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Morphological Description of Megalopal Stages of Three Portunid Species (Decapoda, Brachyura, Portunidae) from Indus Deltaic Area (northern-Arabian Sea)

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Abstract

The larvae of crustaceans, including those of brachyuran crabs, are a significant part of zooplanktonic communities constituting an ecologically important fraction of the pelagic communities. The present study describes taxonomic studies on three megalop stages of *Portunus pelagicus* (Linnaeus, 1758), *Charybdis feriatus* (Linnaeus, 1758) and *Carcinus maenas* (Linnaeus, 1758) belonging to family Portunidae collected from Indus deltaic creek system. Zooplankton samples were collected from three locations: Shahbandar 24°15'48.083'N, 67°90'15'333'E, Ketibandar 24°9'16.06'N, 67°27'7.64'E and Korangi creek 24°48'18.80''N, 67°12'30.31'E during April to October 2018. No data available on taxonomic studies of portunid megalops upto species level from Paksitan, hence this is a first attempt to examine and to describe taxonomic features of megalops collected in the zooplankton samples. This study will contribute to the scientific knowledge on megalops taxonomy and identification as well as be useful for future research by taxonomists and biologists.

Keywords:

Megalops, taxonomic features, portunid species, Indus deltaic area

Article history:

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Introduction

The megalopa is transitional stage between planktonic zoea and the benthic adults which is morphologically unique phase in the life cycle of crab. A larval stage following the zoea in the

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development of most crabs in which the legs and abdominal appendages have appeared, the abdomen is relatively long, and the eyes are large called megalops. The larvae of crustaceans, including those of brachyuran crabs, are a significant part of zooplanktonic communities, constituting an ecologically important fraction of the pelagic communities. The zooplanktons are important component of an aquatic food web by forming link in the trophic level as secondary producers. The study of brachyuran crab larvae has many useful applications, such as dispersal and recruitment studies, possible depletion of species vulnerable to over exploration (Clark & Paula, 2003), evaluating a species diversity in a region and in specifying the reproduction time of brachyuran species (Kornienko & Korn, 2009), systematics, analyses of physiological ecology and analysis of larval behaviour (Hines, 1986). There are over 4500 species of crab in the world, more than 200 crab species have been documented from Pakistani waters, out of which just five are edible (Kazmi, 2003; Kalhoro, 2018) *Portunus pelagicus* (Linnaeus, 1785) and *Portunus sanguinolentus* (Herbst, 1783) are most dominant species from Pakistan and others are *Scylla tranquebarica* (Fabricius, 1798), *S. olivacea* (Herbst, 1796) and *Charybdis feriatus* (Linnaeus, 1785). *Portunus pelagicus*, *Charybdis ferriatus*, *Carcinus maenas* are portunid crab belonging to family Portunidae. This group known as swimming crabs and they are characterized by the flattening of the fifth pair of legs into wide paddles, which are used for swimming, this capability, together with their strong, sharp claws, allows many species to be fast and aggressive predators (Davie, 2002). The swimming crabs (family Portunidae) are distributed worldwide and commonly inhabit estuaries, mangroves, reefs, shallow and the deep sea (Huang & Shih, 2021). *P. pelagicus* distributed throughout the Indo-West Pacific and contribute and important fishery and plays an important role in different regions (Stephenson, 1962; Potter et al., 1983; Kailola et al., 1993; Bryars & Havenhand, 2004).

The coastal region of Sindh lies in the southeast of the country between the Indian border along the Sir creek in the east to the Hub river along the coast of Balochistan in the west. The Sindh coast can be further divided into two parts, the Sindh coast covering 85 % of the coastal belt, whose coastal morphological features among tidal flats; delta wet-lands; estuarine systems and a broad flat continental ledge. The Indus river is ranked as the 22nd largest river on the globe and has developed a fan-shaped delta that is one of the largest bodies of sediment in the modern ocean basins. The Indus delta is the sixth largest delta on the earth with an area of 29.524 km^2. The present delta includes 17 major creeks characterized by mangrove forests; tidal flats; salt marshes and sand dunes, and 97 % of the total mangrove cover in Pakistan is represented by the Indus delta comprising about 95 % almost monotypic dominant species *Avicennia marina* (Ali & Ahmed, 2013). The Indus delta is a home of the largest arid zone mangrove forest in the world, stretching from Korangi creek in the west to Sir creek in the east. The Indus river forms an extensive system of streams, riverbeds, tidal flats, swamps, estuaries and mangrove forests. These streams represent a delicate ecosystem that provides shelter and food for a variety of marine organisms, including commercially important fish and shellfish (Ali & Ahmed, 2014). This creek system is nutrient affluent and providing breeding ground and nursery for a spacious diversity of organisms. The

