

NOTE

Morphological description of Nauplius stages I and III, and Protozoa from stages I to III of *Metapenaeus stebbingi* Nobili, 1904 (Crustacea, Decapoda, Penaeidae)

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ABSTRACT. *Metapenaeus stebbingi* Nobili, 1904 is an Indo-Pacific shrimp species. Larvae of *M. stebbingi* were obtained from eggs that hatched four days after spawning from gravid females captured from incidental fishery. The naupliar and protozoal phases were reared for six days under controlled laboratory conditions at a room temperature of 30 °C, with seawater maintained at 29 °C, a salinity of 37‰, and pH 7.9. Nauplius stages I and III and Protozoa stages I, II, and III were maintained in filtered seawater. The larvae were described based on their principal diagnostic characteristics, and illustrations were prepared from the original material. This study constitutes the first report of the naupliar and protozoal phases of *M. stebbingi* from Pakistan.

Key words: Decapoda, Penaeidae, larvae, Pakistan.

Descripción morfológica de los estadios de nauplio I y III, y de la protozoa de los estadios I a III de *Metapenaeus stebbingi* Nobili, 1904 (Crustacea, Decapoda, Penaeidae)

RESUMEN. *Metapenaeus stebbingi* Nobili, 1904 es una especie de camarón del Indo-Pacífico. Se obtuvieron larvas de *M. stebbingi* a partir de huevos eclosionados cuatro días después del desove de hembras grávidas capturadas por pesca incidental. Las fases de nauplio y protozoa se criaron durante seis días en condiciones de laboratorio controladas, a una temperatura ambiente de 30 °C, con agua de mar mantenida a 29 °C, una salinidad de 37‰ y un pH de 7,9. Los estadios de nauplio I y III, así como los de protozoa I, II y III, se mantuvieron en agua de mar filtrada. Se describieron las larvas basándose en sus principales características diagnósticas y se elaboraron ilustraciones a partir del material original. Este estudio constituye el primer informe sobre las fases de nauplio y protozoa de *M. stebbingi* en Pakistán.

Palabras clave: Decapoda, Penaeidae, larvas, Pakistán.



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Penaeid shrimps have a key role coastal tropical and subtropical marine communities (Khafage et al. 2009). For identification of penaeid larvae, the literature described at genus level (Cook 1966; Hassan 1974; Razek and Taha 2006; Chong 2025), based on body descriptions (Hassan 1973, 1974, 1980, 1981, 1982, 1984, 1987, 1988, 1989, 1992, Haq and Hassan 1975, Tirmizi et al. 1981, Nandakumar et al. 1989, Hassan and Ahmed 1992, Ronquillo and

Saisho 1993, Khafage et al. 2009, Crisp et al. 2016, Chong 2025), genitalia (Tirmizi 1968, Tirmizi and Javed 1976, Siddiqui et al. 2004), breeding (Amjad 1988), reproductive organs and spawning (Zupanovic, 1971, Karim and Rehman 1975, Sultana et al. 1994, Nisa and Ahmed 2001, 2002a, 2002b, Ayub and Ahmed 2002, Amanat and Qureshi 2011).

The aim of this study was provide a description of development of the planktonic stages (nauplius I and III and protozoa I, II, and III) of *M. stebbingi* Nobili, 1904.

The collection of gravid females (TL = 59.6 mm, CL = 17.2 mm) was conducted at Clifton, Karachi (24° 46' 05" N, 66° 57' 51" E) at approximately 30 m depth using a Bongo net (300-µm mesh) towed for 30 min. An intact adult female of *Metapenaeus stebbingi* was incidentally captured during the tow and subsequently transferred alive to a container for transportation to the wet laboratory at (MRC & RC) University of Karachi. The female was kept in the laboratory in 100-l fiber glass tanks filled with filtered seawater and aerated vigorously, with a salinity of 35-37 and a pH of 7.5-7.9 at room temperature (29-30 °C). The larvae were noted to hatch after 4 days. Newly hatched larvae were separated and placed in five beakers (500 ml), each with five larvae. Diatoms, dominated by *Chaetoceros* sp., were fed daily at a density of 50,000 cells ml⁻¹. Each beaker was examined hourly during the day and night for exuviae and dead larvae.

Temporary slides were made by using glycerine plus 5% formalin (3:1). Nauplius stages I and III, as well as Protozoa stages I-III were obtained over six days. Nauplius stage II was not observed and was presumably skipped, possibly reflecting an abbreviated pattern of larval development (Table 1). Abbreviated development is a broad concept encompassing multiple patterns of larval development that differ in the degree of yolk dependence, duration of the planktonic phase, and number of larval stages. A stereomicroscope (Nikon) with 10 × magnification was used to dissect the specimens using tungsten needles. The illustrations were made with the help of an Olympus BX51 compound microscope (magnifications 10 × 10, 10 × 20, and 10 × 40) with Nomarski interference contrast and a drawing tube attachment. Measurements (mm) of illustrated specimens were made using a stage micrometer. The total length (TL) was determined from the tip of the rostrum to the mid-posterior border of the telson. In Nauplius stages we determined the carapace length (CL). The spent female and remaining, non-dissected larvae were preserved in alcohol and lodged in the Marine Reference Collection and Resource Centre, University of Karachi (Cat. No. MRC&RC-UOK-PEND- 259). Stages were compared with field collected specimens of the same species, co-occurring species from the local area, laboratory reared stages described by other authors, and all previously described larval stages of the genus *Metapenaeus* (Table 2).

