

**THE COMPLETE LARVAL DEVELOPMENT INCLUDING
JUVENILE STAGE OF *MICROPROSTHEMA VALIDUM*
STIMPSON, 1860 (CRUSTACEA: DECAPODA:
SPONGICOLIDAE), REARED UNDER
LABORATORY CONDITIONS**

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ABSTRACT: The ovigerous females of *Microprosthema validum* Stimpson, 1860, were collected from Paradise Point (Karachi, Pakistan) on April 26th, 1997 and from Abdur Rehman Goth on May 27th, 1997. They were kept under laboratory conditions. On May 5th and May 31st 1997 larvae were hatched, at 30°C- 33°C temperature in filtered seawater with a salinity of 35- 37 parts per thousand and pH 7.9. The larvae were fed *Artemia* nauplii. *Microprosthema validum* passed through five zoeal stages prior to reaching postlarval stages, which were followed by juvenile stage. These developmental stages are described, illustrated and compared with the available descriptions of stenopoid larvae given earlier.

KEY WORDS: Decapoda, Spongicolidae, *Microprosthema validum* larvae, postlarvae and juvenile.

INTRODUCTION

Four species were recognized in the genus *Microprosthema* by Holthuis (1946) *M. validum*, *M. semilaeve*, *M. plumicorne* and *M. scabridaudatum*, all are "closely related" (Bruce, 1990). Mahadevan *et al* (1962) recorded a single species from India, the identity of which was not determined. But it was thought to be a species distinct from the previous four (Baba *et al*, 1968). In 1979 Tirmizi and Kazmi reported this genus in Pakistani waters (Northern Arabian Sea) represented by a single species, *Microprosthema validum* Stimpson, 1860. This species is widely distributed in the Indo-west Pacific region (Holthuis, 1946), fairly common in rock pools along both the Sindh and Makran coasts of Pakistan and bopyrized by *Argeiopsis kensleyi* (Boyko and Kazmi, 2005).

Previously, the larvae of *Microprosthema validum* were reported by Tirmizi and Kazmi (1983 and 1986, no description) from Pakistan. The other published information of the larval development of this genus is restricted to the description of stenopoid larvae by Raje and Ranade (1975) who provided a description of *M. semilaeve* larvae from India and to the work of Williamson (1976) where he suggested that the three specimens from International Indian Ocean Expedition (I.I.O.E) material which he named species Ind. 5 might be the larvae of *M. scabridaudatum* (Richters, 1880). That species is known to occur in both the eastern and western Indian Ocean (Holthuis, 1946).

The present study is based on the complete life history of laboratory reared zoeae (I-V), postlarvae (I-IV) and the juvenile of *Microprosthema validum*. The development is completed within 46 days. The zoeae, postlarvae and juvenile stages are described,

illustrated and also compared with earlier studied larvae and postlarvae of *Microprosthema semilaeve* and Ind. 5.

MATERIALS AND METHODS

Ovigerous females of *Microprosthema validum* were collected from two locations: Paradise Point on April 26th, 1997 and Abdur Rehman Goth on May 27th, 1997. The specimens were kept under the laboratory conditions at room temperature 30°C- 33°C, in filtered seawater of 35-37 parts per thousand salinity and pH 7.9, until hatching occurred. The newly hatched larvae were segregated after hatching occurred on May 5th and May 31st, 1997 respectively, and placed into five glass beakers (500 ml), ten larvae in each beaker, containing stored filtered seawater having the same salinity and temperature as mentioned before. Each beaker was examined daily for mortality and the next developmental stage. Surviving larvae of subsequent developmental stages were transferred to clean beakers filled with filtered stored seawater, and fed on newly hatched *Artemia* nauplii. Exuviae and dead larvae were preserved in 70% alcohol. Temporary slides of each stage were made by using glycerin plus 5% formalin (3:1).

Measurements of each stage were made with the aid of micrometer. The total length (TL) was determined from the tip of the rostrum to the mid posterior border of the telson. Measurements are in millimeter (mm). The specimens were dissected with tungsten needle under a Nikon binocular microscope (4 x 10/21 magnification). The illustrations were made with the help of Olympus BH2 microscope (magnification 1.25 x 4, 10 and 20) with Nomarski interference contrast and *camera lucida* attachment.

Because the larvae that hatched on May 31st, 1997 survived for 13 days, reaching only postlarva I stage and the larvae that hatched on May 5th, 1997, completed their development from zoea I to juvenile stage within 46 days, the later lot is described in this paper.

The spent females and larvae were preserved and are deposited in the Marine Reference Collection and Resource Centre, University of Karachi, under catalogue No. STEN. 236 and STEN. 237.

RESULTS

DESCRIPTION OF THE LARVAE

Zoea I

Size.- TL = 2.26mm

Duration.- 4 days.

Carapace (Fig. 1A').- Carapace smooth, rostrum reaching near penultimate segment of antennule, with single epigastric knob; eyes sessile.

Antennule (Fig. 1B).- 3-segmented, distal segment biramous, endopod represented by a long plumose seta, exopod bears 1 plumose seta and 2 aesthetascs.

Antenna (Fig. 1C).- 2-segmented, distal segment biramous endopod bears 2 long plumose setae; scaphocerite (exopod) distally segmented with 8 marginal plumose setae.

Mandible (Fig. 1D).- Incisor and molar processes well developed.

Maxillule (Fig. 1E).- Coxal endite with 2 cuspidate, 1 plumodenticulate and few fine

setae; basal endite with 3 cuspidate and 2 plumodenticulate setae.

Maxilla (Fig.1F).- Coxal endite bilobed, with 10 + 3 setae; basal endite bilobed, with 4 + 4 setae; endopod with 3 setae; scaphognathite with 5 marginal plumose setae.

Maxilliped I (Fig.1G).- Coxa with 2 setae; basis with 13 setae; endopod 3-segmented, with 3, 2, 3 setae from proximal to distal segments respectively; exopod with 4 terminal natotary plumose setae.

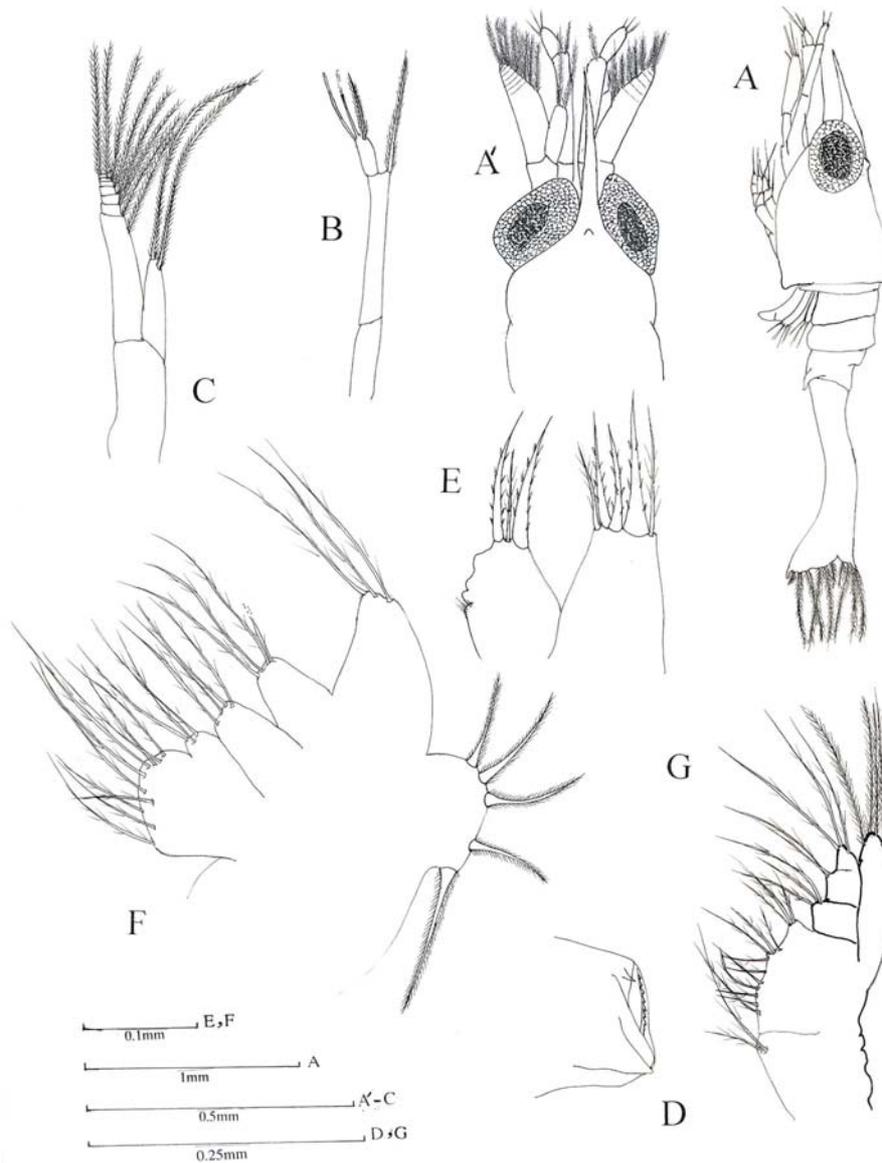


Fig. 1. *Microprosthema validum* Stimpson, 1860. Zoea I: A, entire, lateral view; A', anterior part of carapace and associated appendages; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, maxilliped I.

Maxilliped II (Fig.2A).- Coxa without setae; basis with 4 setae on medial margin; endopod 5-segmented, with 1, 1, 0, 2, 5 +1 setae from proximal to distal segments respectively; exopod with 2 terminal and 4 subterminal natatory plumose setae.

Maxilliped III (Fig. 2B).- Coxa with 1 seta; basis with 3 setae on medial margin; endopod 5-segmented, with 2, 1, 0, 1, 4 + 1 setae from proximal to distal segments respectively; exopod with 4 terminal and 2 subterminal natatory plumose setae.

