Comparative Morphology of First Zoeal Stages of Six Portunid Crab Species Reared in the Laboratory

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Abstract

This study presents a comparative morphological analysis of the first zoeal stage of six commercially important portunid crab species: *Scylla tranquebarica*, *Portunus segnis*, *Charybdis orientalis*, *Charybdis annulata*, *Charybdis hellerii*, and *Thalamita prymna*, reared under laboratory conditions. Larvae were cultured and examined using standard microscopic techniques, and key morphological characters were recorded, illustrated, and compared across species. Diagnostic features of the first zoeal stage, including carapace spination, appendage segmentation, setation patterns, and overall body proportions, were evaluated to identify interspecific variation. The results revealed clear species-specific differences in zoeal morphology, particularly in the structure and arrangement of dorsal and lateral spines, antennal development, and maxilliped setation patterns. These morphological variations provide reliable taxonomic characters for species-level identification during early larval stages. The study contributes to a better understanding of early developmental diversity within Portunidae and supports larval identification in both ecological and aquaculture contexts.

Keywords: Zoea I; Portunidae; Crustacean larvae; Morphology; Comparative study; Brachyura.

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Introduction

The Brachyura represent one of the most diverse groups of decapod crustaceans, comprising approximately 7,000 described species across 98 families and occupying marine, estuarine, freshwater, and terrestrial environments worldwide (Tsang *et al*., 2014). Among them, the family Portunidae includes several ecologically and commercially important swimming crab species that contribute significantly to coastal fisheries and aquaculture in tropical and subtropical regions.

In Pakistan, approximately 29 portunid species have been recorded from coastal waters (Kazmi, 2022), where they represent an important fishery resource due to their abundance and market value. Despite their economic importance, the taxonomy of portunid crabs remains challenging, particularly during early developmental stages, where morphological similarities among species often hinder accurate identification.

Previous studies have demonstrated that the first zoeal stage within Portunidae is generally characterized by conserved morphological traits, including the presence of rostral, dorsal, and lateral carapace spines, a typically unarmed third endopodal segment of the first maxilliped, and a consistent telson structure bearing spinulate setae (Rice and Ingle, 1975; Bookhout and Costlow, 1977). However, subtle interspecific variations in setation patterns, appendage morphology, and telson structure have been reported and are considered important diagnostic characters for species-level discrimination.

Several authors have described larval development in portunid genera, particularly Scylla, Portunus, Charybdis, and Thalamita, highlighting both morphological conservatism and species-specific differences during early zoeal stages (Prasad and Tampi, 1953; Hashmi, 1970; Meyer *et al*., 2006). Nevertheless, intraspecific variability and overlapping morphological characters often complicate reliable identification, especially in planktonic samples where larvae of multiple species co-occur.

Although larval morphology of several Indo-Pacific portunids has been documented, comparative studies involving multiple co-occurring species reared under identical laboratory conditions remain limited. Such studies are essential for improving larval identification keys and for supporting fisheries management, biodiversity assessments, and aquaculture development.

The present study aims to compare the first zoeal stage morphology of six commercially important portunid crab species (*Scylla tranquebarica, Portunus segnis, Charybdis orientalis, Charybdis annulata, Charybdis hellerii, and Thalamita prymna*) reared under laboratory conditions, with emphasis on diagnostic morphological characters useful for taxonomic differentiation.

Materials and methods

Ovigerous females of six portunid crab species (Scylla tranquebarica, Portunus

segnis, Charybdis orientalis, Charybdis annulata, Charybdis hellerii, and Thalamita prymna) were collected from coastal waters of Karachi, Pakistan, including Korangi Creek (24°48′04.52″N, 67°09′15.77″E), Sandspit (24°50′24″N, 66°54′24″E), Buleji (24°50′12″N, 66°49′12″E), and Pacha (24°50′54″N, 66°43′00″E).

Specimens were transported live to the laboratory and maintained in glass aquaria containing unfiltered seawater with salinity ranging from 35–37‰ at ambient temperature (26–29°C) until hatching. Newly hatched larvae were collected and transferred to 500 mL glass beakers containing filtered seawater under identical environmental conditions. Each beaker contained ten larvae, and a total of five replicate beakers were used per species.

Larvae were maintained under a 12:12 h light–dark photoperiod and were fed newly hatched *Artemia* nauplii. Culture water was renewed daily, and larvae were transferred to clean beakers with fresh filtered seawater to minimize microbial contamination. During the culture period, mass mortality occurred in some batches due to heavy proliferation of ciliates; affected specimens were excluded from morphological analysis.