mangrove ecosystem has been familiar as an unbelievable likely resource for its environmental and biological dynamism. Its performing a vital role in fisheries and coastal safety as a usual fence alongside hurricanes and storms.

Earlier published literatures are available on the taxonomic and larval composition of brachyuran crabs from Pakistani coastal waters studied by (Hashmi 1969; 1970a,b; Siddiqui & Tirmizi, 1992; Tirmizi et al., 1993 Ghory & Siddiqui, 2000; Ghory, 2002; Ghory & Siddiqui, 2006; Ghory & Siddiqui, 2008; Ghory et al., 2018). The aim of the present study megalopal satges were isolated form the zooplankton samples collected for identification and taxonomic studies from three major creeks (Shahbandar, Ketibander and Korangi creeks) Indus deltaic area during April to October 2018. The data will be a good addition to the scientific knowledge on taxonomy and identification of megalops and it will also be helpful for taxonomists and biologists for future research.

Materials and Methods

The megalopal stages were sorted out form zooplankton samples collected from three designated sites in Indus deltaic area (Shahbandar 24°15’48.083’N, 67°90’15’333’E), Ketibandar (24°9’16.06’N,67°27’7.64’E) and Korangi (24°48’18.80’’N,67°12’30.31’E) during April to October 2018 (Figure 1). Physico-chemical parameters such as water temperature (°C); salinity (ppt), dissolved oxygen (mg/L); pH and transparency (cm) were measured. For the water temperature (°C), a glass thermometer was immersed below the water surface (10 cm) for three minutes and the measured temperature (°C) was recorded in the data sheet. The salinity (ppt) was measured using a refractometer (S/Mill-E, Atago Co. Ltd., Tokyo, Japan). Dissolved oxygen (mg/L) was measured using a portable device (OSK-14808, DO-20A). The pH was recorded using a digital portable device (model 220 Pen). The transparency (cm) of water was measured using a Secchi disk (Hydro-Bios, 443590).

