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

FARHANA S. GHORY, QUDDUSI B. KAZMI AND FEROZ A. SIDDIQUI

Marine Reference Collection and Resource Centre, University of Karachi, Karachi, Pakistan

Abstract

The ovigerous female of Synalpheus neptunus, captured from intertidal zone at Buleji (Karachi, Pakistan) on May 26, 1997 was kept under the laboratory conditions. The larvae were hatched out on the same day in an advance stage of development as postlarvae. The postlarvae I of Synalpheus neptunus passed through II and III postlarval stages within twenty seven days at room temperature: 30oC - 33oC, in filtered seawater of salinity of 35-37 ppt and pH 7.9. The postlarvae are described along with their illustrations. The development difference between successive morphological characters of the three postlarvae (I-III) are also given in a tabulated form and the comparison between present study with those of previously studied postlarvae of S. tumidomanus from Pakistani waters.

Introduction

Synalpheus is the one of the most diversified genera of family Alpheidae, their species are widely distributed along all the oceans (Hermoso-Salazar, *et. al.,* 2008). Approximately 115 species are commonly inhabiting in reef substrates from tropical and subtropical zones (Chace, 1988). *Synalpheus neptunus* (Dana, 1852), is the third species reported by Kazmi and Kazmi (2011) along with the existing species *S. thai* and *S. tumidomanus* in Pakistani waters. This species shows geographical variations from Thai and Philippino species. During development *Synalpheus neptunus* is behaves like some of the other species of genus *Synalpheus*, which have advance development. According to Bourdillon-Casanoua (1960) *S. laevimanus* …"hatched with all its appendages present, but the larvae passed through four zoeal stages to complete development". Which shows the abbreviated in the developmental stages (Knowlton, 1973), reported by Rabalais and Gore, 1985 : 79. Same is the case of *S. tumidomanus* their eggs hatched into postlarvae and passed through four postlarval stages before attaining juvenile stage reported by Ghory and Siddiqui, (2001).

In the present study the post larvae I-III of *S. neptunus* are illustrated and described along with a comparative note on postlarvae of species from Pakistan and India.

Materials and Methods

Ovigerous female of *Synalpheus neptunus* (Dana, 1852), was obtained from Buleji (long 66^{o} 49' 12" E, lat 24^{o} 50' 12" N) on 26 May 1997. The ovigerous female was kept in the laboratory in unfiltered seawater with a salinity of 35 ^{o}/oo and pH 7.9 at room temperature (30^{o}C). The postlarvae were directly hatched from eggs on the same day. Newly hatched larvae were segregated and placed, five larvae per beaker (500ml), containing filtered seawater of salinity 35-37 ^{o}/oo and temperature 30^{o}C-33^{o}C. *Artemia* nauplii were offered as food. Temporary slides were made by using glycerin plus 5% formalin (3:1). The specimens were dissected through tungsten needle by using a binocular microscope (Nikon) with 10 x / 21 magnifications. The illustrations were made with the help of Olympus BX51 microscope (magnifications WHN10X/22 x10, 20 and 40) with Nomarski interference contrast and *camera lucida* attachment. Measurements (millimeter = mm) of illustrated specimens were made by using stage micrometer. The total length (TL) was determined from the tip of the rostrum to the mid posterior border of the telson. The spent female and the remaining larvae were preserved and housed in Marine Reference Collection and Resource Centre, University of Karachi. (Cat. No. CARI - 248).

Results

Description of the larvae: Postlarva I:
Size.- TL = 3.39mm.
Duration.- 10 days.

Carapace (Fig. 1A).- Carapace smooth; rostrum small, slightly down-turned and does not reach the distal ends of antennule and the antennal scale. Eyes sessile.

Antennule (Fig. 1B).- 4-segmented; distal segment biramous; segment 1-3 with 5 setae + 1 spine, 2,2 setae respectively; inner ramous (endopod) segmented without setae; outer ramous (exopod) segmented with 3 aesthetascs and 7 setae.

Antenna (Fig. 1C).- 3-segmented; distal segment biramous, endopod segmented; scaphocerite (exopod0 with 1 distolateral spine and 15 marginal plumose setae.

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

Maxillule (Fig. 1E).- Coxal endite with 4 plumodenticulate setae; basial endite with 6 cuspidate and 4 plumodenticulate setae; endopod with 1 plumodenticulate seta.

Maxilla (Fig. 1F).- Coxal endite with 2 setae; basial endite bilobed with 5 +5 setae respectively; endopod with 1 seta; scaphognathite with 26 marginal plumose setae.

