

Larval development of three species of *Sesarma* (Crustacea, Brachyura, Grapsidae) from Eastern Australia.

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Abstract—All zoeal stages and the megalopa of *Sesarma* (*P.*) *erythroductyla* Hess, and the first zoeal stages of *Sesarma* (*B.*) *smithii* H. Milne-Edwards and *Sesarma* (*P.*) *messa* Campbell, are described and figured from eastern Australian specimens. Larvae of 16 *Sesarma* (s.l.) species are now known. Features of 10 of these were summarised by Wilson (1980), corresponding features for the other 6 are presented here. Differences between first zoeae of *S. erythroductyla* from Australian and Japanese descriptions are noted, including the presence of fine setules on the telson rami of Australian specimens, and support is given to the suggestion of evolutionary separation between the two stocks. Features previously used in distinguishing between larvae of Indo-West Pacific species of *Sesarma* are revised.

Introduction

At least partial larval life-histories are known for 27 sesarmine crabs (see Lam, 1969; Wilson, 1980; Gore and Scotto, 1982; Fielder and Greenwood, 1983, 1984). In many cases only the first zoeal stage is known, and only four Australian sesarmine species are included. Sixteen species of the genus *Sesarma* (s.l.) have been recorded from Queensland coasts (Davie, 1982). Nine are known from mangrove-associated areas in SE Qld, together with seven other sesarmine species. Four *Sesarma* species are known from the Brisbane River estuary, these being *Sesarma* (*Parasesarma*) *erythroductyla* Hess 1865, *Sesarma* (*Neosarmatium*) *smithii* H. Milne-Edwards 1853, *Sesarma* (*Perisesarma*) *messa* Campbell 1967, and *Sesarma* (*Bresedium*) *brevipes* (De Man, 1887). *Helograpsus haswellianus* (Whitelegge, 1899) is the only other sesarmid known to occur in the same estuary.

Of the five sesarmine species listed above, the present authors have recently described the complete larval development series of *S. (B.) brevipes* (Fielder and Greenwood, 1983) and *H. haswellianus* (Fielder and Greenwood, 1984). The first stage zoeae of *S. (P.) erythroductyla* from east Australian specimens were described by Green and Anderson (1973) and from Japanese specimens by Baba and Fukuda (1975). Davie (pers. comm.) is of the opinion that Japanese and E. Australian specimens may not be conspecific. The present paper completes knowledge of the larval development of *S. (P.) erythroductyla*, and describes the first stage zoeae of *S. (P.) messa* and *S. (N.) smithii*. It is one of a series by the authors on larvae of crabs from east Australian waters. No larvae have been described for other Australian sesarmine species.

S. erythroductyla is an eastern Australian species, being found from Victoria in the south, to northern Queensland. It is found commonly in sheltered high intertidal habitats and mangrove areas where it inhabits crevices or excavations beneath rubble. The species

occurs widely in Moreton Bay, where the present material was captured, adult populations there extending well into estuarine regions (c. 60 km, into salinities as low as c. 5‰) of the Brisbane and other rivers which discharge into the Bay. *S. messa* is known only from the north-eastern (Queensland) coasts of Australia (Davie, 1982), occurring in habitats similar to those of *S. erythroductyla*, though not extending as far into estuaries as that species. It does however extend c. 30 km into the Brisbane R. estuary. *S. smithii* is a relatively large crab (carapace width c. 27 mm) recorded widely in the Indian and central West Pacific Oceans, from the type locality in South Africa, to Fiji, and it is probable (Davie, pers. comm.) that east-Australian specimens are specifically distinct from those in the Indian Ocean. In the present area, individuals are found in characteristic deep burrows amongst coastal trees in very high intertidal regions, which are covered only by spring tides. They do not extend far into estuarine zones.

Methods

Ovigerous females were captured at night from intertidal areas toward the mouth of the Brisbane River (Lat. 27°23'S, Long. 153°9'E). Capture of *S. smithii* was aided by use of a burrow-trap similar to that described by Barnwell (1982). In the laboratory, females were held in water of 20–35‰ salinity at 25°C in a 12/12 h light/dark cycle. Holding containers were of plastic (c. 160 mm diam.) and were filled to a depth of c. 50 mm with pasteurised seawater. Containers were checked for emergent larvae each morning, and the water renewed.

Newly hatched zoeae were removed in groups of c. 200 to rearing containers similar to the holding containers, and abundant newly hatched *Artemia* nauplii provided as food. Each morning subsamples of zoeae were examined to determine moult stages, culture-water and food were renewed.

All other methods were similar to those used previously by the authors (Greenwood and Fielder, 1979; 1983). Zoal stage 4 appendages of *S. erythroductyla* have not been figured since they do not differ markedly from the preceding stage other than in the features tabulated.

Results

Ovigerous females of *S. erythroductyla* were found during the period August–January; those of *S. messa* and *S. smithii* were found only during January–March.

Attempts were made to rear larvae in reduced salinities similar to those in which adults were found (i.e. down to 20‰). Although zoeae hatched at these salinities, only *S. erythroductyla* reared at c. 35‰ survived to metamorphosis. In that species, five zoeal stages occurred prior to metamorphosis to the megalopa; minimal development time to metamorphosis was 15 days; each zoeal stage occupied c. 3 days. No larvae of *S. messa* and *S. smithii* survived beyond the first zoeal stage.

Measurements of all zoeal stages, and of the megalopa of *S. erythroductyla*, are given in Table 1. Details of setation are given in Tables 2 and 3. Drawings of entire larvae are given in Figs. 1, 6, 8 and 9. Appendages of *S. erythroductyla* zoeal stages are illustrated in Figs. 2–5, and of the megalopa in Figs. 6, 7. Appendages of *S. messa* and *S. smithii* first zoeal appendages are included in Figs. 8 and 9.

Table 1. Dimensions of zoeal stages and megalopa of *Sesarma erythroactyla*, and first zoeae of *S. messa* and *S. smithii* (in mm; mean values [6–10 individuals] with standard deviation [in parentheses] and range).

| Feature | <i>S. erythroactyla</i> | | | | | <i>S. messa</i> | <i>S. smithii</i> |
|----------------------|-------------------------|-------------|-------------|-------------|-------------|-----------------|-------------------|
| | Z1 | Z2 | Z3 | Z4 | Z5 | Z1 | Z1 |
| Carapace (A) | 0.37 (0.01) | 0.39 (0.06) | 0.48 (0.02) | 0.55 (0.02) | 0.72 (0.05) | 0.41 (0.02) | 0.41 (0.01) |
| Range | 0.34–0.38 | 0.32–0.50 | 0.46–0.50 | 0.52–0.58 | 0.66–0.78 | 0.38–0.44 | 0.40–0.42 |
| Dorsal Spine (B) | 0.21 (0.01) | 0.19 (0.06) | 0.24 (0.05) | 0.29 (0.01) | 0.37 (0.04) | 0.21 (0.02) | 0.19 (0.02) |
| Range | 0.20–0.22 | 0.12–0.28 | 0.18–0.28 | 0.28–0.30 | 0.30–0.42 | 0.18–0.24 | 0.18–0.20 |
| Rostrum (C) | 0.12 (0) | 0.17 (0.02) | 0.23 (0.04) | 0.30 (0.02) | 0.37 (0.03) | 0.20 (0.02) | 0.15 (0.01) |
| Range | 0.12–0.12 | 0.14–0.20 | 0.18–0.28 | 0.28–0.32 | 0.32–0.42 | 0.18–0.22 | 1.40–1.80 |
| 2nd Antenna (D) | 0.12 (0.01) | 0.10 (0.02) | 0.19 (0.04) | 0.29 (0.02) | 0.32 (0.04) | 0.20 (0.02) | 0.15 (0.01) |
| Range | 0.12–0.14 | 0.08–0.12 | 0.14–0.24 | 0.26–0.32 | 0.28–0.40 | 0.18–0.22 | 1.40–1.80 |
| Spine to Rostrum (E) | 0.59 (0.01) | 0.66 (0.03) | 0.83 (0.09) | 0.92 (0.04) | 1.19 (0.03) | 0.58 (0.03) | 0.67 (0.02) |
| Range | 0.58–0.60 | 0.62–0.70 | 0.70–0.90 | 0.88–0.98 | 1.16–1.24 | 0.56–0.64 | 0.64–0.70 |
| Ratio B/A | 0.57 | 0.49 | 0.50 | 0.53 | 0.51 | 0.51 | 0.46 |
| Ratio B/C | 1.75 | 1.12 | 1.04 | 0.97 | 1.00 | 1.05 | 1.27 |
| Ratio D/C | 1.00 | 0.59 | 0.83 | 0.97 | 0.86 | 1.00 | 1.00 |

