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Comparative Radular Morphology in Some Intertidal Gastropods along Hormozgan Province, Iran

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Abstract

Radula is a specific character and Part of the Appendices of digestive of majority of mollusks; the main organ of the gastropods feeding. Since the shape and structure of the radula teeth is often limited to a species or genus, it is widely used for systematic studies and phylogeny. In this research, the radula morphology of some species from Turbinidae, Trochidae, Neritidae, Cypraeidae, Strombidae, Muricidae and conidae families were analyzed. The collected samples from southern coast of Iran, were fixed, dissected and radular was removed. After preparation, the radular was scanned using a scanning electron microscope (SEM). There were 4 types of radula Rhpidoglossan, Taenioglossan, Rachiglossan and Toxoglossate, among the species under investigation that represents the evolution of feeding from vegetarian to carnivore and indicates a decrease of the number of teeth radula from Archaeogastropoda to the Neogastropoda.

Keywords: Radula; Iran; Evolution; Archaeogastropoda; Neogastropoda

Introduction

Molluscs constitute the largest animal phyla in the marine environment, the species number of which are likely to be highly underestimated [1]. Radula is the characteristic feeding organ of molluscs, lacking only in the class Bivalvia [2]. Modifications of the molluscan feeding apparatus have long been recognized as a crucial feature in diversification that relates to the important process of gathering energy from the environment [3,4]. A radula usually consists of cuticular stiff teeth upon a flexible cuticular membrane, both formed at the proximal end of a specialized ventral pharyngeal invagination. The radular teeth (except in Toxoglossa) are attached to the membrane in transverse rows consisting of two or more teeth that are mirror images about the midline, where there is usually a bilaterally symmetrical tooth. Each transverse row is identical to the adjacent rows, producing columns of identical teeth [5-7]. The structure of Toxoglossa radula differs from other Gastropod. In this group the very small middle teeth are fully destroyed. These teeth are long and are linked to the toxin channel. They are usually arrow-shaped and are not fixed to a base plate. Each tooth can be individually moved to the snout and like a spear is thrown to hunt [8]. Radula is important not only in nutrition but also in classification and phylogenetic studies and reflects the differences in intraspecific classification better than morphology of foot and shell [9-11] and generally indicates similarities in the level of family and compatibility differences in the level of species. Despite extensive research on radula the different species in many countries, in Iran except preliminary studies carried out by this group, no research has been done in this fieldwork. Therefore, further research needs to be conducted on the structure radula.

Materials and Methods

The individuals of each one of the 8 studied species of marine gastropods were collected during the low tide, in the intertidal zone from Gheshm and Larak Islands and port of Lengeh of Iran (winter of 1390). Species were identified from Dance [12]. The individuals were anesthetized in saturate solution of magnesium chloride and sea water for two hours. Then, they were fixed in 70% alcohol. All individuals were removed from their shells and the radulae of *Lunella coronata* (Turbinidae), *Trochus erithreus, Priotrochus kotschyi* (Trochidae), *Nerita albicilla* (Neritidae), *Conomurex persicus* (Strombidae), *Mauritia grayana* (Cypraeidae), and *Indothais lacera* (Muricidae) were carefully removed through dissection from the head region [13]. Radular sacs in *Conus textile* (Conidae) were removed from the body cavities and stored in 70% ethanol. From each specimen, 1-6 mature radular teeth were taken from the short arm of the radular sac for morphometric analysis [14]. The radular were cleaned in dilute sodium hypochlorite solution (10%) followed by double distilled water. Cleaning was repeated two or three times until the soft tissues were completely dissolved, leaving the radula intact [15,16]. After the procedure, radulae were fixed in 70% alcohol until photograph. The radular were subsequently fixed, with the help of a sharp tipped needle, on to double sided tape fixed to SEM stubs. The SEM stubs were then coated with gold and observed on a Philips XL 30 scanning electron microscope.

Results

Among the eight species under study, 4 types of radula were found. Radula in *T. erithreus*, *L. coronata, P. kotschyi* and *N. albicilla* is of the Rhipidoglossan type (Figure 1). This is the general formula radula M+L+R+L+M, that each row of radula teeth consists of, One central or median tooth (R), On each side Some lateral teeth (L) and then beyond that some marginal teeth (M). Different species could have different lateral teeth and there are numerous marginal teeth Uncounted.

