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ON THE LARVAL DEVELOPMENT OF *ACETES INDICUS* H. MILNE-EDWARDS (CRUSTACEA : DECAPODA : SERGESTIDAE) FROM BOMBAY WATERS

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ABSTRACT

The sergestid shrimp, *Acetes indicus* H. Milne Edwards, contributes to a substantial percentage of the crustacean landings along the Maharashtra coast. Although much information on its distribution and fishery is available through the works of Kemp (1917) and Kunju (1966), the larval development of the species has not been worked out so far. The present paper describes the different larval stages of the species from egg through post larva. It is observed that the larva passes through 3 naupliar, 3 protozoeal, 1 mysis and 5 postlarval stages in the course of its development. A comparison of the diagnostic features of the different larval stages with the corresponding stages of other allied species has been given.

INTRODUCTION

AMONG the sergestid shrimps known from the Indian Seas, the species of *Acetes* are commercially important. Along the Maharashtra coast, *A. indicus* forms an important fishery and is also a major forage constituent for fishes of the inshore waters. Although widely distributed in Indian Seas, the Gulf of Thailand Malayasian and Indonesian waters, it is in the northern region of west coast of India that the species appears in vast shoals in the inshore waters and estuaries almost throughout the year and contributes about 20% of the estimated annual crustacean landings.

The taxonomy of *A. indicus* and the seven other species of the genus from the Indian Seas are fairly well known through the works of Kemp (1917), Hansen (1919) and Nataraj (1942). However, hardly anything is known about the biology and life history of these species. The available information mainly pertains to the larval development of *A. japonicus* (Soejima, 1926), *A. erythraeus* (Menon 1933), *A. cochinensis* (Rao, 1968) and on the seasonal abundance of *A. indicus* along the Maharashtra coast (Kunju, 1966). The life-histories of *Sergestes lucens* and *A. japonicus* from Japanese waters have been studied by Omori (1969) and Ikomatsu (1953) respectively.

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MATERIAL AND METHODS

The larval material was obtained from the plankton collected from a fixed station in the inshore waters of Bombay, during the period 1966-1970, with a half

metre organdy net. The samples were preserved in 5 per cent formaldehyde solution. The illustrations were prepared with the aid of a camera lucida.

The total length of the larva was taken from the anterior border to the posterior border excluding the furcal spines in the case of the nauplius and protozoea I; and from the tip of the rostrum to the posterior border of telson excluding the spines from protozoea II onwards. Carapace length was measured from the front border to the posterior border. Width of the body of the nauplius given pertains to the greatest width. The following abbreviations are used in this paper:- A1: Antennule, A2: Antenna, Ab: Abdomen, Md: Mandible, Mx1: First maxilla, Mx2: Second maxilla, Mxp 1: First maxilliped, Mxp 2: Second maxilliped, Mxp 3: Third maxilliped and Tl: Telson. Under 'Material' the number of specimens examined is given followed by the Total length (TL), Width (W) and mean in paranthesis in mm.

DEVELOPMENTAL STAGES

Egg (Fig. 1 a-c)

Material—85; diameter: 0.36 - 0.40 mm (0.38 mm).

Fertilized eggs showing different stages of embryonic development were collected especially during October-November.

Eggs spherical, golden brown and translucent; periviteline space wide; embryonic mass 0.19 - 0.20 mm in diameter. Earliest stage collected appears to be a blastula (Fig. 1a); outline of the naupliar body with three bud-like rudiments of appendages distinct in next stage (Fig. 1b) ; in most advanced stage (Fig. 1c) nauplius is almost fully developed with partially extruding appendages but still covered by a thin embryonic membrane.

Nauplius 1 (Fig. 1d)

Material—14; TL: 0.15 - 0.16 (0.15); W: 0. 11 mm.

Body elliptical, opaque and golden brown with a brownish tinge at base of appendages; naupliar eye present at anterior end; posterior end bears a pair of furcal spines; three pairs of appendages present.

