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A COMPARATIVE STUDY OF POPULATION STRUCTURE AND CONDITION INDEX OF TWO SPECIES OF GASTROPOD MOLLUSCS FROM EXPLOITED AND NON-EXPLOITED SITES OF KARACHI COAST

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ABSTRACT

The condition index of two abundant gastropod species of *Turbo* (*T. coronatus* and *T. intercostalis*) from exploited and non-exploited sites of Karachi was studied on monthly basis, for a period of one year from October 2004 to September 2005. A significant difference in condition index of two species from exploited and non-exploited sites was demonstrated. Condition index values were relatively higher and less varied throughout the year in both the species of *Turbo* at less polluted and non-exploited site (Nathiagali) as compared to polluted and exploited site (Buleji). The two sites also differed in the period of highest and lowest condition index values of standard size snails of both species of *Turbo***.** An inverse relationship between condition index and shell height of snails was noted for most of the year in both the species. The results are discussed with reference to their presence under different environmental conditions.

Key-words: Pollution, exploited, Condition Index, Gastropod species.

INTRODUCTION

Gastropod molluscs are one of the most abundant groups of marine invertebrates on the rocky beaches around Karachi. They are important not only because they are available in large number and hence deserve attention, but also some of them grow to large size and thus may be utilized for their meat (soft tissue). It is known that tissues of marine animals are nutritious and are thus highly prized. In many countries, gastropod tissues are used as food (Ramesh *et al.*, 1991; Patterson-Edward and Ayyakkannu, 1992; Ayyakkannu, 1994; Chantrapornysl, 1995; Krishnamurthy and Soundararajan, 1999; Dwiona and Setyona, 1999).

Assessment of the quantity of edible portion of the soft tissues of marine invertebrates is usually made through condition index studies. A number of methods have been employed to assess the edibility of the species concerned. The main purpose of studying the condition index is to locate the period of maximum availability of tissue or the edible portion so that harvesting time may be determined. It is because of this reason that studies concerning condition index are conducted on seasonal basis.

Assessment of condition studies was mostly been made on commercially important bivalve molluscs. The literature dealing with these studies is comprehensively summarized by Walne (1970), other studies of importance are those of Ansell (1972), Dare (1973), Askew (1972), Gabbot and Bayne (1973), Barkati (1982), Ruiz *et al.* (1992), Barkati and Ahmed (1994), Orban *et al*. (2001), Yang *et al*. (2001), Bologna *et al*. (2001), Babarro and De-Zwaan (2002), Laing (2002).

Few references are available related to condition index of gastropod molluscs (Krishnakumari *et al.*, 1990; Marigomez *et al.*, 1990; Davenport *et al.*, 1998; Leung and Furness, 2001). Some literature is available on condition index of marine molluscs of Pakistan (Fatima *et al*., 1985; Barkati and Tirmizi, 1986; Qasim *et al*., 1987; Barkati and Khan, 1987; Fatima and Temuri, 1992). Seven methods for the assessment of condition index have been described by Barkati (1982) for the blue mussel *Mytilus edulis*. The most commonly used methods are total dry weight method, percent glycogen and wet tissue volume method (Barkati and Ahmed, 1994).

McLachlan and Lombard (1981) and Foster and Hodgson (2000) documented a marked difference in condition index between exploited and inaccessible or unexploited population of gastropod species. According to Warwick (1993) also, undisturbed communities tend to be dominated by conservative species, which are characterized by large body size and long life span. The present study deals with two abundantly available gastropod species, *Turbo coronatus* and *T. intercostalis*, from a well-visited or exploited (Buleji) and unexploited or undisturbed site (Nathiagali) of the Karachi coast.

MATERIALS AND METHODS

Study Sites

Two sites were selected for study, namely, Buleji and Nathiagali along the coast of Karachi, Sindh. One of these sites, Nathiagali is located far from the city at a distance of 30 km and is thus relatively undisturbed. Conversely, Buleji is located at about 18 km NW of Karachi and is the one of the most disturbed rocky shore considering the number of visitors.

Trips were made on monthly basis for a period of one year from October 2004 to September 2005. Visits were always made during the ebb tides so that most of the intertidal area may be examined.

Population Dynamics & Condition Index

The snails were randomly handpicked from the three tidal levels of the rocky shores. For each species not less than 100 individuals of different sizes were used. Few individuals of *T. intercostalis* could have been collected in August 2005 from Nathiagali rocky shore due to rough sea and high tides.