Table 1. An examination of the laboratory reared larva I stages of *Metapenaeus stebbingi* Nobili, 1904 and the time elapsed of their first appearance. TL = total length.

Stage	Time (h)	TL (mm)
Nauplius stage I ^a	3-4	0.21-0.29
Nauplius stage III	4-5	0.35-0.40
Protozoa stage I	48	0.67-0.70
Protozoa stage II	48	0.81-0.85
Protozoa stage III	24	1.64-1.66

^aTime elapsed since hatching

Table 2. Morphological comparison between Nauplius stage I to Protozoa stage III of *Metapenaeus stebbingi* Nobili, 1904 and its congeners. NR: not reported.

Character	<i>M. stebbingi</i> (present study)	<i>M. stebbingi</i> cf. Gurney (1927)	<i>M. dobsoni</i> (Miers, 1878) cf. Menon (1951)	<i>M. affinis</i> (H. Milne Edwards, 1837) cf. Thomas et al. (1974)	<i>M. dobsoni</i> cf. Muthu et al. (1978a)	<i>M. affinis</i> cf. Muthu et al. (1978b)	<i>M. monoceros</i> (Fabricius, 1798) cf. Mohamed et al. (1978)	<i>M. brevicornis</i> (H. Milne Edwards, 1837) cf. Rao (1978)	<i>M. affinis</i> cf. Hassan (1980)	<i>M. affinis</i> cf. Tirmizi et al. (1981)	<i>M. dalli</i> Crisp et al. 2016
Nauplius I											
Total length	0.21 mm-0.29 mm	0.29 mm	0.26 mm- 0.28 mm	0.21 mm-0.25 mm	0.25 mm-0.28 mm	0.24 mm- 0.27 mm	0.26 mm-0.28 mm	0.27 mm	0.28 mm	0.28 mm- 0.30 mm	0.300 mm
Duration of the stage	3 - 4 h	NR	NR	10 h	3-4 h	3-4 h	3-4 h	5 h	10 h	8 h	NR
Antennule	with 3 terminal setae	with 3 terminal setae and some short marginal setae	with 5 setae	with 5 terminal setae	with 3 terminal setae + 3 short lateral setae on inner margin	with 3 terminal setae + 3 short lateral setae on inner margin	with 3 terminal setae + 3 short lateral setae on inner margin	with 3 terminal setae + 3 short lateral setae on inner margin + 1 seta on dorsolateral distal margin	with 3 ventrolateral setae, 2 terminal setae + 1 long dorsolateral setae	with 2 terminal setae	with 4 terminal setae
Antenna endopod	with 3 setae	with 2 setae	with 3-4 setae	with 4 setae	with 5 setae	with 5 setae	with 5 setae	with 5 setae	with 5 setae	not mentioned	with 2 setae
exopod	with 5 setae	with 5 setae	with 5 setae	with 7 setae	with 5 setae	with 5 setae	with 5 setae	with 5 setae	with 5 setae	not mentioned	with 3 setae
Nauplius III											
Total length	0.35 mm ± 0.40 mm	0.11 mm- 0.43 mm	0.36 mm- 0.39 mm	0.26 mm- 0.28 mm	0.28 mm- 0.29 mm	0.25 mm- 0.27 mm	0.28 mm- 0.29 mm	0.28 mm- 0.29 mm	0.31 mm	0.295- 0.336 mm	0.310mm
Duration of the stage	4 - 5 h	NR	NR	4-7 h	5-8 h	3-4 h	3-4 h	7½h	10 h	12 h	NR
Antennule	with 4 terminal setae	not mentioned	with 6-7 setae	with 5 terminal setae	with 3 terminal setae + 3 segments + 1 short lateral setae	with 3 terminal setae + 3 segments + lateral setae	with 3 terminal setae + 3 short lateral setae on inner margin	with 7 terminal setae	with 7 setae	with 3 terminal setae	with 4 terminal setae +4 segments
Antenna endopod	with 4 setae	NR	with 3-4 setae	with 4 setae	with 5 setae	not mentioned	with 3 setae	with 5 setae	with 4 setae	with 3 terminal setae	with 4 setae

Table 2. Continued.

