A Comparative Study on the Radula of Three Coleoid Cephalopods

Deepak V. SAMUEL[1] and Jamila PATTERSON[1]

Abstract

Radula is a unique feeding organ in mollusc specifically to gastropods and cephalopods. They are useful to grind the food besides other functions. The radula for gastropods is classified into different types but there is no such classification for cephalopod radula. There have been differences in opinion due to the variation and complexity in the radula of individual species of cephalopods. In the present study, the radula of two cuttlefishes (*Sepia prashadi, Sepiella inermis*) and a squid (*Sepioteuthis lessoniana*) were studied and the different structures of the individual tooth in the radula are found to be valuable for the taxonomical identification and confirmation of the species.

Key words: cuttlefish, laterals, rachidian, radula, squid

Introduction

The phylum mollusca is characterized by the presence of a long ribbon-like tooth called radula. This apparatus is found nearly in all molluscs in one form or another, and primarily suited for scraping food particles from a surface, although it can assume other functions (MEGLITSCH and SCHRAM 1991). The radula is a unique feeding organ and one of the distinguished features of molluscs (BRADNER and KAY 1996). The radula is further divided into elements, which are different structures of lateral and marginal teeth and these elements vary in different species. The central tooth is called the rachidian followed by the laterals, the marginals and the marginal plates. It is proposed that a nomenclature be established for cephalopods, based on that used for gastropod molluscs (FRETTER and GRAHAM 1962). The gastropod radulae are classified into Docoglossate or Stereoglossate, Ptenoglossate, Rachoglossate, Riphidiglossate, Taenioglossate and Toxoglossate (FRETTER and GRAHAM 1994) but there are no such classifications for cephalopods. As taxonomy is the basis for animal identification and classification of radula becomes an important key in describing a specific species.

Sepia prashadi WINCHWORTH 1936 (SILAS *et al.* 1985), *Sepiella inermis* D'ORBINGY, 1848 (SILAS *et al.* 1985) and *Sepioteuthis lessoniana* LESSON 1830 (SILAS *et al.* 1985) are the commercially important cephalopods of Tuticorin waters that were chosen for the present study. The teeth pattern in radula varies in different orders, classes and even to individual species; for example, there are two marginal teeth in the case of Nautiloidea with an addition of two marginal plates. The radula of *Nautilus* is wide, and its 13 elements are dominated by the relatively large, curved marginal teeth but as for Coleoidea radula, the outer two elements on either side can be omitted for taxonomical analysis (NIXON 1998).

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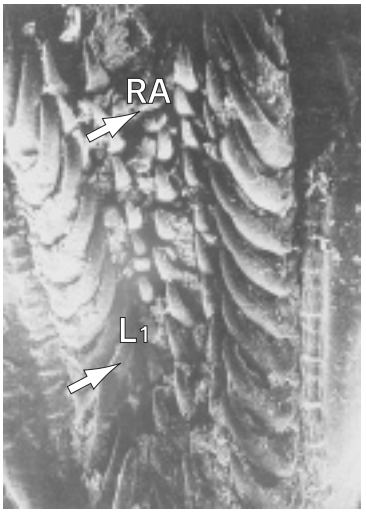
Materials and Methods

The cuttlefishes *Sepia prashadi, Sepiella inermis* and squid *Sepioteuthis lessoniana* were collected from Tuticorin fish landing center, southeast coast of India. The radulae were removed from the proboscis and preserved in 90% alcohol. Scanning electron microscope (SEM) photographs were taken to study the radula in detail and line drawings on the structural pattern of the left transverse row was undertaken. A comparison was also attempted on the earlier described species representing the same genus.

Results and Discussion

In the case of *Sepia prashadi*, the marginal tooth is absent and the outermost is the second lateral tooth transversely present on the right and the left sides (Fig. 1 and 2). In case of *Sepia officinalis,* there are nine elements leaving aside the two outer elements (NIXON 1998). The rachidian tooth is small, the shape being central cone while the basal region distinct. Lateral cusps are poorly developed and the lateral is found embedded into the radular ribbon. The lateral tooth is more pointed, curved away from the rachidian, possessing an irregular basal plate. The first lateral is much smaller and has a conical structure. The marginal tooth is absent and this observation is rare and interesting one in case of *Sepia prashadi*. The marginal plates are seen as walls next to the second laterals.



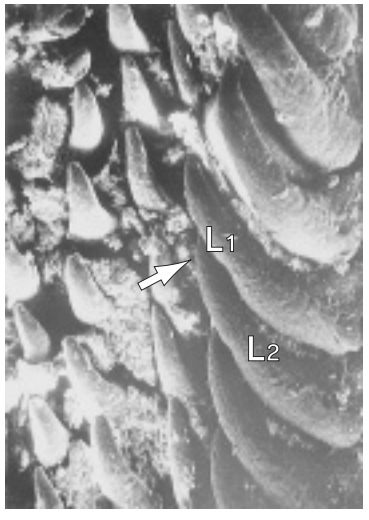


Fig. 1. (Left) Radula of *Sepia prashadi* showing absence of marginal tooth and pointed marginal plates at the distal end (bar = 100 µm). RA: Rachidian, L_1: First lateral.

