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METAMORPHOSIS OF TWO SPECIES OF GENUS *POLYONYX* STIMPSON - *P. HENDERSONI* SOUTHWELL AND *P. LOIMICOLA* SANKOLLI (ANOMURA, PORCELLANIDAE)*

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ABSTRACT

The life history as observed in the laboratory of two porcellanid crabs belonging to the genus *Polyonyx* has been described viz., *Polyonyx hendersoni* Southwell - a species generally found inside *Zoanthus* colonies and sponge cavities and *P. loimicola* Sankolli-a commensal with a polychaet worm *Loimia medusa* (Savigny). In both the species the larval development consists of two zoeal and a megalopa stage. Detailed account of these stages is given along with illustrations. Necessary comparisons of the larval characters of these two species are made with those of the only two known species viz., *P. quadriungulatus* Glassel and *P. gibbesi* Haig - both of which happen to be commensal forms, revealing certain morphological features common to commensal species. Generic features based on the knowledge of the larvae of these four species and a key to the first zoeal stage are also given.

INTRODUCTION

THE earliest record of the larvae of the genus *Polyonyx* is that by Faxon (1879), who described the larvae of *P. gibbesi* Haig (= *P. macrocheles*, collected from plankton. Thereafter, no work has been done until very recently Knight (1966) described the entire metamorphosis of *P. quadriungulatus* Glassell, from California Coast, Gore (1968) described the complete larval development of *P. gibbesi* from Florida, and Sankolli (1967 b) dealt with the pre-zoea and Ist zoea of *P. hendersoni* Southwell, from the west coast of India. All these studies were based on the laboratory hatchings, whereas the identification of Faxon's material, obtained from plankton, is doubtful, as also expressed by Gurney (1938). Besides, Faxon's description of the larvae is not so detailed as to make a specific comparison.

This paper gives an account of the developmental stages of two of the three intertidal species of *Polyonyx*, recorded from Maharashtra (Sankolli, 1963, 1965 and 1967 a), viz., *P. hendersoni* Southwell and *P. loimicola* Sankolli. The third species, *P. splendidus* Sankolli, unfortunately, could not be dealt with as no berried females could be readily available during the course of the studies. The life-history of *P. hendersoni*, as reared in the laboratory, consists of two zoeal and a megalopa stages. The Ist stage, though described by Sankolli (1967b), is also incorporated herein since there are some important generic characters which are not mentioned by him. *P. loimicola* has the same number of stages in its life history as that of *P. hendersoni* but laboratory hatchings could be obtained only upto the IInd zoeal stage and for megalopa, resort had to be taken to plankton - by holding the Ist stage larvae successfully in the laboratory.

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The present work extends the knowledge of the complete life histories in this genus to four species viz., *quadriungulatus, gibbesi, loimicola* and *hendersoni,* the first three being commensals.

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MATERIAL AND METHODS

The material for this study was collected from the intertidal zones off Mirkarwada (Ratnagiri) and Chowpatty (Bombay).

For obtaining successful hatchings of the zoeae, the berried females of *P. hendersoni,* a species generally found inside the *zoanthus* colonies and sponge colonies, were provided with nylon twine tubings of suitable sizes and diameter, prepared specially for the purpose as explained elsewhere (Shenoy and Sankolli, 1973) while dealing with the life history of another porcellanid crab *Pachycheles natalensis* (Krauss).

In the case of *Polyonyx loimicola,* which is a commensal with its host tube-worm *Loimia medusa* (Savigny) (Annelida, Terebellidae) the above mentioned methods failed. Successful hatchings, however, could be obtained only when the female crab was kept along with its host in the tube. Berried crabs kept either in an empty tube or with the tubeless worm, was observed to shed away its eggs before hatching (Sankolli and Shenoy, 1965).

The rearing technique followed in the present work is the same, described earlier (Shenoy and Sankolli, 1967).

OBSERVATIONS

The megalopae in both the species thrived well in the laboratory for about two weeks but none of them moulted to the next instar. Small stones with algal encrustations etc. were provided in the rearing bowls and the megalopae readily took shelter on the underside of these stones.

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

Species	Average number of days in Stage I	Stage II	Megalopa
P. hendersoni	6	7	14
P. loimicola	5	6	10

DESCRIPTION OF LARVAL STAGES

Polyonyx hendersoni Southwell

First Zoea (Fig. 1)

Length of carapace	0.9 mm
Length of rostrum	5.5 mm
Length of posterior spine	2.2 mm

Larva (Fig. 1 a) quite slender with a very long rostrum more than twice length of posterior spines; rostrum armed with 6 or 7 rows of sharp spinules which become less in number but increase in size distalwards; posterior spine provided with two rows of sharp spinules of which ventral row is larger and 3 or 4 of these spinules extending on to posterior margin of carapace; also, 1 or 2 rows of minute tubercles present mainly on 1/3rd of posterior spines; eyes only partially free from carapace; a pair of small dorsal setae present on carapace above eyes as in both *P. gibbesi* (Gore, 1968) and *P. quadriungulatus* (Knight, 1966) and also *P. loimicola* (present study); exopod of first two maxillipeds with 4 setae each, third maxilliped being a rudimentary biramous bud; three pairs of uniramous buds present; abdomen 5 segmented, 4th and 5th segments with a pair of spines each; a medio-dorsal pair of hairs on 4th and a lateral pair of hairs (Fig. 1 q) on 5th segment; telson longer than broad, process formula 7+7, 7th process being situated outside central prominence bearing a pair of hairs.

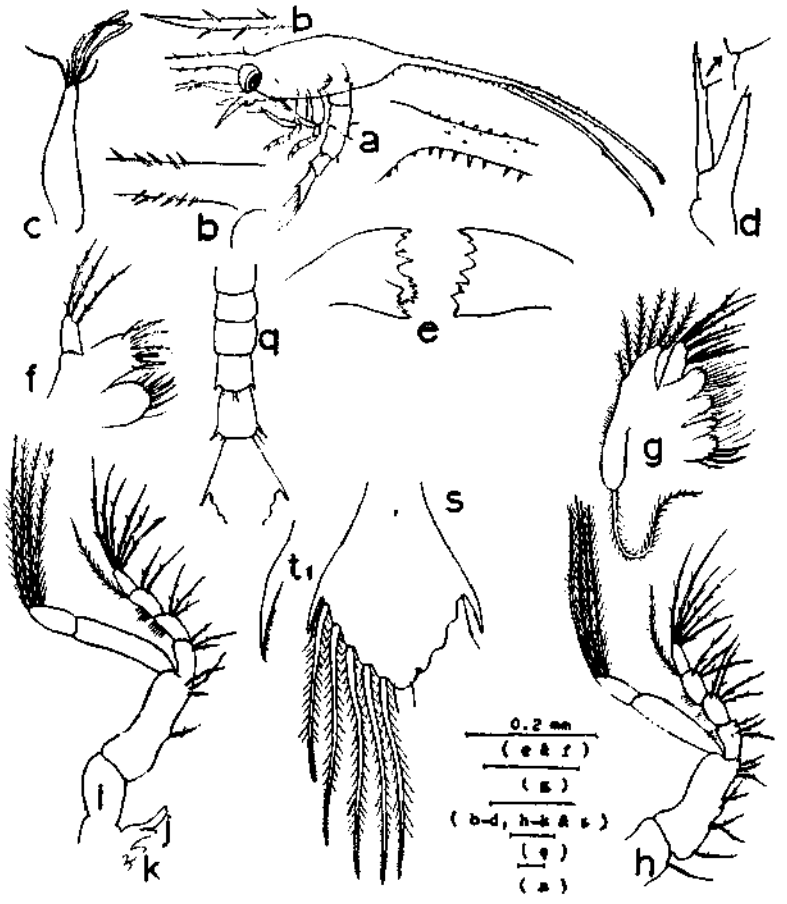

Fig. 1. *Polyonyx hendersoni* Southwell - Ist zoea (See at the end for explanation of letterings in all the text figures).

