Diversity and Distribution of Common Ascidians of South Andaman

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Introduction

Andaman and Nicobar Islands is a chain of 572 islands, islets and rocky outcrops. Out of which 348 are true islands among while only 38 are inhabited, 2 islands are volcanic in nature *i.e.* Barren (active in nature) and Narcondam (inactive in nature) Islands situated at the eastern side of islands in Andaman Sea. Andaman group of islands divided into three regions; North Andaman, Middle Andaman and South Andaman. There are 2 marine National Park, 4 National Parks and 28 Sanctuaries declared in the South Andaman (Venkataraman *et al.*, 2012). **Ascidians are exclusively marine, invertebrate chordate animals found worldwide**. Ascidians of Andaman and Nicobar are least studied. These filter-feeders help in the purification of water by their feeding. Some specific ascidians are also found with association with sponge indicating the pollution free waters. Apart from their filter-feeding nature **they purify the water by accumulating heavy metals in their tunic** (Ruppert *et al.*, 2004) **and this phenomenon helps to give refuge from their predators** (Ruppert *et al.*, 2004). The available literature on ascidians of Andaman and Nicobar Islands are scanty. The recent works of Zoological Survey of India reveals only 50 species of ascidian database in this archipelago. The present paper deals with the diversity and distributional pattern of common ascidians of South Andaman.

Material and Methods

Nine places at South Andaman were surveyed during October, 2013 to February, 2015 (Table 1 and Fig. 1) employing Line Intercept Transect Method (English *et al.*, 1985) and Quadrat methods (Bakus, 1990) to explore the diversity of ascidians. Data was collected by employing Self Contained Underwater Breathing Apparatus (SCUBA) diving. Each quadrat was photographed by Canon G15 underwater camera oriented towards the start of transaction. When possible, entire quadrat was photographed in a single frame.

Table 1: Co-ordinates of surveyed areas

Sl. No.	Study areas	Latitude	Longitude
1.	Inglis Island	12º08.946'N	93º06.8261E
2.	John Lawrence Island	12°03.015'N	92°02.200'E
3.	Neil Island	11°52.112' N	093°01.052'E
4.	North Bay Island	11°41.962' N	92°45.219' E
5.	Rutland Island	11°30.119' N	92°37.112' E
6.	Riflemen Island	11°30.837' N	92°38.767' E
7.	Pongibalu	11°30.956' N	92°30.206' E
8.	South Brother Island	10°55.577' N	092°37.159'E
9.	Little Andaman Island	10°53.226' N	092° 32.060' E

Species diversity was calculated by Shannon-Weaver diversity index (H') (Shannon and Weiner, 1964), Simpson's diversity index (Simpson, 1949), Menhinick diversity index (Menhinick, 1964), Berger-Parker diversity index (Berger & Parker, 1970) and Fisher alpha diversity index (Fisher, 1925).

Fig. 1: Study areas in South Andaman

The formula for the Shannon-Weaver diversity index is:

$H' = -\sum pi \ln pi$

Where, pi = Proportion of number of individual of a particular species and total number of individual of all the species, H'= diversity of a theoretically infinite population.

The formula for the Simpson index is:

$$D = 1 - \sum_{i=1}^{s} \frac{ni\,(ni-1)}{N\,(N-1)}$$

Where S is the number of species, *N* is the total percentage cover or total number of organisms and n is the percentage cover of a species or number of organisms of a species. In this form, D ranges from 1 to 0, with 1 representing infinite diversity and 0 representing no diversity.

The formula for Menhinick diversity index is:

$d = S/\sqrt{N}$

Where, *S* = Total number of species, and *N* = Total number of individuals.

The formula for Berger-Parker diversity index is:

$d = N_{max} / N$

Where, N_{max}=number of individuals in the most abundant species, and N=total number of individuals in the sample.

The formula of Fisher alpha diversity index is:

$S = a \times \ln(1+n/a)$

Where, S=number of taxa, n=number of individuals and a=Fisher's alpha.

Evenness of the ascidian community was described by the Pielou's Evenness Index (J'). The formula of the index (Pielou, 1966) is:

$J' = H'/H'_{max}$

Where H' is the number derived from the Shannon diversity.

Margalef's community index (Margalef, 1968) was calculated by using the following formula below:

$d = S\text{-}1/\log N$

Where, *S* = Total number of species, and *N* = Total number of individuals.

