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LARVAL DEVELOPMENT OF A PORCELLANID CRAB *PACHYCHELES NATALENSIS* (KRAUSS) (DECAPODA, ANOMURA)*

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ABSTRACT

The life history, consisting of 2 zoeal stages and a megalopa of the porcellanid crab *Pachycheles natalensis* (Krauss), as reared in the laboratory has been fully described, along with illustrations.

Necessary comparisons have been made between the larvae of *P. natalensis* and those of *P. stevensii* and *P. rudis*. An attempt has been made to give the generic features of *Pachycheles* based on the larvae of the above three species. A key to the first zoeal stage of the known species of the genus is also formulated.

INTRODUCTION

IN the genus *Pachycheles*, larvae of only three species, namely, *P. stevensii* Stimpson, *P. rudis* Stimpson, and *P. natalensis* (Krauss) have, so far, been studied. Kurata (1964) described two zoeal stages of what he referred as *P. stevensii* from the plankton off Hokkaido (Japan) since that is the only Porcellanid known from the area. Knight (1966) dealt with the entire life-history consisting of two zoeal and a megalopa stages of *P. rudis*, reared in the laboratory and she compared the laboratory material with that from the plankton. Her description of the megalopa including the illustrations, appears rather incomplete. Sankolli (1967 b) described only the pre-zoea and Ist zoea of *P. natalensis*, the only species so far recorded, representing the genus, from the intertidal zones along the Maharashtra Coast (Sankolli, 1967 a). In this case also the larvae are described from the laboratory. Thus, the identity of the larvae of *P. rudis* and *P. natalensis* is authentic but that of *P. stevensii* has to be confirmed.

The present paper completes the account of the larval development, consisting of two zoeal and a megalopa stages of *P. natalensis* (Krauss), partially described by Sankolli (1967 b).

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MATERIAL AND METHODS

Pachycheles natalensis is generally found inside sponge colonies encrusting rocks, in the intertidal zone at Ratnagiri (Mirkarwada). Simulating natural environment, in the aquarium tank by introducing pieces of rocks with sponge-colonies,

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failed to give good results, as the sponge colonies died within 24 hours, polluting the sea water. As such, non-decomposing substitute had to be provided. Synthetic fishing twine, *e.g.* nylon, can withstand sea water immersion for fairly long periods. This twine was wound round a thick pencil and was singed thermatically at diametrically opposite sides to form coiled, flexible tubes, open at both the ends, of requisite size which proved to be suitable hiding places for the berried females. After taking refuge into these improvised tubes, the berried females did not leave the tubes even after their eggs were hatched. The larvae thus hatched were healthy and were reared successfully in finger bowls, using the same technique as described elsewhere (Shenoy and Sankolli, 1967).

OBSERVATIONS

During the course of this study, only 3 megalopae could be obtained which thrived well when provided with small stones and fed on finely chopped prawn meat. For most of the time, the megalopae used to settle on the stones, though occasionally they swam and dived holding the chelipeds straight in front of them. However, they died without moulting to next instar.

The following Table gives the average number of days spent in each stage:

Stage	I	II	Megalopa
Number of days in each stage	6	7	20

DESCRIPTION OF LARVAL STAGES

First Zoea (Fig. 1)

Length of carapace – 1.5 mm; rostrum – 3.9 mm; posterior spine – 1.9 mm.

Larva (Fig. 1 a) fairly stout; rostrum about 2.6 times as long as posterior spines; eyes comparatively small, partially free from carapace; rostrum (Fig. 1b) armed with about 3 rows of sharp spines, distal 1/5 part, however, being naked; posterior spine provided with only one ventral row of sharp tubercles; scaphognathite of second maxilla with a single, long, plumose seta posteriorly in addition to 7 marginal ones; exopods of first two maxillipeds with 4 plumose setae each, third maxilliped being biramous and rudimentary; only first 3 pairs of pereiopods present as buds; telson process formula 7+7 , the 7th process situated on a central prominence.

Antennule (A1) (Fig. 1 c) : unsegmented, bearing 3 aesthetascs of which one is small, and 3 subequal distal setae, one of which is minute.