For morphological examination, larvae at the first zoeal stage were preserved in 5% buffered formalin. Temporary microscope slides were prepared using a glycerin–formalin mixture (3:1). Measurements were taken using an ocular micrometer under a compound light microscope. Carapace length (CL) was measured from the tip of the rostrum to the posterior margin of the carapace. Total length (TL) was measured from the rostral tip to the posterior margin of the telson.

Specimens (ovigerous females and larval stages) were deposited in the Marine Reference Collection and Resource Centre, University of Karachi for future reference and verification.

Results and description

Morphological differences among the laboratory-reared first zoeal stages of six portunid crab species (*Scylla tranquebarica, Portunus segnis, Charybdis orientalis, Charybdis annulata, Charybdis hellerii, and Thalamita prymna*) are summarized in Table 2. Overall, the first zoeal stages of all species showed a high degree of morphological similarity, consistent with the conservative larval morphology typical of Portunidae. However, detailed examination revealed several species-specific diagnostic differences in appendage setation and telson structure.

The first zoea of *Scylla tranquebarica* closely resembled those of *Portunus segnis, Charybdis orientalis, C. annulata, C. hellerii*, and *Thalamita prymna*, but differed in the setation pattern of the maxilla. Specifically, the coxal endite bears 1+3 setae, the basial endite 4+4 setae, and the endopod five setae (Fig. 1G), whereas the other species exhibit a coxal endite with 3+3 setae and variable basial endite counts (3+5, 4+5, or 5+4), with a consistent endopodal count of six setae.

Charybdis orientalis is distinguished from the remaining taxa by the presence of an enlarged posterolateral angle on the fourth abdominal somite (Fig. 3J), which represents a stable diagnostic character at the zoeal stage. In *Charybdis annulata*, the first zoea is characterized by a deep central indentation of the telson (Fig. 4J), which clearly separates it from the other examined species.

Charybdis hellerii differs from the other taxa in showing a reduced setation pattern of the maxillule, including five coxal endite setae, and the absence of a coxal endite seta on the first maxilliped (Fig. 5F, H). These characters provide reliable diagnostic features for species-level identification.

Thalamita prymna exhibited the most distinct morphological pattern among the studied species. It is characterized by a shortened telson furca lacking lateral spines (Fig. 6J) and an antennule bearing two aesthetascs and a single seta (Fig. 6C). These features clearly differentiate it from *Scylla tranquebarica*, *Portunus segnis*, and the three Charybdis species examined.

Overall, despite strong morphological conservatism among portunid first zoeae, consistent interspecific variation in maxillary and maxillulary setation, abdominal somite morphology, and telson structure provides reliable diagnostic characters for species-level identification.

Concluding remarks

This study examined and compared the morphological characteristics of the first zoeal stages of six portunid crab species, with data summarized in Table 1 and comparative differences presented in Table 2. In addition to interspecific comparisons within the genus Portunus and related taxa, diagnostic characters were evaluated across genera within the family Portunidae.

The results demonstrate that, despite a high degree of morphological similarity among first zoeae, consistent species-specific differences in appendage setation and telson morphology can be used as reliable taxonomic characters. These diagnostic traits are particularly useful for larval identification in plankton samples, where morphological overlap often limits accurate species discrimination.

Overall, the findings provide a useful reference framework for larval taxonomy within Portunidae and may contribute to future studies in systematics, biodiversity assessment, and fisheries-related research.

