese seas ” This larva appears to be identical with the Madras specimen and as such Komai and Tung seem to have correctly referred it to *L. multifasciata*, even though it was purely on circumstantial evidence.

Foxon (1939) considers *Lysierichthus rostratus* (Borradaile) as the pelagic larva of *L. multifasciata* and includes a number of larvae under the possible synonymy of this species. *Erichthus* sp. of Claus (his Fig. 19) which Borradaile (1907) gives as synonymous with his *E. rostratus* is, however, different from the final pelagic larva of *L. multifasciata* ; the most conspicuous difference being the nature of the sub-median space of telson. While Tattersall's (1906) *Lysierichthus B* also does not appear to be identical with *L. multifasciata*, it is to be noted that in all probability Tattersall has mixed up to distinct larval species under the name *Lysierichthus B*. In the nature of the telson his 9 mm. long larva (his figs. 39 and 40) appears to be quite distinct from the other stages ascribed to *Lysierichthus B*. The latter differs from *L. multifasciata* in the possession of a larger number of sub-median denticles on telson (7-1-7-1-7). Tattersall's view that *Erichthoidina gracilis*, *E. armata* and *E. brevispinosa* of Claus are probably only developmental stages in the life history of one species only, does not appear to be altogether correct. *E. brevispinosa* (Claus, 1871 ; Gurney, 1946) is probably an early stage of *L. multifasciata* ; the possible relationship of *E. armata* to *L. sulcirostris* has already been pointed out ; while *E. gracilis* has a different type of telson structure than in *E. brevispinosa*.

**LYSIOSQUILLA TIGRINA Nobili**

1944. *Lysiosquilla (Lysierichthus) tigrina*, Alikunhi, *Curr. Sci.*, Bangalore, fig. 1.

*Final Pelagic Stage* (Text-fig. 20a).—Very rare in the Madras waters, only 2 specimens were collected during the period 1936 to 1943. One of these, obtained alive on 3-3-1943 moulted into post-larva in the laboratory and was reared for about 80 days. A detailed description of this larva and the early post-larval stages has already been published (Alikunhi, 1944a). I have now included in this report a figure of the second specimen, obtained from plankton collected on 14-3-1939, for purposes of easy identification and comparison with other species.



TEXT-FIG. 20.—*Lysiosquilla tigrina* Nobili.

a. Final pelagic larva, 13.5 mm. long, dorsal view ; b. *Erichthoidina* larva, 4.3 mm. long, dorsal view.

The larva agrees in all details with the specimen already described. Indications of 9-10 teeth are seen beneath the skin on the dactylus of the raptorial claw.

*Earlier Stages of Larvae* (Text-fig. 20*b*).—Three specimens in the *Erichthoidina* stage, measuring 4.3 mm. to 4.53 mm. in total length are present in the collections. In all the three specimens the characteristic arrangement and number of sub-median denticles (6-1-5-1-6) of telson are remarkably constant. The antero-lateral spines are absent in all the three specimens; while a short zoea spine is present in one of the three. The carapace covers the entire body excepting the telson; the rostrum is long and stout; while the postero-lateral spines have their tips reaching the level of the intermediate spines of telson.

*Remarks*.—As has been shown (Alikunhi, *loc. cit.*) the absence of the antero-lateral and zoea spines of carapace, the characteristic number of sub-median denticles (6-1-5-1-6) and the smaller size of the outer spine of the ventral prolongation of uropod are typical of the second specimen also. The constancy in the number and arrangement of denticles in the sub-median area of telson is remarkable.

The final pelagic larva of *L. multifasciata* closely resembles the present form, but in the presence of the antero-lateral and zoea spines of carapace in the spinulation of the sub-median space of telson and in the larger size of the outer spine of the ventral prolongation of uropod the former markedly differs from *L. tigrina*.

The absence of antero-lateral spines on carapace is characteristic of the *Erichthoidina* stage of several species of *Lysierichthii*; but with advance in age these spines make their appearance. In *L. tigrina*, the above early larval feature persists even in the final pelagic larva and in this the species is probably unique among the smaller *Lysierichthii*.

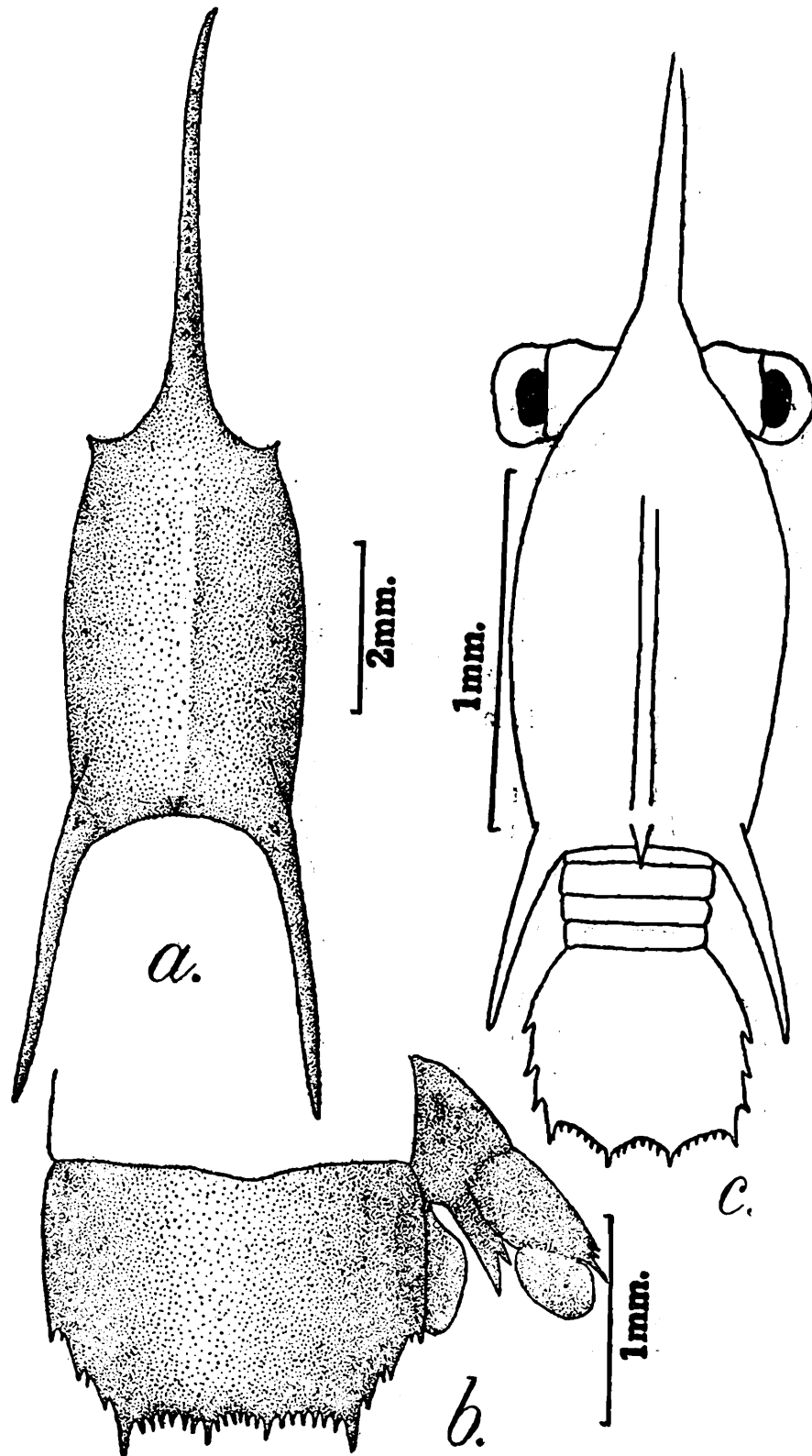
### LYSIOSQUILLA ACANTHOCARPUS Miers.

*Final Pelagic Stage* (Text-Fig. 21*a, b*).—Extremely rare in occurrence, a single specimen was obtained from plankton on 29th March 1943 and it metamorphosed over-night into the post-larva. It closely resembles the final pelagic stage of *L. multifasciata* and is almost of the same size as the latter.

						mm.
Total length .. .. .	..	..	..	..	..	14.0
Length of rostrum .. .. .	..	..	..	..	..	4.5
Median length of carapace .. .. .	..	..	..	..	..	5.1
Anterior breadth of carapace .. .. .	..	..	..	..	..	2.1
Posterior breadth of carapace .. .. .	..	..	..	..	..	2.6
Length of postero-lateral spine .. .. .	..	..	..	..	..	3.4
Length of telson .. .. .	..	..	..	..	..	1.2
Breadth of telson .. .. .	..	..	..	..	..	1.8

The carapace is narrow, not much broader than the abdominal segments, posteriorly extends over the first abdominal segment and has a ventral marginal spinule near the base of the postero-lateral spine.

The mid-dorsal line is arched upwards and looks as if a median carina is present. The rostrum is long and has a ventral row of several spinules, the proximal 2 or 3 of which are large. The antero-lateral spines are short and stout, while the zoea spine is extremely small. The postero-laterals are shorter than the rostrum and have their tips reaching the level of the hind border of the 6th abdominal segment.