Antennule (*A1*) (Fig. 1 c): Simple, unjointed with 3 aesthetascs and 3 unequal setae terminally. *Antenna* (*A2*) (Fig. 1 d): Biramous with a knob-like projection on protopod; endopod is stouter and shorter than exopod and bears a hair-like

dorsal seta which arises from angle of toothed tip; exopod is slender, 1.5 times length of endopod and bears a small spinule and a hair-like seta at some distance distally. In *P. quadriungulatus*, exopod is more than 3-times length of endopod but in other two species, *gibbesi* and *loimicola*, it is only about twice. This small seta arises from a small papillar projection. *Mandibles.* (*Md*) (Fig. 1e): Slightly asymmetrical, teeth of cutting edges are unequal in size.

First maxilla (*Mx* 1) (Fig. 1f): Of two endites, basal endite bears 4 bristle like and 6 sparsely plumose setae and coxal has 5 serrated teeth and 4 setae; endopod unsegmented with 2 terminal and 1 sub-terminal setae. *Second maxilla* (*Mx* 2) (Fig. 1g): Bilobed basal and coxal endites bear 8, 6, 8 and 8 setae from proximal to distal lobes respectively; Endopod unsegmented bearing setae in 3 groups of 3 terminal, 2 sub-terminal and 3 proximal, along inner margin; scaphognathite long, narrow and provided with 6 marginal plumose setae anteriorly and 1 posterior, long, plumose seta as usual. The anterior 2/3 of outer margin, after its setose portion, is fringed with fine hairs. *First maxilliped* (*Mxpd* 1) (Fig. 1h): 4-segmented endopod longer than exopod and has 3, 4 and 3 setae respectively on first, second and third segments; fourth segment bears 6 terminal and 1 plumose setae basally on its outer margin, first three segments have groups of long but delicate hairs on outer margin; exopod 2-segmented with 4 terminal plumose setae; basis is elongate with setae in groups of 3, 2, 2 and 1 each along inner margin; coxa bears one distal seta. *Second maxilliped* (*Mxpd* 2) (Fig. 1 i): As in Mxpd 1, endopod 4-segmented, but shorter than exopod, 3 setae each on first and second segments and 2 on third, last segment provided with 6 terminal and 1 outer setae as in Mxpd 1, delicate hairs are present on outer margin as in Mxpd 1, but only on second and third segments; exopod as in Mxpd 1; basis also similar but has only two groups of 1 and 3 setae each; no setae on coxa.

Other appendages: Third maxilliped (Mxpd 3) and first three pairs of pereiopods (Per 1-3) present in bud form, former being biramous and latter uniramous. *Abdomen* (*Ab*) (Fig. 1 q): Five segmented, with 4th and 5th segments each bearing a pair of postero-lateral spines; a pair of hairs on each segment situated medio-dorsally on 4th and laterally on the 5th segments present as in *P. gibbesi*. In *P. loimocola*, hairs are seen only on 5th segment where as in *P. quadriungulatus* abdominal hairs appear to be absent. *Telson* (*Tel*) (Fig. 1 s): 'Arrow head' shaped, longer than broad with process formula 7+7; 7th process situated outside central prominence, 1st process a fairly long spine, serrated on inner margin in distal half, but naked towards tip; 2nd process delicate anomuran hair; 3rd to 7th processes are long, plumose setae which are minutely spinulose in distal part, spinules being more prominent on 3rd process; central prominence smooth except for a pair of delicate hairs, but knob-like median pair of processes found in *quadriungulatus* and *gibbesi* absent; anal spine present.

Remarks: Asymmetry in telson processes was noticed in one or two larvae, as shown in the Fig. 1 s. In these larvae, the process formula was 7+6. Also the armature of 1st process showed slight variation in being serrated on either margins instead of only on the inner margin as observed in majority of the larvae.

Second Zoea (Fig. 2)

Length of carapace	2.0 mm
Length of rostrum	7.0 mm
Length of posterior spine	2.5 mm

Larva (Fig. 2 a) considerably increased in size; rostrum armed as in 1st stage but posterior spine now with only ventral row of spinules distinct, that too in proximal part only, spinules becoming less conspicuous and widely spaced distally; posterior margin of carapace with only 1 or 2 spines; dorsal row of spinules of posterior spine reduced to a few indistinct spinules; eyes stalked and completely free from carapace; exopod of Mxpd 1 and 2 with 11 or 12 plumose setae each and that of Mxpd 3 with only 6; 5 pairs of pereiopod buds present, first pair being chelate; Ab 5-segmented, no change in segments except that 2nd to 5th segments carry 4 pairs of pleopod buds; Tel process formula 8+8, 8th pair being present on central prominence.

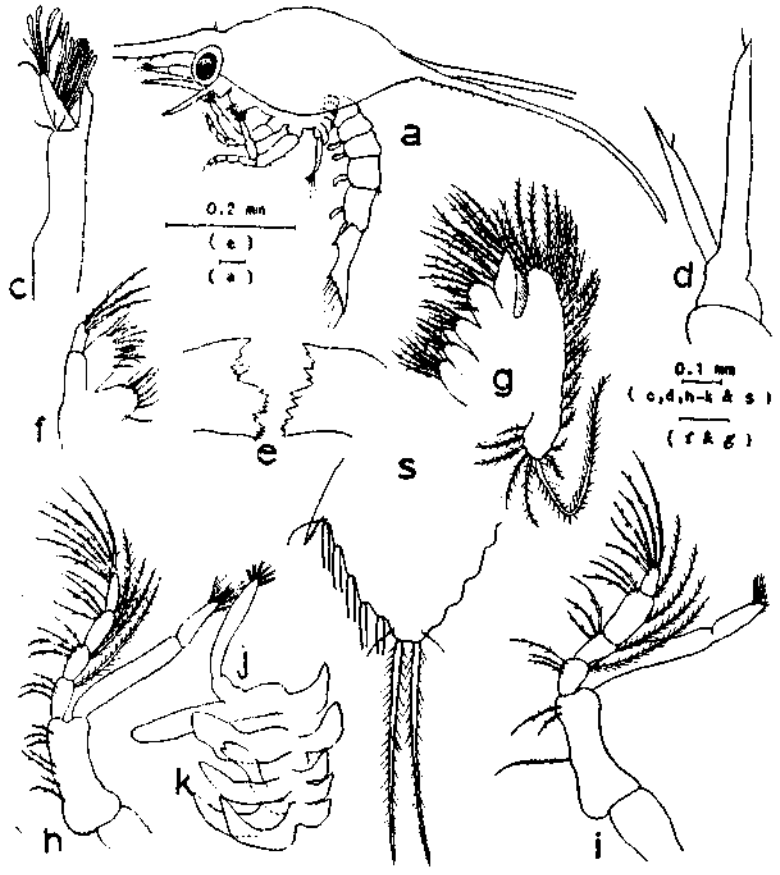

Fig. 2. *Polyonyx hendersoni* Southwell - IInd zoea.