A1 uniramous, unsegmented with 2 unequal terminal setae and one inner subterminal seta. A2 biramous, unsegmented; endopod with 2 terminal setae; exopod longer than endopod, bears 2 terminal and 3 lateral setae. Md biramous, endopod each with 2 terminal 1 subterminal setae.

Nauplius II (Fig. 1e)

Material—17; TL: 0.25 - 0.28 (0.26); W: 0.14 mm.

Body slightly elongate, browinsh, furcal lobes pronounced, each lobe with 4 unequal furcal spines; naupliar eye persists; rudiments of maxilla developed; setae on appendages plumose.

A1 uniramous, unsegmented with 2 terminal setae of unequal length and 3 short lateral setae. A2 biramous, unsegmented, exopod with 3 terminal and 3

lateral setae, endopod with 3 terminal setae. Md biramous, exopod and endopod each bear 3 setae, middle seta of endopod becoming slightly longer.

Nauplius III (Fig. 1f)

Material—46; TL: 0.33 - 0.39 (0.35); W: 0.13 mm.

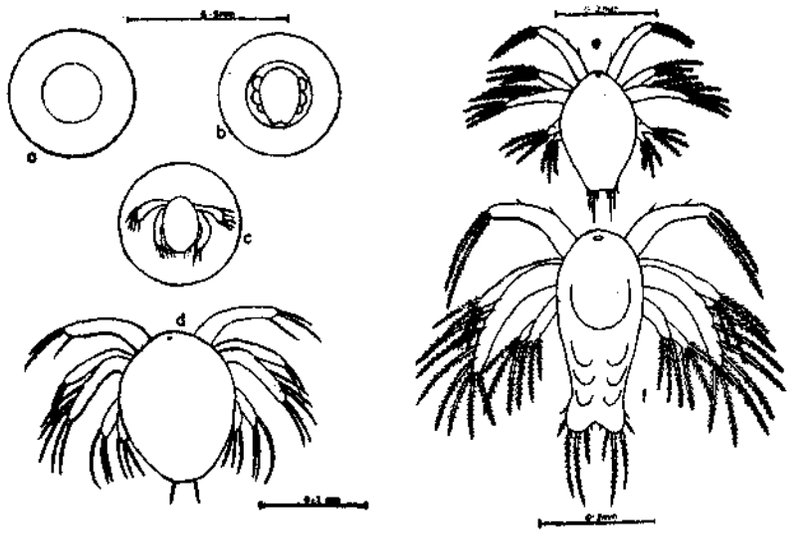

Fig. 1. Eggs and nauplii of *Acetes indicus*-a. first stage; b. second stage; c. egg before hatching; d. nauplius I; e. nauplius II; and f. nauplius III.

Larva longer than broad and translucent, at base of A1, A2 and caudal lobes prominent reddish pigments present; caudal region distinctly bilobed; appendages show signs of segmentation for the first time. In addition to the developing maxillae rudiments of maxillipedes also present.

A1 uniramous, with 2 terminal subequal setae, 2 outer lateral setae, persisting A2 biramous, protopod and endopod faintly segmented; exopod 4-5 segmented with 4 lateral and 3 terminal setae; Md same as in Nauplius II; Mx 1 still rudimentary. Mxp 1 and Mxp 2 bud-like and rudimentary. Furcal lobes bilobed, each lobe with 6 setae, 4 prominent and plumose; outermost and innermost being shortest.

Protozoea I (Fig. 2 a-f)

Material—45; TL: 0.53 - 0.58 (0.56) mm.

During transformation from Nauplius III to Protozoea I, larvae change radically. Anterior portion of body covered by a large loose fitting carapace; on either side of naupliar eye, beneath carapace, developing compound eyes discernible; carapace broader than long ; paired anterior, lateral spines and a single median posterior spine, anterior spines bifurcated; all spines provided with short lateral processes; thorax short and segmented; Ab unsegmented; Tl bilobed, each lobe carrying 5 spines, outermost pair shorter than other spines.