TEXT-FIG. 21.—*Lysiosquilla acanthocarpus* Miers.

*a.* Carapace of final pelagic larva, 14.0 mm. long, dorsal view; *b.* Telson and right uropod of the same, magnified; *c.* *Erichthoidina* larva, 3.09 mm. long, dorsal view.



The antennular peduncle is short and does not reach the level of the first ventral spinule of rostrum. The eyes are large and conspicuous. The raptorial propodus is rather inflated and the dactylus has no free teeth other than the terminal. The abdominal segments are very much broader than long and have the postero-lateral corners smooth. The telson is only  $\frac{2}{3}$  as long as broad. Of the marginal spines the sub-medians are the largest. The denticles number 1 lateral, 2 intermediate and 10 sub-median on each side. The sub-median space is divided into three sections, the 7th denticle from either side being longer than the rest and each section has 6 denticles (6-1-6-1-6). The tip of the uropod when laid back almost reaches the base of the intermediate spines of telson. The exopod has 3 free spines. The outer spine of the ventral prolongation is definitely shorter than the inner.

*Colouration.*—Yellow spots on the 'Hands' of the 3rd and 4th thoracic legs and at the base of the last two pleopods and the uropods are visible to the unaided eye. Under the binoculars, the mandibular region shows a dull green tinge; a dark-brown spot surrounded by a diffused area of light red or brown is seen on the 'Hands' of the 3rd and 4th thoracic appendages; the raptorial propodus shows only a few chromatophores; the pigment spots on either side of the last thoracic segment are larger than those on the preceding segment; one or two chromatophores are seen on either side of the abdominal segments and on the 6th segment there is a conspicuous patch at the base of each uropod. On the carapace the chromatophores are segregated into 2 pairs of groups, one at the level of the raptorial limb and the other at the base of the postero-lateral spines, as in *L. tigrina*.

*Earlier Stages of Larvae* (Text-Fig. 21c).—Two *Erichthoidina* larvae 3.09 mm. and 4.32 mm. respectively in length, are present in the collection. In the smaller larva the carapace covers the whole body excepting the distal  $\frac{4}{5}$  of the telson; while in the second specimen only the first two abdominal segments are covered by the carapace. Postero-lateral spines are rather short. The zoea spine is present; while the antero-laterals have not yet appeared. Telson has the characteristic arrangement and number of denticles as in the final pelagic larva (6-1-6-1-6). In the smallest larva, however, an additional denticle is present in one of the marginal sections, making the arrangement 6-1-6-1-7. A median dorsal carina is present on carapace, terminating posteriorly in the zoea spine.

*Remarks.*—The larva differs from *L. multifasciata* mainly in the distinctly smaller size of the zoea spine of carapace; in the larger number of sub-median denticles and in the smaller size of the outer spine of the ventral prolongation of uropod. The presence of the antero-lateral and zoea spines of carapace easily distinguishes the species from *L. tigrina*; while in the spinulation of the sub-median space of telson, the presence of an additional denticle in the middle section is the only difference from the latter species.

#### UNIDENTIFIED LARVAL FORMS.

Descriptive account of a few *Alima* and *Erichthus* larvae that could not be properly identified, is also included in this report, so as to make

the account of the larval forms in the Madras plankton as complete as possible.

**SQUILLA** Sp. I (" *Quinquedentata* " group?)

*Final Pelagic Stage* (Text-Fig. 22a).—Four specimens collected as follows were available for study :

8-1-1938, one specimen ; 3-4-1940, one specimen ; and 18th September 1941, two specimens.

	mm.
Total length .. ..	20.0
Length of rostrum	4.1
Median length of carapace	5.6
Anterior breadth of carapace ..	2.5
Posterior breadth of carapace	3.4
Length of antero-lateral spine	0.8
Length of postero-lateral spine	2.6
Length of eye-stalk .. ..	1.4
Length of corneal portion of eye ..	1.3
Length of telson .. ..	2.7
Breadth of telson .. ..	2.6

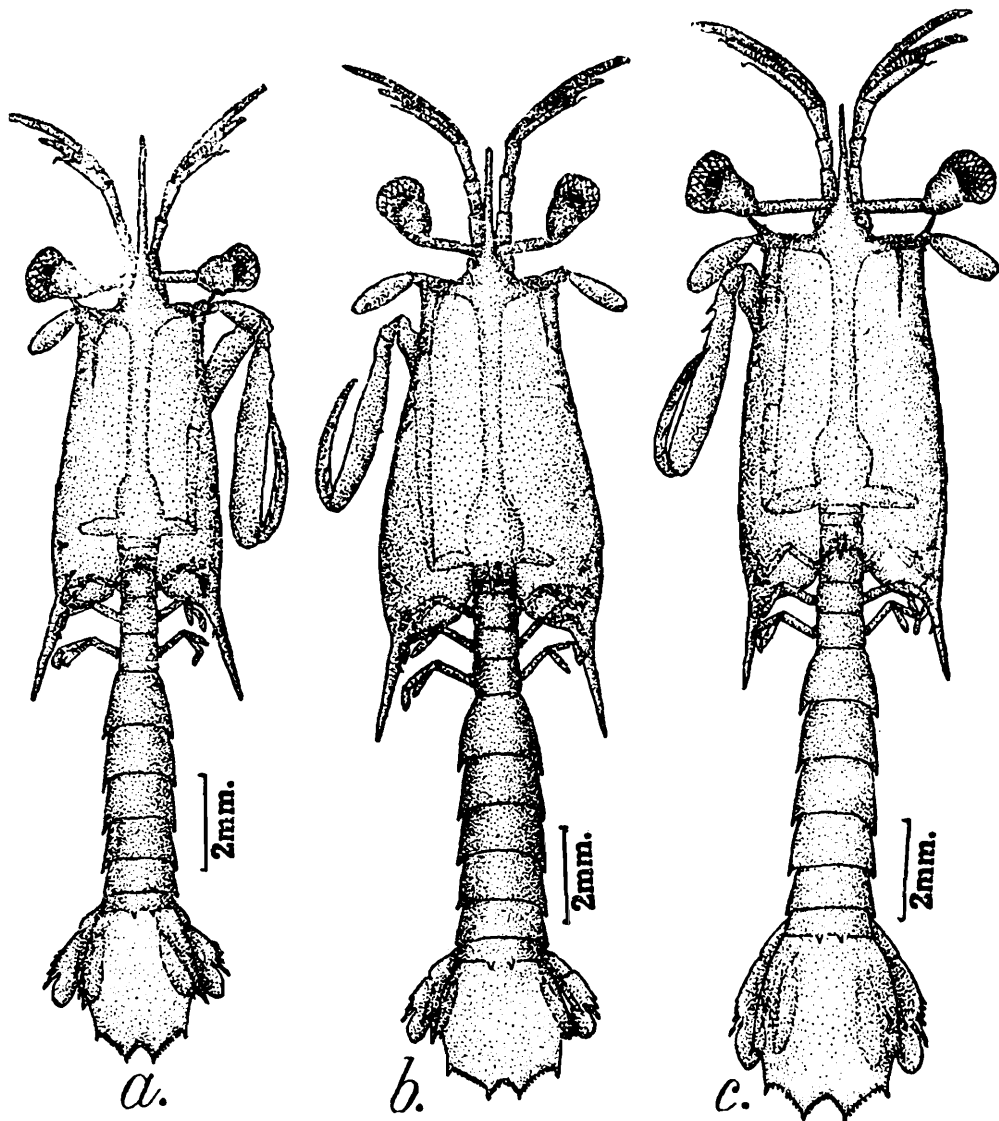
The carapace is relatively small and narrow and leaves the last three thoracic segments exposed dorsally. The lateral margin of carapace has 6+2+3 spinules, the 7th and 8th spinules being ventro-laterally directed, while the rest are directed ventrad. The rostrum is long, slender and unarmed ventrally and has the tip superior to the tip of antennular peduncle. The dorsal spine is very short and is only about half the length of the acutely pointed antero-lateral spines. Each postero-lateral spine has a ventral spinule at about 1/3 its length from base, is slightly divergent posteriorly and has the tip reaching the level of the middle portion of the first abdominal segment. The antennular flagellum carries 8 groups of sensory hairs. Dactylus of the raptorial limb has no free spines other than the terminal ; but distinct indications of five spines are visible through the skin. The thoracic and abdominal segments are relatively narrow, giving the larva a slender appearance. Postero-lateral corners of abdominal segments are produced into acute spines. The 6th abdominal segment has a pair of sub-median dorsal spines and a pair of antero-lateral, ventrally directed spines. Telson is slightly longer than broad and has the marginal spines long and slender. Denticles on telson number 1 lateral, 9 intermediate and 10 or 11 sub-median on each side. The uropod when directed backwards reaches the base of the lateral spines of telson. The basal segment of the exopodite carries 5 free spines and has indications of four more beneath the skin. The outer spine at the tip of the ventral prolongation of the uropod is only about  $\frac{1}{3}$  the length of inner which has a small smooth basal swelling.

