Article

Taxonomical study of laboratory reared developmental stages of *Palaemon semmelinkii* (de Man, 1881) (Crustacea: Caridea: Palaemonidae)

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Received 7 June 2025; *Accepted 15 July 2025*; *Published online 10 August 2025*; *Published 1 March 2026*

Abstract
The ovigerous female of *Palaemon semmelinkii* (de Man, 1881) was collected from Ambro Creek (Lat. 24 °34'9"N Long. 67 °60'8"E) and kept in the laboratory. The larvae hatched after 5 days and survived until zoea II at room temperature 25 °C-29 °C in filtered seawater with a salinity of 35-37 parts per thousand and a pH of 7.5-7.9. In order to feed the larvae, *Artemia* nauplii was used. The larval developmental stages are described, illustrated and compared with those of its congener's larvae recognized previously.

Keywords Caridea; Palaemonidae; *Palaemon semmelinkii* larvae.

Arthropods
ISSN 2224-4255
URL: http://www.iaees.org/publications/journals/arthropods/online-version.asp
RSS: http://www.iaees.org/publications/journals/arthropods/rss.xml
E-mail: arthropods@iaees.org
Editor-in-Chief: WenJun Zhang
Publisher: International Academy of Ecology and Environmental Sciences

1 Introduction

The family Palaemonidae has freshwater, estuarine and marine habitats found along temperate and tropical coastlines. *Palaemon* species are tolerant of low salinities usually ranging up into brackish water estuaries and bays and into fresh water as well. The estuarine and marine species possess comparatively small and plentiful eggs and go through an extended and complex larval development before reaching the juvenile stage (Kazmi and Kazmi, 2012). Approximately 1200 species and 160 genera are included in this family (Sammy et al., 2009; Shane et al., 2011; GBIF, 2019). Some species are of commercial value as food or aquarium specimens (Reeve 1969a,b; Tsou et al., 1989). Until now, three *palaemon* species have been reported in Pakistan (i.e., *P. pacificus*, *P. semmelinki* and *P. sewelli*).

Previously few reports have been published on developmental stages of Palaemonidae in Pakistan (Yaqoob 1980, 1987; Ghory and Kazmi 2014, 2018; Ghory et al., 2021, 2022). Present article describes and illustrates the morphology of *Palaemon semmelinki* from the zoea I and II and given a species wise comparative account in tabulated form.

2 Materials and Methods

2.1 Study area

An ovigerous female of *Palaemon semmelinkii* (TL = 30 mm) was obtained from Ambro Creek Ambro Creek (Lat. 24 °34’9”N Long. 67 °60’8”E) is an inshore creek in Indus delta and receives fresh water through drain canal discharged from agriculture lands.

2.2 Methodology

The female was kept in the laboratory in filtered seawater. The water temperature were kept in 25 °C-29 °C and the salinity were assortment from 35 -37 ‰ until hatching occurred.

When the larvae hatched, the parental female was separated to a different aquarium and newly hatched larvae placed seven larvae per beaker (500 ml) of filtered seawater. The newly hatched nauplii of *Artemia* were served as food. We examined all beakers daily for dead larvae and exuviae.

2.3 Fixation/ preservation

Glycerin plus formalin (3:1) was used to prepare temporary slides. The spent female and the remaining larvae were fixed in 70% Ethanol and stored at the Marine Reference Collection and Resource Centre, University of Karachi.

2.4 Microscopic observations

Specimens were dissected under a binocular microscope (Nikon) with the aid 10x/21 magnifications, through the tungsten needle. Olympus BX51 microscope (magnifications WHN10X/22 x10, 20 and 40) with Nomarski interference contrast and *camera lucida* attachment was used to make the illustrations. The illustrated specimens measured by using a stage micrometer (millimeter = mm). Total length (TL) was measured from the tip of the rostrum to the mid posterior border of the telson.

Fig. 1 *Palaemon semmelinkii* (de Man, 1881).

3 Results

Description of Larvae

3.1 Zoea I (Figs. 2A – 3D)

Size.- TL= 2.26 mm - 2.27 mm

Duration.- 1 day.