MEGALOPA: Carapace length 0.76 (0.08), width 0.56 (0.06).

S. (P.) erythrodactyla

ZOEA 1 (Figs 1A,B; 2A-G).

Carapace without any obvious surface ornamentation; dorsal spine small, delicate with pronounced posterior curve; rostrum simple, almost straight, c. $0.6 \times$ length of dorsal spine, reaching to tip of spinous process of antenna. Eyes immobile. No lateral carapace spines.

Abdomen with 5 somites; second and third with mid-lateral projections, those on third being small. Somites 2-5 with pair of small setae posteromedially; slight extension of postero-lateral margins.

Telson plate broad (c. $2 \times$ length); posterior margin with 3+3 bip Plumose setae of similar length; postero-medial cleft shallowly concave; no lateral telson setae. Each ramus long with three rows of minute setae (only visible under close examination, e.g. $\times 100$); these rows situated laterally, dorsally and medially. Telson length ratio (median length telson plate to total length telson incl. rami) c. 3.28.

Setation of appendages as given in Table 2 and Fig. 2.

ZOEA 2 (Figs 1C, 3A-G).

Eyestalks free from carapace. Carapace of similar size to preceding stage, but dorsal spine stouter and rostrum relatively longer ($\times 0.4$). Abdomen still of five free somites; posterolateral projections of somites 3-5 obvious but small. No evidence of posterior thoracic limb-buds. Telson structure as previously; telson length ratio c. 3.0. Apical process of scaphognathite now a rounded posterior lobe (*sensu* Dover *et al.* 1982) with 3 plumose setae. Setation of appendages as given in Table 2.

ZOEA 3 (Figs 1D; 4A-G).

Considerable carapace size increase from previous stage (c. 25%) with proportional increases in dorsal and rostral spines; length of antennal spinous process almost doubled, but still not reaching beyond tip of rostrum; rostrum straight. Sixth abdominal somite now distinct from telson; posterolateral projections of somites 3-5 as previously, similar but smaller projections on somites 1 and 6; small ventral swellings in presumptive pleopod region evident on somites 2,3 and 6 especially. Telson length ratio changed due to separation of somite 6, ratio now c. 4.5; rami ornamented as previously. Setation of appendages as given in Table 2 and Fig. 4.

ZOEA 4 (Fig 1E)

Size increase, with proportions similar to previous stage except that both rostrum and antennal spinous process are relatively longer, antennal process now extending well beyond the rostrum. Rostrum with slight anterior curve. Posterior thoracic appendages present as small buds. Posterolateral processes of all abdominal somites now all equally well developed, but in all cases they are obtuse and only overlap following somite by c. 12%. Pleopods still only evident as buds on somites 2-6. Telson rami ornamented as previously, but further elongated; telson length ratio c. 5.0. Setation of appendages as given in Table 2.

ZOEA 5 (Figs 1F; 5A-G).

Generally more massive appearance than previous stage, partly due to c. 30% increase in size, also due to development of thoracic and abdominal limbs. Proportions similar to previous stage. Dorsal spine with posterior curvature as throughout zoeal development. Rostrum with distinct anterior flexion. Posterior thoracic limb-buds (maxilliped

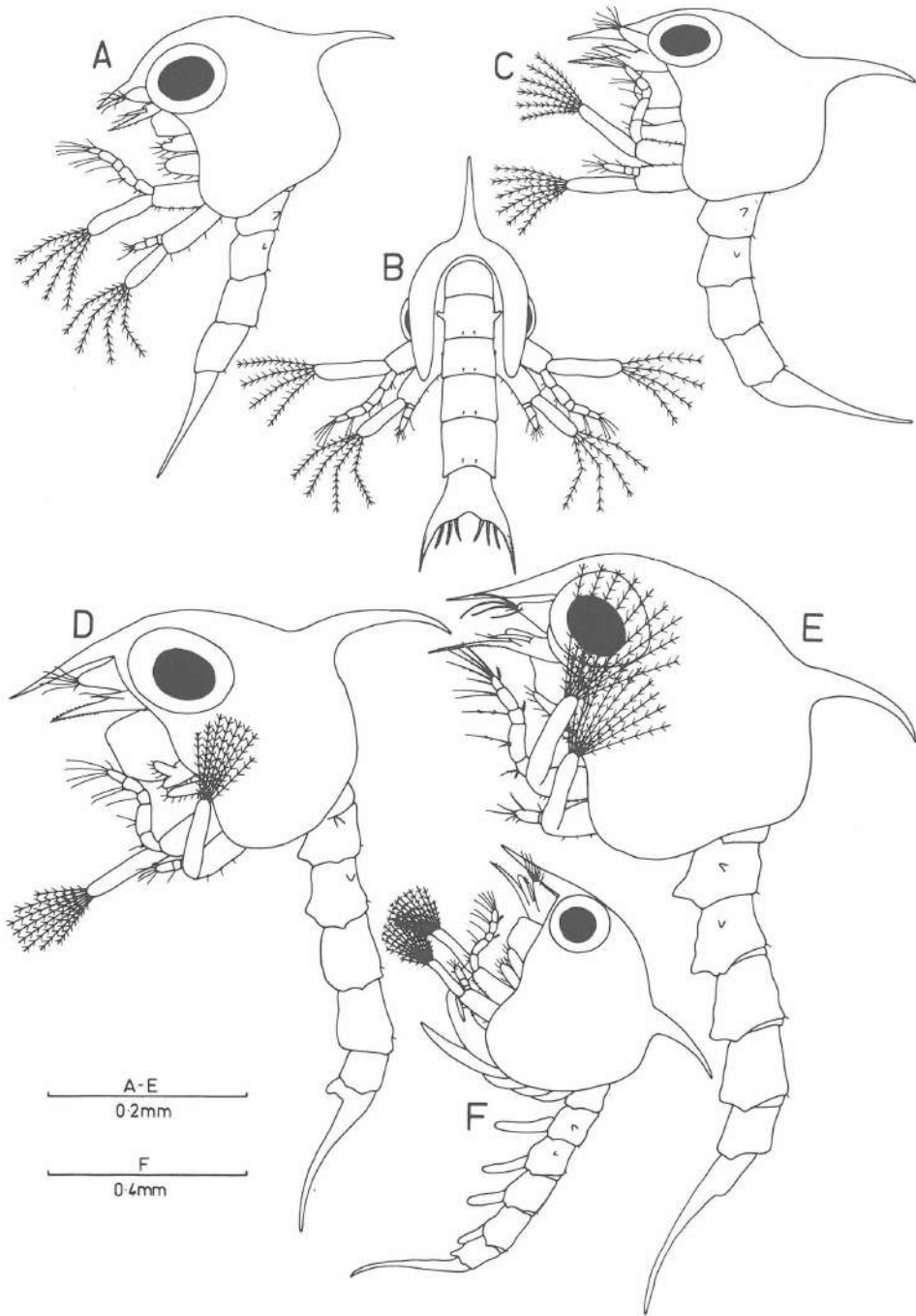


Figure 1. *Sesarma erythroductyla*. A, First zoea, lateral view; B, first zoea, posterior view; C, second zoea; D, third zoea; E, fourth zoea; F, fifth zoea.