*Earlier stages of larvae*.—A single specimen, 17 mm. long, collected on 6th May 1943, belongs to the above species and represents an earlier stage to the final pelagic. General appearance and the proportions of

the various parts of the body are like those in the final pelagic larva. The second antennular flagellum carries 8 groups of sensory hairs. The uropod, however, is in an earlier stage of differentiation. When directed backwards it reaches only to the base of the lateral spines of telson; the exopod has only 3 free spines and in the ventral prolongation the inner larger spine has no noticeable basal swelling. The peraeopods are shorter than in the final pelagic stage and the tip of the postero-lateral spine of carapace reaches the level of the hind border of the first abdominal segment.

*Remarks.*—In general appearance the larva shows close resemblance to the final pelagic larva of *S. quinquedentata*, but, the small size, long, unarmed rostrum, relatively longer postero-lateral spines, the small ventro-laterally directed spinules on the margin of carapace and the number of groups of sensory hairs on the antennular flagellum are features in which it differs from the latter species.

The superficial similarity to *S. (Alima) quinquedentata* and the indications of only five spines on the dactylus of the raptorial claw probably



TEXT-FIG. 22.—Unidentified larvae of *Squilla* spp.

a. *Squilla* sp. I, final pelagic larva, 20.0 mm. long, dorsal view; b. *Squilla* sp. II, same, 20.5 mm. long, dorsal view; c. *Squilla* sp. III, same, 20.6 mm. long, dorsal view.

reveal that the present larva belongs to the "*Quinquedentata*" group. The pelagic larvae of *S. boops*, *S. quinquedentata* and *S. gonypetes* have already been described. In the absence of any positive evidence, it is extremely difficult to assign the present larva to any of the adult species listed by Kemp from the Bay of Bengal.

**SQUILLA** Sp. II ("*Quinquedentata*" group?)

*Final Pelagic Stage* (Text-Fig. 22*b*).—A single specimen was available for study.

	mm.
Total length	20·5
Length of rostrum	3·0
Median length of carapace	6·1
Anterior breadth of carapace	2·6
Posterior breadth of carapace ..	4·0
Length of postero-lateral spine ..	2·5
Length of eye-stalk ..	1·4
Length of corneal portion of eye	1·4
Length of telson ..	2·5
Breadth of telson	2·55

The carapace is comparatively larger than in the foregoing species (*Squilla* sp. (I)), but leaves the last three segments of the thorax exposed dorsally. There are 6+2 spinules along the lateral margin of carapace. All the spinules are ventrally directed; the 7th spinule is fairly large and conspicuous. The rostrum is slender and unarmed ventrally and has its tip inferior to the tip of antennular peduncle. The median dorsal spine of carapace is shorter than the antero-lateral spine. The postero-lateral spines are not very divergent posteriorly; each has a ventral spinule at about  $\frac{1}{4}$  its length from base and has the tip reaching the level of the middle portion of the first abdominal segment. The maximum width of carapace is at about the level of the raptorial limb. The second antennular flagellum carries 8 groups of sensory hairs. The dactylus of the raptorial limb has no free spines other than the terminal. Indications of 5 spines are, however, visible through the larval skin. The last three thoracic segments are broader than long; the 8th segment is longer than those in front. Postero-lateral corners of the abdominal segments are produced into acute spines. The sixth abdominal segment has a pair of sub-median dorsal spines. Telson is almost as broad as long. The marginal spines of telson are well developed, the intermediate spines being the longest. The denticles number 1 lateral, 10 intermediate and 11 sub-median on each side. The uropod when directed backwards reaches half-way to the base of the intermediate spine of telson. The exopod has three free spines, while indications of four more are visible through the skin. The outer spine of the ventral prolongation of the uropod is only about  $\frac{1}{3}$  the length of the inner which has a smooth basal swelling.

*Remarks.*—Though of almost the same size as the final pelagic larva of *Squilla* sp. (I), it has a larger and broader carapace, shorter rostrum which has the tip inferior to the tip of antennular peduncle; and fewer spines

along the lateral margin of carapace and on the exopodite of the uropod. The shape of carapace is also different from that of the former species. Since structural differences between the pelagic larvae of closely allied species are now known to be indeed very slight, as seen in the case of *S. boops*, *S. quinquedentata* and *S. gonypetes*, I feel convinced that the present larva belongs to a different species than the one described above.

As in *Squilla* sp. (I), the indication of only 5 spines on the dactylus of the raptorial claw and the general similarity in appearance to the larva of the "*quinquedentata*" group, probably indicate that this larva also belongs to a species of that group. It appears that the typical *Alima* larvae generally belong to species of the "*nepa*" and "*Quinquedentata*" groups, while the *Alimerichthus* type of larvae are found to belong mostly to species of the "*Chloridella*" group; and, as such, it is unlikely that the present larva belongs to a species of the latter group. Since the pelagic larvae of the species of the "*Quinquedentata*" group listed by Kemp have already been described, it is possible that the present larva belongs to an undescribed adult species.

### SQUILLA Sp. III ("*Quinquedentata*" group?)

*Final Pelagic Stage* (Text-Fig. 22c).—Two specimens were available for study.

	mm.
Total length .. .. .	20.6
Length of rostrum .. .. .	2.7
Median length of carapace .. .. .	6.3
Anterior breadth of carapace .. .. .	3.0
Posterior breadth of carapace .. .. .	4.0
Length of postero-lateral spine .. .. .	2.1
Length of eye-stalk .. .. .	1.5
Length of corneal portion of eye .. .. .	1.5
Length of telson .. .. .	3.2
Breadth of telson .. .. .	2.9

The carapace is relatively long and does not appear very broad posteriorly since its anterior breadth is about  $\frac{3}{4}$  the breadth at the hind portion. The last three thoracic segments are exposed dorsally. The rostrum which is unarmed ventrally, is short and has the tip at the same level as the tip of antennular peduncle. The antero-lateral spines are long and pointed, each being about thrice the length of the short dorsal spine. Postero-lateral spines are short, each has a ventral spinule at about  $\frac{1}{3}$  its length from the base and has the tip reaching the level of the hind portion of the first abdominal segment. Lateral margin of carapace has 6+2 spinules, all directed ventrad. The second antennular flagellum carries 10 groups of sensory hairs. The raptorial dactylus has no free spine other than the terminal; but indications of five spines are clearly seen through the skin. The abdominal segments are broader than long and have the postero-lateral corners produced into acute spines. The sixth abdominal segment has a pair of sub-median spines. Telson is characteristically longer than broad, but the marginal spines are relatively

short. There are 1 lateral, 8 intermediate and 10 sub-median denticles on each side. The uropod, when directed backwards, reaches half-way to the base of the intermediate spines of telson. The exopod of the uropod carries 5 free spines and shows indications of 3 more beneath the skin. In the ventral bifid prolongation of the uropod, the outer spine is about half the length of the inner which has a conspicuous basal swelling.

*Remarks.*—The larva shows close resemblance to *Squilla* sp. (II) and undoubtedly belongs to a very closely related species. It, however, differs from the former in the shape of the relatively longer carapace, shorter rostrum and postero-lateral spines, the characteristically long telson, the larger number of groups of sensory hairs on the antennular flagellum and in the number of denticles on the telson.

The indications of only 5 spines beneath the skin on the dactylus of the raptorial claw probably shows that the larva also belongs to a species of the "*Quinquedentata*" group. As already discussed, it is, at this stage, useless to attempt to refer this larva to any specific adult.

#### LYSIOSQUILLA (LYSIERICHTHUS) Sp. I.

(?) 1871. *Erichthus* sp., Claus, *Abh. Ges. Wiss. Gottingen*, pl. v, fig. 19.