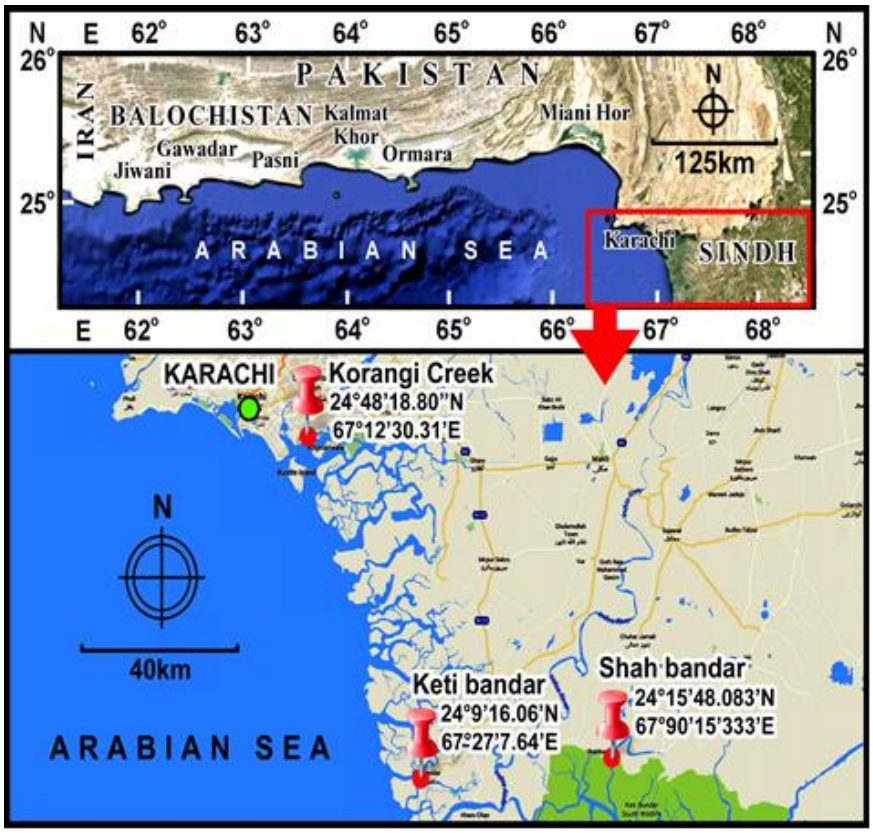

Figure 1. Map showing designated stations in the three major creeks; Shahbandar, Ketibander, and Korangi, Indus deltaic area, northern Arabian Sea

Zooplankton samples were collected using a 500 microns mesh Hydrobios ring trawl by horizontal trawling for 10 minutes at a constant speed of 0.5 m /s from surface waters. A digital flow meter was used to measure the volume of water flowing through the net. Samples were immediately preserved in 5 % (buffered formalin) and placed in plastic containers for laboratory analysis. Samples were divided into aliquots (sub-samples) and megalops were sorted out. Megalop specimen were identified and counted in a counting dish under a stereomicroscope (Wild 181300, Switzerland). Microphotography was also performed using a digital camera (Fujifilm 16 MP). Morphological features and characteristics (colour, size, carapace, abdomen, telson, antennae, mandible, maxilla, periopod, etc.) were studied. Dissection was performed under the stereo zoom microscope.

Carapace was precise from the rostrum tip to the rear edge, the carapace width, across the widest part of the carapace; Rostrum length, from apex to front part of orbit at midline; Belly length, from mid-posterior edge of carapace to tip of telson. Appendages were dissected in glycerol using entomological needles. Drawings, illustrations were made with help of drawing tubes fixed on a stereo zoom microscope (Wild 181300, Switzerland) (10x1x50 = 500x magnification). The

taxonomic studies, identification was conducted with the help of literatures (Newell & Newell, 1977; Pessani et al., 2004; Weiss, 2017).

Results

Original photographs of the species are given in Figures 2.

Family-Portunidae

***Portunus pelagicus* (Linnaeus, 1758)** (Figure 2A)

Material Examined: Location: Shahbandar, Korangi; No. of specimens: 04; Size: Total length was 2 to 2.2 mm and 1.4 to 1.6 mm width.

Diagnostics characteristics:
Carapace (Figure 3A, B): Rectangular and no dorsal or lateral spines present, rostral spine presents half of the length of antenna.

Antennule (Figure 3C)**:** 3-segmented peduncle; unsegmented endopod and five-segmented exopod. aesthetasc setae on outer margin; terminal segment has two stiff simple setae, one terminally and the other sub-terminally.

Antenna (Figure 3D)**:** uniramous, with more than 12-13-segments; no setae present on proximal segment.

Mandible (Figure 3E)**:** Segmented coxalendite, unsegmented basal endite; 2-segmented, endopod.

Maxillula (Figure 3F)**:** Segmented coxalendite, unsegmented basal endite and 2-segmented endopod.

Maxilla (Figure 3G)**:** Endopod two segmented, proximal segment with three setae, distal segment without setae, scaphognathite with several plumose setae.

First maxilliped (Figure 3H)**:** Epipod with 5 setae, coxa and basis unsegmented with several setae, endopod unsegmented with 5 setae, exopod 3-segmented, distal segment with 5 setae.

Second maxilliped (Figure 3I)**:** Endopod four segmented; exopod five segmented, distal segment with four setae.

Third maxilliped (Figure 3J)**:** Exopod two segmented, distal segment with four setae; epipod unsegmented with few plumodenticulate setae and gills.

First periopod (Figure 3K)**:** Well developed. Few short setae on all segments.

Second and fifth pereiopods (Figure 3L, M)**:** Well developed with four segmented endopods.

Pleopod (Figure 3N)**:** Exopods bear plumose setae.

Telson (Figure 3O)**:** It is dorso-ventrally flattened.

***Charybdis feriatus* (Linnaeus, 1758)** (Figure 2B)

Material Examined: Location: Ketibandar; No. of specimens: 03; Size: Total length was 1.4 to 1.5 mm and 0.9 to 1 mm width.

