RESEARCH ARTICLE

Habitat Destruction and Ascidian Biodiversity Loss - An Assessment

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ABSTRACT

Intertidal rocky shores offer good substratum and habitat for sedentary animals accounting for the rich biodiversity. Destruction of coastal habitat by way of industrialization, port expansion activities and construction of tourist spots results in loss of marine resources. The present review focuses the loss of ascidian biodiversity from the intertidal rocky area situated near the western side of the Thoothukudi harbour North breakwater opposite to the SPIC Jothi terminal. Publications reporting the collection and biodiversity of ascidians from this area between 1980 and 2015 were reviewed in the context of destruction to the habitat. The study indicated the occurrence of 24 species of ascidians belonging to 14 genera coming under 7 families over the period of 35 years. Colonial ascidians were predominant compared to simple ascidians. *Eudistoma lakshmiani*, *Eudistoma viride*, *Didemnum psammathodes*, *Diplosoma swamiensis*, *Lissoclinum fragile*, *Perophora formosona*, *Botrylloides chevalense*, and *Microcosmus curvus* were available all through the years. The destruction of the habitat in this area has resulted in the total disappearance of marine resources and hence loss of ascidian biodiversity.

Key words: Ascidian, biodiversity, intertidal rocky area and habitat destruction.

INTRODUCTION

The Gulf of Manaar coast extending from Rameswaram to Kanyakumari is predominated by calcrete and solid rocks. These rocky shores are model natural laboratories to learn the ecology of intertidal habitat as they are environmentally rich with great biodiversity. Complex intertidal rocky habitats provide many different spatial niches. The surface of rock exposed to strong beating surf offers a stable anchorage to many sedentary organisms. Most intertidal sedentary animals are filter feeders which can actively feed only when they are covered by seawater. The cracks and crevices in the rocks and boulders form dynamic microhabitats that provide shelter from dehydration on

exposure to sun, wind and afford protection from breaking waves and a safe hide out from larger predators. They are abundant on the under surface of rocks where they are submerged for longer time. The widely changing abiotic condition in the intertidal zone is a significant factor in creating a large number of ecological niches. Adaptations of different species to withstand the biotic interactions like predation and competition are the factors that lead to zonation on the rocky shore. The coastal zone is rich with respect to nutrients in the form of phyto and zooplankton. Different species of filter feeding animals like mussels, oysters, bryozoans, sea squirts, anemones and barnacles are supported by this plentiful food supply. This allows them to grow rapidly and produce many offspring. Habitat degradation caused by rapidly expanding coastal development is a direct threat to coastal marine biodiversity. Construction activities between low and high tide line have serious implications on species diversity and abundance. Destruction causes instant harm to habitat, loss of resources such as food and mates, kills many species in the process resulting in loss of biodiversity. The present review focuses the status of the species composition and loss of ascidian biodiversity in the intertidal rocky shore of Thoothukudi coast over a period of 35 years from 1980 to 2015.

Literature Servey indicates that the study area has been a paradise for many marine biologists. Researchers and students from various institutions all over India have been visiting this place for collection of marine fauna, flora and study of intertidal rocky habitat as a part of their curriculum. Till recently 40 papers have been published on various aspects like taxonomy, embryology, breeding, fouling, ecology, biology, distribution and seasonal variation in the occurrence, nutritive value, antimicrobial, pharmacology, cytotoxicity, antifouling, chemical investigation and DNA bar coding of ascidians collected from this area (Renganathan 1981, 1982, 1983a,b,c, 1984a,b,c; Renganathan and Krishnaswamy 1985; Renganathan 1986a,b; Krishnan *et al*., 1989; Meenakshi 1997; Meenakshi, 2000, 2004, 2008; Meenakshi *et al*., 2003; Meenakshi and Senthamarai 2013; Renganathan 1983d,e,f, 1984d; Paripooranaselvi, 2013; Meenakshi, 2010; Tamilselvi 2008; Tamilselvi *et al*., 2011; Ajithakumary 1994; Meenakshi 2009; Sri Kumaran and Bragadeeswaran 2014; Sri Kumaran *et al*., 2011, 2012, 2014a; Raja Priyanka Mary *et al*., 2016; Santhana Ramasamy and Senthil Kumar 2009; Rajesh and Murugan 2013, 2015; Santhana Ramasamy and Murugan 2003; Meenakshi *et al*., 2013; Veerabahu *et al*., 2013; Sri Kumaran *et al*., 2014b).