(?) 1907. *Erichthus rostratus*, Borradaile, *Trans. Linn. Soc. Zool. Lond.*

*Final Pelagic Stage* (Text-Fig. 23).—A single specimen, apparently in the final pelagic stage, from plankton collection dated 14th March 1939, was examined :—

		mm.
Total length	..	9.72
Length of rostrum	..	2.92
Median length of carapace		3.65
Anterior breadth of carapace	..	1.65
Posterior breadth of carapace		2.10
Length of postero-lateral spine		1.98
Length of telson	.. ..	1.39
Breadth of telson	.. ..	1.70

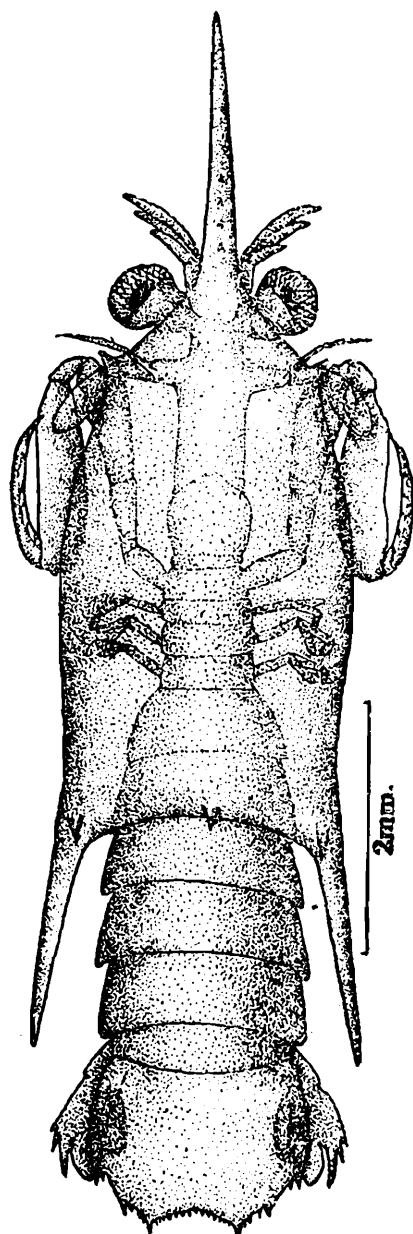
The larva has a broader carapace and looks stouter than the final pelagic stage of *L. multifasciata*. The carapace posteriorly extends over the second abdominal segment. Rostrum and postero-lateral spines are stout; while the antero-lateral and zoea spines are short and small. Rostrum is ventrally armed with 4 spinules. The postero-lateral spines which are slightly divergent distally, have the tips reaching the level of the last abdominal segment. The outline of post-larval carapace is clearly indicated. Raptorial dactylus shows clear indications of 6 teeth beneath the skin. Abdominal segments are about double the breadth of the thoracic and have the postero-lateral corners bluntly rounded. Telson is broader than long. The sub-median space is not divided into 3 sections, unlike the species described above. The denticles number 1 lateral, 3 intermediate and 7 sub-median on each side. The uropod is well developed and when laid back, reaches beyond the base of the lateral

spine of telson. The exopod has three free spines. The outer spine of the ventral prolongation of uropod is longer than the inner, which is longer than half the length of the former.

*Remarks.*—The larva differs from all the *Lysierichthii* encountered during the present investigation in the appearance of the sub-median space of telson. The relatively small size, the larger carapace with rather short thick marginal spines; the undivided sub-median space of telson, and an additional intermediate denticle (3), are features that easily distinguish the larva from other allied *Lysierichthii*.

In the nature of the telson, *Erichthus* sp. of Claus (his figure 19) is closely similar to the present form; but the former specimen was 14 mm. long. Borradaile (1907) finds this *Erichthus* sp. synonymous with his *E. rostratus*.

Gurney (1946) has figured the telson of the final pelagic larva and the early post-larva of a species of *Squilla* (?) collected by Miss Lebour from



TEXT-FIG. 23.—Final pelagic larva of *Lysiosquilla* sp. I, 9.72 mm. long, dorsal view.

Bermuda. In this larva the spinulation of the telson as described and as represented in the figure (his Fig. 8A) is found to be 1 lateral, 2 intermediate and 16 sub-median denticles on each side. In the post-larval telson (his Fig. 8B) a larger number, more than 12, of intermediate denticles are shown. The 6th abdominal segment is also seen to possess a pair of sub-median spines. It is difficult to accept that the larva figured actually belongs to a species of *Squilla*, particularly since, as is generally accepted, the number of intermediate denticles in an *Alima* larva is invariably 4 or more. In all probability, there has been some confusion in labelling the material he has described; for the post-larval telson appears to be that of a species of *Squilla*, in view of the presence of the two sub-median spines on the 6th abdominal segment and the larger number of intermediate denticles on telson. The larval telson figured is most likely that of a *Lysierichthus*. The fact that its carapace did not possess any marginal spinules is additional proof thereto. In the nature of the sub-median space of telson Gurney's larva resembles the one here described; but the much larger size (about 2 inches) of the former would indicate that it belongs to a different but related species.

The 14 mm. long Squilloid larva of Claus (his Fig. 21B) has a similar telson structure as the present larva and as shown by Hansen (1895) is a *Lysierichthus*.

### LYSIOSQUILLA (LYSIERICHTHUS) Sp. II.

*Final Pelagic Stage* (Text-Fig. 24 a).—Four specimens in the final pelagic stage and a few earlier stages were available for study.

The final pelagic larva closely resembles the corresponding stage of *L. acanthocarpus*.

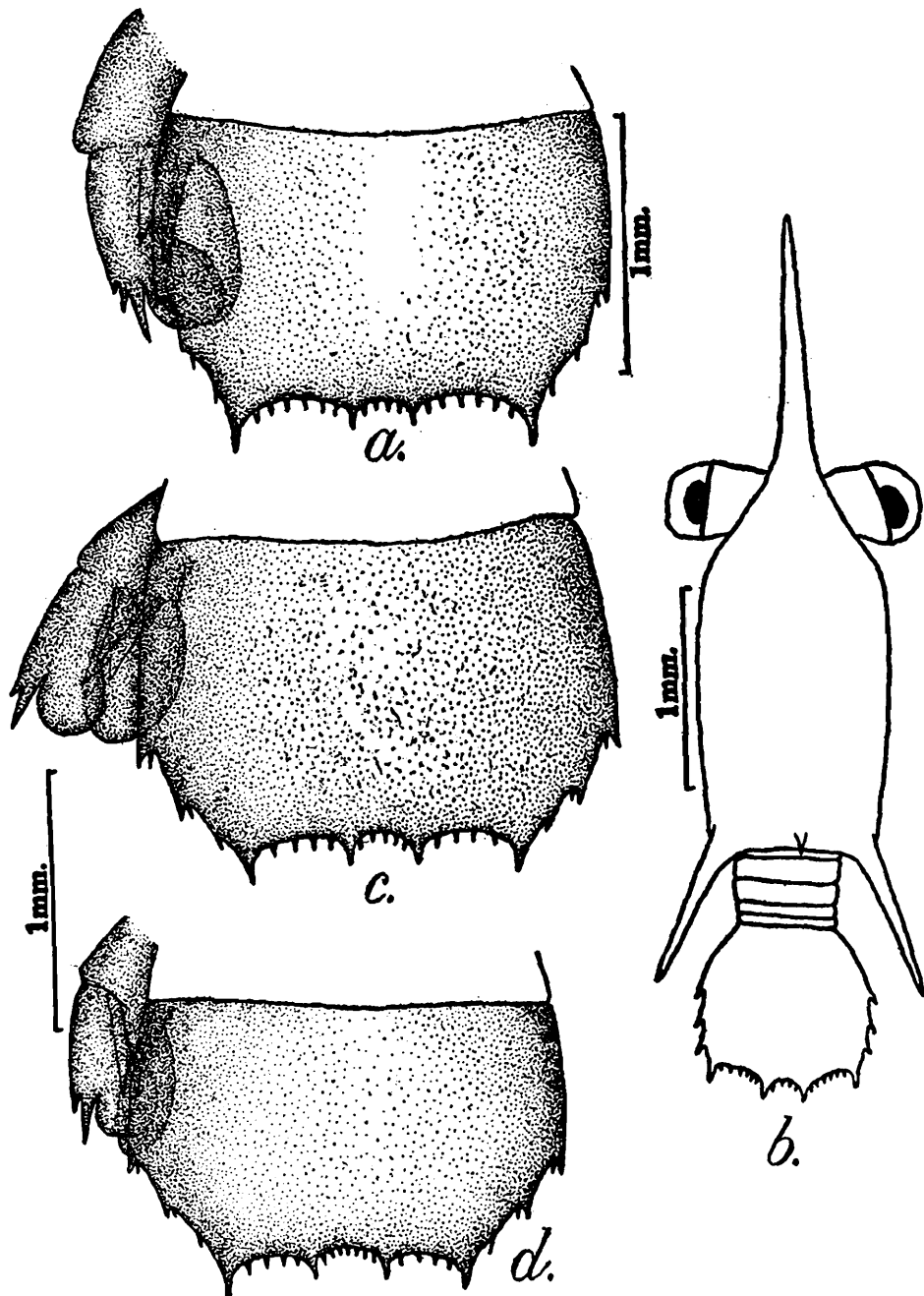
	mm.
Total length	12.8
Length of rostrum	4.6
Median length of carapace	3.7
Anterior breadth of carapace	1.9
Posterior breadth of carapace	2.3
Length of postero-lateral spine	3.4
Length of telson	1.1
Breadth of telson	1.8

Slightly smaller than the final pelagic larva of *L. acanthocarpus*, it has a relatively shorter carapace, with longer rostrum and postero-lateral spines. The carapace extends over the anterior half of the second abdominal segment and has no median dorsal carina. The zoea spine is absent. Tips of the postero-lateral spines are slightly divergent and reach the level of the lateral spines of telson. The raptorial dactylus shows indications of 6 teeth beneath the skin. The sub-median space of telson is divided into three sections; the 7th denticle from each side being larger than the rest; while the central section has only 4 denticles (6-1-4-1-6). The outer spine of the ventral prolongation of uropod is smaller than the inner, which reaches only about 2/3 the distance to the tip of endopod.