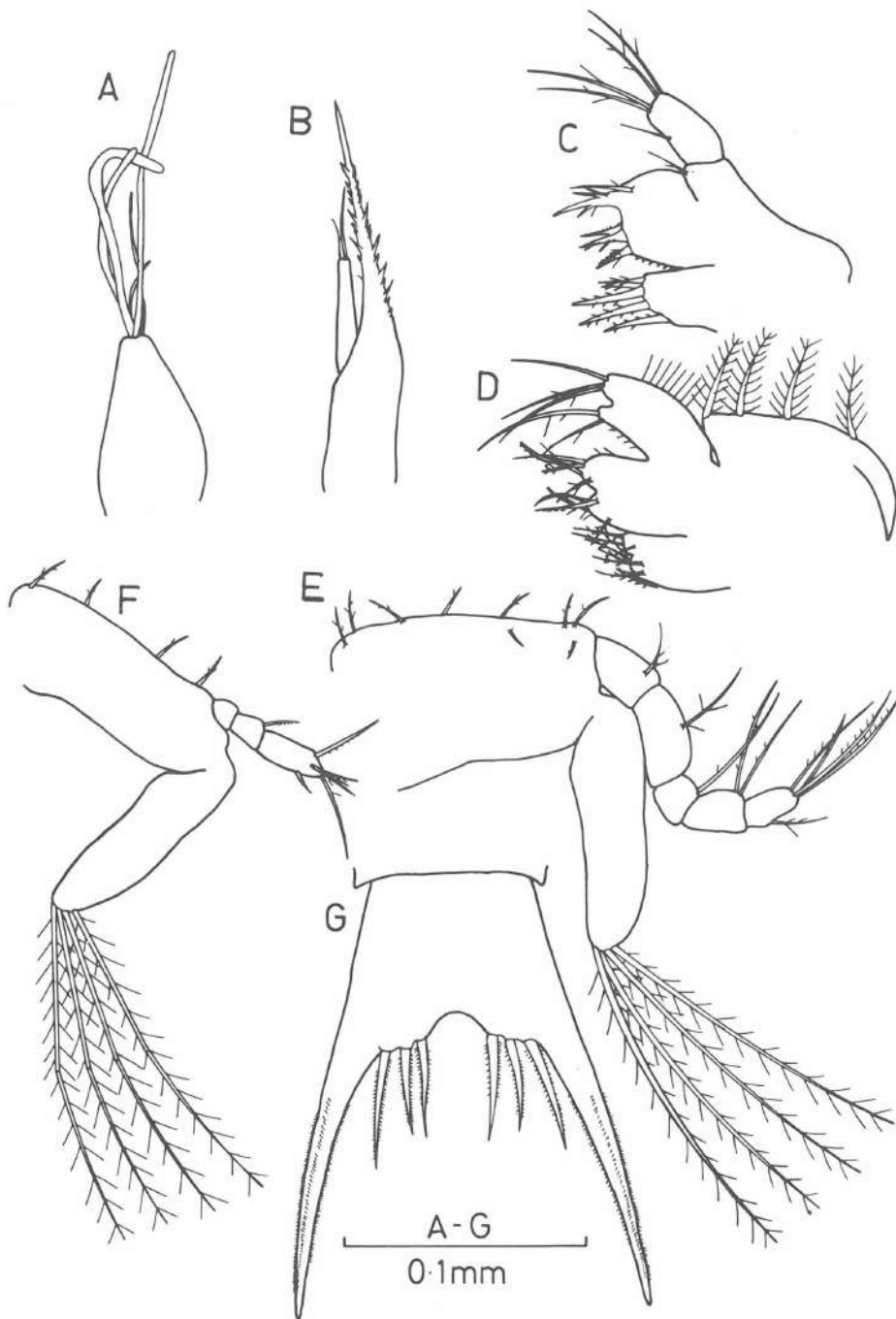


Figure 2. *Sesarma erythroductyla*. first zoea appendages. A, first antenna; B, second antenna; C, first maxilla; D, second maxilla; E, first maxilliped; F, second maxilliped; G, telson.



Figure 3. *Sesarma erythroductyla*, second zoea appendages. A, first antenna; B, second antenna; C, first maxilla; D, second maxilla; E, first maxilliped; F, second maxilliped; G, telson.

| | | | | | | | |
|---------------------|--------------|-------------|-------------|-------------|--------------|--------------|--------------|
| Basal endite, prox. | 2PD, 2S, 1C | 3PD, 1S, 1D | 3PD, 1S, 1D | 3PD, 1S, 1D | 3PD, 1S, 1PD | 3PD, 1S, 1C | 3PD, 1S, 1C |
| dist. | 4PD | 4PD | 4PD | 4PD, 1S | 5PD | 4PD | 4PD |
| Endop.prox. lobe | 2PD | 2PD | 2PD | 2PD | 2PD | 2PD | 2PD |
| dist. lobe | 3PD | 3PD | 3PD | 3PD | 3PD | 3PD | 3PD |
| Scaphognathite | 4HP + apical | 8HP | 10-11HP | 14-15HP | 16-20HP | 4HP + apical | 4HP + apical |
| Maxilliped 1 | | | | | | | |
| Basis | 10PD | 10PD | 10PD | 10PD | 10PD | 10PD | 10PD |
| Endop.seg.prox. | 1PD, 1S | 1PD, 1S | 1PD, 1S | 1PD, 1S | 1PD, 1S | 1PD, 1S | 1PD, 1S |
| 2 | 1PD, 1S | 1PD, 1S | 1PD, 1S | 1PD, 1S | 1PD, 1S | 1PD, 1S | 1PD, 1S |
| 3 | 1PD | 1PD | 1PD, 1S | 1PD, 1S | 1PD, 1S | 1PD | 1PD |
| 4 | 2PD | 1PD, 1S | 1PD, 1S | 1PD, 1S | 1PD, 1S | 2PD | 1PD, 1S |
| 5 | 4PD, 1S | 4PD, 1S | 4PD, 1HP | 5PD, 1HP | 5PD, 1HP | 5PD | 4HP, 1S |
| Exopod | 4HP | 6HP | 8HP | 9-10HP | 11-12HP | 4HP | 4HP |
| Maxilliped 2 | | | | | | | |
| Basis | 3S, 1PD | 4PD | 4PD | 4PD | 4PD | 2PD, 2S | 1PD, 3S |
| Endop.seg.prox. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 1PD | 1PD | 1PD | 1PD | 1PD | 1PD | 1PD |
| 3 | 4PD, 2S | 3PD, 3S | 3PD, 3S | 2PD, 4S | 2PD, 4S | 3PD, 3S | 2PD, 4S |
| Exopod | 4HP | 6HP | 8HP | 10HP | 12HP | 4HP | 4HP |

