

Description of Leucosiidae (Crustacea: Brachyura) Larval Stages Collected from the Manora Channel, Pakistan, During 1993-1995

FARHANA SHAFIQ GHORY AND FERUZ AKHTAR SIDDIQUI

Marine Reference Collection and Resource Centre, University of Karachi, Karachi-75270, Pakistan.
farhanaghory@yahoo.com and safianadeem2001@yahoo.co.in

Abstract.- The present descriptive study is based on the brachyuran larval stages of three Leucosiidae species: *Leucosia* aff. *biannulata* (zoea I and III), *Philyra* aff. *platychira* (zoea I and III) and *Philyra* aff. *syndactyla* (megalopa). Samples were collected fortnightly during the day from the plankton in the Manora Channel, Pakistan between 1993-1995. A total thirty nine samples were collected from which 398 Leucosiidae larvae were sorted and identified. The larval stages are illustrated and described in detail. The differences between the morphological characters of larvae studied and with those previously described by other authors are noted in tabular form.

Key words: Crustacea, Brachyura, Leucosiidae, Manora Channel, *Leucosia* aff. *biannulata*, *Philyra* aff. *platychira*, *Philyra* aff. *syndactyla*.

INTRODUCTION

Twenty six species of Leucosiidae brachyuran crabs are reported in Pakistani waters, by Tirmizi and Kazmi (1996), but little is known about their larvae. A total 398 plankton caught Leucosiidae larvae were obtained from the Manora Channel, in Pakistan waters. When sorted 55 larvae were assigned to the genus *Philyra* and 343 to *Leucosia*. These larvae were tentatively identified as belonging to three species: *Leucosia* aff. *biannulata* Tyndale-Biscoe and George, 1962 (= *L. longifrons* var. *neocaledonica* Alcock, 1896), *Philyra* aff. *platychira* De Haan, 1841 and *Philyra* aff. *syndactyla* Ortmann, 1892.

The results are presented in descriptive and tabulated form including appendages illustrations. The zoeal and the megalopal morphological characters studied have been compared with previous descriptions; *Leucosia pubescens* (Miers, 1877); *L. sima* Alcock, 1896 by Hashmi (1968); *L. longifrons* Alcock, 1896; *L. obtusifrons* De Haan, 1841 and *L. anatum* (Herbst, 1783) by Terada (1979, 1984); *L. craniolaris* (Linnaeus, 1758) by Quintana (1984); *Philyra globosa* (Fabricius, 1798) studied by Chhapgar (1955), Hashmi (1969), and Krishnan and Kannupandi (1990); *P. corallicola*

0030-9923/2008/0005-0353 \$ 8.00/0

Copyright 2008 Zoological Society of Pakistan.

Alcock, 1896 by Sankolli (1961) and Hashmi (1970); *P. syndactyla* Ortmann, 1892 by Terada (1979); *P. scabriuscula* (Fabricius, 1798) by Raja Bai (1960); *P. pisum* De Haan, 1841 and *P. platychira* De Haan, 1841 by Ko (1996, 2000); *P. platychira* and *P. syndactyla* by Quintana (1986); and *Philyra* sp. by Amir (1989) (M.Phil thesis unpublished). The present material was also compared with the larvae of *P. scabriuscula* reared under laboratory conditions by the authors at Marine Reference Collection and Resource Centre (MRCC) University of Karachi.

MATERIALS AND METHODS

Plankton sampling was carried out during the day from Manora Channel (Long. 66° 59' E and Lat. 24° 48' N) at fortnightly intervals during 1993-1995. In total of 398 Leucosiidae larvae were obtained from thirty nine samples.

The samples were collected from two stations 'A and B' 5 kilometers apart and obtained during 10 minutes tows using Bongo net of 300 micron mesh size, equipped with a flow meter. AI (surface sample), AII (subsurface sample), BI (subsurface sample), BII (surface sample) at shallow depth 15'-20'. Air temperature 22–31°C, water temperature

20-30°C, pH 7.0 and salinity 35-36 ppt were recorded.

The samples were preserved in 5% formalin. Brachyuran larvae were sorted out from the samples under a binocular microscope "Ogawa Seiki (4 x 10 magnification)" and transferred into 70% alcohol. Temporary slides were prepared using glycerin plus 5% formalin in a ratio of 3:1. These larvae to species level were identified by comparison with the laboratory reared material of known species and available literature. The specimens were dissected under high magnification (WF 10 x 4.5) using a Ogawa Seiki dissecting microscope and tungsten needles. An Olympus BH2 microscope of high magnification (1.25 x 4, 10, 20 and 40) with Nomarski interference contrast, a micrometer and a camera lucida attachment was used for illustrations.. Measurements of each stage were reported to the nearest 0.01mm. The total length (TL) was determined by adding the carapace length (CL) measured from the tip of the rostral spine to the posterior mid point of the carapace, to the pleon length, the center of the second pleon somite to the mid posterior margin of the telson. Setal count of maxilla and maxillipeds have been made from proximal to distal segment respectively.

