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THE COMPLETE LARVAL DEVELOPMENT OF *PARASESARMA PLICATUM* (LATREILLE, 1806) (DECAPODA: BRACHYURA: GRAPSIDAE) REARED IN THE LABORATORY

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ABSTRACT. - The complete larval development of *Parasesarma plicatum*, comprising five zoeal and a megalopa stages, was studied under laboratory conditions reared at 25 ppt salinity and 28°C ± 1. The larval stages were described and compared with that of other known species.

KEY WORDS. - Zoea, Megalopa, *Parasesarma plicatum*, Sesarminae, Complete larval development

INTRODUCTION

Serene & Soh (1970) and Soh (1978) revised the subfamily Sesarminae and reported three species in the genus *Parasesarma*, viz. *P. affinis, P. plicatum* and *P. pictum. Parasesarma plicatum* inhabits the muddy subtratum of estuarine and mangrove environments and enjoys a wide range distribution in the tropics (Chhapgar,1957). Baba & Fukuda (1975) were the first to describe the first zoea of *P. plicatum*. Later, Fukuda & Baba (1976) reported on the larvae of four sesarmine species viz. *Chiromantes bidens, Holometopus haematochier, Parasesarma plicatum* and *Sesarmops intermedius* . This paper, in Japanese, contains detailed figures of *C. bidens* only, and in the text, the authors only briefly noted that the larvae of *P. plicatum* passed through four zoeal and one megalopal stages. In the present study, the complete larval development of *P. plicatum* involves five zoeal and one megalopal stages. Male and female of *P. Plicatum* are deposited in Natural History British Museum, U.K and female from which larvae reared is deposited in the Marine Biological Museum, CAS - Marine Biology, Parangipettai.

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MATERIALS AND METHODS

Ovigerous females of *Parasesarma plicatum* were collected from Manoli islands, Gulf of Mannar (11° 29' N; 79° 47' E) and placed in plastic troughs containing filtered sea water. Small pieces of clam meat and wethered leaves of mangrove plants were provided as food. Water was changed daily till hatching. Upon hatching, zoeae were transfered to clean glass bowls containing filtered sea water and subsequently they were reared in groups of 15 in each glass bowl. Salinity was 25 ppt and temperature was 28°C ± 1. Water was renewed daily and freshly hatched *Artemia* nauplii were provided as food. Upon attaining megalopa stage they were reared individually in plastic containers where small pieces of mangrove leaves were provided as substrate. Larvae and moults were preserved as suggested by Thakur (1960). Dissections of the larvae and moults were made in 10% glycerin with the help of entomological needles under a binocular microscope. Illustrations of larvae were made with the help of a camera lucida and details regarding setation were verified with moults. Measurements of the larvae were taken from freshly killed larvae as suggested by Rice (1979).

RESULTS

Larvae of *P. plicatum* reared under laboratory conditions attained the first juvenile instar stage after passing through five zoeal and one megalopal stages in a period of 26 days.

Description of first zoea (Figs.1-9). - Dorsal spine length 0.18 mm; rostral spine length 0.12 mm; carapace length 0.38 mm; total length 0.63 mm; abdomen length 0.66 mm.

Carapace: Smooth with dorsal and rostral spines, without lateral spines; eyes sessile.

Antennule: Elongated distally with 3 aesthetascs of equal length and 1 seta terminally.

Antenna: Protopodite gradually tapering to a point with serration on outer margin; exopod about 1/3 length of spinous process with 1 long and 1 short setae terminally.

Mandibles: With well developed molar and incisor process, later with well developed teeth; palp absent.

