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SEM OBSERVATIONS OF THE MOUTHPARTS FROM *EUPHAUSIA SUPERBA* DANA LARVAE (EXTENDED ABSTRACT)

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Euphausiids are maxillary feeders, and appendages such as; labrum, mandibles, labia, 1st and 2nd maxillae, and 1st and 2nd thoracic limbs, are considered to be most important in their feeding (MAUCHLINE and FISHER, 1969; MAUCHLINE, 1980). FRASER (1936) provided line drawings of the development of feeding appendages in the larvae of *Euphausia superba*. This study aims to re-examine the larval mouthparts of *E. superba* using scanning electron microscopy (SEM), a technique superior to light microscopy (LM) used by FRASER (1936).

Larvae used for the present observations were raised from eggs in the laboratory following the method of IKEDA (1984). Both fresh specimens (nauplius I, II and metanauplius) and those preserved in formalin–seawater (calyptopis I–III and furcilia I–VI) were prepared similarly for SEM examination. The fixation method for specimen preparation was similar to that of IKEDA *et al.* (1984). Briefly, larvae were primarily-fixed for 2 h with 4% gluteraldehyde, rinsed for 30 s with distilled water and post-fixed for 2 h with 4% osmic acid. Specimens were then dehydrated in ethanol, critical-point dried and coated with 30 nm of gold. When immediate observation was not possible, specimens were stored in 70% ethanol after fixation. Specimens were examined with a JEOL JSM 840 electron microscope.

No mouth or anal openings are found in either nauplius I or II stages (Figs. 1, 2). Specialization of the mouthparts occur with the commencement of the metanauplius stage (Fig. 3). Anterior lies a large labrum, beneath which are a pair of mandibles. Posterior to these, the bilobed labia are seated (Fig. 4). Maxilla I and II bearing no setae buds are seen posterior to the labia. Metanauplius contain both mouth and anal openings, however, both are considered to be non-functional (IKEDA, 1985).

The mouthparts of the first calyptopis stage are more complicated than the previous larval stages, suggesting a greater capability for food capturing (Fig. 5). The mandible has a *lacina mobilis* between the dentate portion and the molar protuberance (FRASER, 1936). The labrum is covered by an ordered arrangement of brush-like setae (Fig. 6). Numerous broad spines which bear secondary setae, cover the exterior central margin of each labia. These spines overlap when labium are together (Fig. 6). On the interior edge of each labium two types of setae, grouped separately, are found. The most ventral are small dentate-like protrusions. The second set, lying along side the first, are small brush-like setae similar in shape to those situated on the exterior central margin of the labium (Fig. 7). These setae may aid, either chemically or physically, the detection of specific food items. The 1st maxilla of calyptopis I consist of two parts;

the palp and the masticatory lobe. Both parts have two segments, each covered with a variable number of spines. The 2nd maxilla also have increased complexity when compared to earlier larval stages. They are larger, segmented and covered with bristles along it's central margin.

No further major changes occur to the mouthpart structure of calyptopis II or III. Minor changes occur to the outer lobe of the first maxilla with an increase in the number of spines from 3 to 5 (FRASER, 1936). 1st and 2nd maxilla from calyptopis III are depicted in Figs. 8 and 9. Calyptopis larvae, provided a mixture of the diatom *Phaeodactylum tricornutum* and newly hatched *Artemia* nauplii in the laboratory experiment, showed a substantial increase in body weight from stage I to II, and II to III, indicating initiation of active feeding (IKEDA, 1984).

With advancement to the furcilia I stage there is an increase in size of the 1st maxilla. This possibly indicates a more important role of this organ in feeding. Furcilia I mouthpart orientation is seen in Fig. 10, with details of the labrum, mandible and labia shown in Fig. 11. The commencement of continual changes to the mandible occurs in furcilia II. The mandible becoming progressively similar to the adult form with each furcilia stage. Throughout the furcilia larval stages there is a consistent reduction in size of the incisor process which bears small denticulations on the inferior distal border (FRASER, 1936). Thoracic limbs are also well advanced and similar to the adult form at this stage. It may be that from this stage *E. superba* can be described as an efficient filter feeder.