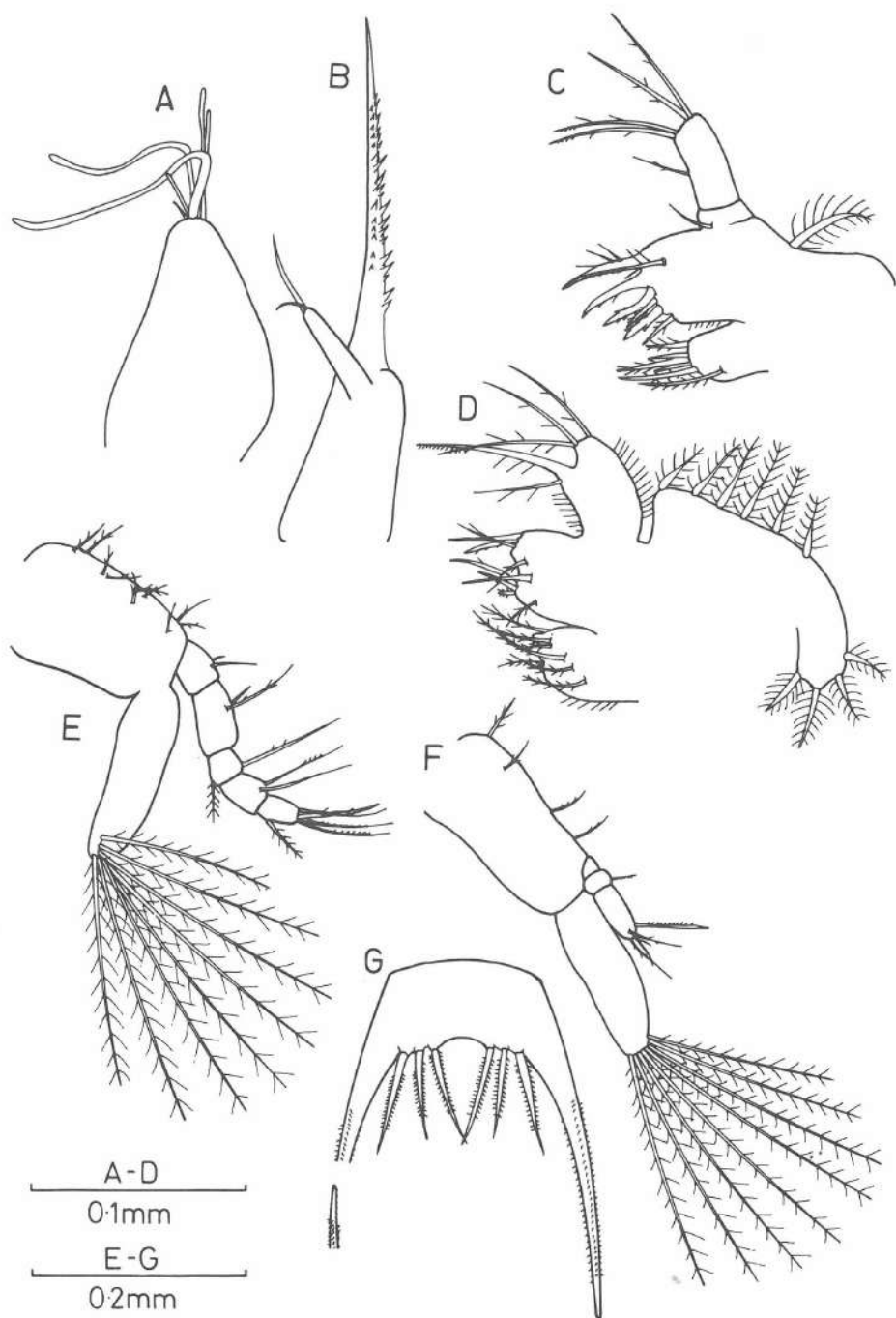


Figure 4. *Sesarma erythroductyla*, third zoea appendages. A, first antenna; B, second antenna; C, first maxilla; D, second maxilla; E, first maxilliped; F, second maxilliped; G, telson.

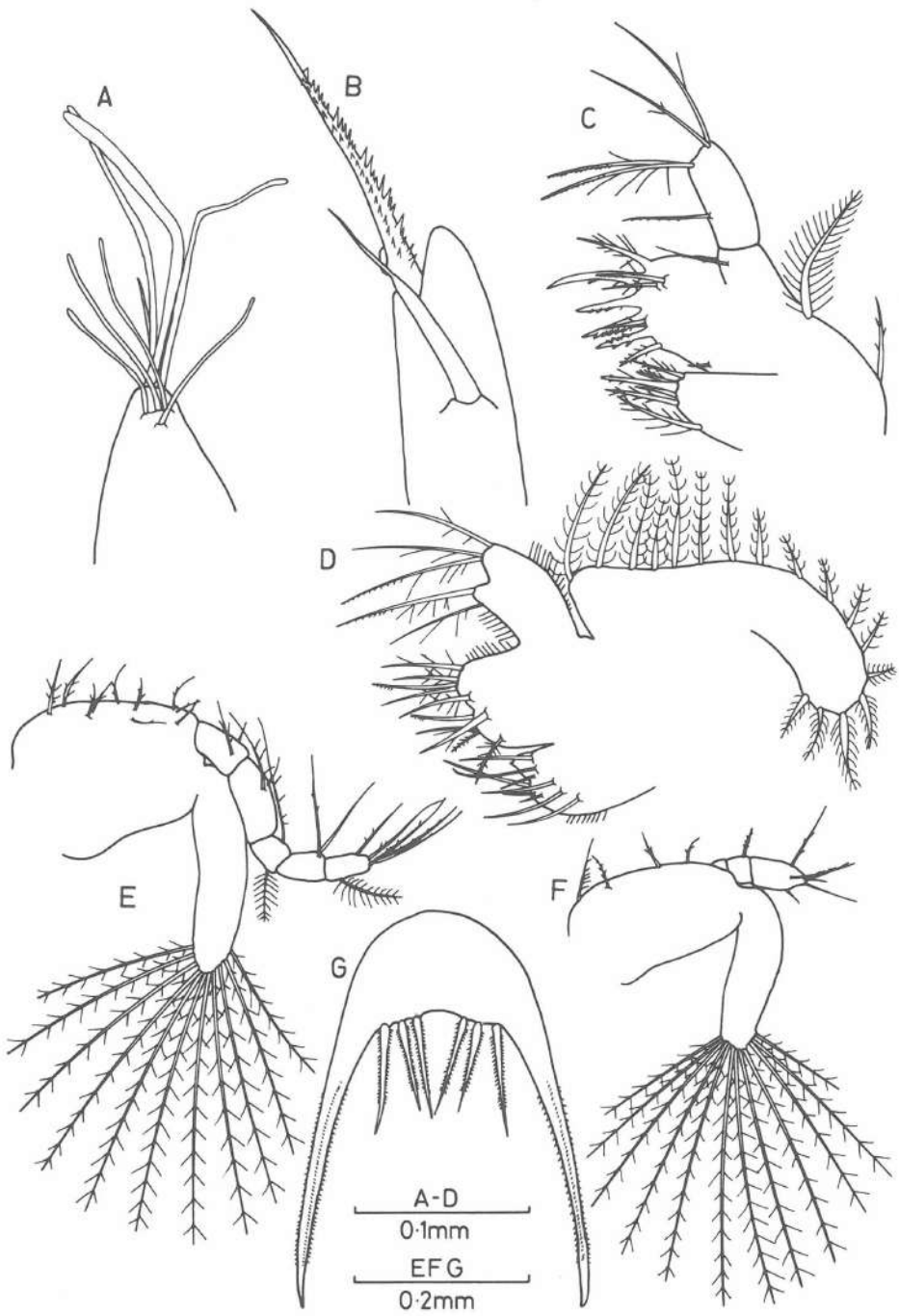


Figure 5. *Sesarma erythroductyla*, fifth zoea appendages. A, first antenna; B, second antenna; C, first maxilla; D, second maxilla; E, first maxilliped; F, second maxilliped; G, telson.