Antenna (A 2) (Fig. 1 d) : basal joint 2-segmented, distal segment with a stouter endopod which is nearly 3/4 length of exopod, bearing a small hair-like seta at tip, which ends in a tooth-like process; exopod broader at base and armed with 3 sharp spine-like teeth distally on inner margin.

Mandibles (M) (Fig. 1 e) : slightly asymmetrical; cutting edge armed with a number of unequal teeth which are sharp and pointed proximally.

First maxilla (Mx 1) (Fig. 1 f): coxal endite rounded and broad, bearing distally about 5 bristle-like and 4 simple setae; basal endite, which is longer, is armed with 4 big and 2 small serrated teeth and 3 simple setae; palp, though unsegmented, appears to be consisting of 2 segments and bears 3 terminal and 1 distal sparsely plumose setae; outer margin of palp fringed with fine, minute hairs.

Second maxilla (Mx 2) (Fig. 1 g): consists of two bilobed endites, an unsegmented palp and a long, narrow scaphognathite; proximal and distal lobes of coxal endite bear 8 and 5 setae each and those of basal endite with 8 and 10 respectively; palp fringed on inner margin and shows partial segmentation into 3 joints, bearing 7 setae in groups of 3, 2 and 2; scaphognathite bears 7 marginal plumose setae in distal 2/3 of its length, and posteriorly one long, plumose seta.

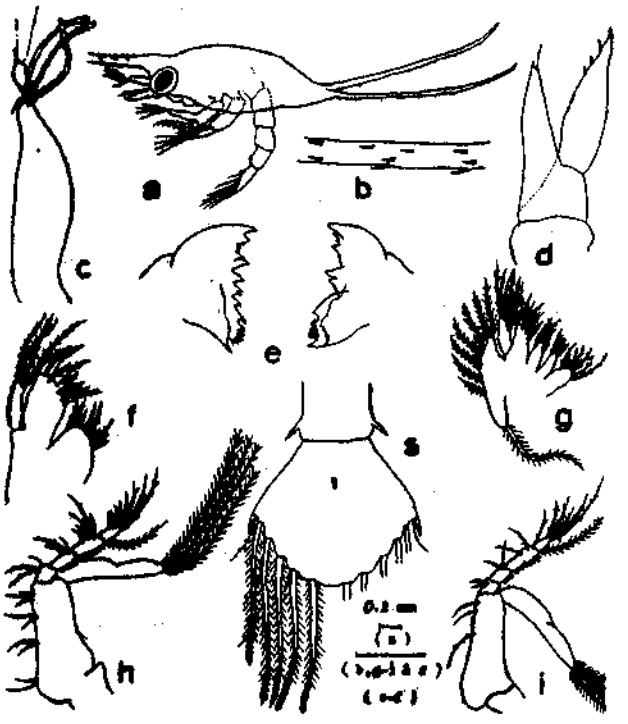

Fig. 1. *Pachycheles natalensis* (Krauss) - Ist zoea: a - entire larva (rostrum partly shown); b-rostrum/front of carapace magnified; c-antennule; d- antenna; e - mandible; f - first maxilla; g-second maxilla; h - first maxilliped; i - second maxilliped; j - third maxilliped ; k - pereiopod buds; l-first leg or cheliped; m - second leg; n - third leg; o - fourth leg; p - fifth leg; q - abdomen; r - pleopod (suffix indicates the number); s - telson; sl - central prominence of telson highly magnified; t- telson process highly magnified (suffix indicates the number); u - telson + uropod; and v - abdomen with telson + uropod.

First maxilliped (Mxp 1) (Fig. 1 h): Endopod 4-segmented and almost as long as exopod; first and second segments have 3 setae each on inner margin, third has 5 setae of which 1 is quite long and last segment has only 2 long sparsely plumose terminal setae and about 8 subequal distal setae; proximally a long, plumose seta present on outer margin of last segment; outer margin of second and third segments

fringed with fine hairs; exopod partially 2-segmented and bears 4 terminal plumose setae; basis long, broad at base with a slightly lobed appearance and bearing 4 groups of setae of 3, 2, 2 and 2 each on inner margin.