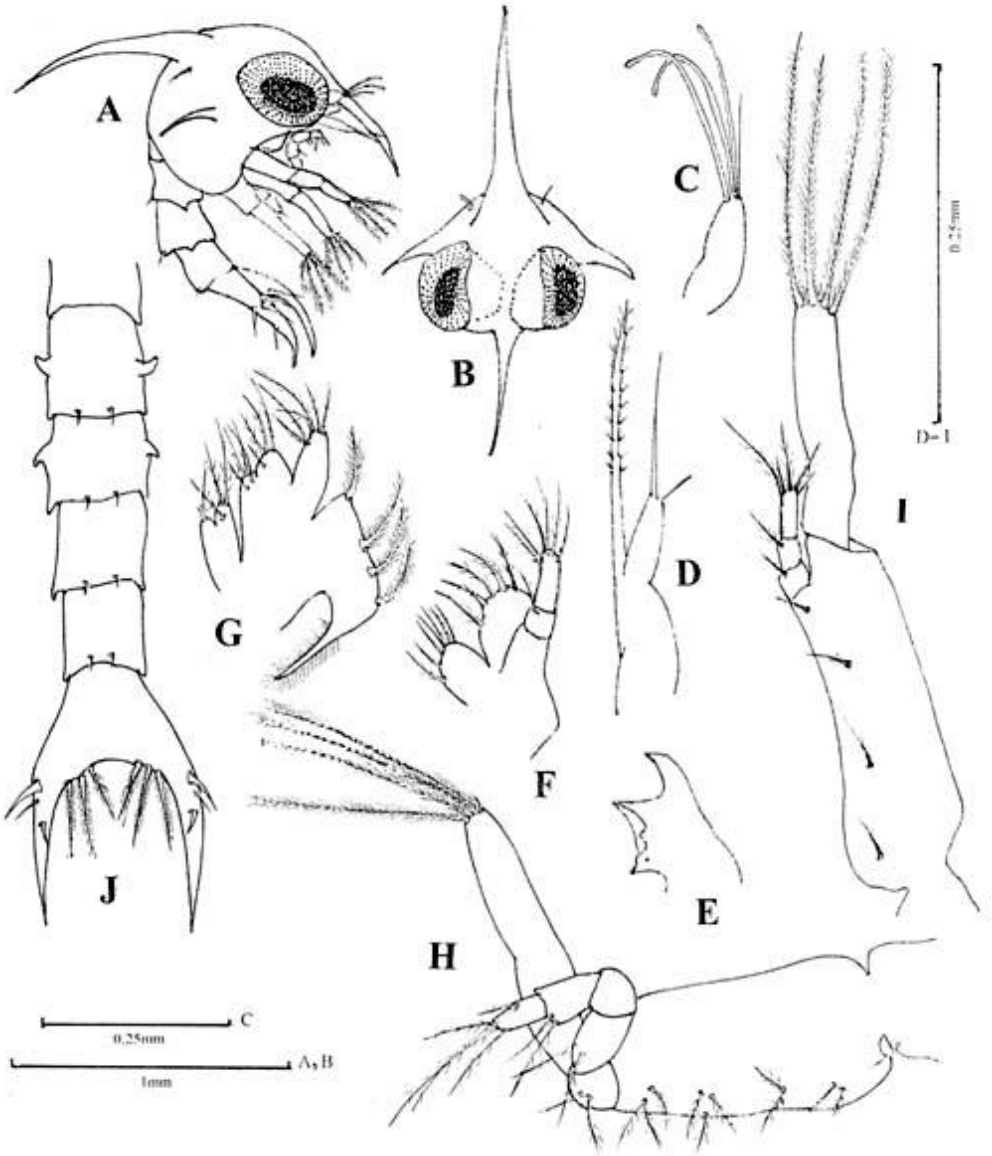

Figure 1: ***Scylla tranquebericа.*** **(Fabricius, 1798) Zoea I: A, entire, lateral view; B, dorsofrontal view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, I maxilliped I, II; J, abdomen with telson, dorsal view.**