Diagnostic Features.-

Carapace (Fig. 2A).- Smooth; rostrum long reaching end of the outer ramus of antennule, eyes sessile.
Antennule (Fig. 2B).- Peduncle 2-segmented, distal segment with 1 long plumose seta (endopod); outer ramus (exopod) with 3 aesthetascs and 2 plumose setae.
Antenna (Fig. 2C).- Biramous; endopod with 1 long plumose seta and 1 small simple seta; scaphocerite 5-segmented with 1,1 + 1,1,1 and 5 setae, respectively.
Mandible (Fig. 2D).- Well developed.
Maxillule (Fig. 2E).- Coxal endite with 4 setae; basial endite with 2 + 3 setae; endopod with 1 seta.
Maxilla (Fig. 2F).- Coxal and basial endites bilobed with 3 + 2 and 4 + 2 plumodenticulate setae, respectively; endopod with 1 seta; scaphognathite with 6 setae.
Maxilliped I (Fig. 2G).- Coxopod with 2 and basipod with 3 plumodenticulate setae; endopod 3-segmented with 0,1 and 3 + 1 plumodenticule setae, respectively;exopod 3-segmented, distal segment with 2 long plumose natatory setae.
Maxilliped II (Fig. 3A).- Coxopod broken; basipod naked; endopod 3-segmented with 0,1 and 5 (4 setae + 1 spine) plumodenticulate setae, respectively; exopod 4-segmented with 0,2,2 and 3 setae.
Maxilliped III (Fig. 3B).- Coxopod broken; basipod with 2 plumodenticulate setae; endopod 4-segmented with 1,0,1 and 6 (5 setae + 1 spine) plumodenticulate setae, respectively; exopod 4-segmented, distal segment with 4 long plumose natatory setae.
Pereiopod I-V (Fig. 3C).- rudimentry.
Abdomen (Fig. 2A).- 5 somites, with rounded posteriolateral angles.
Telson (Fig. 3D).- Triangular, posterior margin with 7 pairs of setae.

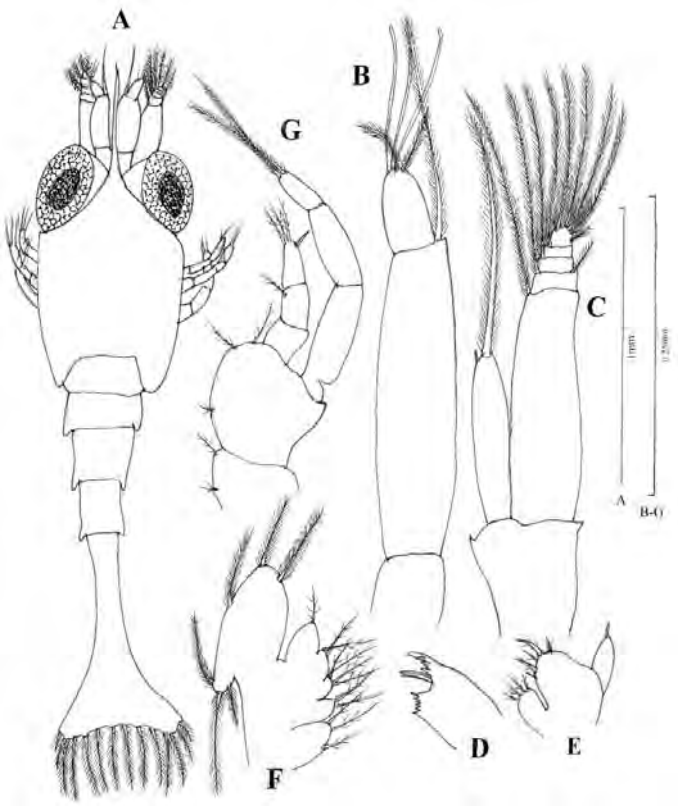

Fig. 2 *Palaemon semmelinkii* (de Man, 1881). Zoea I: A, entire, dorsal view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla, G , maxilliped I.