Second maxilliped (Mxp 2) (Fig. 1 i): Endopod 4-segmented as in first maxilliped, first two basal segments being armed with 2 setae each; third segment elongated, bearing a median seta and 2 distal setae; terminal segment bears 5 apical setae and a single, long plumose outer seta; exopod similar to that of Mxp 1; basis bears only 3 setae, 2 distal and 1 somewhat in middle; basis of Mxp 2 characteristically elongated, broader and somewhat lobed basally; second and third segments of endopod fringed with fine hairs on outer margin.

Third maxilliped (Mxp 3): It is a biramous bud.

Pereiopods (Per): Only first 3 pairs present as uniramous, rudimentary buds.

Abdomen (Ab) (Fig. 1 a): 5-segmented, 6th segment fused with telson; a pair of postero-lateral spines on 5th segment, all other segments smooth; pleopods absent. *Telson* (T) (Fig. 1 s): slightly longer than broad, 'arrow-head' shaped; telson process formula 7 + 7, 1st process a simple spine, 2nd a reduced sparsely plumose anomuran hair, 3rd to 7th processes long, plumose, 7th process being borne on a central prominence as in *Petrolisthes,* which is typically straight and smooth; 3rd to 7th processes armed with peculiar marginal hooks in distal part, these being large and about 5 or 6 in number on 3rd and 4th processes; on 5th to 7th processes, hooks are smaller but more in number, those on the 5th being maximum; posterior margin, in between processes, is smooth; anal spine present.

Second Zoea (Fig. 2)

Length of carapace – 1.8 mm; rostrum – 5.2 mm; posterior spine – 2.4 mm.

Though larva (Fig. 2 a) has increased in size, the proportion of rostrum and posterior spine remains the same as in the Ist stage. Eyes stalked. Md with a rudimentary palp. The number of plumose setae borne on exopods of Mxp 1 & 2 increased to 13 each and Mxp 3 still a rudimentary biramous bud but increased in size. Per 1–5 seen as uniramous buds, the first being chelate and the fifth being minutely chelate. Also, rudimentary gills formed. The Ab Seg 6 still fused to telson as in the Ist stage. In this stage, 4 pairs of pleopods appear as buds on Ab Seg 2–6 Telson process formula 7 + 1 + 7, the median process being situated on central prominence as in *Petrolisthes.*

A 1 (Fig. 2 c): more advanced than in Ist stage; two rami are now distinctly articulated to peduncle; outer ramus bearing 3 aesthetascs and 3 subequal setae distally and 15 or 16 aesthetascs in 4 groups on inner margin; bud-like inner ramus does not bear any setae.

A 2 (Fig. 2 d): Endopod of A2 much elongated, bearing a small seta and a tooth at tip; exopod reduced to nearly 3/4 length of endopod and 3 spine-like teeth have become very minute.

Md (Fig. 2 e): present on rudimentary bud-like palp as in *Petrolisthes.*

Mx 1 (Fig. 2 f): practically unchanged structurally, except for an additional serrated tooth on basal endite.

Mx 2 (Fig. 2 g): Except for a slight increase in number of setae, endites do not show any change; palp as in the 1st stage scaphognathite fringed along its entire margin with about 17 setae, of which proximal 7 are smaller; posterior part bears 4 plumose setae, of which innermost is small.

Mxp 1 (Fig. 2 h): first three segments of the 4-segmented endopod which is as long as exopod, bear 2, 3 and 4 setae respectively on inner side and 1 long plumose seta on outer; last segment distally bears 9 subequal setae; exopod 2-segmented and bears 13 setae around distal end of terminal segment; terminal segment shorter than basal.

Mxp 2 (Fig. 2 i): Endopod shorter than exopod and bears 2, 1 and 3 setae respectively on first three segments; last segment has 6 distal setae; one outer plumose seta each present on all segments; exopod as in Mxp 1.

Other appendages: Mxp 3 and Per 1–5 (Fig. 2 j, k) still rudimentary former being biramous; per 1 chelate; gills borne as buds on all these appendages.

Ab: 5–segmented, 6th segment being still fused to telson; four pairs of pleopod buds present on Ab Seg 2-5; except for 5th segment, which has a pair of postero-lateral spines, all other segments are smooth.

Telson (Fig. 2 s): Telson process formula 7 + 1 + 7, median process being present as a short plumose seta on central prominence as in *Petrolisthes;* all other processes are as in previous stage with hooks at their distal ends as shown in the Fig. 2, t_3 and t_4; anal spine continues to be present in this stage also.