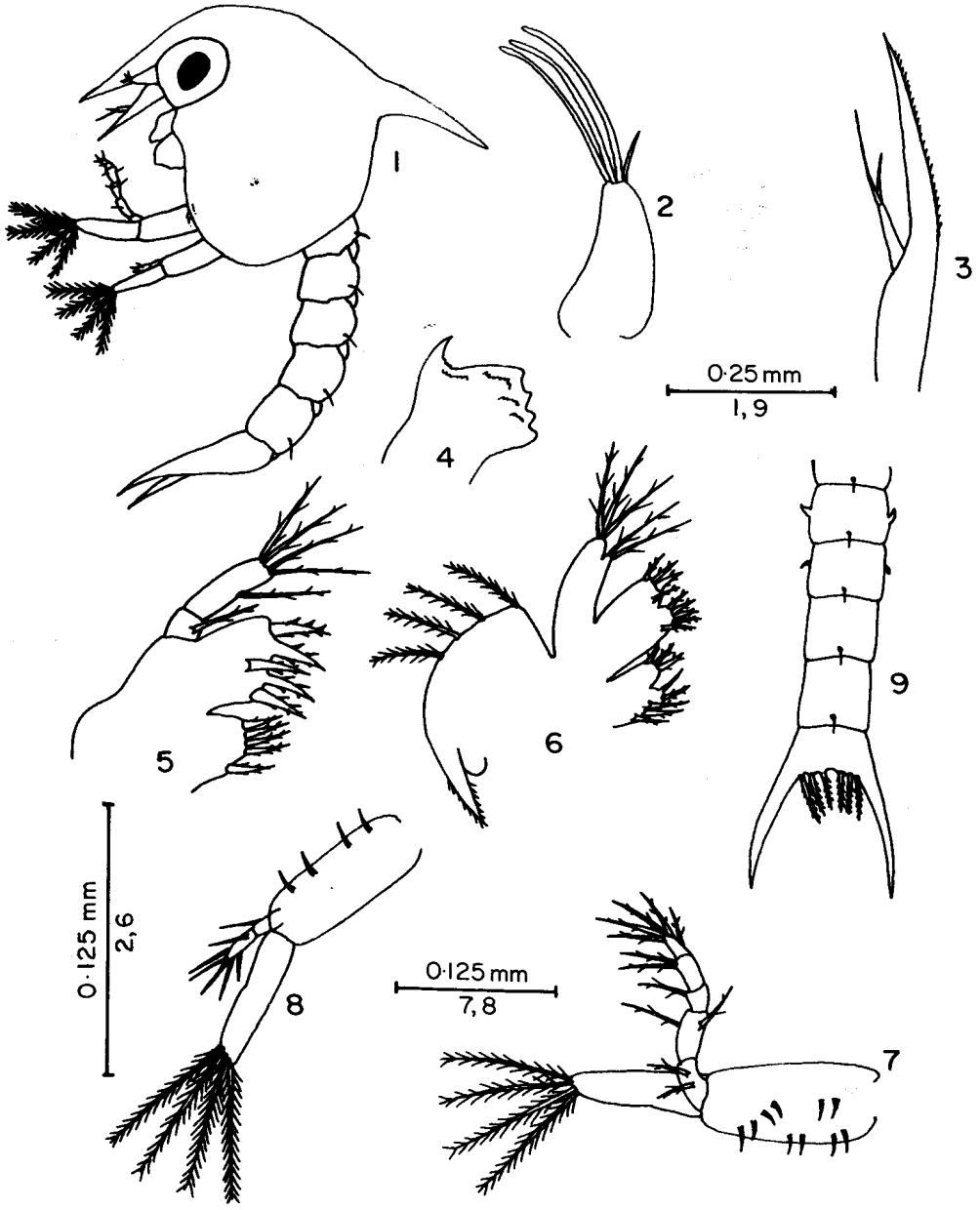
Maxillule: Coxa endite with 5 setae (4+1); basial endite with 5 serrate spines; single seta absent from outer margin; endopodite 2-segmented, proximal segment with 1 seta, distal segment with 4 terminal and 1 subterminal setae.

Maxilla: Bilobed coxal and basial endites with 5 (3+2), 3, 5 (4+1), 4 (3+1) setae respectively; endopod bilobed with 3, 2 setae; scaphognathite with 4 plumose setae and a plumose tip.

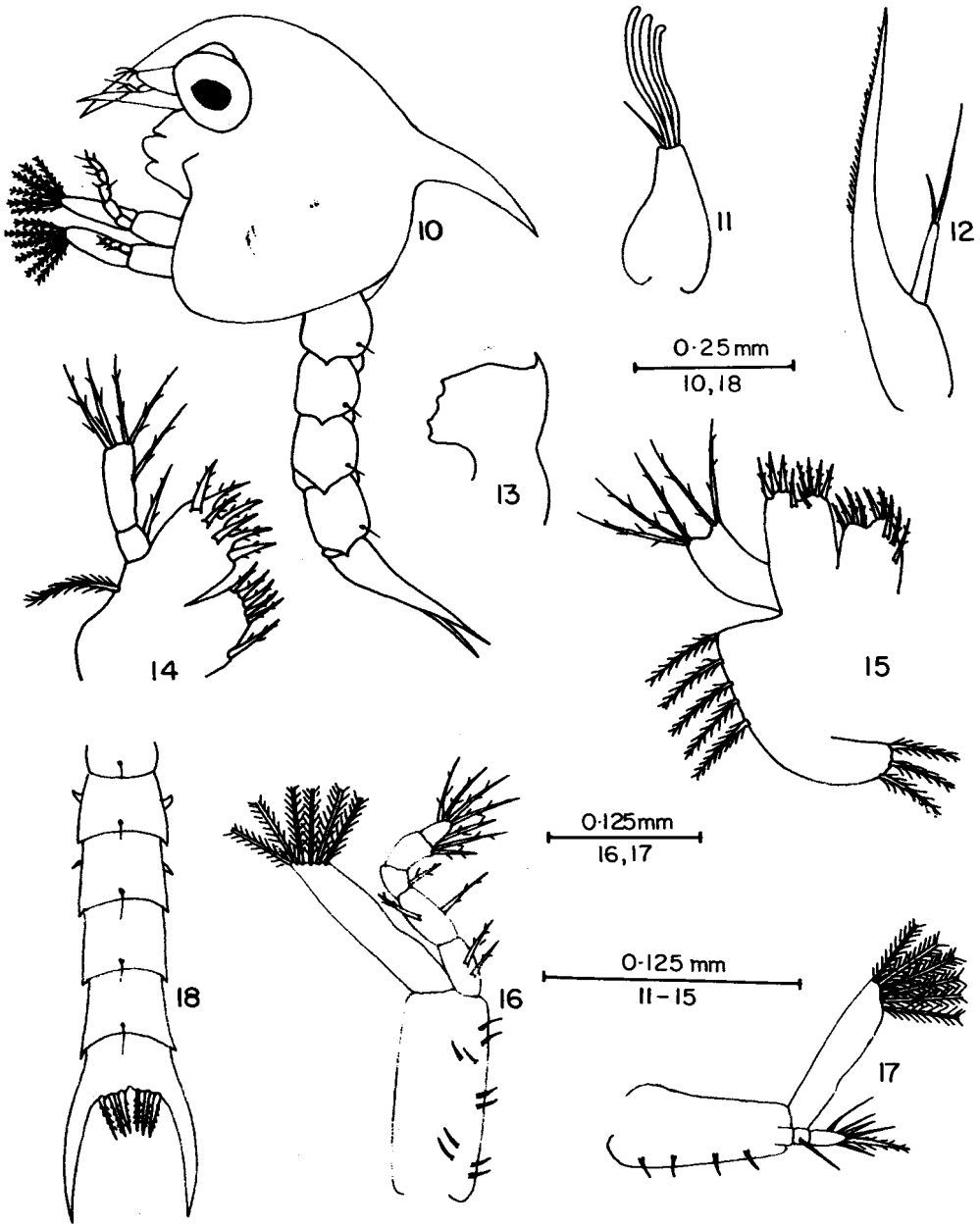
First maxilliped: Basis with 10 short setae; endopodite 5-segmented with 2, 2, 1, 2, 5 setae arranged distalwards; exopodite with 4 terminal plumose setae.