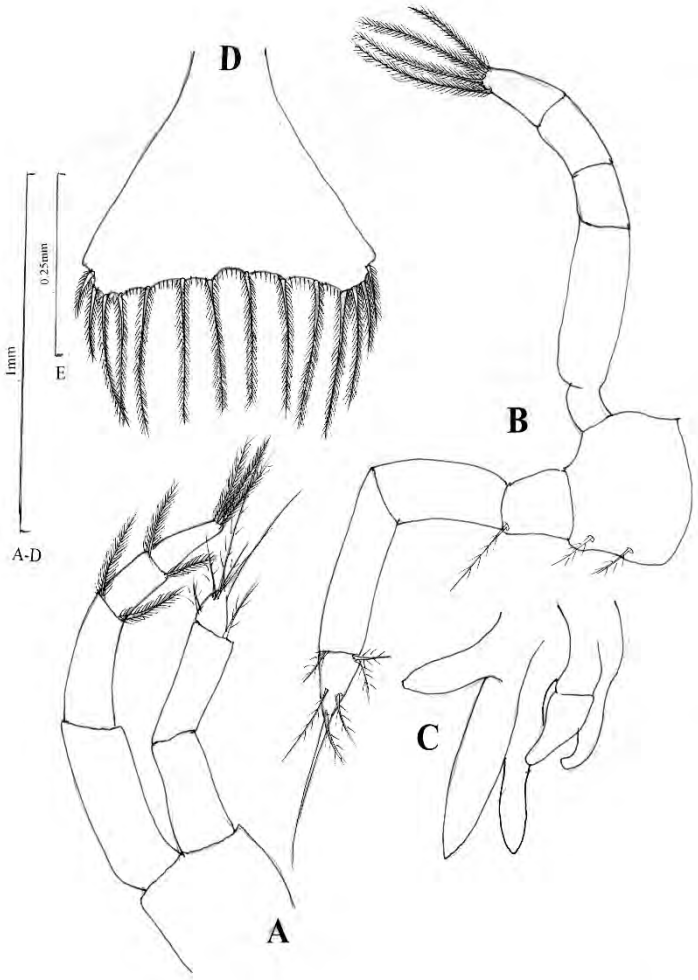

Fig. 3 *Palaemon semmelinkii* (de Man, 1881) Zoea I: A, B, maxilliped II,III; C, pereiopods I-V; D, telson.

3.2 Zoea II (Fig. 4A – M)

Size.- TL= 2.06 mm - 2.10 mm

Duration.- 1 day (died).

Diagnostic Features.-

Carapace (Fig. 4A).- With 1 epigastric and 1pairs of antennal spine; eyes stalked.

Antennule (Fig. 4B).- Peduncle unsegmented with 11 plumodenticulate setae; endopod in a form of long plumose seta; outer ramus (exopod) with 3 aesthetascs and 2 setae.

Antenna (Fig. 4C).- Biramous; endopod with 2 terminal plumose setae;scaphocerite 3-segmented with 14 setae.

Mandible (Fig. 4D).- Well developed.

Maxillule (Fig. 4E).- Coxal endite with 4 plumodenticulate setae; basial endite with 4 cuspidate and 3 plumodenticulate setae; endopod with 1 seta.

Maxilla (Fig. 4F).- Coxal endite with 4 + 2 plumodenticuate setae; basial endite with 4 + 2 plumodenticulate setae; endopod with 1 plumodenticulate seta; scaphognathite with 7 setae.

Maxilliped I (Fig. 4G).- Coxopod naked; basipod with 5 plumodenticulate setae; endopod 2 segmented with 0 and 3 + 1 plumodenticule setae, respectively; exopod 3-segmented with 2,2 and 4 setae.

Maxilliped II (Fig. 4H).- Coxopod with 1 seta; basipod with 3 plumodenticulate setae; endopod 3-segmented with 0,3 and 4 (3 setae + 1 spine) plumodenticulate setae, respectively; exopod 4-segmented with 0,2,2 and 4 plumose natatory setae

Maxilliped III (Fig. 4I).- Coxopod broken; basipod with 1 plumodenticulate seta; endopod 4-segmented with 1,0,2 and 5 (4 setae + 1 spine) plumodenticulate setae, respectively; exopod 3-segmented with 2,2 and 4 plumose natatory setae .

Pereiopod I-V (Figs. 4J-L).- Biramous; pereiopod I (Fig. 4J), basipod naked; endopod 4-segmented with 1,0,2 and 2 (1 seta + 1 spine) plumodenticulate setae; exopod 3-segmented with 0,2 and 4 plumose natatory setae; pereiopod II (Fig. 4K), basipod naked; endopod 4-segmented with 2,1,2 and 2 (1 seta + 1 spine) plumodenticulate setae; exopod 3-segmented with 0,2 and 3 plumose natatory setae; pereiopods III-V (Fig. 4L) rudimentary.

Abdomen (Fig. 4A).- Fifth abdominal somite with large posteriolateral angles.

Telson (Fig. 4M).- Posterior margin with 8 pairs of long plumose setae.

