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ADVANCE DEVELOPMENTAL STAGES OF *SYNALPHEUS TUMIDOMANUS* (PAULSON, 1875) (CRUSTACEA, DECAPODA, ALPHEIDAE) REARED UNDER LABORATORY CONDITIONS

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ABSTRACT: An ovigerous female of *Synalpheus tumidomanus* (Paulson, 1875), captured from Buleji (Karachi, Pakistan) on May 18, 1996 was kept under the laboratory conditions. On May 23, 1996 larvae were hatched out in an advanced stage of development as postlarvae. The postlarvae I of *Synalpheus tumidomanus* passed through II, III and IV postlarval stages within eighteen days at room temperature: 30ºC-32ºC, in filtered seawater of a salinity of 35 ppt and pH 7.9. The postlarvae are described along with illustrations for the first time to our knowledge. The comparison between successive morphological characters of postlarvae I-IV and adult are also noted in tabulated form.

KEY WORDS: Decapoda, Alpheidae, Advance developmental stages of *Synalpheus tumidomanus*.

INTRODUCTION

The genus *Synalpheus* contains approximately 115 recognized species (Chace, 1988). This genus is represented in Pakistani waters (Northern Arabian Sea) by three species: *S. tumidomanus* (Paulson, 1875) reported by Kazmi and Kazmi, (1979), *S. thai* Banner and Banner, 1966*,* reported by Kazmi and Tirmizi, (1991) and *S. coutierei* Banner, 1953 as an unpublished record by Kazmi (personal communication: F.A.S.).

S. tumidomanus is a very common species, ranging from Mediterranean coast of Israel, Red Sea and Northern Arabian Sea to South Africa, eastwards to Japan, Philippines, Indonesia, Australia and across the Pacific to the Phoenix Island; it is intertidal to 148 meters in dead coral and sponges (Chace, 1988).

To our knowledge the postlarvae of *S. tumidomanus* have not been studied before. Bhuti, *et. al.* (1977) described three zoeal stages of *S. tumidomanus* from India.

MATERIALS AND METHODS

On May 18, 1996 an ovigerous female of *Synalpheus tumidomanus* (Paulson, 1875) was collected from Buleji (Long. 66º49'E, Lat. 24º59'N). An ovigerous female was kept in unfiltered seawater of a salinity of 35 ppt under the laboratory conditions at room temperature: 30ºC-32ºC until hatching occurred. The postlarvae were directly hatched from eggs on May 23, 1996. The newly hatched postlarvae were segregated and devided among four beakers (seven in each beaker, 500 ml) filled with filtered seawater of the same salinity and temperature. Each beaker was examined daily for mortality and next developmental stage. The exuviae were preserved and the live postlarvae were transferred

to clean beakers filled with freshly filtered seawater, and at the same time offered newly hatched *Artemia* nauplii as food. Temporary slides of each stage were made using glycerin and 5% formalin (3: 1).

Measurements of each stage were made with the aid of a micrometer. The total length (TL) was determined by adding the carapace length (CL) (measured from the tip of the rostral spine to the posterior midpoint of the carapace) and abdominal length (measured from the centre of the second abdominal somite to the midposterior margin of the telson). Measurements are in millimeter (mm). The specimens were dissected through tungsten needle by using a Ogawa Seiki binocular microscope (4x10 magnification). The illustration were made with the help of Olympus BH2 microscope (magnifications 1.25 x 4, 10 and 20) with Nomarski interference contrast and *camera lucida* attachment.

The successive changes in morphological characters of I-IV postlarvae of *Synalpheus tumidomanus* (Paulson, 1875) are shown in table 1 as illustrated in figures 1-7 and the morphological characters of IV postlarvae are also compared with the characters of adult, studied by M.A. Kazmi (1972, Ph.D. thesis, unpublished).

The remaining postlarvae (Cat. No. CARI. 235) were deposited in the Marine Reference Collection and Resource Centre University of Karachi. An ovigerous female is unfortunately misplaced.

RESULTS

DESCRIPTION OF THE POSTLARVAE

Postlarva I
Size.- TL = 3.75mm.
Duration.- 6 days.

Carapace (Fig. 1A').- Carapace smooth with few minute setae, rostrum basally broad and distally pointed, reaching more than 3/4 length of distal end of first antennular article, with a single epigastric tooth (Fig. 1A); eyes stalked and very prominent free from carapace, their orbits produced into teeth.

Antennule (Fig. 1B).- Peduncle 3-segmented, basal segment largest, each segment with a few fine setae, distal segment bears endopod and exopod as a articulated flagella; inner flagellum (endopod) with 4 long plumose and few fine setae; as well as outer flagellum (exopod) with 3 aesthetascs and a few fine setae.

Antenna (Fig. 1C).- Peduncle 3-segmented, nearly equal in size, distal segment bears a segmented flagellum (endopod) with few fine setae; scaphocerite (exopod) with pointed distolateral spine, spine is shorter than the squamose portion, which bears 16 marginal plumose setae, lateral margin semi concave.

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

Maxillule (Fig. 1E).- Coxal, basial endites and endopod rudimentry.

Maxilla (Fig. 1F).- Coxal and basial endites without setae; endopod with 1 seta, scaphognathite with 17 marginal plumose setae.

