

Larval Development of the Xanthid Crab, *Ozius rugulosus rugulosus* Stimpson (Decapoda, Brachyura) under Laboratory Conditions

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Complete life history of the *O. rugulosus rugulosus*, as observed in the laboratory, comprising 4 zoeal and a megalopa stages, is described. Comparisons are made with the larvae of *O. truncatus* from New Zealand, the only other species of the genus in which the larvae are so far known. Important generic features suggested, based on the present work, are dorsal spine on 1st abdominal segment in zoeal stages and ventral spine on ischium of chilled of megalopa.

THE crab family Xanthidae is one of the most predominant families of rocky shore crabs, represented by number of genera, including *Ozius*. Larvae of many of the genera are fairly well known from different regions of the world¹⁻⁴.

As far as the genus *Ozius* is concerned, however, larval information is restricted only to 2 species—*O. truncatus* from New Zealand described by Wear³ who deals with the complete life history of this species reared in the laboratory. From the Indian waters Chhapgar⁵ describes the 1st stage only, based on planktonic material from Bombay waters, of what he refers to *O. rugulosus*, the identity of which is rather doubtful.

The present paper deals with the complete life history, comprising 4 zoeal and a megalopa stages as observed in the laboratory, of *O. rugulosus rugulosus* Stimpson one of the two species recorded from the Indian region⁶.

Materials and Methods

An ovigerous female was collected during low tide on the 9 Dec. 1973 on the rocky shore at Binaga, Karwar, along the west coast of India. The crab was kept alive in the laboratory until the larvae hatched on the 12 Dec. 1973. Larvae were reared by similar method described by Kakati and Sankolli⁷.

Temperature and salinity of the water during the experiment ranged from 25-27°C and 35-37‰ respectively.

The berried female from which the hatchings for the present study were obtained was identified as *O. rugulosus rugulosus* Stimpson as per Serene⁸.

The following abbreviations are used throughout the paper: A1, antennule; A2, antenna; Md, mandible; Max 1, first maxilla; Max 2, second maxilla; Mxp 1, first maxilliped; Mxp 2, second maxilliped; Mxp 3, third maxilliped; P₁₋₅, pereopods 1-5; and Pl₁₋₅, pleopods 1-5.

