Shell Injuries in Two Intertidal *Gastropods Littorina scabra* (Linnaeus,1758) and *Thais bufo* (Lamarck, 1845) From Tranquebar, Southeast Coast of India

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Abstract

Littorina scabra and Thais bufo were collected from the rocky shore of Tranquebar and the shell injury due to predation or wave action was estimated in both male and female snails. In both the cases, the results show that the shell injury is not depending on shell size but mainly on their exposure to continuous wave action. The physical damage caused to them due to the rolling of small rocks, boulders and the risk of predation was mainly from crabs and birds. In the present study a survey has been made to estimate the percentage of shell injury in male and female snails and different size groups of the above two different species. Obviously there is a relationship between crabs, stones and shell damage. In L. scabra the shell damage in male and female was 47.18% and 41.1% and the size group of 16.10mm to 18.10mm is dominant with 28.44%of shell injury. Whereas in T. bufo it was 50.81% in male and 44.44% in female and the size group of 40.01mm to 48.10mm is dominant with 21.22% of shell injury respectively. The male and female of both the species for the length and width of shell damage were positively correlated. Anova for within the species in shell damage in L. scabra didn't show variation but for T. bufo it showed variation. Anova for between the species showed significant variation. Among these the female in L. scabra and male in T. bufo showed a maximum injury .This may be able to asses the threat to organisms and shows the level of predation and the damage caused by environmental factors.

***Key words** : Tranquebar, gastropods, predation, shell injury, rocky shore*

Introduction

The class Gastropoda is the largest class of Phylum Mollusca. There is more than 35,000 existing species. Considering the wide variety of habitats to which they have invaded, they are certainly the most successful group of the molluscs in general. They invade both marine and fresh water and become adapted to live on both ecosystems. The typical gastropod shell is conical and composed of tubular whorls. Starting at the apex, which contains the smallest and oldest whorls, successively larger whorls are coiled about a central axis. A gastropod shell typically consists of four layers. The outer periostracum is thin and composed of a horny protein material called conchiolin or conchin. The inner layer consists of calcium carbonate.

The gastropods found in the rocky shore face many type of stress. Crab and bird predation are correlated with size, lip thickness and shell injuries of the periwinkle (Raffaelli, 1978). By analogy with repaired shell injuries in modern molluscs, the scars in *Marocella* are interpreted as repaired injuries following failed predation. Repaired shell damage in the commercial scallop *Zygochlamys patagonica* from Argentine Sea were analyzed by Laura & Claudia (2007). Moderate and severe damage was mostly recorded in individuals of commercial size (≥ 55 mm). This indicates not only the fragility of smaller scallops, but also the accumulation of damage in older specimens, probably more resistant to damage because of their thicker shells. The selective removal of commercial individuals could explain in part our results that indicate a higher percentage of repaired shell damage when the average size of the population was also higher.

No detailed study on shell injuries on sexes have been made on two intertidal species (*Littorina scabra* and *Thais bufo*) in Indian waters. For any shore the proportion of damaged (repaired) molluscan shells reflects the intensity of predation and crushing by boulders as a result of wave action. Because of their increased vulnerability to injuries, the shells show a tendency to increase their lip thickness (Raffaelli, 1978). Hence in the present study an attempt was made to assess the shell injury in different size groups and both sexes of two intertidal gastropods *L. scabra* and *T. bufo.*

Materials and Methods

In present study, a rocky shore was selected to study the different types of shell damage in two species. The study area was Tranquebar, situated in south

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east coast of India (Lat E 11°02'N; Long 79°52'E). The coast line along Tranquebar is a gently steeping sandy beach without crops of weed covered slippery rocks between stretches of firm sand and masses of bricks, shingles and boulders.

The animals inhabit the boulders, especially on the sheltered sides against large waves, it is found mainly binding in crevices during high tide. These species are found in sheltered areas, has a short and compressed shell. It is more stout, considerably large and globular in outline in a small spire. The intertidal species of *L. scabra* & *T. bufo* were collected from the rocky shore randomly by hand picking during low tide and the animals were brought to the laboratory. In the laboratory the species were sorted out and shell length, width and lip thickness was measured by using a 0.1mm Vernier caliper. The lip thicknesses, variations of the undamaged shells were also estimated between the 2 population and between the sexes. It is assumed that the lip thickness is representative of total shell thickness (Raffaeli, 1978).The animals were grouped into male & female and the damaged and undamaged shells were grouped of both species were taken. Generally the females are larger than males (Tagore, 1988).