Similarity Index is the simple measure of the extent to which two habitats species in common. The Sørensen index is a statistic used for comparing the similarity of two samples (Sørensen, 1948). It has been formulated below:

$QS = (2C/A + B)$

Where, *A* and *B* are the species numbers in samples A and B, respectively, and C is the number

Table 2: Distribution of Ascidians in surveyed areas of South Andaman

Sl. No.	Species Name	IN	JNL	NL	NB	PB	RFL	RL	SB	LA
1.	*Didemnum molle* (Herdman, 1886)	-	-	+	+	+	-	+	+	+
2.	*Lissoclinum bistratum* (Sluiter, 1905)	-	-	-	-	-	-	-	-	+
3.	*Lissoclinum fragile* (Van Name, 1902)	-	-	-	-	-	-	-	-	+
4.	*Eudistoma gilboviride* (Sluiter, 1909)	-	-	-	+	-	+	+	-	+
5.	*Aplidium multiplicatum* Sluiter, 1909	-	-	+	-	-	-	-	-	-
6.	*Aplidium pliciferum* (Redikorzev, 1927)	-	-	+	-	-	-	-	-	-
7.	*Clavelina moluccensis* (Sluiter, 1904)	-	-	+	-	-	-	-	-	-
8.	*Clavelina robusta* (Kott, 1990)	-	-	-	-	+	-	+	-	-
9.	*Rhopalaea macrothorax* (Tokioka, 1953)	+	+	-	-	+	+	+	-	-
10.	*Ascidia conchilega* (Muller, 1776)	-	-	-	-	-	-	-	+	-
11.	*Ascidia sydneiensis* (Stimpson, 1855)	-	-	+	-	-	-	-	-	-
12.	*Phallusia arabica* (Savigny, 1816)	+	+	+	-	-	+	+	+	+
13.	*Phallusia mammillata* (Cuvier, 1815)	-	-	+	-	+	+	+	-	+
14.	*Phallusia nigra* (Savigny, 1816)	-	-	-	+	-	-	-	-	-
15.	*Polycarpa pigmentata* (Herdman, 1906)	-	+	+	+	-	-	+	+	+
16.	*Eusynstyela latericius* (Sluiter, 1904)	-	-	-	-	-	-	-	+	-
17.	*Eusynstyela misakiensis* (Watanabe & Tokioka, 1972)	-	-	+	-	+	+	+	-	-
18.	*Pyura vittata* (Stimpson, 1852)	-	-	+	-	-	-	+	-	+
19.	*Pyura curvigona* Tokioka, 1950	-	-	-	+	-	-	-	-	-
20.	*Microcosmus exasperatus* Heller, 1878	-	-	-	+	-	-	-	-	-
21.	*Herdmania momus* (Savigny, 1816)	-	-	+	+	+	-	-	-	+
22.	*Herdmania pallida* (Heller, 1978)	-	-	+	+	+	-	+	+	+
23.	*Halocynthia dumosa* (Stimpson, 1855)	-	-	+	+	-	-	-	-	+
		2	3	13	9	7	5	10	6	11

[IN-Inglis Island, JNL-John Lawrence Island, NL- Neil Island, NB-North Bay Island, PB-Pongibalu, RL-Rutland Island, RfL-Riflemen Island, SB-South Brother Island,LA-Little Andaman Island]

of species shared by the two samples. This expression is easily extended to abundance instead of incidence of species.

Results

Epitome of the study revealed out a total of 23 species of ascidians (Table 2 & Plate 1) was identified from 9 different area of South Andaman. Among these areas maximum species (13) of ascidians species were observed from Neil Island and minimum species (2) at Inglis Island. None of the species is common at all the places of study as all the species shown different degree of distribution.

Shannon-Weaver diversity index (H') is maximum (1.66) at North Bay while minimum (0.23) at the South Brother Island (Fig. 2). Menhinick Diversity Index also displayed the