Megalopa (Figs. 3 & 4)

Length of carapace – 1.3 mm; Breadth – 1.1 mm.

It closely resembles the adult in most of the characters. Carapace somewhat rounded (Fig. 3 a); front broad and bordered with a row of minute granular tubercles and a few setae interspersed (Fig. 3 b). The branchial margin with a row of setae. The dorsal surface of carapace armed with a few small scattered hairs, but no spines. Eye-peduncles without spines or setae, only the corneal portion projecting beyond the margin of carapace.

A1 (Fig. 3 c): peduncle 3-segmented, last segment bearing outer and inner rami; basal segment smaller, enclosing antennular gland, opening of which is fringed with plumose setae; anterior margin provided with sharp spine-like tubercles and 2 or 3 small tooth-like spines in upper half of lateral margin; small delicate setae present on margin as well as on surface; second segment smooth, third segment bears a few small setae distally; inner ramus 3-segmented; outer ramus 5-segmented, last segment being smallest, bears 2 long and a few small setae; penultimate segment distally bears a few subequal setae; first four segments bear in all, about 20 aesthetascs and 4 to 5 long setae along their inner border.

A2 (Fig. 3 d): peduncle 3-segmented; outer margin of basal segment has a sharp distal tooth and a row of short setae; second segment 2 distinct and one indistinct teeth on outer margin and 2 setae on inner margin; third segment is smooth and smallest; flagellum consists of 18-19 segments which are not distinctly marked in basal part; each segment carries a circlet of setae which are less in number on basal segments; antennal scale absent.

Md (Fig. 3 e) : characterised by an elongated apophysis; cutting edge of dorsal plate is corneous, yellow and armed with 2 to 3 indistinct, blunt teeth; ventral plate unarmed; palp 3–segmented, terminal segment being slightly elongated and armed with 15 to 16 setae most of which are bristle-like and others plumose.

Mx 1 (Fig. 3 f) : coxal endite bears 25 to 30 setae distally; basal endite armed with about 16 unequal conical teeth and 4 plumose setae; a row of 5 setae present distally below conical teeth; palp partially 2-segmented, bearing 2 to 3 small hair-like setae.

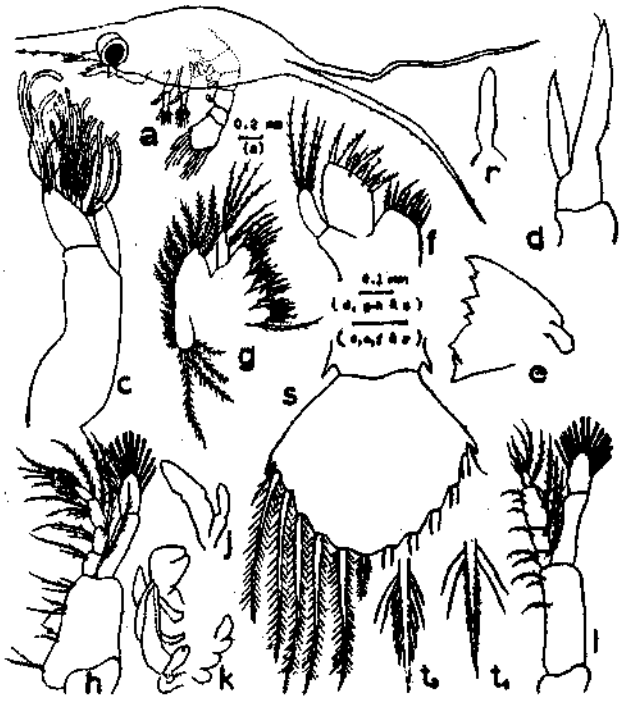

Fig. 2. *Pachycheles natalensis* (Krauss) - IInd zoea. (for details see explanation under Fig. 1).

Mx 2 (Fig. 3 g) : consists of two bilobed endites, a palp and a scaphognathite; palp finger-like, unsegmented with a small terminal and 1 or 2 marginal hairs; scaphognathite broad distally and ends proximally in a somewhat triangular lobe, with about 60 plumose setae on its entire margin.