The larvae were deposited in the MRCC, University of Karachi.

RESULTS

Leucosia aff. *biannulata* Tyndale-Biscoe and George, 1962

Zoea I (Fig. 1A- J)

Materials and measurements

Station AI (surface sample), 95 specimens; Station AII (subsurface sample), 47 specimens; Station BI (subsurface sample), 40 specimens; and Station BII (surface sample), 61 specimens.

Total

243 specimens.

Size

CL, 1.20-1.27 mm; TL, 1.81-1.82 mm (100 specimens examined).

Carapace (Fig. 1A, B)

Rostral and dorsal spines long lateral spines small; one pair of posterodorsal setae present; posterolateral marginal setae not seen; eyes sessile.

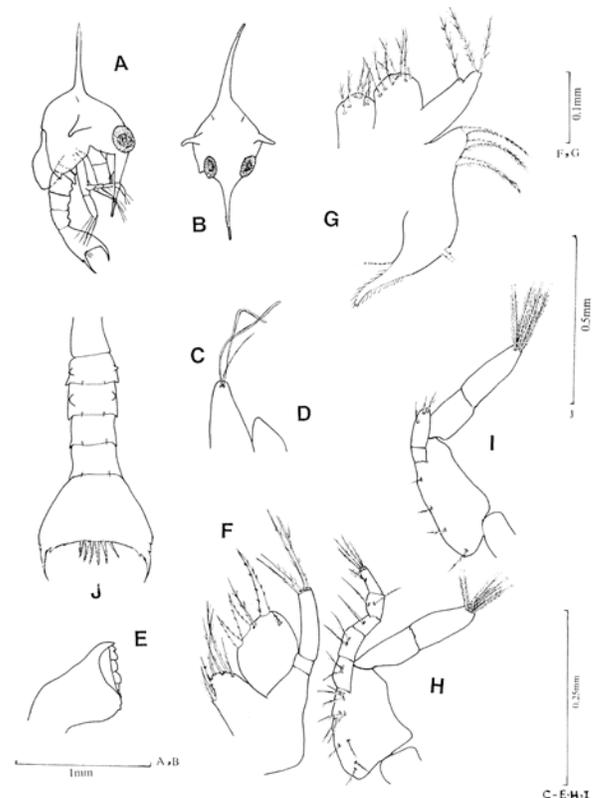


Fig. 1. *Leucosia* aff. *biannulata*. Zoea I: A, lateral view; B, anterior view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, first maxilliped; I, second maxilliped; J, pleon with telson, dorsal view.

Antennule (Fig. 1C)

Uniramous with 2 terminal aesthetascs and 1 seta.

Antenna (Fig. 1D)

Uniramous, small bulbous structure without setae; exopod absent.

Mandible (Fig. 1E)

With well developed incisor and molar processes; palp absent.

Maxillule (Fig. 1F)

Coxal endite with 6 plumodenticulate setae; basal endite with 3 cuspidate and 2 plumodenticulate setae; endopod 2-segmented distal segment with 4 terminal plumodenticulate setae; exopod seta absent.

Maxilla (Fig. 1G)

Coxal endite with 6 plumodenticulate setae; basal endite with 8 plumodenticulate setae; endopod bilobed with 2 terminal +1 subterminal plumodenticulate setae; exopod (scaphognathite) with 4 (one damaged) plumose marginal setae and 1 long, stout plumose posterior process.

First maxilliped (Fig. 1H)

Coxa without setae; basis with 10 plumodenticulate setae arranged 2,2,3,3 on medial margin; endopod 5-segmented with 2,2,1,2,5 (1 subterminal + 4 terminal) plumodenticulate setae; exopod 2-segmented, distal segment with 4 long terminal plumose natatory setae.

Second maxilliped (Fig. 1I)

Coxa without setae; basis with 4 plumodenticulate setae on medial margin; endopod 2-segmented, distal segment with 3 subterminal plumodenticulate setae; exopod 2-segmented, distal segment with 4 long terminal plumose natatory setae.

Third maxilliped absent.

Pereiopods absent.

Pleon (Fig. 1J)

Five somites; somites 2 and 3 each with 1 pair of small dorsolateral processes and with slightly produced posterolateral angles, somites 2-5 with paired posterodorsal setae; pleopods absent.

Telson (Fig. 1J)

Broad; posterolateral angles each with 2 minute and 1 long spine; posterior margin slightly concave with 1 minute lateral spines and 3 pairs of spinulose setae centrally.

Zoea III (Fig. 2A-P)

Materials and measurements

Station AI (surface sample), 15 specimens;

Station AII (subsurface sample), 4 specimens; Station BI (subsurface sample), 42 specimens; and Station BII (surface sample) 37 specimens.