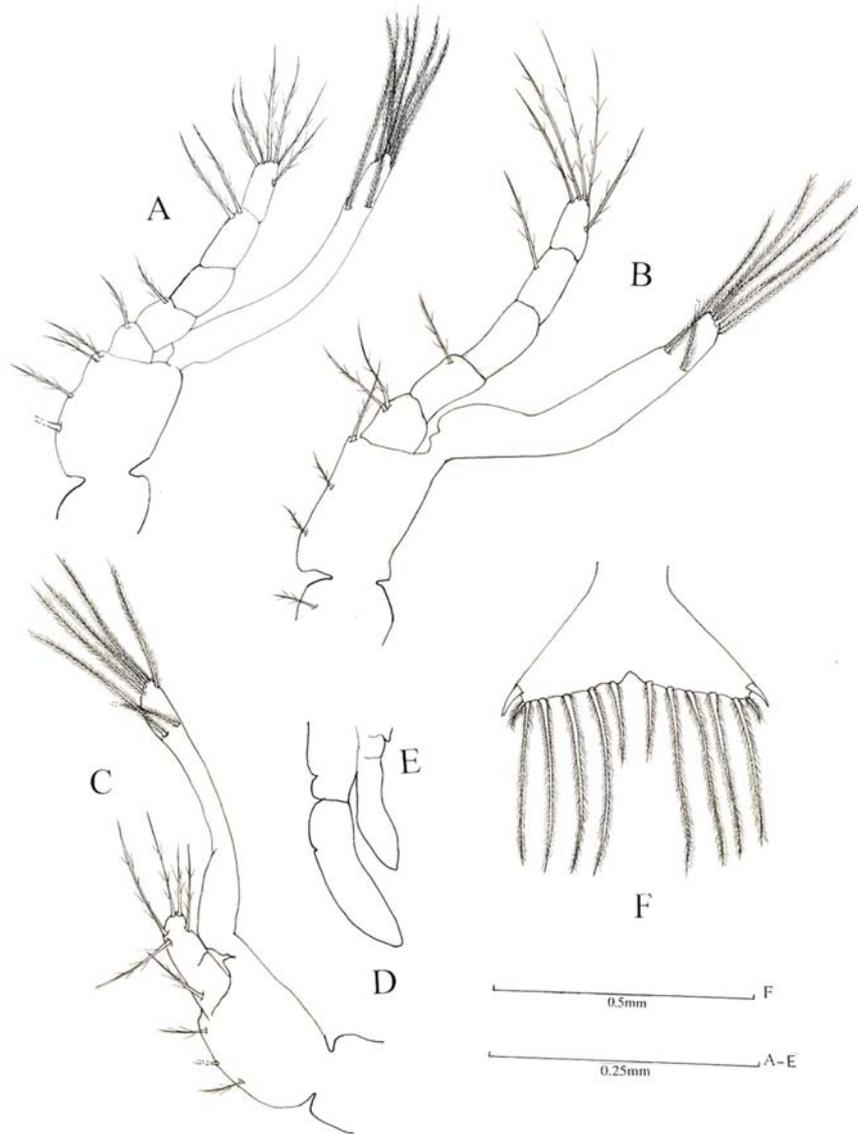


Fig. 2. *Microprosthema validum* Stimpson, 1860. Zoea I: A, B, maxillipeds II, III; C-E, pereopods I-III; F, telson.

Pereiopod I (Fig. 2C).- Coxa without setae; basis with 3 setae on medial margin; endopod partially 2-segmented with 1, 5 setae; exopod with 4 terminal and 2 subterminal natatory plumose setae.

Pereiopod II and III (Figs. 2D, E).- Rudimentry.

Abdomen (Fig. 1A).- 6 somites, somite 1, 2 and 5 with blunt projections on ventroproximal angles.

Telson (Fig. 2F).- Telson broad and triangular, posterior margin with central indentation, 1 pair of spines and 6 pairs of plumose setae.

Zoea II

Size.- TL = 2.78mm

Duration.- 5 days.

Carapace (Fig. 3A').- Unchanged.

Antennule (Fig. 3B).- 3-segmented, distal segment biramous, endopod with 4 plumodenticulate setae; exopod with 3 aesthetascs.

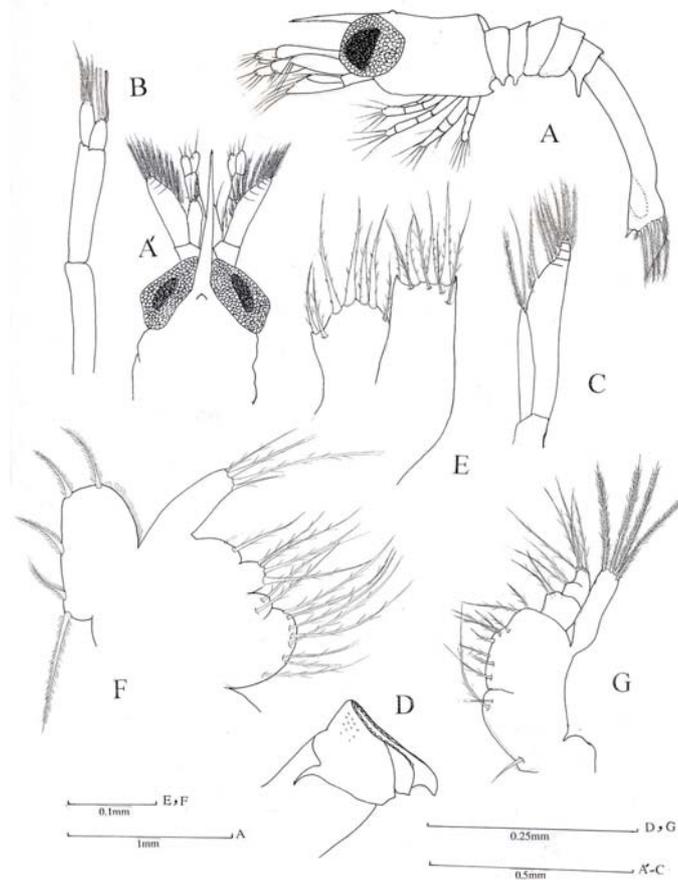


Fig. 3. *Microprosthema validum* Stimpson, 1860. Zoea II: A, entire, lateral view; A', anterior part of carapace and associated appendages; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, maxilliped I.

Antenna (Fig. 3C).- 2-segmented; distal segment biramous, endopod unchanged; exopod (scaphocerite) with 10 long plumose setae.

Mandible (Fig. 3D).- Unchanged.

Maxillule (Fig. 3E).- Coxal endite with 4 cuspidate and 3 plumodenticulate setae; basal endite with 4 cuspidate and 4 plumodenticulate setae.

Maxilla (Fig. 3F).- Coxal endite bilobed, with 8 + 2 setae; basal endite bilobed, with 4 + 2 setae; endopod with 4 setae; scaphognathite unchanged.

Maxilliped I (Fig. 3G).- Coxa with 3 setae; basis with 10 setae; endopod 3-segmented with 2, 2, 5 setae from proximal to distal segments respectively; exopod unchanged.

Maxilliped II (Fig. 4A).- Coxa without setae; basis unchanged; endopod 5-segmented with 2, 1, 0, 2, 4 + 2 setae from proximal to distal segments respectively; exopod with 4 terminal and 2 subterminal natatory plumose setae.

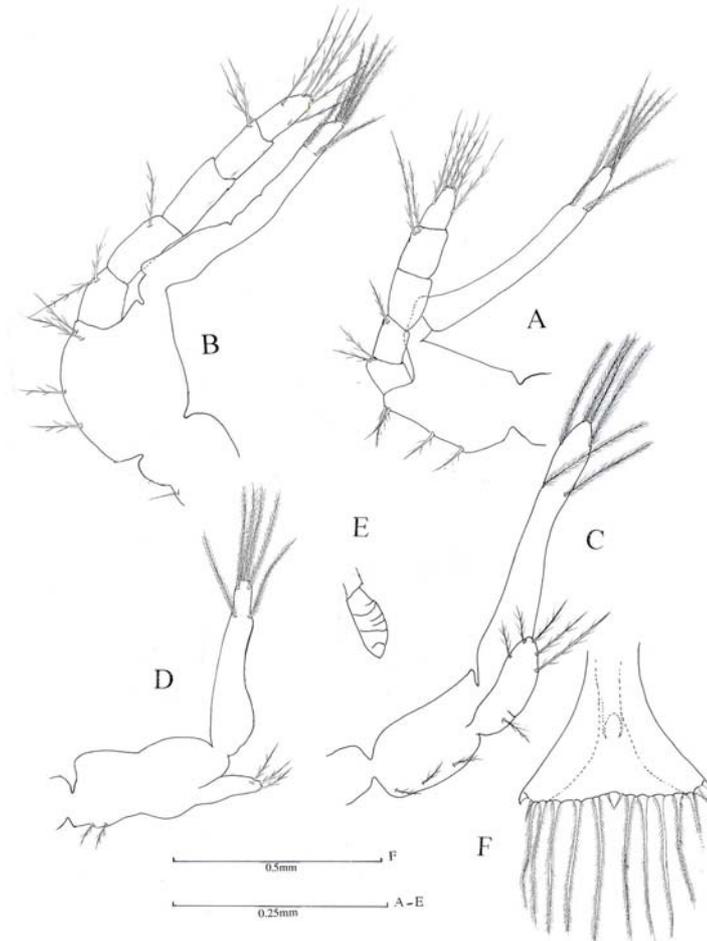


Fig. 4. *Microprosthema validum* Stimpson, 1860. Zoea II: A, B, maxillipeds II, III; C-E, pereopods I-III; F, telson.

Maxilliped III (Fig. 4B).- Coxa with 1 seta; basis with 4 setae on medial margin; endopod 5-segmented with, 2, 1, 0, 2, 4 + 2 setae from proximal to distal segments respectively; exopod unchanged.

Pereiopod I (Fig. 4C).- Coxa without setae; basis with 3 setae; endopod with 6 setae; exopod with 2 terminal and 4 subterminal natatory plumose setae.

Pereiopod II (Fig. 4D).- Coxa without setae; basis with 2 setae; endopod with 3 setae; exopod with 2 terminal and 4 subterminal natatory plumose setae.

Pereiopod III (Fig. 4E).- Rudimentary, partially segmented.

Abdomen (Fig. 3A).- Unchanged.

Telson (Fig. 4F).- Central indentation reduce, posterior margin with 1 pair of spines, 6 pairs of plumose and 1 pair of simple setae.

Zoea III

Size.- TL = 2.99mm

Duration.- 3 days.

Carapace (Fig. 5A').- Unchanged.

Antennule (Fig. 5B).- 4-segmented, distal segment biramous, segments 1-3 with 3, 1, 3 setae respectively; endopod with 2 setae; exopod with 5 aesthetascs.

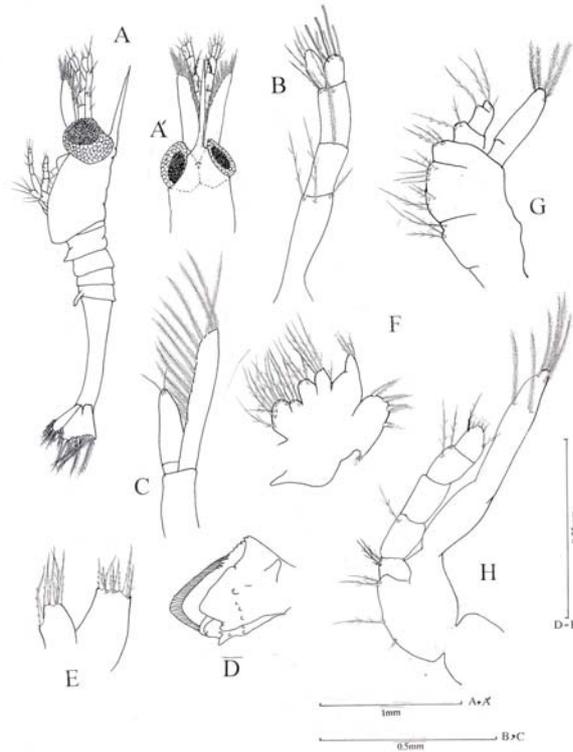


Fig. 5. *Microprosthema validum* Stimpson, 1860. Zoea III: A, entire, dorsal view; A', anterior part of carapace and associated appendages; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, H, maxillipeds I, II.

Antenna (Fig. 5C).- 2-segmented; endopod unchanged; exopod (scaphocerite) with 12 long plumose setae.

Mandible (Fig. 5D).- Palp present in bud form.