A1 six segmented, proximal 4 segments short, 5th one longer and 6th indistinct with 3 terminal subequal and 2 shorter lateral setae; protopod and endopod of A2 two segmented, latter with 5 apical setae; exopod 8 segmented (the basal most indistinct) with lateral setae one on each segment from 2nd to 7th and with 4 setae on terminal segment (Fig. 2g); cutting edge of Md with 7 teeth, 1st and 2nd teeth from ventral margin long, slender and pointed (Fig. 2b); protopod of Mx 1 bilobed, with 3 and 4 setae on proximal and distal lobes respectively; endopod 3 segmented, first 2 segments with 2 inner setae, 3rd with 4 terminal setae; exopod bears 4 plumose setae (Fig. 2c). Mx2 protopod 4 lobed, first carrying 5 to 6 setae, 2nd to 4th each with 3 setae and 5th with 3 terminal and 3 lateral setae, small exopod with 4 plumose setae; endopod unsegmented with 5 lateral and 3 terminal setae (Fig. 2d); endopod of Mxp1 6 segmented, first 5 segments carry 2 setae each, 6th with 5 plumose setae; exopod unsegmented with 3 terminal and 3 lateral setae (Fig. 2e); endopod of Mxp 2 four segmented, first 3 segments with 2 setae each and distal segment with 6 terminal setae; exopod half as long as endopod with 3 terminal and 3 lateral setae (Fig. 2 f). Mxp 3 rudimentary.

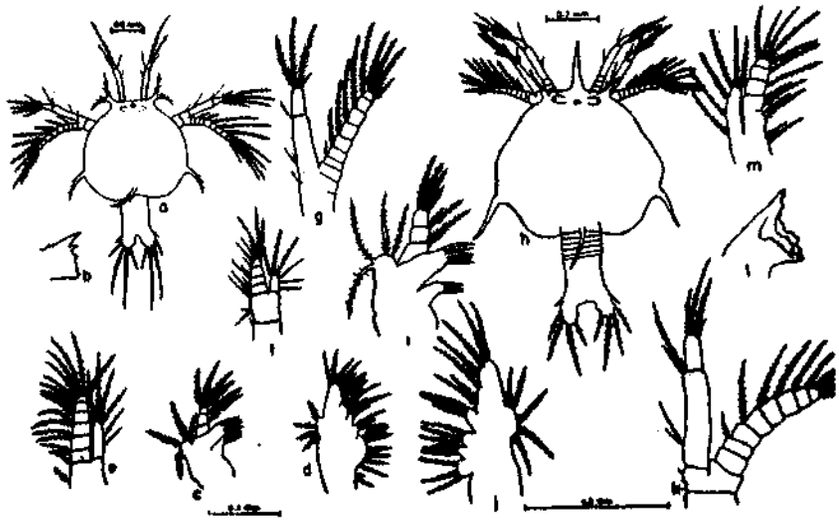

Fig. 2. Protozoea I and II of *Acetes indicus*—a. Protozoea I; b. mandible; c: first maxilla; d. second maxilla; e. first maxilliped; f. second maxilliped; g. antenna; h. Protozoea II; k. antenna; l. mandible; i. first maxilla; j. second maxilla; and m. first maxilliped.

Protozoea II (Fig. 2 h-j)

Material—74; TL: 1 - 1.08 (1.03) mm.

Most marked changes from previous stage are development of rostrum at anterior end of carapace and segmentation of abdomen. Rostrum well developed, median eye persists, compound eyes not free of carapace but with a stout stalk; lateral processes on anterior, lateral and posterior spines disappear; Ab six segmented; Tl bilobed, well developed, each lobe with 5 spines; pigmentation clearly visible at base of appendages and telson.

A1 six segmented, setation remains unchanged except for an additional small seta at inner margin near tip; A2 same as in Protozoea I (Fig. 2k); cutting edge of Md with 12 indistinct teeth (Fig. 2 l). Mx l same as in Protozoea I (Fig. 2 l). Mx 2 endopod indistinctly segmented, exopod with 5 plumose setae (Fig. 2j). Mxpl, Mxp 2 and Mxp 3 as in Protozoea I.