Character	<i>M. stebbingi</i> (present study)	<i>M. stebbingi</i> cf. Gurney (1927)	<i>M. dobsoni</i> (Miers, 1878) cf. Menon (1951)	<i>M. affinis</i> (H. Milne Edwards, 1837) cf. Thomas et al. (1974)	<i>M. dobsoni</i> cf. Muthu et al. (1978a)	<i>M. affinis</i> cf. Muthu et al. (1978b)	<i>M. monoceros</i> (Fabricius, 1798) cf. Mohamed et al. (1978)	<i>M. brevicornis</i> (H. Milne Edwards, 1837) cf. Rao (1978)	<i>M. affinis</i> cf. Hassan (1980)	<i>M. affinis</i> cf. Tirmizi et al. (1981)	<i>M. dalli</i> Crisp et al. 2016
exopod	with 8 setae	NR	with 8 setae	with 7 setae	with 7 setae	with 6 setae	with 6 setae	with 7 setae	with 7 setae	with 5 terminal setae	with 7 setae
Protozoa I											
Total length	0.67mm ± 0.70 mm	0.66 mm-0.94 mm	0.67 mm- 0.74 mm	0.71 mm-0.78 mm	0.73 mm-0.77 mm	0.77 mm- 0.78 mm	0.80 mm-0.85 mm	0.81 mm- 0.89 mm	0.81 mm	0.85 mm- 1.25 mm	0.746 mm
Duration of the stage	48 h	NR	NR	48-74 h	36-48 h	24-72 h	48-60 h	48 h	42 h	72 h	NR
Antennule	3-segmented with 4+1 setae	6-segmented with 2 setae	5-segmented with 2 setae, 3 (aesthetascs) + few setae on internal & outer margin	3-segmented with 3+3 setae	3-segmented with 1, 3+1 and 1+3 setae	3-segmented with 1+2 setae, 3 (aesthetascs) and 2 setae	3-segmented with 5, 2+2 and 4+ 3 (aesthetascs)	3-segmented with 1, 3, 2 and 2 (aesthetascs)	3-segmented with 1, 4 and 3+3 setae	3-segmented with 2, 2 and 0 setae	3-segmented with 1, 2, 1,1 and 1 setae
Antenna endopod	2, 2 and 4 setae	2-segmented	2, 2 and 4 setae	3 and 5 setae	1+2+3 and 5 setae	1+2+3 and 5 setae	2-segmented with 1+2+3 and 5 setae	2-segmented with 3+2+1 and 5 setae	2-segmented with 2+2, 1 and 5 setae	3, 2 and 4 setae	5, 6 and 3 setae
scaphocerite	12 setae	13 setae	11 setae	11 setae	12 setae	12 setae	12 setae	12 setae	12 setae	9 setae	4 setae
Maxillule coxa	6 setae	NR	6 setae	6 setae	7 setae	7 setae	7 setae	7 setae	7 setae	4 setae	7setae
basis	5 setae	NR	5 setae	4 setae	4 setae	4 setae	4 setae	4 setae	4 setae	5 setae	7 setae
endopod	2-segmented with 3 and 4 setae	3-segmented	3-segmented with 5, 2 and 3 setae	3-segmented with 2, 2 and 4 setae	3-segmented with 5, 2 and 3 setae	3-segmented with 5, 2 and 3 setae	3-segmented with 5, 2 and 3 setae	3-segmented with 5, 3 and 2 setae	3-segmented with 4, 2 and 2 setae	partially segmented with 2, 4 and 2 setae	2-segmented with 5 and 5 setae
Maxilla protopodite	5 lobes with 5, 2, 1, 3 and 2 setae	4 lobes	5 lobes with 5, 3, 3, 4 and 3 setae	5 lobes with 5, 2, 3, 3 and 3 setae	5 lobes with 8 and 3-4 setae	5 lobes with 6-8 and 3-4 setae	5 lobes with 7-8 and 3-4 setae	5 lobes with 6 and 3-4 setae	5 lobes with 6 and 3-4 setae	5 lobes with 5, 2, 2, 3 and 2 setae	NR
endopod	with 2, 2 and 3 setae	NR	with 2, 2 and 3 setae	with 3 and 2 setae	with 3 and 2 setae	with 2, 2 and 3 setae	with 2, 2, 2 and 3 setae	with 3, 2, 2 and 2 setae	with 3, 2, 2 and 2 setae	with 2, 2, 1 and 3 setae	with 3, 2, 2,2 and 1 setae
scaphognathite	with 4 setae	with 5 setae	with 5 setae	with 5 setae	with 5 setae	with 5 setae	with 5 setae	with 5 setae	with 5 setae	with 4 setae	with 5 setae

Table 2. Continued.

