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Study on Chiton from the Intertidal Region of South Andaman

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Abstract

Study on chiton was carried out during February 2018, from the intertidal region of South Andaman. A total of 14 species of chiton belonging to 5 genera were identified in the study area. Two species were identified up to the level of Family only and one specimen reported as unidentified. Genera *Acanthopleura* was the most dominant (69%) while *Acanthochitona* and *Mopalia* contributed low (0.3-6.7%) to the total chiton population. Relatively high species richness (d=2.64) and low evenness in chiton species distribution (J= 0.6) at St.2 was found which could be due to the dominance of few species such as *Acanthopleura spiniger, Acanthopleura* sp.2 and *Chiton imitator.* Species composition of Carbyns Cove and Burmanallah were almost same showing 87% similarity, while species composition of Kodiyaghat differed from both the stations.

Keywords: *Polyplacophora, Chiton, Intertidal Region, South Andaman.*

Introduction

Since the Carboniferous period, polyplacophoran molluscs (chitons/ seacradles/ coat-of-mail shells) have persisted with little change in morphology (Sirenko, 2006) with over 900 species worldwide that are exclusively marine and are important intertidal grazers (Dethier and Duggins, 1984; Elahi and Sebens, 2013). Chitons are oval in shape and dorso-ventrally flattened, possessing eight distinctive overlapping shell plates or valves on the dorsal side. These valves are arranged longitudinally surrounded by a muscular girdle ornamented with scales, spicules, bristles or other protuberances (Kaas and Van, 1985), providing protection from wave exposure, predation, and other sources of damages.

Chitons have a large surface area of gills with numerous sensory organs distributed on their girdle and across the upper surface of their valves that helps to respire air by direct diffusion. Among the molluscs, chitons have a unique presence of shell organs called esthetes in the upper layer of valves known as the tegmentum that are modified as shell eyes visible to the naked eye (Leise and Cloney, 1982). The largest Indian chiton *Acanthopleura spiniger* from Andaman and Nicobar Islands was reported by Tikader et al., (1986).

Studies on chitons from the Andaman and Nicobar Islands are inadequate (Tikaderetal., 1986; Rao and Dey, 2000; Dey, 2003) though a rich component of molluscs represent in this little studied ecosystem. Chitons have a unique role and niche as primary consumers of marine plants. Very few literatures are available pertaining to the study of chitons from these waters. This entails the attention of scientific community for conserving the habitat as well as the species biodiversity itself.

Material and Methods

Station 1, Carbyns Cove (CC) -

This sampling site is located between 11°38.428′N to 92°44.652′E. Carbyns Cove has a long stretch of rocky shore with number of tide pools.

Station 2, Burmanallah (BN) -

This sampling site is located between 11°33.228′N and 092°44.866′E. Burmanallah has a long rocky shore stretch with mangroves on one side with diverse biodiversity.

Station 3, Kodiyaghat (KG) -

The sampling site is located between 11°31.733′N and 092°43.415′E. Kodiyaghat has a stretch of muddy and rocky shore with numerous tide pools.

Sample Collection

The study was undertaken during February, 2018. Stations were selected based on the availability of food source, habitat traits and accessibility. Sampling method was based and established on the availability of the organisms in the intertidal zone during low tide. Sample collection was carried out by using a $1m^2$ transect (Elftheriou and McIntyre, 2005). Chitons attached on rocks were thwarted by using freshwater and were collected in plastic bags. The use of freshwater allowed the organisms to loosen their grip on the attached substratum as they are marine organisms, thereby making the collection easy. Forceps were also used for the sample collection of chiton. Most of the species were photographed and measured in their natural habitat.

Laboratory Analysis

Chitons were brought to the laboratory for further taxonomic identification and were stored in deep freezer (-5°C). Identification of chiton till the lowest possible taxon level was done following literatures based on Rajagopal and Rao (1974), Subbarao and Dey (1991), Rao and Dey (2000) and Dey (2003). Chitons were defrosted and dissected by using steel blade and forceps. The internal morphology of chiton viz. gills, radula, insertion slits and spicules were observed under microscope (Nikon Trinocular Inverted Microscope). Following the identification, the specimens were preserved in 10% formaldehyde solution (Schwabe, 2006).