MATERIALS AND METHODS

Study area:

In the context of review on habitat destruction and loss of biodiversity, the intertidal rocky shore spread over an area of 1000 m^2 situated near the western side of the outer 4098.66 m long Thoothukudi harbour North breakwater (Latitude 8° 47’ 10” N and Longitude 78° 9’ 60” E) opposite to the SPIC Jothi terminal was selected (Fig. 1). This area is in continuation with the sandy coastal stretch leading to the Hare Island, one of the islands of Gulf of Mannar in the southeast coast of India. The habitat is predominated by loose calcrete rocks and large coral *Diplosoma macdonaldi* stones with scattered embedded rocks and is mostly free from anthropogenic activities though a few country boats

Fig. 1: Study area before 2016

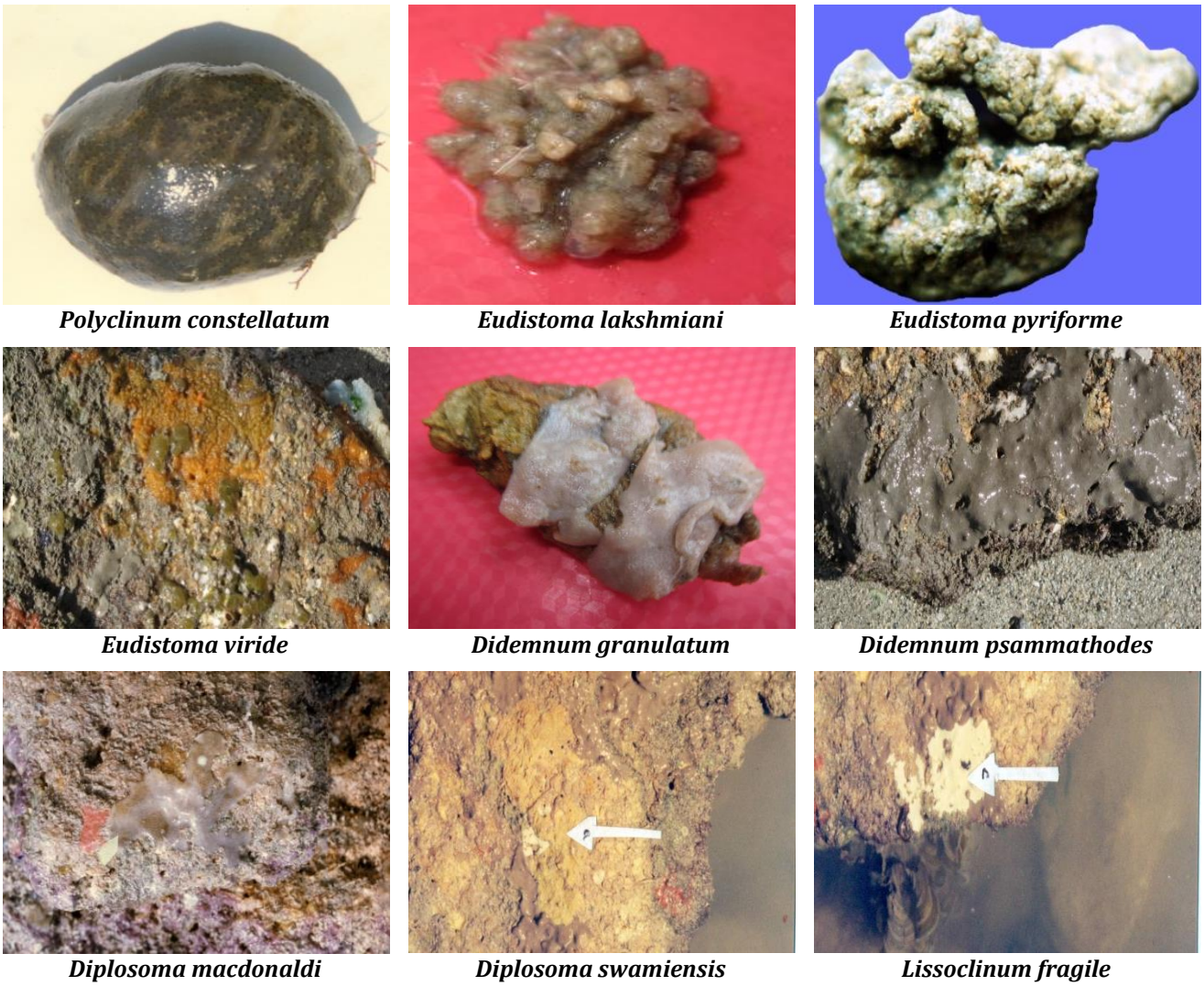
Fig. 2: Study area - 2016

operated from here in early 1990. With moderate wind and wave action, this shallow littoral zone anchors numerous sedentary animals including ascidians and is exposed more than ½ a km during the lowest low tides. In addition to the sedentary animals, other fauna including flat worms, annelids, arthropods, molluscs and echinoderms were available in plenty in this study area. Research papers on ascidian collection and biodiversity of this area published between the years 1980 - 2015 has been considered here for review. Field visit to the study area was also carried out in the early 2016.