Maxilliped I (Fig. 1G).- Coxopod without setae; basipod bilobed with 2+4 setae respectively; endopod unsegmented without setae; exopod with 4 terminal plumose natatory setae and 3 lateral setae.

Maxilliped II (Fig. 1H).- Coxopod and basipod without setae; endopod partially segmented with 3 terminal and 4 subterminal setae; exopod with 2 terminal and 4 subterminal plumose natatory setae.

Maxilliped III (Fig. 1I).- Coxopod and basipod without setae; endopod 2-segmented with few setae; exopod with 2 terminal and 4 subterminal plumose natatory setae.

Pereiopod I-V (Figs. 2A-E).- Pereiopod I and II chelate, pereiopod III to V uniramous endopod; exopod with 2 terminal and 4 subterminal natatory plumose setae.

Abdomen (Fig. 1A).- 6-segmented.

Pleopod (Fig. 2F).- Biramous; endopod with 2 simple setae; exopod with 4 plumose setae.

Telson (Fig. 2G).- Longer than broad; posterior margin with 6 pair of long plumose setae and 1 pair of simple setae; uropod biramous; endopod with several marginal plumose setae; exopod with 2 spines and several marginal plumose setae.

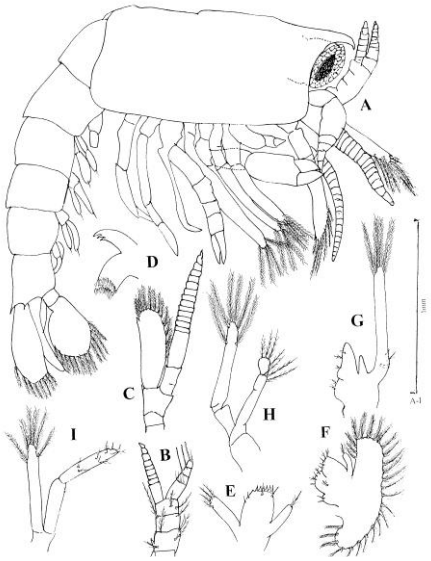

Fig. 1. ***Synalpeus neptunus.*** **Postlarva I: A, lateral view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G - I, maxillipeds I – III.**

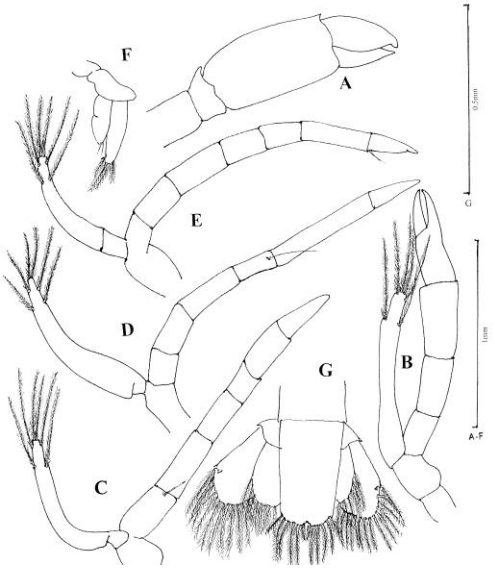

Fig. 2. ***Synalpeus neptunus.*** **Postlarva I: A -E, pereiopods I - V; F, pleopod II; G, telson, dorsal view.**

Postlarva II:
Size.- TL = 4mm.
Duration.- 15 days.

Carapace (Fig. 3A,B).- Antennal spine developed, rostrum and antennal spine with 1 pair of anterolateral setae. Eyes sessile.

Antennule (Fig. 3C).- 4-segmented; distal segment biramous; segment 1-3 with 10 setae + 1 spine, 8, and 8 setae respectively; inner ramous (endopod) segmented with fine setae; outer ramous (exopod) segmented with 3 aesthetascs and fine setae.

Antenna (Fig. 3D).- Unchanged.

Mandible (Fig. 3E).- Unchanged.

Maxillule (Fig. 3F).- Coxal endite with 5 plumodenticulate setae; basial endite with 6 cuspidate and 7 plumodenticulate setae; endopod unchanged.

Maxilla (Fig. 3G).- Coxal endite unchanged; basial endite bilobed with 11 + 11 terminal and 2 subterminal setae respectively; endopod unchanged; scaphognathite with 40 marginal plumose setae.

Maxilliped I (Fig. 4A).- Coxopod with 2 setae; basipod bilobed with 3 marginal + 1 submarginal and 12 marginal + 4 submarginal setae respectively; endopod with 5 setae; exopod with 4 terminal plumose natatory setae and 5 lateral setae.