Data analysis

One time sampling was conducted to pursue taxonomic classification, so the presence or absence data was used to determine the similarity between the stations by using Primer V6.0 and MS excel.

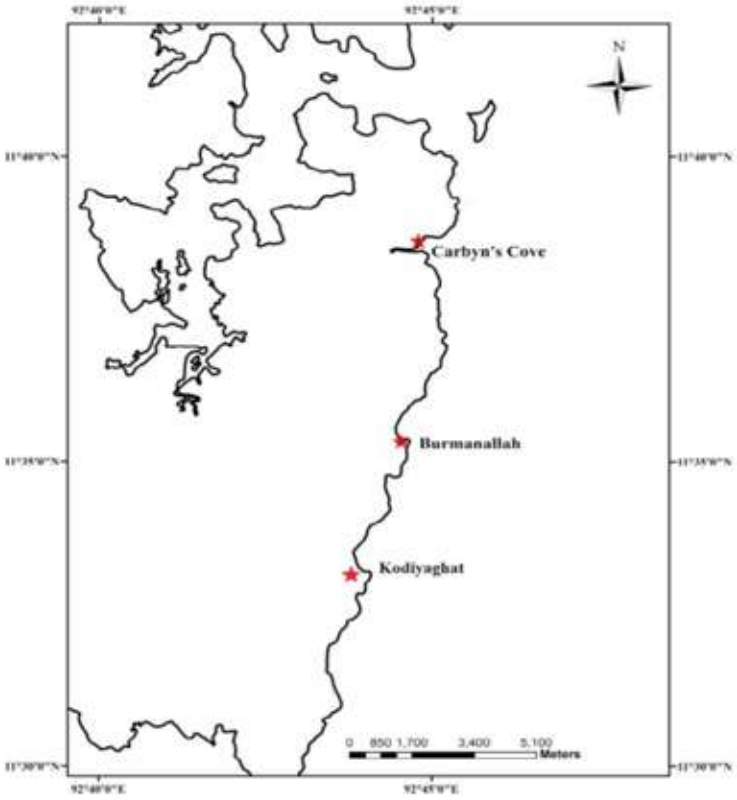

Fig.1. Map showing sampling location

Results

Water temperature varied from (29.3-30 °C) while air temperature (25.7-26 °C) did not show much variation among the stations. Dissolved Oxygen ranged from 4.1mg/L at St.1 to 4.8mg/L at St.2. Maximum salinity of 32.3 PSU was recorded at St.1. pH was maximum (8.4) at St. 1 and minimum (8.2) at St. 2 and St.3 (Fig. 2).

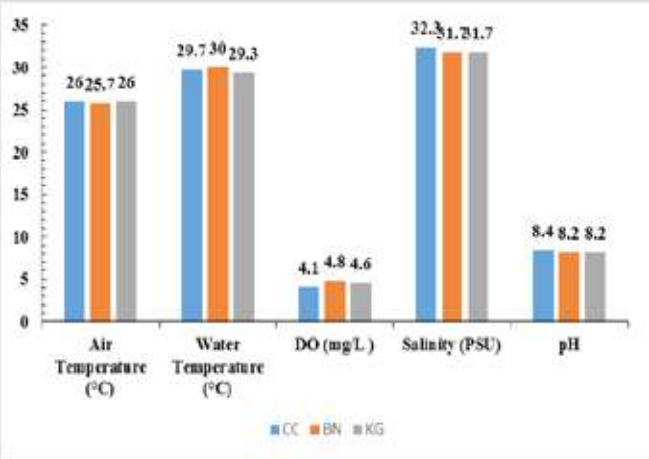

Fig.2 Physico-chemical parameters recorded during the study period

(CC= Carbyns Cove; BN= Burmanallah; KG= Kodiyaghat)

Phylum: Mollusca Cuvier, 1795

Class: Polyplacophora de Blainville, 1816

Order: Chitonida Thiele, 1909

1. *Acanthopleura spiniger* Sowerby, 1840

Collection site - Carbyns Cove, Burmanallah, Kodiyaghat

Preferred habitat - Commonly attached to the rocks in intertidal region

Size - 7-7.2cm

Description - Largest and thorny chiton in the study area, length up to 7-7.2 cm. Girdle with numerous curved spines. Shell large and rounded, with thick and heavy valves.