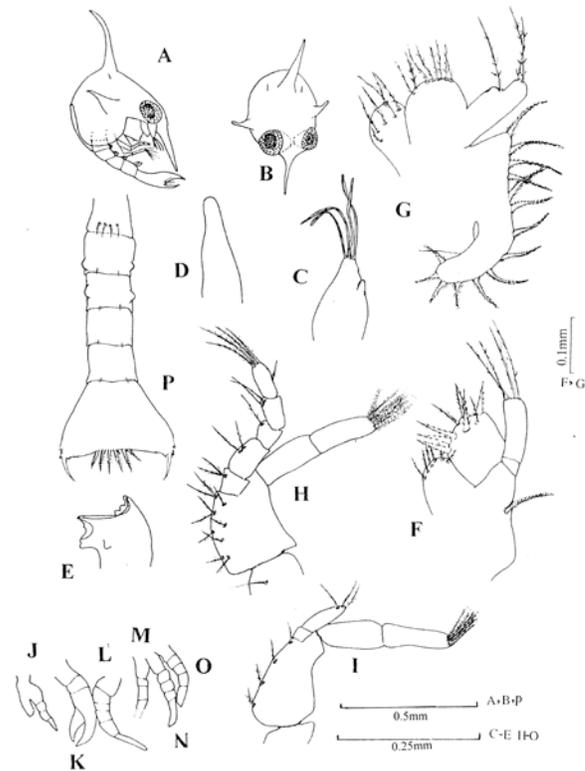


Fig. 2. *Leucosia* aff. *biannulata*. Zoea III: A, lateral view; B, anterior view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, first maxilliped; I, second maxilliped; J, third maxilliped; K-O, pereopods I-V; P, pleon with telson, dorsal view.

Total

98 specimens.

Size

CL, 1.37-1.89mm; TL, 1.51-2.91mm (50 specimens examined).

Carapace (Fig. 2A,B)

Slight increase in size; one pair of posterodorsal setae present; anterodorsal and posterolateral marginal setae not seen; eyes stalked, otherwise unchanged.

Antennule (Fig. 2C)

Biramous with 4 terminal aesthetascs;

endopod rudimentary.

Antenna (Fig. 2D)

Increase in size, otherwise unchanged.

Mandible (Fig. 2E)

Mandibular palp present.

Maxillule (Fig. 2F)

Coxal endite and endopod unchanged except, basis with 6 cuspidate and 2 plumodenticulate setae; exopod plumose seta present.

Maxilla (Fig. 2G)

Exopod (scaphognathite) with 14-15 plumose marginal setae, otherwise unchanged.

First maxilliped (Fig. 2H)

Coxa with 1 seta; basis with 10 plumodenticulate setae arranged 2,2,3,3 on medial margin; endopod 5-segmented with 2,2,1,2,5 (1 subterminal + 4 terminal) plumodenticulate setae; exopod with 6 terminal plumose natatory setae.

Second maxilliped (Fig. 2I)

Exopod 2-segmented, distal segment with 6 long terminal plumose natatory setae.

Third maxilliped (Fig. 2J)

Biramous; rudimentary.

Pereiopods I-V (Fig. 2K-O)

Rudimentary, chela bilobed.

Pleon (Fig. 2P)

Somite 2-5 with biramous rudimentary pleopods; somite 1 with 2 pairs of posterodorsal setae, somites 2-5 with paired posterodorsal setae.

Telson (Fig. 2P)

Unchanged.

Philyra aff. *platychira* De Haan, 1841

Zoea I (Fig. 3A-J)

Materials and measurements

Station AI (surface sample), 11 specimens;
Station AII (subsurface sample), 25 specimens;
Station BI (subsurface sample), 2 specimens;

Station BII (surface sample), and 11 specimens.

Total

49 specimens.

Size

CL, 0.76-0.87mm, TL, 1.14-1.37mm (30 specimens examined).