Maxilliped I (Fig. 1G).- Coxopod, basipod and endopod rudimentry; exopod with 3 terminal plumose setae.

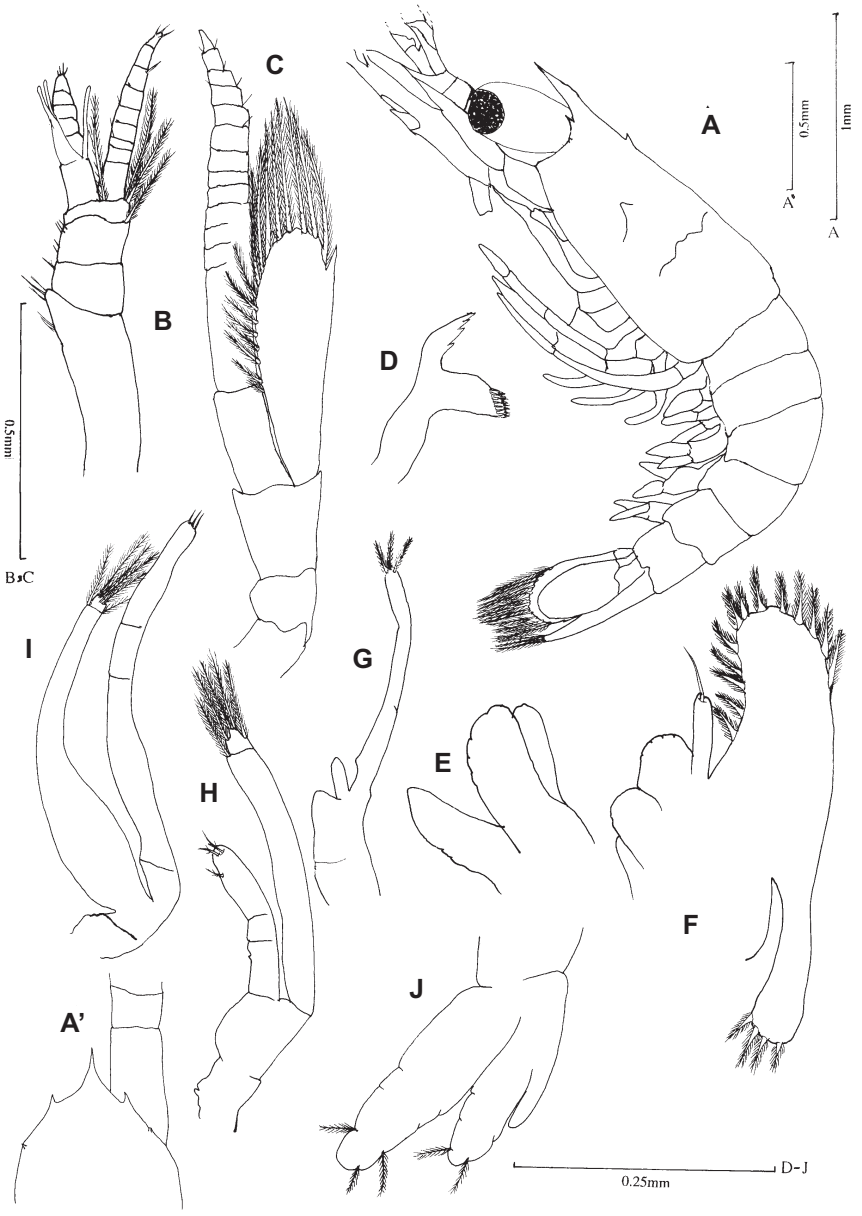

Fig. 1. *Synalpheus tumidomanus* (Paulson, 1875) postlarva I: A, lateral view; A', frontal view of carapace; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G-I, maxillipeds I-III; J, pleopod II.

Maxilliped II (Fig. 1H).- Coxopod and basipod without setae; endopod 3-segmented, distal segment with 3 plumodenticulate setae; exopod 2-segmented, proximal segment with 1 plumose seta, distal segment with 2 terminal and 2 subterminal plumose setae.

Maxilliped III (Fig. 1I).- Coxopod and basipod without setae; endopod 3-segmented, distal segment with 3 terminal simple setae; exopod 2-segmented proximal segment with 2 plumose setae, distal segment with 4 terminal plumose setae.

Pereiopods I-V (Fig. 5A-E).- Biramous pereiopod I, II chelate (Fig. 5A,B) endopod and exopod partially segmented; exopod of pereiopod I segmented and with 2, 4 plumsoe setae, exopod of pereiopod II broken; exopod of pereiopods III and IV segmented and with 2 and 3 terminal natatory plumose setae respectively.

Abdomen (Fig. 1A).- 6 somites with rounded posterolateral angles.

Pleopod (Fig. 1J).- Pleopods I-V biramous developed on each abdominal somite; exopod and endopod with 2-3 setae; appendix interna present on each pleopod.

Telson (Fig. 7A).- Posterior margin with 2 simple and 10 plumose setae; uropod (Fig. 7A) endopod with 3-4 small simple setae; exopod with 20-23 long plumose setae on their margins.

Postlarva II

Size.- TL = 3.84 mm.

Duration.- 5 days.

Carapace (Fig. 2A).- Carapace smooth except few minute setae, rostrum reaching near to distal end of first antennular segment; rostral tip bears 2 subterminal setae, eyes sessile.