Diagnostics Characteristics:
Carapace (Figure 4A)**:** Carapace broad, rostrum short and knob like.

Antennule (Figure 4B)**:** 3 segmented peduncle, expanded proximal segment, 2 distal flagella present. endopod with three setae; exopod with 19 aesthetascs and 1 seta.

Antenna (Figure 4C)**:** Endopod elongated and multisegmented flagellum.

Maxillula (Figure 4D)**:** Coxalendite with plumodenticulate setae.

Maxilla (Figure 4E)**:** Coxal endite uniramous with 7 plumodenticulate setae, basial endite bilobed with 9+ 11 setae, endopod unsegmented, exopod (scaphognathite) with several setae. Coxal and basal endites both are bilobed.

Maxilliped (Figures 4F, G, H)**:** maxillipied 1 has epipodhas 21 setae, exopod has 2,5 setae.

Maxilliped 2: protopod 1 setae, endopod 2,3,2,8,10 setae, exopod 1.6 setae.

Pereiopod (Figures 4I, J)**:** A couple of huge cornua found inposterior-laterally on sternal shield.

Telson (Figure 4K)**:** Long and broad; subsequent edging convexly curved, dorsal surface with two pairs of small setae.

***Carcinus maenas* (Linnaeus, 1758)** (Figure 2C)

Material Examined: Location: Shahbandar, Korangi; No. of specimens: 05; Size: Total length is (1.72 to 1.75 mm) and is (0.4 to 0.5 mm) width

Diagnostic characteristics:

Carapace (Figures 5A, B)**:** Dorsal surface of carapace with a pair of small bristles, rostrum tip pointed onward and somewhat descending. Between eyes rostrum was with skinny dejection.

Antennule (Figure 5C)**:** Exopode 4 segmented cheliped ischial spine, or pereiopod 2-coxal spine or both.

Antenna (Figure 5D)**:** 8-segmented, and no setae found on distal end of last segment.

Maxilla (Figure 5E)**:** Well developed.

Pereiopod (Figures 5F, G)**:** Slightest seven segmented pereiopod; five dactyls with terminal sub terminal setae. Pereiopod five dactyl with two, three or four incurable or sub incurable setae.

Telson (Figure 5H)**:** long and broad, dorsal surface with three pairs of small setae.

