J. Mar. biol. Ass. India, 1962, 4 (2): 177-18

STRUCTURE OF THE MOUTH PARTS AND OBSERVATIONS ON THE FEEDING MECHANISM IN *CARIDINA LAEVIS* (HELLER) (CRUSTACEA, DECAPODA)

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INTRODUCTION

THE structure of the digestive system of *Caridina laevis* has already been worked out (Pillai, 1960). The present communication deals with the structure of the mouth parts and some observations on the feeding mechanism. Comparatively little attention has been given to the feeding mechanism of Natantia. The only available references on this are confined to the subfamily Palaemoninae. Borradaile (1917) studying the homology of the appendages of Crustacea has described the structure of the mouth parts and the mechanism of feeding in *Leander serratus*. Patwardhan (1935) has described the feeding mechanism of *Palaemon malcolmsonii*. Forster (1951) & Kunju (1955) have studied *Leander serratus* and *L. styliferus* respectively. No work on this respect seems to have been made on other families of the tribe Caridea.

METHODS

The mouth parts were dissected out for study. Several methods were tried to study the mechanism of feeding. Attempts to induce the animals to feed on activated charcoal and powdered carmine to study the role of appendages were not successful. Direct observation of animals feeding in upside down position was made under the stereoscopic binocular microscope and this method was found to be very useful. Starved individuals, gently fixed to soft plasticine on their back refused to feed even when food was provided. But occasional brisk movements of the mouth parts were observed in this position which were quite comparable to feeding movements exhibited by the animal. Borradaile (1917) has also observed that *Leander* exhibits feeding movements as a result of shock or amputation.

MOUTH PARTS

The mouth is a longitudinally elongated slit concealed by the mandibles and other mouth parts. The labrum overhangs the mouth anteriorly. The base and anterior walls of the labrum are comparatively thick while the oral side of its tip has a thin and soft wall. Bordering the posterior margin and sides of the mouth are a pair of membraneous projections, the paragnathae.

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Mandibles (Fig. 2)

These are small and stout structures articulated obliquely to the sternum. Very strong mandibular muscles lie inside the cavity of the apophysis each one continued posterodorsally into a long tendon. Connecting these two longitudinal tendons, there is an additional transverse tendon which controls and co-ordinates their movements. The apophysis carries the head of the mandible, divisible into an incisor process and a molar process, the latter projecting into the mouth. The number and shape of the teeth on the incisor process are highly variable and those of the two sides are asymmetrical. Below the teeth, the rim of the mandible bears a variable number of stout setae and a tuft of closely set slender bristles. The molar process is not quite separate from the incisor process unlike in *Anthanus* and *Hippolyte* (Patwardhan, 1935) and most members of the Caridea and is much reduced, comparable to the condition in the penaeidea. The right molar process is wedge-shaped and its grinding area is on the upper side while that of the left side is on the lower side and obliquely truncated. The grinding surface bears numerous grooves and transverse ridges. Adjacent grooves are inter-connected by short channels so that the area ultimately bears numerous small tubercles, the size of which diminishes cephalad. There is no palp.

First Maxilla (Fig. 3)

These are very small and extremely membraneous. There are two endites and these compare with the two endites described by Hansen (1925). The proximal endite arises from the precoxa and curves under the paragnatha (Fig. 1). The distal endite originates from the basis and is flattened with a cutting edge bearing a row of teeth. The exite is platelike and seems to correspond to the pseudexopod of Euphausiacea (Hansen, 1925) which does not seem to be represented in other Caridea. The endopod is small and exopod unrepresented.

Second Maxilla (Fig. 4)

These are larger and cover the first maxillae. The precoxa has strong muscles passing through it which are responsible for the movements of the scaphognathite. The coxa bears a fleshy endite with long arched setae. The basis has an elongated endite divided into two by a notch in the middle and bears a double row of long setae. The scaphognathite which represents the flattened exopod (Calman, 1909) is expanded and tapers posteriorly. There is a chitinous ridge running almost the entire length of the scaphognathite giving it rigidity. When it works, a bunch of stiff and long bristles at the hind end cleans the gills of dirt and grit. The anterior and outer margins are fringed with plumose bristles. The endopod is small and unsegmented. The plane of the scaphognathite makes an angle of about 40 degrees with that of the gnathobase to accommodate inside the branchial cavity.

First Maxilliped (Fig. 5)

The precoxa forms a distinct basal lobe. The basis is elongated and the inner margin is concave so that when apposed they leave a space leading to the mouth. Each has a double row of setae, one on the ventral aspect and the other on the inner margin. The latter row is constituted by three types of setae (1) beaded bristles which end in hooked discs (2) beaded bristles without hooked discs and (3) non-beaded bristles ending in spatulate discs. They all curve upwards and in fact get interwoven with the setae borne by the second maxillae. When the scaphognathite works, its gnathobase also moves up and down and the two sets of interlocked setae move in and out. These brushing movements help to prevent the food particles from getting clogged. Attached to the sympod on its outer side is an expanded exopod which is

produced into a narrow anterior part corresponding to the flagellum of the succeeding appendages. Lobe ' a ' of Boas (1880) is well represented, this being a characteristic expansion in Caridea. The endopod is small and triangular. A small mastigobranch is also present on the outer side of the coxa.