Antennule (Fig. 2B).- Peduncle 3-segmented; lateral margin of basal segment produced into a blunt process (stylocerite) reaching middle of second segment of antennular peduncle, each segment of peduncle bears a few fine setae, terminal segment with exopod and endopod; endopod 14 segmented with few setae, exopod 10-segmented with 3 aesthetascs and a few fine setae.

Antenna (Fig. 2C).- Endopod several segmented with small setae; distolateral spine of scaphognathite (exopod) long and reaching middle of second antennular peduncle, mesial margin with 17 plumose setae.

Mandible (Fig. 2D).- Well-developed; endopod bud present with 1 plumose seta.

Maxillule (Fig. 2E).- Coxal endite with 11 setae; basial endite with 11 cuspidate and 9 plumodenticulate setae; endopod with 1 seta.

Maxilla (Fig. 2F).- Coxal endite without setae; basial endite bilobed with 16+15 setae; endopod with 1 seta; scaphognathite with 33 marginal plumose setae.

Maxilliped I (Fig. 2G).- Coxopod without setae; basipod with 23 plumodenticulate setae; endopod with 4 plumodenticulate setae; exopod with 4 terminal plumose and 1 lateral marginal plumodenticulate setae.

Maxilliped II (Fig. 2H).- Coxopod without setae; basipod with 2 plumodenticulate setae; endopod 5-segmented, distal segment with 33 plumodenticulate setae; exopod 2-segmented with 4 terminal plumose setae.

Maxilliped III (Fig. 2I).- Coxopod without setae; basipod with 2 setae, endopod 3-segmented each with several small plumodenticulate setae; exopod with 4 terminal

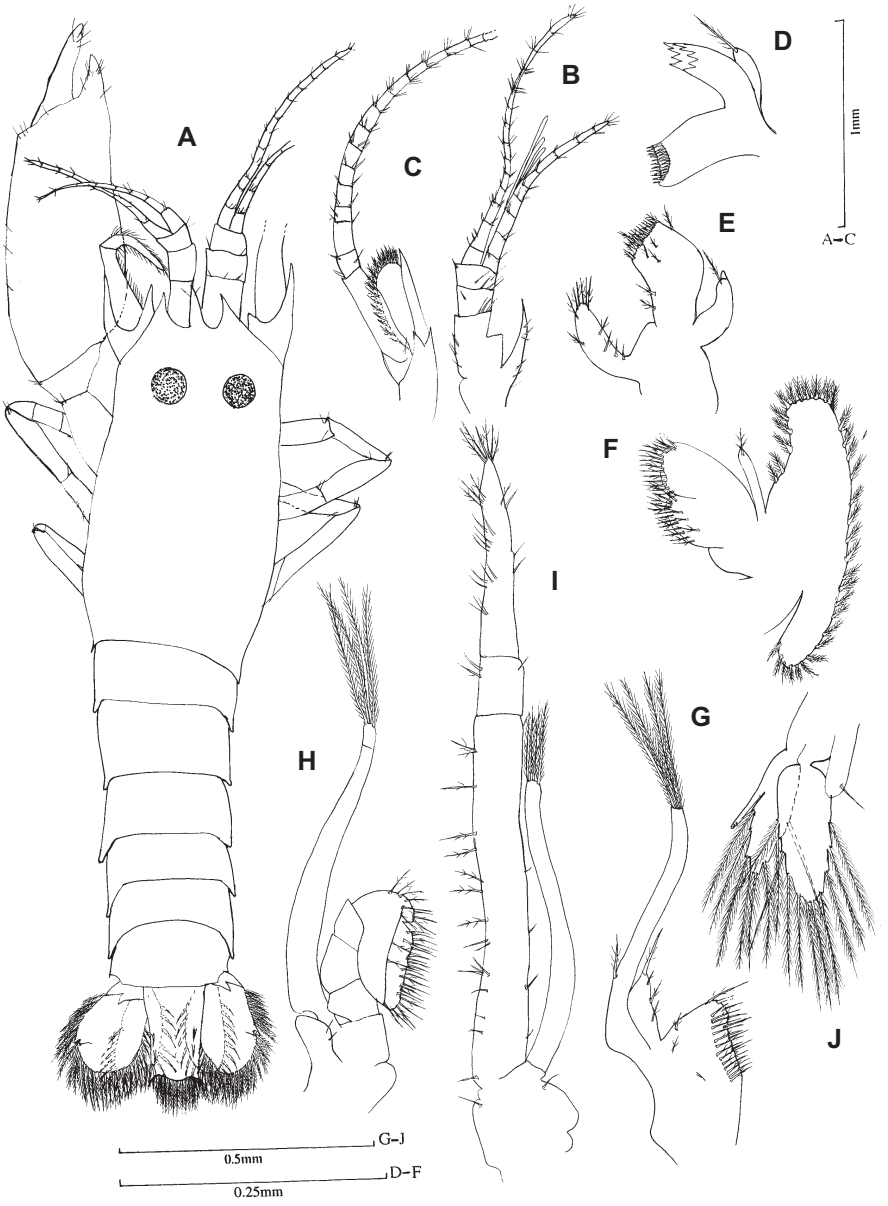

Fig. 2. *Synalpheus tumidomanus* (Paulson, 1875) postlarva II: A, dorsal view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G-I, maxillipeds I-III; J, pleopod II.

plumose setae.