Mxp 1 (Fig. 3 h): considerably changed; protopod bilobed, basal lobe bearing two rows of 9 and 6 setae; distal lobe fringed with about 30 setae on its margin and just below this, is present a row of few setae; endo-and exopods much reduced and have lost their segmentation; endopod finger-like, unsegmented with 1 or 2 basal setae and exopod scale-like with 4 median and 2 distal setae in distal half of its outer margin.

Mxp 2 (Fig. 3 i): Endopod 5-segmented, first and second segments, fringed with setae on inner margin; third segment has groups of setae distally; fourth segment broad and carries a number of setae distally; terminal segment bears distal tufts

of setae and also a few bristles; exopod 2-segmented, basal segment being large, broad and bearing 5 setae on inner and 2 on outer margins; second segment somewhat flagellate, bearing 7 subequal, plumose setae terminally; basis armed with 4 to 6 setae on inner margin.

Mxp 3 (Fig. 3 j): consists of a large, flattened, 5-segmented endopod, and a small bud like exopod; basal segment of endopod as in adult, expanded ventrally into flat lobe, inner margin of which is somewhat sinuate and armed with 4 or 5 small spine-like teeth in middle; distal part of outer margin produced into two unequal blunt, tubercle-like spines and also bears several stiff, plumose setae; second segment similarly expanded into a small lobe as in adult, bearing 15 or 16 long, sparsely plumose setae on inner margin above this lobe; third segment carries 7 long plumose and 7 short setae on inner margin; fourth segment has 9 long plumose setae on inner margin and 4 or 5 bristles distally. last segment which is smallest, bears 7 or 8 distal long plumose setae and 2 small setae on outer angle; a few hairs present on outer margins of the second and third segments; inner margin of basis armed with 3 to 5 blunt tubercles, distal most being largest; 2 gills present.

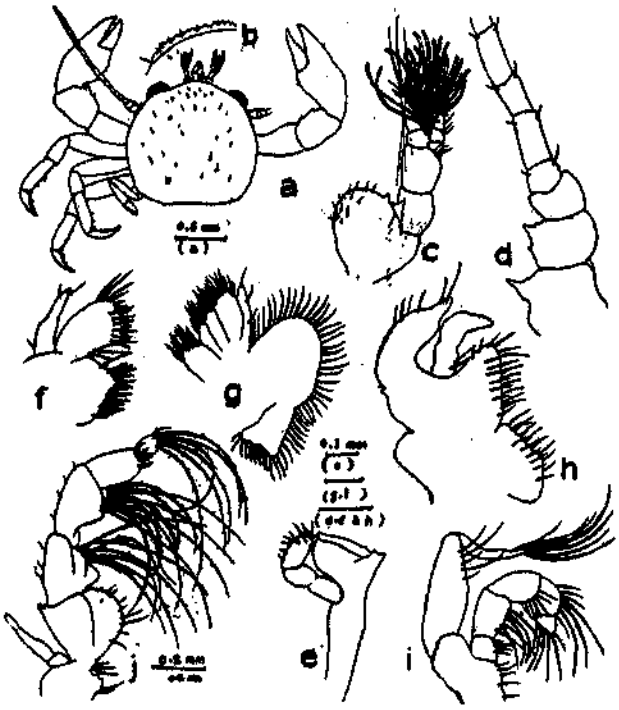

Fig. 3. *Pachycheles natelensis* (Krauss) - Megalopa (for details see explanation under Fig. 1).

Per: Per 1-5 present, of which Per 1 distinctly chelate and Per 5 minutely chelate.

First pair or Chelipeds (Fig. 4 l): almost equal or sub equal; ischium is small, triangular with a few setae but no spines; merus slightly smaller than carpus in length and is smooth, with a few simple setae on both margins, but lobe on anterior margin as found in adult is not yet developed; carpus, as in adult, as long as broad and its

inner margin is serrated into 2 large and 2 or 3 smaller spines; its outer margin is armed distally with a tooth-like spine as in adult and 4 or 5 spinules along margin; distal margin smooth ventrally but serrated dorsally; propodus longer than broad with is outer and inner margins slightly sinuate; dactylus and fixed finger are almost equaltin length leaving no gap between them when closed, as in smaller cheliped of adult; their cutting edgs are smooth, horny and armed with a few setae only; several setae scattered on dorsal surface and on outer margins of propodus and carpus; fewer setae on merus and ischium.