C. persicus and *M. grayana* have a taenioglossan radula with transverse rows of seven teeth composed of a central tooth flanked on each side by one lateral and two marginal teeth (Figure 2). This can be

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Figure 1: The location of study areas.

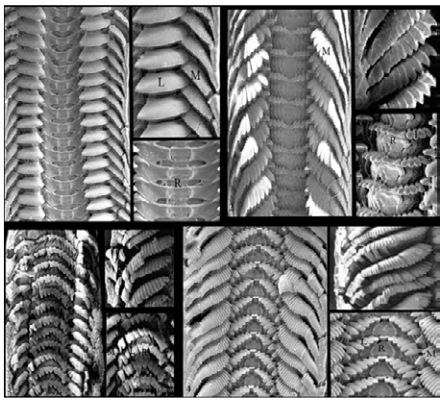

Figure 2: Scanning electron micrographs of Rhipidoglossan radula. 1. *Neritaalbicilla*, 2. *Lunella coronata*, 3. *Trochus erithreus*, 4. *Priotrochus kotschyi*.

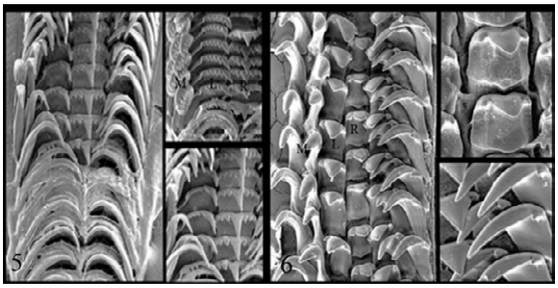

Figure 3: Scanning electron micrographs of taenioglossan radula. 5. *Conomurexpersicus*, 6. *Mauritia grayana*.

expressed in a typical formula such as: 2+1+R+1+2.

The radula of *I. lacera* is of the Rachiglossan type, characterized by a large central rachidian, surrounded by a pair of marginal teeth. This type of radula has the general formula 1+R+1 (Figure 3).

Traditionally assigned to the Conidae family along with the Terebridae and Turridae, Toxoglossate families, marine gastropods are one of the most populous animal groups that use venom to capture their prey. Toxoglossa are the most diverse and abundant group of predatory snails. A venom apparatus made up of a muscular venom bulb and a tubular venom gland generally characterize these marine mollusks. The toxoglossan radula is often compared with a hypodermic needle for its use as a conduit to inject toxins into prey. Toxins are injected into target animals via hollow disposable radular teeth and act to immobilize prey or defend against predators. The main feature of this mechanism is the use of individual, hollow marginal teeth at the proboscis tip for stabbing the prey to completely reduce the function of the radula as a whole organ within the buccal cavity. These are the vestigial radular membrane, the absence of an odontophore; the presence of the radular sac, where the fully formed marginal teeth are stored. Each row has only two teeth of which only one is in use at a time. These grooved teeth are very long and pointed, with venom channel (neurotoxins) and barbs, and are not firmly fixed to the basal plate. The teeth can therefore be individually transferred to the proboscis and ejected like a harpoon into the prey. The general formula: 1 + 0 + 1. that the middle teeth are lacked completely (Figure 4).

Discussion

Exploitation of clear nourishing resources by animals in marine environments resulted in evolution of different nourishing structures and mechanisms like radula, gill and proboscis. Initial studies about radula indicate diversity in different species [17,18]. Among 8 kinds of investigated Gastropod in this study, there are 4 radula structures. Rhipidoglossan radula (in these species: *L. coronata*, *P. kotschyi, T. erithreus*, *N. albicilla*) and Taenioglossan radula (in these species: *C. persicus* and *M. grayana*) are usually found in vegetarian species. Rachiglossan radula (in *I. lacera*) and Toxoglossate radula (in *C. textile*) are found in carnivorous species. Radula's mechanic properties is mostly affected by size, form, material of teeth, nutritive material properties as well as the reactions between teeth and nutrition which determine the need of each species to special radula. Radula's' type is known as an important nourishing tool. Form, number, specialized teeth arrangement and its lumps in different radula structures indicate its different functions in various groups with different diets and can also generate nutrition capabilities and restrictions in Gastropod and help to explain the quality of reaction between different species with similar diets without competing to eliminate each other (Figure 5). Investigating the structure of radula Gastropod indicates their evolution from vegetarian type to carnivorous ones. In general, Gastropods in order to carve alga, need more teeth and carnivorous needs less teeth especially side teeth. This process can be seen in different investigated species in this study.