Second maxilliped: Basis with 4 short setae; endopodite 3-segmented with 0,1,6 non-plumose setae; exopod with 4 plumose setae terminally.

Abdomen: 5 somites and a telson, somites 2 and 3 with postero-lateral process directed anteriorly and posteriorly respectively; somites 1-5 each with a seta mid-dorsally; telson



Figs.1-9. *Parasesarma plicatum*. First zoea. 1, Lateral view; 2, Antennule; 3, Antenna; 4, Mandible; 5, Maxillule; 6, Maxilla; 7, First maxilliped; 8, Second maxilliped; 9, Abdomen.



Figs.10-18. *Parasesarma plicatum*. Second zoea. 10, Lateral view; 11, Antennule; 12, Antenna; 13, Mandible; 14, Maxillule; 15, Maxilla; 16, First maxilliped; 17, Second maxilliped; 18, Abdomen.

bifurcated into 2 long process, each with 3 serrated spines.

Chromatophores: Dark brown chromatophores on lateral side of the carapace, base of the antennule and protopod of maxilliped I and II, and on abdominal segments. The pattern of chromatophore distribution is consistent throughout development.

Description of second zoea (Figs.10-18). - Dorsal spine length 0.25 mm; rostral spine length 0.15 mm; carapace length 0.44 mm; total length 0.71 mm; abdomen length 0.76 mm.

Carapace: Eyes stalked.

Antenna: No change except increase in size.

Maxillule: Coxal endite with 6 setae; basial endite with 7 serrate spines; outer margin now with 1 plumose setae.

Maxilla: Bilobed coxal and basial endites with 5, 4, 5, 5 setae respectively; scaphognathite with 8 plumose setae (5 from distal to middle and 3 apically).

First and second maxillipeds: Distal segment of endopod of second maxilliped now become plumose; natatory setae of both exopods increased to 6.

Abdomen: Somites 2-5 with short postero-lateral spines.

Description of third zoea (Figs.19-27). - Dorsal spine length 0.29 mm; rostral spine length 0.16 mm; carapace length 0.50 mm; total length 0.86 mm; abdomen length 1.04 mm

Carapace: Smooth; with rudiments of third maxilliped and pereiopod buds.

Antennule: Conical with 3 aesthetascs of equal length and 2 setae.

Antenna: Endopod bud developed.

Maxillule: Outer margin now with 2 highly plumose setae.

Maxilla: Scaphognathite with 11 (7+3) plumose setae.

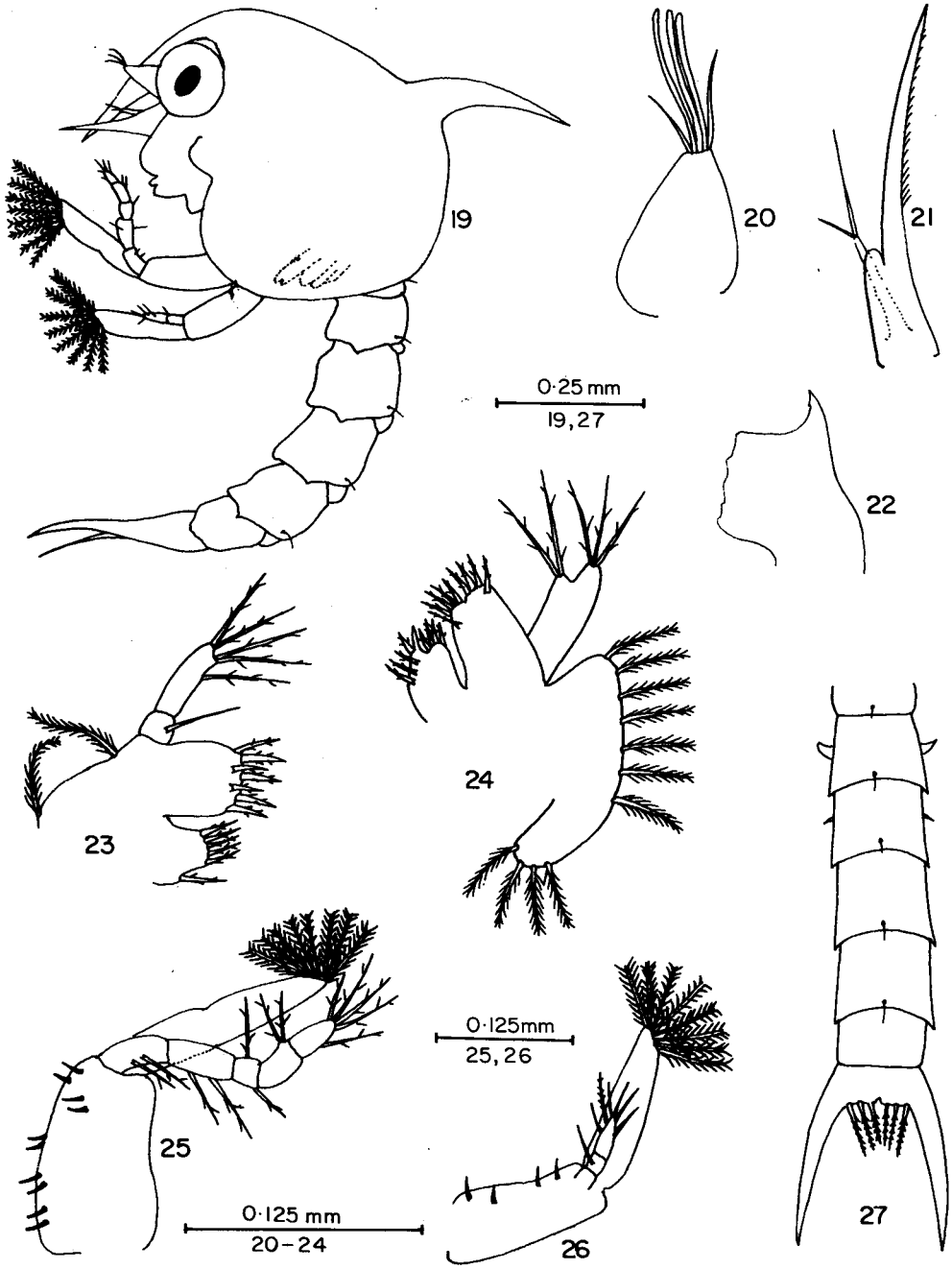
First and second maxillipeds: Third segment of endopod of first maxilliped with 2 setae; natatory setae of both exopods increased to 8.