A functional mandibular palp is developed by furcilia III. The *lacina mobilis* is still present, although greatly reduced in size. The labia have an increased cover of setae compared to earlier calyptopis stages (Figs. 12 and 13). A less segmented and more robust 1st maxilla which supports more bristles is now apparent, while the 2nd maxilla remains unchanged.

Figure 14 depicts mouthparts from furcilia IV. This stage and final furcilia V and VI stages show no further dramatic changes to their mouthpart structure. There is

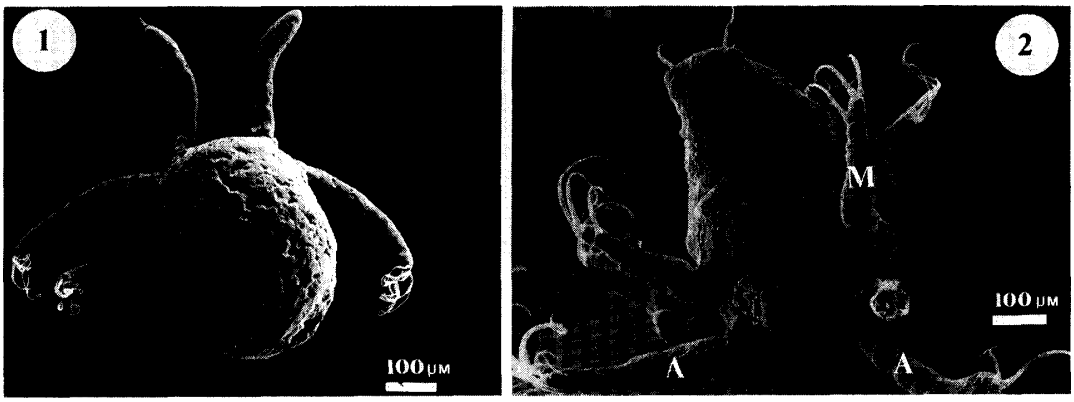

Fig. 1. Dorsal view of Nauplius I. Body typically oval with 3 pairs of swimming appendages. The first pair of limbs are uniramous with the remaining two pair being biramous.

Fig. 2. Ventral orientation of Nauplius II. Uniramous antennules (An) with two terminal spines have developed. The succeeding 2 pair of biramous appendages have specialised into; antennae (A) and mandibles (M). Two characteristic spines can be seen in each postero-lateral corner of the body.