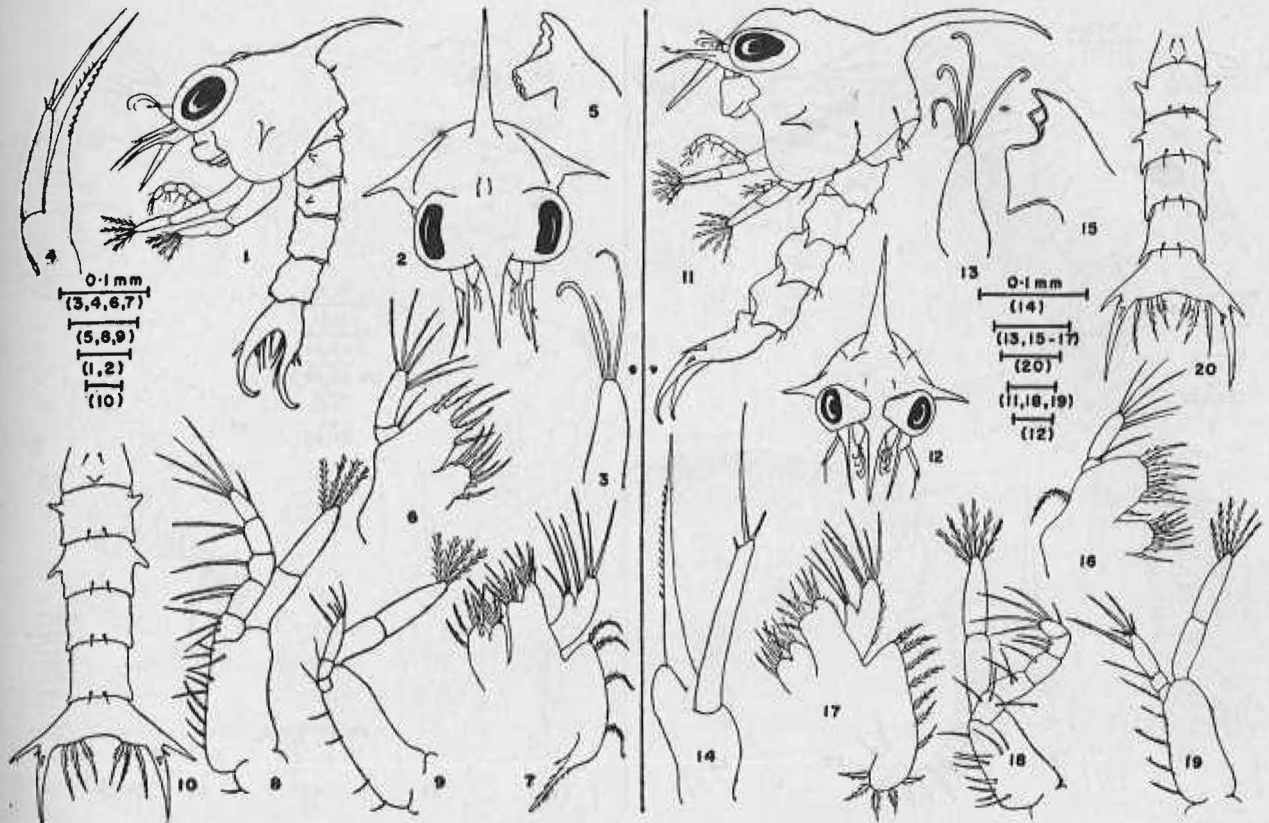
Description of Larval Stages

1st zoea — Rostral spine, 0.29 mm; dorsal spine, 0.45 mm; lateral spine, 0.15 mm; carapace length,

0.53 mm; abdomen length, 1.12 mm; and duration of stage, 3-5 days.

Carapace with rostral, dorsal and lateral spines, dorsal spine curved posteriorly and with a pair of small setae basally on carapace; a medio-dorsal and a medio-frontal tubercles (Figs. 1 and 2). Eyes sessile. A1 (Fig. 3): Uniramous, with 2 aesthetascs and a seta. A2 (Fig. 4): Spinous process well developed with 2 rows of spinules; exopod half the length of spinous process and with one very long and 2 small, unequal setae; endopod not yet developed. Md (Fig. 5): Without palp but with well developed incisor and molar processes. Max 1 (Fig. 6): Coxal endite with 7 and basal with 5 setae; palp 2-segmented, long distal segment with 4 terminal and 2 subterminal setae and short proximal with a single seta. Max 2 (Fig. 7): Coxal and basal endites bilobed and with 5, 4, 5 and 5 setae respectively; palp unsegmented, bilobed, proximal lobe with 3 setae and distal with 2 subterminal +3 terminal setae; scaphognathite with 4 plumose setae and its proximal portion drawn out to form a broad plumose seta. Mxp 1 (Fig. 8): Basis with 10 setae; 5-segmented endopod with 3, 2, 1, 2 and 5 setae distalwards; exopod 2-segmented with 4 natatory setae. Mxp 2 (Fig. 9): Basis with 4 setae; 3 segmented endopod with 1, 1 and 5 setae distalwards; exopod as in Mxp 1. Abdomen (Fig. 10): Five segmented; 1st segment with a posterior rather broad and blunt dorsal spine; 2nd and 3rd segments with lateral protuberances, 2nd directed anteriorly and 3rd posteriorly. Segments 1-5 with a pair of small, mid-dorsal setae each; postero-lateral corners of segments slightly drawn. Telson (Fig. 10): Short, widely forked, forks being parallel to each other and each carrying 3 spines proximally as illustrated. Process formula 3+3. Chromatophores: Yellowish brown chromatophores present at base of A1 and A2; brownish one on Md, Max 1 and Max 2; dark brown chromatophores laterally on carapace below lateral spines and on eyestalks; branched brown chromatophores dorsolaterally on each abdominal segments. Yellowish tinge is seen dorsally on the carapace and laterally on each abdominal segments. Telson

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Figs. 1 to 10 — First zoea of *O. rugulosus rugulosus* Stimpson [1, Lateral view of zoea; 2, front view of zoea; 3, antennule; 4, antenna; 5, mandible; 6, first maxilla; 7, second maxilla; 8, first maxilliped; 9, second maxilliped; and 10, abdomen]