Protozoea III (Fig. 3 a-f)

Material—77; TL: 1.26 1.45 (1.35) mm.

Characteristic changes that occur during metamorphosis of Protozoea II to Protozoea III are development of uropod and lateral spines on abdominal segments; well developed rostrum, anterior, lateral and posterior spines present; compound eyes stalked, prominent and free of carapace; thorax segmented; Ab six segmented, 5 segments each with a pair of short postero-lateral spines and the last segment with 2 pairs of spines.

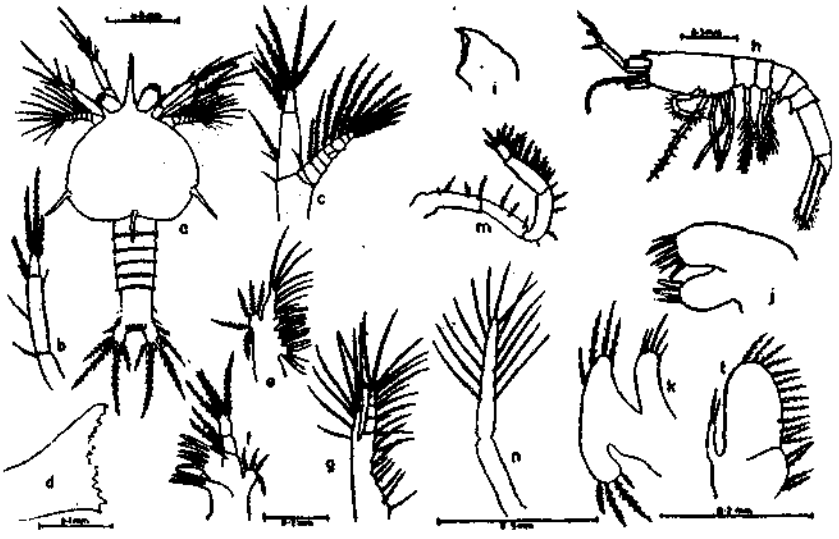

Fig. 3. Protozoea III and postlarva I of *Acetes indicus*—a. Protozoea III; b. antennule; c. antenna; d. mandible; e. second maxilla; f. first maxilla; g. first maxilliped; h. postlarva I; i. mandible; j. first maxilla; k. second maxilla; l. first maxilliped; m. second maxilliped; and n. pleopod.

A1 three segmented the proximal segment formed by fusion of 6 basal segments, distal segment with 2 aesthetes and 3 terminal setae (Fig. 3b) ; A2 protopod two-jointed, exopod 8 segmented, one inner lateral seta each on segments 2 to 8 and one outer lateral seta on segment 4 (Fig. 3c). Md teeth prominent (Fig. 3d) Mx1 protopod with 2 lobes, proximal and distal provided with 4 and 5 setae respectively; endopod 3 segmented, 2 inner setae on first and second segments, 4 terminal setae on 3rd segment; exopod small, knob like and with 4 plumose setae (Fig. 3f). Mx2 exopod with 5 plumose setae (Fig. 3e); Mxp 1 exopod half length of endopod and with 4 terminal and 3 lateral setae (Fig. 3g);Mxp 2 as in Protozoea II; Mxp 3 biramous and unsegmented; pereopods biramous, rudimentary and bud-like; uropods biramous.

Mysis (Fig. 4 a-h)

Material—89; TL: 2.1 - 2.3 (2.2) mm

Transformation of Protozoea III into mysis brings out radical changes in general shape and organisation of larvae, which assume a shrimp-like form; carapace covers thorax dorsolaterally; antero-lateral and postero-lateral spines on carapace (except the rostrum) disappear; rostrum prominent with a minute dorsal spine; stalked eyes well developed; Ab slender, segments 1 to 5 almost of equal length with short lateral spines, the 6th with posterior median dorsal spine; a pair of pleopods on each of first 3 segments are developed; uropods enlarged, becoming setose; Tl bilobed, each lobe with 4 pairs of spines, second one from the inner angle being larger.