2. *Acanthopleura* sp. 1

Collection site - Kodiyaghat

Preferred habitat - Intertidal to shallow shore, found active at night during the study period.

Size - 4.5-5.9 cm

Description - Smooth girdle. Girdle milky white. Jugum present on all valves. Gills extending till the foot.

3. *Acanthopleura* sp. 2

Collection site - Carbyns Cove, Kodiyaghat, Burmanallah

Preferred habitat - Rock beds covered with algal patches.

Size - 5.1-6.7 cm

Description - Girdle with numerous curved spines. Shell large and rounded. Jugum absent on the head and tail valves with distinct lateral black lining. Presence of demarcating lines on all valves. Girdle colour- whitish; Valve colour- black or dark green.

4. *Chiton iatricus* Winckworth, 1930

Collection site - Burmanallah, Carbyns Cove

Preferred habitat - Attached to rocks in the intertidal region observed during the period of sampling.

Size - 1.6-2.1 cm

Description - Shell with subdued sculpture with marked ridge separating the lateral areas from the median area, anterior margins of the valves with marked growth lines. Colour reddish brown with dark markings on a yellowish background. Girdle is scaly and smooth.

5. *Chiton imitator* Nierstrasz, 1905

Collection site - Carbyns Cove, Burmanallah

Preferred habitat - Found in the intertidal area, crawling through algae over rocks.

Size - 3.2-3.6 cm

Description - Shell small. Anterior most valve semicircular. The second valve slightly larger than other valves. Posterior most valve slightly depressed.

6. *Chiton* sp.

Collection site - Kodiyaghat, Burmanallah

Preferred habitat - Commonly attached to the rocks in intertidal region. There are numerous species observed in this area

Size - 3.1-3.9 cm

Description - Animals small. Girdle naked and leathery or with well-developed, solid, rounded and closely overlapped scales or spicules.

7. *Acanthochitona* sp. 1

Collection site - Carbyns Cove, Burmanallah

Preferred habitat - Rock surfaces in the intertidal zone

Size - 2-2.2 cm

Description - Jugum present on all valves. Girdle hairy and black in colour. Insertion plate slitted. Tegmentum absent. Valves-light brown and black.

8. *Acanthochitona* sp. 2

Collection site - Burmanallah, Carbyns Cove

Preferred habitat - Found on rock surfaces in the intertidal zone of this area

Size - 2.8-3.4 cm

Description - Jugum absent on the head and tail valve. Girdle hairy and olive green in colour. Presence of spicules. Gills extending till the foot.

9. *Acanthochitona* sp. 3

Collection site - Carbyns Cove

Preferred habitat - Rocks where hydroids are present

Size - 3.5-4.3 cm

Description- - Jugum present on all valves. Girdle spiny and grey in colour. Presence of demarcating lines on the intermediate valves. Head valve slightly bigger than tail valves.

10. *Ischnochiton* sp. 1

Collection site - Kodiyaghat, Burmanallah

Preferred habitat - Attached to the dead shells or other hard substratum

Size - 3.8-4.2 cm

Description - Animal medium in size. Tegmentum of the valves 2-7 usually divided into lateral and central areas by a diagonal rib. Gills are holobranchial.

11. *Ischnochiton* sp. 2

Collection site - Kodiyaghat, Burmanallah

Preferred habitat - Attached near encrusted algae

Size - 4.8-5.6 cm

Description - Girdle hairy and smooth. Jugum absent on head and tail valve. Gills extending to the foot.

12. *Ischnochiton bouryi*

Collection site - Carbyns Cove, Burmanallah, Kodiyaghat

Preferred habitat - Found feeding exclusively on filamentous algae in intertidal rock pools.

Size - 3.6-4.6 cm

Description - All the valves of equal width. Tegmentum grayish brown in colour. Girdle narrow. Gills holobranchial and abanal.

13. *Ischnochiton winckworthi* Leloup, 1936

Collection site - Carbyns Cove, Burmanalla, Kodiyaghat.

Preferred habitat - Around sponges.