Character	<i>M. stebbingi</i> (present study)	<i>M. stebbingi</i> cf. Gurney (1927)	<i>M. dobsoni</i> (Miers, 1878) cf. Menon (1951)	<i>M. affinis</i> (H. Milne Edwards, Thomas et al. (1974)	<i>M. dobsoni</i> cf. Muthu et al. (1978a)	<i>M. affinis</i> cf. Muthu et al. (1978b)	<i>M. monoceros</i> (Fabricius, 1798) cf. Mohamed et al. (1978)	<i>M. brevicornis</i> (H. Milne Edwards, 1837) cf. Rao (1978)	<i>M. affinis</i> cf. Hassan (1980)	<i>M. affinis</i> cf. Tirmizi et al. (1981)	<i>M. dalli</i> Crisp et al. 2016
Maxilliped I coxa and basis	without setae	NR	coxa with 4 setae; basis with 6 setae	coxa with 5 setae; basis with 3 setae	coxa with 7 setae; basis with 4 setae	coxa with 3-4 setae; basis with 11-12 setae	coxa with 5 setae; basis with 2 setae	coxa with 5 setae; basis with 11-12 setae	coxa with 6 setae	coxa without setae; basis with 1 seta	coxa with 5 setae; basis with 3 setae
endopod	4-segmented with 2, 2, 1 and 5 setae, respectively	NR	4-segmented with 2, 3, 2 and 5 setae, respectively	4-segmented with 3, 1, 2 and 5 setae, respectively	4-segmented with 3, 1, 2 and 5 setae, respectively	4-segmented with 3, 1, 2 and 5 setae, respectively	4-segmented with 3, 1, 2 and 5 setae, respectively	4-segmented with 3, 1, 2 and 5 setae, respectively	4-segmented with 3, 2, 2 and 4 setae, respectively	5-segmented with 1, 1, 1, 1 and 4 setae, respectively	5-segmented with 5, 2, 2, 3 and 3 setae, respectively
exopod	4-segmented with 0, 1, 1 and 3 setae, respectively	unsegmented with 6 setae	unsegmented with 5 setae	unsegmented with 7 setae	unsegmented with 7 setae	unsegmented with 7 setae	unsegmented with 7 setae	unsegmented with 7 setae	unsegmented with 7 setae	unsegmented with 6 setae	unsegmented with 7 setae
Maxilliped II exopod	3-segmented	NR	unsegmented	unsegmented	unsegmented	Unsegmented	unsegmented	unsegmented	unsegmented	unsegmented	NR
Maxilliped III	well developed	biramous, exopod with 1 or 2 setae	biramous, exopod with 2 setae	rudimentary	rudimentary	biramous, exopod with 2 setae	biramous, exopod with 2 setae	unsegmented	biramous, exopod with setae	rudimentary	uniramous, exopod with 2 setae
Protozoaea II											
Total length	0.81 mm ± 0.85 mm	1.3 mm- 1.4 mm	0.81 mm- 0.98 mm	1.16 mm- 1.20 mm	1.15 mm- 1.30 mm	1.19 mm- 1.26 mm	1.41 mm- 1.64 mm	1.09 mm- 1.15 mm	1.23 mm	1.56 mm- 2.18 mm	1.178 mm
Duration of the stage	48 h	NR	NR	25-31 h	48-72 h	24-48 h	48-60 h	40 h	46 h	120 h	NR
Maxilliped III	well developed	biramous, exopod with 1 or 2 setae	biramous, exopod with 3 setae	biramous, exopod with 3 setae	biramous, exopod with 2 setae	biramous, exopod with 3 setae	biramous, exopod with 3 setae	biramous, exopod with 3 setae	biramous, exopod with 3 setae	NR	biramous, exopod with 3 setae
Protozoaea III											
Total length	1.64 mm ± 1.66 mm	1.65 mm- 1.75 mm	1.6 mm	1.86 mm- 1.88 mm	1.48 mm- 1.75 mm	1.77 mm- 2.03 mm	1.92 mm- 2.99 mm	1.38 mm- 1.51 mm	1.75 mm	2.8 mm- 3.2 mm	1.824mm
Duration of the stage	died after 12 h	NR	NR	23-30 h	36-48 h	48-72 h	36-60 h	32 h	48 h	168 h	NR
Uropod	biramous without setae	biramous with setae	biramous with few setae	biramous without setae	biramous with setae	biramous with setae	biramous with setae	biramous with setae	biramous with setae	biramous with setae	biramous with setae

Metapenaeus stebbingi Nobili, 1904

Synopsis of previous work reporting the development of the species

Gurney (1927): 228-229; Hassan and Haq (1975): 219-231; Tirmizi and Javed (1976): 55-67 (juvenile); Samocha and Lewinsohn (1977): 291-292 (rearing to postlarva); Hassan (1992): 190-194 (juvenile); Saxena (2005): 446 (postlarva, juvenile).