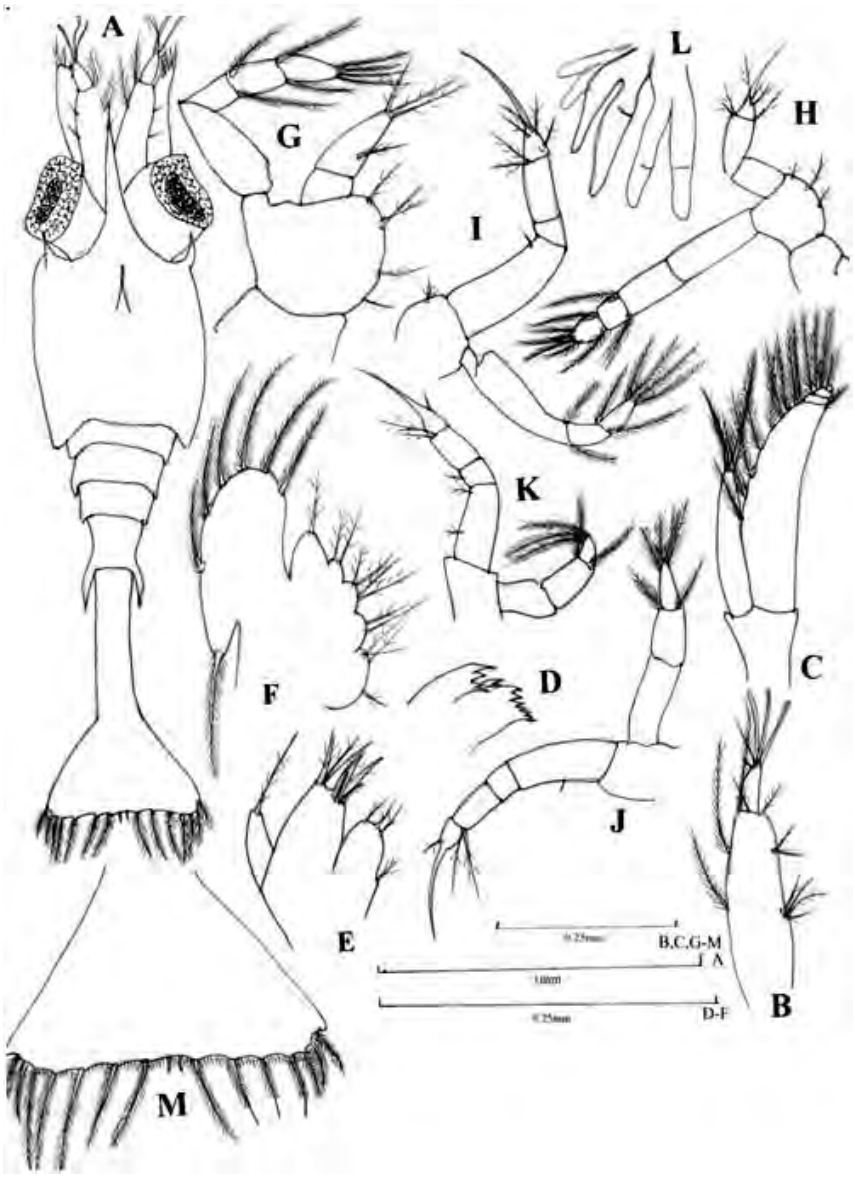

Fig. 4 *Palaemon semmelinkii* (de Man, 1881) Zoea II: A, entire, dorsal view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla, G - I, maxillipeds I - III; J - L, pereiopods I-V; M, telson.

Table 1 Comparative study of zoea I & II of *Palaemon semmelinkii* (present study) reared in the laboratory and its congeners.