Size - 1.8-2.5 cm

Description - Oblongovate and flattened. Dorsal surface of the intermediate valves bearing three distinct bands in the centre. Girdle with closely packed scales.

14. *Mopalia hindsii* Reeve, 1947

Collection site - Kodiyaghat

Preferred habitat - Commonly attached to the rocks in intertidal region.

Size - 4.4 cm

Description - Cross hatched "basket-weave" pattern on plates II-VII. Girdle wide. Plates often solid dark green, brown or nearly black and sometimes bi-coloured with white.

Phylum : Mollusca Cuvier, 1795

Class : Polyplacophorade Blainville, 1816

Order : Lepidopleurida

Family : Leptochitonidae Dall, 1889

15. Leptochitonidae sp. 1

Collection site - Burmanallah, Kodiyaghat

Preferred habitat - Commonly attached to the rocks in intertidal zone

Size - 3.2-3.6 cm

Description - Smooth and hairy girdle. Jugum absent on head and tail valves. Valves brownish to white in colour.

16. Leptochitonidae sp. 2

Collection site - Burmanallah, Kodiyaghat

Preferred habitat - Attached to the rocks in intertidal zone

Size - 1.8-2.1 cm

Description - Smooth and hairy girdle. Jugum irregular. Gills not extending till the foot. Insertion plate grooved. Valves brownish to white in colour. Girdle narrow and absence of tegmentum.

Species Composition of Chiton

Genera *Acanthopleura* was the most dominant (69%) followed by *Ischnochiton* (22%) and *Chiton* (14%). Whereas, the Genus *Acanthochitona* and *Mopalia* were contributed low (0.3-6.7%) percentage to the total population, during the study period.

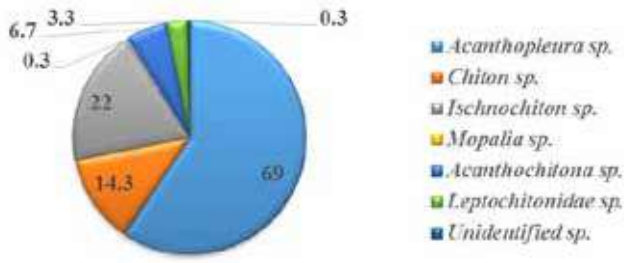

Fig. 3: Percentage composition of major genera of Chiton in the study area

A total of 14 species of Chiton belonging to 5 genera and 2 species were identified till the family level from the study area (Table 1).

Acanthopleura spiniger ranged from 21 ind./m^2 at St.1. to 76 ind./m^2 at St.3 (avg 49.7±2.7) and contributed 42.8% to the total Chiton population in the study area. Only a single individual of *Acanthopleura* sp.1 was recorded at St.3 during the study period. *Acanthopleura* sp. 2 ranged from 11 ind./m^2 at St.1. to 28 ind./m^2 at St.3 (avg. 19.0±8.5) and contributed 16.3% to the total population.

Ischnochiton winckworthi ranged from 1 ind./m^2 at St.2 to 45 ind./m^2 at St.1 (avg. 16.0±2.5) and contributed

13.7% to the total population. The species *Ischnochiton bouryi* exhibited 3-4 ind./m^2 at all the stations (avg. 3±0.5) and contributed 2.5% to the total population. Only 1 ind./m^2 of *Ischnochiton sp.*1 was collected from St.2 and St.3. the species *Ischnochiton* sp. 2 was collected 3-4 ind./m^2 of at St.2 and St.3 in the study area (avg 2.3±2.1) and contributed 2.0% to the total population. The species *Chiton imitator* ranged from 5 ind./m^2 at St.2 to 23 ind./ m^2 atSt.2 (avg. 9.3±2.9) and contributed 8.1% to the total population. Species *Chiton iatricus* was recorded 1-2 ind./m^2 at St.1 and St.2. The *Chiton* sp.1 ranged from 1 ind./m^2 at St.2 to 11 ind./m^2 at St.3 (avg. 4.0±6.1) and contributed 3.5% to the total population.