Pereiopod I (Fig. 5F, left, large cheliped).- Unequal in size, large chela with broad movable finger as compared to immovable finger, pereiopods I (Fig. 5G right, small cheliped) equal in size, both fingers simillar to each other and provided with fine tufts of setae as in pereiopod I. Pereiopods II-V (Fig. 5H-K) well developed, sparsely setose; dactylus of III, IV and V pereiopods biunguiculate; superior unguis longer than inferior.

Abdomen (Fig. 2A).- Unchanged.

Pleopod (Fig. 2J).- Endopod and exopod with 8-10 plumose setae; appendix interna with 2 coupling hooks present on each endopod of pleopods.

Telson (Fig. 7B).- Dorsal surface with 2 pairs of spines, posterior margin with 2 pairs of spines and 10 long plumose setae, uropod (Fig. 7B) endopod and exopod with 30-32 and 22 long plumose setae respectively.

Postlarva III

Size.- TL = 3.88 mm.

Duration.- 7 days.

Carapace (Fig. 3A).- Unchanged.

Antennule (Fig. 3B).- No change in armature except addition of 4 aesthetascs.

Antenna (Fig. 3C).- Unchanged.

Mandible (Fig. 3D).- Unchanged.

Maxillule (Fig. 3E).- Coxal endite with 11 plumodenticulate setae; basial endite with 16 cuspidate and 7 plumodenticulate setae; endopod bilobed with 1 plumodenticulate seta.

Maxilla (Fig. 3F).- Coxal endite with 2 plumodenticulate setae; basial endite bilobed with 17+23 plumodenticulate setae; endopod with 1 terminal simple seta, scaphognathite with 33 marginal plumose setae.

Maxilliped I (Fig. 3G).- Coxopod without setae; basipod with several setae; endopod with 4 plumodenticulate setae; exopod with 4 terminal plumose and 6 lateral marginal plumodenticulate setae.

Maxilliped II (Fig. 3H).- Coxopod broken; basipod with 2 simple setae; endopod 5-segmented with several setae; exopod with 4 terminal and 2 subterminal plumose setae.

Maxilliped III (Fig. 3I).- Coxopod without setae; basipod with 1 simple seta; endopod and exopod unchanged.

Pereiopods (Fig. 6A-F).- Unchanged.

Pleopod (Fig. 3J).- Endopod and exopod with 6-10 plumose setae.

Telson (Fig. 7C).- Posterior margin with 2 pairs of spines and 10 plumose setae; uropod (Fig. 7C) unchanged.

Postlarva IV

Size.- TL = 4.45 mm.

Duration.- Died within 1 day.

Carapace (Fig. 4A).- Unchanged except slight increase in size.

Antennule (Fig. 4C).- Unchanged except 5 aesthetascs on inner flagellum.

Antenna (Fig. 4D).- Unchanged.