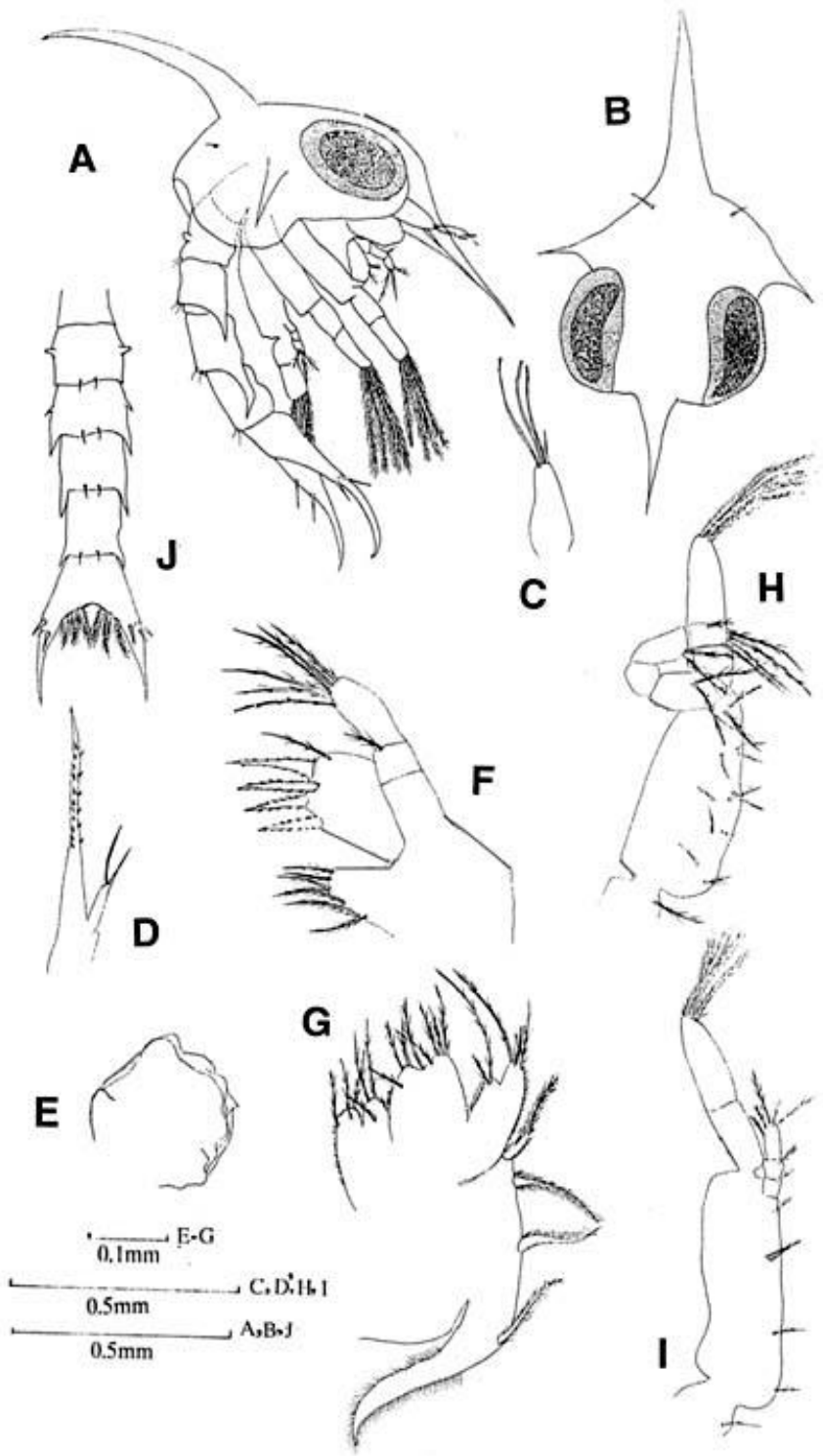

Figure 2: ***Portunus segnis*** **(Forskal, 1775). Zoea I: A, entire, lateral view; B, dorsofrontal view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, I maxillipeds I, II; J, abdomen with telson, dorsal view.**