A1 three segmented; first segment elongate with 3 inner setae, 3rd segment with 2 unsegmented flagella, outer one bears 2 aesthetes (Fig. 4b); protopod of A2 two-segmented, flagellum long, slender and 7 segmented, distal segment with 2 setae; exopod flattened and with 4 terminal setae (Fig. 4c). Md devoid of teeth, incissor process prominent (Fig. 4d). Mx 1 proximal endite with 2 setae and distal with 5 longer spines (Fig. 4e); Mx2 exopod enlarged with 5 plumose setae; protopod with 4 lobes, each carrying 2 small setae (Fig. 4f); Mxp 1 protopod large, exopod and endopod unsegmented (Fig. 4g); Mxp2 protopod 2 segmented; endopod 5 segmented,

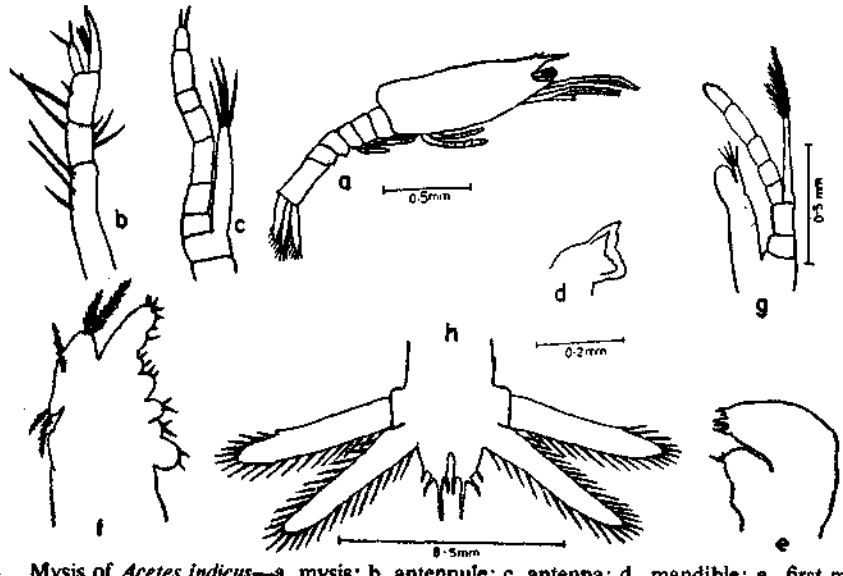

Fig. 4. Mysis of *Acetes indicus*—a. mysis; b. antennule; c. antenna; d. mandible; e. first maxilla; f. second maxilla; g. first and second maxilliped; and h. telson.

exopod with 3 terminal plumose setae (Fig. 4g). Mxp 3 as in Protozoea III. Three pereopods present, biramous with 5 segmented endopod, exopod unsegmented. Pleopod uniramous, on first 3 abdominal segments; uropod-exopod with a small sharp spine at the outer postero-lateral margin, endopod with 25 to 26 setae.

Postlarva I (Fig. 3 h-n)

Material—45; TL: 2.5 - 2.8 (2.6) mm.

Most noticeable changes at this stage are development of setae on pleopods, reduction in size of exopods of peraeopods, and presence of a dorsal tooth on rostrum; Ab six segmented, 1 - 5 segments with lateral spines, 6th with a posterior median dorsal spine; Tl distinctly bilobed, each lobe with 4 spines.

A1 peduncle 3 segmented, proximal segment with a basal swelling; inner flagellum unsegmented, outer 3 segmented, proximal segment of outer flagellum with 2 aesthetes and distal tipped with 3 setae; flagellum of A2 long with 18 to 20 segments; Md devoid of teeth (Fig. 3i); Mx1 well developed with 2 endites, proximal endites with 5 and the distal with 10 setae (Fig. 3j); endopod of Mx2 with 5 setae, exopod ear-shaped with 8 setae, 4 placed on posterior margin (Fig. 3k); protopod of Mxp 1 two segmented, exopod unsegmented, small and with 2 setae (Fig. 3l); Mxp 2 endopod 5 segmented, distal 3 segments curved inwards (Fig. 3m); pereopods 3 chelate legs. Pleopods on Ab segments 1 to 3, uniramous with unsegmented protopod and exopod which is bordered with long plumose setae (Fig. 3n); uropod same as in previous stage except for additional number of setae.