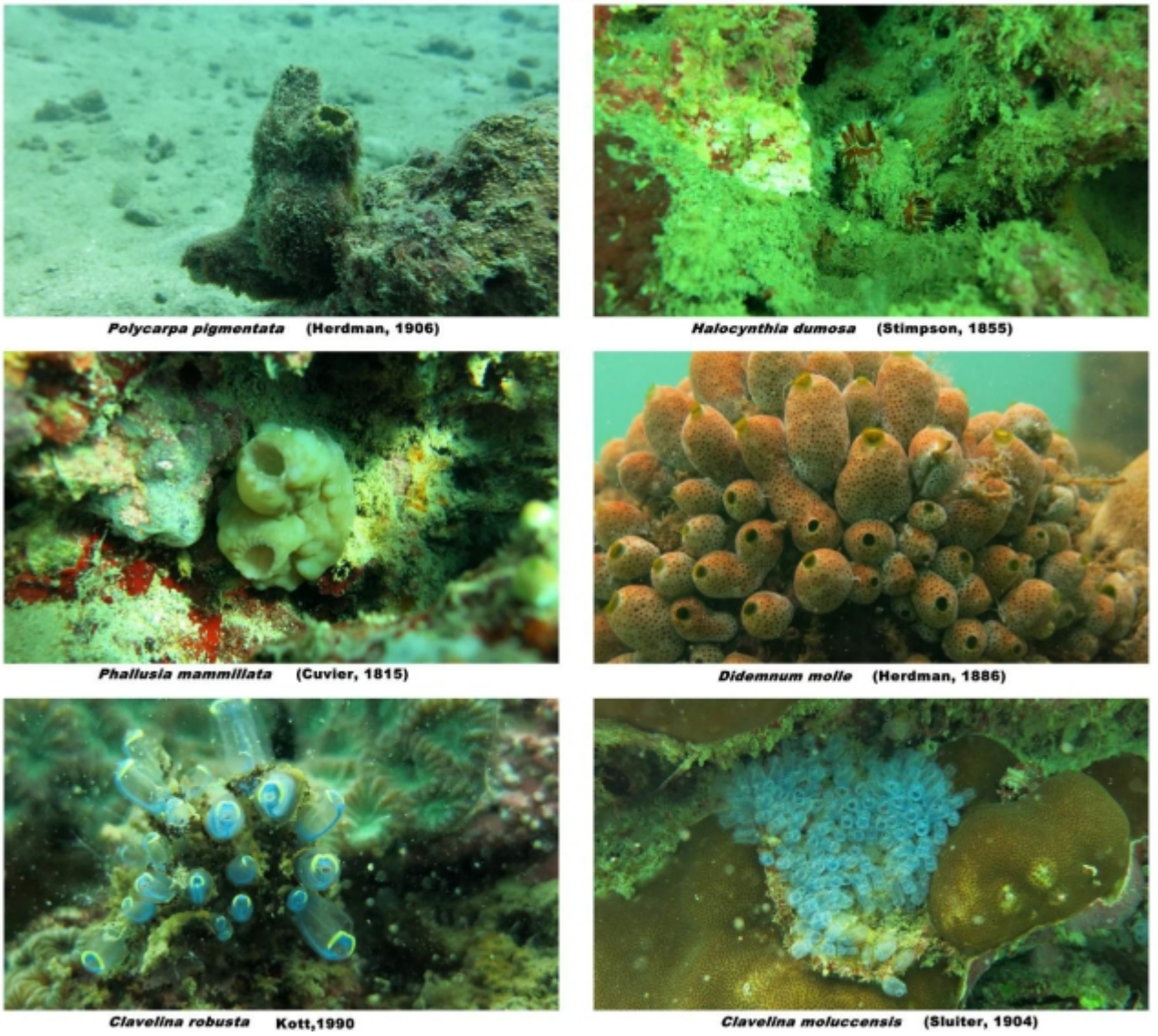

Plate 1: Some common Ascidians of South Andaman

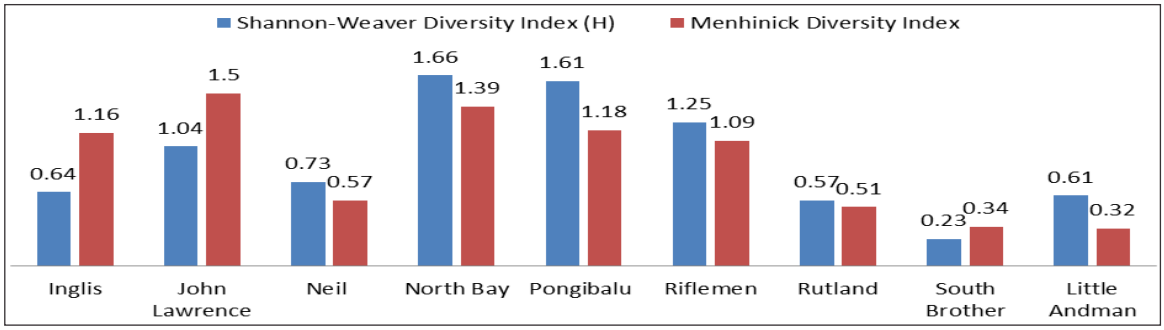

Fig. 2: Garphical representation of Shannon-Weaver Diversity Index and Menhinick Diversity index.