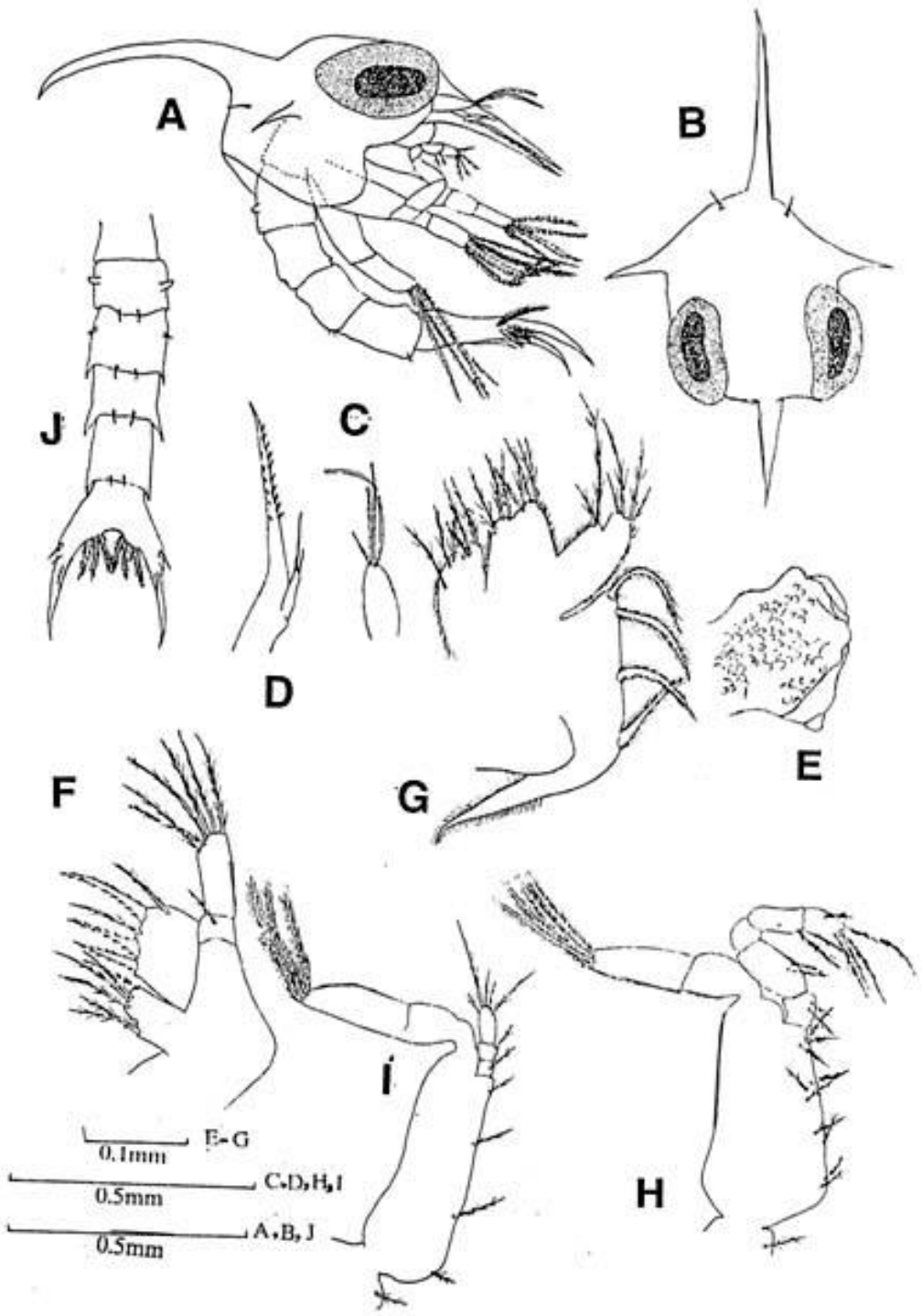

Figure 3: ***Charybdis orientalis*** **Dana, 1852. Zoea I:** A, entire, lateral view; B, dorsofrontal view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, I maxilliped I, II; J, abdomen with telson, dorsal view.