Abdomen: Somite 6 separated from telson; rudiments of pleopod buds present.

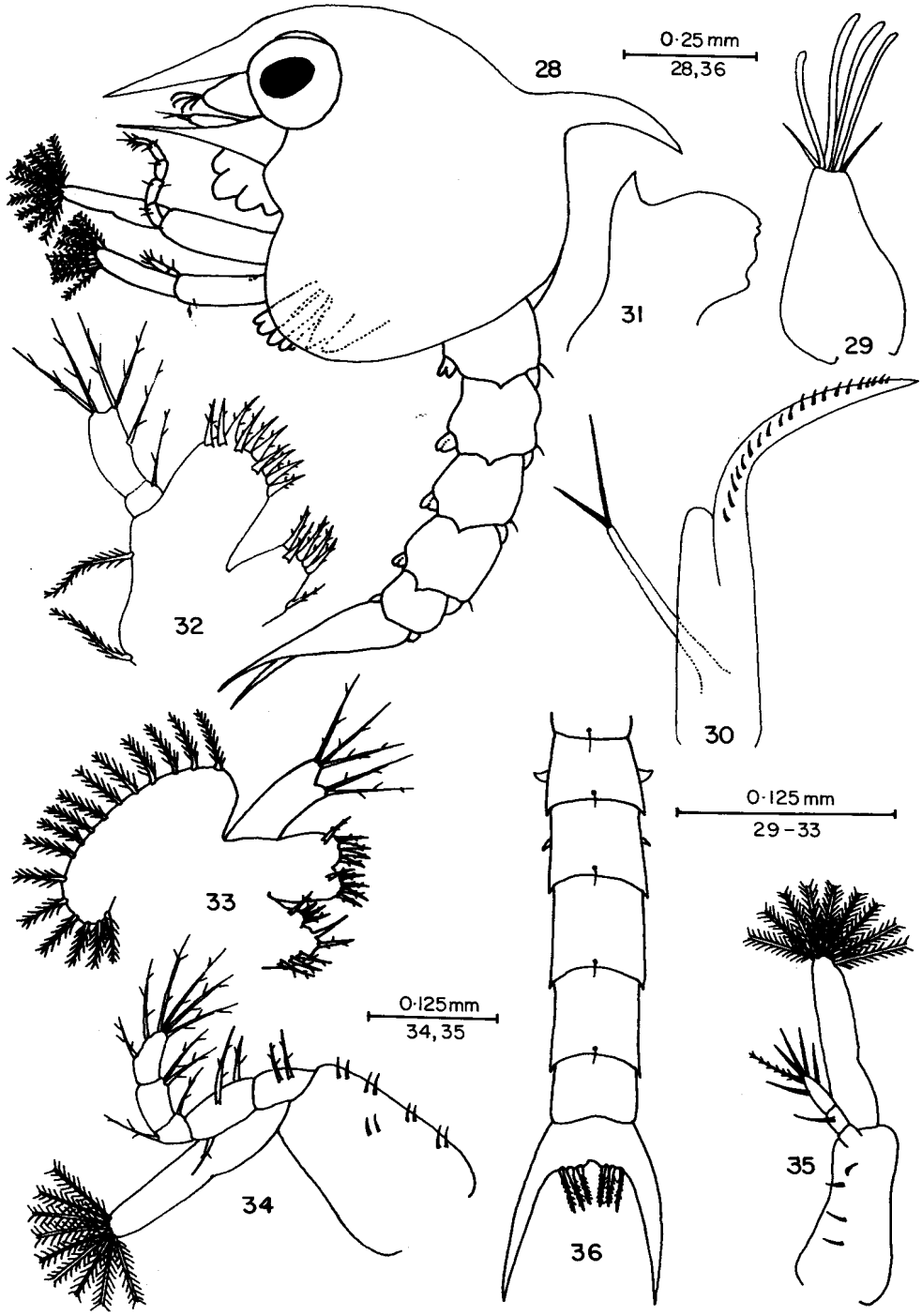
Description of fourth zoea (Figs.28-36). - Dorsal spine length 0.31 mm; rostral spine length 0.27 mm; carapace length 0.65 mm; total length 01.02 mm; abdomen length 1.12 mm.