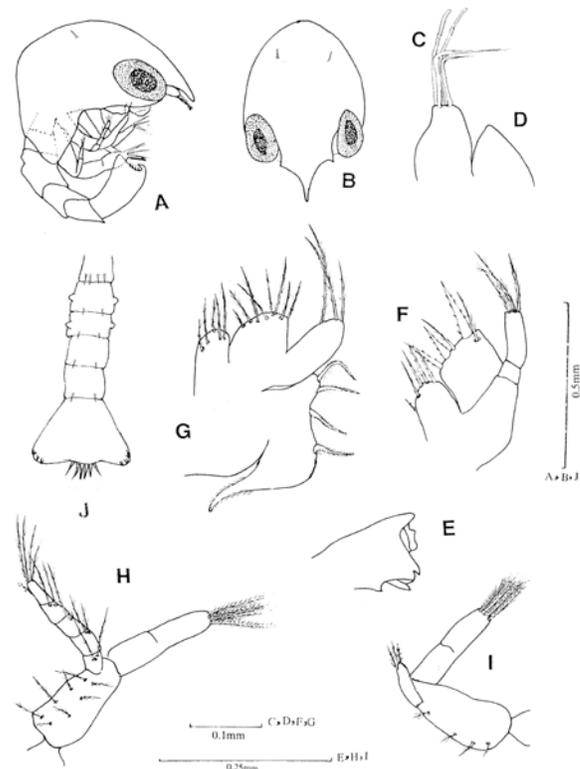


Fig. 3. *Philyra* aff. *platychira*. Zoea I: A, lateral view; B, anterior view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, first maxilliped; I, second maxilliped; J, pleon with telson, dorsal view.

Carapace (Fig. 3A, B)

Globular and pubescent; rostral spine small; dorsal and lateral spines absent; one pair of posterodorsal setae present; posterolateral marginal setae not seen; eyes sessile.

Antennule (Fig. 3C)

Uniramous with 2 terminal aesthetascs and 2 setae.

Antenna (Fig. 3D)

Uniramous, small, conical and bulbous structure devoid of setae; exopod absent.

Mandible (Fig. 3E)

With well developed incisor and molar processes; palp absent.

Maxillule (Fig. 3F)

Coxal endite with 5 plumodenticulate setae; basal endite with 3 cuspidate and 2 plumodenticulate setae, endopod 2-segmented distal segment with 4 terminal plumodenticulate setae, exopod seta absent.

Maxilla (Fig. 3G)

Coxal endite with 5 plumodenticulate setae; basal endite with 8 plumodenticulate setae and endopod with 3 plumodenticulate setae; exopod (scaphognathite) with 4 plumose marginal setae and 1 long, stout plumose posterior process.

First maxilliped (Fig. 3H)

Coxa without setae; basis with 8 plumodenticulate setae arranged 2,2,2,2 on medial margin; endopod 5-segmented with 2,2,1,2,5 (1 subterminal + 4 terminal) plumodenticulate setae; exopod 2-segmented, distal segment with 4 long terminal plumose natatory setae.

Second maxilliped (Fig. 3I)

Coxa without setae; basis with 4 plumodenticulate setae on medial margin; endopod unsegmented, distally with 3 terminal plumodenticulate setae, exopod 2-segmented, distally with 4 long terminal plumose natatory setae.

Third maxilliped absent.

Pereiopods absent.

Pleon (Fig. 3J)

Five somites; somite 2 and 3 each with 1 pair of small dorsolateral process; somites 1-5 each with simple posterolateral angles; somite 1 with 2 pairs of dorsomedian setae, somites 2-5 with paired posterodorsal setae.

Telson (Fig. 3J)

Triangular; posterolateral angles of either side with 3 spines; mid-posterior margin with 6 spinulose setae.

*Zoea III (Fig. 4A-P)**Materials and measurements*

Station AI (surface sample), 3 specimens; Station AII (subsurface sample), 2 specimens; Station BI (subsurface sample), Nil; and Station BII (surface sample), 1 specimen.

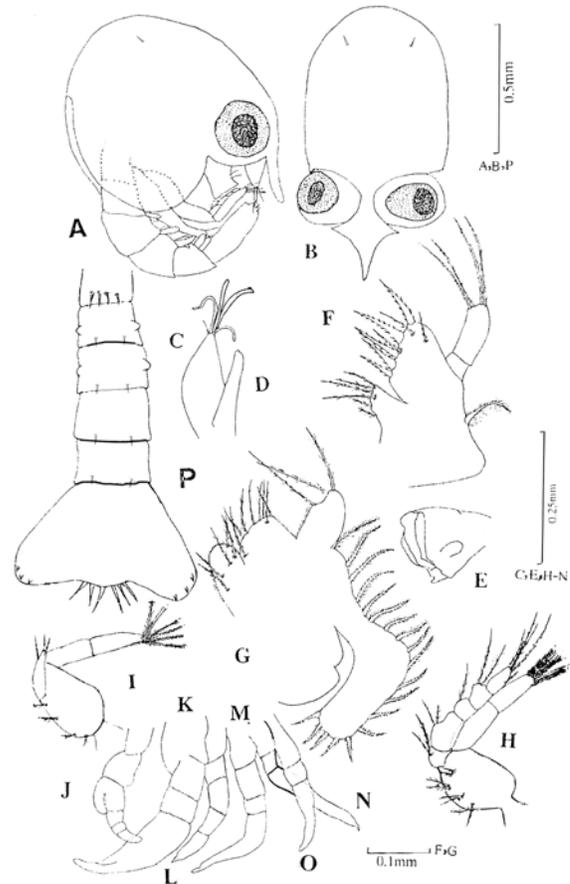


Fig. 4. *Philyra* aff. *platychira*. Zoea III: A, lateral view; B, anterior view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, first maxilliped; I, second maxilliped; J, third maxilliped; K-O, pereiopods I-V; P, pleon with telson, dorsal view.