*Earlier Stages of Larvae* (Text-fig. 24 b).—Specimens ranging from 4.39 mm. to 8.0 mm. in total length are represented in the collection. The characteristic arrangement of the sub-median denticles of telson is found even in the earliest stage collected (*Erichthoidina*, 4.39 mm. long). The antero-lateral spines are not formed in the early larva, while the zoea spine is small. Rostrum and postero-lateral spines appear relatively longer than in the final pelagic stage.

*Remarks.*—The characteristic appearance of the sub-median space of telson it shares in common with *L. multifasciata*, *L. tigrina* and *L. acanthocarpus*; but in the number of sub-median denticles it differs from



TEXT-FIG. 24. Unidentified larvae of *Lysiosquilla* spp.

a. Telson and left uropod of final pelagic larva of *Lysiosquilla* sp. II, 12.8 mm. long; b. *Erichthoidina* larva of *Lysiosquilla* sp. II, 4.39 mm. long, dorsal view; c. Telson and left uropod of final pelagic larva of *Lysiosquilla* sp. IV, 12.0 mm. long; d. Telson and left uropod of final pelagic larva of *Lysiosquilla* sp. V, 12.0 mm. long.

all these species. The remarkable constancy in the number and arrangement of sub-median denticles, even from the early *Erichthoidina* stage, cannot be without significance, particularly since in those larvae that have been positively correlated with their adults even such minor differences like one denticle more or less, are seen to be of specific significance. Except slight differences in the relative size of carapace and its spines, in the arrangement of sub-median denticles and in the indications of only 6 teeth in the dactylus of the raptorial claw, the present larva is almost identical with the final pelagic larva of *L. acanthocarpus*. However, the absence of the antero-lateral and zoea spines on carapace in the earlier stages and the presence of at least the zoea spine in the corresponding stages of *L. acanthocarpus*, more or less clearly show that the former is specifically distinct from the latter.

It may be noted that of the adult species listed by Kemp (1913) from the Indo-Pacific region, *L. biminiensis*. Sub sp. *pacificus* is closely related to *L. acanthocarpus*, and has the same number of dactylar teeth (6) as indicated in the present larva.

The *Erichthoidina* larva (Brooks, 1866, Pl. XII, fig. 3 and Pl. IV, fig. 1) described by Brookes as belonging to *Gomodactylus*, appears to be identical with the larva here described and has the characteristic 6+1+4+1+6 arrangement of spinules in the sub-median space of telson.

### LYSIOSQUILLA (LYSIERICHTHUS) Sp. III.

*Final Pelagic stage*.—Two specimens in the final pelagic stage were available for study.

	mm.
Total length ..	12.0
Length of rostrum	4.8
Median length of carapace ..	3.9
Anterior breadth of carapace ..	1.9
Posterior breadth of carapace	2.35
Length of postero-lateral spine ..	3.6
Length of telson .. ..	1.1
Breadth of telson . . . .	1.7

The narrow carapace extends over the anterior half of the second abdominal segment. The antero-lateral spines are short, while the zoea spine is wanting. Rostrum is armed with 2 ventral spinules. The postero-lateral spines are directed almost parallel and close to the sides of the abdominal segments and each has the tip reaching beyond the hind border of telson. In the raptorial dactylus 6 teeth are seen clearly differentiated beneath the skin. The sub-median space of telson is divided into 3 sections, the 5th sub-median denticle from either side being longer than the rest. There are altogether 16 denticles, the central section containing 6; and the arrangement is 4-1-6-1-4. There are only two intermediate denticles, while in the post-larval telson the outline of which is clearly visible beneath the larval skin, 4 intermediate denticles are seen. The exopod of the uropod has 2 or 3 free spines and shows indications

of 3 more beneath the skin. In the ventral prolongation the terminal spines are of almost equal size ; in one specimen alone the outer spine appearing just a little longer than the inner.

*Remarks.*—The larva though slightly smaller than the final pelagic stage of *Lysiosquilla* sp. (II), has the carapace, rostrum and postero-lateral spines relatively longer than in the latter. In the absence of the zoea spine of carapace, in the number and arrangement of the sub-median denticles of telson and in the relative size of the spines of the ventral prolongation of the uropod also, this larva differs from *Lysiosquilla* sp. (II).

In the characteristic number and arrangement of the sub-median spinules of telson the *Erichthoidina* (*Lysiosquilla*) larva from Honolulu, figured by Brooks (1886, pl. XII, figs. 1, 2 ; Pl. V, figs. 5,9) appears to be identical with the present form.

#### LYSIOSQUILLA (LYSIERICHTHUS) Sp. IV.

*Final Pelagic Stage (Text-fig. 24c).*—Two specimens in the final pelagic stage were collected on 2nd August, 1940 and 29th March, 1941 respectively.

Closely agreeing with the foregoing species (*Lysiosquilla* sp. (III)) it is distinguished from the latter by the following features :—

1. The outer spine of the ventral prolongation of the uropod is longer than the inner as in *L. multifasciata*.
2. In the central section of the sub-median space there are only 5 denticles ; the arrangement being 4-1-5-1-4, *i.e.*, one denticle less than in *Lysierichthus* sp. (III) and one denticle more than in *L. multifasciata*.

The larva largely resembles *L. multifasciata* and *Lysierichthus* sp. (III), but it is almost certain that it is specifically distinct from these species, since only 5 teeth are indicated on the dactylus of the raptorial claw in the early post-larva. In the corresponding stage of *L. multifasciata* and *Lysierichthus* sp. (III) 6 teeth are clearly indicated on the dactylus of the raptorial claw. The nature of the intermediate and sub-median denticles of telson is also different.

#### LYSIOSQUILLA (LYSIERICHTHUS) Sp. V

*Final Pelagic Stage (Text-fig. 24d).*—Two specimens in the final pelagic stage were collected on 18th March, 1940 and 9th July, 1941 respectively.

Almost of the same size as the two foregoing species, it is distinguished from them only by the presence of an additional denticle in the central section of the sub-median space, the general arrangement thus being 4-1-7-1-4. The dactylus of the raptorial claw shows indications of only 5 teeth. The two spines of the ventral prolongation of the uropod are of almost equal size, as in *Lysiosquilla* sp. (III).

*Remarks.*—While the distinguishing features of this larva are insignificant, it is likely that it is not specifically identical with the foregoing species.

**GONODACTYLUS (GONERICHTHUS) Sp.**

1906. *Gonerichthys* B. Tattersall, *Rept. Pearl Oyster Fish.* Figs. 43 to 45. (?)

*Fina Pelagic Stage (Text-fig. 25).*—A single specimen was picked out from plankton collected on 10th April, 1939.

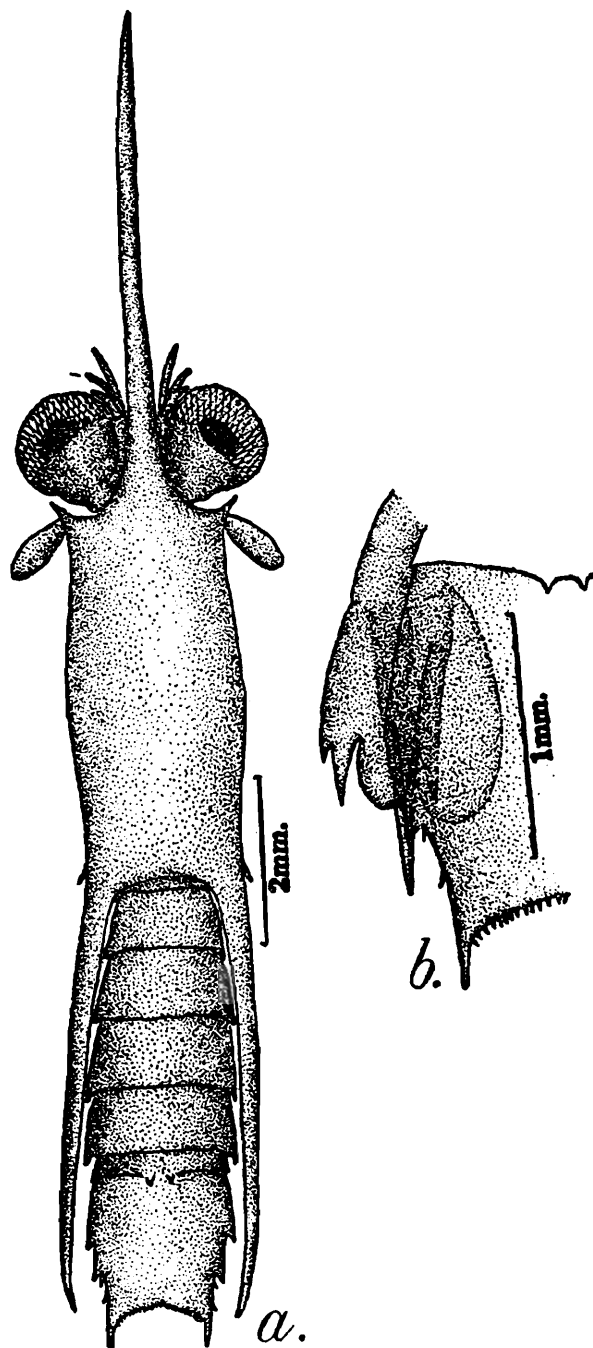
Total length	..	mm.	14.9
Length of rostrum	..		6.0
Median length of carapace			4.1
Anterior breadth of carapace	..		1.8
Posterior breadth of carapace			1.8
Length of postero-lateral spine	..		4.9
Length of telson	.. ..		1.7
Breadth of telson	..		1.6