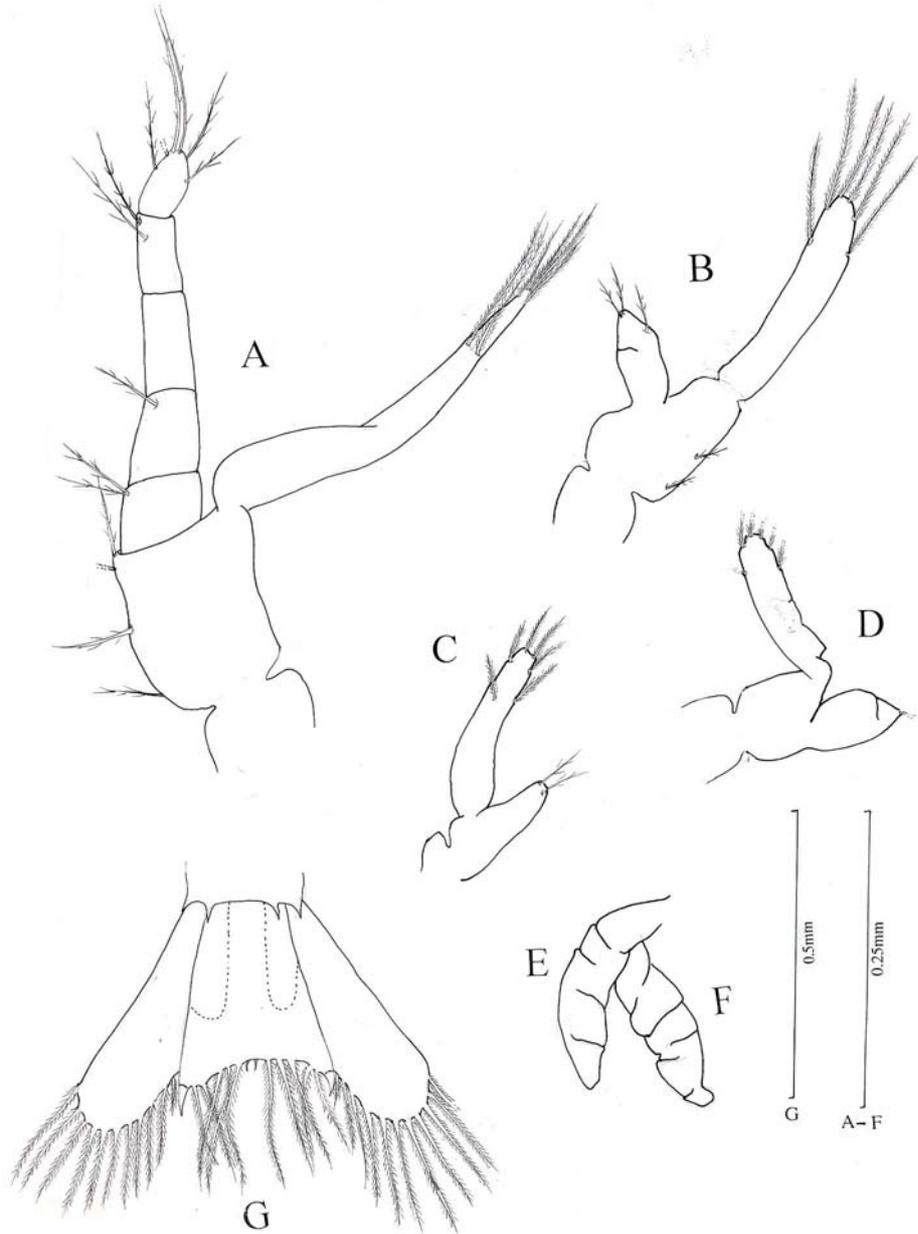


Fig. 6. *Microprosthema validum* Stimpson, 1860. Zoea III: A, maxilliped III; B-F, pereiopods I-V; G, telson with uropods.

Maxillule (Fig. 5E).- Coxal endite with 4 cuspidate and 1 plumodenticulate setae; basal endite with 4 cuspidate and 3 plumodenticulate setae.

Maxilla (Fig. 5F).- Coxal endite bilobed, with 9 + 3 setae; basal endite bilobed, with 3 + 5 setae; endopod with 3 setae; scaphognathite unchanged.

Maxilliped I (Fig. 5G).- Coxa with 3 setae; basis partially 2-segmented with 9, 3 setae; endopod 3-segmented, with 2, 2, 2 setae from proximal to distal segments respectively; exopod with 4 natatory plumose setae.

Maxilliped II (Fig. 5H).- Coxa without setae; basis unchanged; endopod 5 segmented with 2, 1, 0, 2, 4+2 setae from proximal to distal segments respectively; exopod unchanged.

Maxilliped III (Fig. 6A).- Coxa without setae; basis unchanged; endopod 5-segmented, with 2, 1, 0, 2, 4 + 2 setae from proximal to distal segments respectively; exopod with 2 terminal and 4 subterminal natatory plumose setae.

Pereiopod I (Fig. 6B).- Coxa without setae basis with 2 setae; endopod partially 2-segmented, with 2 + 1 setae; exopod unchanged.

Pereiopod II (Fig. 6C).- Coxa and basis without setae; endopod with 2 setae; exopod with 2 terminal and 4 subterminal natatory plumose setae.

Pereiopod III (Fig. 6D).- Coxa and basis without setae; endopod partially segmented, with 1 seta; exopod with 2 terminal and 4 subterminal natatory plumose setae.

Pereiopod IV and V (Figs. 6E,F).- Rudimentry.

Abdomen (Fig. 5A).- Unchanged.

Telson (Fig. 6G).- Longer than broad, posterior margin with 1 pair of spines, 5 pairs of long plumose setae and 1 pair of simple setae; uropod biramous, endopods without setae; exopods with 11 marginal plumose setae.

Zoea IV

Size.- TL = 3.74mm

Duration.- 3 days.

Carapace (Fig. 7A').- Unchanged.

Antennule (Fig. 7B).- 4-segmented, distal segment biramous, segments 1-3 with 7,3,7 setae respectively; endopod with 1 seta; exopod with 5 aesthetascs.

Antenna (Fig. 7C).- 2-segmented; endopod 3-segmented, distal segment bears 3 setae; exopod (scaphognathite) with 13 long plumose setae.

Mandible (Fig. 7D).- Unchanged.

Maxillule (Fig. 7E).- Coxal endite with 4 cuspidate and 5 plumodenticulate setae; basal endite with 4 cuspidate and 4 plumodenticulate setae; endopod rudimentry.

Maxilla (Fig. 7F).- Coxal endite bilobed, with 8 + 2 setae; basal endite bilobed, with 4 + 5 setae; endopod with 3 setae; scaphognathite with 10 marginal plumose setae.

Maxilliped I (Fig. 7G).- Coxa with 2 setae; basis with 12 setae; endopod 3-segmented with 2, 2, 3 + 1 setae respectively; exopod with 4 natatory plumose setae.

Maxilliped II (Fig. 7H).- Coxa without setae; basis with 4 setae; endopod 5-segmented, with 2, 1, 0, 2, 5 + 2 setae from proximal to distal segments respectively; exopod with 2 terminal and 4 subterminal natatory plumose setae.

Maxilliped III (Fig. 8A).- Coxa without setae; basis with 4 setae; endopod 5-segmented, with 2, 1, 0, 2, 4 + 2 setae from proximal to distal segments respectively; exopod with 2 terminal and 4 subterminal natatory plumose setae.

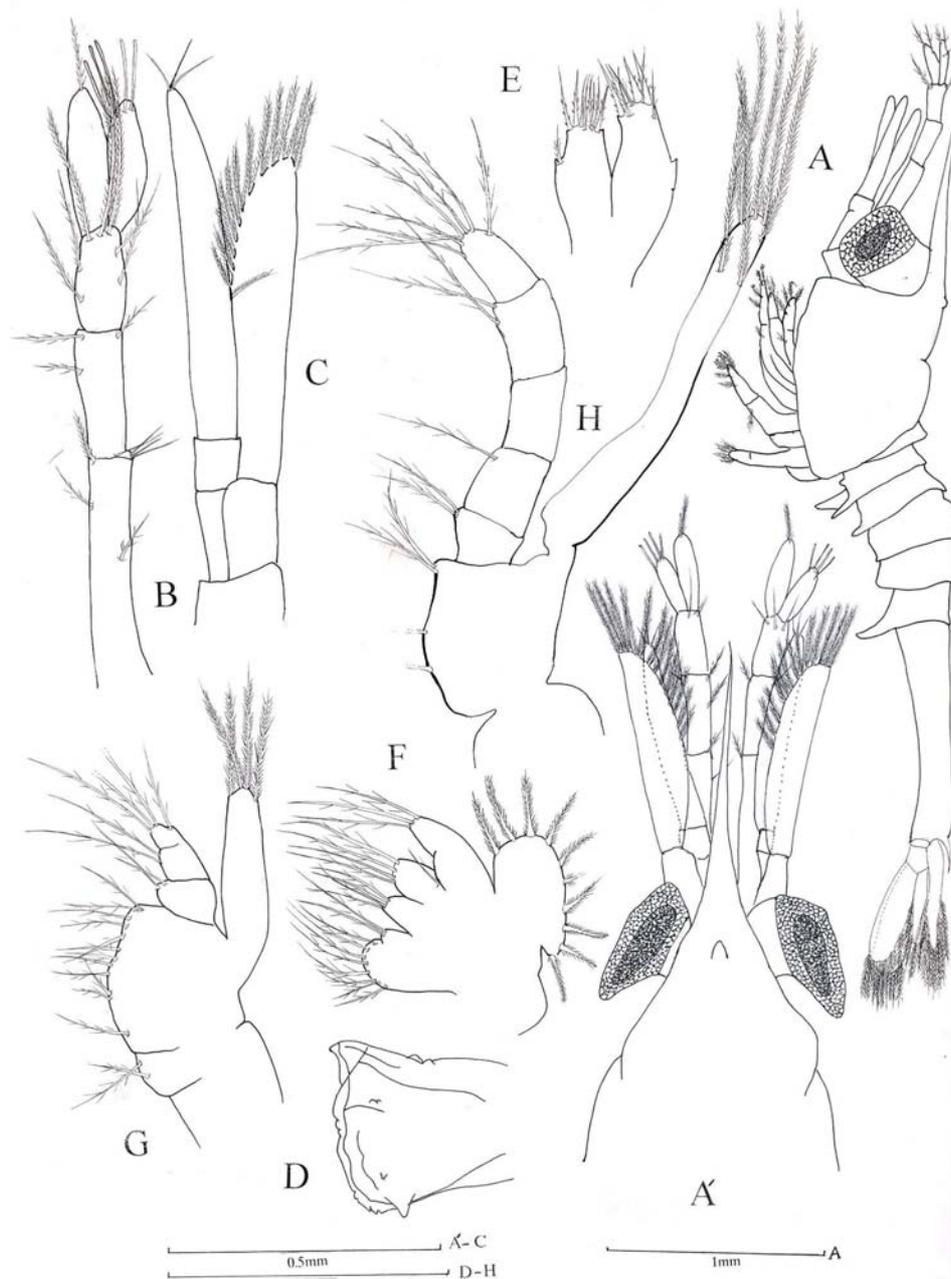


Fig. 7. *Microprosthema validum* Stimpson, 1860. Zoea IV: A, entire, lateral view; A', anterior aprt of carapace and associated appendages; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, H, maxillipeds I, II.

Pereiopod I (Fig. 8B).- Coxa without setae; basis with 2 setae; endopod unsegmented, with 3 setae; exopod with 2 terminal and 4 subterminal natatory plumose setae.