The families of Turbinidae [19], Trochidae [20] and Neritidae [21] which have Rhipidoglossan radula and are unofficial systematic

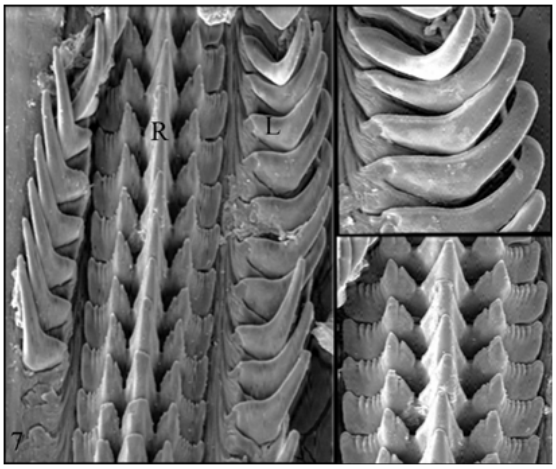

Figure 4: Scanning electron micrographs of Rachiglossan radula. 7. *Indothaislacera*.

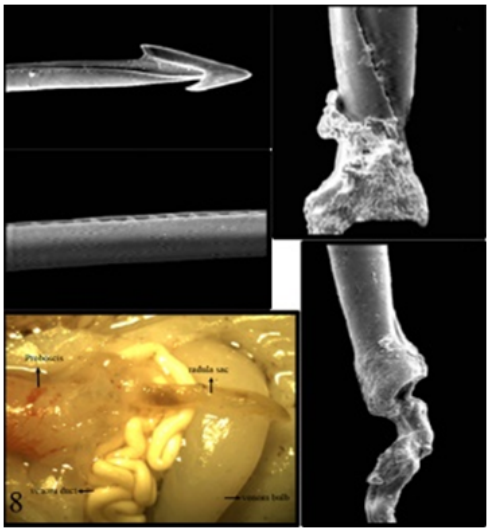

Figure 5: Scanning electron micrographs and Stereo microscope of Toxoglossate radula. 8. Conus textile.

classifications are put in Archaeogastropoda group, have the most number of teeth specially side ones. The three above mentioned families are vegetarian and feed from alga. The family of Cypraeidae and Strombidae lay in Mesogastropoda group. They have Taenioglossan type of radula. In this kind of structure the number of side teeth regarding the type of Rhipidoglossan has been reduced. Not so many studies have been done on the diet of Cypraeidae family, yet the whole part of this species diet is vegetables [22]. The Strombidae family is specifically vegetarian. Muricidae and conidae families lay in Neogastropoda group. Both family species are carnivorous but get their prey in two different ways [23]. The number of teeth in Muricidae family with Rachiglossan type of radula has been reduced, to the extent of lacking side teeth and having just two marginal teeth which lay in two sides of central teeth (rachidian). Conidae family has a special type of Toxoglossate radula and compared to other Gastropods has a completely different way of nourishment. In this structure which the fewest number of teeth is seen, radula lacks side and central teeth and there is just one marginal tooth which turns to snout in each nutrition.

Conclusion

The radula structure are the same in different types based on diet, and gastropoda needs to a special type and structure of radula for better using in available, different and special food sources and all different shapes of radula teeth has its special performance and are appropriate to any kind of food. On the other hand, given that the carnivores need less teeth and herbivores need more teeth than carnivores, this feature can be used to study the evolution of gastropod.