The carapace is very narrow and extends over the first abdominal segment posteriorly. Rostrum is very long; longer than the postero-lateral spines and has 3 ventral spinules. The antero-lateral spines are short and pointed. At the base of each postero-lateral spine, on the hind corner of the lateral margin of carapace there is a ventrally directed spinule. The zoea spine is wanting. The postero-lateral spines are directed almost parallel to the abdominal segments and have their tips reaching the level of the hind border of telson. The antennular flagella are very short and the second flagellum carries 4 groups of hairs. Eyes are conspicuously large, mounted on very short stalk. Dactylus of the raptorial claw is long and slender. Peraeopods are well developed. The thoracic and abdominal segments are broad. The postero-lateral corners of the first 3 abdominal segments do not end in acute spines; while in the last 3 segments the pleura end posteriorly in short, acute spines. A pair of sub-median dorsal spines is present on the 6th abdominal segment. The telson is long and narrow, with wide sub-median space. The sub-median spines are very long. Denticles number 1 lateral, 2 intermediate and 14 sub-median on each side. The uropod is well developed and has the tip reaching the base of the intermediate spines of telson. The exopod has 2 free spines. In the ventral prolongation the outer spine is conspicuously large, the inner being only about 1/4 the length of the outer.

*Remarks.*—The larva shows some resemblance to *Gonerichthys B* of Tattersall (1906), but differs from it in the absence of the zoea spine, in the longer rostrum and postero-lateral spines and in the slightly larger carapace. Tattersall's specimen, however, was in an earlier stage than the present one.

The larva described as *Lysierichthys A* by Tattersall (loc. cit.) appears to show some striking features that are not generally found in *Lysierichthii*. In the majority of *Lysierichthii*, particularly the smaller species, the postero-lateral corners of the abdominal segments are not pointed but are smoothly rounded. In the larger larvae of the *maculata* group, however, the postero-lateral corners of the abdominal segments end in acute spines. Further, the presence of a pair of sub-median dorsal spines on the 6th abdominal segment is a feature that is not known to be shared

by any *Lysierichthus* that has been positively correlated with the adult species. Tattersall himself observes that his *Lysierichthus A* differs from all the *Lysierichthii* so far described in the possession of the submedian dorsal spines on the 6th abdominal segment. In the nature of the ventral prolongation of the uropod also *Lysierichthus A* differs from the true *Lysierichthus*. Except in minor differences in the relative size of the different parts, *Lysierichthus A* shows all characters of *Gonerichthii* and I am, therefore, inclined to consider that the former should properly be placed under *Gonerichthus*.



TEXT-FIG. 25.—Unidentified larva of *Gonodactylus* sp.

*a.* Final pelagic larva, 14.9 mm. long, dorsal view ; *b.* Left half of telson and left uropod of the same, magnified.

**PSEUDOSQUILLA (PSEUDERICHTHUS) Sp. I.**

A single specimen, 4.95 mm. long, was examined.

Carapace is relatively small ; extends over the last thoracic segment posteriorly ; has the antero-lateral and zoea spines long ; tip of postero-lateral spine reaches hind border of the third abdominal segment and a single spinule is present at the postero-lateral corner of carapace, close to the base of the postero-lateral spine. Rostrum is armed with 4 ventral spinules. Eyes are large with short stalk. The raptorial claw is well developed ; the propodus has one stout basal spine and a few scattered pectinations on the inner aspect. Postero-lateral corners of abdominal segments are acutely pointed ; the 6th abdominal segment has a pair of sub-median dorsal spines; telson is long and quadrate, with wide sub-median space. The sub-median spines are long and the denticles number 1 intermediate and 15 sub-median on each side. Uropods are rudimentary.

### **PSEUDOSQUILLA (PSEUDERICHTHUS) Sp. II.**

About a dozen specimens ranging from 3.2 mm. to 4.5 mm. in total length, were available for study.

More slender in appearance than *Lysierichthii*, they resemble true *Alima* except in the nature of the telson, the conspicuous eyes and the shape and spinulation of carapace.

In the smallest larva the carapace extends over the first abdominal segment posteriorly and the postero-lateral spines, directed almost parallel to the abdominal segments, though slightly diverging distally, reach the level of the 3rd segment. The antero-lateral and zoea spines are small. Rostrum is relatively short. The lateral margin of carapace has a single spinule near the base of the postero-lateral spine. The raptorial limb is well developed. The postero-lateral corners of abdominal segments end in acute spines. There are 5 pairs of well developed pleopods. The 6th abdominal segment which is not fully differentiated, has a pair of sub-median dorsal spines. Telson is quadrate and long ; with 1 lateral and 10 or 11 sub-median denticles on each side.

In the larger specimens the carapace extends over the second abdominal segment and the postero-lateral spines reach the level of the 4th abdominal segment. The rostrum has 2 ventral spinules. Tips of antennular flagella reach upto the tip of rostrum. Uropod is still rudimentary.

### **KEY FOR IDENTIFICATION OF LARVAE.**

Since several species of larvae have been described in this report, it is felt that a key for their easy identification would be of use. Only those larvae that have been correlated with the adult species have been included in the key, in preparing which only characters of the advanced planktonic larvae have been taken into account. No attempt has been made to arrange the species according to the relationship exhibited by the adults ; eventhough based on larval characters also they fall into well known adult groups, with very few exceptions. As will be discussed subsequently, this might throw some light on the true affinities of the different species.

**Genus SQUILLA Fabricius : ALIMA LARVAE.**

Lateral margin of carapace with varying number of spinules ; postero-lateral spine ordinarily with a spinule at or near its base ; a conspicuous spinule near the base of the antero-lateral spine ; sixth abdominal segment usually with a pair of sub-median dorsal spines at the hind margin ; postero-lateral corners of abdominal segments, in advanced larvae, ending in acute or sub-acute spines ; telson ordinarily with four or more intermediate denticles ; sub-median space of telson relatively narrow, in advanced larvae.

- A. Hind margin of carapace with a small spinule, mid-way between the dorsal and postero-lateral spines.
1. Rostrum and postero-lateral spines moderately long ; lateral margin of carapace with 1+2 spinules ; length at final pelagic stage :  
11 to 12 mm.    ..    ..    ..    .. *Squilla scorpio* var. *immaculata*.
  2. Rostrum and postero-lateral spines very long ; lateral margin of carapace with 1+3 spinules ; length at final pelagic stage : 11 to 12 mm.    ..    ..    ..    .. *Squilla scorpio*.
- B. Hind margin of carapace without any spinule mid-way between the dorsal and postero-lateral spines.
- I. Raptorial dactylus with one or more free teeth other than the terminal.
    - (a) Margin of carapace without laterally directed spinules.
      - i. Carapace triangular, with long, stout rostrum and postero-lateral spines ; marginal spinules 1+2 ; raptorial dactylus with one or rarely two free teeth besides the terminal ; length at final pelagic stage ; 11 to 13 mm.    ..    .. *S. latreillei*.
      - ii. Carapace very narrow ; marginal spinules 1+2 ; raptorial dactylus with 3 teeth besides the terminal ; length at final pelagic stage : 13.5 mm.    ..    .. *S. lata*.
    - (b) Margin of carapace with one laterally directed spinule on either side. Carapace fairly broad ; marginal spinules 2+2 ; raptorial dactylus with 2 free teeth besides terminal ; length at final pelagic stage : 14.5 mm.    ..    .. *S. fasciata*.
  - II. Raptorial dactylus without any free tooth besides the terminal.
    - (a) Margin of carapace with 2 laterally directed spinules on either side ; total number of marginal spinules 4+3 ; length at final pelagic stage : 18 to 18.5 mm.    ..    .. *S. raphidea*.
    - (b) Margin of carapace without conspicuous laterally directed spinules.
      1. Rostrum with ventral spinules.
        - i. Last two thoracic segments exposed ; marginal spinules, 7+3 ; rostral spinules 7 ; carapace fairly wide posteriorly, tip of postero-lateral spines reaching level of 2nd abdominal segment ; 2nd antennular flagellum with 15 groups of hairs ; length at final pelagic stage : 29.5 mm.    ..    .. *S. interrupta*.