Total

6 specimens.

Size

CL, 1.12-1.52 mm; TL, 1.99-2.09mm (6 specimens examined).

Carapace (Fig. 4A, B)

Slight increase in size from previous stage; one pair of posterodorsal setae present; anterodorsal and posterolateral marginal setae are not seen; eyes stalked, otherwise unchanged.

Antennule (Fig. 4C)

Uniramous with 4 terminal aesthetascs and 1 seta.

Antenna (Fig. 4D)

Uniramous, now cylindrical in shape, otherwise unchanged.

Mandible (Fig. 4E)

Mandibular palp present.

Maxillule (Fig. 4F)

Coxal endite with 6 plumodenticulate setae; basal endite with 5 cuspidate setae and 3 plumodenticulate setae; exopod with 1 plumose seta, otherwise unchanged.

Maxilla (Fig. 4G)

Exopod (scaphognathite) with 19 marginal plumodenticulate setae, otherwise unchanged.

First maxilliped (Fig. 4H)

Exopod 2-segmented distal segment with 6 long terminal plumose natatory setae, otherwise unchanged.

Second maxilliped (Fig. 4I)

Exopod 2-segmented distal segment with 6 long terminal plumose natatory setae, otherwise unchanged.

Third maxilliped (Fig. 4J)

Biramous; rudimentary.

Pereiopods I-V (Fig. 4K- O)

Rudimentary, chela bilobed.

Pleon (Fig. 4P)

Somite 2-5 with biramous rudimentary

pleopods; somite 1 with 2 pairs of posterodorsal setae, somites 2-5 with paired posterodorsal setae.

Telson (Fig. 4P)

Unchanged.

Philyra aff. syndactyla Ortmann, 1892

Megalopa (Fig. 5A-L)

Material and measurement

Station AII (subsurface sample), 1 specimen.

Size

CL, 1.37 mm; TL, 1.99mm. Single specimen.

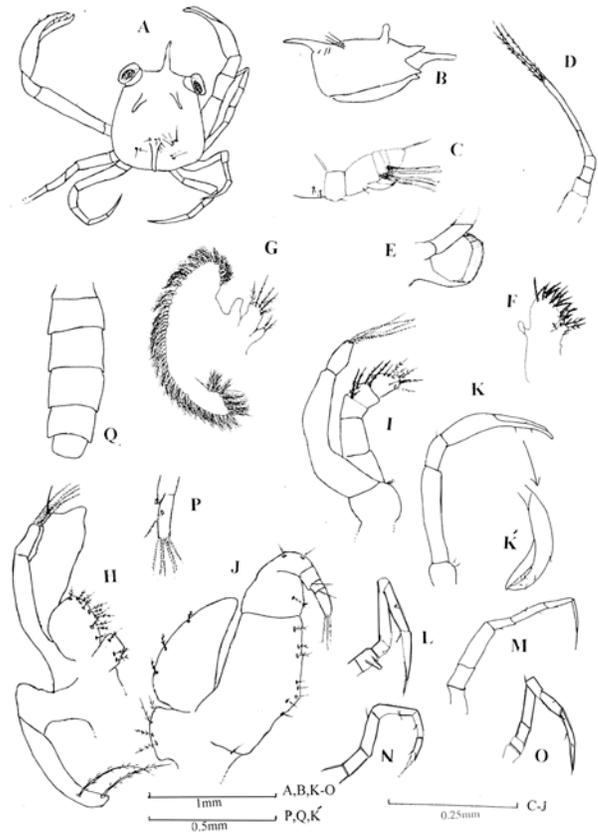


Fig. 5. *Philyra aff. syndactyla*. Megalopa: A, dorsal view; B, lateral view of carapace; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, first maxilliped; I, second maxilliped; J, third maxilliped; K-O, pereiopods I-V; K', dactylus of chela, enlarged; P, pleopod IV; Q, pleon with telson, dorsal view.

Carapace (Fig. 5A, B)

Carapace oblong; rostral spine long, with rounded tip; dorsal surface with 1 pair of large anterodorsal spines and a single posterodorsal spine, with few setae; eyes stalked and prominent.

Antennule (Fig. 5C)

Peduncle 3-segmented with 2,1,1 very small setae; endopod unsegmented with 1 small terminal seta; exopod 3-segmented, segments 1 and 2 with 2 and 3 subterminal aesthetascs respectively and segment 3 with 1 terminal seta.

Antenna (Fig. 5D)

2-segmented peduncle without setae; 4-segmented flagellum; ultimate segment with 3 terminal plumodenticulate setae.

Mandible (Fig. 5E)

Well developed, palp broken.