Antennule: With 4 aesthetascs (3 equal in length + 1 Short setae) and 2 setae.

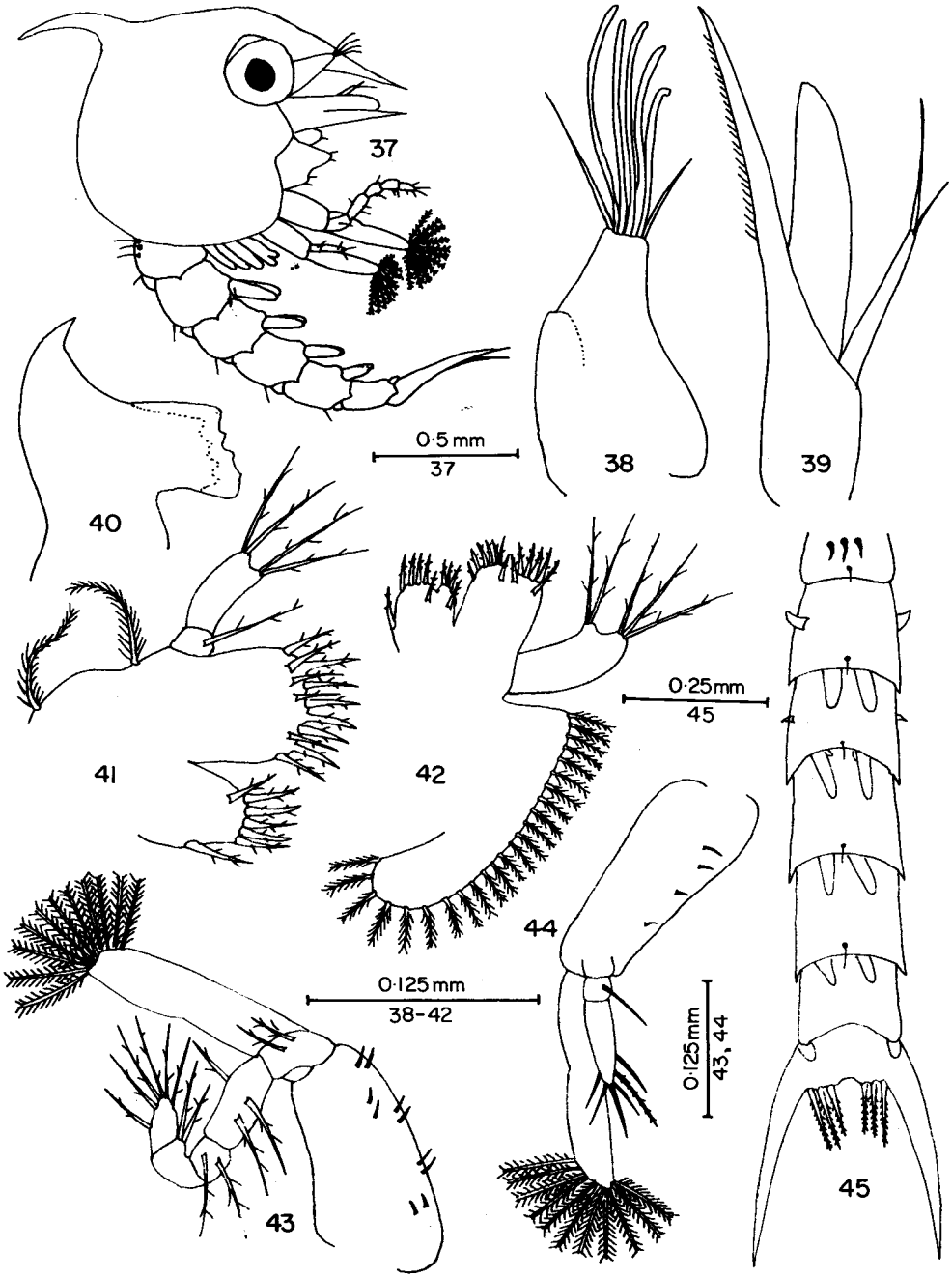
Antenna: Spinous process curved well, serrated with strong spinules middorsally; endopod bud less than exopod in length.



Figs.19-27. *Parasesarma plicatum*. Third zoea. 19, Lateral view; 20, Antennule; 21, Antenna; 22, Mandible; 23, Maxillule; 24, Maxilla; 25, First maxilliped; 26, Second maxilliped; 27, Abdomen.



Figs. 28-36. *Parasesarma plicatum*. Fourth zoea. 28, Lateral view; 29, Antennule; 30, Antenna; 31, Mandible; 32, Maxillule; 33, Maxilla; 34, First maxilliped; 35, Second maxilliped; 36, Abdomen.



Figs. 37-45. *Parasesarma plicatum*. Fifth zoea. 37, Lateral view; 38, Antennule; 39, Antenna; 40, Mandible; 41, Maxillule; 42, Maxilla; 43, First maxilliped; 44, Second maxilliped; 45, Abdomen.