Figs. 11 to 20 — Second zoea of *O. rugulosus rugulosus* Stimpson [11, Lateral view of zoea; 12, front view of zoea; 13, antennule; 14, antenna; 15, mandible; 16, first maxilla; 17, second maxilla; 18, first maxilliped; 19, second maxilliped; and 20, abdomen]

carries brown chromatophores in the centre and near the dorsal cornua spine. No chromatophores are present on the carapace spines. Basipods of maxillipeds with brown chromatophores.

IInd zoea — Rostral spine, 0.35 mm; dorsal spine, 0.66 mm; lateral spine, 0.18 mm; carapace length, 0.64 mm; abdominal length, 1.35 mm; and duration of stage, 3-9 days.

This stage (Figs. 11-20) is characterized by stalked eyes; posterior border of carapace with a single plumose seta; A1 with 4 aesthetascs; A2 with endopod bud; Max 1 with 3 more setae on basal endite, and a plumose seta on outer margin; Max 2 with 12 scaphognathite setae; exopods of Mxp 1 and 2 with 6 natatory setae; pereopods and Mxp 3 present as rudimentary buds.

IIIRD zoea — Rostral spine, 0.64 mm; dorsal spine 0.79 mm; lateral spine, 0.21 mm; carapace length, 0.85 mm; abdominal length, 1.65 mm; and duration of stage, 4-6 days.

Following are the important characters of this stage (Figs. 21-30): Ventral margin of carapace with 4 plumose setae; A1 with endopod bud and 6 aesthetascs; A2 with elongated endopod bud; Md with palp bud; coxal and basal endites of Max 1 with 8 and 10 setae respectively; scaphognathite of Max 2 with 21 setae; Mxp 1 and 2 with 7 natatory setae, endopod of 1st with 6 setae; first abdominal

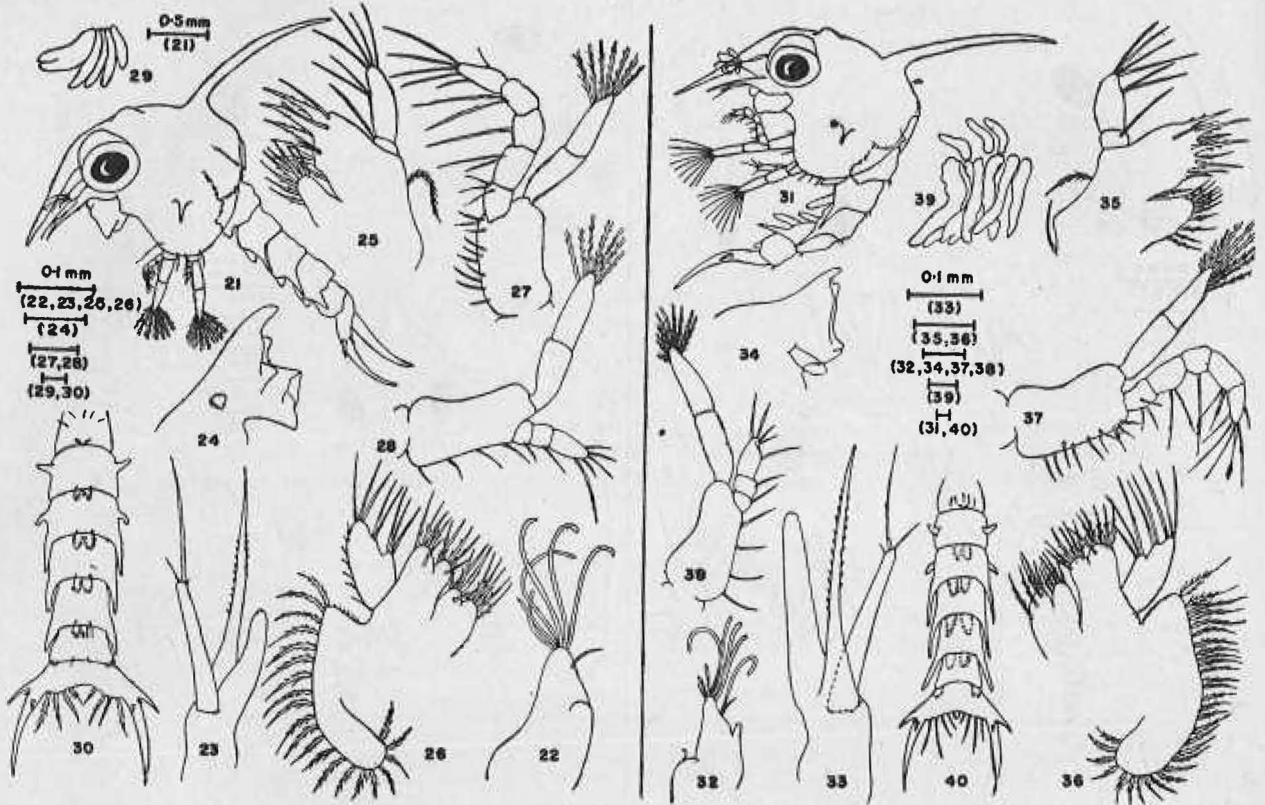
segment with 5 dorsal setae; pleopod buds on 2-5 abdominal segments and uropod buds on 6th; telson separated from 6th abdominal segment, with 2 dorsal setae and process formula 4+4.