A1 (Fig. 2 c): biramous although inner ramus is still bud-like, terminating in a small papilla-like tip, and not separated from peduncle; outer ramus is distinctly articulated to peduncle and bears 3 aesthetascs and 3 setae terminally; aesthetascs in groups of 2, 4 and 3 present on inner margin; peduncle slightly bulging in basal part on its outer margin and bears about 3 fine hairs on its distal margin. *A2* (Fig. 2 d): endopod much longer and stouter, reaching about 2/3rd exopod as in *gibbesi*, still retaining hair-like seta of earlier stage; exopod as in *gibbesi* has lost spinule of previous stage but has retained seta. In

quadriungulatus, however, the endopod is quite long but shorter than exopod and in *loimicola*, the endopod is stouter and longer than exopod. *Md* (Fig. 2 e): no change in this appendage; palp not yet developed. *Mx*1 (Fig. 2 f): basal endite provided with 4 bristle-like and 8 sparsely plumose setae; like-wise, coxal endite has increased number of teeth, 4 big and 3 short serrated, and about 5 setae; endopod remains unchanged; *Mx*2 (Fig. 2 g): two lobes of basal endite bear 9 and 6 setae respectively: Some of these setae are bristle-like and others sparsely plumose; endopod provided with 9 sparsely plumose setae in groups of 3, 2 and 4 respectively; scaphognathite fringed with 27 or 28 marginal setae and long posterior seta continues to be present; fine hairs on clefts of endites as well as on inner margin of scaphognathite present; *Mxpd* 1 (Fig. 2 h): number of setae on endopod segments is 3, 4 and 4 respectively on inner margin and 1 long plumose seta each on outer margin of first, second and third segments; last segment bears 7 terminal and 1 outer setae; outer seta on first two segments situated distally, third, median and last, basal; exopod bears 11 or 12 distal plumose setae; basis is as in Ist stage; *Mxpd* 2 (Fig. 2 i): endopod segments much larger than those of Mxpd 1 and bear 3 inner marginal setae each on first three segments in addition to outer plumose seta; last segment has 6 terminal and 1 outer setae; exopod bears 12 plumose setae, basis is unchanged; *Mxpd* 3 (Fig 2 j): exopod 2-segmented, bearing 6 terminal plumose setae; endopod still bud-like but greatly enlarged.

Per (Fig. 2p): All 5 pairs of pereiopod buds well formed, first pair being chelate; 5th is quite small and concealed by others; gill rudiments present on Mxpd 3 and pereiopod buds. *Ab* (Fig. 2a): except for presence of 4 pairs of pleopod buds on 2nd to 5th segments, there is no other change; 6th segment still fused to telson. *Tel* (Fig. 2 s). Tel process formula is 8+8; in addition to 7 pairs of processes which remain as in Ist stage, there is a pair of long plumose setae (8th pair) on central prominence, on inner side of two delicate hairs of Ist stage; in some larvae, this median pair, however, showed unequal length; anal spine persists.

Megalopa (Figs. 3 and 4)

Length of carapace	1.5 mm
Breadth of carapace	1.0 mm

Megalopa (Fig. 3 a) is very much like the adult in general appearance. It is somewhat hairy, showing a tendency to settle down and crawl. It occasionally swam with jerking movements holding its chelipeds straight in front, as though diving. It also firmly clung to the small stones provided in the rearing bowls, when not swimming.

Carapace oval, longer than broad; front broad, like in adult, 3/4 times width of carapace and serrated with about 9 subequal teeth on either side (Fig 3 b) of a median bifid tooth-like structure; a few stiff setae scattered along anterior margin; orbital notch fairly deep, exposing only corneal part of eyes; orbital margin edged with 2 or 3 spines; lateral margins of carapace also serrated; 2 or 3 spines on antennal margin and 4 or 5 larger and 1 or 2 smaller ones on remaining part of lateral margin (Fig. 3 b) present except for posterior 1/3 part. In other three species, i. e. *P. quadriungulatus, P. gibbesi* and *P. loimicola*, carapace and the front smooth. Dorsal surface of carapace fully setose, setae being stiff, giving a hairy appearance to megalopa; Chelipeds also hairy, left being slightly larger than right; walking legs like-wise hairy; propodus armed with 3 spines and dactylus 4-clawed.

A1 (Fig. 3 c): Peduncle 3-segmented, basal segment being much enlarged with a dentate anterior margin and bearing about 9 subequal spine-like teeth and a few setae on surface; last segment distally bears 2 groups of 5 or 6 plumose setae on ventral side; inner ramus 3-segmented, bearing a few setae on each of segments; outer ramus longer, consisting of about 6 or 7 segments which carry 15 to 18 aesthetascs except on last segment, which has a few unequal setae; *A2* (Fig. 3 d): Consists of 3-segmented peduncle and a flagellum of about 22 segments; first segment of peduncle armed with a big tooth distally on anterior margin and a smaller one on posterior margin; a similar tooth also present but on anterior border of second segment, whereas in adult, segments of peduncle are smooth; segments of flagellum bear varying numbers of small setae distally, these being more prominent towards

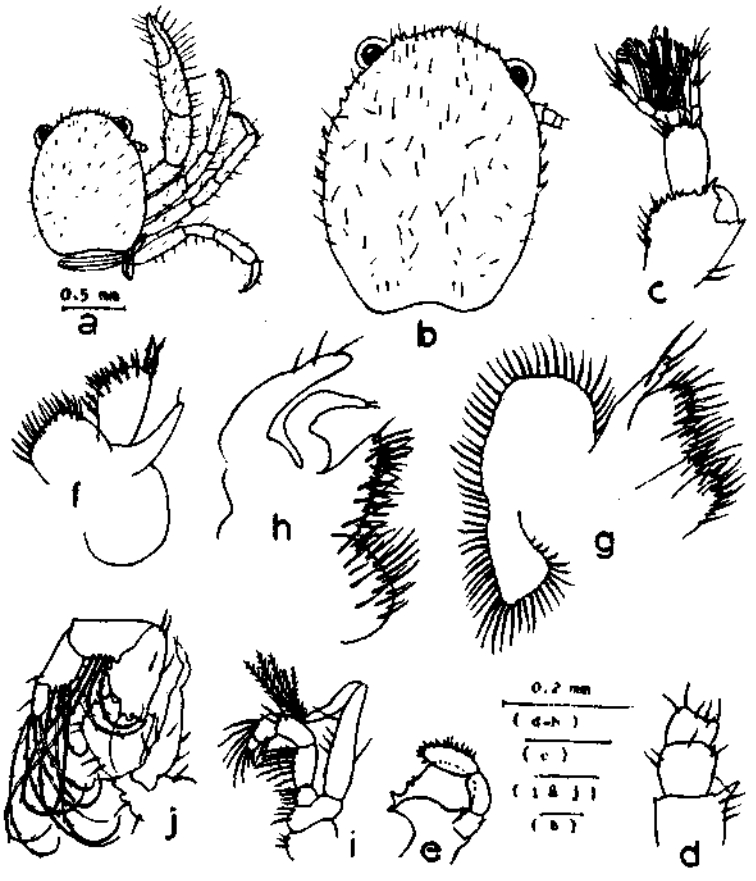

Fig. 3. *Polyonyx hendersoni* Southwell - megalopa.