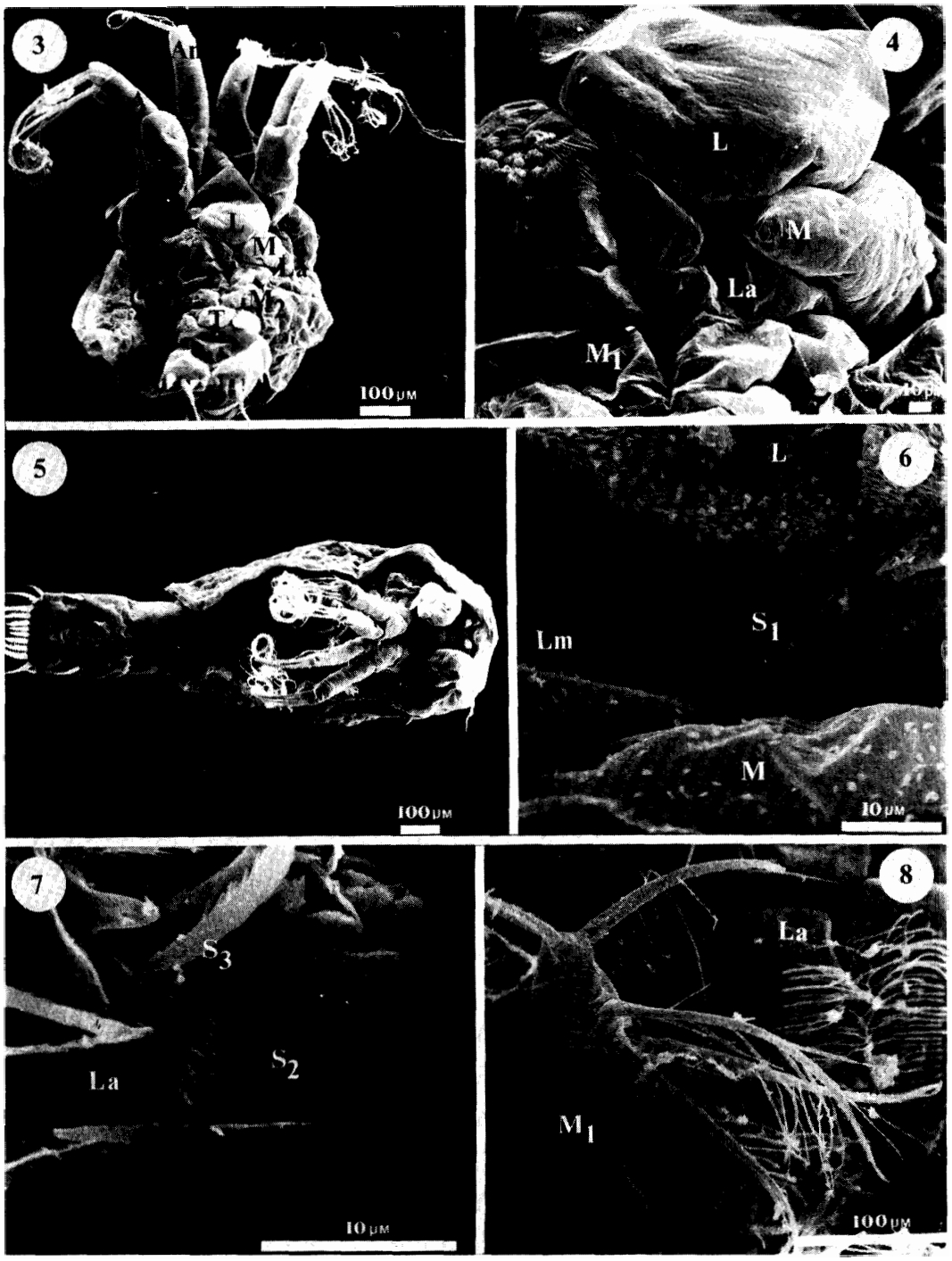

Fig. 3. Metanauplius (ventral view). Uniramous antennules (An) and biramous antennae (A) are seen anterior to the labrum (L), mandibles (M), bilobed labium (La), 1st maxilla (M_1) and 2nd maxilla (M_2).

Fig. 4. Mouthparts of the metanauplius stage. For symbols refer to Fig. 3.

Fig. 5. Ventral view of calyptopis I.

Fig. 6. Mouthparts of calyptopis I. Labrum (L) is covered with brush-like setae (S_1). Mandibles (M), lacina mobilis (Lm).

Fig. 7. Interior edge of labium (La) covered with two distinct types of setae; dentate-like protrusions (S_2) and larger brush-like setae (S_3).

Fig. 8. 1st maxilla of calyptopis III (M_1) shows distinct segmentation and is seen overlying the labium (La).