Mandible: Without palp.

Maxillule: Coxal endite with 6 setae; basial endite with 10 serrate spines.

Maxilla: Schognathite fringed with 16 plumose setae.

First and second maxillipeds: Second segment of endopod of second maxilliped now with 3 setae, distal segment with 6 setae (i.e.2,3,2,2,6); natatory setae of both exopods increased to 9.

Description of fifth zoea (Figs.37-45). - Dorsal spine length 0.40 mm; rostral spine length 0.39 mm; carapace length 0.80 mm; total length 01.30 mm; abdomen length 1.29 mm.

Carapace: Dorsal spine shorter than rostral spine; third maxilliped and pereiopod buds well developed, elongated.

Antennule: Base broad with 5 aesthetascs of unequal length and 2 setae; endopod bud present.

Antenna: Endopod bud elongated about 2/3 as long as spinouse process.

Maxillule: Coxal endite with 7 (5+2) setae; basial endite with 12 (8+4) serrate spines.

Maxilla: Bilobed coxal and basial endites with 6 (4+2), 4 (3+1), 7 (6+1), 6 (4+2) setae respectively; scaphognathite fringed with 24 plumose setae.

First and second maxillipeds: Natatory setae of both exopods increased to 11.

Abdomen: First abdominal somite with 3 setae middorsally.

Description of megalopa (Figs.46-60). - Carapace length 0.89 mm; carapace width 0.79 mm.

Carapace: With fine hair, front lobulated, orbital cavity large, outer orbit highly lobulated and broader, posterior end with strong, short setae one on either side; eyes stalked; carapace laterally deppressed.

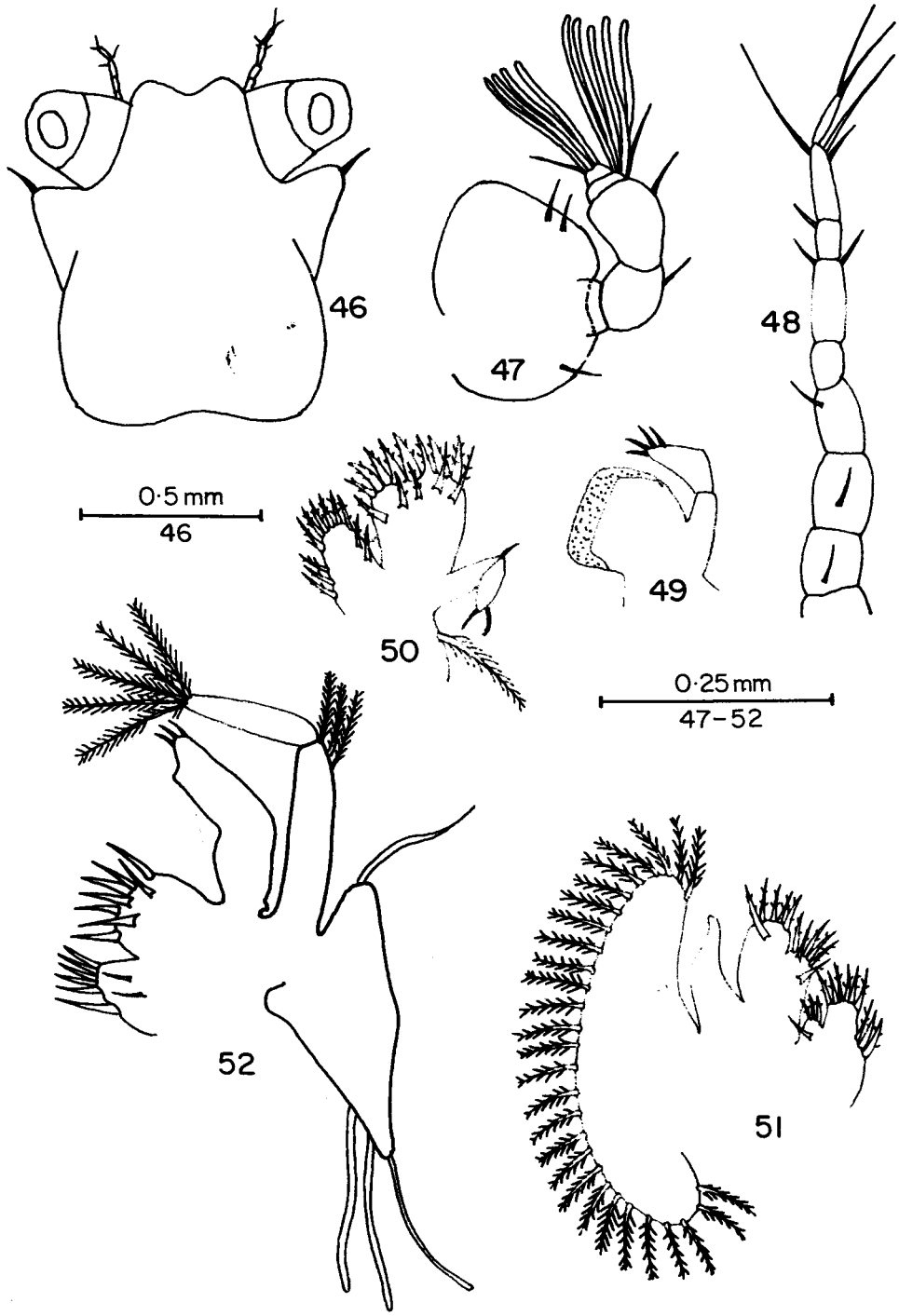
Antennule: Base with 3 setae; second and third segment of peduncle each with 1 seta; flagellar portion with 5 aesthetascs and 1 seta on proximal segment, 4 aesthetascs and 1 seta on distal segment.