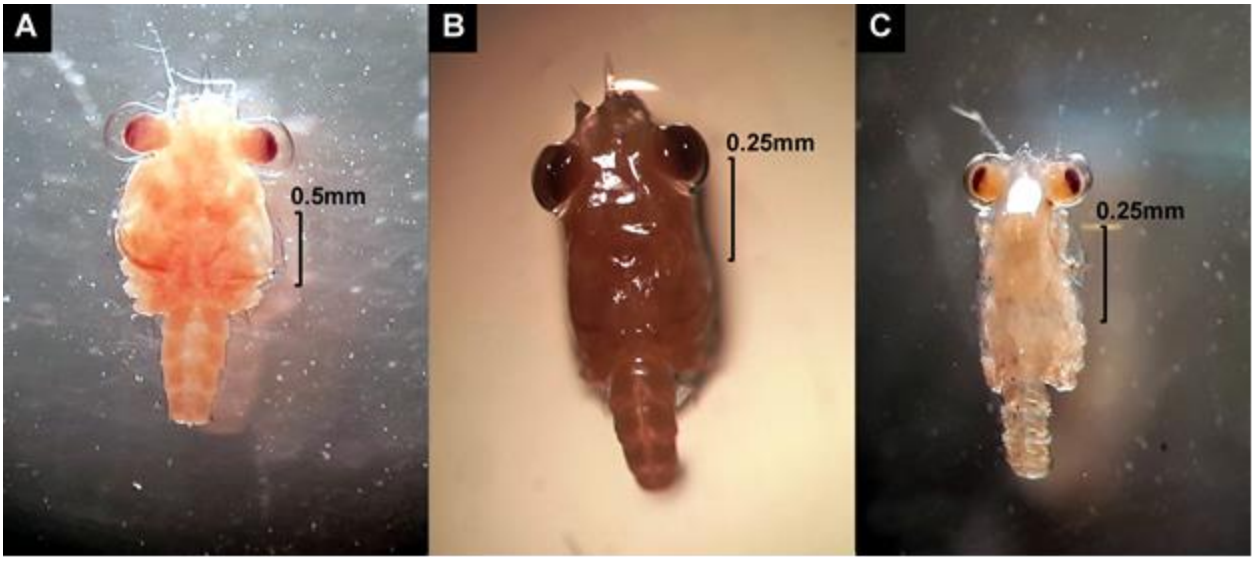

Figure 2. A) *Portunus pelagicus* (Linnaeus, 1758) B) *Charybdis feriatus* (Linnaeus, 1758) C) *Carcinus maenas* (Linnaeus, 1758)