- ii. Last 3 thoracic segments exposed; marginal spinules 7+3; rostral spinules 6 or 7; carapace not much wider posteriorly; tip of postero-lateral spine reaching level of hind border of last thoracic segment; 2nd antennular flagellum with 12 groups of hairs; length at final pelagic stage: 31 mm. .. *S. boops.*
- iii. Last 3 thoracic segments exposed; marginal spinules 8+3; rostral spinules 8; carapace very narrow and small; tip of postero-lateral spine reaching level of junction between 7th and 8th thoracic segments; 2nd antennular flagellum with 11 groups of hairs; length at final pelagic stage: 27 to 27.5 mm. .. *S. quinquedentata.*
2. Rostrum without ventral spinules.
- (a) One or more thoracic segments exposed dorsally.
- i. Last thoracic segment alone exposed dorsally; carapace fairly large and broad; marginal spinules 8+3; tip of postero-lateral spine reaching level of 2nd abdominal segment; length at final pelagic stage: 30 mm. .. .. *S. hieroglyphica.*
- ii. Last two thoracic segments exposed dorsally; carapace short, narrow; marginal spinules 6+2 or 3; tip of postero-lateral spine reaching level of 1st abdominal segment; 2nd antennular flagellum with 12 groups of hairs; length at final pelagic stage: 27 mm. .. *S. gonypetes.*
- iii. Last two thoracic segments exposed; carapace long, fairly broad; marginal spinules 12+4; tip of postero-lateral spine reaching level of hind margin of 1st abdominal segment; 2nd antennular flagellum with 18 groups of hairs; length at final pelagic stage: 35.5 to 36 mm. .. *S. wood-masoni.*
- (b) No thoracic segment exposed dorsally.
- i. Carapace conspicuously large, shield-like; marginal spinules 8+3; tip of postero-lateral spine reaching level of 4th abdominal segment; 2nd antennular flagellum with 15 groups of hairs; length at final pelagic stage: 34.5 to 35 mm. .. *S. holoschista.*
- ii. Carapace fairly large, shield-like; marginal spinules 8+4; tip of postero-lateral spine reaching level of 4th-5th abdominal segment; 2nd antennular flagellum with 12 groups of hairs; length at final pelagic stage: 22.5 to 25 mm. .. .. *S. nepa.*



**Genus LYSIOSQUILLA Dana : LYSIERICHTHUS LARVAE.**

Lateral margin of carapace ordinarily without any spinule ; postero-lateral spines of carapace, each with a spinule, almost invariably situated near the very base ; no spinule at or near the base of the antero-lateral spines ; no sub-median dorsal spines at the hind margin of the sixth abdominal segment ; postero-lateral corners of abdominal segments in the majority of cases smoothly rounded and not ending in spines ; intermediate denticles of telson always less than four ; sub-median space of telson relatively broad during all stages.

A. Postero-lateral corners of abdominal segments ending in sub-acute or acute spines.

1. Carapace thick, shield-like, without antero-lateral spines ; zoea spine short, sometimes blunt ; rostrum and postero-lateral spines very short ; lateral margin of carapace at the middle, extends downwards and ends in a stout spine on either side ; abdominal segments very broad ; sub-median space of telson relatively narrow ; length at final pelagic stage : 23·5 mm. . . . . *L. maculata*.

2. Similar to the above ; but carapace with antero-lateral spines ; zoea spine wanting ; rostrum and postero-lateral spines longer ; lateral downward extension of carapace not ending in acute spines ; sub-median space of telson broad ; and length at final pelagic stage : 24 mm. . . . . *L. sulcirostris*.

B. Postero-lateral corners of abdominal segments rounded and not ending in spines.

I. Carapace without antero-lateral and zoea spines.

Outer spine of ventral prolongation of uropod smaller than the inner ; sub-median denticles 6-1-5-1-6 ; length at final pelagic stage : 13 to 13·5 mm. . . . . *L. tigrina*.

II. Carapace with antero-lateral and zoea spines.

(a) Outer spine of ventral prolongation of uropod longer than the inner ; sub-median denticles 4-1-4-1-4 ; length at final pelagic stage : 15 mm. . . . . *L. multifasciata*.

(b) Outer spine of ventral prolongation of uropod smaller than the inner ; sub-median denticles 6-1-6-1-6 ; length at final pelagic stage : 14 mm. . . . . *L. acanthocarpus*.

**DISCUSSION.**

*Stomatopods of the Madras Coast*.—The following 19 species belonging to the genera *Squilla* and *Lysiosquilla* have been recorded from the Madras coast (Kemp, 1913 ; Gravely, 1940).

<i>S. latreillei</i> ,	<i>S. microphthalma</i> ,	<i>S. gilesi</i> ,
<i>S. scorpio</i> ,	<i>S. tenuispinis</i> ,	<i>S. quinquedentata</i> ,
<i>S. gonypetes</i> ,	<i>S. nepa</i> ,	<i>S. holoschista</i> ,
<i>S. oratoria</i> , var. <i>inornata</i> ,		<i>S. interrupta</i> ,
<i>S. wood-masoni</i> ,	<i>S. stridulans</i> ,	<i>S. supplex</i> ,
<i>S. lirata</i> ,	<i>S. multicarinata</i> ,	<i>S. raphidea</i> ,
<i>L. maculata</i> ,	and	<i>L. acanthocarpus</i>

The present investigation has resulted in the addition of seven more species from the Madras waters as follows :—

*S. boops*,  
*S. fasciata*,  
*L. tigrina*.

*S. hieroglyphica*,  
*L. sulcirostris*,

*S. lata*,  
*L. multifasciata*, and

All these seven species appear to be new records for the west coast of the Bay of Bengal. *S. fasciata*, *S. lata* and *S. boops* have been recorded from the east coast of the Bay of Bengal; while *S. fasciata* and *L. sulcirostris* have been collected from the Andaman and Nicobar area. *L. multifasciata* which is known to occur in the Arabian sea, has not hitherto been recorded from the Bay of Bengal; while *S. hieroglyphica* and *L. tigrina* are two rare species the distribution of which is extended to the Indian waters (Alikunhi, 1944 *a, b*). Thus, of the seven additional species obtained from the Madras coast, six are additions to the Indian Stomatopod fauna. The presence of several unidentified larvae, particularly the *Lysierichthii*, in the Madras plankton shows that our knowledge of the stomatopod fauna of the Indian coastal waters is far from exhaustive.

*Correlation of Larvae with Adults.*—Foxon (1939) considers description of unidentified *Alima* larvae as an unprofitable business; while Gurney (1946) feels that “apart from hatching of the first larva of any available species, the most important contribution to knowledge that can be made now would be the rearing from plankton materials of as many consecutive post-larval stages as possible”. As has already been pointed out, description of the larval forms without correlating them with the adult species has resulted in much confusion and in the absence of any definite information as to which characters indicate specific differences, in several cases more than one species of larvae have been ascribed to a single species. To remove this confusion and to obtain a true picture of the stomatopod population of any particular locality, it is necessary to rear the planktonic larvae to the post-larval stages. The habits of adult stomatopods are such that they are caught in trawling nets and other fishing tackle, mostly by chance only (Kemp, 1913). That records of the adult species from any locality will, therefore, be necessarily very incomplete and have to be supplemented by the study of larval forms from the same waters, has been well demonstrated by the present investigation, which has resulted in the positive correlation of the larvae of 12 species of *Squilla* and 5 species of *Lysiosquilla* with their adults.

*Larval Characters.*—The studies embodied in the present report amply illustrate that certain characters hitherto considered as of little significance as specific features, are really very useful in distinguishing even closely related larvae. Between allied species the specific differences are often trivial, but remarkably constant. The size at the final pelagic stage; the shape and spinulation of carapace; the presence or absence of teeth other than the terminal on the dactylus of the raptorial claw; the shape and spinulation of telson and the uropod, etc., are features that hardly show any variation within a species. The larvae of *S. nepa* and *S. holoschista* are very similar to each other, but they could always be distinguished by the differences in size and the number of spinules on the lateral margin of carapace. Likewise *S. scorpio* is distinguished from

its variety *immaculata*, by the presence of an additional spinule on the margin of carapace and by the relatively longer size of the rostrum and postero-lateral spines in the former. In the " *Quinquedentata* " group, the larvae of *S. boops* and *S. quinquedentata* very closely resemble each other and are distinguished from one another by characters which would not have been considered as of any specific significance, if the larvae were not actually reared into different post-larval forms. In the *Lysierichthii* of the " *Acanthocarpus* " group, the number and arrangement of denticles on telson, particularly in the sub-median space, are found to be remarkably constant features which are of definite taxonomic significance.

From their size at the final pelagic stage, the shape and spinulation of carapace and the relative size of the thoracic and abdominal segments, the *Alima* larvae dealt with in the present report could be arranged into distinct groups. The larvae of *S. latreillei*, *S. lata* and *S. fasciata* belong to the *Alimerichthus* type and are characterised by the relatively small size, short small carapace with a few marginal spinules and the relatively broad thoracic and abdominal segments which make the larvae appear stout. The region between the antenna and the labrum is not much telescoped in these larvae, which are also characterised by the possession of one or more free teeth other than the terminal, on the dactylus of the raptorial claw. Generalising from this, it is perhaps justifiable to suggest that the true *Alimerichthus* type of *Alima* larvae probably belongs to species of the *chloridella* group.