Maxilliped II (Fig. 4B).- Coxopod broken; basipod with 2 setae; endopod 5-segmented with 7,9,3+1,2+5,2+12 setae respectively; exopod 2-segmented, proximal segment with 2 setae and distal segment with 2 terminal and 6 subterminal plumose natatory setae.

Maxilliped III (Fig. 4C).- Coxopod unchanged; basipod with 2 setae; endopod unchanged except number of setae increase; exopod with 2 terminal and 6 subterminal plumose natatory setae.

Pereiopod I-V (Figs. 4D-H).- Pereiopod I and II chelate with fine tuft of setae; dactylus of pereiopod III to V biunguiculate, superior unguis longer than inferior, sparsely setose.

Abdomen (Fig. 3A).- Unchanged.

Pleopod (Fig. 4I).- Endopod with 6 plumose setae and 2 coupling hooks; exopod with 6 plumose setae.

Telson (Fig. 4J).- Dorsal surface with 1 pair of spine and few setae; posterior margin with 2 pair of spines and 6 long plumose setae; uropod biramous; endopod with several marginal plumose setae; exopod with 2 spines and several marginal plumose setae.

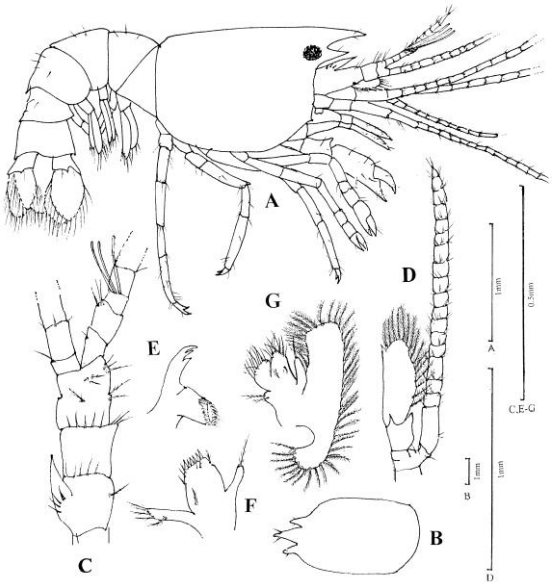

Fig. 3. ***Synalpeus neptunus.*** **Postlarva II: A, lateral view; B, dorsal view of carapace; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla.**

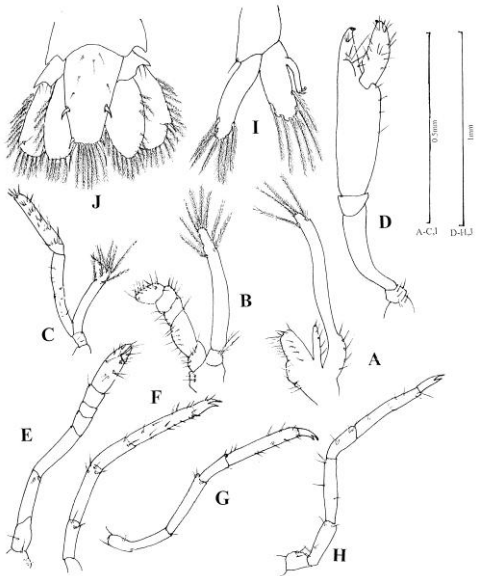

Fig. 4. ***Synalpeus neptunus.*** **Postlarva II: A - C, maxillipeds I – III; D - H, pereiopods I - V; I, pleopod II; J, telson, dorsal view.**

Postlarva III:
Size.- TL = 5mm.
Duration.- 2 days.

Carapace (Fig. 5A).- Unchanged.

Antennule (Fig. 5B).- 4-segmented; distal segment biramous; segment 1-3 with 8 setae and 1 spine, 6, and 4 setae respectively; endopod and exopod unchanged.

Antenna (Fig. 5C).- Unchanged.

Mandible (Fig. 5D).- Endopodal bud 3-segmented; segment 1 with 1 terminal seta.

Maxillule (Fig. 5E).- Coxal endite with 12 plumodenticulate setae; basial endite with 10 cuspidate and 10 plumodenticulate setae; endopod unchanged.

Maxilla (Fig. 5F).- Coxal endite with 4 setae; basial endite bilobed with 16 terminal and 1 subterminal + 16 terminal and 3 subterminal setae respectively; endopod unchanged; scaphognathite with 34 marginal plumose setae.

Maxilliped I (Fig. 6A).- Coxopod broken; basipod bilobed with 2 marginal + 2 submarginal and 19 marginal + 9 submarginal setae respectively; endopod and exopod unchanged.