distal part of flagellum; *Md* (Fig. 3 e): Fully formed resembling that of adult and has a 3-segmented palp; cutting edge somewhat cup-shaped, ventral plate having 3 or 4 subequal blunt tooth-like projections and dorsal plate almost smooth except for a small tooth at inner extremity; palp bears 2 small setae distally on basal and 11 or 12 bristle-like setae on terminal segments.

Mx 1 (Fig. 3 f): Endopod or palp unsegmented with a small terminal seta; two endites do not change much from those of last zoea; basal endite somewhat triangular in shape and has about 13 or 14 conical tooth-like spines and a row of about 5 setae distally; on inner margin, there are 3 distal sparsely plumose long setae and outer margin is beset with 3 similar setae coxal endite is more rounded and bordered anteriorly with about 30 bristles. *Mx* 2 (Fig. 3 g): Resembles that of adult in having 2 setose endite, a finger-like palp which bears 2 or 3 setae anteriorly and a long scaphognathite which is fringed with plumose setae all along margins; anterior lobe of scaphognathite is broad, and posterior one somewhat triangular. *Mxpd* 1 (Fig. 3 h): Differs much from zoeal appendage; exopod scale-like with 3 to 5 setae on outer margin distally and 2 setae basally; endopod reduced to a finger-like process with a projecting tip; protopod produced into a triangular basal lobe and a rounded larger coxal lobe, former boardered with about 30 and latter with about 20, sparsely plumose setae. *Mxpd* 2 (Fig. 3 i): Exopod 2-segmented, basal segment being broad and elongate, bearing 7 or 8 setae on inner and 1 or 2 on outer margins; second segment flagellar, curving down towards mouth region and provided with 6 or 7 plumose setae terminally; endopod 5-segmented, with tufts of setae on last and penultimate segments; on inner margin of first and second segments is a row of setae and so also on distal margin of third; basis and coxa are simlarly provided with setae. *Mxpd* 3 (Fig. 3 j): Endopod highly developed and 5-segmented; exopod reduced, 2-segmented, with a large basal segment provided with small setae on either margins and a bent terminal segment which shows only 2 tip-like projections; ischium to carpus of endopod have plate-like lateral extensions; extension of ischium is toothed along inner distal part and so also of merus; carpus has only a triangular basal extension without any armature; all segments except ischium, bear groups of long, filtering setae bent towards mouth; coxa and basis armed with a number of setae; similar setae are scattered on surface of ischium and merus of endopod.

Per 1-5: All 5 pairs of legs are well developed. *First pair or chelipeds* (Fig. 4 l): These are somewhat unequal, left being slightly larger than right; chelipeds are hairy, covered with fairly long stiff bristles; all segments bearing spines unlike in the other three species - *quadriungulatus*, *gibbesi* and *loimicola* where these are smooth; merus somewhat triangular, broadening distally, its margin in distal half provided with about 3 or 4 spines, distal most being more conspicuous; near to this spine, is present a smaller spine on distal margin; similarly, there are 2 spines on anterior margin; carpus is almost twice as long as broad, and not as long as broad as in adult, its posterior margin bearing about 4 fairly long spines, interspersed with 2 or 3 small spinules; anterior margin in its middle half, is provided with 3 subequal spines, smaller than those of posterior margin; distal margin has 1 or 2 small tubercle-like spines on inner side; propodus, although longer than broad as in adult, does not widen out at once distally, but is elongated uniformly; posterior margin of propodus is bordered with about 20 uneven spines, distal most being largest; near base of dactylus, there are 2 large spines on anterior margin of propodus; dactylus long as or slightly longer than fixed finger and armed with 4 or 5 spines on outer margin, one towards tip being so arranged as to give a bifid appearance; cutting edges of both fingers are smooth unlike in adult and are only lined with a row of small setae; all cheliped segments are covered with stiff hairs, more densely arranged on dactylus, propodus and carpus. *Walking legs* (Fig. 4 o): Second to fourth legs are similar in structure but gradually decrease in length; merus large, nearly thrice as long as broad and smooth; carpus more than $\frac{1}{2}$ length of merus and provided with a small tooth at distal end of anterior margin; propodus bears 3 spine-like teeth distally on posterior margin as in adult; dactylus 4-clawed, last claw being largest, last but one slightly smaller and remaining

two much smaller; all segments are provided with stiff, long setae, more thickly set along anterior margin. *Fifth leg* (Fig. 4 p): Chelate, distal part armed with many setae of which 3 to 5 are long with their tips plumose only on inner side.

Ab (Fig. 4 v): 6-segmented, 6th segment free from telson; 1st segment, small and triangular and so also last; 2nd to 5th segments are broad and setose lateraly bearing 4 pairs of biramous pleopods, decreasing in size posteriorly; first pleopod (Fig. 4 r_1) bears 13 plumose setae on its exopod whereas second and third have 12 setae each and last one has only 11; endopod small and bears 3 minutes hooks on