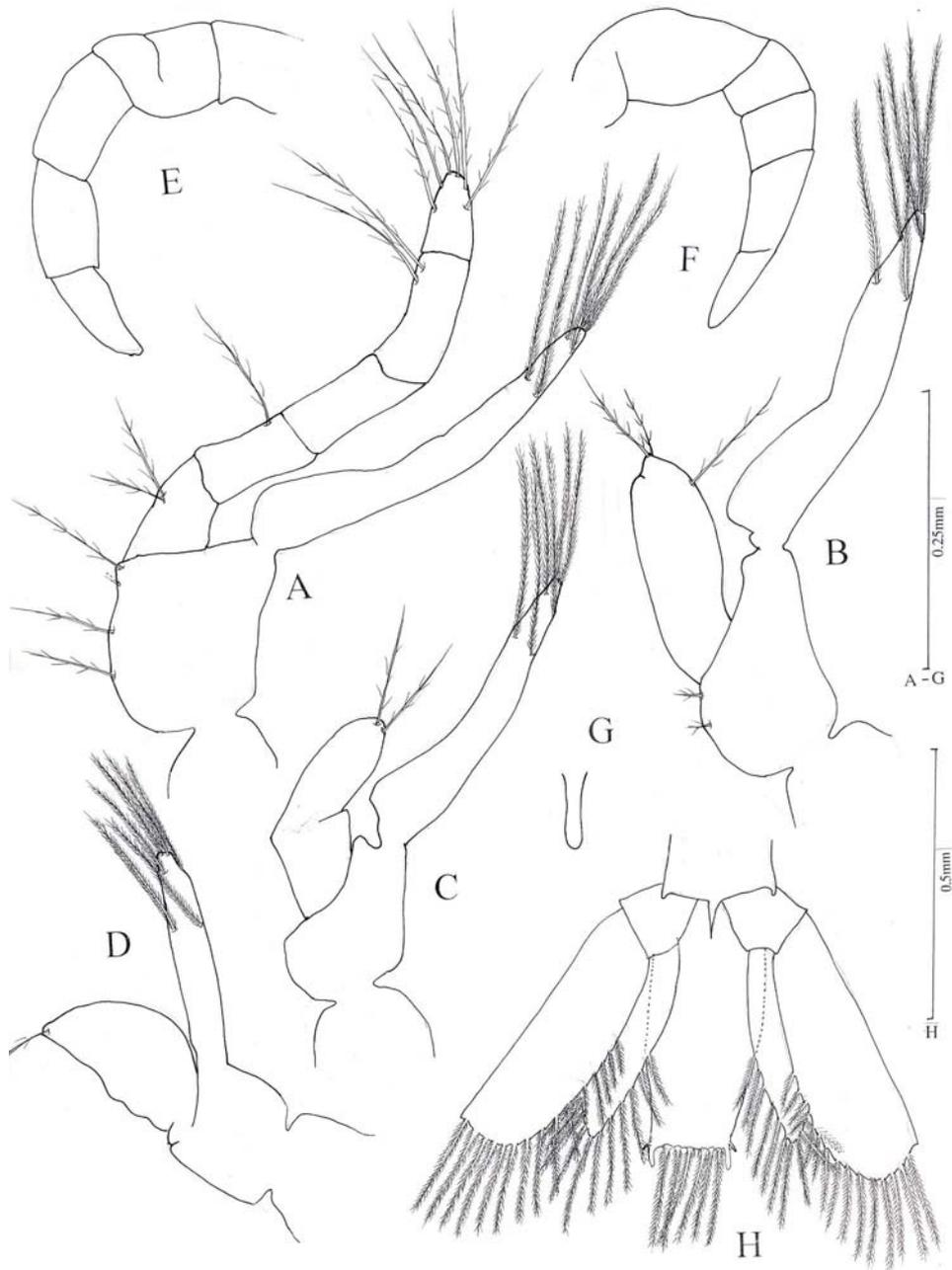


Fig. 8. *Microprosthema validum* Stimpson, 1860. Zoa IV: A, maxilliped III; B-F, pereiopods I-V; G, pleopod I; H, telson with uropods.

Pereiopod II (Fig. 8C).- Coxa and basis without setae; endopod partially segmented, with 2 terminal setae; exopod with 2 terminal and 4 subterminal natatory plumose setae.

Pereiopod III (Fig. 8D).- Coxa and basis unchanged; endopod unsegmented, with 1 terminal seta; exopod 2 terminal and 4 subterminal natatory plumose setae.

Pereiopods IV and V (Figs. 8E, F).- Rudimentary, uniramous, segmented, without setae.

Abdomen (Fig. 7A).- Unchanged.

Pleopod (Fig. 8G).- Rudimentary.

Telson (Fig. 8H).- Longer than broad; posterior margin with 1 pair of finger-like projections, 3 pairs of long plumose setae and 1 pair of simple setae; lateral margin with 1 pair of simple setae; uropod biramous, endopods with 10-11 marginal plumose setae; exopods with 15 marginal plumose setae; annal spine present.

Zoea V

Size.- TL = 3.78mm

Duration.- 2 days.

Carapace (Fig. 9A').- Unchanged.

Antennule (Fig. 9B).- 4-segmented, distal segment biramous, segments 1-3 with 4, 4, 5 setae respectively; endopod unchanged; exopod with 3 aesthetascs.

Antenna (Fig. 9C).- 2-segmented; endopod 2-segmented, exopod (scaphocerite) with 15 long plumose setae.

Mandible (Fig. 9D).- Unchanged.

Maxillule (Fig. 9E).- Coxal endite with 4 cuspidate and 4 plumodenticulate setae; basal endite with 4 cuspidate and 3 plumodenticulate setae; endopod rudimentary.

Maxilla (Fig. 9F).- Coxal endite bilobed, with 9 + 3 setae; basal endite bilobed, with 3 + 3 setae; endopod with 3 setae; scaphognathite with 5 marginal plumose setae.

Maxilliped I (Fig. 9G).- Coxa with 3 setae; basis with 14 setae; endopod 3-segmented, with 2, 1, 4 setae from proximal to distal segments respectively; exopod unchanged.

Maxilliped II (Fig. 9H).- Coxa without setae; basis with 4 setae; endopod 5-segmented, with 2, 1, 0, 2, 4 + 2 setae from proximal to distal segments respectively; exopod with 4 terminal and 2 subterminal natatory plumose setae.

Maxilliped III (Fig. 10A).- Coxa without setae; basis with 4 setae; endopod 5-segmented, with 3, 1, 0, 2, 4 setae from proximal to distal segments respectively; exopod with 3 terminal and 3 subterminal natatory plumose setae.

Pereiopod I (Fig. 10B).- Coxa and basis without setae; endopod biramous with 2 setae; exopod with 2 terminal and 4 subterminal natatory plumose setae.

Pereiopod II (Fig. 10C).- Coxa and basis without setae; endopod biramous, with 1 seta; exopod with 2 terminal and 4 subterminal natatory plumose setae.

Pereiopod III (Fig. 10D).- Coxa and basis without setae; endopod biramous with 1 seta; exopod with 4 terminal and 2 subterminal natatory plumose setae.

Pereiopod IV and V (Figs. 10E, F).- Uniramous, segmented, without setae.

Abdomen (Fig. 9A).- Unchanged.

pleopod (Fig. 10G).- Pleopods 1-5 biramous, developed on each abdominal somite, endopod and exopod without setae.

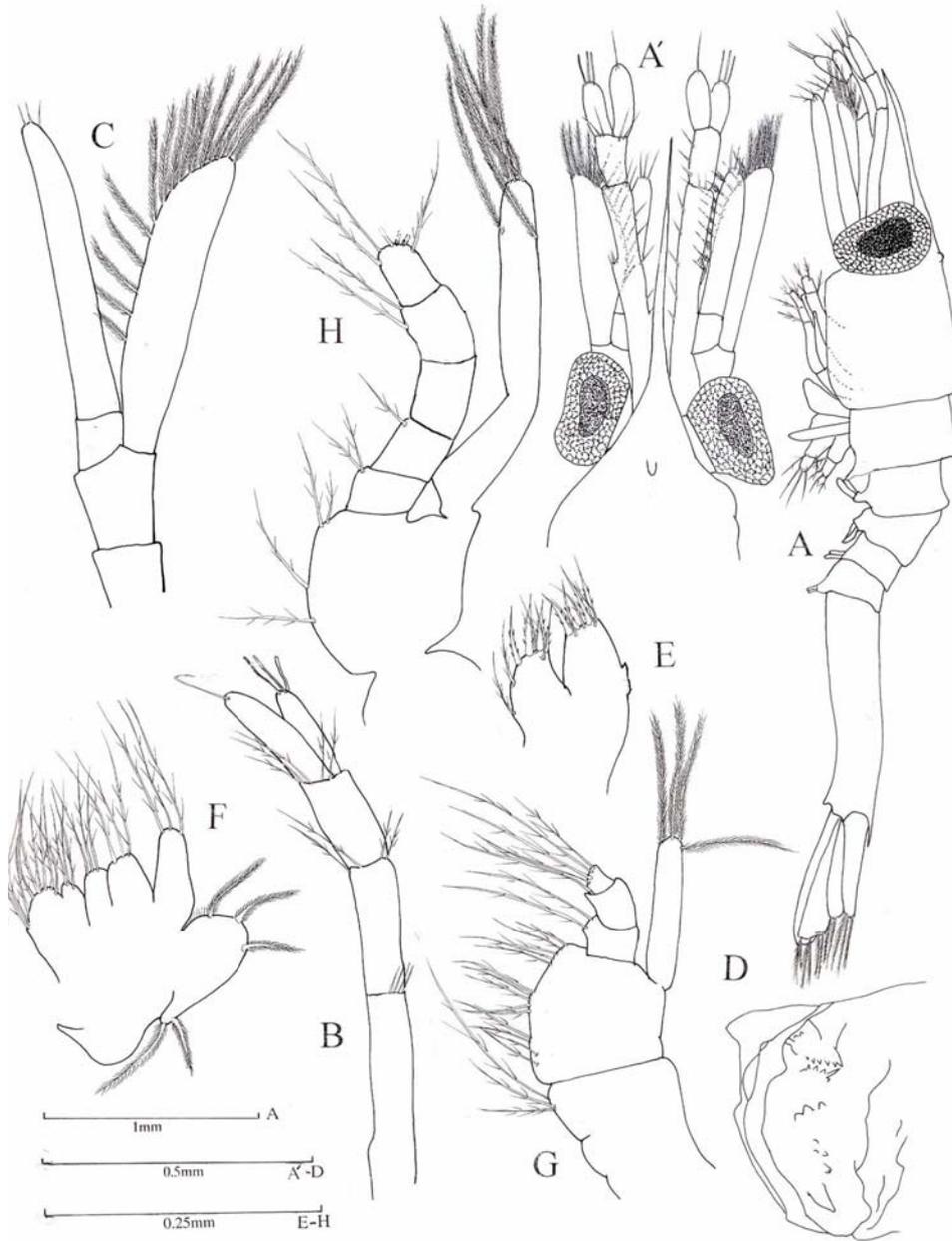


Fig. 9. *Microprosthema validum* Stimpson, 1860. Zoea V: A, entire, lateral view; A', anterior part of carapace and associated appendages; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, H, maxillipeds I, II.

Telson (Fig. 10H).- Dorsal surface with 2 pairs of spines; posterior margin with 1 pair of finger-like projections and 4 pairs of long plumose setae; uropod biramous; endopod and exopod unchanged; anal spine present.