The statistical analysis (correlation) was made within and between the species to analyse the shell damage of the study animals. The statistical analysis Anova was made within and between the species to obtain the "F" value and asses the shell damage of the study animals.. For any shore the proportion of damaged molluscan shell reflects the intensity of predation and crushing by boulders as a result of wave action. The shell lip thickness was greater in areas of increased shell damage. (Raffaeli, 1978)

Results

In present study the animals collected from the study area showed a high degree of variation in shell size. A total 230 ind. *L. .scabra* was collected in which male was 38.7% and female was 61.2%. The total number of damaged and undamaged male was 41.1 and 58.88 % whilts in female was 47.18% damaged and 52.81% undamaged. The lip thickness of *L. scabra* ranged from 0.04 to 0.21 mm in male (mean value was 0.1001 mm). The lip thickness of female *L. scabra* ranged from 0.04 to 0.24 mm and the mean value was 0.121 mm. In present study the size group of *L. scabra* ranged 10.01-26.10mm, in which most of animals recorded was in between size of 12.20-20.01mm. The damage level was 37.88%.

There is positive correlation between shell injury for male and female *L. scabra* ($p<0.01$). ANOVA single factor was performed within the species (male and female) of *L. scabra* and it revealed that there is significant variation shell injury in length for male and female ($p<0.05$), but not for the width ($P>0.05$).

T. bufo examined was 151 individus, in which the male was 40.3% and female 59.6%. The total number of damaged and undamaged in male *T .bufo* were 50.81% and 49.18% respectively. The damaged and undamaged female *T .bufo* were 44.44% and 55.55%. The lip thickness of *T. bufo* ranged from 0.16 to 0.45 mm in male (mean value was 0.27 mm). In female *T. bufo,* the lip thickness ranged from 0.7 to 0.45 mm (mean value was 0.26 mm). The size of *T. bufo* ranged from 23.10 to 57.80 mm. Most of animals recorded were in the size group of 40.01-48.10mm (47.12%). The damage level was 21.22%. There was positive correlation between shell injury of male and female *T. bufo* ($p<0.01$). ANOVA single factor was performed within the species (male and female) of *T. bufo* and showed that there was no significant shell injury variation in length and width for male and female ($P>0.05$).

ANOVA between the species and the shell injury in both male and female of *L. scabra* and *T. bufo* in length and width showed significant variation ($p<0.001$).

Discussion

Nacella concinna is the most conspicuous macroinvertebrate in the intertidal of King George Island. An important predator, the Kelp gull *Larus dominicanus*, feeds on *Nacella* during spring low tides. The gulls deposit empty *Nacella* shells as regurgitates mainly on coastal rocks. The regurgitates were found to consist of 40% shell fragments by weight and 60% intact shells. (Gerhard, 1999).

Dislodgement is common in the European limpet, which are over grown with algae (*Himathalia elongate*), may be became detached from rocks on the channel coast and washed ashore on Dutch beaches (Lucas, 1954, Van Regteren – Altena, 1957).

Rocking stones may not only dislodged shells but also cause shell damage either directly or by subsequent tumbling of the dislodged animal in the intertidal. These observations suggest that shell fractures are caused by rolling stones in the intertidal (Blankley & Branch, 1985).

Shanks & Wright (1986) have convincingly demonstrated that breading waves 'throw' rocks and cobbles and such missiles can damage and kill the organisms. The number of movable rocks (i.e. potential projectiles) was positively related to the frequency of shell damage in two populations of the limpet *Lottia gigantea* studied in southern California.

Shabica (1971) already mentioned the mortality of *Nacella* by rolling boulders. Bulkley (1968) also related part of the natural shell Californian coast to loose rocks pounding against the shells. In intertidal

littorinid gastropods, injuries due to wave–borne rocks have been observed (Ankel, 1942; Raffaelli, 1978).