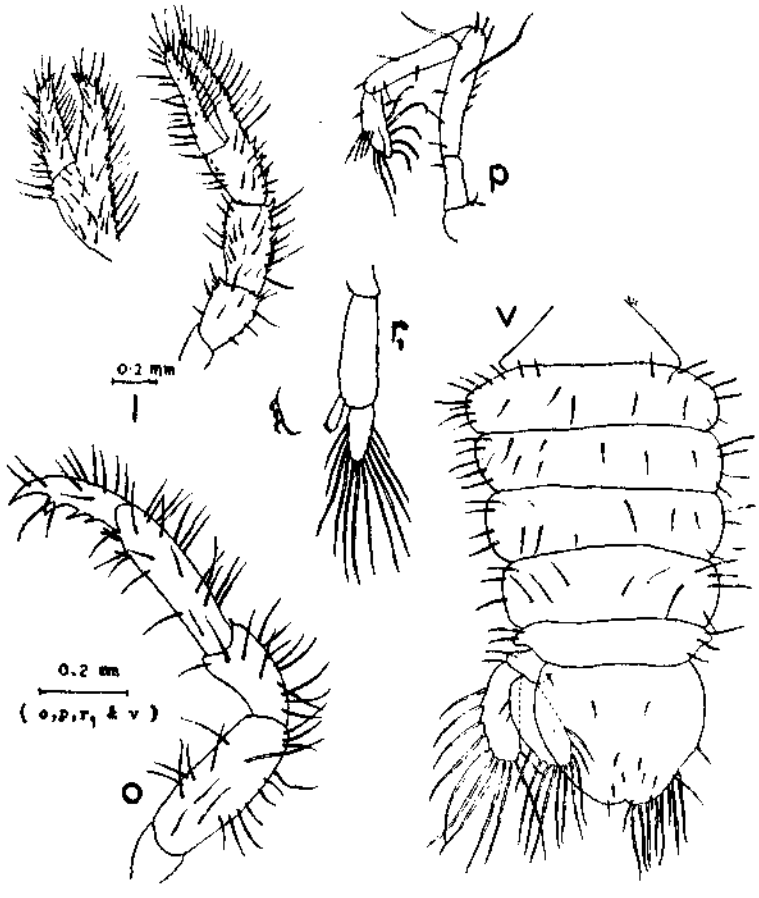

Fig. 4. *Polyonyx hendersoni* Southwell - megalopa

first pleopod, 4 on second, and 2 or 3 on last pleopod; third pleopod bears 2 minute hooks and a small plumose seta on endopod. *Uropods* (Fig. 4 v): biramous with an oval exopod and smaller endopod; exopod bordered with about 12 plumose setae upto basal half of inner margin. Endopod similarly provided with 10 plumose setae on distal margin and 2 or 3 small hairs proximally on outer margin. *Tel* (Fig. 4 v): More or less rounded in outline, being broader at base; posterior margin has a shallow median cleft, on either side of which are 7 or 8 plumose setae interspersed with 4

or 5 long spine-like setae; last plumose seta is situated at some distance from remaining setae and is lateral in position; rows of small setae present on dorsal surface indicating probably future median suture of telson plates;lateral notches are not yet formed.

Polyonyx loimicola Sankolli

First Zoea (Fig. 5)

Length of carapace	1.0 mm
Length of rostrum	5.0 mm
Length of posterior spine	0.8 mm

Larva (Fig. 5 a) quite small with a long rostrum which is more than 6 times length of posterior spines, which in turn are even shorter than carapace; rostrum

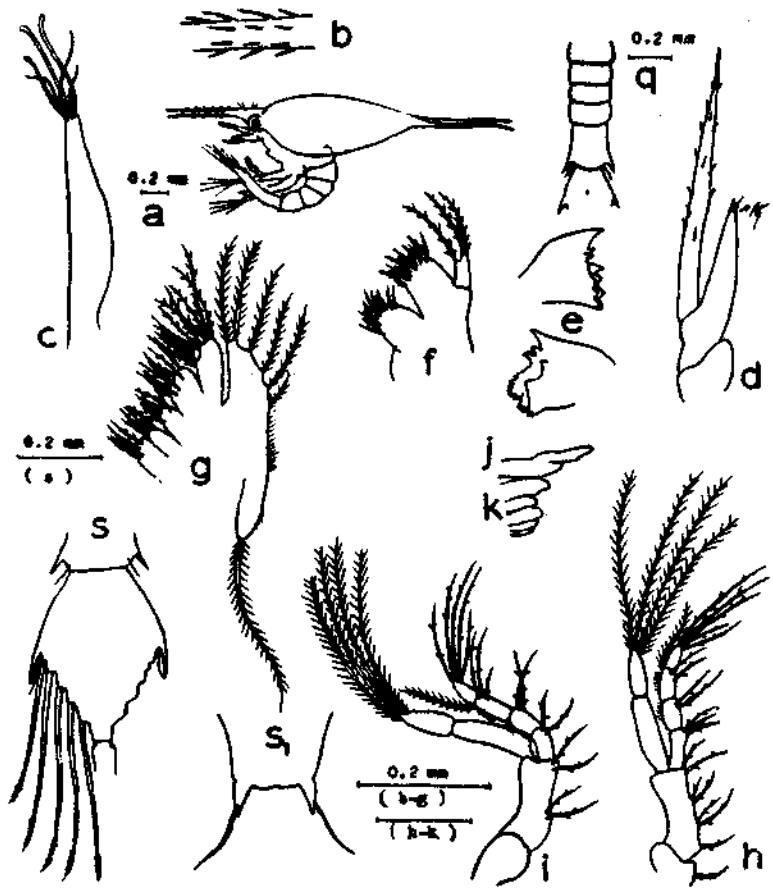

Fig. 5. *Polyonyx loimicola* Sankolli - Ist zoea.

armed (Fig. 5b) with 6 rows of sharp spines upto its tip as in *quadriungulatus, gibbesi* and *hendersoni*. but posterior spines smooth unlike in these species; eyes very small and partially free from carapace; just above eyes, minute setae are present

on carapace as in other species but two pairs and not one; exopod of functional Mxpd with 4 plumose setae each and Mxpd 3 a rudimentary, biramous bud. Five pair of uniramous pereiopod buds also present as in *gibbesi* and *quadriungulatus*. Ab 5-segmented, 5th segment bearing a pair of delicate hairs laterally, as in *hendersoni* and *gibbesi*. *Tel* longer than broad; process formula 7 + 7 with *central prominence bifid in appearance*.

*A*1 (Fig. 5 c) : Simple, unjointed with 3 aesthetascs and 3 unequal setae terminally. *A*2 (Fig. 5 d): biramous with a short, stout endopod which ends in a tooth-like tip and a small hair; exopod distinctly separated from peduncle and is slender, elongated and armed with small spinules in the distal 2/3 as in *quadriungulatus* but is only twice length of its endopod as in *gibbesi* and not 3 times as in latter species (however, seta found on exopod of the other two species, is not present here).

Md (Fig. 5 e): Slightly asymmetrical, with unevenly toothed processes as in *P. hendersoni*. *Mx* 1 (Fig. 5 f): As in *quadriungulatus* having 4 big and 2 shorter serrated teeth on coxal and 4 curved bristles and 6 setae on basal endites; endopod unsegmented with 3 setae as in other species. *Mx* 2 (Fig. 5 g): coxal and basal endites bear 8 and 7, and 4 and 9 setae respectively on their lobes; endopod unsegmented, bearing 9 sparsely plumose setae arranged in 3 groups of 3 basal, 2 subterminal and 4 terminal, (as in *quadriungulatus*) scaphognathite as in other two species, bearing 6 marginal and a long posterior plumose setae. *Mxpd* 1 (Fig. 5 h): 4-segmented endopod is slightly longer than exopod as in *hendersoni*. 3, 2 and 2 setae present respectively on first three segments and 5 terminal and 1 outer basal on fourth egments; only second and third segments have fine hairs on outer margin as in *quadriungulatus*, but these are shorter than those of *hendersoni*; 2-segmented exopod bears 4 terminal, plumose setae; basis shows a wavy inner margin as in *hendersoni*, with 4 groups of setae of 2, 2, 2 and 1; coxa has one distal seta. Mxpd 2 (Fig. 5 i): Endopod is shorter than exopod, as is generally found in the genus, bearing 2, 2 and 3 setae each on first three segments, last segment as in Mxpd 1 exopod is as in Mxpd 1; basis bears only 2 groups of setae as in other species.