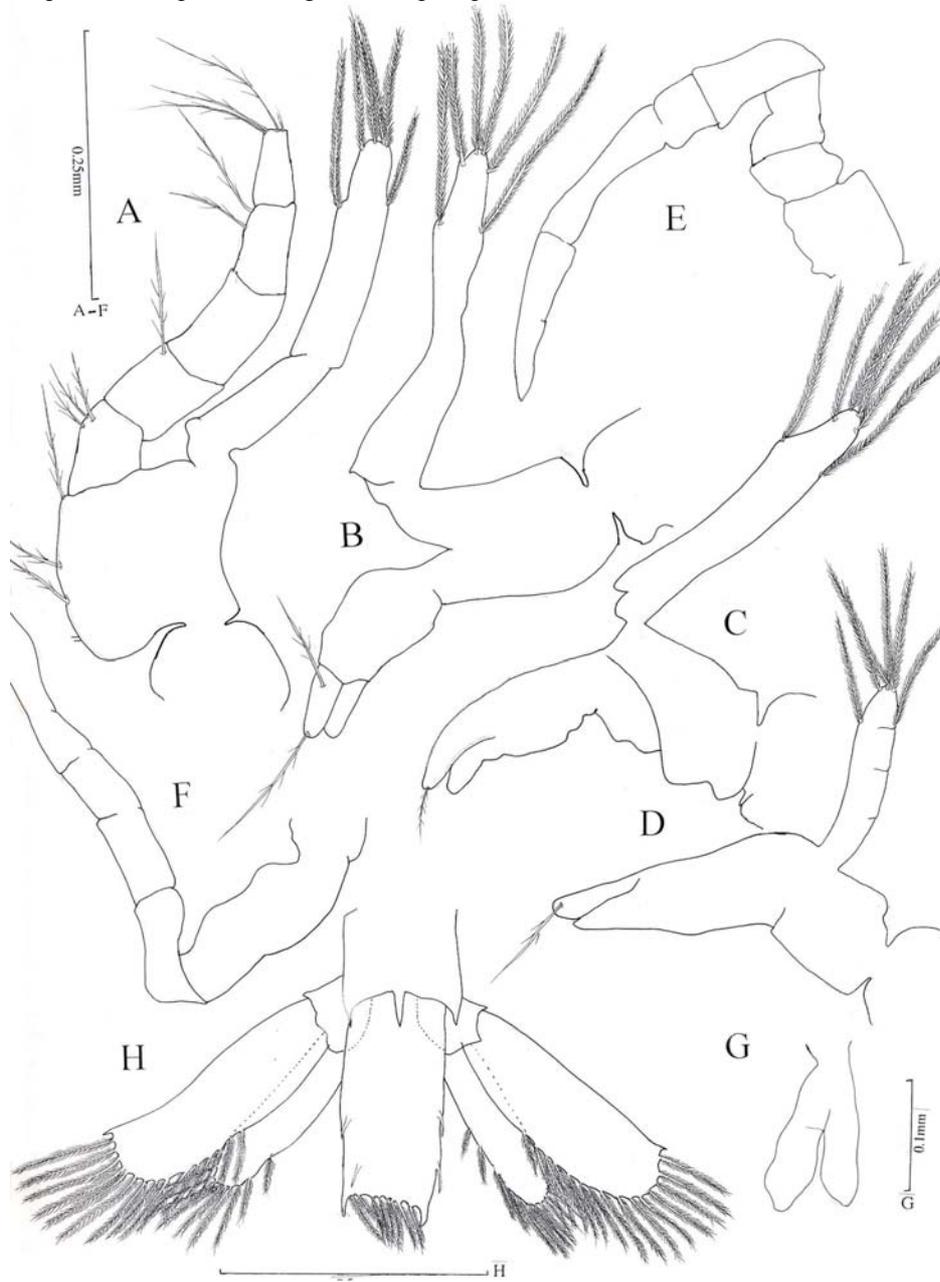


Fig. 10. *Microprosthema validum* Stimpson, 1860. Zoea V: A, maxilliped III; B-F, pereiopods I-V; G, pleopod I; H, telson with uropods.

Postlarva I

Size.- TL = 2.52mm

Duration.- 7 days.

Carapace (Fig. 11A).- Smooth; rostrum with 5 spines along with fine setae.

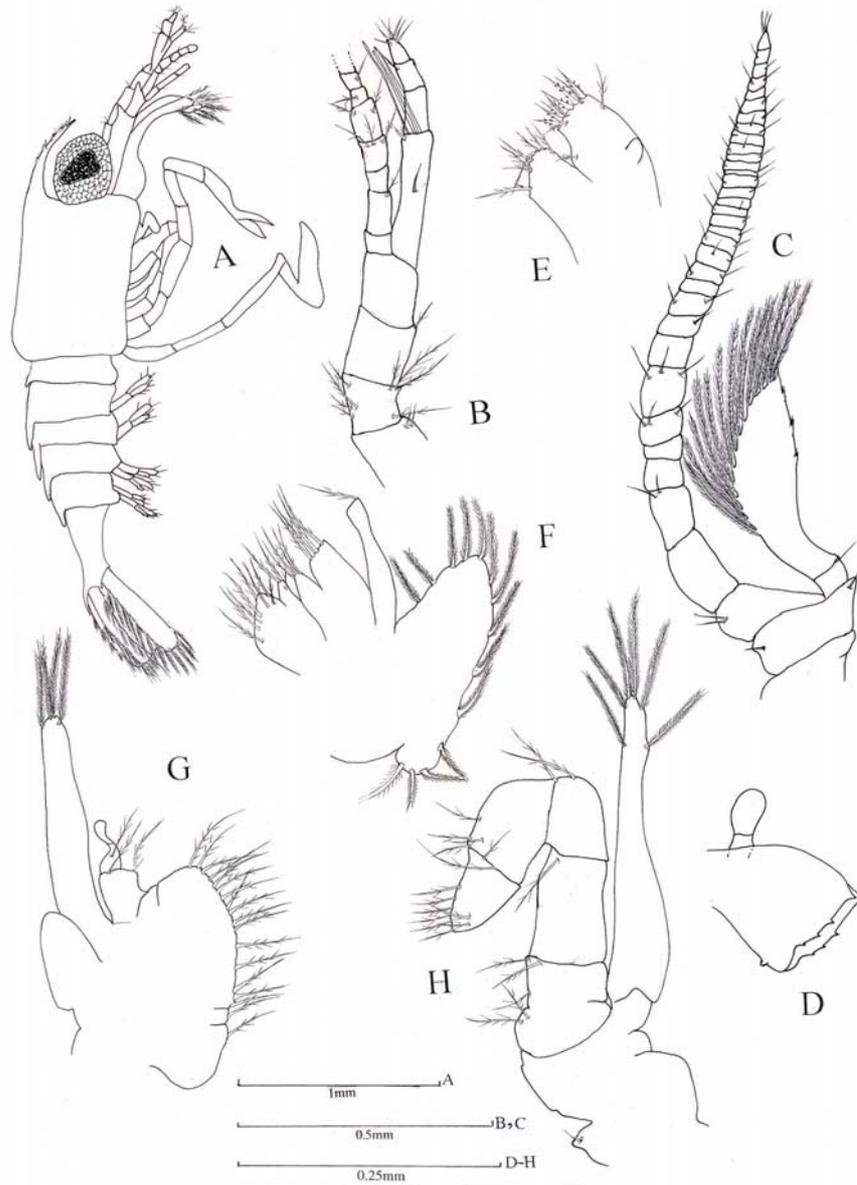


Fig. 11. *Microprosthema validum* Stimpson, 1860. Postlarva I: A, lateral view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, H, maxillipeds I, II.

Antennule (Fig. 11B).- 5-segmented, distal segment biramous, segments 1-4 with 2, 4 + 3, 1, 0 setae respectively; endopod segmented, with fine setae; exopod segmented, with 4 aesthetascs and fine setae.

Antenna (Fig. 11C).- 3-segmented, distal segment biramous, endopod segmented, with fine setae; exopod (scaphocerite) with pointed distolateral spine, spine longer than squamose portion bearing 13-17 marginal setae; lateral margin with 3 spine and 3 fine setae.

Mandible (Fig. 11D).- Palp 2-segmented.

Maxillule (Fig. 11E).- Coxal endite with 8 setae; basal endite with 6 cuspidate and 5 plumodenticulate setae; endopod rudimentary.

Maxilla (Fig. 11F).- Coxal endite bilobed, with 8 + 3 setae; basal endite bilobed, with 4 + 4 setae; endopod with 1 seta; scaphognathite with 14 marginal plumose setae.

Maxilliped I (Fig. 11G).- Coxa with 1 seta; basis long, with 17 setae; endopod 3-segmented, with 2, 1, 0 setae from proximal to distal segments respectively; exopod with 4 terminal plumose setae.

Maxilliped II (Fig. 11 H).- Coxa with 1 seta; basis without setae; endopod 5-segmented, with 5, 1, 2, 6, 8 setae from proximal to distal segments respectively; exopod with 2 terminal and 4 subterminal plumose setae.

Maxilliped III (Fig. 12A).- Coxa without setae; basis with 2 setae; endopod 5-segmented, with 3, 3, 4, 3, 6 setae from proximal to distal segments respectively; exopod with 2 terminal and 4 subterminal plumose setae.

Pereiopod I - V (Figs. 12B-F).- Pereiopod I - III chelate with fine tuft of setae. Dactylus of IV and V biunguiculate.

Pleopod (Fig. 12G).- Well developed; endopod and exopod with 3, 6 plumose setae respectively.

Telson (Fig. 12H).- Dorsal surface with 3 pairs of spines and 3 fine setae; posterior margin with 1 seta; posterolateral margin bears with 13 plumose setae; endopod with 2 spines and 17-19 marginal plumose setae; exopod with 4 spines and 15-18 long marginal plumose setae.

Postlarva II

Size.- TL = 3.2mm

Duration.- 6 days.

Rostrum (Fig. 13A).- With 5 dorsal and 1 lateral spines and fine simple setae, rostral tip bears 2 subterminal setae.

Antenna (Fig. 13B).- No change in armature, exopod (scaphocerite) with 20 marginal plumose setae.

Pereiopod III (Fig. 13C).- Dactylus chelate, with fine tuft of setae, inner margin of dactylus with few denticles.

Pereiopod V (Fig. 13D).- Dactylus biunguiculate, superior unguis longer than inferior.

Telson (Fig. 13E).- No change in armature except posterolateral margin bears 21 plumose setae; endopod with 25 plumose setae; exopod with 5 spines and 22-23 marginal plumose setae.

