Pueruli of *Panulirus polyphagus* (Herbst) (Crustacea, Decapoda, Palinuridae) from east coast of India with a key to known Indo-West Pacific pueruli of *Panulirus* White

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ABSTRACT

Pueruli of the spiny lobster *Panulirus polyphagus* are being reported for the first time from the western part of the Bay of Bengal, along the east coast of India. Diagnostic characters and a revised key to the identification of the known pueruli of the Indo-West Pacific species of *Panulirus* are given.

INTRODUCTION

Puerulus stage [post-larva (Gordon 1953); megalopa (Williamson 1969)] in the life history of five of the eleven Indo-West Pacific species of the spiny lobster *Panulirus* White, 1847, has been described; of these, the puerulus of only *P. polyphagus* (Herbst 1793) has so far been reported from Indian waters, and that too from the west coast of India. The pueruli of the other four species have not so far been recorded from Indian waters. This is the first report of the puerulus of *P. polyphagus* from the western part of the Bay of Bengal along the east coast of India, the other two Indian records being from Bombay (Deshmukh 1966) and Cochin (Rao and Kathirvel 1972). Although there is no fishery for *P. polyphagus* along this part of the coast, the present collection of pueruli suggests the existence of a lobster bed off the mouth of river Krishna.

MATERIAL AND METHOD

One puerulus from a boat seine catch off Suryalanka on December 30, 1973 and six pueruli from a stow net catch in Kothapalem Bay (immediately south of the mouth of river Krishna) on January 24, 1974. Two of the pueruli from the latter collection have been deposited in the British Museum (NH)—Reg. No. 1974: 739.
**Pueruli of Panulirus polyphagus**

Body length (BL) measured mid-dorsally from tip of supraorbital spine to telson tip; carapace length (CL) measured from tip of supraorbital spine to posterior margin of carapace; carapace width (CW) measured at level of third pereopod base where it is widest; although antennae incomplete in all specimens, length measured (for confirming identification) from base of peduncle to broken tip; antennules intact in all but one specimen—length of longer (inner, thinner) flagellum measured from base of peduncle to tip; number of segments in inner and outer flagellae of antennule counted.

**CHARACTERS OF THE Puerulus**

At the time of collection the pueruli were dead. Body (figure 1) milky white; antennal flagellae with alternate light brown and white bands. Biometric data are given in table 1.

Carapace studded with spines and carinae as follows:

1. anterior margin bears a pair of triangular supraorbital spines with short carinae dorsally; 2. the anterolateral angle bears a strong spine; 3. dorsally in the anterior half there are three pairs of small but distinct spines and 4. the posterior half of the carapace has three longitudinal carinae, one mid-dorsal and two lateral.

**Table 1. Biometric data of pueruli of Panulirus polyphagus (Herbst); measurements in mm.**

<table>
<thead>
<tr>
<th>No.</th>
<th>Locality and date</th>
<th>BL</th>
<th>CL</th>
<th>CW</th>
<th>Length of antennae (incomplete) left/right</th>
<th>Length of antennule (right, inner longer flagellum)</th>
<th>No. of segments in right antennular flagellae inner/outer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Suryalanka</td>
<td>21.5</td>
<td>8.5</td>
<td>5.0</td>
<td>46.5/51.0</td>
<td>9.0</td>
<td>27/23</td>
</tr>
<tr>
<td>2.</td>
<td>Kothapalem Bay</td>
<td>21.0</td>
<td>8.5</td>
<td>5.0</td>
<td>23.0/35.5</td>
<td>8.5</td>
<td>26/21</td>
</tr>
<tr>
<td>3.*</td>
<td>,,</td>
<td>21.5</td>
<td>8.5</td>
<td>5.0</td>
<td>28.0/44.5</td>
<td>9.0</td>
<td>26/22</td>
</tr>
<tr>
<td>4.</td>
<td>,,</td>
<td>22.0</td>
<td>9.0</td>
<td>5.0</td>
<td>46.0/52.0</td>
<td>9.0</td>
<td>27/22</td>
</tr>
<tr>
<td>5.</td>
<td>,,</td>
<td>22.5</td>
<td>9.0</td>
<td>5.5</td>
<td>36.5/..</td>
<td>9.0</td>
<td>29/22</td>
</tr>
<tr>
<td>6.</td>
<td>,,</td>
<td>23.0</td>
<td>9.0</td>
<td>5.5</td>
<td>52.0/35.0</td>
<td>(left = 9.0) (left = 26/21)</td>
<td></td>
</tr>
<tr>
<td>7.*</td>
<td>,,</td>
<td>23.0</td>
<td>9.0</td>
<td>5.5</td>
<td>24.5/..</td>
<td>10.0</td>
<td>27/23</td>
</tr>
</tbody>
</table>

Of the three pairs of spines on the anterior half of the carapace, one pair lies behind the short carinae extending from the supraorbital spines, the second pair is behind the eyes and the third pair at the anterior end of the lateral carinae. In addition there are two pairs of 'incipient spinules' (Gordon 1953) in the gastric region just in front of the median carina.