3, pereopods 1–5) now larger than protopods of maxillipeds 1,2; chela evident. Postero-lateral processes of abdominal somites of similar size to previous stage, but those of somites 3–5 now acutely pointed. Pleopod buds elongated, those of first somite being longer than twice diameter of somite, others progressively smaller. Telson with 3 rows of minute setae on each ramus, as throughout zoeal development; telson length ratio c. 4.2. Setation of appendages as given in Table 2.

MEGALOPA (Figs 6A–G; 7A–H)

Carapace elongate, length $1.36 \times$ width, no apparent sculpturing other than slight longitudinal indentation medially on rostral plate between orbits. Rostral plate less than one-third width of carapace; rostrum small, obtusely rounded and directed antero-ventrally. Thoracic appendages all fully differentiated.

Fifth abdominal somite the longest, with postero-lateral extensions reaching to mid-length of sixth somite on each side. Similar but smaller processes on fourth somite. All somites with 2–3 setules on each postero-lateral border; similar setules dorsally, formula (somites 1–6) c. 0, 4, 6, 8, 8, 2. Telson wider than long, convexly rounded posteriorly, four dorsal and 5–6 posterior setules. Biramous pleopods on somites 2–5, those on somite 2 longest; endopods small, with 2 minute hooked setae distomedially; exopods elongate, flattened, with 11–13 highly biplumose setae around disto-lateral borders. Uropods uniramous, 2-segmented; proximal segment with single lateral biplumose seta; distal segment as wide as long, with 6 long biplumose setae.

Details of other appendages as shown in Figs 6, 7 and Table 3.

S.(P.) messa

ZOEA 1 (Fig. 8A–I)

Carapace apparently smooth, without lateral spines, postero-ventral margins relatively extended; dorsal spine short, c. half length of carapace, with distinct posterior curvature; rostrum curved, directed postero-ventrally, of similar length to dorsal spine and reaching to tip of spinous process of antenna.

Abdomen of five somites; mid-lateral projections of similar size on second and third somites; somites 2–5 with pair of postero-dorsal setae; small obtuse postero-lateral projections on somites 3–5, those on 5th largest.

Telson plate width c. $2 \times$ medial length; 3+3 biplumose setae of similar length on posterior margin; no lateral telson setae; postero-medial cleft shallow. Telson rami each with two distinct longitudinal rows of spinules (one dorsally, one near medial border), less distinct row laterally. Telson length ratio (median length of plate: total length incl. rami) c. 3.56.

Other details including appendage setation as given in Tables 1 and 2, and Fig. 8.

S.(N.) smithii

ZOEA 1 (Fig. 9A–I)

Carapace smooth and globose; dorsal spine delicate, curved posteriorly, less than half carapace length (c. $0.4 \times$); no lateral spines; rostrum straight, directed postero-ventrally beneath orbits and difficult to observe, reaching to tip of antennal spinous process.

Five abdominal somites; mid-lateral projections on second larger than those on third; pair of dorsal setae on somites 2–5; distinct but small postero-lateral projections on somites 3–5, all of similar size.

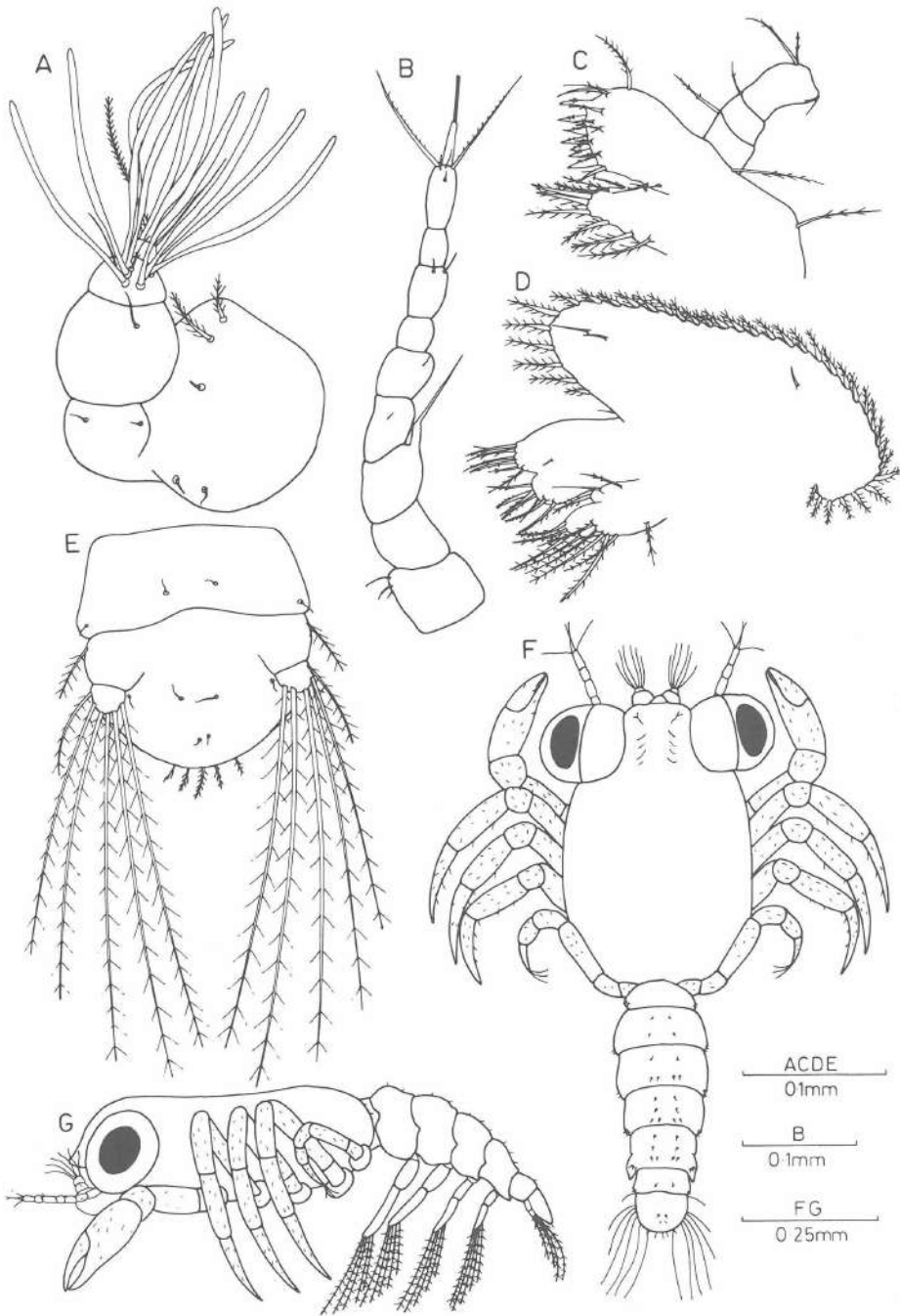


Figure 6. *Sesarma erythroductyla*, megalopa. A, first antenna; B, second antenna; C, first maxilla; D, second maxilla; E, last abdominal segment, uropods and telson; F, dorsal view; G, lateral view.