The high intertidal zone is not an effective spatial refuge for many molluscs because in the up shore extension there is most marine predators, including crabs. There is correlation between crab and bird predation and habitat characteristics with shell damage. For any shore the proportion of damaged molluscan shell reflects the intensity of predation and crushing by boulders as a result of wave action. The exposed shore has usually small shells which is protected in crevices and holes against the strong wind action (Maruthamuthu *et. al*., 1985)

Tropical crabs are considered to be more specialized for attacking hard shelled molluscan prey, possibly as a result of prolonged intense co - evolution between these predators and their prey. Most crabs forage selectively on small sized molluscan prey well below the critical size that can be opened (Seed & Hughes, 1995). The array of invertebrate predators on cultured shellfish also includes echinoderms. Starfish such *as Asterias forbesi* and *A. vulgaris* prey on clams and oysters in northeastern coastal waters. Shell damage along the margin of the aperture at various stages of growth, which may have been caused by one of the associated faunal elements such as echinoids (Gef Flimlin, 1993).

Shells of deep-endobenthic bivalves from several localities of the Spanish littoral are affected by various modalities of shell damage, which cannot be attributed to the direct activity of predators. The frequency and morphology of these damage features, together with the results of tests with living specimens, indicate that they are brought about by the process of burrowing. Several aspects of their distribution at the individual and population level also allow to differentiate at least two indirect origins for them escape movements from predators and readjustments to storm-induced changes in the sediment column. As expected, the first cause is likely only for some taxa from sheltered coastal environments, while the second applies to all samples from exposed shores (Checa, 1993). Furthermore, the shell shape in the population investigated, besides varying with age, also varies due to shell damage. No significant differences were found between the shapes of the shells of males and females. (Peter Van Marion, 1981). The shell shape in the population investigated was not only varying with age, but also due to shell damage. No significant differences were found between the shapes of the shells of males and females

Experimental studies were conducted to investigate the possible causes of shell scars in the bivalve mollusc *Glycymeris glycymeris*, including fishing disturbance, predator attacks and burrowing activity. Individuals collected from an area of sea bed experimentally fished once by a scallop dredge 12 months previously did not display significantly more shell scars than those collected before fishing or from a control area. In the laboratory, *G. glycymeris*, which was offered to the predatory crab *Cancer pagurus,* had a significantly higher incidence of scars seen in acetate peels of shell cross-sections than control shells (Seed & Hughes, 1995). However, scarring on *G. glycymeris* excavated from the sediment and left to reburrow was not significantly different from those in an undisturbed control group. For *G. glycymeris,* it was not possible to differentiate between scars caused by fishing disturbance or natural disturbances, either on the grounds of visual appearance or position of damage (Ramsay, 2001).

In the study area there were also bird predators such as crow, Brahmin kite and Kingfisher which feeds on gastropods. They also prefer matured stage size groups . They break the shells for their flesh. These birds are commonly found in the study area during low tide. When the gastropod were found exposed, the birds preferably chose the matured females for consumption but they damaged both species of gastropods. It was the observation where the injuries in matured females in *L.scabra* are mostly than the male. which is concluded from the present study.

In the rocky shore the animals commonly get dislodged, because of the wave action. During the time of dislodgement they have been washed away by the wave and fed by the other animals (Simpson, 1976). The rocky shore Tranquebar is artificial rocky shore where there are patches of rocks found along the coast. So the damage may be of rocking stones in the intertidal. The animals may also get dislodged because of the algae which are grown on the animals and they became detached from the rocks. Maruthamuthu *et. al*. (1985) have also studied shell damage in *Littorina* in three different habitats and reported that predation by crab seems to enhance shell in injuries in mangrove area, where the proportion of shell injury was high.

The Molluscan species (*Thais* and *Littorina*) which are being attached to rocks, crevices and gaps of the bricks are mostly exposed during low tides. In this condition the crabs feed on them. The crabs cut these molluscan shells, to suck out their flesh (Seed & Hughes, 1995) but this happens only in the small sized prey (*Littorina*) but not in big size prey (*Thais*). In Tranquebar there are more than 11 species of crab and most of them feed on gastropods. In addition of shell injury caused by predator, the human activities in the coastal area was also results in shell damage, since they take gastropods' flesh for consumption.

Conclusion

In the present study a survey has been made to estimate the percentage of shell injury in male and female snails and different size groups of the two different species. Obviously there is a relationship between crabs, stones and shell damage. The results show that the shell injury is not depending on shell size but mainly on their exposure to continuous wave action, the physical damage caused to them due to the rolling of small rocks, boulders and the risk of predation mainly from crabs and birds. In this way we can asses the threat to organisms and shows the level of predation and the damage caused by environmental factors.

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