Larvae description

Nauplius phase

Nauplius stage I (Figure 1 A-D). The first free swimming unsegmented planktonic larval phase. Body (Figure 1 A): Oval shape, median eye present, 1 pair of furcal setae on posterior end. Antennule (Figure 1 B): Uniramous, with 3 terminal setae. Antenna (Figure 1 C): Biramous; unsegmented endopod and exopod with 3 and 5 setae, respectively. Mandible (Figure 1 D): Biramous, palps with 2 and 3 setae, respectively.

Nauplius Stage II. Not observed.

Nauplius Stage III. Body (Figure 2 A): More or less elongated, median eye present. Antennule (Figure 2 B): Uniramous; 3-segmented peduncles, terminal segment with 1 long and 3 short setae. Antenna (Figure 2 C): Biramous; endopod and exopod with 4 and 8 setae, respectively. Mandible (Figure 2 D): Biramous, with 3 setae on each ramus. Telson (Figure 2 E): Forked with 7 + 7 setae, central notch present.

Zoeal phase

Protozoea I (Figure 3 A-J). Carapace (Figure 3 A): Smooth, notched at the anterior margin; rostrum absent; eyes sessile. Antennule (Figure 3 B): Uniramous; 3-segmented peduncle, terminal segment with 4 terminal and 1 subterminal plumodenticulate setae. Antenna (Figure 3 C): Biramous; with three segments endopod with 2, 2 and 4 plumodenticulate setae; scaphocerite with 12 setae. Mandible (Figure 3 D): Well developed. Maxillule (Figure 3 E): Coxa with 6 setae; basis with 5 setae; 2-segmented endopod with 3 and 4 setae, respectively; exopod with 4 setae. Maxilla (Figure 3 F): Protopodite with 5 lobes bearing

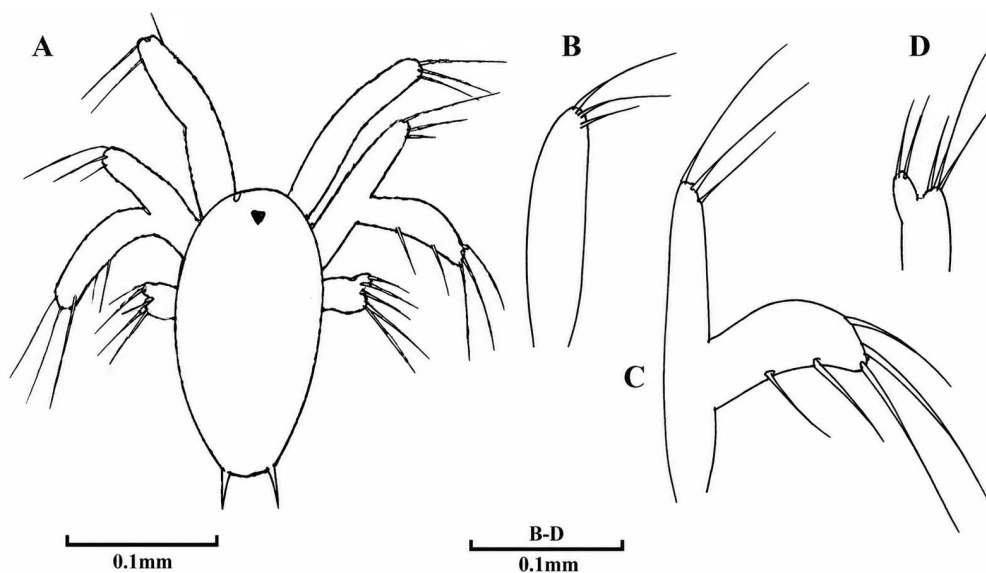


Figure 1. *Metapenaeus stebbingi* Nobili, 1904. Nauplius Stage I: entire animal, dorsal view (A), antennule (B), antenna (C), mandible (D).