Postlarva II (Fig. 5 f-i)

Material—54; TL: 3.3 - 3.6 (3.4) mm.

Noticeable changes in this stage are increase in size of larvae and presence of a small spine at base of rostrum; pleopods developed on 4th abdominal segment, but rudimentary and non-functional; median indentation of telson becomes shallow.

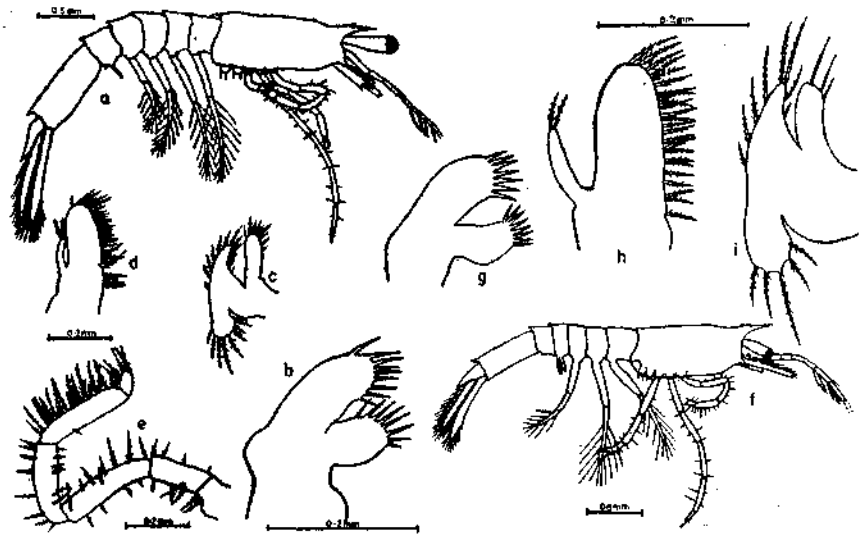

Fig. 5. Postlarva II and IV of *Acetes indicus*—a. postlarva IV; b. antenna; c. first maxilla; d. first maxilliped; e. second maxilliped; f. postlarva II; g. first maxilla; h. first maxilliped; and i. second maxilla.

A small spine developed on outer lateral margin above statocyst swelling in proximal segment of A1; outer flagellum 8 to 9 jointed; A2 flagellum with more than 20 segments; Md same as in Postlarva I; both endites of Mx 1 carry stout setae (Fig. 5g); Mx2 scale enlarged and beset with 13 to 15 setae (Fig. 5 l). Mxp 1 and Mxp 2 as in Postlarva I (Fig. 5h); Mxp3 exopod disappeared; pereopods longer;

pleopods 4 pairs, uniramous, 1 to 3 well developed with exopod carrying setae, 4th rudimentary; uropod as in Postlarva I.

Postlarva III

Material—33 ; TL: 3.9 - 4.0 (3.93) mm.

In this stage besides increase in size larva has 3 aesthetes on antennular flagellum.

Postlarva IV (Fig. 5 a-e)

Material—18; TL; 4.5 - 4.9 (4.7) mm.

Larva has 4 aesthetes on antennular flagellum and shows increase in size.

Spine on the outer lateral angle of the statocyst swelling of A1 enlarged; external flagellum 15 or 16 segmented and with 4 aesthetes at thickened basal portion; A2 scale with 16 plumose setae; Mx 1 as in Postlarva II and III (Fig. 5b); Mx2 endite with 8 or 9 setae, scale with setae along the border at anterior and posterior ends (Fig. 5c); Mxp1, Mxp2 and Mxp3 as in Postlarva II and III ; pleopods 5 pairs, first two pairs uniramous with 17 or 18 setae, 3rd and 4th biramous, endopod devoid of setae, exopod with 14 to 16 setae; 5th uniramous and devoid of setae.