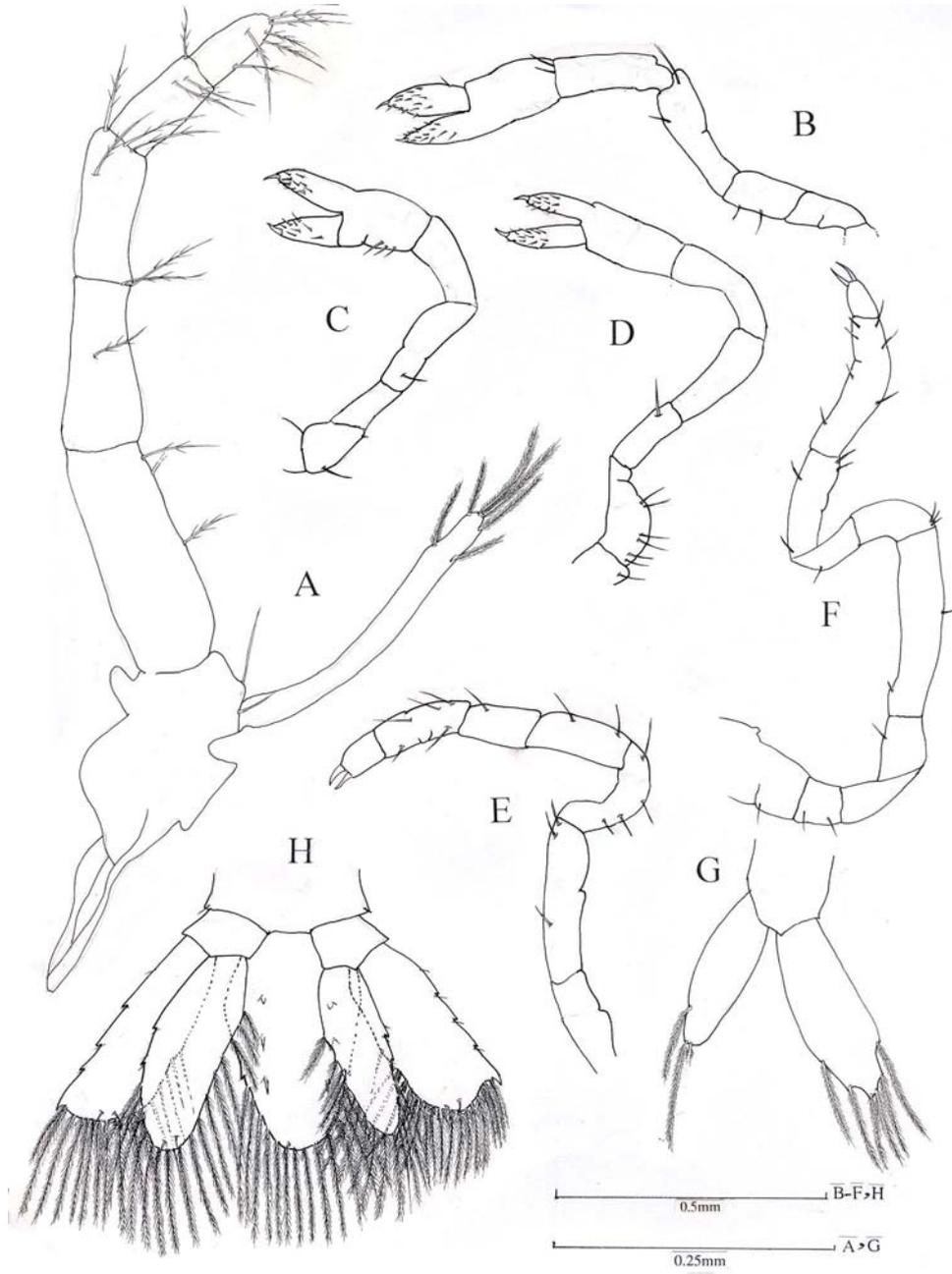


Fig. 12. *Microprosthema validum* Stimpson, 1860. Postlarva I: A, maxilliped III; B-F, pereopods I-V; G, pleopod I; H, telson with uropods.

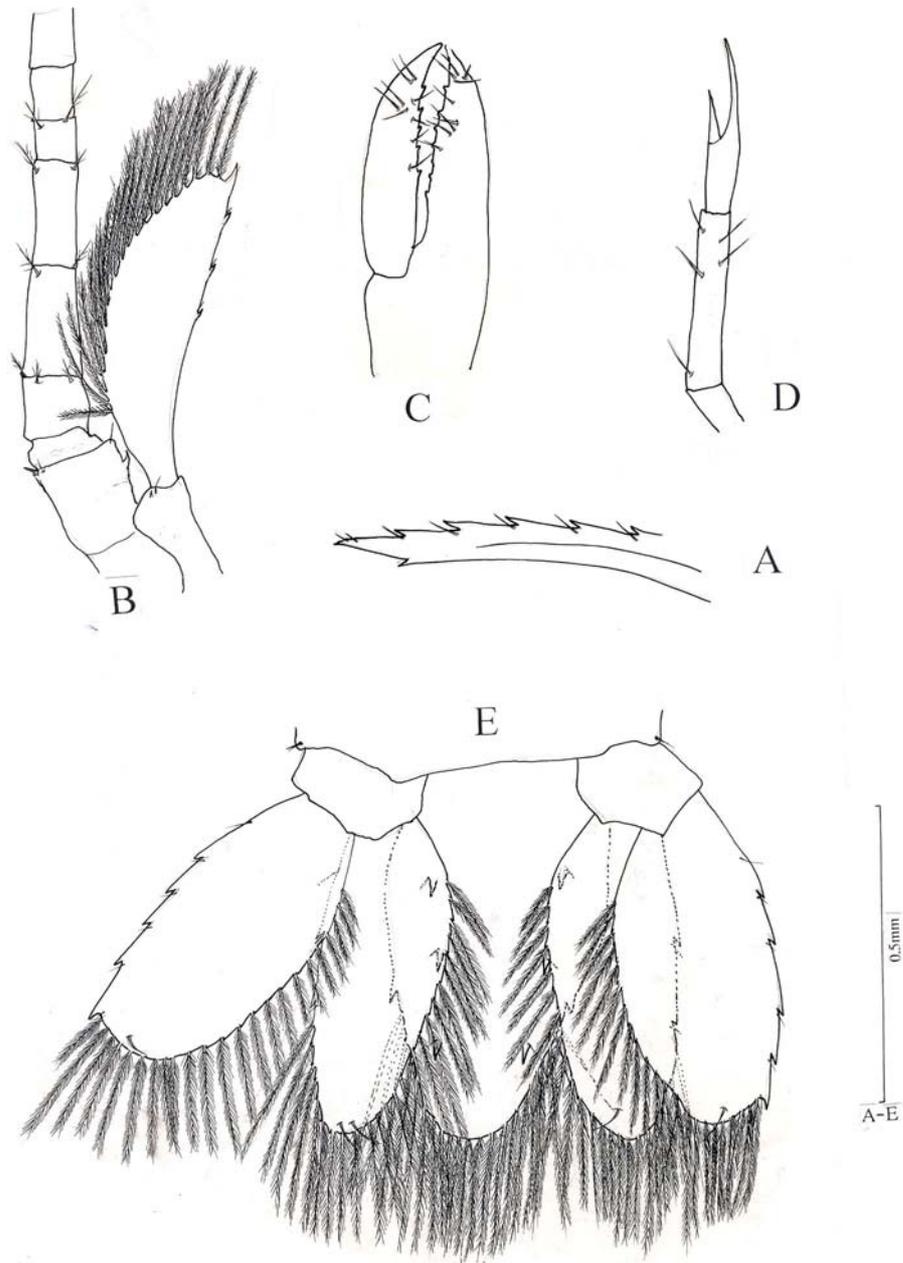


Fig. 13. *Microprosthema validum* Stimpson, 1860. Postlarva II: A, rostrum, lateral view; B, antenna; C, dactylus of pereopod III; D, pereopod V; E, telson with uropods.

Postlarva III

Size.- TL = 3.21mm

Duration.- 4 days.

Rostrum (Fig. 14A).- Unchanged.

Antenna (Fig. 14B).- Unchanged, exopod (scaphocerite) with 23 marginal plumose setae.

Pereiopod III (Fig. 14C).- Unchanged.

Telson (Fig. 14D).- No change in armature except posterolateral margin bears 24 plumose setae; endopod with 27 plumose setae; exopod with 7 spines and 25-26 marginal plumose setae.

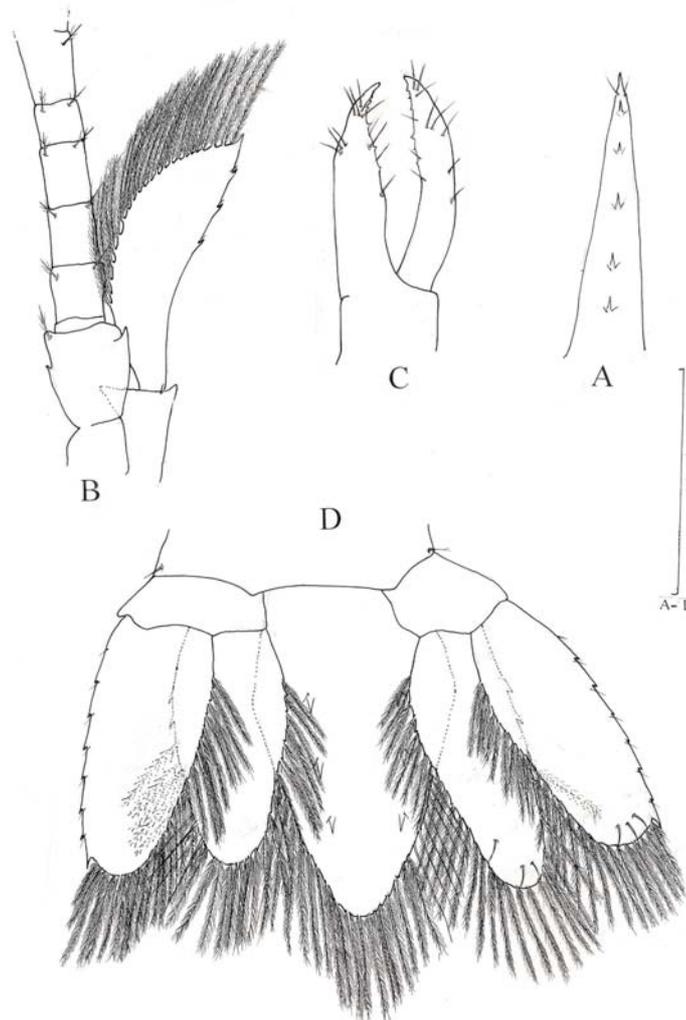


Fig. 14. *Microprosthema validum* Stimpson, 1860. Postlarva III: A, rostrum, dorsal view; B, antenna; C, dactylus of pereiopod III; D, telson with uropods.

Postlarva IV

Size.- TL = 4.27mm

Duration.- 6 days.

Rostrum (Fig. 15A).- Unchanged.

Antenna (Fig. 15B).- Exopod (scaphocerite) with 4 lateral marginal spines and 24 marginal plumose setae.

Pereiopod III (Fig. 15C).- Unchanged.

Telson (Fig. 15D).- Posterolateral margin bears 29 long plumose setae; endopod with 3 spines and 27 long plumose setae; exopod with 7 spines and 32 long plumose setae.

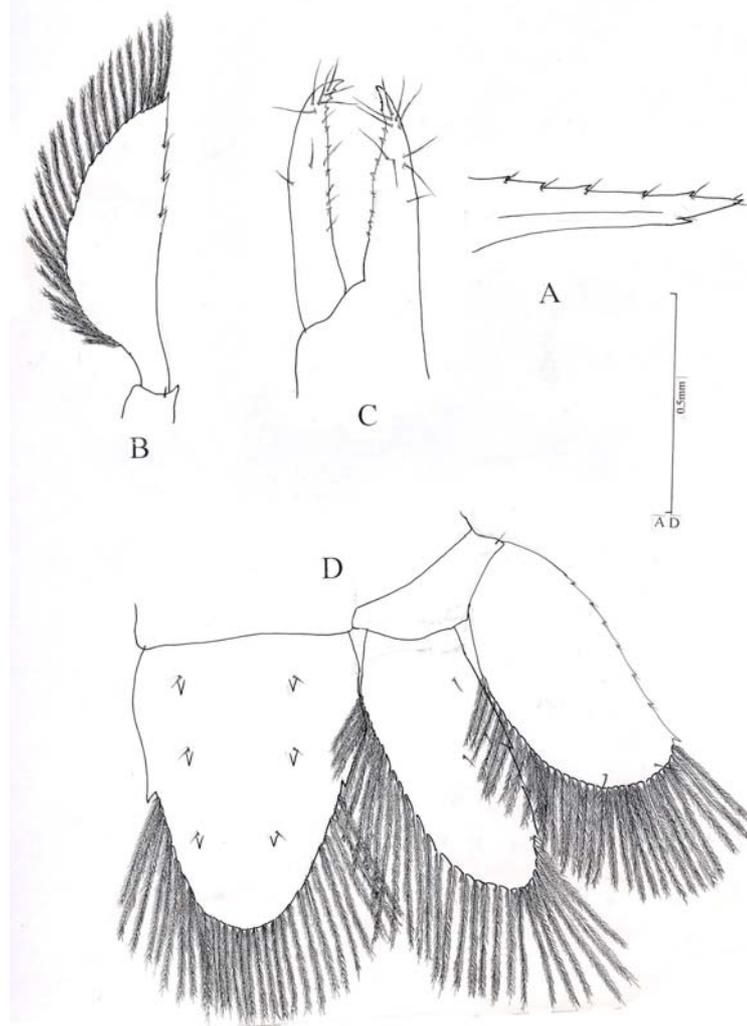


Fig. 15. *Microprosthema validum* Stimpson, 1860. Postlarva IV: A, rostrum, lateral view; B, antenna, scaphognathite; C, dactylus of pereiopod III, D, telson with uropod.