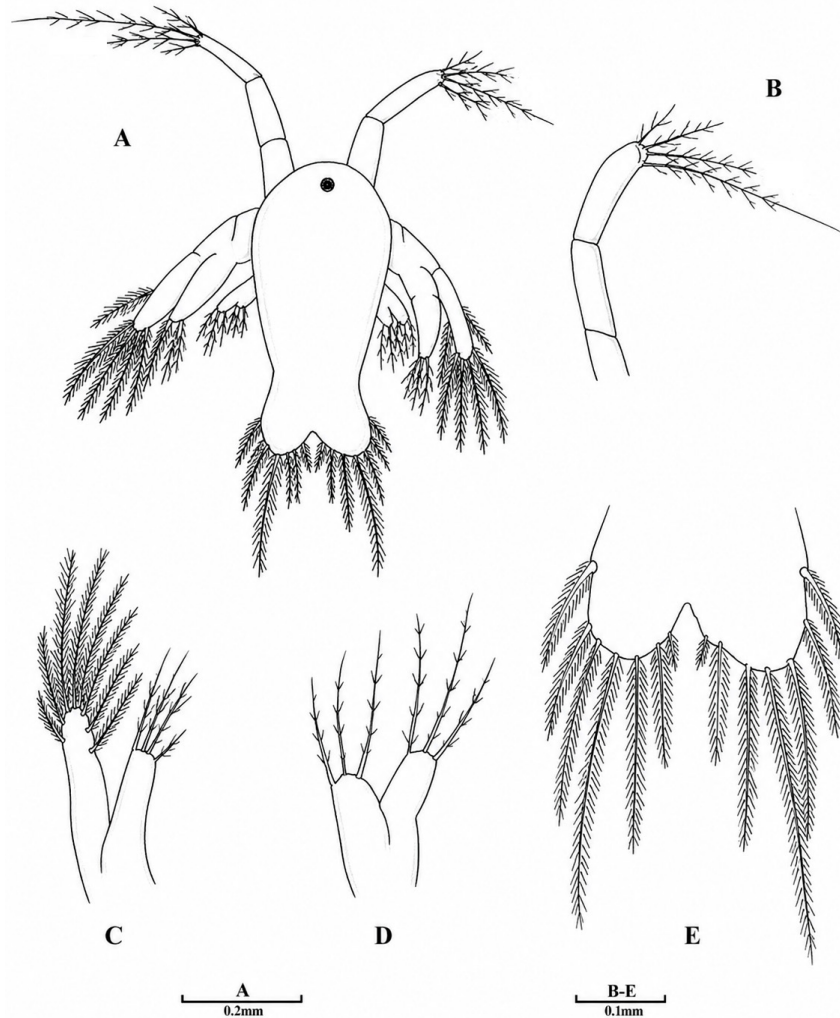


Figure 2. *Metapenaeus stebbingi* Nobili, 1904. Nauplius Stage III: entire animal, dorsal view (A), antennule (B), antenna (C), mandible (D), telson (E).

5, 2, 1, 3 and 2 setae, respectively; 3-segmented endopod, with 2, 2 and 3 plumodenticulate setae; scaphognathite with 4 setae. Maxilliped I (Figure 3 G): Coxa and basis naked (without setae); 4-segmented endopod with 2, 2, 1 and 5 plumodenticulate setae, respectively; 4-segmented exopod with 0, 1, 1 and 3 plumodenticulate setae, respectively. Maxilliped II (Figure 3 H): Coxa and basis naked; 3-segmented endopod with 1, 1 and 1 + 4 plumodenticulate setae, respectively; 3-segmented exopod with 1, 1 and 1 + 3 plumodenticulate setae,

respectively. Maxilliped III (Figure 3 I): Biramous; basis with 1 seta; 2-segmented endopod with 1 and 3 setae, respectively; 3-segmented exopod with 1, 0 and 2 plumodenticulate setae. Abdomen (Figure 3 A): Indistinctly segmented, last somite longer than the others. Telson (Figure 3 J): Forked with 1 pair of lateral setae and 6 pairs of postero-lateral setae, central indentation deep.

Protozoa II (Figure 4 A-D). Carapace (Figure 4 A): Smooth, as long as broad; small rostrum present; 1 median and 1 pair of supra-orbital spines