Other appendages: Mxpd 3 is a biramous bud and 5 pairs of pereiopods present as uniramous buds (Fig. 5 j, k). *Ab* (Fig. 5 q): 5-segmented, 5th segment being longest and bearing lateral pair of hairs as in *hendersoni* and *gibbesi*; posterolateral spines present on 5th segment only. *Tel* (Fig. 5 s): Longer than broad, 'arrow-head' shaped, process formula being 7 + 7 and 7th process situated outside central prominence; latter appears bifid as (Fig. 5. s_1) it bears 2 lateral tooth-like processes, each bearing a delicate hair dorsally at its tip, among telson processes, 1st is a long spine, serrated on distal half of inner margin only, as in *hendersoni*, 2nd process is delicate Anomuran hair and 3rd to 7th processes are long, plumose setae with spinulose distal ends; anal spine present, knobs on central prominence or dorsal hairs of telson found in *gibbesi* and *quadriungulatus*, are absent in present species.

Second Zoea (Fig. 6)

Length of carapace	1.4 mm
Length of rostrm	5.0 mm
Length of posterior spine	0.7 mm

Larva considerably increse in size (Fig. 6 a). No change in armature of rostrum and posterior spines. Eyes free from carapace and stalked. The 2 pairs of minute

setae on carapace still present but shifted back, one above eyes and one at some distance behind. *A1* biramous; no mandibular palp formed yet. The number of setae on exopod of *Mxpd* 1-3, 10, 10 and 5 respectively. *Ab* 5-segmented, but with 4 pairs of pleopod buds on the 2nd to 5th segments. *Tel* process formula 8+8, 8th process situated on central prominence.

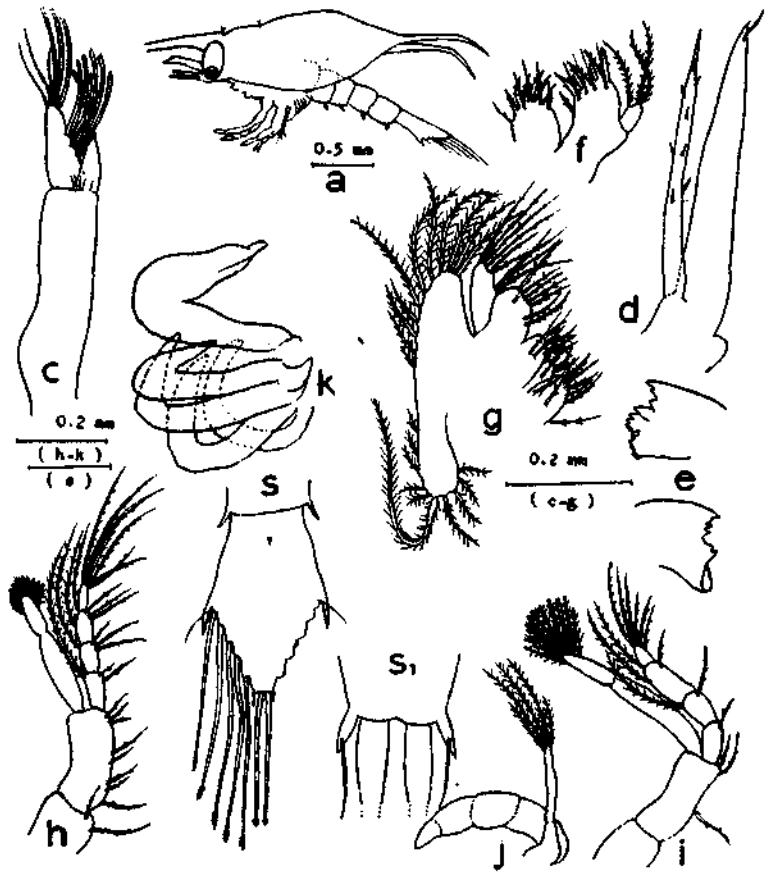

Fig. 6. *Polyonyx loimicola* Sankolli - IInd zoea

A1 (Fig. 6 c): Biramous with a distinctly articulated outer ramus and a small bud-like inner ramus still fused to peduncle; outer ramus bears 3 setae and 3 aesthetascs terminally and groups of 2, 3 and 3 aesthetascs on inner margin; inner ramus has a papilla-like tip; on distal margin of peduncle are 3 to 4 fine hair-like setae; peduncle is swollen in proximal part of outer margin and there are small hairs on this bulging part.

A2 (Fig. 6 d): Endopod much enlarged, more than twice thicker than exopod; number of spines on exopod is reduced; relative length of endopod and exopod is almost same as in *quadriungulatus*. *Md* (Fig. 6 e): Practically same as in 1st stage; palp not formed yet. *Mx* 1 (Fig. 6 f): Coxal endite has 4 curved bristle-like and 7 simple setae and basal has 4 big and 3 short serrated teeth and 5 simple setae; endopod is not changed. *Mx* 2 (Fig. 6 g): Number of setae on lobes of endites has increased

to 9, 6, 9 and 10 respectively from proximal to distal; palp does not change in structure scaphognathite generally bears 11 plumose setae on anterior half of outer margin and 5 on posterior half of margin and 4 on inner, in addition to long, posterior seta; non-setose portion of outer margin fringed with fine hairs, which is not observed in other species where margin is setose all along. *Mxpd* 1 (Fig. 6 h): Except for a addition of a long plumose seta on outer margin of first three segments, three is no other change in endopod; exopod bears 10 plumose setae distally; basis and coxa remain as in Ist stage. *Mxpd* 2 (Fig. 6 i): Endopod bears only 1 inner seta on each of first three segments, and one outer on second and third segments only but in other three species outer seta is present on 4th segment also; last segment bears 6 terminal and one outer setae; exopod as in *Mxpd* 1, bears 10 plumose setae; basis is as in Ist stage. *Mxpd* 3 (Fig. 6 j); Exopod bears 5 terminal, plumose setae; endopod, though not functional, is greatly increased in size and shows traces of segmentation in advanced larvae.

Pereiopods (Fig. 6 k): All 5 pairs of buds are fairly elongated and well formed, first one being chelate. *Ab*: 5-segmented with 2nd to 5th segments bearing 4 pairs of pleopod buds; lateral hairs on 5th segment still persist as in *hendersoni*. *Tel* (Fig. 6 s): Process formula is 8+8, 8th process being situated on central prominence but on inner side of tooth-like processes; all long plumose processes including 8th, are spinulose distally, spinules being more distinct on 7th and 8th processes; central prominence remains as in Ist stage; anal spine continues to be present.