Maxilliped II (Fig. 6B).- Basipod with 1 seta; endopod 5-segmented with 5,1,0,8 and 23 setae respectively; exopod unchanged.

Maxilliped III (Fig. 6C).- Basipod with 4 setae; endopod 3-segmented with several plumodenticulate setae; exopod unchanged.

Pereiopod I-V (Figs. 6D-H).- Unchanged.

Abdomen (Fig. 5A).- Unchanged.

Pleopod (Fig. 6I).- Unchanged.

Telson (Fig. 6G).- Dorsal surface with 2 pairs of spine and some simple setae; posterior margin with 2 pair of spines and 8 long plumose setae; uropod unchanged except number of setae increase.

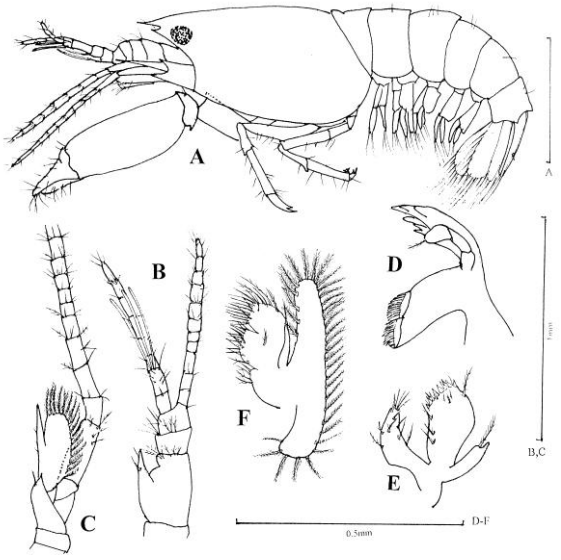

Fig. 5. ***Synalpeus neptunus*****. Postlarva III: A, lateral view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla.**

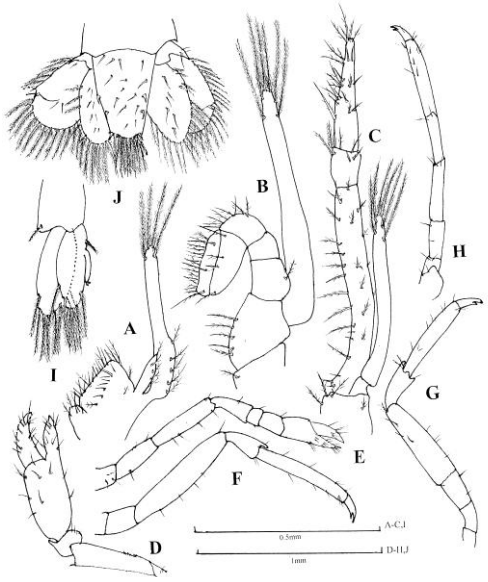

Fig. 6. ***Synalpeus neptunus.*** **Postlarva III: A - C, maxillipeds I - III; D - H, pereiopods I - V; I, pleopod II; J, telson, dorsal view.**

Table 1. The successive changes in morphological characters of *Synalpeus neptunus* (Dana, 1852) of postlarvae I - III.

Characters	Postlarva I TL= 3.39mm	Postlarva II TL= 4mm	Postlarva III TL= 5mm
Carapace:			
rostrum			
antennal spine			
Eyes:			
Antennule:			
aesthetascs			
Antenna:			
distolateral spine	shorter than the squamose portion	"	longer, reaching middle of second antennular peduncle
Mandible:			
palp	absent	"	present, 3-segmented with 1 seta
Maxillule:			
setae:			
coxal endite	4	5	12
basial endite	9	13	20
endopod	1	no change	no change
Maxilla:			
setae:			
coxal endite	2	"	4

Table 1. Continue…

endopod	1	no change	no change
scaphognathite	26	40	34
Maxilliped I:			
setae:			
coxopod	absent	2	broken
basipod	2+4	4+16	4+28
endopod	absent	5	no change
exopod (distal setae)	4	no change	no change
Maxilliped II:			
setae:			
coxopod	absent	broken	broken
basipod	"	2	1
endopod	7	41	14
exopod	6	8	8
Maxilliped III:			
setae:			
coxopod	absent	absent	broken
basipod	absent	2	4
endopod	few setae	several setae	no change
exopod	6	8	"
Pereiopods I-V:	pereiopod I and II chelate, III to V uniramous endopod	dactylus of III to V biunguiculate	"
Pleopod:	developed with2 , 4 setae	6+ 2 coupling hooks, 6	no change
Telson:	longer than broad posterior margin with 6 pair of plumose setae +1 pair spine	dorsal surface with1 pair of spine with few setae, posterior margin with 2 pairs of spine + 6 long plumose setae	dorsal surface with 2 pairs of spine with simple setae, posterior margin with 2 pairs of spine + 8 plumose setae
Uropod:			
endopod	several setae	no change	no change
exopod	several setae+2 pines	"	"

Table 2. Comparison between potlarvae I-III of *Synalpheus neptunus* (Dana, 1852) (present study) and *S. tumidomanus* (Paulson, 1875) studied by Ghory and Siddiqui, 2001.