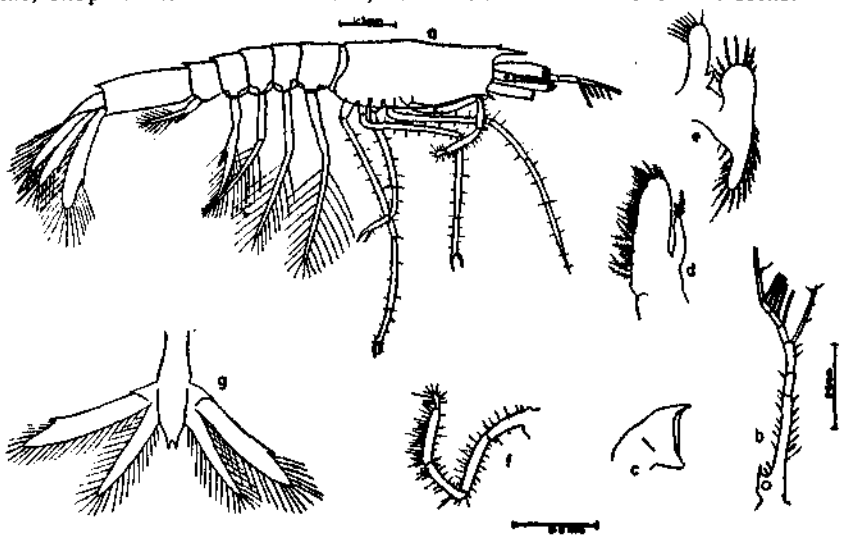

Fig. 6. Postlarva V of *Acetes indicus*—a. postlarva V; b. antennule; c. mandible; d. first maxilliped; e. second maxilla; f. second maxilliped; and g. telson.

Postlarva V (Fig. 6 a-g)

Material—58; TL: 4.1 - 6.4 (5.0) mm.

Larva possesses 5 aesthetes on antennular flagellum; 20 or 21 setae in antennal scale; Mx2 with well developed palp; pleopods, except first with endopods; telson increased in size, gap between spines wider and lateral spines reduced. Thus, the larva gradually attains the adult characters.

DISCUSSION

A. indicus in its larval development, as has been described above, passes through 3 nauplius, 3 protozoeal, 1 mysis and 5 postlarval stages. The eggs of *A. indicus* are pelagic and slightly smaller than those of *A. cochinensis*. The relatively larger ratio between embryonic mass and the diameter of the egg may be useful in identifying the eggs of the species.

The morphological differences between the nauplii of different species of *Acetes* appear to be few due to their simple body form and relatively fewer setae. The nauplius I of *A. indicus* is medium sized, smaller than that of *A. cochinensis* but larger than that of *A. japonicus*. The number of terminal setae in the antennule of nauplius II and III of *A. indicus* is 2, while in the corresponding stages of *A. cochinensis* and *A. japonicus* it is 3.

In general, the protozoeal stages of *A. indicus* are larger in size and differ from those of *A. japonicus*, *A. erythraeus* and *A. cochinensis* in the number of telsonic spines, and in the setation of the different appendages. There is only a single mysis stage in *Acetes* of which the development is known at present. The characters such as the 8 segmented antennal flagellum, absence of teeth in the mandible, presence of median dorsal spines on the 5th and 6th abdominal segments, and 4 pairs of spines in the telson serve to identify the mysis of *A. indicus* from the corresponding stages of the other Indian species. An important character by which the postlarval stages of *A. indicus* could be distinguished are the larger size and the number of aesthetes in the antennule.

One of the noteworthy features in the larval development of *A. indicus* is the relatively larger size of this larva as well as the presence of a prominent rostrum. It is interesting to note that the adult of the species also grow to a comparatively larger size than its congeners. In Bombay waters, *A. indicus* is fished throughout the year and the peak season of fishery extends from January to May. The seasonal distribution of the larvae shows that they occur abundantly during October - January.

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