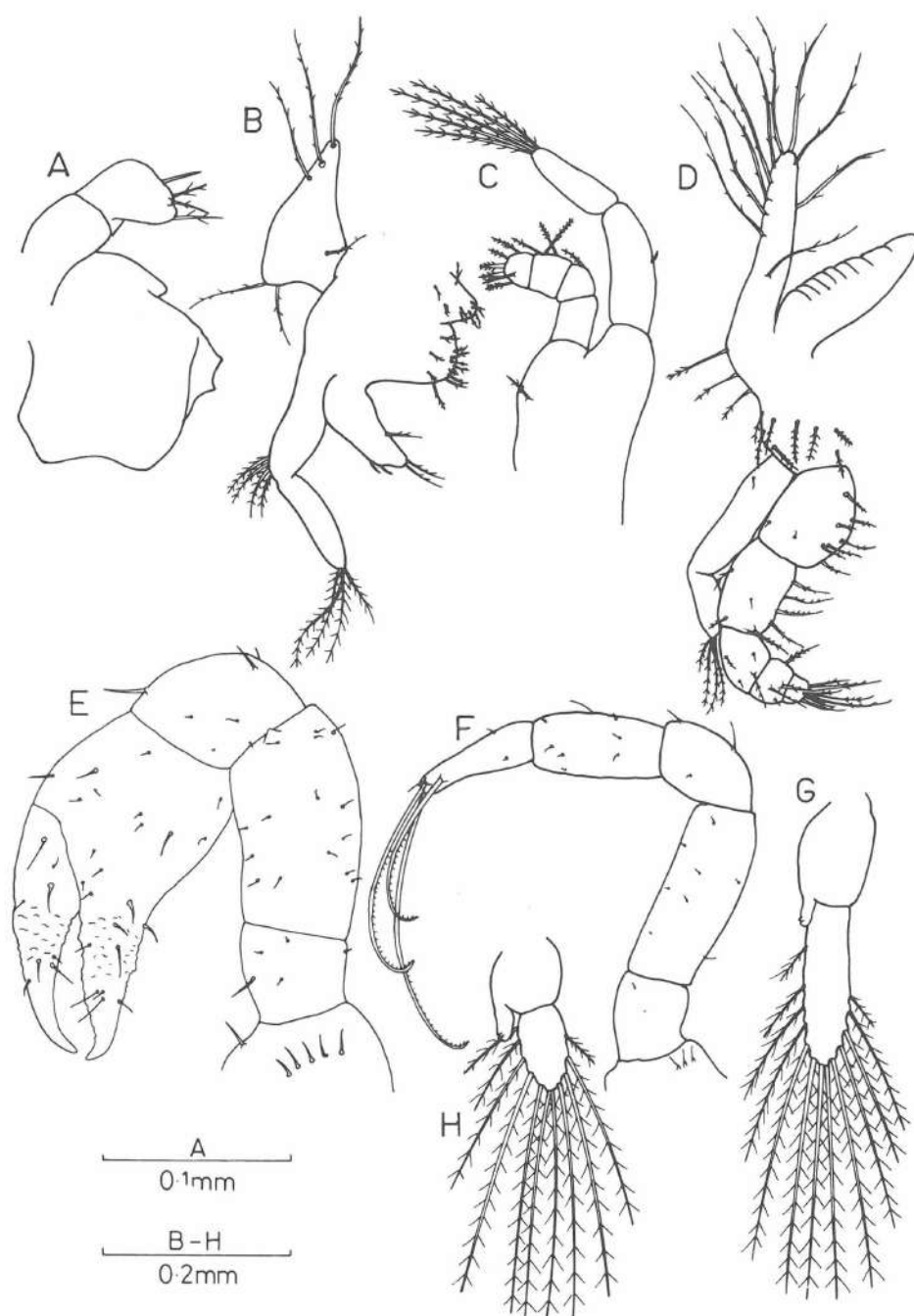


Figure 7. *Sesarma erythroductyla*, megalopa. A, mandible; B, first maxilliped; C, second maxilliped; D, third maxilliped; E, first pereiopod; F, fifth pereiopod; G, first pleopod; H, fourth pleopod.

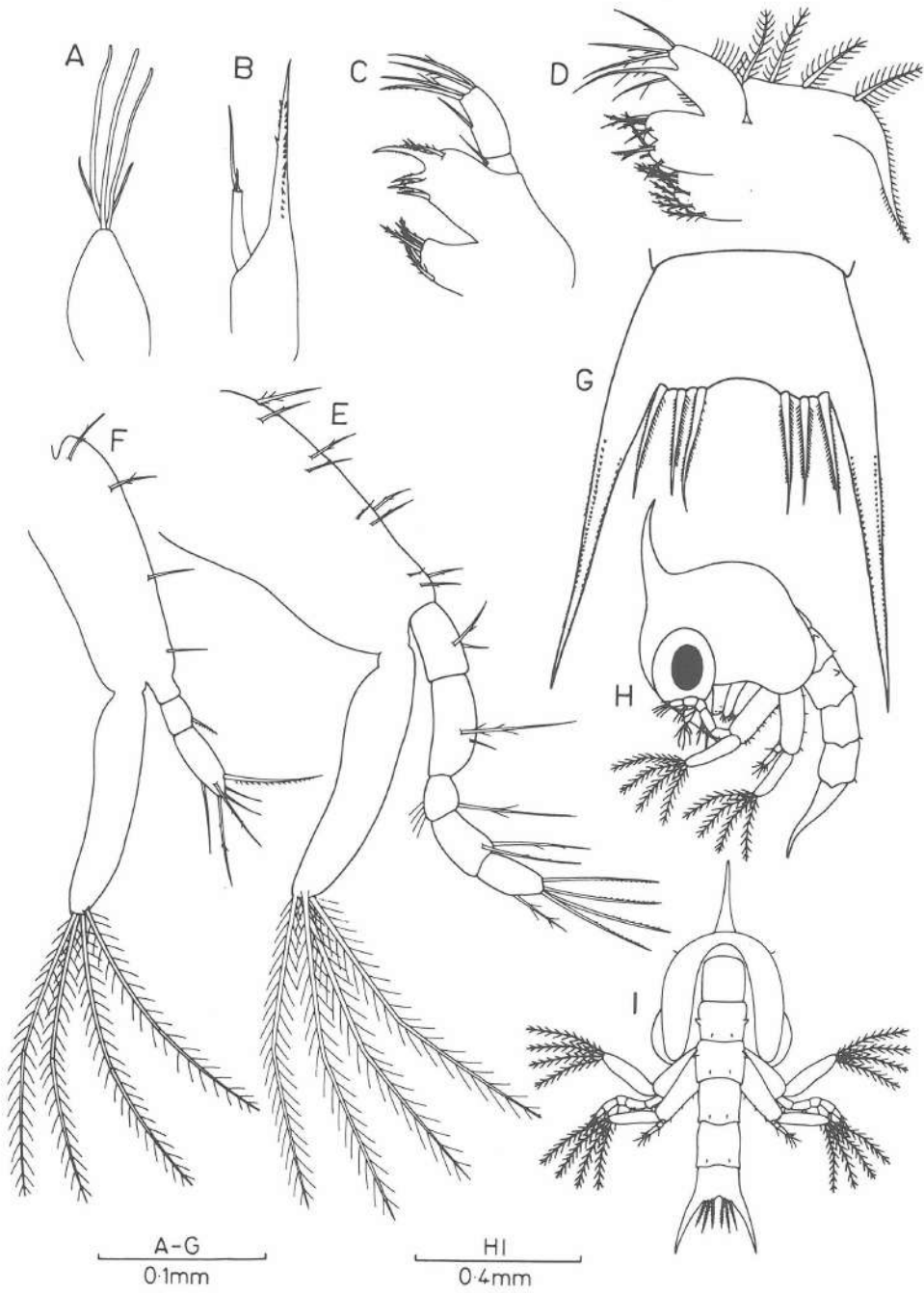


Figure 8. *Sesarma messa*, first zoea. A, first antenna; B, second antenna; C, first maxilla; D, second maxilla; E, first maxilliped; F, second maxilliped; G, telson; H, lateral view; I, posterior view.