Megalopa (Fig. 7 & 8)

Length of carapace	0.8 mm
Breadth of carapace	1.0 mm

Megalopa, as usual, shows a tendency to settle down and closely resembles the adult. Carapace more or less quadrangular, broader than long (Fig. 7 a) as in the adult. Front broad, nearly $\frac{2}{3}$ the breadth of carapace and fringed, as in adult, (Fig. 7 b) with a row of about 8 fine setae on either side, as in *quadriungulatus*. Eyes comparatively small, orbital notch rather shallow. Carapace smooth (as in *gibbesi* and *quadriungulatus* except for a few setae on the postero-lateral margin. Chelipeds and walking legs much less hairy than in *P. hendersoni*. Three spines on propodus of walking legs and dactylus 4-clawed, as in the genus.

*A*1 (Fig. 7 c): Peduncle 3-segmented, basal segment is somewhat swollen and has a row of setae medially and also on distal margin; all segments are smooth as in *quadriungulatus* and *gibbesi*; inner ramus is 3-segmented and bears a few setae; outer ramus consists of 5 segments with 3 tiers of about 20 aesthetascs arranged on all segments except on last; 2 groups of long, plumose setae at base of two rami and distally on peduncle present as in *hendersoni*. *A*2 (Fig. 7 d): consists of a 3-segmented peduncle and a long flagellum of about 18 to 20 segments (in *gibbesi* flagellum consists of 25 segments and in *quadriungulatus* of 30 segments). No spines or teeth on peduncular segments as in *gibbesi* and *quadriungulatus*.

Md (Fig. 7 e): Fully formed with a 3-segmented palp; distal segment of palp bears about 12 bristle-like setae; dorsal cutting edge basally bears a single tubercle-like tooth whereas ventral cutting edge is uneven with 3 tubercle-like projections. *Mx* 1 (Fig. 7 f): Endopod unsegmented with one short terminal seta as that of *P. hendersoni*; coxal and basal endites are similarly armed as in *hendersoni*. *Mx* 2 (Fig. 7 g): Of two setose bilobed endites, coxal one is smaller with cleft dividing

lobes rather deep and clear, whereas basal endite is broad with a superficial notch; endopod is like that of *hendersoni*; scaphognathite is fringed with setae along its entire margin and is much broader than in other two species.

Mxpd 1 (Fig. 7 h): Coxal and basal endites are fully fringed with setae as usual; endopod unsegmented, simple and has 2 to 3 setae on either margin; exopod scale-like, bearing about 5 minute setae on outer margin and terminates in 3 or 4 setae as in *hendersoni*. *Mxpd* 2 (Fig. 7 i): Endopod shows four distinct segments, remaining segments being fused; basal segment lined with 4 or 5 setae on inner margin; on remaining segments, setae are arranged in distal tufts, those of third covering last segment; exopod has a large basal segment bearing 4 or 5 setae on

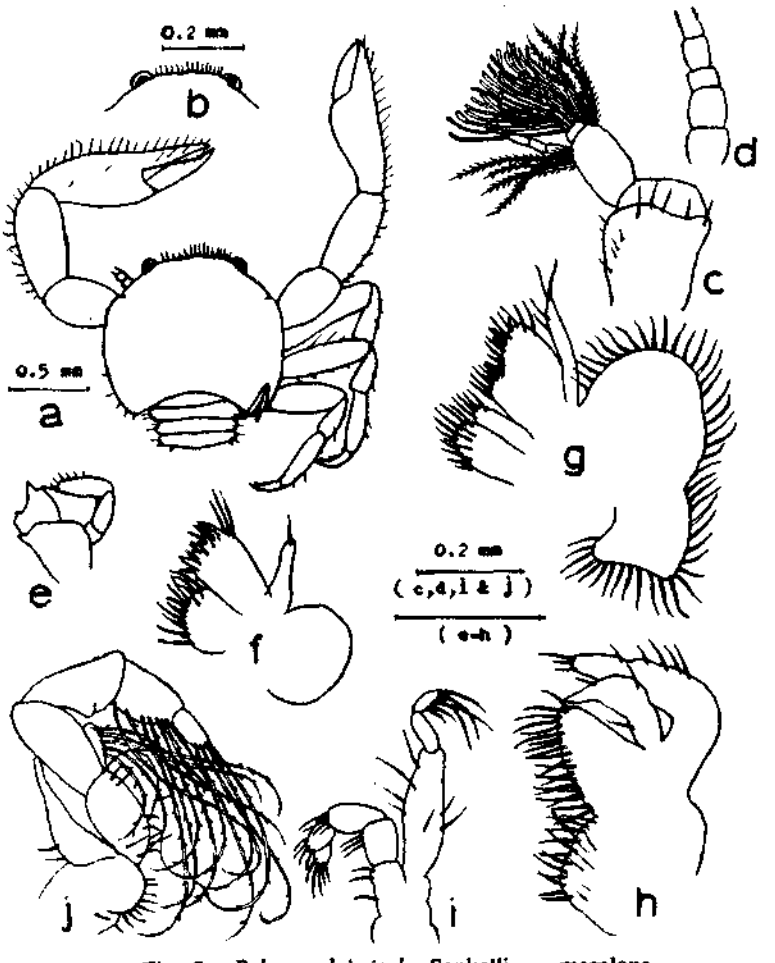

Fig. 7. *Polyonyx loimicola* Sankolli - megalopa.

inner and 2 or 3 on outer margins; terminal segment flagellar, slightly bent and bears a few distal setae. *Mxpd* 3 (Fig. 7 j): Greatly modified; endopod well developed with ischium, merus and carpus having flat, lateral extensions, and merus to dactylus being provided with long tufts of filtering setae which are bent in direction of mouth

and practically cover up appendage. Lateral extensions of ischium to carpus are smooth as in *quadriungulatus* and *gibbesi* and not toothed as in *hendersoni*; exopod not fully segmented but distal part flagellar and bent inwards, with no setae; basal part is bordered with a few setae on either margins; setae are present also on inner margin of ischium and basis.

Pereiopods:

First pair or chelipeds (Fig. 8 l): Mainly unequal, all segments are smooth as in adult (also as in megalopae of *quadriungulatus* and *gibbesi* without any spines but setae), except for a few scattered setae; only propodusis bordered with a row of setae and carpus to a lesser degree, on posterior edge; dactylus as long as fixed finger and cutting edges of both fingers are smooth and not provided with tubercles found in adults.