RESULTS AND DISCUSSION

The Ascidiacea are a class of the subphylum Tunicata of phylum Chordata. Class Ascidiacea includes two orders. They are Enterogona and Pleurogona. Aplousobranchia and Phlebobranchia, are the two suborders of Enterogona and suborder Stolidobranchia of Pleurogona. A review of research papers on ascidian collection and biodiversity of the study area published since 1980 revealed the following. During 1980 to 1989, 11 species of ascidians belonging to 9 genera coming under 5 families were reported. Of these 10 were colonial ascidians - *Eudistoma lakshmiani*, *Eudistoma viride*, *Didemnum psammathodes*, *Diplosoma swamiensis*, *Lissoclinum fragile*, *Ecteinascidia imperfecta*, *Ecteinascidia krishnani*, *Perophora formosona*, *Botrylloides chevalense*, *Botrylloides magnicoecum* and one was simple ascidian *Microcosmus curvus* (Renganathan 1981, 1982, 1983a,b,c, 1984a,b,c, Renganathan and Krishnaswamy 1985, Renganathan 1986a,b).

13 species of ascidians belonging to 11 genera coming under 6 families were recorded from 1990 - 1999. Out



Polyclinum constellatum ***Eudistoma lakshmiani*** ***Eudistoma pyriforme***

Eudistoma viride ***Didemnum granulatum*** ***Didemnum psammathodes***

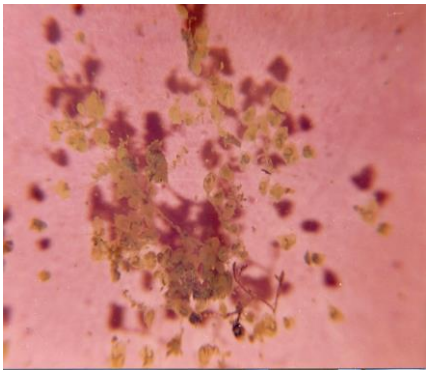
Diplosoma macdonaldi ***Diplosoma swamiensis*** ***Lissoclinum fragile***