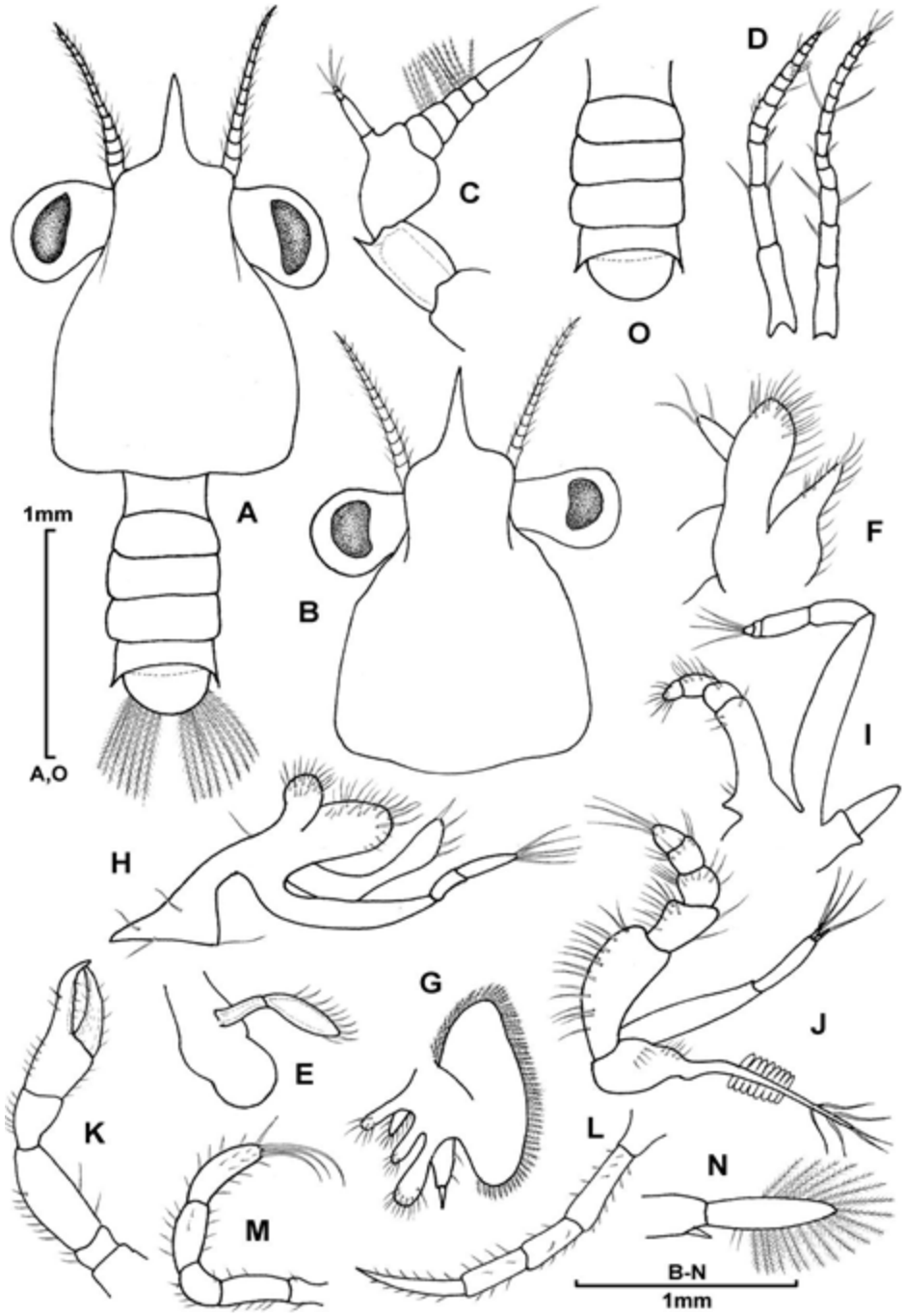

Figure 3. Taxonomy of megalopal stage of *Portunus pelagicus* A) Dorsal view B) Carapace C) Antennule D) Antenna E) Mandible F) Maxillule G) Maxilla. H) First maxilliped I) Second maxilliped J) Third maxilliped K) 1st pereiopod L) Second pereiopod M) Fifth pereiopod N) Pleopod O) Telson.