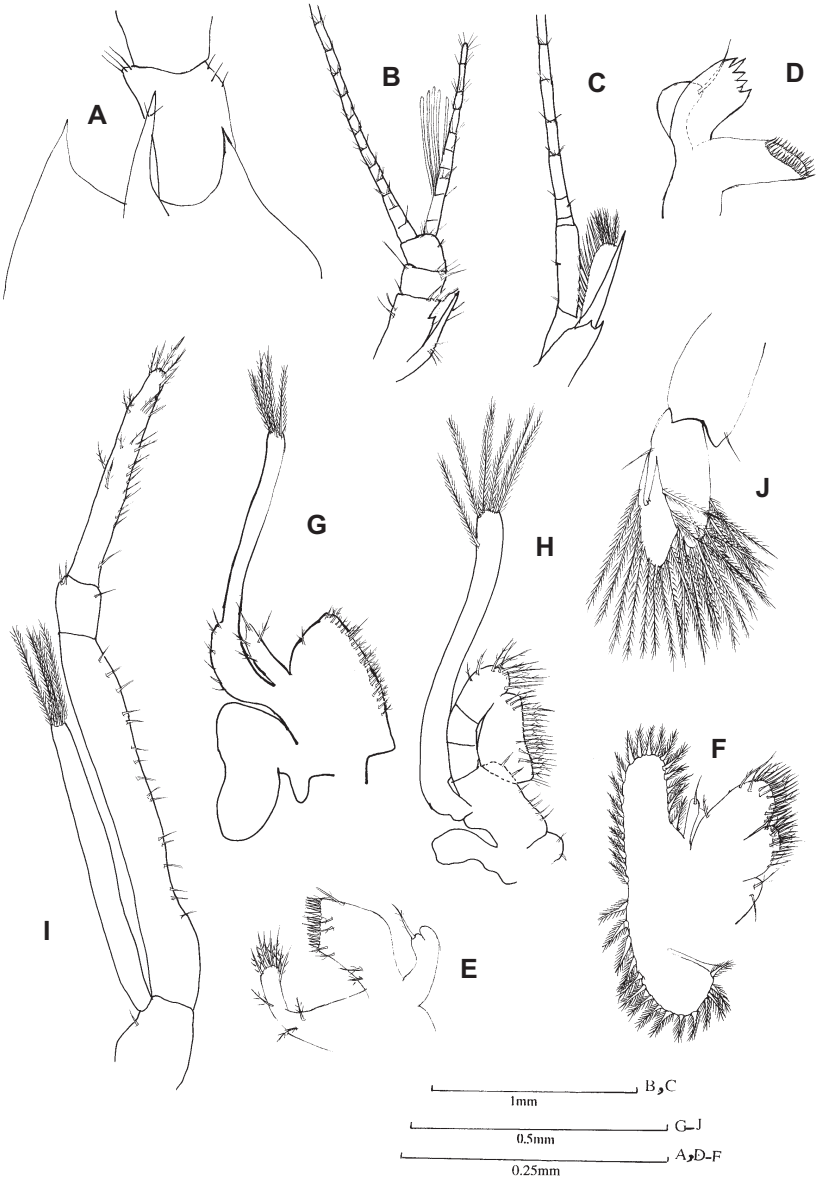

Fig. 3. *Synalpheus tumidomanus* (Paulson, 1875) postlarva III: A, frontal margin of carapace; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G-I, maxillipeds I-III; J, pleopod II.

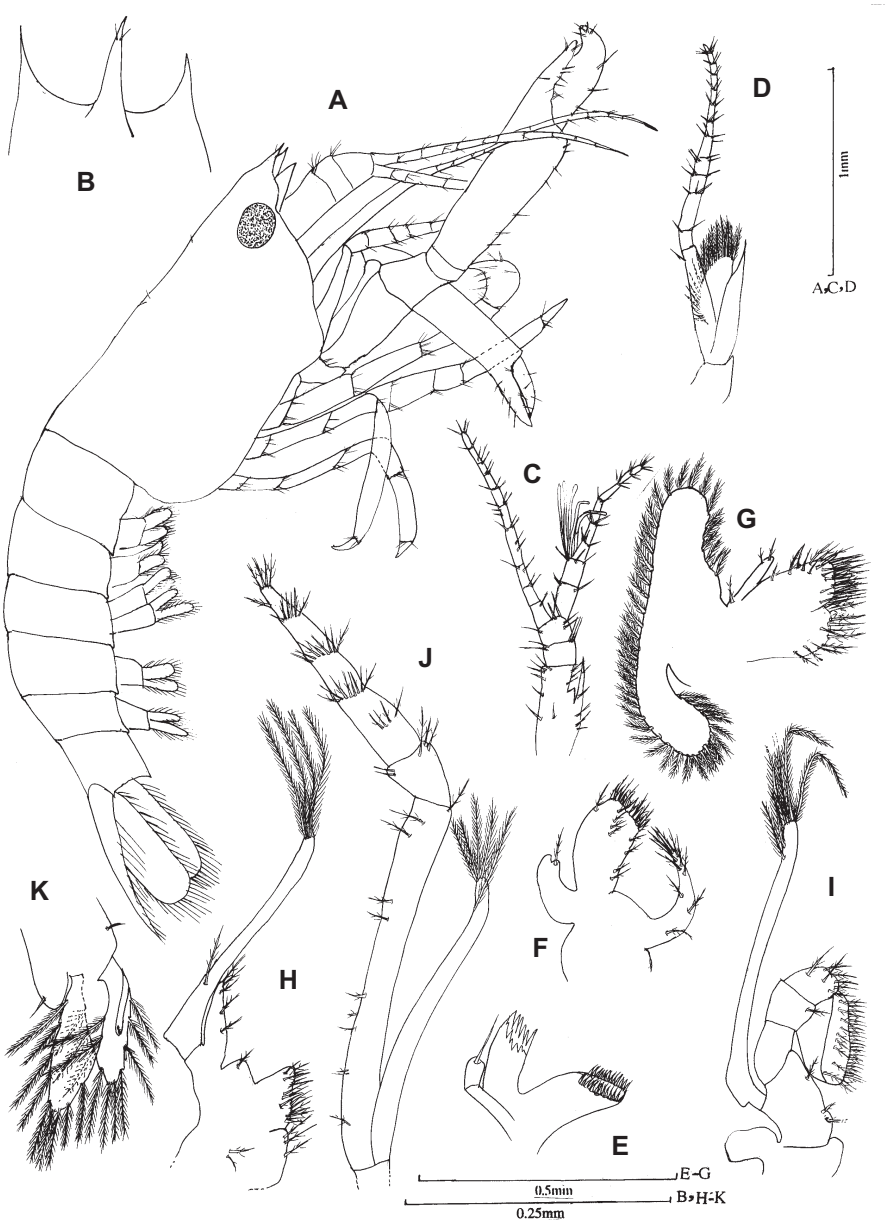

Fig. 4. *Synalpheus tumidomanus* (Paulson, 1875) postlarva IV: A, lateral view; B, frontal margin of carapace; C, antennule; D, antenna; E, mandible; F, maxilule; G, maxilla; H-J, maxillipeds I-III; K, pleopod II.