The *Acanthochitona* sp.1 ranged from 2 ind./m^2 at St.1 to 4 ind./m^2 at St.2. The species *Acanthochitona* sp.2 ranged from 1 ind./m^2 at St.2 and 8 ind./m^2 at St.1, while 5 ind./m^2 of *Acanthochitona* sp.3 was recorded at St.1, while only one ind./ m^2 of *Mopalia hindsii* was collected at St.3 in the study area.

Table1: Species Composition of Chiton at St.1, St.2 and St.3 during the study period.

+ : Present; - : Absent

S.No.	Species Composition	St.1	St.2	St.3	%
1.	*Acanthopleura spiniger*	+	+	+	42.82
2.	*Acanthopleura* sp.1	-	-	+	00.29
3.	*Acanthopleura* sp.2	+	+	+	16.38
4.	*Chiton iatricus*	+	+	-	00.86
5.	*Chiton* sp.1	-	+	+	03.45
6.	*Ischnochiton bouryi*	+	+	+	02.59
7.	*I. winckworthi*	+	+	+	13.79
8.	*Ischnochiton* sp.1	-	+	+	00.57
9.	*Ischnochiton* sp.2	-	+	+	02.01
10.	*Mopalia hindsii*	-	-	+	00.29
11.	*Acanthochitona* sp.1	+	-	+	01.72
12.	*Acanthochitona* sp.2	+	+	-	02.59
13.	*Acanthochitona* sp.3	+	-	-	01.44
14.	Leptochitonidae sp.1	-	+	+	01.15
15.	Leptochitonidae sp.2	-	+	+	01.72
16.	Unidentified sp.	-	-	+	00.29

Species diversity of Chiton

The number of species (S) and diversity indices in the study area are given in Fig. 4. Highest number of individuals was recorded at St.3 (N= 134) and the least number of individuals were recorded at St.2 (N=94). The number of species recorded was high at St.2 (S=13) and low at St. 1 (S=9). Relatively high species richness (d=2.64) and low evenness in chiton species distribution (J= 0.6) at St.2 was found.

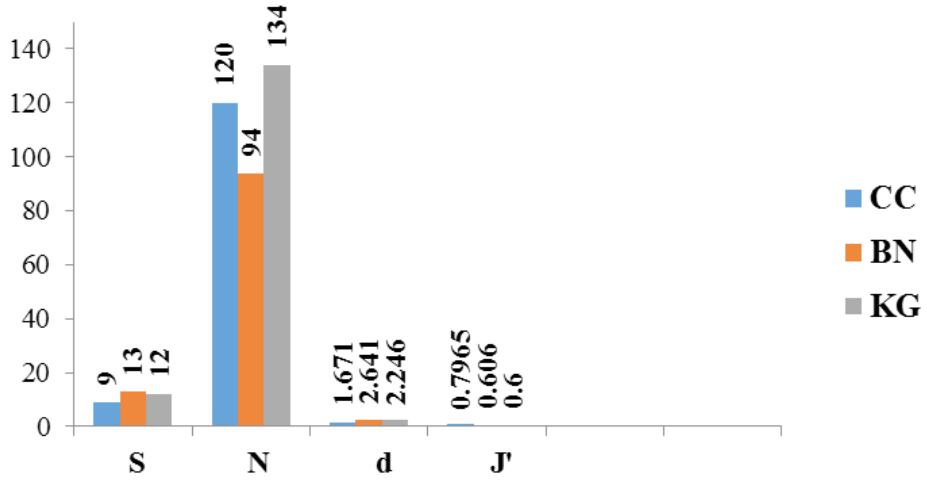

Fig. 4: Diversity indices among the stations in the study area.

(CC= Carbyns Cove; BN= Burmanallah; KG= Kodiyaghat)

luster Analysis of Chiton

From the Bray Curtis similarity, it was observed that the species composition of CC and BN were almost same showing 87% similarity while species composition of KG was different from both the stations. Based on the presence or absence of species data, the study area grouped into 2 major clusters (Fig.5).

The species *C. imitator, Acanthochitona* sp.1 and sp. 2 were common in St.1 and St. 1, 2, and 3 represented *Acanthopleura spiniger*, *Acanthopleura* sp.2, *Ischnochiton bouryi* and *I. winckworthi.* The species *Acanthochitona* sp.3 was observed only in St. 1 and *Acanthopleura* sp.1 and *Mopalia hindsii* were observed only in St. 3.