Shell height (apex to the tip of the siphonal canal) was measured using vernier caliper to the nearest 0.01 mm. Snails were first cleaned of encrusting organisms, then the soft tissues were removed from the shells, blotted dry on absorbent paper and weighed. The shells and tissues were then dried to a constant weight at 70 ^{0}C in a vacuum oven and weights were recorded to the nearest 0.01 gm.

The proportion of dry tissue weight to total dry weight is termed as condition index and is expressed by the formula:

$$C.I. = \frac{\text{Dry tissue weight}}{\text{Total weight (Dry shell + Dry tissue)}} \times 100$$

For statistical analysis, Zar (1974) was followed.

RESULTS

1. *Turbo intercostalis*

a. Buleji Rocky Shore

Condition index generally decreased with increase in shell size in most of the months (**Fig. 1**) whereas reverse is true for three months i.e. November 2004, May (**Fig. 2**) and September 2005. A marked decrease in condition index values may be seen in March and April 2005 with increasing size as compared to other months. The seasonal variation in the condition index of a standard size snail (4 cm) *T. intercostalis* from Buleji rocky shore varied between 7.42 and 18.83 (X = 14.81). The highest values were noted in November 2004 and lowest in September 2005 (**Fig. 3**).

b. Nathiagali Rocky Shore

An inverse relationship between condition index and height of snail was recorded in most of the samples except during the period January to March and July 2005. However, changes with increase in height were less pronounced. The condition index values of a standard size snail (4 cm) varied between 15.67 and 24.19 (X = 20.24). The lowest values were found in February and highest in May 2005 (**Fig. 4**).

Comparison between Sampling Sites

The weight parameters (tissue and shell weights) showed an exponential increase relative to increasing shell height in both species at the two sites. Condition index values were higher and less varied throughout the year in *T. intercostalis* at non-exploited site as compared to exploited site. The condition index values of *T. intercostalis* from Buleji increases with increase in shell size in November 2004, May (**Fig. 2**) and September 2005, whereas, the condition index values increased from January to March and July 2005.

The two sites differ in the period of highest and lowest condition index values of standard size snails of both species of *Turbo***.** In *Turbo intercostalis* from Buleji, the highest values were found in November 2004 and lowest in September 2005, whereas lowest values were found in February and highest in May 2005 from Nathiagali rocky shore (**Fig. 3**).