Maxillule (Fig. 5F)

Coxal endite with 7 plumodenticulate setae; basal endite with 5 cuspidate and 8 plumodenticulate setae; endopod unsegmented and very much reduced, without setae.

Maxilla (Fig. 5G)

Coxal and basal endites uniramous, coxal endite with 2 plumodenticulate setae and basal endite with 5 plumodenticulate setae; endopod simple; exopod (scaphognathite) with 41 marginal plumose setae.

First maxilliped (Fig. 5H)

Epipod with 2 long setae; coxal endite with 3 plumodenticulate setae and basal endite with 12 plumodenticulate setae; endopod with 1 seta; exopod 2-segmented, distal segment with 4 terminal plumose natatory setae.

Second maxilliped (Fig. 5I)

Epipod and coxa broken; basis with 1 tiny plumodenticulate seta; endopod 5-segmented; ischium and merus without setae, carpus with 1 seta, propodus with 3 plumodenticulate setae and dactylus with 5 cuspidate and 2 plumodenticulate setae; exopod 2-segmented; distal segment with 4 terminal plumose natatory setae.

Third maxilliped (Fig. 5J)

Epipod and coxa broken; basis with 5 plumodenticulate setae; ischium broad and with 8 plumodenticulate setae; merus with 3 plumodenticulate setae; carpus and propodus each with 1 plumodenticulate seta; dactylus with 3 terminal plumodenticulate setae; exopod broad unsegmented, with 3 plumodenticulate setae laterally.

Pereiopods (Fig. 5K- O)

I-V pereiopods developed and sparsely covered with setae; pereiopod I chelate and ischium of pereiopod II with a single prominent blunt spine.

Pleon (Fig. 5Q)

Five somites with simple posterolateral angles. Somites 2-5 each with pair of biramous pleopods; pleopod 4 (Fig. 5P) endopod unsegmented with 2 subterminal hooks on medial internal margin; exopod unsegmented; pleopods 1-4 with 6-7 long marginal plumose natatory setae; posterodorsal setae on somite 1-5 are not seen.

Telson (Fig. 5Q)

Broader than long, simple and smooth, setae not seen.

REMARKS

The morphological characters described for zoea I of *Leucosia* aff. *biannulata* in the present study are compared with those of four *Leucosia* species (Table I) and shows a greater overall resemblance to that of *L. longifrons* = *L. biannulata* and also *L. obtusifrons* studied by Terada (1979 and 1984, respectively). The zoea III (present study) is compared with those of five leucosid species (Table I) and zoea III is also similar to both the above species as noted in zoea I. However, there are a few morphological differences between the other species, worth noting including the numbers of aesthetascs and setae of antennule and the absence of posterodorsal setae on pleon somite-1 as they are 4 in our material, but in case of *L. craniolaris* (studied by Quintana, 1984) they are 5. Our material is also different from *L. anatum* (studied by Terada, 1979) as shown in Table II. The zoea I and III of *L. pubescens* and *L. sima* studied by Hashmi (1968),

have no carapace spines, which are present in zoea I and III of *L. aff. biannulata* and also have setal differences as noted in Tables I and II.

According to Ko (2000) the zoeae of genus *Philyra* can be easily separated from the other

Table I.- Morphological differences between the plankton caught zoea I of *Leucosia aff. biannulata*, *Leucosia longifrons* = *L. biannulata*, *Leucosia obtusifrons*, *Leucosia pubescens*, *Leucosia sima*.

Characters: Zoea I	<i>L. aff. biannulata</i> Present study	<i>L. biannulata</i> as <i>L. longifrons</i> (Terada, 1979)	<i>L. obtusifrons</i> (Terada, 1984)	<i>L. pubescens</i> (Hashmi, 1968)	<i>L. sima</i> (Hashmi, 1968)
Carapace spines					
rostral	+	+	+	+	+
lateral	+	+	+	- or small	-
dorsal	+	+	+	-	-
Antennule					
aesthetascs	2	2	2	3	2
setae	1	2	1	-	1
Maxillule					
setae endopod	2+2	2+2	2+2	2+2	2+2
Maxilla					
setae endopod	2+1	2+1	2+1	2+1	2+1
Telson					
outer spine	4	4	4	3	3

Table II.- Morphological differences between the plankton caught zoea III of *Leucosia aff. biannulata*, *Leucosia longifrons* = *L. biannulata*, *Leucosia obtusifrons*, *Leucosia sima*, *Leucosia craniolaris* and *L. anatum*.