Zoea I

Characters	***P. semmelinkii* present study**	***P. semmelinkii* Jagadisha & Sankolli (1977)**	***P. pacificus* Han & Hong (1978)**	***P. concinus* Pillai (1979)**	***P. concinus* Jayach andran (2001)**	***P. serrifer* Shy et al. (2005)**	***P. pacificus* Ghory & Kazmi (2014)**	***P. sewelli* Ghory et al. (2021)**
Total length	2.26mm - 2.27mm	2.35mm	2.10mm-2.28mm	2.37mm-2.62mm	--------	---------	2.08mm-2.59mm	1.43mm - 1.54mm
Carapace: epigastric spines	absent	absent	absent	absent	absent	one spine present	present	absent
Antennule: aesthetascs	3 aesthetascs	4 aesthetascs	4 aesthetascs	3 aesthetascs	3 aesthetascs	2 aesthetascs	3 aesthetascs	3 aesthetascs
Antenna: endopod	2 setae	1 spine +1 seta	1 spine +1 seta	1 spine +1 seta	1 spine +1 seta	2 setae	2 setae	1 seta
scaphocerite	10 setae	10 setae	10 setae	12 setae	17 setae	6 setae	distolateral spine + 8 setae	10 setae
Maxilliped I: exopod	2 setae	6 setae	4 setae + 2 spine	4 setae	4 setae	4 setae	6 setae	5 setae
Maxilliped II: exopod	7 setae	8 setae	7 setae	4 setae	4 setae	4 setae	8 setae	6 setae
Maxilliped III: exopod	4 setae	8 setae	8 setae	4 setae	4 setae	8 setae	8 setae	6 setae
Pereiopod I:	rudimentary	rudimentary	rudimentary	rudimentary	rudimentary	developed	rudimentary	rudimentary

Zoea II

Characters	***P. semmelinkii* present study**	***P. semmelinkii* Jagadisha & Sankolli (1977)**	***P. pacificus* Han & Hong (1978)**	***P. concinus* Pillai (1979)**	***P. concinus* Jayach andran (2001)**	***P. serrifer* Shy et al.(2005)**	***P. pacificus* Ghory & Kazmi (2014)**	***P. sewelli* Ghory et al. (2021)**
Carapace: epigastric spines	1 spine present	1 spine present	1 spine present	absent	absent	2 spines present	1 spine present	1 spine present
Antennule: aesthetascs	3	4 aesthetascs	4	3	3 aesthetascs	4	3	4

	aesthetascs		aesthetascs	aesthetascs		aesthetascs	aesthetascs	aesthetascs
Antenna: endopod	2 setae	1 spine + 1 seta	1 spine + 3 setae	1 spine + 3 setae	1 spine + 3 setae	2 setae	2 setae	3 setae
scaphocerite	14 setae	14 setae	13 setae	11 setae	11 setae	13 setae	16 setae	9 setae
Maxilliped I: exopod	8 setae	6 setae	4 setae	6 setae	5 setae	3 setae	6 setae	6 setae
Maxilliped II: exopod	8 setae	8 setae	8 setae	5 setae	4 setae	4 setae	8 setae	5 setae
Maxilliped III: exopod	8 setae	10 setae	8 setae	5 setae	5 setae	6 setae	8 setae	8 setae
Pereiopod I:	developed	developed	developed	developed	developed	developed	developed	rudimentary

4 Discussion

The larval development in palaemonid shrimp is divided into three types, including the common type, the abbreviated type, and the complete restraint type (Shokita,1970). *Palaemon semmelinkii* goes through 12 larval stages before the adult-like decapodid is reached (Jagadisha and Sankolli, 1977). It is considered more primitive than other congeners (Al-Abbad et al., 2008).

There are several points of similarity between the larvae of various species (Bhimachar, 1962). However, some differences in external features differ in the number of segments, endites and setal count do exist by which it is possible to distinguish the larvae (Table 1). These differences because of laboratory rearing conditions, ambient conditions related to geography, and / or individual genotypes (Knowlton and Vargo, 2004). Larvae of *P. semmelinkii* are very similar to those of *P. pacificus*; however, the some differences were found in antennal aesthetascs and exopod of maxilliped I.

References

Al-Abbad MY, Al-Mayah SH, Ali MH, Salman SD. 2008. Larval development of Caridean shrimp *Exopalaemon styliferus* (H. Milne-Edwards, 1840) (Decapoda: Caridae: Palaemonidae) from the south of Iraq reared in the laboratory. Turkish Journal of Zoology, 32: 397-406

Bhimachar BS. 1962. Information on prawns from Indian waters- Synopsis of biological data. Proceedings of the Indo-Pacific Fisheries Council (10th Session). 124-133, India

GBIF. 2019. Retrieved Palaemonidae. 12-30

Ghory FS, Kazmi, QB. 2014. Developmental stages of *Palaemon pacificus* (Stimpson, 1860) (Crustacea: Decapoda: Palaemonidae) reared under laboratory conditions. International journal of Biological Research, 2(2): 67-78

Ghory FS, Kazmi QB. 2018. Morphological study of first zoeal stage of *Anchistus custos* (forsskål, 1775) (Crustacea: Caridea: Palaemonidae: Pontoniinae) reared under laboratory conditions and note on parental mother identity. International Journal of Fauna and Biological Studies, 5(6): 23-26