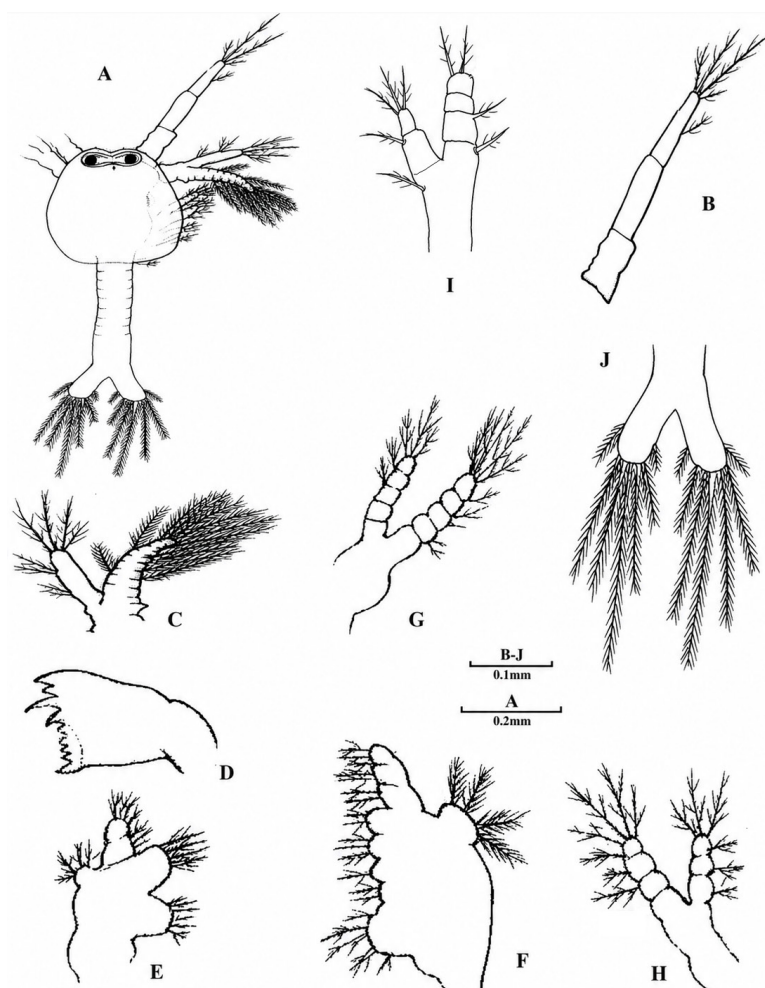


Figure 3. *Metapenaeus stebbingi* Nobili, 1904. Protozoa Stage I: entire animal, dorsal view (A), antennule (B), antenna (C), mandible (D), maxillule (E); maxilla (F); maxillipeds I-III (G-I), telson (J).

present; eyes stalked. Antennule (Figure 4 B): Uniramous; 3-segmented peduncle, with 1, 1 and 4 plumodenticulate setae, respectively. Antenna (Figure 4 C): Biramous; with three segmentes-endopod with 2, 2 and 4 plumodenticulate setae; scaphocerite with 12 setae. Abdomen (Figure 4 A): Segmented, last somite longer than the others. Telson (Figure 4 D): Forked with 2 pairs of lateral setae, and 5 pairs of posterolateral setae, central indentation broad.

Protozoa III (Figure 5 A-E). Carapace (Figure 5 A): Smooth, as long as broad; rostrum long, dis-

tally pointed; median and lateral spines present; eyes stalked. Antennule (Figure 5 B): Uniramous; 3-segmented peduncle, with 0, 1 + 2 + 1 and 1 + 4 plumodenticulate setae. Antenna (Figure 5 C): endopod with 1 + 1 and 3 plumodenticulate setae; scaphocerite with 12 setae. Abdomen (Figure 5 A): 6-segmented, with pointed posterolateral angles. Telson (Figure 5 D): Forked with 1 pair of lateral spines, 2 pairs of lateral setae, 3 pairs of posterolateral setae; central indentation broad; uropod biramous with both rami fully formed (Figure 5 E).

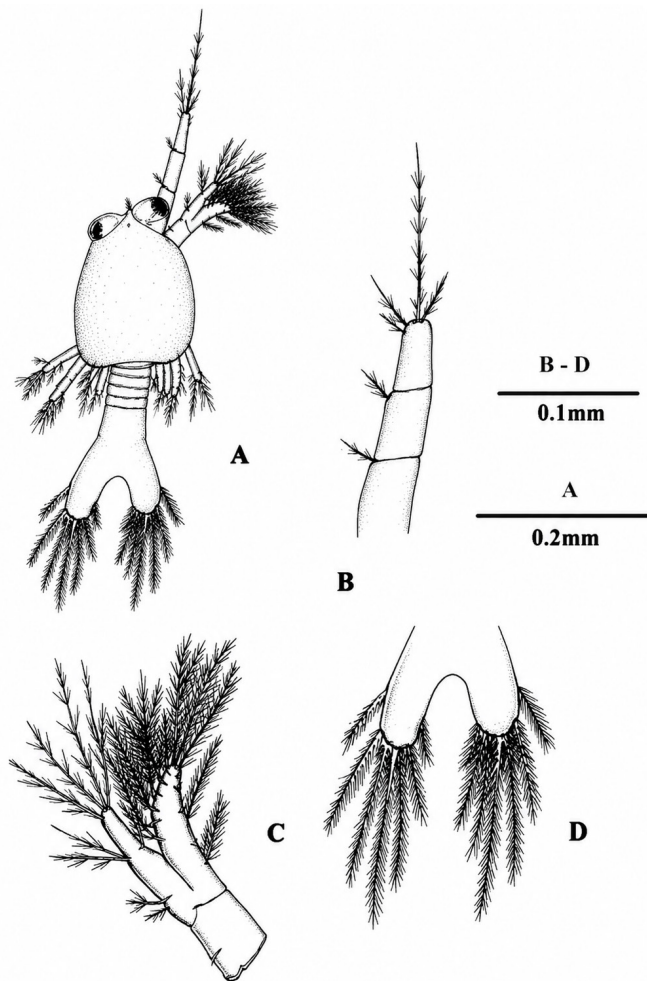


Figure 4. *Metapenaeus stebbingi* Nobili, 1904. Protozoeca Stage II: entire animal, dorsal view (A), antennule (B), antenna (C), telson (D).