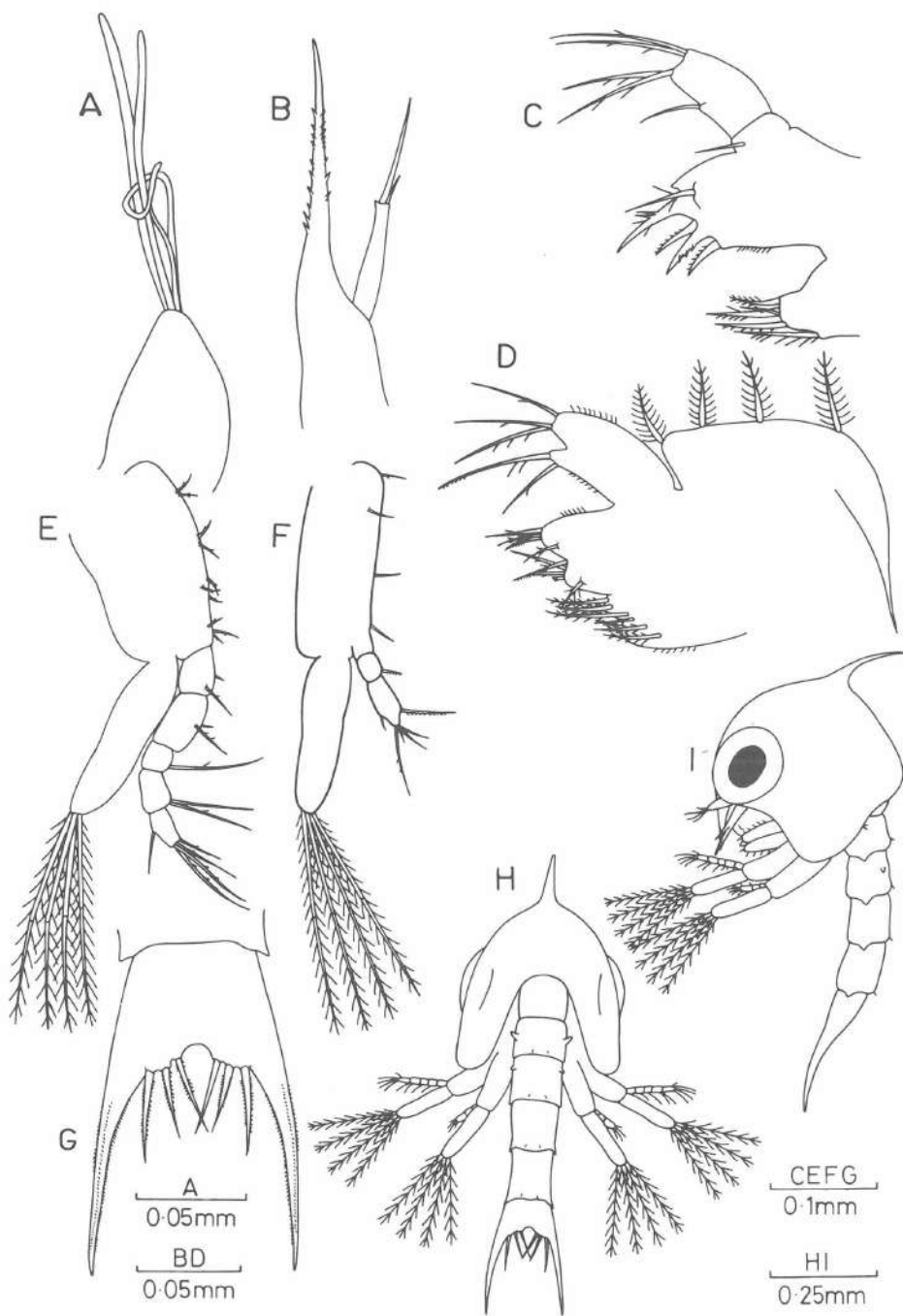


Figure 9. *Sesarma smithii*, first zoea. A, first antenna; B, second antenna; C, first maxilla; D, second maxilla; E, first maxilliped; F, second maxilliped; G, telson; H, posterior view; I, lateral view.

Table 3. Setation details of megalopal appendages of *Sesarma erythroactyla*. (Abbreviations as in Table 2.)

| Appendage | Setation | Appendage | Setation |
|------------------------|------------------|----------------------|-----------|
| Ant. 1 peduncle | 3S + 2PD, 2S, 1S | Max'ped 1 coxal end. | 9PD |
| inner flag. | — | basal end. | 11PD |
| term. flag. | | endopod | 2-4PD, 2S |
| seg. 2 } 3 } | 8A, 1S, 1PD | exop. seg. 1 | 4HP |
| 4 | 3A, 1S, 1HP | 2 | 4-7HP |
| Ant. 2 flagellum | | epipod | 6PD |
| seg. 1 | 3S | Max'ped 2 basis | 1PD |
| 2 | 0 | endop. seg. 1 | 0 |
| 3 | 1M (= exopod) | 2 | 0 |
| 4 | 1S | 3 | 1PD |
| 5 | 1S | 4 | 3PD |
| 6 | 0 | 5 | 5-6PD |
| 7 | 2S | exop. seg. 1 | 1S |
| 8 | 0 | 2 | 5-11PD |
| 9 | 2PD, 3S | epipod | — |
| 10 | 3S | Max'ped 3 basis | 8PD |
| Max. 1 coxal end. | 10-11PD | endop. seg. 1 | 6-7PD, 2S |
| basal end. | 11PD, 7SP | 2 | 7PD, 1S |
| endop. seg. 1 | 1PD | 3 | 2PD, 1S |
| 2 | 1PD | 4 | 3PD, 1S |
| 3 | 2PD, 2S | 5 | 7PD |
| coxa | 2PD | exop. seg. 1 | 1S |
| Max. 2 coxa prox. end. | 10PD | epipod. | 12-14PD |
| dist. end. | 3PD | | |
| basis prox. end. | 6-8PD | | |
| dist. end. | 5-6PD, 1S | | |
| endopod | 1HP, 2PD | | |
| scaphognath. | 32-35HP, 3S | | |

Telson plate relatively long, width c. $1.8 \times$ length, posterior margin with 3+3 subequal biplumose setae either side of semi-circular medial cleft; no lateral telson setae. Telson rami with two distinct and one less distinct, longitudinal rows of small setae (one dorsal, one medial, one lateral). Telson rami relatively short, length ratio c. 2.3.

Other details and appendage setation as given in Tables 1 and 2, and Fig. 9.