Walking legs: second to fourth legs are structurally similar (Fig. 4 m - o) ; ischium small and with a few setae; merus smooth and largest segment, with some setae on its either margins; carpus bears a sharp spinelike tooth at distal end of anterior margin which is absent in adult; propodus long, cylindrical, 2/3 longer than carpus, its posterior margin being armed with 2 marginal and 3 distal spines, unlike in adult which has only 2 distal spines; of the 3 distal spines, one is long and incurved, remaining 2 being smaller and situated on either side of larger spine - former resemble those of adult; dactylus claw-like, bent inwards and armed with 3 sharp spines on its posterior margin as in adult.

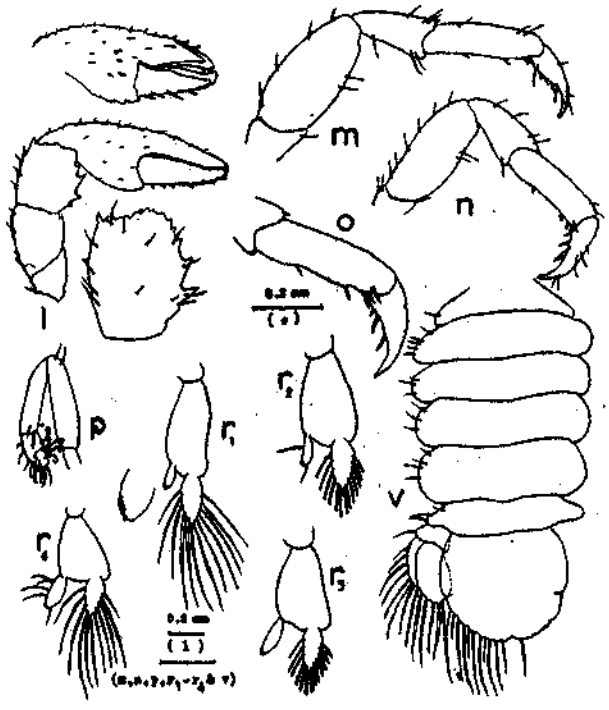

Fig. 4. *Pachycheles natalensis* (Krauss) - Megalopa (for details see explanation under Fig. 1).

Fifth leg (Fig. 4 p): reduced, minutely chelate, generally held inside or against carapace and folded; ischium small but merus is largest segment; all segments cylindrical and longer than broad; carpus nearly $\frac{2}{3}$ length of merus and bears a distal tuft of stout setae; propodus large, forming a minute chela with dactylus; propodus bears distally, on one side, 6 to 8 long plumose setae; propodus and dactylus are covered with a number of closely arranged setae.

Ab (Fig. 4 v) : consists of 6 segments and telson, 6th segment distinctly articulated to telson; all segments are dorso-ventrally compressed and laterally setose; Ab Seg 1 and 2 are slightly smaller than others; Ab seg 2 to 5 bear 4 pairs of biramous pleopods which decrease in size posteriorly; a typical pleopod consists of a large protopod, a small endopod and an oval and fairly large setose exopod (Fig. 4 r_1); endopod with 4 or 5 minute hooks and with 1 to 4 small setae; first pleopod (Fig. 4 r_1) has 5 hooks and a small seta on endopod and 12 plumose setae on exopod; second and third pleopods (Fig. 4 r_2, r_3) each have 5 hooks and 2 setae on their endopods and 13 plumose setae on exopods; fourth pleopod (Fig. 4 r_4) smallest with 4 hooks and 4 setae on endopod and 11 plumose setae on exopod.

Tl (Fig. 4 v) : more or less rounded in outline with a slight notch near about middle of its lateral margins and a shallow, concave notch on posterior margin; posterior margin on either side, bears about 8 long plumose setae with few simple setae.

Upd (Fig. 4 v): consists of a short protopod and oval exo - and endopods; exopod slightly larger than endopod and bears about 9 setae and 2 or 3 small hairs; There are 11 and 1 or 2 plumose setae on exopod and protopod respectively.