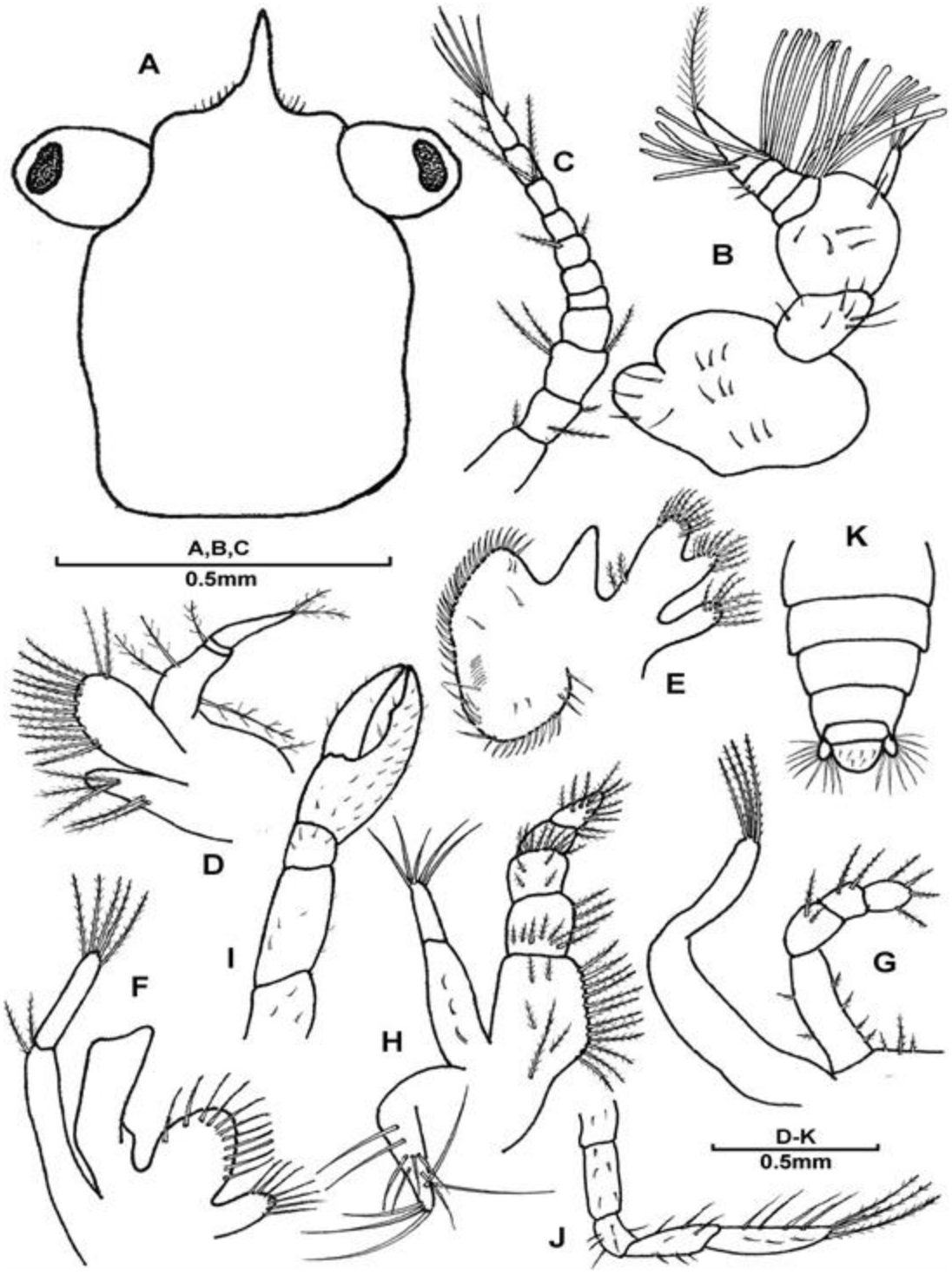

Figure 4. Taxonomy of megalopal stage of *Charybdis feriatus* A) Carapace B) Antennule C) Antenna D) Maxillule E) Maxilla F) First maxilliped G) Second maxilliped H) Third maxilliped I) First pereiopod J) Fifth pereiopod K) Telson

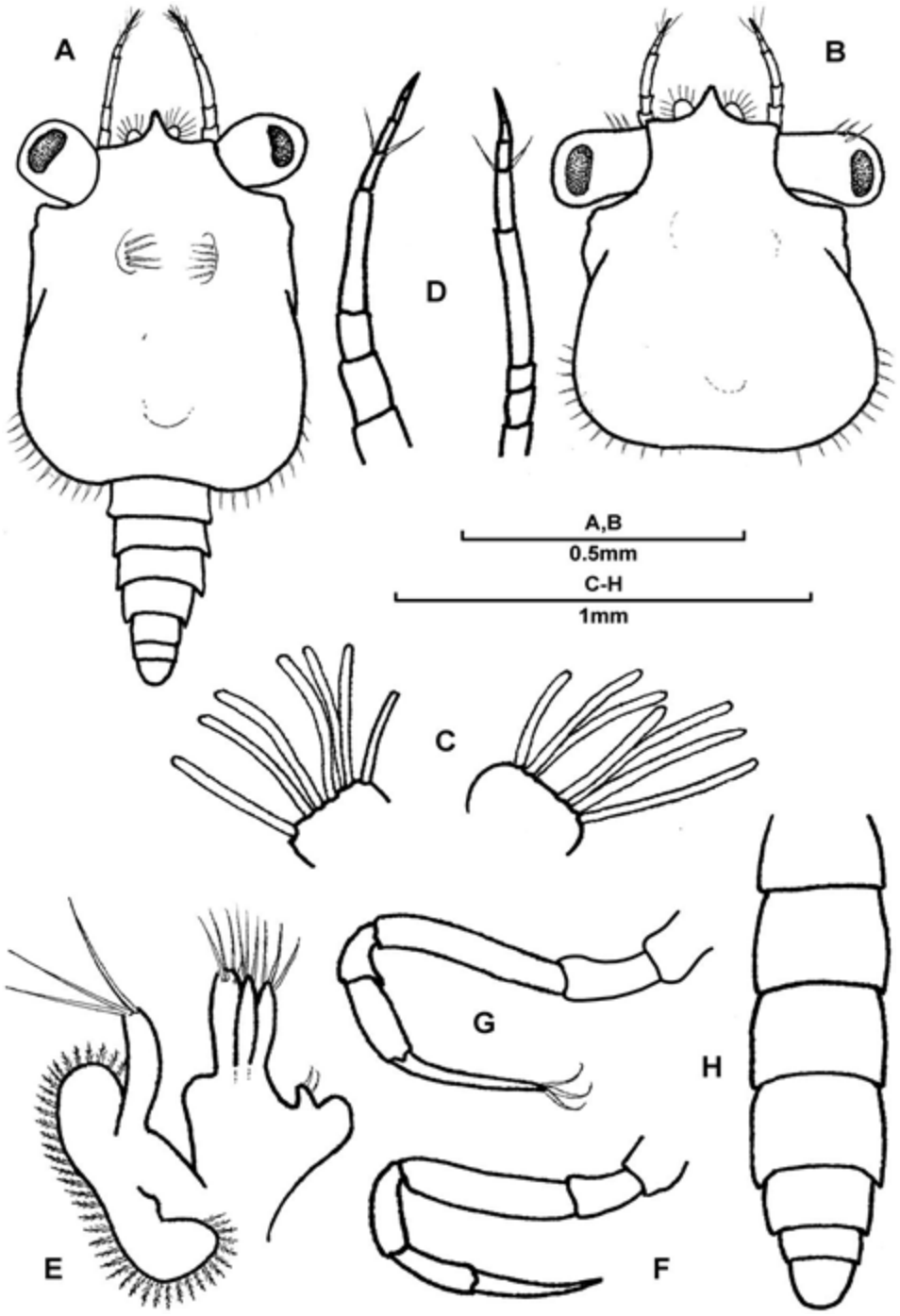

Figure 5. Taxonomy of megalopal stage of *Carcinus meanas* A) Dorsal view B) Carapace C) Antennules D) Antenna E) Maxilla F) Fourth pereiopod G) Fifth pereiopod H) Telson