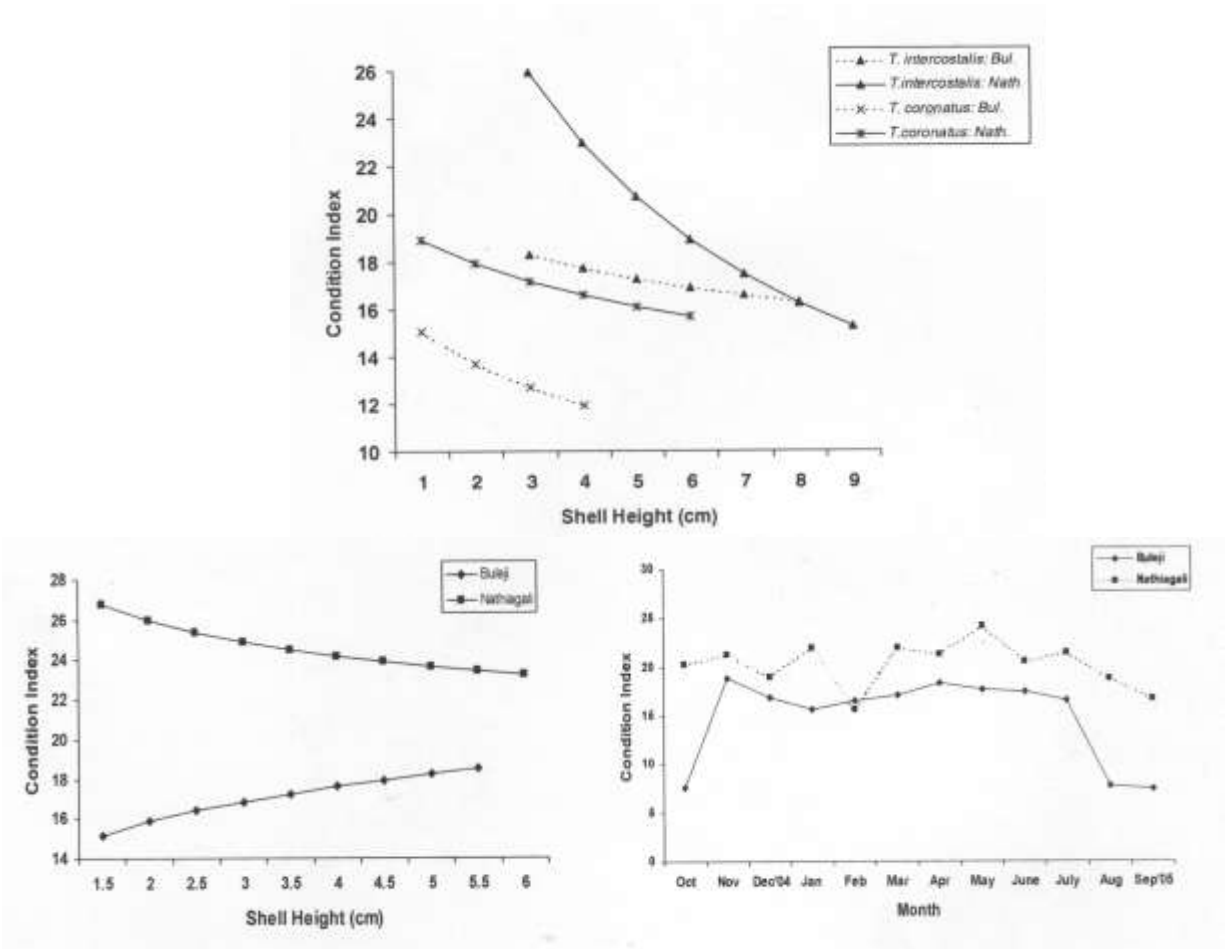

Fig. 1. An inverse relationship between shell height and condition index of two gastropod species from Buleji and Nathiagali sampled on December 2004.
Fig. 2. Changes in condition index with increase in size of *Turbo intercostalis* showingtwo different trends from the exploited (Buleji) and non-exploited (Nathiagali) sites sampled on May 2005.
Fig. 3. Seasonal changes in the condition index of 4 cm shell height gastropods, *Turbo intercostalis* from Buleji and Nathiagali.

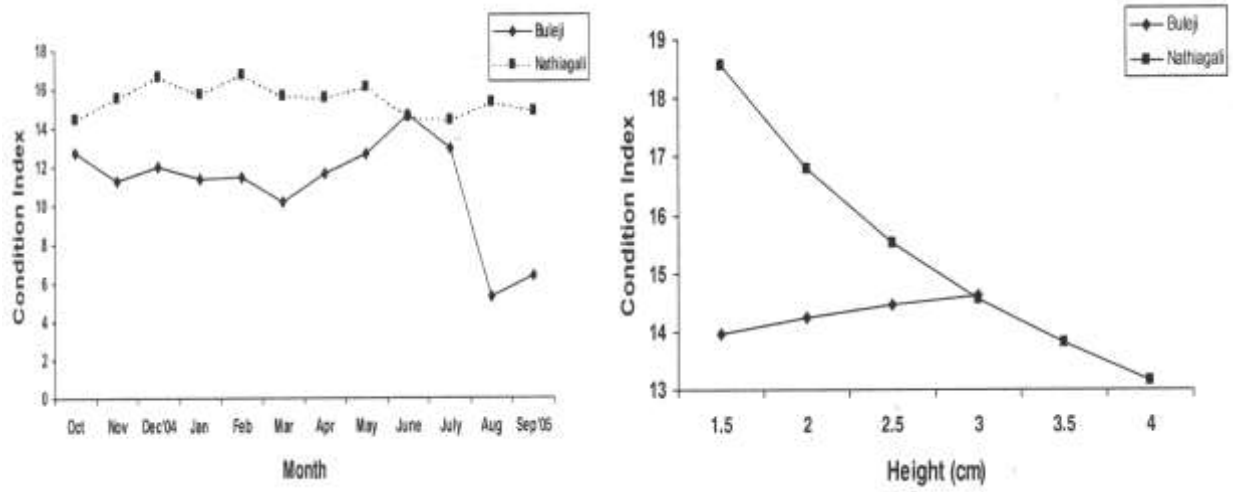

Fig. 4. Seasonal changes in the condition index of 3 cm shell height gastropods, *Turbo coronatus* from Buleji and Nathiagali.
Fig. 5. Changes in condition index with increase in size of *Turbo coronatus* showing two different trends from the exploited (Buleji) and non-exploited (Nathiagali) sites sampled on June 2005.

2. *Turbo coronatus*

a. Buleji Rocky Shore

An inverse relationship between condition index and shell size was observed in *T. coronatus* throughout the year (**Fig. 1**) except in June 2005. However, the rate of increase in condition index with increase in size is negligible in June 2005 (**Fig. 5**). A marked decrease in condition index values in most of the samples was observed except in February and September 2005, where changes were negligible. Condition index of standard size (3 cm) snails, *T. coronatus* from Buleji rocky ledge varied between 5.26 and 14.63 (X = 11.04). Peak values of condition index were recorded in June 2005 and minimum in August 2005 (**Fig. 4**).

b. Nathiagali Rocky Shore

An inverse relationship between condition index and shell size were noticed save that of February and September 2005. A marked decrease in condition index values may be seen in most of the samples. The rate of increase is however, just noticeable. The condition index of a standard size snail (3 cm) of *T. coronatus* varied between 14.35 and 16.74 (X = 15.44). The highest values were observed in February and lowest in July 2005 (**Fig. 4**).