IVth zoea — Rostral spine, 0.72 mm; dorsal spine, 0.95 mm; lateral spine, 0.24 mm; carapace length, 1.05 mm; abdominal length, 2.05 mm; and duration of stage, 4-6 days.

Salient features of this stage (Figs. 31-40) are: Ventral margin of carapace with 6 plumose hairs; A1 with 7 aesthetascs + 2 setae, endopod bud of A1 distinctly separated; A2 with elongated exopod; coxal and basal endites of Max 1 with 10 and 12 setae respectively, and outer margin with an additional seta; scaphognathite of Max 2 with 31 setae; 9 and 10 natatory setae on Mxp 1 and 2; 1st abdominal segment with 5 dorsal setae; telson process formula 5+5.

Megalopa — Carapace length, 1.35 mm; and carapace width, 1.23 mm.

Entire dorsal surface of carapace covered with setae; rostrum a small, triangular, deflexed projection; front broad; interorbital space 0.6 mm; eyes large, projecting as far as the lateral margins of carapace, eye stalks long with a few setae (Figs. 41 and 42). A1 (Fig. 43): Peduncle 3-segmented with setation 1, 3 and 2 distalwards, the basal segment is dilated; inner ramus 2-segmented with 5-setae

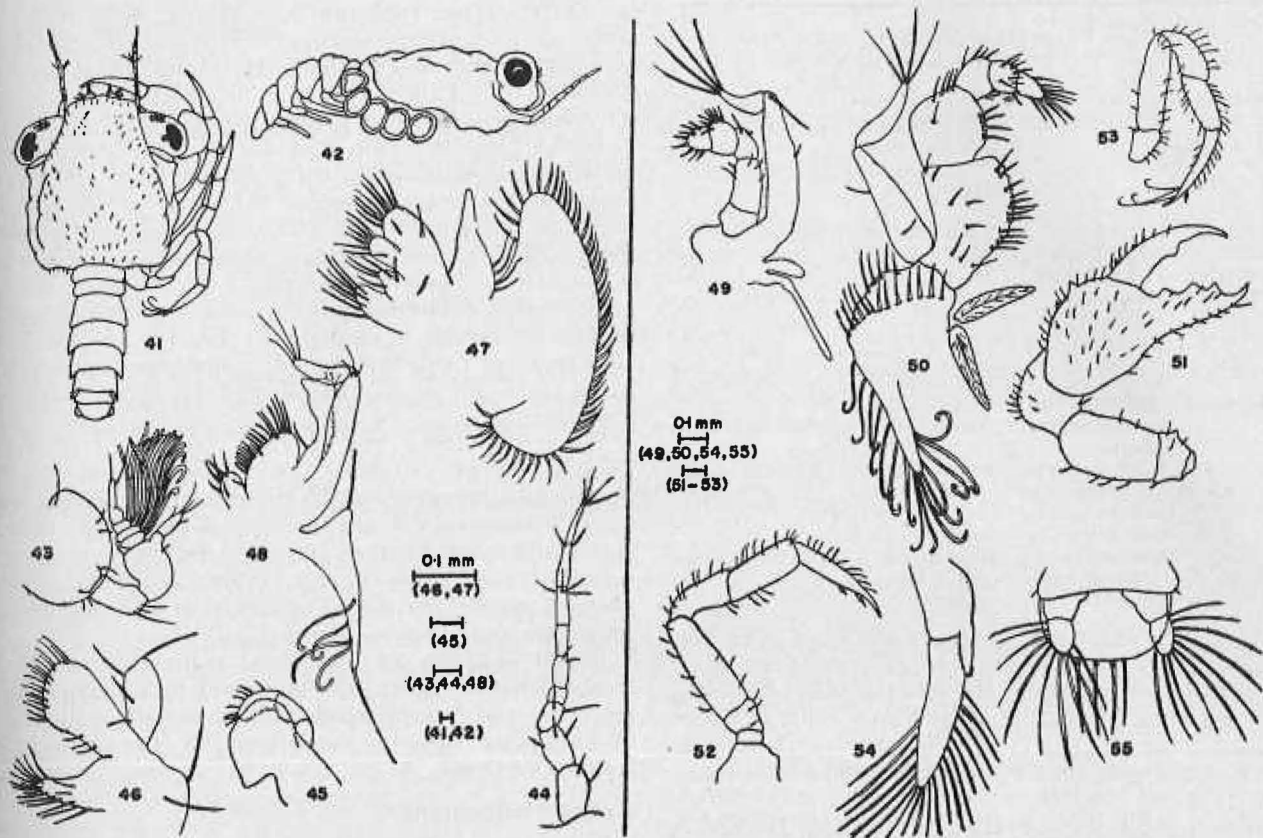


Figs. 21 to 30 — Third zoea of *O. rugulosus rugulosus* Stimpson [21, Lateral view of zoea; 22, antennule; 23, antenna; 24, mandible; 25, first maxilla; 26, second maxilla; 27, first maxilliped; 28, second maxilliped; 29, pereopod buds; and 30, abdomen]