Fig. 3: Ascidian biodiversity of the study area

Tridemnum clinides

Ecteinascidia garstangi

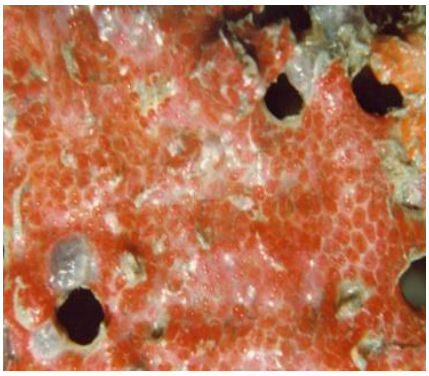
Ecteinascidia venue



Perophora formosana

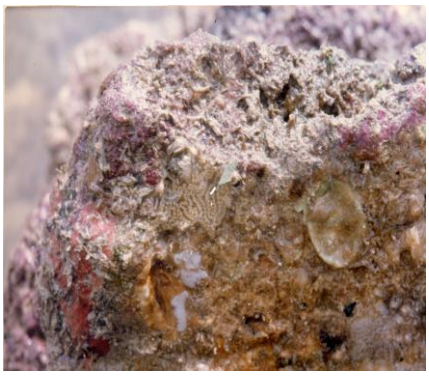
Ascidia gemmata

Styela canopus



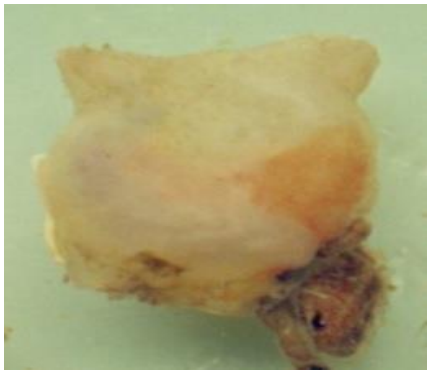
Symplegma oceania

Symplegma viride



Botrylloides chevalense

Botrylloides magnicoecum



Herdmania momus

Microcosmus curvus

Fig. 3 continued : Ascidian biodiversity of the study area

Table 1: Ascidian biodiversity of the study area from 1980 to 2015

	Classification	**S/C**	**1980-1989**	**1990-1999**	**2000-2009**	**2010-2015**
	Class Ascidiacea					
	Order I Enterogona Perrier, 1898					
	Suborder I Aplousobranchia Lahille, 1887					
	Family 1 Polyclinidae Milne-Edwards, 1841					
	Genus 1 *Polyclinum* Savigny, 1816					
1.	*Polyclinum constellatum* Savigny, 1816	C	-	-	+	-
	Family 2 Polycitoridae Michaelsen, 1904					
	Genus 2 *Eudistoma* Caullery, 1909					
2.	*Eudistoma lakshmiani* Renganathan, 1986	C	+	+	+	+
3.	*Eudistoma pyriforme* Herdman, 1886	C	-	-	+	+
4.	*Eudistoma viride* Tokioka, 1955	C	+	+	+	+
	Family 3 Didemnidae Giard, 1872					
	Genus 3 *Didemnum* Savigny, 1816					
5.	*Didemnum granulatum* Tokioka, 1954	C	-	-	-	+
6.	*Didemnum psammathodes* (Sluiter, 1895)	C	+	+	+	+
	Genus 4 *Diplosoma* Macdonald, 1859					
7.	*Diplosoma swamiensis* Renganathan, 1986	C	+	+	+	+
8.	*Diplosoma macdonaldi* Herdman, 1886	C	-	+	-	-
	Genus 5 *Lissoclinum* Verrill, 1871					
9.	*Lissoclinum fragile* (Van Name, 1902)	C	+	+	+	+
	Genus 6 *Tridemnum* Della Valle, 1881					
10.	*Tridemnum clinides* Kott, 1977	C	-	-	+	+
	Suborder II Phlebobranchia Lahille, 1887					
	Family 4 Perophoridae Giard, 1872					
	Genus 7 *Ecteinascidia* Herdman, 1880					
11.	*Ecteinascidia garstangi* Sluiter, 1898	C	-	+	-	-
12.	*Ecteinascidia imperfecta* Tokioka, 1950	C	+	-	-	-
13.	*Ecteinascidia krishnani* Renganathan & Krishnaswamy, 1985	C	+	-	+	+
14.	*Ecteinascidia venui* Meenakshi, 2000	C	-	-	+	-
	Genus 8 *Perophora* Wiegmann, 1835					
15.	*Perophora formosana* Oka, 1931	C	+	+	+	+
16.	*Perophora multiclathrata* (Sluiter, 1904)	C	-	-	+	-
	Family 5 Ascidiidae Adams and Adams, 1858					
	Genus 9 *Ascidia* Linnaeus, 1767					
17.	*Ascidia gemmata* Sluiter, 1895	S	-	+	-	-
	Order II Pleurogona Perrier, 1898					
	Suborder III Stolidobranchia Lahille, 1887					
	Family 6 Styelidae Sluiter, 1895					
	Subfamily I Styelinae Herdman, 1881					
	Genus 10 *Styela* Fleming, 1822					
18.	*Styela canopus* Savigny, 1816	S	-	-	+	-
	Subfamily II Polyzoinae Hartmeyer, 1903					
	Genus 11 *Symplegma* Herdman, 1886					
19.	*Symplegma oceania* Tokioka, 1961	C	-	-	+	+
20.	*Symplegma viride* Herdman, 1886	C	-	+	-	-

Table 1: Continued…

	Classification	S/C	1980-1989	1990-1999	2000-2009	2010-2015
	Subfamily III Botryllinae Hartmeyer, 1903					
	Genus 12 *Botrylloides* Milne-Edwards, 1841					
21.	*Botrylloides chevalense* Herdman, 1906	C	+	+	+	+
22.	*Botrylloides magnicoecum* Hartmeyer, 1912	C	+	-	+	-
	Family 7 Pyuridae Hartmeyer, 1908					
	Genus 13 *Herdmania* Lahille, 1888					
23.	*Herdmania momus* Savigny, 1816	S	-	+	-	-
	Genus 14 *Microcosmus* Heller, 1878					
24.	*Microcosmus curvus* Tokioka, 1954	S	+	+	+	+
Total			**11**	**13**	**17**	**13**

of these 10 species were colonial ascidians - *Eudistoma lakshmiani*, *Eudistoma viride*, *Didemnum psammathodes*, *Diplosoma macdonaldi*, *Diplosoma swamiensis*, *Lissoclinum fragile*, *Ecteinascidia garstangi*, *Perophora formosona*, *Symplegma viride*, *Botrylloides chevalense* and 3 were simple ascidians - *Ascidia gemmata*, *Herdmania momus* and *Microcosmus curvus* (Meenakshi 1997).