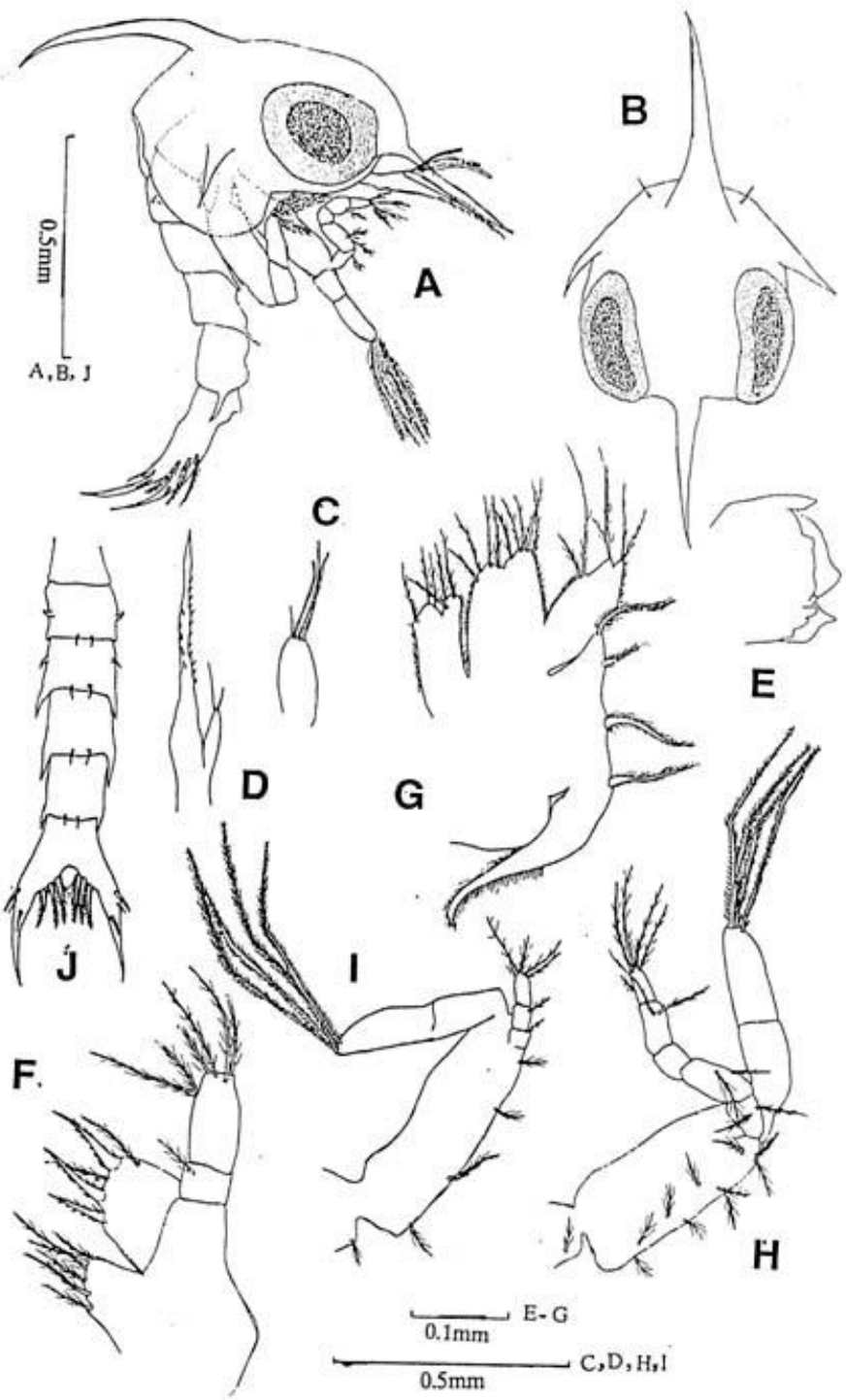

Figure 4: ***Charybdis annulata*** **(Fabricius,1798). Zoea I:** A, entire,distal lateral view; B, dorsofrontal view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, I maxilliped I, II; J, abdomen with telson, dorsal view.