Figs. 31 to 40 — Fourth zoea of *O. rugulosus rugulosus* Stimpson [31, Lateral view of zoea; 32, antennule; 33, antenna; 34, mandible; 35, first maxilla; 36, second maxilla; 37, first maxilliped; 38, second maxilliped; 39, third maxilliped and pereopod buds; and 40 abdomen]

on distal segment; outer ramus 5-segmented bearing about 20 aesthetascs and only 2 setae at tip of last segment. A2 (Fig. 44): Peduncle 3-segmented with 2, 3 and 2 setae respectively on 1st to 3rd segments; flagellum of 6 segments with setation distalwards being 0, 2, 0, 4, 2 and 4. Md (Fig. 45): With 3-segmented palp bearing 9 setae on its distal segment. Both incisor and molar processes merged. Max 1 (Fig. 46): Coxal endite with 17 and basal with 18+3 setae; palp unsegmented with 4 setae; outer margin with 2 setae. Max 2 (Fig. 47): Bilobed coxal and basal endites with 7, 5, 7 and 10 setae respectively on each of the lobes; palp with 4 outer, basal setae; scaphognathite fringed with about 51 setae. Mxp 1 (Fig. 48): Coxal endite with 6 setae and basal with about 25; endopod flattened distally, unsegmented and with 3 distal and 1 proximal setae; exopod large and 2-segmented; proximal segment with 3 apical setae and distal with 4 plumose setae terminally; epipod large with a slender distal portion bearing 5 setobranch-like setae and proximally 1 seta. Mxp 2 (Fig. 49): With 5-segmented endopod bearing 0, 5, 1, 7 and 8 setae distalwards; exopod 2-segmented with 4 apical setae on its distal segment; a podobranch and a long, narrow epipod present. Mxp 3 (Fig. 50): Endopod 5-segmented; ischium large with faintly