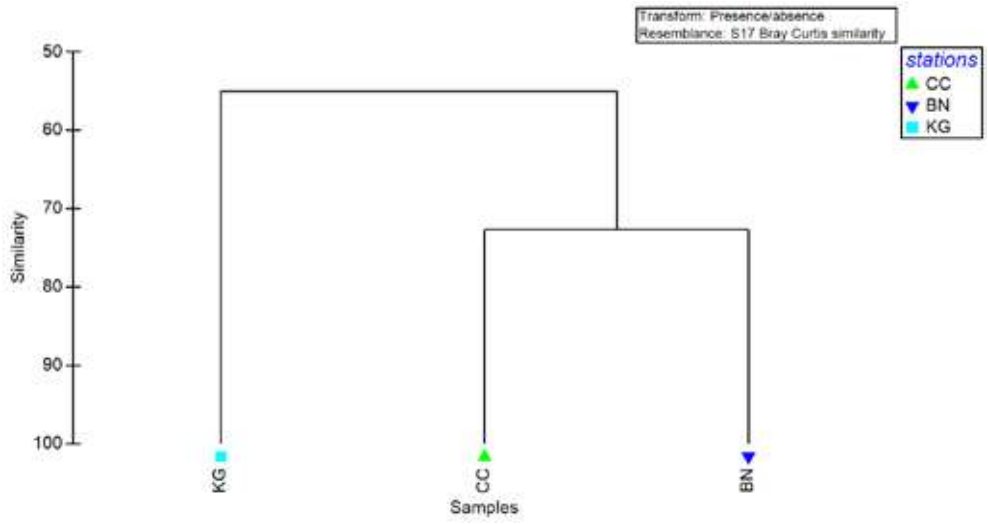

Fig.5. Bray-Curtis Similarity showing the formation of groups between stations in the study area.

CC= Carbyns Cove; BN= Burmanallah; KG= Kodiyaghat

Discussion

A total of 17 species were observed, among them 14 species were confined to the 5 genera in the present study. Two species were identified upto the level of Family and one species were not identified beyond Class. The species *Acanthopleura spiniger* was the most common species found in Kodiyaghat (St.3) and Burmanallah (St.2) followed by *Ischnochiton winckworthi* at Carbyns Cove (St.1). The species of *Acanthopleura spiniger* showed higher abundance in St.3 while St.2 showed higher diversity and abundance of the whole chiton population.

High number of species were observed in St.2 (S= 13) and St.3 (12) where algal patches were abundant. This is indicating that the access to availability of food is the major sourced for high abundance. Furthermore, chiton species at St.2 and St.3 in this study were usually exposed during the low tide in moist areas, signifying the need of O2 that are utilized by the large surface area of gills allowing them to respire in air by direct diffusion (Eernisse and Reynolds, 1994). The forward growth of the tegmentum in the larger chitons are correlated with the erosion of the superimposed umbo (Leslie and Crozler, 2010). The high chiton assemblage, abundance and species richness at St.3 (N= 134) also tallies to the type of substrata present at the stations i.e., high number of hard rock boulders compared to other stations, which has soft and brittle rocks. The variable pattern of species aggregation on different types of rocks as found in this study has also been carried out in Australia by Liversage and Benkendroff (2013). Relatively high species richness (d=2.64) and low evenness in chiton species distribution (J=0.6) at St.2 was found which could be due to the dominance of few species such as *Acanthopleura spiniger, Acanthopleura* sp.2 and *Chiton imitator* as found in this study has been reported earlier from this area (Tikader et al., 1986).

Out of the 17 species of Chitons observed in this study, *Acanthopluera* sp., especially the larger size ranging from 7.00 - 7.20 cm were found. Bigger sized chitons in the present study had more barnacles attached to its shell valve.

Conclusion

It can be concluded that chitons are an ecologically important species of the intertidal zones of the South Andaman Islands. Hence, a continuous monitoring of chitons from these areas will help in better understanding of the distribution, diversity and ecological role of this mollusk.

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Fig. 6. Photographs of the Chitons recorded in the study area