Thoracic sternum bears a pair of strong backward directed spines at the base of fifth pereopod. Abdominal terga smooth dorsally; pleura of somites 2 to 6 end in posteriorly directed spines and tergum of somite 6 prolonged posteriorly into a pair of prominent spines lying on either side of telson base.

Antennules long and slender, flagellae distinctly longer than peduncle, inner flagellum thin and a little longer than the outer stouter one [the flagellae are of equal length in the pueruli from Bombay (Deshmukh 1966: 140)]. Inner flagellum bears 26–29 segments, the outer bears 21–23 segments (table 1) and the latter bears tufts of setae from seventh or eighth segment onwards. Expanded proximal part of first segment of antennular peduncle bears a statocyst. Antennular tergum devoid of spinules.

Antennae incomplete because the distal parts of the stiff flagellae are broken in all specimens. In the specimen having the longest (incomplete) flagellum (table 1), the length of the antenna (52.0 mm including peduncle which is 7.0–7.5 mm long) is more than twice body length (23.0 mm). Even this, the longest flagellum, shows no sign of expanding into a spatula distally. It shows six light-brown bands 3–5 mm wide, alternating with white bands; the coloured bands are closer together proximally, the distance between them increasing distally. In the only complete specimen known (BL 22.8 mm) (from Bombay; Deshmukh 1966: 140), the antenna measured 88 mm (flagellum length 81.5 mm).

Figure 1, Puerulus of Panulirus polyphagus (Herbst); vide s. no. 4 in table 1 for measurements.
Exopodites of maxillipeds 2 and 3 are of taxonomic value. In maxilliped 2 (figure 2), the flagelliform exopodite (most authors refer to the basal unsegmented part and the segmented extension of the exopodite as distinct entities) extends a little beyond the carpus of endopodite and its distal half is divided into 11–12 annular segments. Maxilliped 2 of both sides in all seven specimens shows no variation in the structure of exopodite. Maxilliped 3 long and slender and ischium bears a bud-like vestigial exopodite. Other mouth parts and pereopods conform to the description of Deshmukh (1966).

However, some details in the structure of pereopods have not been reported by Deshmukh. Propodus of pereopods 1 and 5 bears simple setae ventrally, along its distal half; they are reduced or absent on propodus of other pereopods. Pereopod 5, in addition to the ventral setae, bears long sickle-shaped setae about twice the length of former on the propodus and dactylus; there are one or two such setae on each segment. The distal half of each such seta is curved, with a finely serrated adaxial margin. Like the other setae, these setae also probably serve to cleanse the body. Dactylus of pereopods 4 and 5 possesses ventrally, 2 or 3 moveable spinules directed towards terminal claw, the distal-most being always larger.

Pleopods on abdominal somites 2 to 5 well developed; in all the specimens they are biramous (as in adult females) and their endopods bear rod-like appendix interna.

Telson roughly rectangular; the soft portion of the telson as well as that of the uropods does not bear any dorsal spinules. The margin of the proximal hard portion of the telson bears eight teeth; similar margins of the uropodal endopods and exopods bear three, and five to seven teeth, respectively.

Figure 2. Puerulus of Panulirus polyphagus (Herbst); left maxilliped 2 (dorsal view); vide s. no. 1 in table 1 for measurements.
Although Deshmukh (1966) has given the diagnostic characters of the puerulus of *Panulirus polyphagus*, the present pueruli could be assigned to that species independently, on the basis of a character which has not been given due importance by him. As stated by Gordon (1953: 41), "A well-developed exopodite, with long multi-articulate flagellum, on the second maxilliped is characteristic of [adults of] some species, e.g., *Panulirus polyphagus* (Herbst) — unless, on re-examination of many specimens, the flagellum proves to be variable." More recently, George and Holthuis (1965) and George (1968), in their key to the Indo-West Pacific species of *Panulirus*, keyed out the adults of *P. polyphagus* by the fact that the exopodite of second maxilliped bears a well-developed and multi-articulate flagellum. One could therefore reasonably expect that a multi-articulate flagellum, which is of such taxonomic importance in the adults, occurs in the puerulus stage also, and this is in fact the case: the distal part of the flagelliform exopodite of maxilliped 2 is composed of 11–12 annular segments (figure 2). We can therefore identify the puerulus of this species even in the absence of post-puerulus stages.

Deshmukh (1966) identified the Kenya puerulus described by Gordon (1953) as that of *P. ornatus* (Fabricius 1798). His identification can also be confirmed by the fact that the exopodite of maxilliped 2 in the puerulus is rather short and about three-fourths of the merus (Gordon 1953: 24) as in the adults, a point apparently overlooked by Deshmukh.