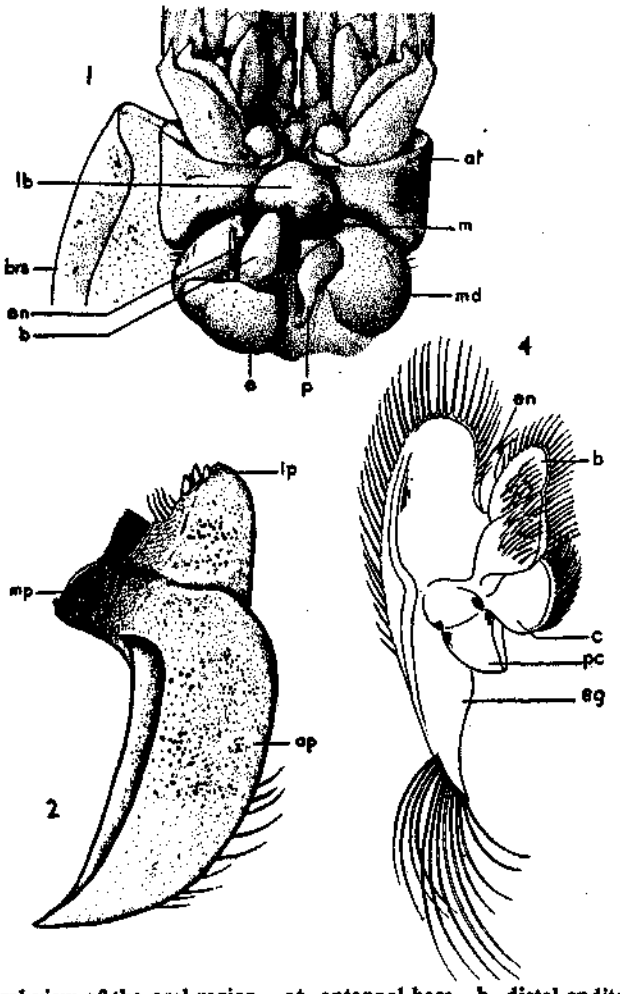

FIG. 1. Ventral view of the oral region. at. antennal base, b. distal endite of first maxilla. brs. branchiostegite, e. endite of first maxilla, en. endopod of first maxilla, lb. labrum, m. mouth, md. mandible, p. paragnatha.
FIG. 2. Left mandible. ap. apophysis, ip. incisor process, mp. molar process.
FIG. 4. Second maxilla. b. distal endite of basis, c. coxal endite, en. endopod, pc. precoxa, sg. scaphognathite.

Second Maxilliped (Fig. 6)

This is more pediform and plays the major role in feeding. The coxa bears a rudiment of an endite in the form of a small tubercle and a podobranch. The basis has coalesced with the ischium forming an elongated podomere with a ventral ridge. The merus and the carpus are separate, the major movements of the appendage being effected at this joint. The distal segment viz., the dactylus gets folded on the propodus

which bears a few long and plumose setae. The flattened dactylus is concave on its topographically inner margin and is heavily chitinised with rows of strong brownish setae with which the food first comes into contact. The exopod, but for a faint notch proximally is unsegmented with 12 to 13 pairs of jointed plumose setae. It is highly vibratile and drives a strong current of water forwards.

Third Maxilliped (Fig. 7)

This appendage is truly pediform. The sympod consisting of a large coxa and a small basis gives origin to a well developed mastigobranch. The coxa has a cluster of setae mesially representing probably an endite. The main axis consists of three segments. The proximal segment is formed as a result of the merging of the ischium and the merus. The carpus is separate and has 11 transverse rows of short setae mesially, each row comprising of about 5 to 7 jointed setae. The distal segment represents the coalesced propodus and dactylus and is flattened in a vertical plane. It is movable on the carpus in the same plane. Its broad basal part is armed with 11 to 13 rows of closely set brush-like setae. Borradaile (1917) could not ascribe a function to these in *Leander*. In *Caridina* the flagella of the antenna and the antennule have often been observed to be drawn between the apposed segments for the purpose of cleaning them. The exopod is quite similar to that of the second maxilliped.

All the above described appendages of the two sides leave a space between them, the ' food basin ' (Manton 1928) into which the mouth opens.

Food

Caridina is more vegetarian than carnivorous. Usually it feeds on small particles of vegetable matter and debris found attached to the surface of water weeds like *Elodea*, *Hydrilla* etc. At times it is also seen to feed on dead and decaying parts of other shrimps. A microscopic examination of the greenish yellow contents of the stomach reveals it to be composed of very small particles which elude identification. Because of the external trituration, the food in the stomach is pulpy. Small globules, constituting the secretory products of the hepatopancreatic gland are plenty. Minute unicellular algae, filaments of *Spirogyra*, fragments of the leaves of *Elodea* and numerous spores are often met with. Fragments of crustacean appendages, small bits of muscles and sand grains could also be identified.