Characters: Zoea III	<i>L. aff. biannulata</i> Present study	<i>L. biannulata</i> as <i>L. longifrons</i> (Terada, 1979)	<i>L. obtusifrons</i> (Terada, 1984)	<i>L. sima</i> (Hashmi, 1968))	<i>L. craniolaris</i> (Quintana, 1984)	<i>L. anatum</i> (Terada, 1979)
Carapace spines						
rostral	+	+	+	+	+	+
lateral	+	+	+	knob	+	ND
dorsal	+	+	+	-	+	+
Antennule						
aesthetascs	4	3	3	4	3	3
setae	-	-	2	2	2	-
Antenna	uniramous	uniramous	uniramous	biramous	uniramous	ND
Maxillule						
setae endopod	4	4	4	4	4	4
Maxilla						
setae endopod	2+1	2+1	2+1	2+1	2+1	2+1
Pleonal						
Posterodorsal setae on somite 1	4	-	-	ND	5	ND
Telson						

outer spine 4 4 4 3 4 ND

ND, no data; +, present; -, absent.

Table III.- Morphological differences between the plankton caught zoea I of *Philyra* aff. *Platychira* (1, Present study), *P. platychira* (2, Ko, 2000), *P. pisum* (3, Ko, 1996), *P. globosa* (4, Hashmi, 1969; 5, Chhapgar, 1955; 6, Krishnan and Kannupandi, 1990), *P. corallicola* (7, Hashmi, 1970; 8, Sankolli, 1961), *P. syndactyla* (9, Terada, 1979), and *P. scabriuscula* (10, Rajabai, 1960; 11, Lab.).

Characters Zoea I	1	2	3	4	5	6	7	8	9	10	11
Carapace spines											
rostral	+	+	+	+	+	-	+	+	+	+	+
lateral	-	-(s)	-	+	+	-	+	-	-	-	-
dorsal	-	-	-	+	+	+	+	+	+	+	+
Antennule											
aesthetascs	2	4	ND	2	3	4	2	3	2	4	2
setae	2	1	ND	1	-	-	2	-	2	-	2
Antenna	bulbous	bulbous	ND	stout	bulbous	stout	stout	stout	ND	stout	stout
Maxillule											
setae coxal	5	5	5	5	4	5	6	5	6	6	4
endite											
basial endite	5	5	5	5	6	4	5	5	5	5	4
endopod	2+2	2+2	2+2	2+2	2+1	2+2	2+2	2+1	2+2	2	2+2
Maxilla											
setae coxal	5	5	5	5	5	ND	5	5	5	ND	5
endite											
basial endite	8	8	8	8	8	ND	5	7	8	ND	6
endopod	2+1	2+1	2+1	2+1	ND	2+1	2+2	2+1	2+1	2+1	2+1
scaphognathite	4	4	ND	3	ND	3	4	3	6	3	4
Maxilliped I											
setae basis	8	8	ND	7	4	10	7	6	8	3	8
Maxilliped II											
setae basis	4	4	ND	4	-	4	5	-	4	-	4
endopod	3	3	ND	3	2	1	3	3	3	3	3
Telson											
outer spine	3	3	3	3	-	-	2	3	4	3	3

Table IV.- Morphological differences between the plankton caught zoea III of *Philyra* aff. *platychira*, *P. platychira*, *P. syndactyla* and *P. pisum*.

Characters: Zoea III	<i>P. aff. platychira</i> Present study	<i>P. platychira</i> (Quintana, 1986)	<i>P. platychira</i> (Ko, 2000)	<i>P. syndactyla</i> (Terada, 1979)	<i>P. pisum</i> (Terada, 1979)
Carapace spines					
lateral	-	-	+	-	-
Antennule					
aesthetascs	4	4	6	3	3
setae	1	3	1	-	1
Maxillule					
scaphognathite	19	23	22	17-19	9
Pleonal					
Posterodorsal	4	3	3	-	3

megalopa of *Philyra syndactyla* described by Quintana (1986) except for a few setal differences in the exopod (scaphognathite) of maxilla; coax, basis and epipodal setae of maxilliped I; and the number of setae on the propodus and dactylus of maxilliped II as shown in Table V.

ACKNOWLEDGEMENTS

Our sincere thanks go to the Director, Marine Reference Collection and Resource Centre, University of Karachi for providing research facilities. The second author acknowledges the HEC (Higher Education Commission's Expansion Program of Hiring of Eminent Educationists and Researchers having Ph.D. degrees) as Research Scholars for providing this research opportunity.