There is one important difference between the pueruli of *P. polyphagus* from Bombay and those in our material from the east coast. While in our specimens the entire distal half of the exopodite of maxilliped 2 is divided into 11–12 distinct annular segments (figure 2) as in the adults, in the Bombay specimens the segmentation is indistinct and restricted to the middle region; the number of segments also is less: 7–11 (Deshmukh 1966: 142; figure 2 F). According to Deshmukh, a post-puerulus obtained from the moult of one of the live pueruli did not show even the indistinct annular segments in the middle of the exopodite, which was simple and rod-like (Deshmukh, 1966: 145; figure 4 C). In the absence of a post-puerulus stage in our material, we are unable to comment on the observation of Deshmukh which implies that whereas the pueruli and adults show a segmented exopodite, the post-puerulus stage shows an unsegmented exopodite. Rao and Kathirvel (1972: 131) state that they obtained nine pueruli, four post-pueruli and one juvenile of *P. polyphagus* from Cochin backwater and that in morphological characters, the pueruli and the post-pueruli agree with those described by Deshmukh (1966); one only wishes
that they had commented on the structure of the exopodite of the maxilliped 2, which is taxonomically important, in the three stages they obtained.

**Revised Key to Known Pueruli of the Indo-West Pacific Species of *Panulirus White***

George and Holthuis (1965) recognise eleven Indo-West Pacific species of *Panulirus*: *homarus* (Linnaeus), *penicillatus* (Oliver), *laponicus* (Von Siebold), *pascuensis* Reed, *marginatus* (Quoy and Gaimard), *longipes* (A. Milne Edwards), *cygnus* George, *polyphagus* (Herbst), *ornatus* (Fabricius), *stimpsoni* Holthuis and *versicolor* (Latreille). According to George (1973), the following six occur along Indian coasts: *homarus, penicillatus, longipes, polyphagus, ornatus* and *versicolor*.

The puerulus stages of only five of the eleven species have been described. The following characters of *Panulirus* applicable to pueruli are from Gordon (1953: 20):

Antennular flagella at least as long as the peduncle, outer not much more robust than the inner (figures 2 a, 5 a, c). Anterior margin of antennular* tergum as wide as the space between the tips of the supraorbital spines. Rostrum absent. The “longicorns” group. [Usually a large pair of posterolateral spines on last somite of thoracic sternum and three carinae on the carapace. One (occasionally two) spine(s) at anterolateral angle of carapace. Second segment of antennular peduncle equal to third. First pair of pereopods not more robust than the others (figure 7 b, c).] *Panulirus* White.

The following revised key to the species is prepared on the basis of data compiled from Calman (1909), Bouvier (1913), Gordon (1953) and Deshmukh (1966):

1. posterolateral spines on thoracic sternum absent; exopodite of maxilliped 3 distinct and with two distal segments; antennae about one and half times body length and tapering distally
   posterolateral spines on thoracic sternum present
   
   **P. japonicus**  ..  2

2. two spines, one behind the other, at anterior end of each lateral carina on carapace; exopodite of maxilliped 3 a bud-like vestige, that of maxilliped 2 about the length of merus (of endopodite) and with one (or two) distal segment(s); antennae about twice body length and with spatulate apex
   only one spine at anterior end of each lateral carina
   
   **P. homarus**  ..  3

*The antennal tergum of some authors.*
3. exopodite of maxilliped 3 absent, that of maxilliped 2 shorter than merus and usually with one distal segment; antennae about thrice body length and without spatulate apex
   - exopodite of maxilliped 3 a bud-like vestige
   
   $P. \text{versicolor}$

4. exopodite of maxilliped 2 about three-fourths the merus, usually unsegmented; antennae about twice body length and with markedly spatulate apex
   - exopodite of maxilliped 2 flagelliform, multi-articulate, extending a little beyond carpus; antennae about four times body length and with indistinctly spatulate apex
   
   $P. \text{ornatus}$

   $P. \text{polyphagus}$

**ADDENDUM**

We could not consult the publication cited below until after the present paper had gone to press. It reports the pueruli of two more Indo-West Pacific species: $Panulirus \text{longipes}$ and $B. \text{penicillatus}$. These pueruli have feeble posterolateral spines on thoracic sternum; short but distinct unsegmented exopodite on maxilliped 3 and antennae about one and half times body length and tapering distally. They can be distinguished as follows:

exopodite of maxilliped 2 as long as the endopodite and may be divided into two at its middle, that of maxilliped 3 clearly surpasses the ischium (of endopodite)
   
   $P. \text{longipes}$

exopodite of maxilliped 2 reaching middle of endopodite and may be divided into two at its middle, that of maxilliped 3 clearly falls short of the ischium
   
   $p. \text{penicillatus}$


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Pueruli of Panulirus polyphagus

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