DISCUSSION

Larvae of the 3 known species of the genus *Pachycheles* viz., *P. stevensii*, *P. rudis* and *P. natalensis*, show common telson characters, (1) the 7th pair of processes situated on the central prominence in stage I, and (2) a single median process on the central prominence in stage II. By these characters, the genus *Pachycheles* fits in the *Petrolisthes* group of larvae (Lebour, 1943), as already suggested by Knight (1966).

Although the larvae of the above 3 species agree in general in respect of the number of larval stages *i. e.*, 2 zoeal and a megalopa, and in the form of the telson and the other appendages, *P. natalensis* can be distinguished by the following characters:

1. Abdomen: The abdominal segments in the zoeal stages are smooth except for a pair of postero-lateral spines on the 5th segment. In the other species, the abdominal segments have fine teeth along their postero-dorsal margin and the 4th and 5th segments have each a pair of lateral spines.

2. In the IInd zoea, there is a long plumose seta on the outer margin on each of the endopod segments of the 2nd maxilliped. In *P. rudis*, only the second and third segments possess such setae.

As far as the megalopa stage of *P. natalensis* is concerned, the comparison can be made only with *P. rudis* (Knight, 1966) since the megalopa of *stevensii* (Kurata, 1964) remains undescribed. Knight (1966) gives a sketchy account of the megalopa of *P. rudis* and as such comparison can be made only with her figure of the entire megalopa and its walking legs. The front of the carapace is broad and serrated in both the species. However, the megalopae can be distinguished by the following characters: (1) In *P. natalensis*, the carapace is broader than long and the ventral indentation between the eyes is absent, whereas in *P. rudis*, the carapace is longer than broad with the ventral indentation present between the eyes; (2) The carpus of the cheliped bears 3 broad, tooth-like spines on the inner margin in *P. natalensis*

but only one such spine is present in *P. rudis*; and (3) In *P. natalensis*, the walking leg bears 3 distal and 2 marginal spines on the posterior margin of the propodus, whereas in *P. rudis*, there are 2 distal and 2 subdistal spines.

Thus the distinguishing characters of the larvae of the genus *Pachycheles* can be summarised as follows:

1. Telson broader than long with central prominence of posterior margin rather straight and smooth; a small plumose seta on it in IInd stage. The lst telson process is a small, slightly broad, simple spine.

2. Rostrum, in length, is 2 times or more than posterior spines, both these being armed with sharp spines or tubercles.

3. Antennal exopod is 1.5 to 2 times the endopod with 3 hooks distally on inner margin and 1 sub-terminal minute seta on endopod.

4. Mandibles with a number of unequal teeth on cutting edges and with a rudimentary palp in IInd zoeal stage.

5. Endopod of first maxilla with 4 setae and that of second maxilla with 8 or 9 setae in 3 groups.

6. Exopod of first and second maxillipeds with 13 or 14 setae and endopod with outer setae on all segments or these being absent on first segment in IInd stage.

7. Abdominal segments in zoeal stages with or without minute teeth on dorsal margin, the 4th and 5th or only the 5th segment with lateral spines which are small. Four pairs of pleopods on 2nd to 5th segments.

8. The front of carapace of megalopa is broad, minutely serrated; eye-stalks short, only corneal part exposed. Lateral margins of carapace smooth.

9. Chelipeds and walking legs quite thick and robust, with prominent spines on inner margin of carpus only of chelipeds; dactylus of walking leg, half or slightly more, than propodus in length, with 3 long spines on posterior margin; propodus with distal and median spines on posterior margin.

KEY TO THE ZOEAL STAGES OF KNOWN SPECIES OF *PACHYCHELES*

1. Abdominal segments with fine teeth around the dorso-posterior margin; postero-lateral spines on either 4th or 5th abdominal segments or on both 3

2. Abdominal segments smooth with no teeth on dorso-posterior margin; postero-lateral spines on 5th abdominal segment only .. .. *P. natalensis* (as per present work)

3. Fine teeth on 3rd to 5th abdominal segments, 5th segment alone has a pair of postero-lateral spines .... *P. stevensii* (after Kurata)

   Fine teeth on all the abdominal segments, postero-lateral spines on both the 4th and 5th segments. .... *P. rudis* (after Knight)

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