Discussion

Complete or partial larval development series are now known for 16 species of *Sesarma* (s.l.). Ten of these were included in a table of comparative anatomy by Wilson (1980, Table 2; including *S. erythroactylum* larvae as described by Baba and Fukuda, 1975), there being 8 species of *Sesarma* (see also Fielder and Greenwood, 1983) and one each of *Sesarmops* and *Parasesarma*. Corresponding data on six *Sesarma* species which

Table 4. First zoeal features of *Sesarma* larvae additional to those included in Wilson's (1980) Table 2.

| | Telson Type | Antenna Type | Lateral carapace spines | Mouthpart Setation | | | | No. Stages | Authors |
|-------------------------------|-------------|----------------|-------------------------|--------------------|----------------------|----------------------|----------------------|------------|------------------------------|
| | | | | Maxilla endopod | Maxilliped I basipod | Maxilliped I endopod | Maxilliped 2 endopod | | |
| <i>S. bidentatum</i> | ? | ? | No | 0 | 0 | 0 | 0 | No data | Hartnoll, 1964 |
| <i>S. (B.) brevipes</i> | B | B ₂ | No | 2, 3 | 2, 2, 3, 3 | 2, 2, 1, 2, 4+1 | 0, 1, 6 | 4 | Fielder & Greenwood, 1983 |
| <i>S. (P.) erythrodactyla</i> | B | B ₂ | No | 2, 3 | 2, 2, 3, 3 | 2, 2, 1, 2, 4+1 | 0, 1, 6 | 5 | present paper |
| <i>S. (P.) messa</i> | B | B ₂ | No | 2, 3 | 2, 2, 3, 3 | 2, 2, 1, 2, 4+1 | 0, 1, 6 | No data | present paper |
| <i>S. (G.) perracae</i> | ? | ? | No | 0 | 0 | 0 | 0 | 2 | Lam, 1969 |
| <i>S. (N.) smithii</i> | B | B ₂ | No | 2, 3 | 2, 2, 3, 3 | 2, 2, 1, 2, 4+1 | 0, 1, 6 | No data | present paper |
| <i>S. tetragonum</i> | B | B ₂ | No | 2, 2 | 1, 1, 2, 1 | 2, 1, 1, 2, 2+1 | 0, 1, 3 | No data | Rajabai, 1961 |

can be added to that table are given here in Table 4. *S. erythroductyla* is again included here to allow inclusion of data not available to Wilson.

Sesarma bidentatum and *S. perracae* are included in Table 4 for completeness; however, comparison of the first zoeae of these two species with those of other *Sesarma* spp. may not be very meaningful. Both these species live in essentially freshwater habitats and have very large eggs from which zoeae hatch at a very advanced stage. The zoeae are non-feeding, hence the mouthparts lack setae, and they already have typical late-zoeal features such as well developed pereopods and pleopod buds (see Hartnoll, 1964; Lam, 1969). It is clear both these species have an abbreviated development; in *S. perracae* there are only 2 zoeal stages, the "stage 3 larva" described and figured by Lam (1969) being a megalopa; similarly the state of the abdominal and posterior thoracic appendages in the first zoea of *S. bidentatum* (Hartnoll, 1964) strongly suggests there is (at most) only one further zoeal stage prior to the megalopa.

Amongst the remaining 5 species in Table 5, it is evident that *S. tetragonum* zoeae differ from those of all other *Sesarma* species (see also Wilson 1980, Table 2) in mouthpart setation. The other 4 species in Table 5 are remarkably consistent in all characters tabulated and, together with Wilson's (1980) data on *S. reticulatum* and *S. ricordi*, suggest the typical setal formula for *Sesarma* (s.l.) species first maxilliped basis is 2,2,3,3.

The description of *S. erythroductylum* first zoeae from Japanese waters given by Baba and Fukuda (1975) contains no figures and is very brief, consisting of a listing of points on which that species zoeae differ from those of *S. intermedium* (which are figured and more fully described). Green and Anderson's (1973) description of *S. erythroductyla* first zoeae from Australia is detailed throughout. Comparisons between those descriptions and the present one reveal some differences, which are summarised in Table 5.

One article of antennule setation is absent from Japanese specimens, and it appears Green and Anderson (1973) may have misinterpreted one small aesthete as a seta. Most *Sesarma* zoeae have antennae of Aikawa's (1933) B2-type (Table 4; also Baba and Fukuda, 1975), i.e., with two terminal processes on the exopod, as is the case with the three species described here. In contrast, Green and Anderson (1973) found *S. erythroductyla* to have B3-type antennae. Similar within-species differences have appeared in descriptions of *S. haematocheir* zoeae (Terada, 1974; Baba and Fukuda, 1975) where it was noted however that the third seta was difficult to confirm. Careful re-examination has re-

Table 5. Selected features of *S. erythroductyla* first zoea in which differences are found between description sources. (A = aesthete, S = seta.)

| Feature | Reference Source | | |
|-----------------------------------|------------------|--------------------------|-----------------------|
| | Present study | Green and Anderson, 1973 | Baba and Fukuda, 1975 |
| Antenna | 4A, 1S | 3A, 2S | 3A, 1S |
| Antenna 2 exopod | 2 | 3 | 2 |
| Maxilla 2 endites | 9, 9 | 8, 9 | 7, 7 |
| Maxilliped 1 basis | 2, 2, 3, 3 | 2, 2, 2, 2 | ?3 |
| Telson rami with rows of spinules | yes | yes | no |

vealed no 3rd seta in our material. Setation of the maxillary endites is not so difficult to observe, and it would appear differs between Australian and Japanese specimens. The most remarkable difference between Japanese and Australian *S. erythrodactyla* first zoeae is in ornamentation of the telson rami. In Japanese specimens it is positively stated (Baba and Fukuda, 1975: 65) that these are . . . "quite smooth without fine setae", whereas in Australian specimens several fine rows of setae extend along these rami. This feature is one which Baba and Fukuda (1975) have noted . . . "seems more or less important" in clarifying species of *Sesarma*, and together with the other differences between Japanese and Australian larvae in setation of other larval structures (Table 5), supports suggestions of an evolutionary separation between *S. erythrodactyla* stocks of these two regions.

Some discussion of differences between *S. erythrodactyla* larvae (based on the earlier Japanese description) and those known for related Indo-Pacific species (*S.(B.) brevipes* and *S. intermedium*) was included in Fielder and Greenwood (1983). That comparison could now be modified on the basis of the present description, and briefly extended to include *S.(P.) messa* and *S.(N.) smithii*. A more comprehensive guide to identification of these and other crab larvae is under development.

The number of spinules on the process of the second antenna in the first zoea of *S.(B.) brevipes* (7–12) is clearly fewer than in the other four species, but this feature is of little value in distinguishing between the other four species for although *S.(N.) smithii* generally has fewer spinules (15–20) than do *S.(P.) erythrodactyla* and *S.(P.) messa* (both 20–30) there is a slight overlap in ranges between them, and also *S. intermedium* (20).

Whereas it was previously thought that *S.(P.) erythrodactyla* differed from the other species in lacking spinules on the telson rami, it is now clear (see above; also Baba & Fukuda, 1975) that all five species have this feature. Nor does the shape of the post-lateral projections on abdominal somites 3–5 provide much assistance in distinguishing these larvae, for they are small, similar, and difficult to distinguish.

Body proportions may provide the most practical means of distinction. The ratio of dorsal carapace spine length to carapace length decreases from *S.(B.) brevipes* (0.62) through *S.(P.) erythrodactyla* (0.57) and *S.(P.) messa* (0.51) to *S.(N.) smithii* (0.46). Similarly the ratio of dorsal spine to rostrum length is much greater in *S.(P.) erythrodactyla* (1.75) than in the other species, and much less in *S.(P.) smithii* than *S.(B.) brevipes* (1.32) and *S.(P.) messa* (1.27). In all cases the rostrum bears a similar relationship to the antennal spinose process, and the antennal exopod is \leq half the length of the spinose process.

Comparisons between megalopae of previously known *Sesarma* species have been given by Diaz and Ewald (1968) and Fielder and Greenwood (1983). The megalopa of *S.(P.) erythrodactyla* may be clearly distinguished from its known congeners by the combination of having: a very small rostrum; retention of the antennal exopod as a "modified seta" with swollen base (see Fig. 6B); three segments in the maxillule endopod.

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