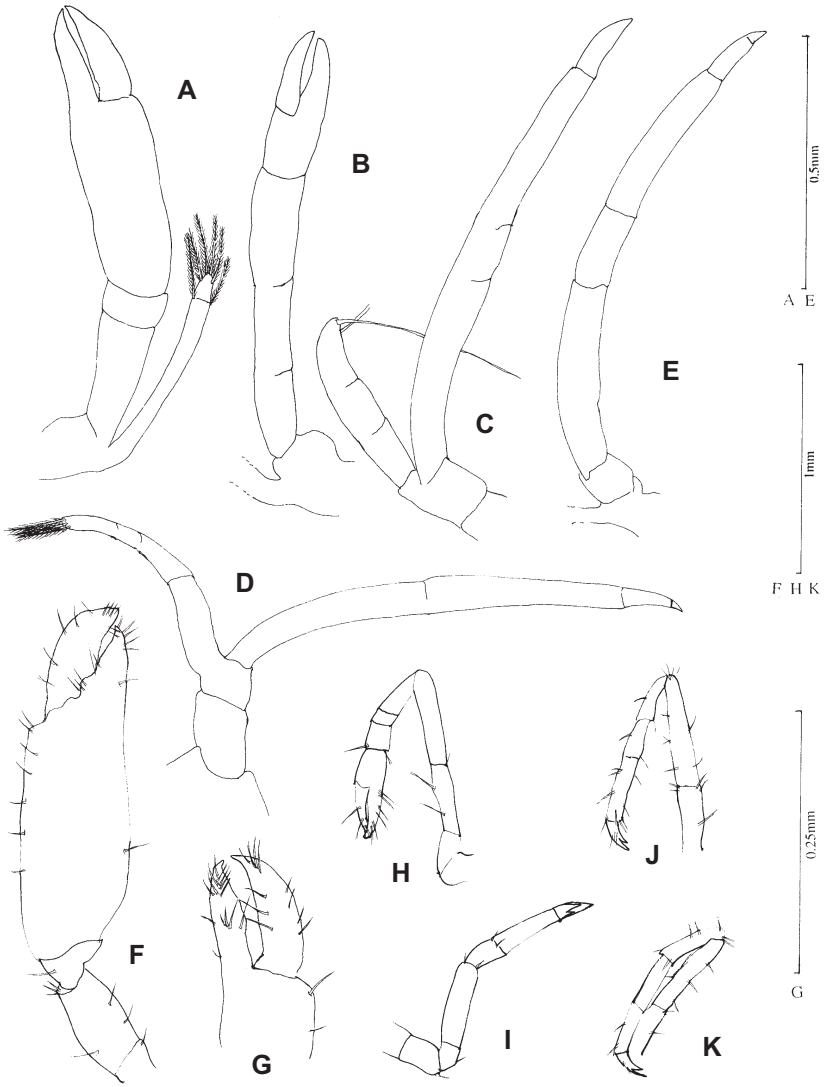

Fig. 5. *Synalpheus tumidomanus* (Paulson, 1875) postlarva I: A-E: A, first large cheliped; B-E, pereiopods II-V; postlarva II: F-K: F, first (left) large cheliped; G, first (right) small cheliped; H-K, pereiopods II-V.