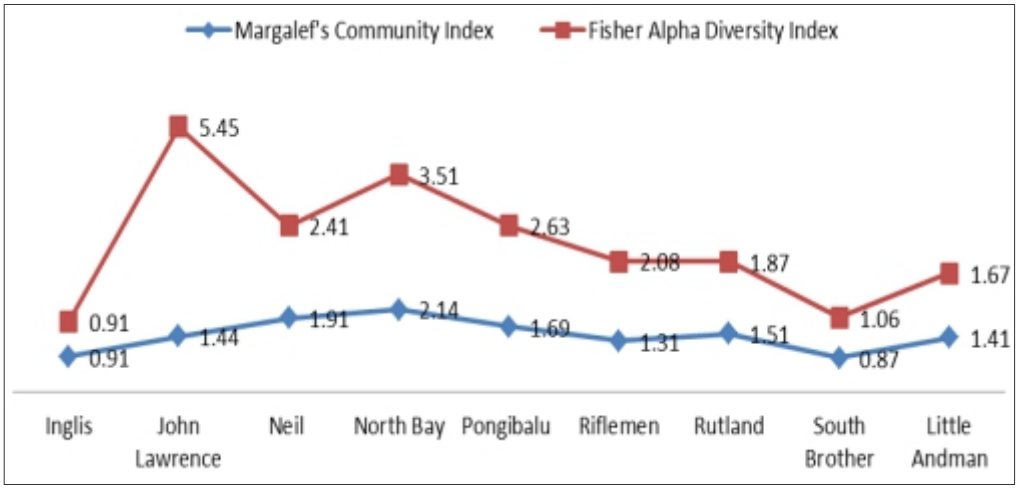

Fig. 3: Garphical representation of Margalef's Community Index and Fisher Alpha Diversity index.

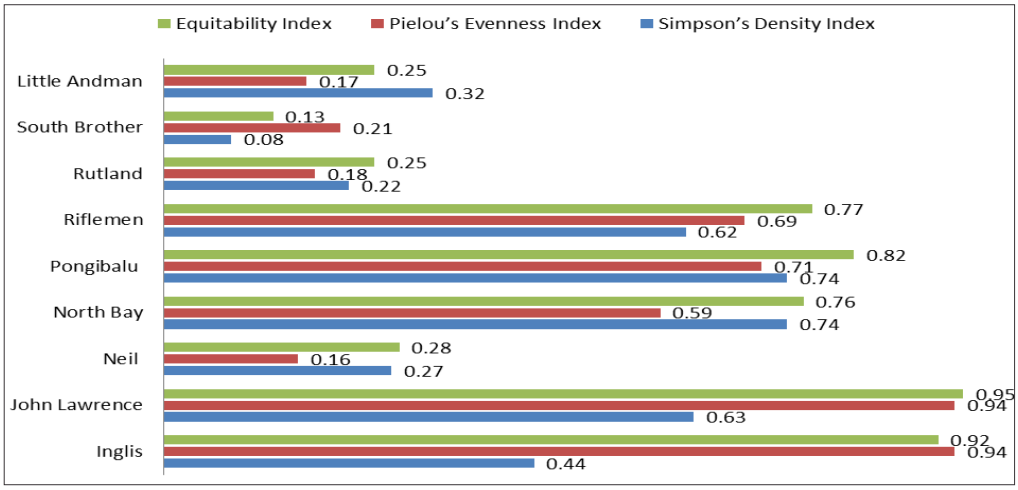

Fig. 4: Garphical representation of Equitability Index, Pielou's Evenness Index and Simpson's Diversity index.