Postlarva I:

Characters	***S. neptunus***	***S. tumidomanus***
	present study	Ghory and Siddiqui, 2001
Carapace:		
rostrum	slightly down-turned and rounded tip	straight and pointed tip
epigastric tooth	Absent	present
Maxillule:		
Setae		
coxal endite	4 setae	setae absent
basial endite	6+4 setae	"
endopod	1 seta	"
Maxilla:		
Setae		
coxal endite	2 setae	setae absent
basial endite	5 + 5 setae	"
scaphognathite	26 setae	17 setae
Maxilliped I:		
Setae		
basipod	2 + 4 setae	setae absent
exopod	4 terminal +3 lateral setae	3 terminal setae
Maxilliped II:		
Setae		

Table 2. Continue…

endopod	3 + 4 setae	3 setae
exopod	distal segment with2 terminal + 4 subterminal setae	distal segment with 2 terminal + 2 subterminal setae
Maxilliped III:		
Setae		
endopod	2-segmented	3-segmented
Telson:	6 pair of long plumose setae + 1 pair of simple setae	5 pair of long plumose setae + 1 pair of simple setae
Uropod:		
Endopod	several plumose setae	3-4 small simple setae
exopod	with 2 spines	with 1 spine

Postlarva II:

Characters	***S. neptunus***	***S. tumidomanus***
	present study	Ghory and Siddiqui, 2001
Mandible		
endopod bud	absent	present
Maxillule		
Setae		
coxal endite	5 setae	11 setae
basial endite	6 + 7 setae	11 + 9 setae
Maxilla		
Setae		
coxal endite	2 setae	setae absent
basial endite	11 + 13 setae	16 + 15 setae
scaphognathite	40 setae	33 setae
Maxilliped I		
Setae		
coxopod	2 setae	setae absent
basipod	4 + 16 setae	23 setae
endopod	5 setae	4 setae
exopod	4 terminal + 5 lateral setae	4 terminal + 1 lateral setae
Maxilliped II:		
Setae		
exopod proximal segment	8 setae	4 setae
Maxilliped III:		
Setae		
exopod	8 setae	4 setae
Telson		
dorsal surface	1 pair of spine	2 pair of spines
posterior margin	2 pair of spines + 6 long plumose setae	2 pair of spines + 10 long plumose setae

Postlarva III:

Characters	***S. neptunus***	***S. tumidomanus***
	present study	Ghory and Siddiqui, 2001
Maxillule		
Setae		
coxal endite	12 setae	11setae
basial endite	10 + 10 setae	16 + 7 setae
Maxilla		
Setae		
coxal endite	4 setae	2 setae
basial endite	17 + 19 setae	17 + 23 setae
scaphognathite	34 setae	33 setae
Maxilliped I		
Setae		
endopod	5 setae	4 setae
exopod	4 terminal + 5 lateral setae	4 terminal + 6 lateral setae

Table 2. Continue…

Maxilliped II		
Setae		
basipod	1 seta	2 setae
Maxilliped III		
Setae		
basipod	4 setae	1 seta
Telson		
posterior margin	2 pair of spines + 8 long plumose setae	2 pair of spines + 10 long plumose setae

Discussion

Synalpheus neptunus (Dana, 1852), have been reared in the laboratory from ovigerous female to postlarvae III. This species also exhibits the same behavior as observed during the development of *S. tumidomanus* (Paulson, 1875) by Ghory and Siddiqui, 2001. Their young hatch more or less in the form of the adult, possessing distinct juvenile morphology, as occur in many marine and freshwater caridean shrimps, including Alpheidae (Brooks and Herrick, 1892, Dobkin, 1965 and Rabalais and Gore, 1985).

The differences between *S. neptunus* (Present study) and *S. tumidomanus* are noted in table-2. The most prominent difference is the shape of rostrum and the absence of epigastric spine in *S. neptunus*, which helps in differentiating the postlarvae of both the species, inspite of that the setal differences are also present. The identification of the species is often very difficult from adult specimens. The larval study of the species may help in correct identification. This study will help in planktonic study of the area.

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