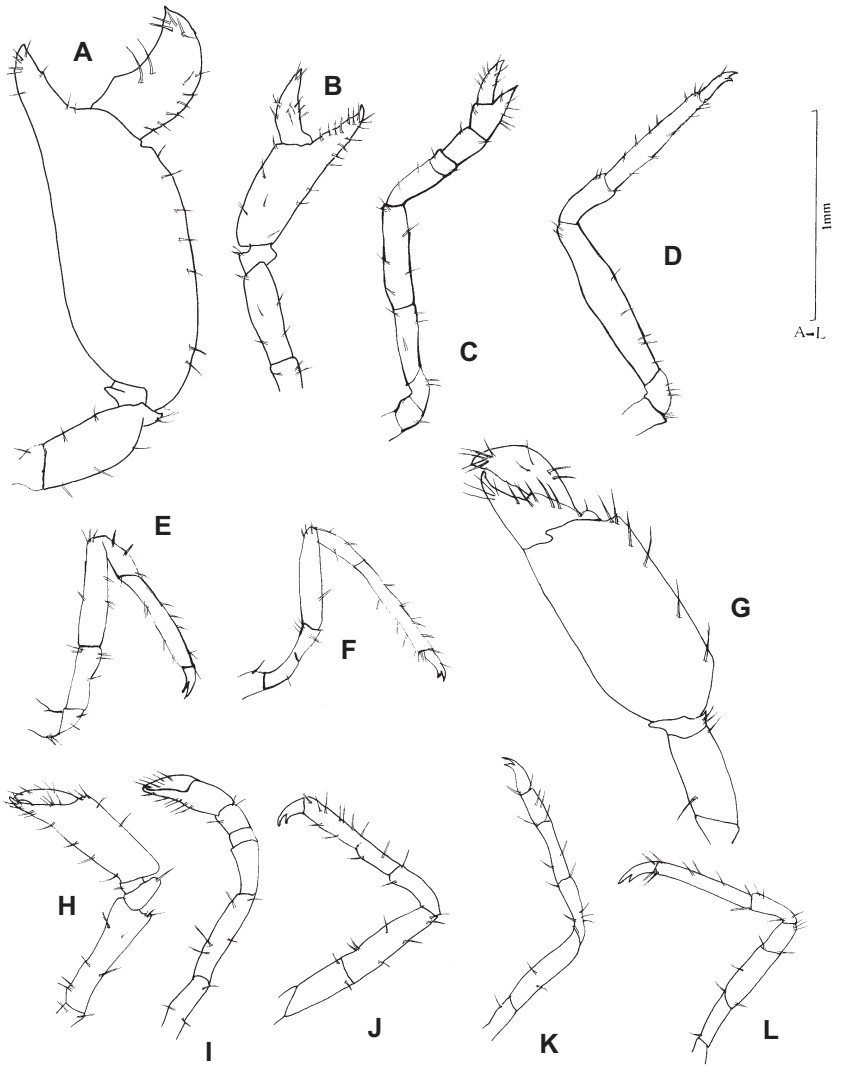

Fig. 6. *Synalpheus tumidomanus* (Paulson, 1875) postlarva III: A-F: A, first (right) large cheliped; B, first (left) small cheliped; C-F, pereiopods II-V; postlarva IV: G-K: G, first (right) large cheliped; H, first (left) small cheliped; I-L, pereiopods II-V.

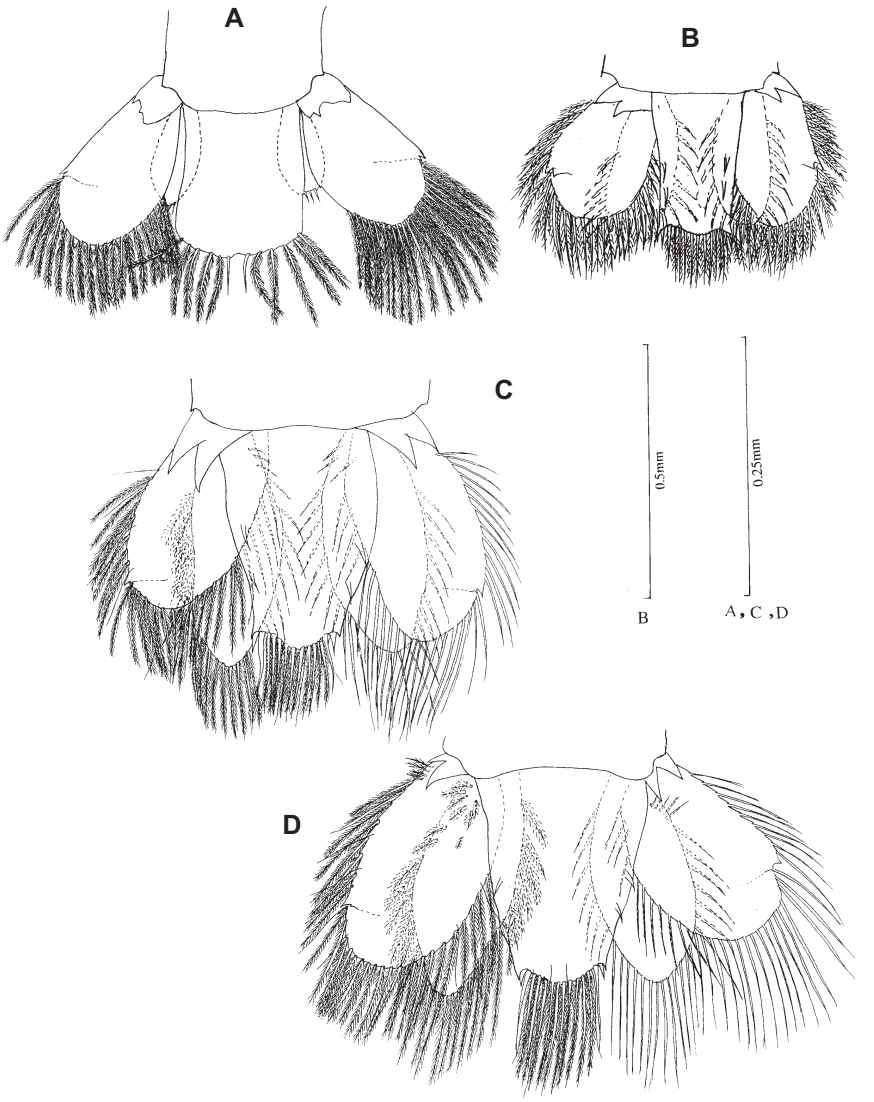

Fig. 7. *Synalpheus tumidomanus* (Paulson, 1875) postlarva I: A, telson with uropods, dorsal view; postlarva II: B, telson with uropods, dorsal view; poslarva III: C, telson with uropods, dorsal view; postlarva IV: D, telson with uropods, dorsal view.

Mandible (Fig. 4E).- Endopodal bud 2-segmented, distal segment with 1 simple seta.

Maxillule (Fig. 4F).- Coxal endite unchanged; basial endite with 9 cuspidate and 15 plumodenticulate setae; endopod bilobed with 1 terminal seta.

Maxilla (Fig. 4G).- Coxal endite broken; basial endite bilobed with 12+24 setae; endopod with 3 plumodenticulate setae; scaphognathite with 45 marginal plumose setae.

Maxilliped I (Fig. 4H).- Coxopod with 5; basipod with several and endopod with 5 plumodenticulate setae respectively; exopod with 4 terminal plumose and 1 lateral marginal plumodenticulate seta.

Maxilliped II (Fig. 4I).- Coxopod broken; basipod without setae; endopod 5-segmented with several setae; exopod unsegmented with 4 terminal and 2 subterminal plumose setae.