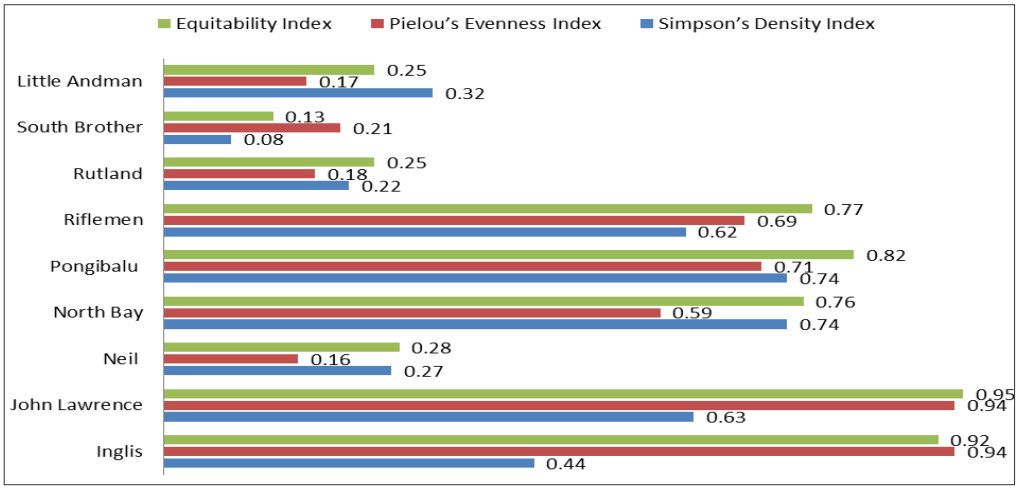

Fig. 5: Garphical representation of Dominance Index and Berger-Parker Diversity index.

Table 3: Species Similarity Index (%) between the surveyed areas of South Andaman

Island Name	John Lawrence Island	Neil Island	North Bay Island	Pongibalu	Riflemen Island	Rutland Island	South Brother Island	Little Andaman Island
Inglis Island	80	13.33	-	22.22	57.14	33.33	25	15.38
John Lawrence Island		28.57	16.67	20	50	46.15	44.44	28.57
Neil Island			50	33.33	37.5	60.89	42.11	66.67
North Bay Island				37.5	14.29	42.11	40	60
Pongibalu					50	70.59	30.77	44.44
Riflemen Island						66.67	18.18	37.50
Rutland Island							50	66.67
South Brother Island								47.06

maximum value (1.39) at North Bay while minimum (0.32) at Little Andaman Island (Fig. 2).

Fisher Alpha Diversity Index exhibited the highest value (5.45) at John Lawrence although displaying the minimum value (1.06) at South Brother Island (Fig. 3) while Margalef's Community Index displayed the maximum value (2.14) at North Bay Island and the minimum value (0.87) at South Brother Island (Fig. 3).

Simpson's Density Index displayed the highest value (0.74) at North Bay and Pongibalu and the lowest value (0.08) found from South Brother Island (Fig. 4). Pielou's Evenness Index (Fig. 4) represents the highest value (0.94) from John Lawrence Island and Inglish Island while Equitability Index represent the highest value (0.96) at John Lawrence Island and second highest value (0.92) from Inglis Island and lowest value (0.15 and 0.13) at Neil and South Brother Island (Fig. 4) respectively.

Both the Dominance Index and Berger-Parker Diversity Index represent the highest value (0.92 and 0.96 respectively) at South Brother Island and lowest value (0.26 and 0.40 respectively) at North Bay (Fig. 5).

Similarity Index (S) has been calculated and the values are illustrated in Table 3. The maximum percentage of similarity (80) was observed between John Lawrence Island and Inglis Island and no similarities found between North Bay and Inglis Island. As the number of species was less found in Inglis Island and John Lawrence Island it is very obvious that the similarity with other places will be low. Species similarities in most of the areas are ranging between 60 to 40%.

Discussion

Ascidians play a great role in reef ecosystem as it exhibits the allelopathic relationships with other reef inhabiting invertebrates (Jackson and Buss, 1975). Being bio-fouling in nature, ascidians are also found on the crabs and other organisms providing a strong base including on other ascidians. Ascidians have symbiotic relationships with amphipods, shrimps and other very small invertebrates, as these organisms inhabit in ascidians branchial sac and helps to keep clean the branchial sac while ascidians provide them a predator free environment. Ascidians of Andaman and Nicobar Islands are mainly reef associated though some are found on the sandy sea bottom, however, their occurence is very low. Venkataraman *et al.* (2012) reported 7 ascidians from Andaman and Nicobar Islands. Present survey showed that the maximum (13) of the species of ascidians were found from the Neil

Island and minimum (2) from Inglis Island, out of 23 ascidian species reported. However, due to the high density of *Didemnum molle* (which is very common in whole Andaman and Nicobar Islands), diversity of ascidians varies greatly as the diversity depends on the species richness as well as evenness of species abundance and that can be observed from the diversity indices. It is found that where the density of *Didemnum molle* is less or absent, diversity of other ascidian species found in resemble number. Similarity index exhibits a high similarity (80%) between the nearby localities *i.e.* Inglis Island and John Lawrence Islands. The present study suggested that extensive surveys are required to explore the ecological aspects of these cryptic creatures of Andaman and Nicobar Islands.

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"The great challenge of the twenty-first century is to raise people everywhere to a decent standard of living while preserving as much of the rest of life as possible."

– Edward O. Wilson