Ghory FS, Kazmi QB, Kazmi MA. 2022. Description of the first to fourth zoeal stages of *Macrobrachium*

equidens (Dana, 1852) (Crustacea: Decapoda: Palaemonidae). Pakistan Journal of Marine Sciences, 31(1): 13-27

Ghory FS, Kazmi QB, Siddiqui FA. 2021. First report of laboratory reared developmental stages of *Palaemon sewelli* (Kemp, 1925) (Crustacea: Caridea: Palaemonidae: Palaemonidae). International Journal of Biological Science, 3(2): 56-62

Han CH, Hong SY. 1978. The larval development of *Palaemon pacificus* Stimpson (Decapoda : Palaemonidae) under the laboratory conditions. Publications of Institute of Marine Science Natural Fisheries University, 11: 1-17

Jagadisha K, Sankolli KN. 1977. Laboratory culture of the prawn *Palaemon* (*Palaeander) semmelinkii* (De Man) (Crustacea: Decapoda: Palaemonidae). In: Proceedings of the Symposium on Warm Water Zooplankton. 619-633, NIO, Goa

Jayachandran KV. 2001. Palaemonid prawns. Biodiversity, Taxonomy, Biology and Management. Science Publishers Inc, New Hampshire, USA

Kazmi QB, Kazmi MA. 2012. Biodiversity and Biogeography of Caridean Shrimps of Pakistan. MRC and HEC Publication, Pakistan

Knowlton RE, Vargo CK. 2004. The larval morphology of *Palaemon floridanus* Chace, 1942 (Decapoda, Palaemonidae) compared with other species of *Palaemon* and *Palaemonetes*. Crustaceana, 77(6): 683-715

Pillai NN. 1979. Early larval stages of *Palaemon* (*Palaemon) concinnus* Dana (Decapoda: Palaemonidae). Contribution to Marine Science Dedicated to Dr. C.V. Kurian. 243-255

Reeve MR. 1969a. The laboratory culture of the prawn *Palaemon serratus*. Fisheries Investigations, 26(1): 1-38

Reeve MR. 1969b. Growth, metamorphosis and energy conversion in the larvae of the prawn, *Palaemon serratus*. Journal of Marine Biological Association of the United Kingdom, 49(1): 77- 96

Sammy De G, N. Dean P, Shane TA, Tin-Yam C, Keith AC, Peter CD, Darryl LF, Rodney M F, Charles HJMF, Laura YDG, Rafael L, Martyn EYL, Joel WM, Peter KL Ng, Carrie E S, Tan SH, Dale T, Regina W. 2009. A classification of living and fossil genera of Decapod Crustaceans. Raffles Bulletin of Zoology, Supplement No. 21: 1-109

Shane TA, James KL, Miguel A, Roger N B, Geoffrey AB, Peter C, Sarah G, Gordan S K, Joseph WG, Diana SJ, Kenneth M, D. Christopher R, Jörundur S. 2011. Subphylum Crustacea Brünnich, 1772. In: Animal Biodiversity: An Outline Of Higher-Level Classification and Survey Of Taxonomic Richness (Vol. 3148) (Zhang ZQ, ed). 165-191

Shokita S. 1970. Studies on the multiplication of the freshwater prawn *Macrobrachium formosense* Bate-I. The larval development reared in the laboratory. Biological Magazine Okinawa, 6: 1-12

Shy JY, .Changand JJ, Lai HT. 2005. Complete larval development of *Palaemon serrifer* (Stimpson, 1860) (Crustacea: Decapoda: Palaemonidae) reared in Laboratory. Journal of the Fisheries Society of Taiwan, 32 (1): 79-86

Tsou YE, Shy JY, Yu HP. 1989. Morphological observations on larval development of *Palaemon (Palaemon) ortmanni* (Crustacea: Decapoda: Palaemonidae). Journal of the Fisheries Society of Taiwan 164: 247-260

Yaqoob M. 1980. Rearing of an economic fresh water prawn, *Macrobrachium lamarrei* (H.M.Edwards) under laboratory conditions. Pakistan Journal of Agriculture Research, 1(2): 139- 141

Yaqoob M. 1987. Larval development of freshwater commercial prawn under laboratory conditions. Pakistan Journal of Agriculture Research, 8(1): 90-101