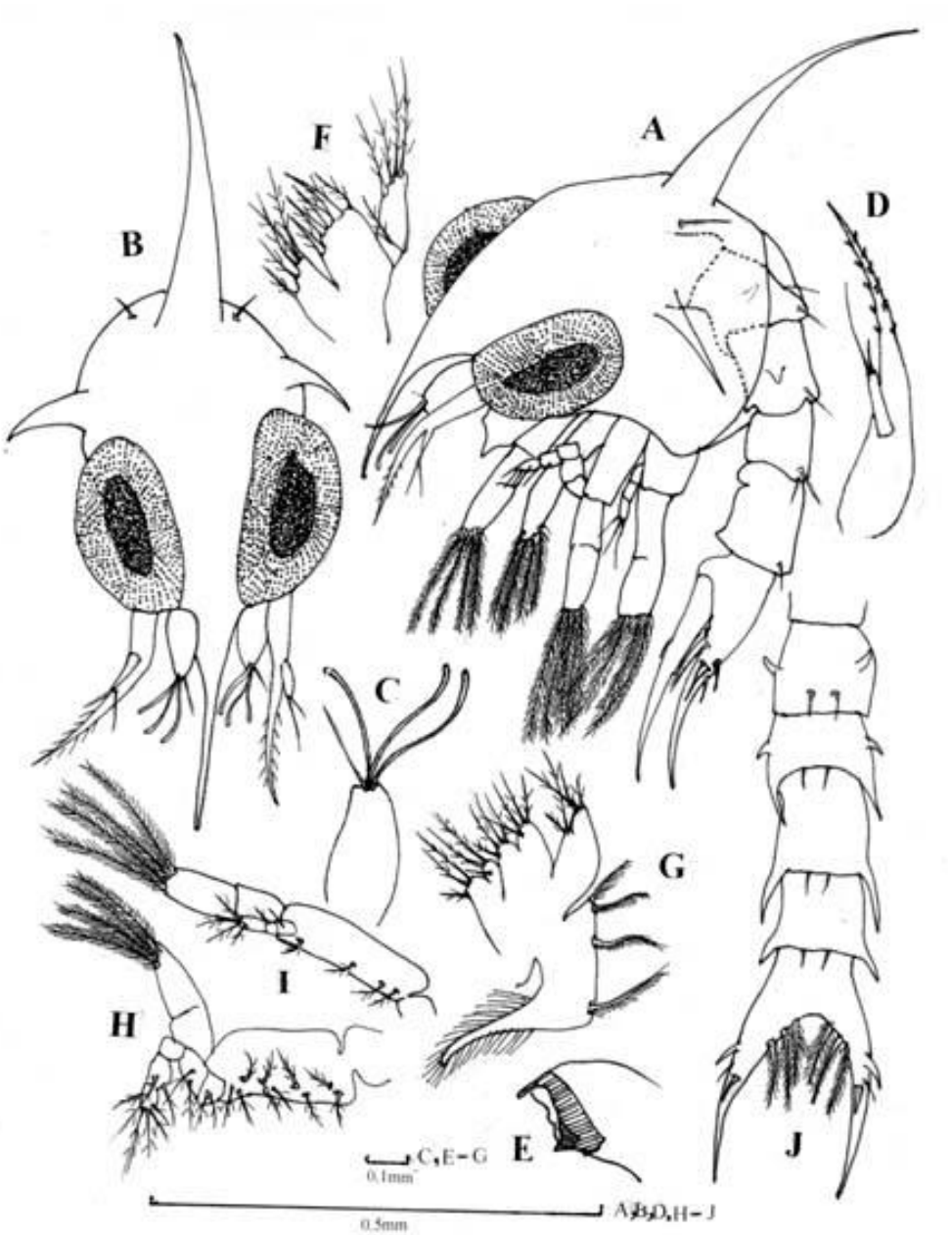

Figure 5: ***Charybdis hellerii*** **(A. Milne Edwards, 1867). Zoea I: A, entire, lateral view; B, dorsofrontal view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, I maxilliped I, II; J, abdomen with telson, dorsal view.**

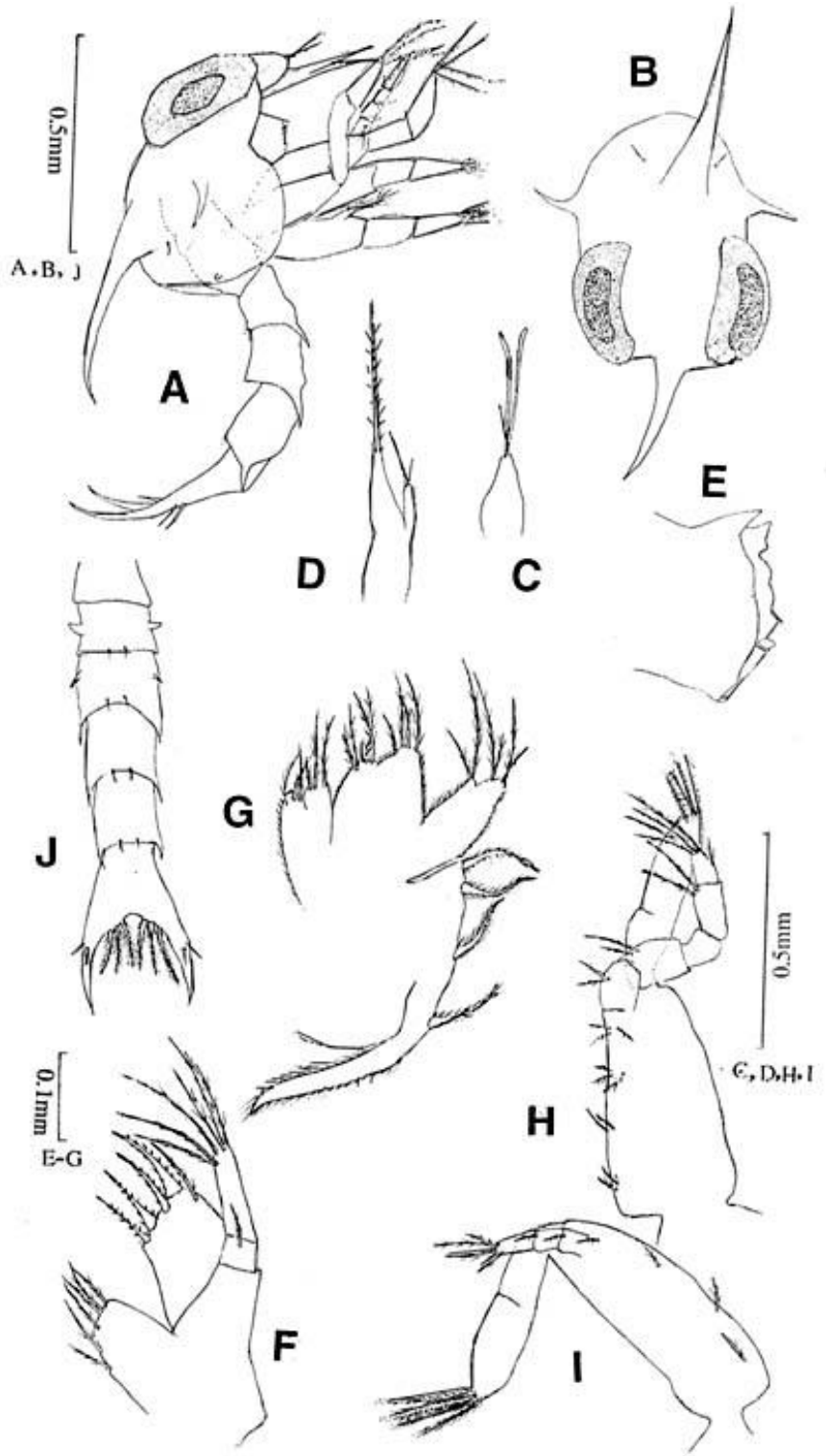

Figure 6: ***Thalamita prymna*** **(Herbst, 1803). Zoea I: A, entire, lateral view; B, dorsofrontal view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, I maxilliped I, II; J, abdomen with telson, dorsal view.**