Comparison between Sampling Sites

Condition index values were higher and less varied throughout the year at non-exploited site i.e. Nathiagali as compared to exploited site i.e. Buleji. The peak of condition index values of *T. coronatus* differ at the two sites studied viz it increases with increase in shell size in June 2005 (**Fig. 5**) at Buleji, but in February and September 2005 at Nathiagali.

The two sites differed in the period of highest and lowest condition index values of standard size snails of *T. coronatus***.** In *T. coronatus* from Buleji, the highest values were recorded in June 2005 and lowest in August 2005, whereas in snails from Nathiagali February and July were the months of highest and lowest values, respectively (**Fig. 4**).

DISCUSSION

A number of studies on site to site variation in the growth and population dynamics of gastropod species were undertaken, particularly on rocky shores such as *Nassarius festivus* (Mortan and Chan, 2004), *Nucella lapillus* (Davenport *et al*., 1998; Leung *et al*., 2001), *Cerithium rubus* (Krishnakumari *et al*., 1990), *Littorina littorea* (Marigomez *et al*., 1990), *Turbo sarmaticus* (Foster and Hodgson, 2000), *Collisella subrugosa* (Tanaka *et al*., 2002), *Patelloida striata* (Kurihara, 2002). The site-to-site variations were mainly due to fluctuation in abiotic and biotic factors such as degree of wave action, substrate stability, substrate hardness and heterogeneity, desiccation stress, human induced and natural disturbances, food abundance, and availability, competition and predation. The only reference on growth and condition index from two sites of Pakistan is that of bivalve, *Perna viridis* (Fatima *et al*., 1985).

According to Mortan and Chan (2004) life span of *Nassarius festivus* differed between three localities of Hong Kong depending mainly upon food availability. The individuals of *N. festivus* attained the largest shell height and the shortest life span at Starfish Bay having the highest food availability and lowest pollution. Due to scarcity of food at Tai Mong Tsai, individuals mature at a smaller maximum size. Tai Tom bay was moderately polluted and low in food availability. Maximum size of snails was intermediate and also the life span. According to Krishnakumari *et al.* (1990) the growth and condition index values of *Cerithium rubus* were higher at a relatively clean marine habitat compared to the polluted sites near Bombay. The growth rate and condition index of *Nucella lapillus* was highest at sites with less pollution and better food condition in the Firth of Clyde, West Scotland (Leung *et al*., 2001). He also observed that the condition index of small size individuals values were high. Davenport *et al*. (1998) also recorded high condition index of *Nucella lapillus* living under mussel hummock (food source) as compared to dogwhelks from nearby barnacle zone. Starvation due to shortage of food induced loss of condition index in dogwhelks. Rahman and Barkati (2004) also noted that the molluscan species are of large body size and dominated in terms of biomass at less polluted and undisturbed sites i.e. Cape Monze and Nathiagali. Whereas, the species are of small size in relatively disturbed and polluted sites i.e. Manora and Buleji. The result of the present investigation is in conformity with the above results. The growth and condition index of gastropod species is higher at less polluted and undisturbed site i.e. Nathiagali as compared to moderately disturbed site i.e. Buleji throughout the year.

Underwood (1976) mentioned that adult animals of *Nerita atramentosa* did not grow after. According to Barkati

and Tirmizi (1986) also, it seems that the efficiency of feeding in adult *Telescopium telescopium* decreases. The present observation agrees with these conclusions as condition index values decreases after reaching to a certain size. In the present investigation, the two sites differed in the period of lowest condition index values. Same results were concluded by Fatima *et al.* (1985) in the mussel, *Perna viridis* from Karachi coast. According to Lee and Lee (1979), the changes in condition index and gonad maturity were closely related to water temperature in *Turbo* species, but their values decreased markedly during the spent condition of the topshell. Spawning in turban shell was found related to rise in temperature (Villiers, 1981; Lee, 1983). However, according to Lasiak (1986), *T. coronatus* has a prolonged breeding period with peak spawning taking place from December to February on the Transkei coast. An inverse relationship between temperature and condition index in *Turbo* species from Karachi is in general agreement to Lee and Lee (1979).

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