serrated margin and 20 setae; merus smaller than ischium and with 9 setae; the remaining segments with 7, 8 and 9 setae respectively; 2-segmented exopod not large, with 4 apical setae on its distal segment; epipod large with 18 bristle-like setae proximally and 15 setobranch-like setae distally; 2 arthrobranchs present. P1-5 (Figs. 51-53): P1 chelate, inner margin of ischium with a strong spine, outer margins of palm and dactylus with 2 and 3 large spines respectively; cutting edges of fingers with well developed broadly triangular teeth; P2 to 5 similar except for 5th bearing 3 long curved setae ('feelers' of Lebour, 1928), and with a serrated bristle-like spine near tip on anterior margin, such 2 spines also present on dactylus of 2nd-4th pereopods (Fig. 52). Abdomen (Fig. 42): 6-segmented, all segments setose; postero-lateral corners of 3rd to 5th segments angularly produced; 4 pairs of biramous pleopods (Fig. 54) on 2nd to 5th segments; a pair of uniramous uropods (= 5th pleopod) on 6th segment (Fig. 55), exopod of first 4 pairs of pleopods with 19, 19, 17 and 14-15 plumose setae respectively while that of uropod with only 10. Telson (Fig. 55): With rounded posterior margin carrying 4 long plumose setae. Chromatophores: Dark brown chromatophores present on: basal segments of A1, A2, on carapace (reticulate); eyestalks;



Figs. 41 to 48 — Megalopa of *O. rugulosus rugulosus* Stimpson [41, Dorsal view of megalopa; 42, lateral view of megalopa; 43, antennule; 44, antenna; 45, mandible; 46, first maxilla; 47, second maxilla; and 48, first maxilliped]

Figs. 49 to 55 — Megalopa of *O. rugulosus rugulosus* Stimpson [49, Second maxilliped; 50, third maxilliped; 51, first pereopod; 52, second pereopod; 53, fifth pereopod; 54, second pleopod; and 55, telson and uropods]

on sternal region near coxae and coxa proper; each segment of pereopods; on palm and fingers of chelipeds; and dorsolaterally on abdominal segments.

Discussion

Larvae of the present species, *Ozius rugulosus rugulosus* Stimpson, while possessing their own distinguishing features, share the following characters of the family Xanthidae³. The presence of 4 zoeal stages; development of antennal exopod as a distinct segment; presence of a pair of lateral protuberances on each of the 2nd and 3rd abdominal segments; presence of postero-lateral spines on the 3rd to 5th abdominal segments.

As far as the genus *Ozius* is concerned, larvae are now known in 3 species viz. *O. truncatus*³ *O. rugulosus*⁵ and the present *O. rugulosus rugulosus*. Chhapgar's larvae of *O. rugulosus*, though of doubtful identity as they are described from plankton, have been considered here for comparison.

Comparing the 1st zoeae of the above 3 species, it is observed that the larvae show the following common features: well developed spine on the telson cornua and the carapace tubercles which are also apparently present in Chhapgar's *O. rugulosus* though not clearly illustrated.

The above 3 species, however, can easily be differentiated mainly in respect of carapace, abdomen and telson as indicated in Table 1.

Differences between the remaining 2 species (*O. truncatus* and *O. rugulosus rugulosus*) in the subsequent stages are: IInd zoea in *O. rugulosus rugulosus* develops only one seta at postero-lateral angle of carapace, 1st maxilla with 2-segmented palp and scaphognathite with 12 setae whereas in *O. truncatus* carapace with postero-lateral fringe of setae, 1st maxilla with a 3-segmented palp and scaphognathite with 19-20 setae.

IIIrd zoea in *O. rugulosus rugulosus*, carapace with 4 postero-ventral setae, 7 maxilliped natatory setae; abdomen with postero-lateral angles of 2nd to 5th segments without minute serrations; telson process formula 4+4 but in *O. truncatus* the fringe on carapace continuing; 8 natatory setae; abdomen with minute serrations on posterolateral angles of 2nd-5th segments; telson process formula 5+5.

IVth zoea in the present subspecies, posterolateral setae of carapace now 6; scaphognathite with 31 setae and 9 and 10 natatory setae on 1st and 2nd maxillipeds respectively while in *O. truncatus*, carapace fringe continued; scaphognathite with 50 and maxillipeds with 10 natatory setae each.