The larvae of *S. scorpio*, which as pointed out by Kemp (1915) are perhaps unique among *Alima* larvae in the possession of the characteristic spinule on the hind margin of carapace, mid-way between the dorsal and the postero-lateral spines on either side, are also of the *Alimerichthus* type but differ from the larvae of the " *Chloridella* " group, in the absence of free teeth other than the terminal, on the dactylus of the raptorial claw.

The larvae of *S. raphidea* occupy a peculiar position. Though described as belonging to the *Alimerichthus* group, they show some conspicuous differences from the typical *Alimerichthus* of the " *Chloridella* " group, viz. ; larger size ; broad, shield-like carapace and absence of free teeth other than the terminal on the dactylus. In the number of marginal spinules on carapace (4+3) these larvae perhaps occupy an intermediate position between *Alimerichthii* of the " *Chloridella* " and *Scorpio* groups on the one hand and the typical *Alima* larvae on the other. They resemble the true *Alimerichthus* only in the relatively broad thoracic and abdominal segments ; the short antenna-labral region and the consequent stout build of the body.

The other larvae are all relatively large-sized and slender in appearance. These belong either to the " *quinquedentata* " group or to the " *nepa* " group. The antenna—labral region is invariably highly telescoped and the thoracic and abdominal segments are comparatively narrow, giving the abdomen a slender appearance, in sharp contrast to the condition in the *Alimerichthus* type. No free tooth other than the terminal is developed on the raptorial dactylus in any of these larvae. The lateral margin of the carapace is invariably provided with a larger number of spinules than in *Alimerichthus*.

In the “*quinquedentata*” group the carapace is generally very narrow and relatively small. *S. hieroglyphica* shows some variation from this type of carapace. The larvae of species of the “*nepa*” group consisting of *S. nepa*, *S. holoschista*, *S. wood-masoni* and *S. interrupta*, have large shield-like carapace which is characteristic. However, *S. interrupta* differs from the other three species in the possession of ventral spinules on the rostrum. In this feature it agrees with the larvae of *S. oratoria* and this probably indicates its closer relationship to the latter than to *S. nepa*, *S. holoschista* or *S. wood-masoni*.

In the *Lysierichthii* larvae also two distinct types are noticeable. Larvae of the “*maculata*” group are characterised by their large size, very broad abdominal segments; stout build of body and strong shield-like carapace with marginal spines short or moderately long. Unlike the majority of *Lysierichthii*, in these larvae the postero-lateral corners of the abdominal segments, particularly the last three, end in acute spines.

The larvae of the “*acanthocarpus*” group are generally small-sized and relatively very slender as compared with those of the “*maculata*” group. The very narrow carapace, with long marginal spines and the fairly broad thoracic and abdominal segments are characteristic. In contrast to the “*maculata*” group of larvae, in these the postero-lateral corners of the abdominal segments do not end in spines.

Considering the outstanding characters of the larvae, it is clear that in each genus they fall into distinct groups as indicated above. It is significant to note further that these different groups of larvae correspond to similar groups of adult species. Since the similarity between the adult species is thus indicated in the pelagic larvae also, it is possible that outstanding larval features might easily provide clues to the real affinities of the different groups and genera.

The distinguishing characters of the larvae of the different genera of stomatopods have been discussed thoroughly and classified by several authors, including Claus, Brooks, Hansen, Giesbrecht, Foxon and Gurney. While I do not propose to go into the details of these different classifications, certain features which are likely to be of some significance in tracing the affinities of the different genera and which have hitherto not been considered in that light are discussed below.

In his revised classification of the stomatopod larvae, Foxon (1939) separates *Lysiosquilla* and *Coronida* from the rest of stomatopods which comprise the genera *Squilla*, *Pseudosquilla*, *Gonodactylus* and *Odontodactylus*. In the position of *Pseudosquilla*, which Foxon believes as closely related to *Squilla*, his classification differs from that of Hansen (1895) and of Giesbrecht (1910), both of whom have placed *Pseudosquilla* in the *Gonodactylus* group. Gurney (1946) examining the characters on which the classification is based, feels it “difficult to find any reason for placing *Pseudosquilla* nearer to *Squilla* than to *Lysiosquilla*”. While Foxon does not accept the view that there is a fundamental difference between the *Antizoea* and the *Pseudozoea*, as pointed out by Gurney, he gives much weight to the *Antizoea* for separating *Lysiosquilla* from the other genera. Eventhough the *Antizoea* in the course of later development gets transformed to the *Pseudozoea* type of body structure, it must

be admitted that in the early stages they appear fundamentally different. In spite of the structural similarity during the late larval life, *Lysiosquilla* larvae show some important differences from the larvae of the other genera. The advanced *Alima* larva invariably has the postero-lateral corners of the abdominal segments produced into acute spines and besides, the 6th abdominal segment is likewise provided with a pair of sub-median dorsal spines. These features are shared by *Pseuderichthus*, *Gonerichthus* and *Odonterichthus*; while in *Lysierichthus*, except perhaps in the "maculata" group, the postero-lateral corners of the abdominal segments are not produced into acute spines, but are smooth and rounded. Further, in none of these, the 6th abdominal segment is provided with the sub-median dorsal spines.

These features probably support the view that the *Antizoea* and the *Pseudozoea* are fundamentally different; in which case Foxon's classification of the larvae separating *Lysiosquilla* and *Coronida* from the other genera should be accepted as indicating the true relationship of the different forms. If the late larval characters give any indication of the affinities of the genera, the possession of pleural points on the hind corners of the abdominal segments and the presence of sub-median spines of the 6th abdominal segment bring *Squilla*, *Pseudosquilla*, *Gonodactylus* and *Odontodactylus* in one section as opposed to *Lysiosquilla* and *Coronida* in which these features are generally absent. Foxon's contention that the larval forms also fall in the same grouping as that given by Kemp for the adult genera, thus appears to be largely justified. That the larvae could be easily arranged in intra-generic groups, in the same way as the adults, has already been demonstrated.

The presence of 4 or more denticles between the intermediate and sub-median spines of telson, is accepted as one of the fundamental characters of the *Alima* type of larva. While this is almost invariably the case, it may be mentioned that in an early *Alima* of *S. scorpio*, 5.1 mm. long, there are only three intermediate denticles on each side. The smallest larva of *S. scorpio*, var. *immaculata* from the Chilka Lake, also measuring 5.1 mm. in length, has the sub-median denticles variable in number; in one specimen there were 3 on one side and 4 on the other; a second specimen had 3 on one side and 5 on the other. It is likely that in the earlier stages of these species the number of intermediate denticles might have been definitely less than 4 on each side.

#### SUMMARY.

1. The plankton collections from the sea, off the Madras coast made during the years 1936 to 1943 (seven and a half years) were analysed for the stomatopod larvae. Out of 413 collections examined, 298 contained stomatopod larvae which totalled 14,197; the maximum number per collection encountered being only 432.

2. The great majority of the larvae were of an advanced stage of development, a good many being in the final pelagic stage.

3. Larvae of *S. nepa* formed the bulk of the catches, followed by *S. holoschista*, *S. wood-masoni*, *S. quinquedentata*, *S. latreillei* and *S. interrupta* in the order of abundance.

4. *Erichthus* larvae were relatively few and were only occasionally caught.

5. The live larvae were sorted into types according to their external characters and were separately reared in laboratory aquaria. By thus obtaining the post-larval stages, the species were identified and the larvae were correlated with the adults.

6. The following species of stomatopods were, in this way, correlated with their pelagic larvae :

<i>S. nepa,</i>	<i>S. holoschista,</i>	<i>S. wood-masoni,</i>
<i>S. interrupta,</i>	<i>S. boops,</i>	<i>S. quinquedentata,</i>
<i>S. gonyptetes,</i>	<i>S. hieroglyphica,</i>	<i>S. raphidea,</i>
<i>S. latrcillei,</i>	<i>S. lata,</i>	<i>S. fasciata,</i>
<i>L. maculata,</i>	<i>L. sulcirostris,</i>	<i>L. multifasciata,</i>
<i>L. tigrina,</i>	and	<i>L. acanthocarpus.</i>

7. Certain larval species (3 of *Squilla*, 5 of *Lysiosquilla*, 1 of *Gonodactylus* and 2 of *Pseudosquilla*), which could not be reared and correlated with their adults, have been described for future reference.

8. The synonymy of the different species of larvae has been discussed at some length to facilitate identification of the forms already described and to remove the existing confusion about their identity.

9. A key for the easy identification of the different larvae dealt with in this report, has been included.

10. The present studies have resulted in the discovery of seven species which are new to the Madras coast. All these species are now recorded for the first time from the west coast of the Bay of Bengal. The rare species *S. hieroglyphica* and *L. tigrina* are new additions to the stomatopod fauna of the Indian waters, along with *S. boops*, *S. lata*, *S. fasciata* and *L. sulcirostris*.

11. The general characters of the different types of larvae have been discussed briefly in the light of the present studies.

12. The possible affinities of the different genera and species have been considered in the light of the larval characters.

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