Maxilliped III (Fig. 4J).- Coxopod and basipod broken; endopod and exopod unchanged.

Pereiopods (Fig. 6G-L).- Unchanged.

Abdomen (Fig. 4A).- Unchanged.

Pleopod (Fig. 4K).- Endopod and exopod with 10-11 plumose setae.

Telson (Fig. 7D).- Unchanged; uropod (Fig. 7D) unchanged.

Table 1. The successive changes in morphological characters of *Synalpeus tumidomanus* (Paulson, 1875) of postlarvae I - IV.

Characters	postlarva I TL=3.750 mm	postlaeva II TL= 3.84 mm	postlarva III TL=3.88 mm	postlarva IV TL=4.45 mm
Carapace:				
rostrum:	with pointed tip	no change	no change	no change
epigastric tooth	present	absent	"	"
Eyes:	stalked	sessile	"	"
Antennule:				
aesthetascs	3	no change	5	"
setae	4	absent	"	"
Antenna:				
distolateral spine	shorter than the squamose portion	longer, reaching middle of second antennular peduncle	"	"
Mandible:				
palp	absent	present unsegmented with 1 seta	" "	present, 2-segmented with 1 seta
Maxillule:				
setae:				
coxal endite	rudimentry	11	no change	no change
basial endite	"	20	23	24
endopod	"	1	bilobed with 1 seta	no change

Table 1 Continued....

Maxilla:				
setae:				
coxal endite	"	absent	2	broken
basial endite	"	16+15	17+23	12+24
endopod	1	1	1	3
scaphognathite	17	33	no change	45
Maxilliped I:				
setae:				
coxopod	absent	no change	no change	5
basis	"	23	several	several
endopod	"	4	no change	5
exopod				
(distal setae)	3	4	"	no change
Maxilliped II:				
setae:				
coxopod	absent	no change	broken	broken
basis	"	2	no change	absent
endopod	3-segmented, with 3 setae	5-segmented with 33 setae	5-segmented with several setae	no change
exopod	2-segmented, with 5 setae	2-segmented, with 4 setae	unsegmented, with 6 setae	"
Maxilliped III:				
setae:				
coxopod	absent	no change	no change	broken
basis	absent	2	1	broken
endopod	3-segmented, with 3 setae	3-segmented, with several setae	no change	no change
exopod	2-segmented with 2,4 setae	unsegmented with 4 setae	"	"
Pereiopods I-V	exopod present	exopod absent, sparsely setose, dactylus of pereiopods III, IV and V biunguiculate	"	"
Pleopod	developed with 2 or 3 setae	8-10 setae	6-10 setae	10-11 setae
Telson	as broad as long with 10 plumose and 2 simple spinulate setae on posterior margin	as longer as wider with 2 pairs of dorsal spines, on posterior margin 10 plumose and 2 pairs of simple spinulate setae	no change	no change
Uropod:				
endopod	with 3-4 small setae	with 22 plumose setae	"	"
exopod	with 20-23 long plumose setae	with 30-32 long plumose setae	with several plumose setae	no change

CONCLUDING REMARKS

Synalpheus tumidomanus (Paulson, 1875) have been reared in the laboratory from ovigerous female to postlarvae IV. The Pakistani species show direct development as the young hatch more or less similar to its parent, as has been reported by Rabalais and Gore, 1985: 47 "....direct development occur in some marine caridean shrimps such as *Synalpheus brooksi* (Dobkin, 1965), *S. longicarpus* (Brooks and Herrick, 1892)". The postlarvae hatched from the egg resembling the adult form, although certain larval characters are retained and later lost in subsequent molts. The Indian specimens of *S. tumidomanus,* hatched in the form of larvae as studied by Bhuti, *et al* (1977) might be different from Pakistani species perhaps at the species level because the Alpheidae is infect a complex of cryptic species that's why the Indian and Pakistani developmental patterns are not exactly the same (Knowlton, 1986). Morphological comparison (table 2) between postlarva IV (present study) and the adult specimen studied by M.A. Kazmi, 1972 (Ph.D. thesis, unpublished) have shown that the aesthetascs are present on antennule in the postlarva IV, whereas they are absent in adult specimens. Otherwise it is noted that the other morphological characters of postlarva IV are very close to adult specimens except for a few setal differences, which are shown in Table 2.

Table 2. Comparison between postlarva IV of *Synalpeus tumidomanus* (Paulson, 1875) (present study) and adult specimen studied by M.A. Kazmi, (1972, Ph.D. thesis, unpublished).

Characters	**postlarva IV** present study	**Adult specimen** M.A. Kazmi, (1972)
Antennule:		
aesthetascs	5	absent
Mandible:		
palp	present, 2-segmented with 1 seta	present, 2-segmented with several setae
Maxillule:		
setae:		
coxal endite	11	33
basial endite	24	20
endopod	1	1+2
Maxilla:		
setae:		
basial endite	12+24	11+23
endopod	3	absent
scaphognathite	45	several

Table 2 Continued....

Maxilliped I:		
setae:		
endopod	5	8
exopod (distal setae)	4	several
Maxilliped II:		
setae:		
exopod	unsegmented, with 6 setae	unsegmented, with 16 setae
Pleopod	10-11 setae	several
Telson	with 2 pairs of spines and 10 plumose setae	with 1 pair of spines and 11 plumose setae

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