Table 1: Morphological characters of laboratory reared first zoeal stages of six species of portunid crabs: *Scylla tranqueberica*, *Portunus segnis, Charybdis orientalis, C. annulata, C. hellerii* and *Thalamita prymna.*

Characters	*S. tranqueberica*	*P. segnis*	*C. orientalis*	*C. annulata*	C. hellerii	T. prymna
Total length	1.42mm-1.47mm	1.37mm-1.64mm	1.50mm-1.75mm	1.59mm-1.80mm	1.03mm-1.59mm	1.46mm-1.72mm
Carapace:						
spine:	Long, downwardly curved	no change	no change	no change	no change	no change
rostral	"	"	"	"	"	"
dorsal	Long, backwardly curved	"	"	"	"	"
lateral	Short, pointed					
Eyes	sessile	"	"	"	"	"
Antennule:						
aesthetasca	3	"	"	"	"	2
setae	1	"	"	"	"	1
Antenna:						
protopod	Long with minute spine on both sides	"	"	"	"	no change
exopod	one long and one short terminal spine	"	"	"	"	"
Mandible:						
palp	absent	"	"	"	"	"
Maxillule:						
setae	6	"	"	"	5	6
coxal endite	2+3	4+1	3+2	"	4+1	4+1
basial endite	1+6	no change	no change	"	1+4	1+6
endopod						
Maxilla:						
setae	1+3	3+3	no change	"	no change	"
coxal endite	4+4	3+5	4+5	"	4+4	5+4
basial endite	2+3	2+3	2+4		2+3	2+4
endopod	tapering	no change	no change	"	no change	no change
scaphognathite	4	"	"	"	"	"
proximal end						
marginal setae						
Maxilliped I:						
setae	1	"	"	"	absent	1
coax	10(2,2,3,3)	"	"	"	no change	"
basis	11(2,2,2,4+1)	"	"	"	"	"
endopod	4				"	
exopod						
Maxilliped II:						
setae	absent	1	"	"	absent	1
coax	4(1,1,1,1)	4(1,1,1,1)	"	"	no change	no change
basis	7(1,1,5)	7(1,1,5)	"	"	6(1,1,4)	7(1,1,5)
endopod	4	4	"	"	"	"
exopod						
Abdomen: posterolateral angles on somite 3rd-5th	3rd and 4th enlarged	no change	Only 4th enlarged	3rd and 4th enlarged	3rd-5th enlarged	3rd-5th enlarged
Telson:						
furca	shallow	no change1	no change	deep	shallow	shallow
center indentation	1 pair	"	"	no change	no change	absent
lateral spine	1 pair	"	"	"	"	1 pair
lateral setae	1 pair	"	"	"	"	no change
dorsal spine	3+3	"	"	"	"	"
posterior processes						

Table 2: Comparison between morphological characters of laboratory reared first zoeal stages of six species of portunid crabs: *Scylla tranqueberica*, *Portunus segnis, Charybdis orientalis, C. annulata, C. hellerii* and *Thalamita prymna.*

Characters	*S.tranqueberica*	*P. segnis*	*C. orientalis*	*C. annulata*	*C. hellerii*	*T. prymna*
Antennule: aesthetascs + setae	3+1	no change	no change	no change	no change	2+1
Maxillule:						
setae	6	6	6	6	5	6
coxal endite	2 cuspidate spines + 3 plumose setae	4 cuspidate spines + 1 plumose setae	3 cuspidate spines + 2 plumose setae	no change	no change	4 cuspidate spines + 1 plumose setae
Basial endite						
endopod	1+6	no change	no change	no change	1+4	1+6
Maxilla:						
Coxal endite	1 +3 setae	3 +3 setae	no change	"	"	no change
Basial endite	4 + 4 setae	3+5 setae	4 +5 setae	"	4+4setae	5 +4 setae
endopod	5 setae	no change	6 setae	"	5 setae	6 setae
Maxilliped I: setae coax	1	no change	no change	no change	absent	1
Abdomen: posterolateral angles of somites 3^{rd}-5^{th}	3^{rd} and 4^{th} enlarged	no change	only 4^{th} enlarged	3^{rd} and 4^{th} enlarged	3^{rd} - 5^{th} enlarged	3^{rd} - 5^{th} enlarged
Telson:						
Center	shallow	"	no change	deep	shallow	shallow
indentation	1 pair	"	"	1 pair	1 pair	absent
lateral spine						

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