Feeding

It is usually in the afternoon that *Caridina* feeds busily. They are seen to take three positions in feeding (1) When the weeds are plenty they suspend themselves from weeds by the three pairs of walking legs. Food is gathered from the surface of weeds by the chelipeds and released into the food basin (2) The animal rests on the bottom and feeds with its front part raised on the walking legs. The feeding is carried on till the water at the spot becomes foul (3) Occasionally they feed on debris from the surface film. The animal clings to drifting weeds in a vertical or upside down position and gathers floating particles from the surface by the chelipeds. This type of feeding has been observed to continue indefinitely. In feeding the two chelipeds of the same segment work alternately and these two, in turn, alternate with the two chelipeds of the other segment.

When the food material is large in size, like decaying weeds or pieces of muscles, the chelipeds tear the food into small shreds which are passed over to the second maxillipeds. Larger pieces are seen to be held firmly between the powerful spines of the propodus-dactylus of the third maxillipeds and smaller pieces are torn off from

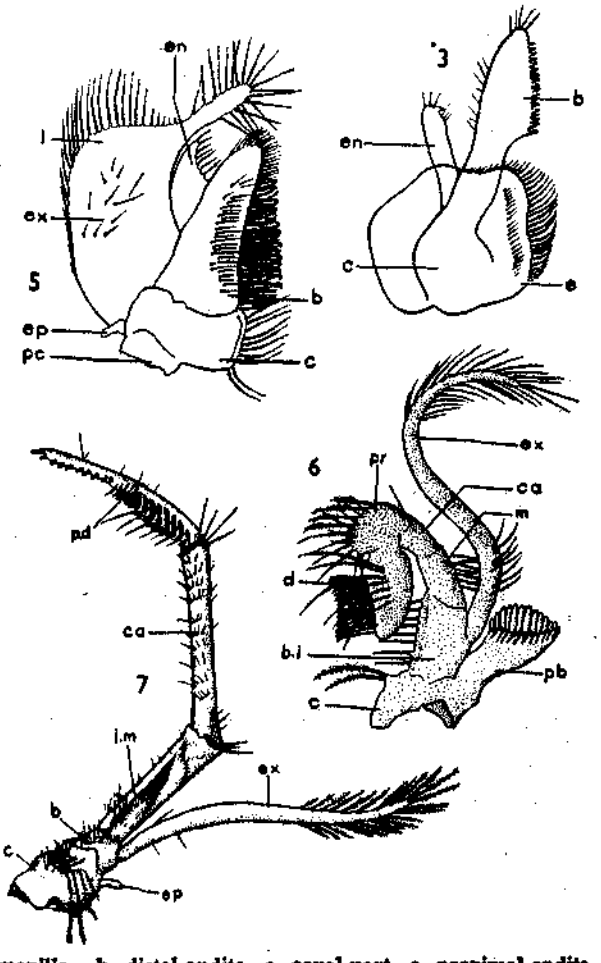

FIG. 3. First maxilla. b. distal endite, c. coxal part, e. proximal endite, en. endopod.
FIG. 5. First maxilliped. b. basis, c. coxa, en. endopod, ex. exopod, ep. epipod, l. lobe 'a' of Boas, pc. precoxa.
FIG. 6. Second maxilliped. b.i. basis-ischium, ca. carpus, d. dactylus, pb. podobranch, pr. propodus.
Fig. 7. Third maxilliped. im. ischium-merus, pd. propodus-dactylus. Other lettering as above.

this by the chelipeds. The dactylus of the second maxillipeds, armed with rows of bristles work against each other, forwards and sideways. Reduced particles are prevented from being carried away with the current by the plumose bristles of the propodus. The first maxillipeds do not take any active part in the manipulation of food. The diversity in form and shape of the long bristles on its gnathobase points out to some special significance. It is probable that they might have a sensory

function. The rejected food particles are driven away by the flagella of the second and third maxillipeds.

It is evident that the gnathobases of the first maxilliped, first maxilla and second maxilla in *Caridina* do not have an active masticatory function. These possess slender bristles which serve to pass on the fine particles of food. A gastric mill is absent in the stomach of *Caridina* (Pillai, 1960). This appears to have been due to its secondary suppression, represented by degrees in *Caridina*, *Hippolyte* and *Virbius* (Patwardhan, 1935). If this be so, it is interesting to note that the mouth parts, especially the mandible, do not consequently exhibit any specialization.

Summary

The various mouth parts, *viz.*, mandible, first and second maxilla and the first, second and third maxillipeds are described. The second maxilliped is the most important organ connected with feeding. Gnathobases of the maxillae and first maxilliped have no masticatory function. Mandibles do not show any specialization in the absence of a gastric mill. The food and feeding methods are described.

Acknowledgement

For the invaluable help and guidance, I am deeply indebted to Dr. K. Bhaskaran Nair, Professor of Zoology, University College, Trivandrum. This work was carried out during the tenure of a Government of India Research Scholarship. My thanks are due to the administration of the University College, Trivandrum, for the facilities provided.

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* Not referred to in original.