Fig. 2. (Right) Radula of *Sepia prashadi* showing the right transverse row with pointed and curved second laterals (bar = 200 µm). L_1: First lateral, L_2: Second laterals

The rachidian tooth is small in *Sepiella inermis* as in the former species (Fig. 3 and 4). The rachidian is comb-like (Ctenodont) and has a prominent basal structure. The first lateral tooth resembles the rachidian tooth, but bigger in size. The second laterals are more complex, pointed more towards the radula. Marginal plates are well observed in Fig.3 taken from the left transverse row and they are found pointed upwards from the left side. The arrangement varies considerably.

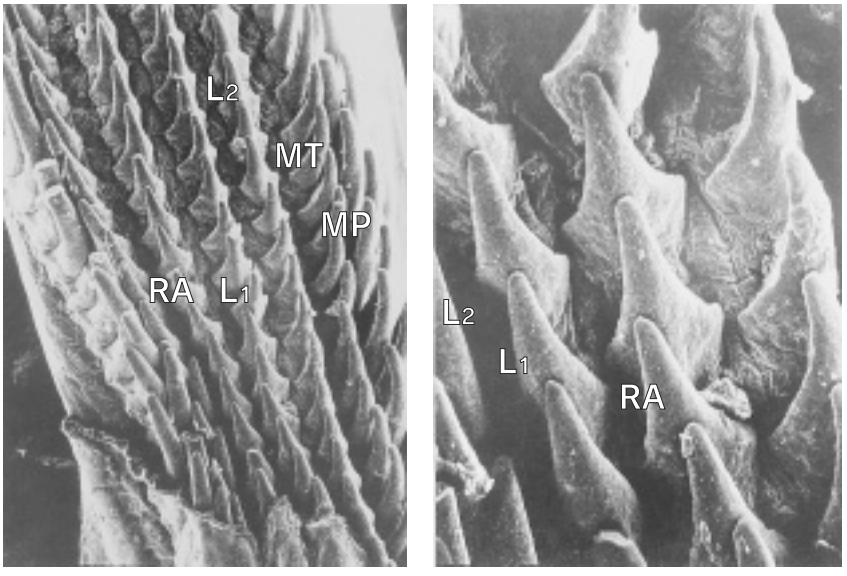


Fig. 3. (Left) Whole radula of *Sepiella inermis*:(bar = 70 µm). RA: Rachidian, L_1: First lateral, L_2: Second laterals, MT: Marginal tooth, MP: Marginal plate.

Fig. 4. (Right) Radula of *Sepiella inermis* showing pointed and smooth rachidian without cusps (bar = 200 µm). RA: Rachidian, L_1: First lateral, L_2: Second laterals.

For *Sepioteuthis lessoniana*, the rachidian tooth is larger in structure and well pointed (Fig. 5 and 6). The cusps are modified in the rachidian where the central cusp is more elevated than the cusps on either side. The shaft is also broader for the rachidian. First lateral tooth has a pointed appearance, while the basal denticle is wider in structure. The second laterals are more slender, pointed away from the rachidian. Marginal tooth is much pointed towards the rachidian and seems overlying the second laterals. Marginal plates are more conical in shape.