Juvenile

Size.- TL = 4.53mm

Duration.- 15 days

Carapace (Fig. 16A).- Broader than long, anterolateral angles with 2 pairs of spines and 1 pair of setae; dorsal surface with fine denticles or spinules and setae; rostrum with 5 dorsal and 1 ventral spines (Fig. 16B); eyes stalked.

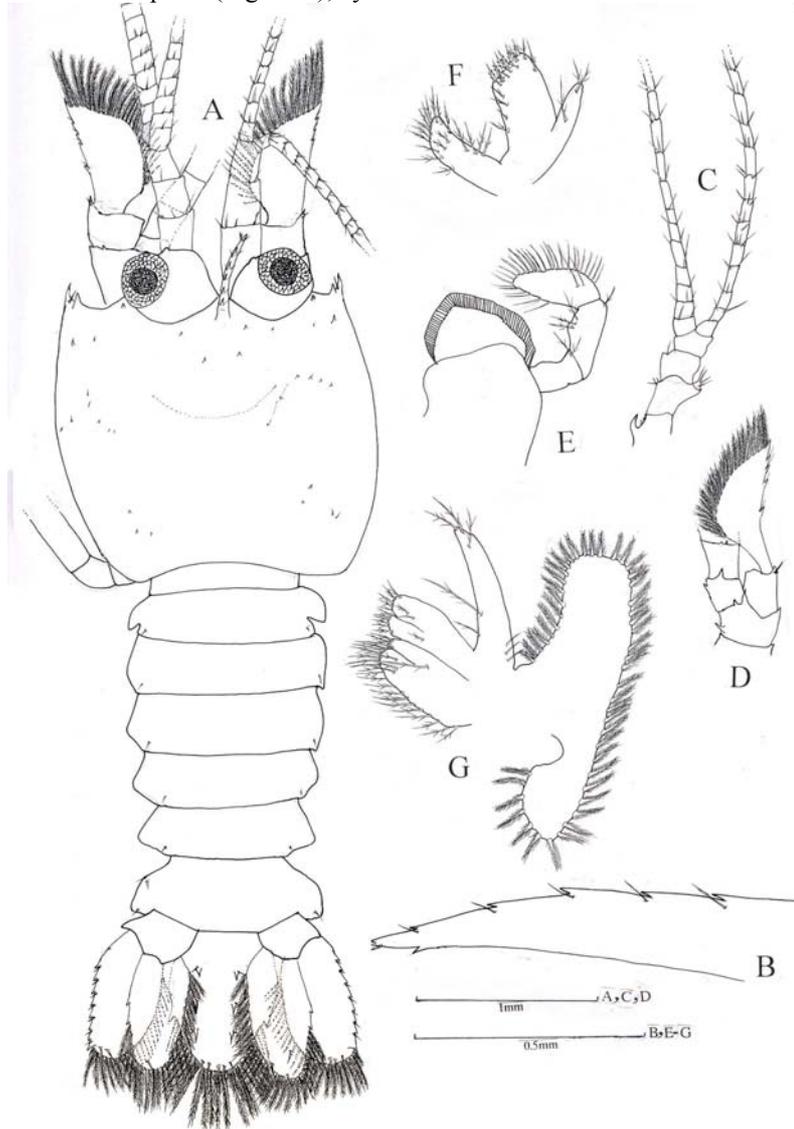


Fig. 16. *Microprosthema validum* Stimpson, 1860. Juvenile: A, dorsal view; B, rostrum, lateral view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla.

Antennule (Fig. 16C).- 5-segmented, distal segment biramous, segments 1-4 with few setae; endopod and exopod segmented, with several setae.

Antenna (Fig. 16D).- 3-segmented, distal segment biramous, endopod broken; exopod (scaphocerite) with pointed distolateral spine, spine longer than squamose portion, that bears 23 marginal plumose setae; lateral margin with 4 spines and 4 fine setae.

Mandible (Fig. 16E).- Endopodal bud 3-segmented, with 2, 4, 30 setae respectively.

Maxillule (Fig. 16F).- Coxal endite with 18 setae; basal endite with 8 cuspidate and 10 plumodenticulate setae; endopod with 3 setae.

Maxilla (Fig. 16G).- Coxal endite bilobed, with 21 + 6 setae; basal endite bilobed, with 7 + 8 setae; endopod with 8 setae; scaphognathite with 49 marginal plumose setae.

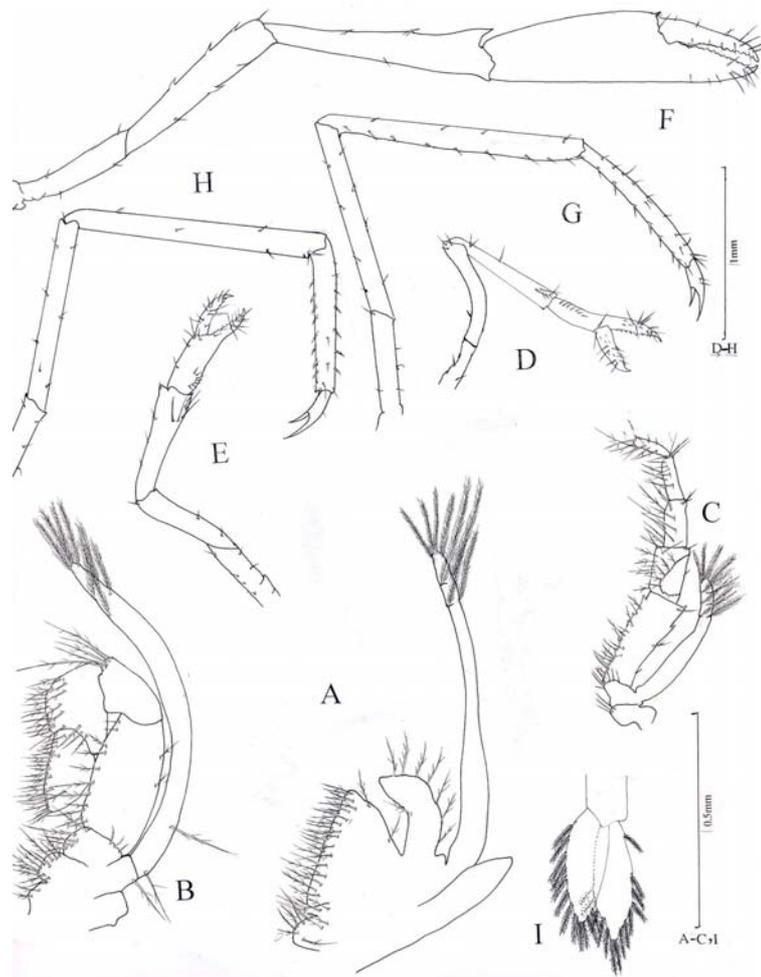


Fig. 17. *Microprosthema validum* Stimpson, 1860. Juvenile: A-C, maxilliped I-III; D, pereopod I (left); E-H, pereopods II-V (right); I, pleopod II.

Maxilliped I (Fig. 17A).- Coxopod with 6 setae; basipod with several setae; endopod unsegmented, with 8 setae; exopod with 2 terminal and 6 subterminal plumose setae.

Maxilliped II (Fig. 17B).- Coxopod with 2 setae; basipod with 11 + 1; endopod 5-segmented, with several setae; exopod with 2 terminal, 8 subterminal plumose setae and 2 lateral plumodenticulate setae.

Maxilliped III (Fig. 17C).- Coxopod with 3 setae; basipod with 7 setae; endopod 5-segmented, with several setae, proximal segment with few denticles; exopod with 10 natatory plumose setae.

Pereiopods I -V (Fig. 17D-H).- Pereiopods I-III chelate with fine tufts of setae; inner margin of dactyli with few denticles (Figs. 17D-F); pereiopod III greater than pereiopods I and II; pereiopods IV and V sparsely setose; dactyli of pereiopods IV and V biunguiculate; superior unguis longer than inferior (Figs. 17 G,H).

Pleopods (Fig. 17I).- Endopod and exopod with 12-14 plumose setae.

Telson (Fig. 16A).- Dorsal surface with 3 pairs of spines, posterolateral margin with 29 long plumose setae and 9 small simple setae; endopod with 3 spines and 30-34 setae; exopod with 8 spines and 35-37 setae.

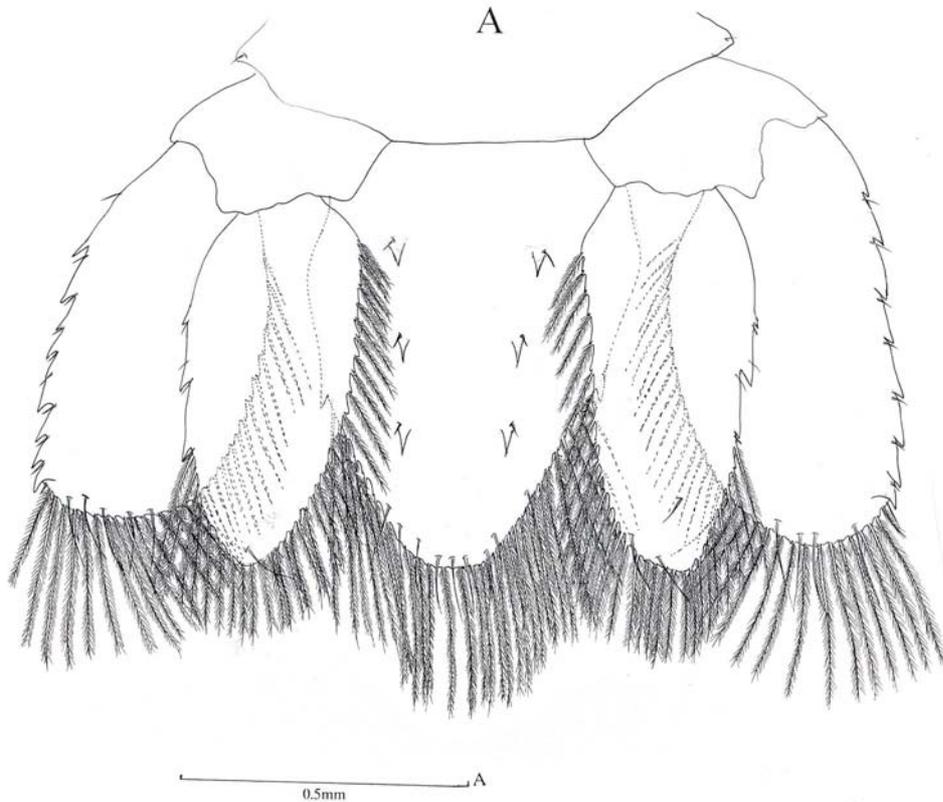


Fig. 18. *Microprosthema validum* Stimpson, 1860. Juvenile: A, telson with uropods.