A maximum diversity of 17 species of ascidians belonging to 12 genera coming under 6 families including 15 colonial ascidians - *Polyclinum constellatum*, *Eudistoma lakshmiani*, *Eudistoma pyriforme*, *Eudistoma viride*, *Didemnum psammathodes*, *Diplosoma swamiensis*, *Lissoclinum fragile*, *Trididemnum clinides*, *Ecteinascidia krishnani*, *Ecteinascidia venui*, *Perophora formosona*, *Perophora multiclathrata*, *Symplegma oceania*, *Botrylloides chevalense*, *Botrylloides magnicoecum* and two simple ascidians *Styela canopus*, *Microcosmus curvus* were observed during 2000 - 2009 (Meenakshi 2000, 2004, 2008, Meenakshi *et al*., 2003)

Among the 13 species of ascidians belonging to 10 genera coming under 5 families collected during 2010 - 2015, 12 of them were colonial - *Eudistoma lakshmiani*, *Eudistoma pyriforme*, *Eudistoma viride*, *Didemnum granulatum*, *Didemnum psammathodes*, *Diplosoma swamiensis*, *Lissoclinum fragile*, *Trididemnum clinides*, *Ecteinascidia krishnani*, *Perophora formosona*, *Symplegma oceania*, *Botrylloides chevalense* and one was simple ascidian *Microcosmus curvus* (Meenakshi and Senthamarai 2013).

An overall consolidation of the ascidian biodiversity of the study area from 1980 to 2015 indicated 24 species of ascidians belonging to 14 genera coming under 7 families (Fig. 3). Of these, 20 species were colonial - *Polyclinum constellatum*, *Eudistoma lakshmiani*, *Eudistoma pyriforme*, *Eudistoma viride*, *Didemnum granulatum, Didemnum psammathodes*, *Diplosoma macdonaldi*, *Diplosoma swamiensis*, *Lissoclinum fragile*, *Trididemnum clinides*, *Ecteinascidia garstangi*, *Ecteinascidia imperfecta*, *Ecteinascidia krishnani*, *Ecteinascidia venui*, *Perophora formosona*, *Perophora multiclathrata*, *Symplegma oceania*, *Symplegma viride*, *Botrylloides chevalense*, *Botrylloides magnicoecum* and the remaining 4 were simple ascidians - *Ascidia gemmata*, *Styela canopus*, *Herdmania momus* and *Microcosmus curvus*. Colonial ascidians were predominant compared to simple ascidians. *Eudistoma lakshmiani*, *Eudistoma viride*, *Didemnum psammathodes*, *Diplosoma swamiensis*, *Lissoclinum fragile*, *Perophora formosona*, *Botrylloides chevalense*, and *Microcosmus curvus* were available all through the years. A field visit to the study area in early 2016 indicated destruction of the habitat which was once upon a time a paradise of marine biologists (Fig. 2). The entire intertidal rocky habitat was buried, completely covered with sand and gravel, the seacoast pushed back and protected by large boulders leading to the loss of the rich marine biodiversity including that of ascidians of this area.

In general, marine organisms provide ingredients for food, cosmetics, industrial chemicals, dyes and host of other valuable products. Among these, ascidians play a significant role in the ecology of the marine environment as they form natural prey to nudibranchs, flatworms, molluscs, crabs, star fishes, fishes, birds and aquatic mammals substantiating their importance in the food chain and food web. Ascidians

are a delicacy to human beings and they form a part in the diet of commercial fishes. Their capacity of filtering the water causes them to accumulate pollutants making them sensitive bioindicators. Elimination of ascidians that filter sediments and pollutants can lead to reduction in water quality with an indirect impact on human health. To add up ascidians are valuable as they occupy an interesting position acting as a connecting link between the invertebrates and chordates. In addition to their ecological and evolutionary importance, ascidians are model organisms for studying the embryology of chordates and excellent materials for studies on regeneration, microbiology, immunology, asexual reproduction, colony organization, isolation of secondary metabolites with pharmaceutical potential. Medical applications of bioactive compounds identified from ascidians have gained much attention with the introduction of ET -743 with trade mark Yondelis in the treatment of soft tissue sarcoma. It is suggested that conservation of biodiversity should become an integral part while implementing and managing developmental activities.

Conflicts of interest: The authors stated that no conflicts of interest.

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