TABLE 1 — CHARACTERS DIFFERENTIATING THE 3 SPECIES OF *Ozius*

Features of zoea I	<i>O. truncatus</i> (Wear, 1968)	<i>O. rugulosus rugulosus</i> (present work)	<i>O. rugulosus</i> (Chhapgar, 1956)
CARAPACE			
Pair of seta	Infront of dorsal spine	Behind dorsal spine	No seta shown
Posterior margin	Fringed with fine hairs	No fringe of hairs	No information
ABDOMEN			
1st segment	With sharp medio-dorsal spine posteriorly	Medio-dorsal spine rather blunt	No information
3rd to 5th segments	With postero-lateral spines rather well developed	Posterolateral blunt projections and not spine	No information
Dorsal setae	Present on first 4 segments	Present on all 5 segments	No information
TELSON			
Length	Fairly long and not much broad	Distinctly short and broad	Not clearly illustrated
Cornua	With dorsal spine which is less than half the cornua and with a single axillary hair	With lateral spine which is about half the length of cornua, with 2 small proximal spines, no axillary seta or hair	Apparently with dorsal spine which is almost as long as cornua; with neigher spines nor axillary setae

Megalopae of *O. rugulosus rugulosus* and of *O. truncatus* resemble each other closely in the following characters: (i) Outer ramus of antennular flagellum with 2 terminal setae, (ii) Mandibular palp 3-segmented, (iii) Palp of 2nd maxilla with a few basal setae, (iv) 2nd maxilliped with a small epipod and a podobranch, (v) 3rd maxilliped with a podobranch and 2 arthrobranches, (vi) 3 long terminal setae (= 'feelers' of Lebour) at the tip of dactylus of 5th pereopod, (vii) Ischium of 1st pereopod with a strong ventral spine.

But the two megalopae can be differentiated from each other by the following: (i) No postero-dorsal tubercles on carapace of *O. rugulosus rugulosus*

but there are two such tubercles present in *O. truncatus*; (ii) Antenna consists of 9 segments in *O. rugulosus rugulosus* whereas 11 segments in *O. truncatus*; (iii) Palp of 1st maxilla unsegmented in *O. rugulosus rugulosus* but 2-segmented in *O. truncatus*; (iv) The palp and dactylus of cheliped, on their outer surface, carry strong teeth in *O. rugulosus rugulosus* whereas no such teeth are found in *O. truncatus*; (v) Dactylus of walking legs 2-4 carry only two serrated spines in subspecies *O. rugulosus rugulosus* whereas 3 such spines are present in *O. truncatus*; (vi) Exopods of pleopods 1st to 5th (including uropods) bear 19, 19, 15, 14-15 and 10 setae respectively in *O. rugulosus rugulosus* while there are 22, 22, 22, 20 and 12 setae in *O. truncatus*.

While describing the Xanthid larvae of New Zealand, Wear³ stresses the importance of the presence of dorsal spine on 1st abdominal segment in *O. truncatus* as a unique feature amongst the Brachyuran larvae then known. But the occurrence of this spine though rather blunt in the present species perhaps indicates that this feature may have only generic significance.

Dorsal spine on 1st abdominal segment in zoeal stages (neither shown nor described in Chhapgar's material) and ventral spine on ischium of cheliped of megalopa can be considered as the generic features of *Ozius*.

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References

- GURNEY, R., *Ray Soc. London*, (1939).
- GURNEY, R., *Ray Soc. London*, (1942).
- WEAR, R., *New Zealand J. Mar. Fresh Wat. Res.*, 2 (2) (1968), 239.
- SANDIFER, P. A., *Bull. Mar. Sci.*, 24 (1974), 378.
- CHHAPGAR, B. F., *Rec. Indian Mus.*, 54 (1956), 33.
- ALCOCK, A., *J. As. Soc. Bengal*, 1xvii (1898), 67.
- KAKATI, V. S. & SANKOLLI, K. N., *J. Karnatak Univ. Sci.*, 20 (1975), 275.
- SERENE, R., *Singapore National Academy Special Publ.*, 1 (1968), 33.
- LEBOUR, M. V., *Proc. Zool. Soc. London*, (1928), 473.