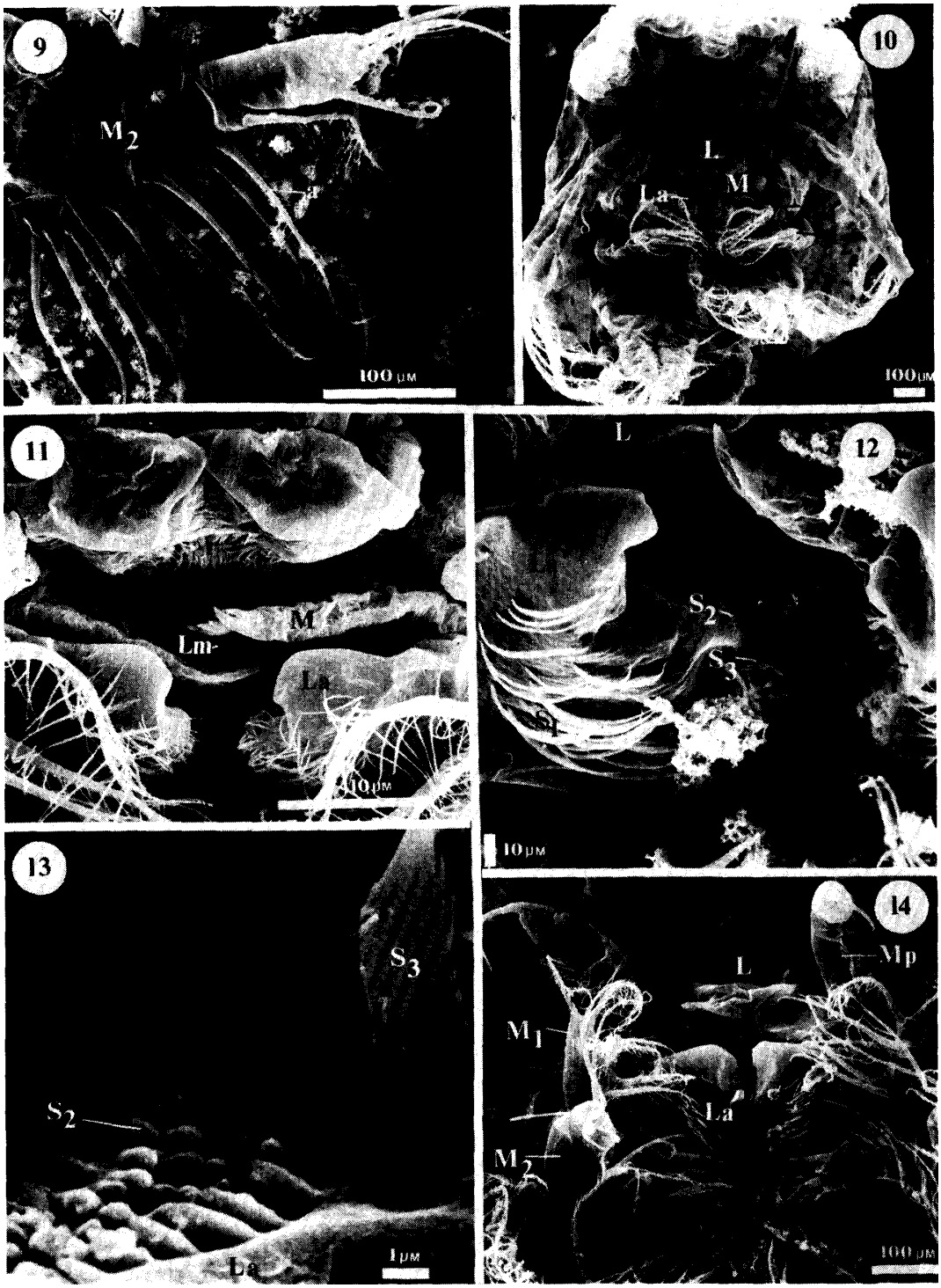

Fig. 9. *2nd maxilla of calyptopis III (M_2) also shows further segmentation and complexity. Artifacts (a) formed from fixing material in buffered formalin.*

Fig. 10. *Furcilia I (ventral view) showing mouthpart orientation. For symbols refer to previous figures.*

Fig. 11. *Covered with setae the labrum (L) lies anterior to the mandibles (M) and labium (La).* Lacina mobilis *(Lm) is seen between the mandibles of furcilia I.*

Fig. 12. *Labium (La) of furcilia III, showing the position of three different setae (S_1, S_2, S_3).*

Fig. 13. *Dentate-like protrusions setae (S_2) and brush-like setae (S_3) on the interior edge of the labium of furcilia III.*

Fig. 14. *Ventral view of the mouthparts of furcilia IV. Mandibular palp (Mp) is shown.*

an elongation of the mandible with a complete reduction of the *lacina mobilis*. The labrum has maintained its patterned dentate-like protrusions since calyptopis I. Setae, possibly involved in the detection of specific food items, have been retained on the labium. A shortening and broadening of the 1st maxilla occurs in conjunction with the development of the pseudoexopod by furcilia VI. The 2nd maxilla also broadens in proportion to its length and now consists of 3 portions; distally, a broad palp, a middle and a basal portion each having two lobes (FRASER, 1936).

General features of the larval mouthparts examined by SEM are consistent with FRASER's (1936) LM observations. However, the use of the SEM has allowed observation of the fine structures associated with these mouthparts. Such information may assist in the determination of major food items of these larvae, or shifts in food preference associated with mouthpart changes throughout the larval development of *E. superba*.

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