Antenna: 8-segmented with 1, 1, 1, 0, 2, 1, 4 (2 long & 2 Short) and 2 (long) arranged distalwards.

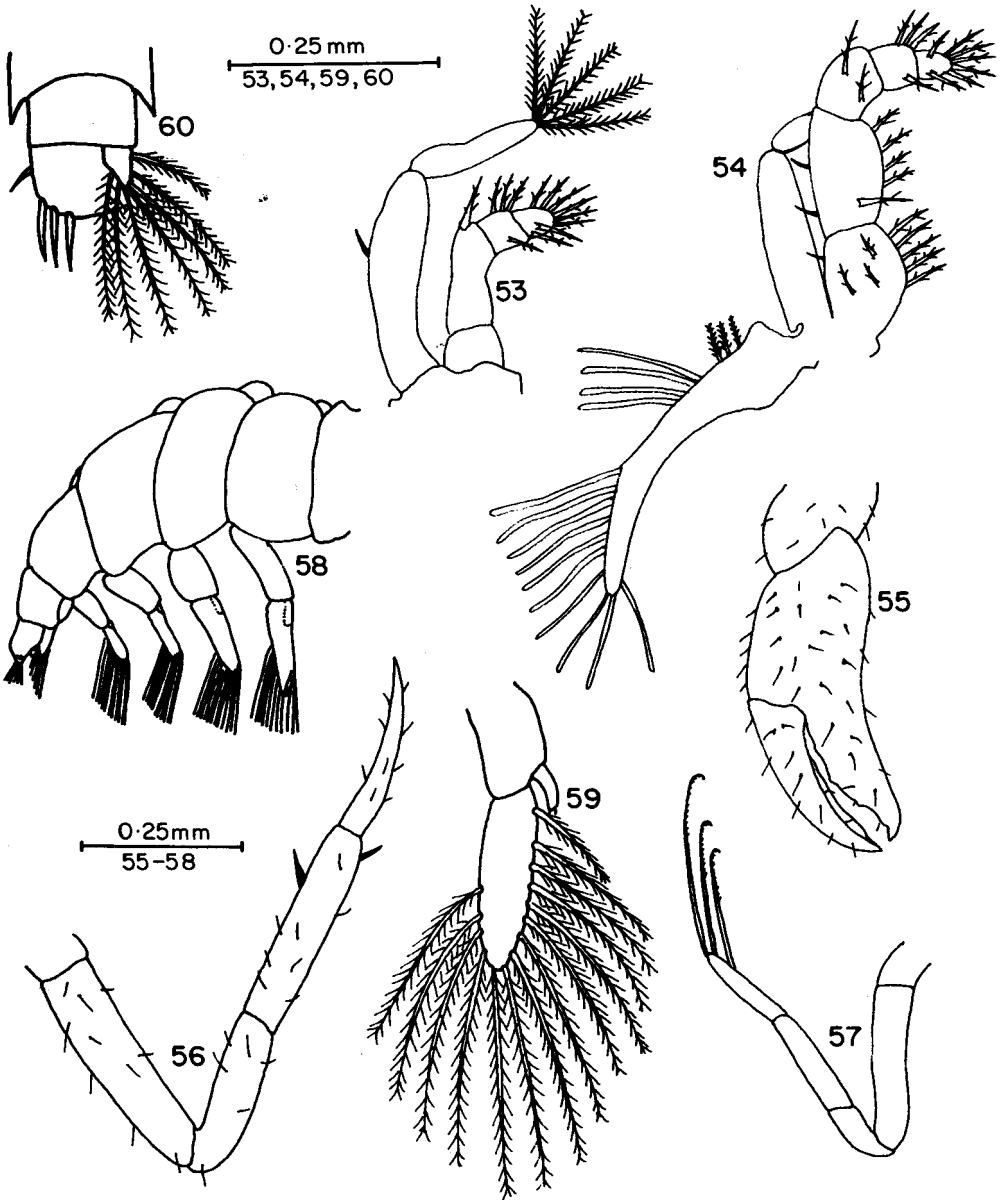
Mandible: Palp 2-segmented with 4 setae on distal segment; endopod bud absent.

Maxillule: Coxal and basial endites with 11, 13 setae; endopod 2-segmented with 3 setae on proximal segment; outer margin with 1 plumose setae.

Maxilla: Bilobed coxal and basial endites with 9 (6+3), 4 (3+1), 6 (5+1), 5 (4+1) respectively; endopod devoid of setae; scaphognathite with 28 short, plumose setae.



Figs. 46-51. *Parasesarma plicatum*. Megalopa. 46, Dorsal view; 47, Antennule; 48, Antenna; 49, Mandible; 50, Maxillule; 51, Maxilla.



Figs. 52-60. *Parasesarma plicatum*. Megalopa. 52, First maxilliped; 53, Second maxilliped; 54, Third maxilliped; 55, First pereiopod; 56, Third pereiopod; 57, Fifth pereiopod; 58, Abdomen; 59, Second pleopod; 60, Uropod and telson.

First maxilliped: Coxopodite and basipodite each with 8 setae; endopod unsegmented with 3 setae distally; exopod 2 - segmented with 3, 5 plumose setae on proximal and distal segments; epipod with 1 long plumose seta proximally and 3 distally.