The larval development of this species has not previously been described in detail, except for a brief report by Samocha and Lewinsohn (1977). Thus, the present study provides new information on the early larval development of *M. stebbingi*. All other accounts focus on juveniles (Hassan and Haq 1975; Sultana and Mustaqim 1991; Hassan 1992; Ahmed and Ayub 1999; Siddiqui et al. 2004; Saxena 2005; Razek and Taha 2006). Gurney (1927) found penaeid eggs and all larval stages of a penaeid species in the Bitter Lakes, Suez Canal and by a process of elimination, it was concluded that

they probably belonged to *M. stebbingi*. Morphological changes during the larval development of *M. stebbingi* are generally similar to those reported for other penaeid species (Thomas et al. 1974; Mohamed et al. 1978; Muthu et al. 1978a, b; Rao 1978; Hassan 1980; Tirmizi et al. 1981). However, reliable identification of penaeid larvae to species level requires the analysis of diagnostic morphological characters, often using discriminant analysis (Rothlisberg et al. 1983; Jackson 1986). Detailed characterization of larval development is therefore important for evaluating developmental patterns,

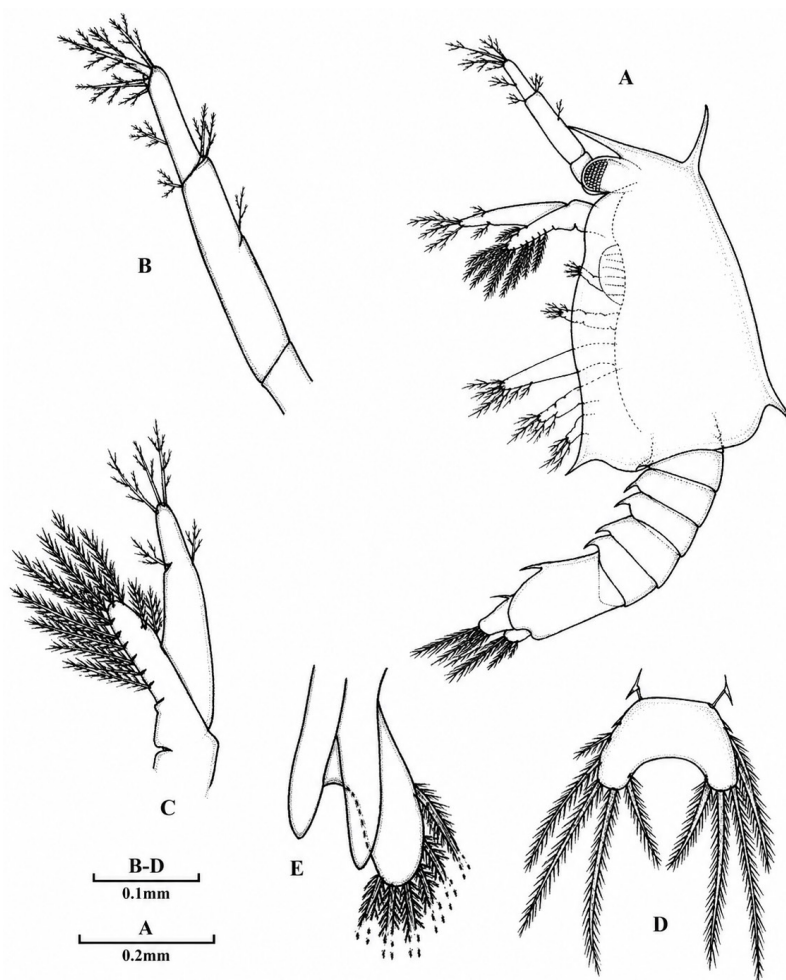


Figure 5. *Metapenaeus stebbingi* Nobili, 1904. Protozoa Stage III: entire animal, lateral view (A), antennule (B), antenna (C), telson (D), uropod with tip of telson (E).

improving aquaculture rearing techniques, and distinguishing among congeneric species with overlapping geographical distributions (Rothlisberg et al. 1983; Jackson and Rothlisberg 1994). Previous studies have consequently sought morphological characters that can be used to distinguish penaeid larvae at the generic and specific levels (Cook 1966; Cook and Murphy 1971; Courties 1976).

In the present study, the naupliar and protozoal stages of *M. stebbingi* were compared with field-collected larvae of the same species, larvae of co-occurring penaeid species from the local

area, laboratory-reared stages reported by previous authors, and all previously published larval descriptions of the genus *Metapenaeus*. These comparisons revealed differences in larval size, number of developmental stages, and the setation of appendages. Such comparative morphological characters provide a useful basis for distinguishing the early developmental stages of *M. stebbingi* from those of other penaeid species. The present study therefore contributes to the identification and morphological characterization of the early larval stages of *M. stebbingi*.

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Author contributions

Farhana S. Ghory: conceptualization; data curation; funding acquisition; investigation; methodology; resources; writing-original draft preparation. Quddusi B. Kazmi: conceptualization; data curation; investigation; methodology. Patricio R. De los Ríos-Escalante: investigation; writing-original draft preparation; writing-review and editing.

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