Table 1. The successive changes in morphological characters of *Microprosthema validum* Stimpson, 1860 of zoea I - juvenile stage.

Characters	Zoea I TL=2.26mm	Zoea II TL=2.78mm	Zoea III TL=2.99mm	Zoea IV TL=3.7mm	Zoea V TL=3.78mm	Postlarva I TL=2.52mm	Juvenile TL=4.53mm
Carapace:							
rostrum						5 spine	5 dorsal and 1 lateral spine no change
epigastric knob	present	no change	no change	no change	no change	absent	absent
Antennule:							
aesthetascs	2	3	5	5	3	4	absent
setae	2	4	2	1	no change	several fine setae	no change
Antenna:							
setae:							
endopod	2	no change	no change	3	“	several setae	broken
exopod	8	10	12	13	15	13-17	5 spines, 23 setae
Mandible:							
palp	absent	no change	present	no change	no change	2 segmented	3 segmented with 2, 4, 30 setae
Maxillule:							
setae:							
coxal endite	3	7	5	9	8	no change	18
basal endite	5	8	7	8	7	11	18
endopod	absent	no change	no change	rudimentary	no change	no change	3
Maxilla:							
setae:							
coxal endite	10+3	8+2	9+3	8+2	9+3	8+3	21+6
basal endite	4+4	4+2	3+5	4+5	3+3	4+4	7+8
endopod	3	4	3	no change	no change	1	8
scaphognathite	5	no change	no change	10	5	14	49
Maxilliped I:							
setae:							
coxa	2	3	“	2	3	1	6
basis	13	10	12	no change	14	17	several

Table 1 Continued...

endopod	3 segmented with 3, 2, 3 setae	no change with 2, 2, 5 setae	no change with 2, 2, 2 setae	no change with 2, 2, 3+1 setae	no change with 2, 1, 4 setae	no change with 2, 1, 0 setae	unsegmented with 8 setae
exopod	4	no change	no change	no change	no change	no change	8
Maxilliped II:							
setae:	absent	"	"	"	"	1	2
coxa	4	"	"	"	"	absent	11 + 1
basis	1, 1, 0, 2, 5+1	2, 1, 0, 2, 4+2	2, 1, 0, 2, 4+2	2, 1, 0, 2, 5+2	2, 1, 0, 2, 4+2	5, 1, 2, 6, 8	several setae
endopod	6	no change	no change	no change	no change	no change	10
Maxilliped III:							
setae:	1	"	absent	"	"	"	3
coxa	3	4	no change	"	"	2	7
basis	2, 1, 0, 1, 4+1	2, 1, 0, 2, 4+2	"	"	3, 1, 0, 2, 4	3, 3, 4, 3, 6	several setae & few denticles
endopod	6	no change	no change	no change	no change	no change	10
exopod							
Pereiopod I:							
setae:	absent	no change	no change	no change	no change	chelate, sparsely setose	well developed
coxa	3	no change	2	"	absent		
basis	6	"	3	"	2		
endopod	6	no change	no change	no change	no change		
exopod	rudimentary						
Pereiopod II:							
setae:	-	absent	"	"	"	chelate, sparsely setose	well developed
coxa	-	2	"	absent	"		
basis	-	3	2	no change	1		
endopod	-	6	6	no change	"		
exopod	rudimentary	no change					
Pereiopod III:							
setae:	-	-	absent	"	"	chelate, sparsely setose	well developed
coxa	-	-	"	"	"		
basis	-	-	1	"	1		
endopod	-	-	6	"	no change		
exopod	-	-					

Table 1 Continued...

	absent	no change	rudimentary	"	"	biunguiculate dactylus	well developed
Pereiopod IV:							
Pereiopod V:	"	"	"	rudimentary	"	biunguiculate dactylus	well developed
Pleopod	"	"	absent	rudimentary, uniramous	rudimentary, biramous	3, 6 setae	12, 14 setae
Telson	broad, posterior margin with 1 pair of spines & 12 plumose setae	broad, posterior margin with 1 pair of spines, 12 plumose setae & 1 pair of simple setae	longer, posterior margin with 1 pair of spines, 10 plumose setae & 1 pair of simple setae	no change posterior margin with 1 pair of finger like projection, 3 pairs of plumose setae & 1 pair of simple setae, lateral margin with 1 pair of simple setae	no change 2 pairs of spines on dorsal surface, on posterior margin 1 pair of finger like projection, & 4 pairs of plumose setae	triangular 3 pairs of spines on dorsal surface, on posterior margin with 1 seta, posterior lateral margin with 13 setae	no change 3 pairs of spines on dorsal surface, on posterolateral margin with 29 plumose setae & 9 small setae
Uropod setae:	absent	no change					
endopod	-	-	absent	10-11	no change	2 spines & 17-19 setae, 4 spine & 15-18 setae	3 spines & 30-34 setae, 8 spines & 35-37 setae
exopod	-	-	11	15	"		

Table 2: Comparison between number of setae in zoea I to zoea IV and postlarva I of *Microprosthema validum* Stimpson, 1860 (present study) and *Microprosthema semilaeve* studied by Raje and Ranade, 1975, from India.

Characters	<i>M. validum</i> Pakistan	<i>M. semilaeve</i> India
Zoea I:		
Antenna:		
setae:		
exopod	8	9
Maxillule:		
setae:		
coxal endite	3	5
basial endite	5	7
Maxilla:		
setae:		
coxal endite	10+3	6 + 2
basial endite	4+4	4 + 3
junction of endopod and protopod	absent	1
Maxilliped I:		
setae:		
coax	2	3
basis	13	8
endopod	3, 2, 3	2, 2, 4
Maxilliped II:		
setae:		
coax	absent	1
basis	4	3
endopod	1,1,0,2,6	2, 1, 0, 2, 6
Maxilliped III:		
setae:		
coax	1	absent
endopod	2,1,0,1,5	2, 1, 0, 2, 5
Periopod I:		
setae:		
basis	3	absent
endopod	6	3
exopod	6	8
Zoea II:		
Antennule:		
setae:		
endopod	4	1 seta
exopod	3 aesthetascs	7

Table 2 Continued....

Maxillule:		
setae:		
basial endite	8	7
Maxilla:		
setae:		
coxal endite	8 + 2	8 + 3
basial endite	4 + 2	4 + 4
Maxilliped I:		
setae:		
coax	3	5
basis	10	11
endopod	2, 2, 5 setae	2, 2, 4 setae
Maxilliped II:		
setae:		
coax	absent	1
basis	4	3
Maxilliped III:		
setae:		
coax	1	absent
basis	4	3
endopod	2, 1, 0, 2, 6	2, 1, 0, 2, 5
Pereiopod I:		
setae:		
basis	3	absent
Zoea III:		
Antennule:		
setae:		
endopod	2	1 seta
exopod	5 aesthetascs	7
peduncle	3, 1, 3 setae	6, 3, 7 setae
Antenna:		
setae:		
exopod	12	13
Maxillule:		
setae:		
coxal endite	5	7
Maxilla:		
setae:		
coxal endite	9 + 3	8 + 3
basial endite	3 + 5	4 + 4
Maxilliped I:		
setae:		
coax	3	2
basis	12	9
endopod	2, 2, 2 setae	3, 2, 4 setae

Table 2 Continued....

Zoea IV:		
Antennule:		
setae:		
endopod	1 seta	5 setae
peduncle	7, 3, 7 setae	5, 4, 4 setae
Antenna:		
setae:		
exopod	13	14
Maxillule:		
setae:		
coxal endite	9	7
basial endte	8	7
Maxilla:		
setae:		
coxal endite	8 + 2	9 + 4
basial endite	4 + 5	5 + 5
Telson:		
lateral setae	1 pair	2 pair
 Postlarval I:		
Rostrum		
	5 spines	3 setae
Antennule:		
aesthetascs	4	absent
statocyst	absent	present
Antenna:		
setae:		
exopod	13-17	18
Maxilla:		
setae:		
coxal endite	8 + 3	9 + 2
scaphognathite	13 or 14	23
Maxilliped I:		
setae:		
coax	1	13
basis	17	19
Telson:		
lateral notched	absent	present
posterolateral margin	13 setae	16 setae

DISCUSSION

Tirmizi and Kazmi (1979) suggested that because *M. validum* exhibits considerable variation, Mahadevan *et al's* (1962) specimens appeared to be within the range of variation and very likely referable to *M. validum*. Among species of the genus, *M. validum* and *M. semilaeve* are very much alike and have been confused in the past.

Mahadevan *et al* (1962) suggested that the two species might be synonymous, while Rajee and Ranade (1975) wanted knowledge of larval characters of *M. validum* to verify Mahadevan *et al's* (1962) opinion. Felder, *et al.* (1985), while discussing patterns of larval development of decapods, suggested ... “that the larvae and postlarvae reported as *Microprosthema semilaeve* represent *Microprosthema validum* or a new species from the Indian Ocean”.

Table 3. Comparison between zoea V of *Microprosthema validum* Stimpson, 1860 (present study) and Species Ind. 5, studied by Williamson, 1976.

Characters	<i>M. validum</i> (present study)	Species Ind. 5
Rostrum:	more than half of antennular peduncle	less than half and one specimen slightly more than half of antennular peduncle
Supra orbital Spine	absent	present
Maxillule:		
setae:		
coxal endite	8	6
basial endite	7	9
endopod	rudimentary	absent
Maxilla:		
endopod	unsegmented with 3 setae	2 segmented with 1, 3 setae
Maxilliped I:		
setae:		
coxa	3	4
endopod	3 segmented with 2, 1, 4 setae	3 segmented with 3, 2, 3 setae
epipod	absent	present
Pleopod on somite one	present	absent
Telson:		
dorsal surface	2 pairs of spines present	spine absent
posterior margin	4 pairs of setae	3 pairs of setae

Microprosthema validum has five zoeal stages followed by postlarvae I-IV and the juvenile stage, which is quite similar to the adult. The stenopoids lacked postlarval stages equivalent to those of carideans (Anger, 2001). The present larval and postlarval stages can be differentiated through gradual changes in size and morphological characters, such as increase in the number of rostral spines, exopodal setae of antennae, and posterolateral

marginal setae, exopod and endopodal setae of telsons. The juvenile, however changed its body shape from being laterally compressed in postlarvae to dorsoventrally compressed and increase in the number of posterolateral marginal setae, exopodal and endopodal setae of telson.

The comparison between developmental stages of *M. semilaeve* by Raje and Ranade (1975) and present study of *M. validum* shows that *M. semilaeve* had a shorter larval history, i.e. only four zoeal stages but the postlarval duration was longer, where six postlarvae were reported. There are setal differences in antennules, antennae, maxillules, maxillae, maxillipeds, pereopods and telsons of the two species (Table 2) and also the telson of postlarva I of *M. semilaeve* has a lateral notch that is absent in *M. validum*.

Late zoea of *M. validum*, when compared with those of Ind. 5 of Williamson, (1976), (Table 3) shows that setal differences occur in the maxillule, maxilla, maxilliped I and telson, but the major difference is that the supraorbital spine, present in species Ind. 5, which is absent in *M. validum*, and the telson of species Ind. 5, is without 2 pairs of spines, which is present in *M. validum*. These differences suggest that the three species: *M. validum*, *M. semilaeve* and *M. scabricaudatum* are allied but separate species.

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