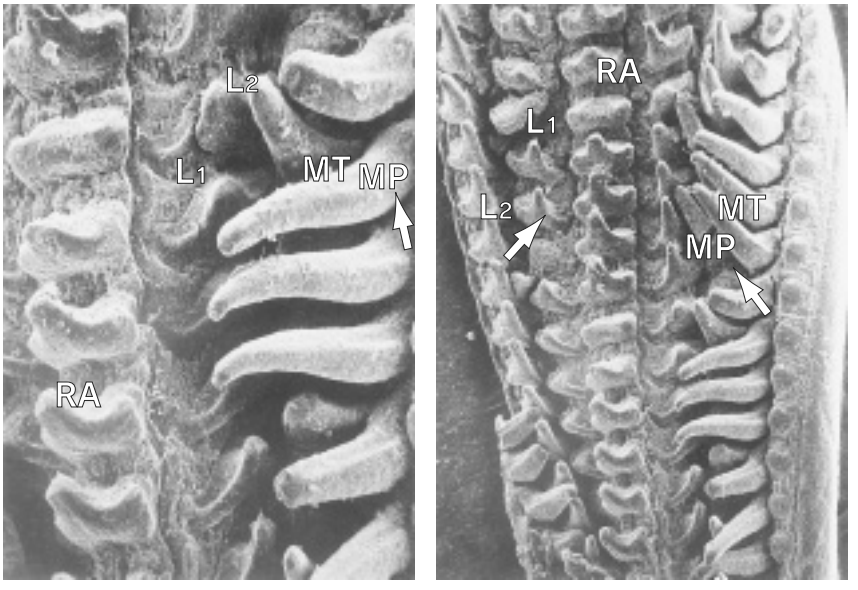


Fig. 5. (Left) Radula of *Sepioteuthis lessoniana* showing rachidian with cusps, wide laterals and marginals pointing towards the rachidian (bar = 140 µm). RA: Rachidian, L_1: First lateral, L_2: Second laterals, MT: Marginal tooth, MP: Marginal plate.

Fig. 6. (Right) Radula of *Sepioteuthis lessoniana* showing prominent marginal plates on right side (bar = 60 µm). RA: Rachidian, L_1: First lateral, L_2: Second laterals, MT: Marginal tooth, MP: Marginal plate.

The cusps in the rachidian are not seen in *Sepia prashadi* (Fig. 7) or *Sepiella inermis* (Fig. 8) but very characteristic in *Sepioteuthis lessoniana* (Fig. 9). Radular difference between the three species is very distinct than their other relatives of the same genus (NIXON 1998). These distinct findings serve as key identification characters for taxonomical references. The usual radular formula for Coeloid cephalopods (inclusive of cuttlefishes, squids and octopods) is written as MP+MT+L_2+L_1+R, where MP is the marginal plate, MT is marginal tooth, L_2 is second lateral, L_1 is the first lateral and R is radula (from the left; transverse row). There are no specific radula types as mentioned earlier for cephalopods as in gastropods (NIXON 1998). It would be very useful to name individual radula types for species identification but till now the complexity has narrowed the chances to categorize the types of radula. The positive result is that the different shapes of the individual tooth structures can be used for identification of different species with similar morphological characters coming under the same genus.

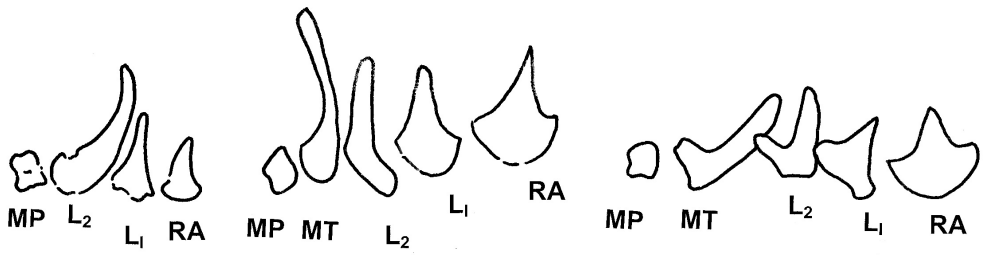


Fig. 7. (Left) Radular teeth pattern of *Sepia prashadi*. RA: Rachidian, L_1: First lateral, L_2: Second laterals, MT: Marginal tooth, MP: Marginal plate.
Fig. 8. (Middle) Radular teeth pattern of *Sepiella inermis*. RA: Rachidian, L_1: First lateral, L_2: Second laterals, MT: Marginal tooth, MP: Marginal plate.
Fig. 9. (Right) Radular teeth pattern of *Sepioteuthis lessoniana*. RA: Rachidian, L_1: First lateral, L_2: Second laterals, MT: Marginal tooth, MP: Marginal plate.

Each row of teeth on the radular ribbon usually repeats precisely the number and shape of the teeth in the rows in front of and behind it (BRADNER and KAY 1996). There are no clear-cut radular modifications or repetitions in the case of *Sepia prashadi* and the absence of the marginals further portrays the difference. From the present study radular formula are formulated for all the three species as followed:

$MP+M+L_2+L_1+R$ for *Sepiella inermis*
$MP+M+L_2+L_1+R$ for *Sepioteuthis lessoniana*
$MP+L_2+L_1+R$ for *Sepia prashadi*

Morphometric studies of the radula should be carried out first on ontogenic series of one species to determine the degree of individual variation (BRADNER and KAY 1996). For this, repeated sampling and studies on radula of a single species could help us to arrive at new results and possibly a clear radular structure for that particular species. Investigation of the radula in species with worldwide distributions may be of special interest and certainly examinations of the radula of other germinate congeneric pairs of cephalopods (VOIGHT 1998).

In conclusion, the different structures of the individual tooth in the radula of the cuttlefishes (*Sepia prashadi* and *Sepiella inermis*) and the squid (*Sepioteuthis lessoniana)* will be a positive key and reliable one for the identification and confirmation of the species whenever there is difficulty in identifying the species with morphological characters.

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