The water temperature range (29-31°C), salinity (37-45‰), pH (7.8-8.0), DO (6.9-10.0 mg/L) and Transparency (40-120 cm) were measured during April to October 2018 (Table 1).

Table 1. Physico-chemical parameters and zooplankton samples were collected for taxonomic studies on megalopal stages of (Family-portunidae) from three designated sites of Indus deltaic area (Shahbundar, Ketibandar and Korangi creek) during April to October 2018.

Stations	Seasons	Months/Date of sample collection	Nos. of megalops collected in zooplankton sample	Water Temperature (ºC)	Salinity (‰)	pH	Dissolved oxygen (mg/L)	Transparency (cm)
Shahbandar	Pre-monsoon	10-April-2018	09	29.6	42	7.8	9.6	120
	Monsoon	10-July-2018	04	30.2	45	7.8	10.0	90
	Post-Monsoon	15-October-2018	36	31.0	40	8.0	9.4	60
Ketibandar	Pre-monsoon	17-April-2018	23	29.0	33	8.0	7.1	90
	Monsoon	17-July-2018	18	31.0	30	8.0	9.0	70
	Post-Monsoon	29-October-2018	27	30.0	37	8.0	8.2	40
Korangi	Pre-monsoon	24-April-2018	13	30.0	39	8.0	6.9	40
	Monsoon	4-July-2018	24	29.5	38	8.0	7.0	60
	Post-Monsoon	18-October-2018	16	30.2	38	8.0	7.9	50

Discussion

The present study describes taxonomic features of three megalopal stages of *Portunus pelagicus* (Linnaeus, 1758), *Charybdis feriatus* (Linnaeus, 1758) and *Carcinus maenas* (Linnaeus, 1758) belonging to family Portunidae collected from Indus deltaic creek system. The present taxonomic studies on *P. pelagicus* were compared with Juwana et al. (1987) from Indonesia and Shinkarenko (1979) from Australian waters, Joisleen & Menon (2004) from southeast India. Based on taxonomic features carapace shape, antennae, antennae, mandibles, maxilla, first, second and third maxilla, pereiopods, pleopods and telson were very similar to by Juwana et al. (1987).

Taxonomic studies on *Charybdis* sp. earlier reported by Ghory (2020) from Pakistan. The megalopa characteristics of *C. feriatus* were similar with Ghory (2020) on genus level. Campbell et al. (1984) described megalops of *C. feriatus* from Moreton Bay, Queensland. The taxonomic features of *C. feriatus* megalop, narrowing anteriorly, rostral plate shortened with a broad at exact angles and the present study shows the dorsal view of the carapace broadly triangular, the width is greater and narrows anteriorly to the rostral plate. Telson as long as wide, subsequent covex margin; Dorsal surface with one pair of small bristles. Current taxonomic studies of *C. feriatus* have been closely related to Campbell et al. (1984). No literature is available on the taxonomic features of *Carcinus maenas* species, thus, Spitzner et al. (2018), studied the organogenesis of the *Carcinus maenas*, presented the detailed atlas of the internal organization of the larva in a multi-method approach to complement obtainable descriptions of their external morphology. The present results indicate that the edges of the carapace may have curved and clumpy, the dorsal surface of the carapace is without distinct protuberances, the apex of the rostrum tapering forward or faintly descending, Platform among the eyes with a petty dejection. Based on these characteristics our specimen was like Spitzner et al. (2018). Weiss (2017) also examined the dorsal facade of the carapace with no divergent protuberances, edges and rostrum tips pointing slightly forward.

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Conflict of Interest

The authors declare there is no conflict of interest in this study.

Author Contributions

All authors performed all the experiments and drafted the main manuscript text.

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