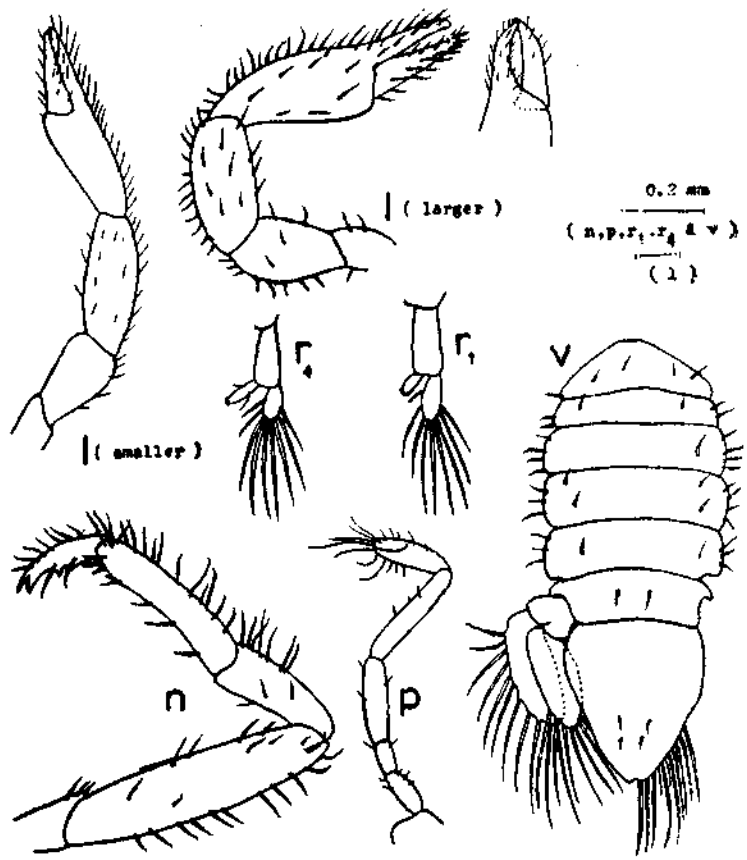

Fig. 8. *Polyonyx loimicola* Sankolli - megalopa.

Both chelipeds are structurally similar, larger cheliped differs from smaller only in being massive and stout. *Walking legs* (Fig. 8 m, n, o): Second to fourth pairs of legs are similar, only decreasing in size gradually; merus is very long and

carpus nearly half length of merus, both segments being smooth; propodus, is twice as long as broad and bears on posterior margin, 3 spines, 2 of which are at distal and 3rd which is smaller, behind distal ones; dactylus, as in adult, 4-clawed, accessory claw being smaller than principal which is largest; two remaining claws are much smaller. *Fifth leg* (Fig. 8 p): Chelate, tip armed as in other species.

Ab (Fig. 8v): 6-segmented, 6th segment distinctly separated from tel; segments are sparsely setose and 2nd to 5th bear 4 pairs of biramous pleopods which gradually decrease in size posteriorly; first and fourth pleopods each bears 9 plumose setae on exopod whereas second has 11 and the third 10; endopods of all pleopods have 3 or 4 minute hooks each and only fourth pair has 2 basal setae in addition to these hooks. *Uropods* (Fig. 8 a): Exopod and endopod are more or less oval, latter being slightly smaller; exopod is provided with 19 to 20 plumose setae along entire margin , whereas endopod has 9 to 10 setae on its distal margin. *Tel* (Fig. 8 v): Somewhat triangular in outline with its posterior part narrowing and provided with a shallow notch in middle of posterior margin; on eihter side of this notch are 7 to 8 plumose setae and 3 or 4 hair-like setae, indication of lateral notches is not as yet formed; pairs of small setae along the median notch present.

DISCUSSION

The present knowledge of the Porcellanid larvae reveals that not only the genera *Porcellana* and *Pisidia* but also the genus *Polyonyx* can be accommodated in the *Porcellana* group of Lebour (1943), as already suggested by Knight (1966).

Considering the larvae of the 4 species of the genus *Polyonyx*, viz., *hendersoni*, *loimicola*, *quadriungulatus* and *gibbesi*, they agree in general, with one another. The presence of minute hairs/setae on the carapace above the eyes seems to be a feature of generic importance since it is present in all the species described so far. The presence of dorsal hairs on abdominal segments, 2-3 pairs in *hendersoni* and *gibbesi* and 1 pair in *loimicola*, and their absence in *quadriungulatus*, are quite characteristic and appear as rather an independent feature of specific status.

The antenna of *hendersoni* is like that of *Porcellana gravelei* whereas those of the other *Polyonyx* species resemble closely the antenna of *Porcellana ornata*, *Pisidia spinulifrons* and *P. dehaani* (Shenoy, 1967). Thus, the significance of the antennal proportion, as suggested by Knight (1966), does not seem to be of much importance.

The zoeal and the megalopal characters of *quadriungulatus*, *gibbesi* and *loimicola* resemble each other more closely than either of the three with *hendersoni*. This kind of similarity is probably due to the fact that the adults of the former three species have commensal habits in common whereas the later species is rather a free living form.

Considering the megalopal characters, it may be noted that of these 4 *Polyonyx* species, the megalopa of *hendersoni* alone can easily be distinguished (by spinose nature of carapace and chelipeds) while the other three, can scarsely be differentiated, from each other by the numbr of segments of the antennal flagellum.

The characters of the larvae of the genus *Polyonyx* can be summarised as follows:

Presence of a dorsal pair or two, of minute hairs on the carapace above the eyes; rostrum armed with sharp spines upto the tip. Posterior spine armed or smooth;

mandible with several unequal teeth but with no palp in zoeal stages. Palp of the first maxilla with not more than 3 setae. The endopod of second maxilla with 8 or 9 setae in 3 groups, scaphognathite generally with 6 marginal setae and fringed with fine hairs in the non-setose part of the outer margin. The endopod of first maxilliped larger than the exopod. Telson process formula 7+7 with a pair of delicate hairs or/and with a pair of tooth-like terminations on the central prominence; in the IInd zoea, the process formula is 8+8, the eighth pair of processes being situated on the central prominence but in between the tooth-like proceses.

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

1. Abdominal hairs present; a pair of dorsal minute setae on carapace above eyes 2

   Abdominal hairs absent; a pair of dorsal minute setae on carapace above eyes ..... *P. quadriungulatus* (After Knight)

2. Lateral spines present on all abdominal segments ..... *P. gibbesi* (After Gore)

   Lateral spines present on *some* abdominal segments 3

3. Lateral spines present only on 5th abdominal segment; so also abdominal hairs; posterior carapace spine smooth with no tubercles ..... *P. loimicola* (Present work)

   Lateral spines present on 4th and 5th abdominal segments; so also abdominal hairs; posterior carapace spine with tubercles extending to posterior ventral margin of carapace ..... *P. hendersoni* (Present work)

KEY TO THE MEGALOPAE OF THE KNOWN SPECIES OF *POLYONYX*

1. Front of carapace serrated (with unequal teeth on either side of a median bifid tooth); lateral margin of carapace with spines; chelipeds spinuous and hairy; antennal flagellum of 22 segments ..... *P. hendersoni* (Present work)

   Front and lateral margin of carapace smooth; chelipeds not spinuous but hairy or smooth 2

2. Eyes small, only the corneal portion exposed; chelipeds unequal to subequal, only a few scattered hairs present but not dense; antennal flagellum of 18-20 segments ..... *P. loimicola* (Present work)

   Eyes comparatively large, eye stalks extend beyond lateral margin of carapace ... 3

3. Antennal flagellum of 25 segments ..... *P. gibbesi* (After Gore)

   Antennal flagellum of 30 segment ..... *P. quadriungulatus* (After Knight)

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EXPLANATION FOR LETTERING IN THE FIGURES

a– entire larva/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; si– central prominence of telson highly magnified; t-telson process highly magnified (suffix indicates the number); u - telson + uropod; v- abdomen with telson + uropod;