REFERENCES

- ALCOCK, A., 1896. Materials for a carcinological fauna of India. No. 2. The Brachyura Oxystomata. Reprinted from *J. Asiat. Soc. Bengal*, **65**: 134-296.
- AMIR, N., 1989. *Abundance and distribution of some brachyuran larvae* (Decapoda: Crustacea) in the northern Arabian Sea. M.Phil thesis (unpublished data).
- CHHAPGAR, B.F., 1955. On the life history of *Philyra globosa* (Decapoda: Brachyura). *Rec. Indian Mus.*, **53**: 87-92.
- DE HAAN, W., 1841. Crustacea. Fauna Japonica, sive Descriptio animalium, quae in itinere per Japoniam, jussu et auspiciis superiorum, qui summum in India Batava imperium tenent, suscepto, annis 1823-1830 collegit, notis, observationibus et adumbrationibus illustravit P.F. de Siebold. Conjunctis studiis C.J. Temminck et H. Schlegel pro Vertebratis atque W. de Haan pro Invertebratis elaborata Regis auspicio edita. Leiden, Lugundi-Batavorum, **5**: 109-164, pls 33-37, 39-42, 47.
- FABRICIUS, J.C., 1798. *Supplementum Entomologiae Systematicae*, pp. 1-572. Hafniae.
- HASHMI, S.S., 1968. The larvae of Leucosiidae of W. Pakistan reared in the laboratory (Brachyura: Decapoda). *Pakistan J. scient. Res.*, **20**: 38-44.
- HASHMI, S.S., 1969. Early development stages of *Philyra globosa* (Fabricius) hatched in the laboratory. (Brachyura: Decapoda). *J. Agric. Pakistan*, **20**: 207-215.
- HASHMI, S.S., 1970. The larval development of *Philyra corallicola* (Alcock) under laboratory conditions (Brachyura: Decapoda). *Pakistan J. Zool.*, **2**: 219-233.
- KO, H.S., 1996. Larval development of *Philyra pisum* De Haan, 1841 (Crustacea: Decapoda: Leucosiidae) reared in the laboratory. *Korean J. Syst. Zool.*, **12**: 91-99.
- KO, H.S., 2000. Larval development of *Philyra platychira* (Decapoda: Leucosiidae) reared in the laboratory. *J. Crust. Biol.*, **20**: 309-319.
- KRISHNAN, T. AND KANNUPANDI, T., 1990. Larval and post-larval development of the purse crab *Philyra globosa* (Fabricius, 1888) (Decapoda: Brachyura: Leucosiidae) reared in the laboratory. *Hydrobiologia*, **190**: 171-182.
- LINNAEUS, C., 1758. *Systema Naturae per Regna Tria Naturae, Secundum Classes, Ordines, Genera, Species cum Characteribus, Differentiis, Synonymies locis*. Ed. **10**, 1:1-854, Holmiae.
- MIERS, E.J., 1877. Notes upon oxystomatous crustacea. *Trans. Linn. Soc. London (Zoology)*, Ser. **2**: 235-241.
- ORTMANN, A.E., 1892-1894. *Die Decapoden – Krebse des Strassburger Museums*, 1842-V Hippidea, Dromiidea und Oxystomata. *Zool. Jahrb., Syst.*, Bd. **6**: 532-588, pl.26. 1893-VI. Brachyura. I. Majoidea und Cancroidea. *Ibid.*, **7**: 23-88, pl.3, 1893-VII. Brachyura. II. Cyclometopa *Ibid.*, **7**: 411-495, pl. 17. 1894. – VIII. Brachyura. III. Catometopa. *Ibid.*, **7**: 683-772, pl.23.
- QUINTANA, R., 1984. Observations on the early post-larval stages of *Leucosia craniolaris* (L., 1758) (Brachyura: Leucosiidae). *Rep. USA Mar. Biol. Inst. Kochi Univ.* **6**: 7-21.
- QUINTANA, R., 1986. The megalopal stage in the Leucosiidae (Decapoda, Brachyura). *Zool. Sci.*, **3**: 533-542.
- RAJA BAI, K.G., 1960. Studies on the larval development of Brachyura. II. Development of *Philyra scabriuscula* (Fabricius) and *Ixa cylindricus* (Fabricius) of the family Leucosiidae. *Crustaceana*, **1**: 1-8, 24 figs.
- SANKOLLI, K.N., 1961. On the early larval stages of two leucosiid crabs, *Philyra corallicola* Alcock and *Arcania septemspinosa* (Fabricius). *J. Mar. Biol. Assoc. India*, **3**: 87-91.
- TERADA, M., 1979. On the zoeal development of five species of the subfamily Illinae and Leucosiinae (family Leucosiidae). *Res. Crust.*, **9**: 27-42.
- TERADA, M., 1984. Larval forms of eight species of crabs (Philyrinae and Leucosiinae). *Res. Crust.*, **13**, **14**: 153-164.
- TRIMIZI, N.M. AND KAZMI, Q.B., 1996. *Marine fauna of Pakistan: 6. Crustacea: Brachyura, Brachyrhyncha Part II (Portunidae)*. MRC Publication. pp. 72.
- TYNDALE-BISCOE, M. AND GEORGE, R.W., 1962. The Oxystomata and Gymnopleura (Crustacea, Brachyura) of Western Australia with descriptions of two new species from Western Australia and one from India. *J. R. Soc. West. Aust.*, **45**: 65-96.

(Received 8 February 2007; revised 29 June 2008)