Second maxilliped: Endopod 5-segmented with 0, 0, 1, 4, 8 setae distalwards; exopod 2-segmented with 1 short non-plumose seta on proximal, 5 plumose setae on distal segment; epipod absent.

Third maxilliped: Endopod 5-segmented with 9 (6+3), 7 (5+2), 2, 4 (3+1), 7 (5+2) setae arranged distalwards; exopod 2-segmented with 5 plumose setae on distal segment (not shown in figure); epipod large, ribbon-like, proximally with 3 short plumose setae, middle with 4 and distal portion with 10 non-plumose setae.

Pereiopods: First pair chelate, unequal; fifth pereiopod with 3 feelers armed with minute spinules.

Abdomen: 6 somites, without spines, with very fine hair; postero-lateral spines absent; 4 pairs of biramous pleopods, exopod of which with 13, 14, 13, & 11 plumose setae; endopod non-setose with 2 small hooks; uropod with 7 setae (6+1).

Telson: With 3 pairs of setae posteriorly and 1 pair of setae laterally one on either side.

DISCUSSION

The number of zoeal stages varies within the subfamily Sesarminae, with four or five stages being the most common. Fukuda & Baba (1976) reported that the larval development of *P. plicatum* involved only four zoeal and one megalopa stages. But in the present study, five zoeal stages were observed. Variation in number of zoeal stages have been attributed to environmental factors, laboratory induced factors and ecological factors (Rabalis & Gore, 1985; Lim et al., 1986). However, when the larvae of *P. plicatum* were exposed to different test salinities in the laboratory ranging from 5 ppt to 35 ppt, all the larvae still passed through five zoeal stages (Selvakumar, 1988).

The complete larval development is known only for two species in the genus *Parasesarma*. First zoea of *Sesarma plicatum* (Baba & Fukuda, 1975) was compared with the first zoea of the present study (Table 1). Considerable differences are evident. Baba & Fukuda (1975) reported a B-2 type antenna, but the B-4 type antenna is observed in *P. plicatum* in the present study. The figures of the antenna of the zoeal stages shown in Fukuda & Baba (1976) showed the B-4 antennal type. In *S. plicatum*, the coxal endite of the maxillule possessed six setae but in *P. plicatum* and other species like *S. lanatum* (see Kakati & Sankolli, 1975), *Nanosesarma andersoni* (see Vijayakumar & Kannupandi, 1986), *Episesarma tetragonum* (see Sundaramoorthy, 1987), *E. mederi*, and *Nanosesarma batavicum* (see Selvakumar, 1988) only five setae were reported. However, in *Selatium brockii* (see Vijayakumar & Kannupandi, 1988), *Parasesarma picta* and *Parasesarma erythrodactyla* (see Terada, 1976), six setae have been reported. Similarly, on the basis of the maxilla, nine setae are quite common in many sesarminies, including the present one, but Baba & Fukuda's (1975) report showed seven setae. In general, 8-10 and 4 setae on the protopod of maxillipeds I and II are present, but in *S. plicatum*, Baba & Fukuda (1975) reported only three and two setae respectively. Furthermore, fine setae observed on the inner margin of the telson in *S. plicatum* by Fukuda

Table 1. Comparison of the first zoea of *Sesarma plicatum* Baba & Fukuda (1975) and *Parasesarma plicatum* (present study)

Characters	*S. plicatum*	*P. plicatum*
Total length	0.70 mm	0.63 mm
Antennule	3 aesthetascs, 1 seta	3 aesthetascs, 1 seta
Antenna		
Type	B2	B4
Exopod	with 1 seta	2 unequal setae
Maxillule		
Coxa	6 setae	5 setae
Basis	5 setae	5 setae
Endopod	1, 5 setae	1, 5 setae
Maxilla		
Coxa	8 setae	8 setae
Basis	7 setae	9 setae
Scaphognathite	4 pulmose setae	4+1 pulmouse setae
First maxilliped		
Protopodite	3 setae	10 setae
Endopodite	2,2,1,2,4+1 (5) setae	2,2,1,2,4+1 (5) setae
Exopodite	4 natatory setae	4 natatory setae
Second maxilliped		
Protopodite	2 setae	4 setae
Endopodite	0,1,6 setae	0,1,6 setae
Exopodite	4 natatory setae	4 natatory setae

& Baba (1976) are absent in the present species. The differences in morphological features observed in the larvae of above two species suggest that the crabs identified as *S. plicatum* (Fukuda & Baba, 1976) in Japan and *P. plicatum* (present study) in India might be a separate species.

While the larvae of *P. plicatum* closely resemble those of *Parasesama picta* and *Parasesama erythrodactyla* (see Terada, 1976), they can still be effectively distinguished by the following characters. In *P. plicatum*, each abdominal somite has a seta middorsally whereas the other two species have one pair of setae on each somite. In *P. plicatum*, one plumose seta in zoea II and two plumose setae in zoea III, IV and V on the outer margin of the maxillule are present whereas only one plumose seta occurs in zoea II which is retained throughout the development in other two species. The larvae of *P. plicatum* is also characterised by having one non-plumose seta on the proximal lobe of the coxa of the maxilla in first four zoeal stages. One plumose seta appears on the distal segment of the endopod of the maxilliped II in the second stage which is retained throughout the development.

In the megalopal stage, *P. plicatum* has six setae on the posterior margin of the second segment of the uropod whereas *S. (P.) plicatum* and *S. (P.) erythrodactyla* have two and eight setae respectively.

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