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References

1. Barco A, Claremont M, Reid DG, Houart R, Bouchet P, et al. (2010) A molecular phylogenetic framework for the Muricidae, a diverse family of carnivorous gastropods. Molecular Phylogenetics and Evolution 56: 1025-1039.
2. Arularasan S, Kesavan K, Lyla PS (2011) Scanning electron microscope (SEM) studies of Radula of the Dog conch Strombuscanarium (Gastropoda: Prosobranchia: Strombidae). Pelagia Research Library 1: 122-127.
3. Cruz R, Lins U, Farina M (1998) Minerals of the radular apparatus of Falcidens sp. (Caudofoveata) and the evolutionary implications for the phylum Mollusca. Biological Bulletin 194: 224-230.
4. Robert G, Krister S (1999) Historical and biomechanical analysis of integration and dissociation in Molluscan feeding, with special emphasis on the true limpets (Patellogastropoda: gastropoda). Journal of Morphology 241: 175-195.
5. Smith DA (1988) Radular kinetics during grazing in Helisomatrivolvis (Gastropoda:Pulmonata). Journal of Experimental Biology 136: 89-102.
6. Scheltema AH, Kerth K, Kuzirian AM (2003) Original molluscan radula: comparisons among Aplacophora, Polyplacophora, Gastropoda, and the Cambrian fossil Wiwaxiacorrugata. J Morphology 257: 219-245.
7. Shaw JA, Macey DJ, Brooker LR (2008) Radula synthesis by three species of iron mineralizing molluscs: production rate and elemental demand. Journal of the Marine Biological Association of the UK 88: 597-601.
8. Kantor YI (1990) Anatomical basis for the origin and evolution of the toxoglossan mode of feeding. Malacologia 32: 3-18.
9. Mutlu E (2004) Sexual dimorphisms in radula of Conomurex persicus (Gastropoda: Strombidae) in the Mediterranean Sea. Marine Biology 145: 693-698.
10. Andrade SCS, Solferini VN (2006) The influence of size on the radula of Littoraria angulifera (Gastropoda: Littorinidae). Institute of Mallacology 49: 1-5.
11. Beria F, Deniz A (2007) Further SEM assessment of radular characters of the limpets Patella caerulea (Linneaus 1758)and P. rustica (Linneaus 1758) (Mollusca: Gastropoda) from Antalya Bay, Turkey. Turkian J Zoology 33: 359-365.
12. Dance SP (1998) Seashells of Eastern Arabia. Art Books Intl Ltd, English.
13. Meirelles CO, Matthews-Cascon H (2003) Relations between shell size and radula size in marine prosobranches (Mollusca: Gastropoda). Marine Sciences 19: 45-53.
14. Franklin JB, Fernando SA, Chalke BA, Krishnan KS (2007) Radular morphology of Conus (Gastropoda: Caenogastropoda: Conidae) from India. Molluscan Research 27: 111-122.
15. Chaijirawowg R, Nuamsee K, Dumrongrojwattana P (2008) Shell and radula morphology and reproductive anatomy of the introduced carnivorous snail, gulella bicolor (pulmonata: streptaxidae) from chon buri province. Kasetsart J 42: 251- 255.
16. Harding JM, Gera SM, Mann R (2008) Radula morphology in veined rapa whelks, Rapana venosa (Valenciennes, 1846) (Gastropoda: Muricidae) from Chesapeake Bay, USA. The Nautilus 122: 217-227.
17. Kantor YI (2006) On the morphology and homology of the “central tooth” in the radulae of Turrinae (Conoidea: Turridae). Ruthenica 16: 47-52.
18. Mclean JH (2011) Reinstatement of the fissurellid subfamily hemitominae, with the description of new genera, and proposed evolutionary lineage, based on morphological characters of shell and radula (gastropoda: vetigastropoda). Malacologia 54: 407-427.
19. Foster GG, Hodgson AN, Balarin M (1999) Effect of diet on growth rate and reproductive fitness of Turbo sarmaticus (Mollusca:Vetigastropoda: Turbinidae). Marine Biology 134: 307-315.
20. Wakefield R L, Murray SN (1998) Factors influencing food choice by the seaweed-eating marine snail Norrisianorrisi (Trochidae). Marine Biology 130: 631-642.
21. Alyakrinskaya IO (2003) Certain biological traits and morphobiochemical adaptations to nutrition in strombus decorus raybaudii Nicolay and manoja, 1983. Biology Bulletin 30: 171-179.
22. Osorio C, Jara F, Ramirez ME (1993) Diet of Cypraea caputdraconis (Mollusca: Gastropoda) As It Relates to Food Availability in Easter Island. Pacific Science 1: 34-42.
23. Jeffrey TW, Craig MY (2006) Feeding habits and phenotypic changes in proboscis length in the southern oyster drill, Stramonita haemastoma (Gastropoda: Muricidae), on Florida sabellariid worm reefs. Marine Biology 148: 1021-1029.