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Distribution of Alien Tunicates (Ascidians) in Tuticorin Coast, India

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Abstract: Ascidians or tunicates are dominant members of many sessile marine communities throughout the world. They are sedentary, efficient filter feeders having hermaphrodite gonads and their larval stages are planktonic contributing to dispersal of species. In the past decade many aquatic invasive species have been introduced into Indian coastal waters resulting in alteration of ecosystem at various levels. Hence the present study focused on the invasive species of the tunicates in different sites of Tuticorin coast, India. A total of 32 ascidian species have been identified at four stations situated along the Tuticorin coast. Of the 32 species, 22 species are believed to be invasive / alien, which include 10 simple and 12 colonial ascidians. The occurrence of alien tunicates are more at Station 1 (72%) followed by Station 3 (71%), Station 4 (67%),and Station 2 (55%). The present study suggested that a thorough long term study is needed to assess the impact of alien on native species.

Key words: Alien / Invasive ascidians · Tuticorin coast · India

INTRODUCTION

Introduction of non-indigenous species into new regions, fortuitously or intentionally, causing severe threats to marine biodiversity. Increasing global trade and sea transportation contribute to the blending of variety of flora and fauna across biogeographical boundaries. Number of marine organisms such as marine alga *Monostroma oxyspermum* native to Atlantic and Northwest Pacific [1], hydroid *Mercierella enigmata* native to Australia [2], mussel *Mytilopsis sallei* from Atlantic waters [3], wood-borer *Lyrodus medilobata* from New Zealand [4] and barnacles *Balanus amphitrite hawaiiensis* from Malay Archipelago and Persian Gulf [5] are translocated into Indian coastal waters. Eventhough a number of marine organisms translocated from various parts of the world, little information exists from Indian coastal waters regarding the distribution of invasive/alien ascidian species [6,7]

Tuticorin is well known for pearl fishing and fishing centre in the southern peninsular region. Tuticorin port is one of the 12 major ports in India, in particular the second largest in Tamilnadu and has the greatest volume of exports and imports. During cargo handling, ship's hull is very important potential source for the introduction of non-native species and these species affects the quality and quantity of cultured organisms causing economical loss to the aquaculturers [8]. Many ascidians are highly invasive, can spread rapidly to new habitats [9,10], damage coastal installation [11], displace the local species [12] and affect community structure [13]. Hence the present study is aimed to identify and understand the presence and distribution of alien ascidian species from the four different ecologically significant stations along Tuticorin coastal waters. The current survey is the first of its kind at Tuticorin coast to assess the distribution of nonindigenous ascidian in different sites. This baseline data at regional level is of great importance since it will provide tools for estimating the invasion rates and possible effects on the natural fauna at the invaded site in the years to come.

MATERIALS AND METHODS

In the present study, four intertidal stations situated along the Tuticorin coast (Figures 1 and 2) were selected for sampling during low tides. Samples were collected for one year from August 2007 to July 2008 and the collected

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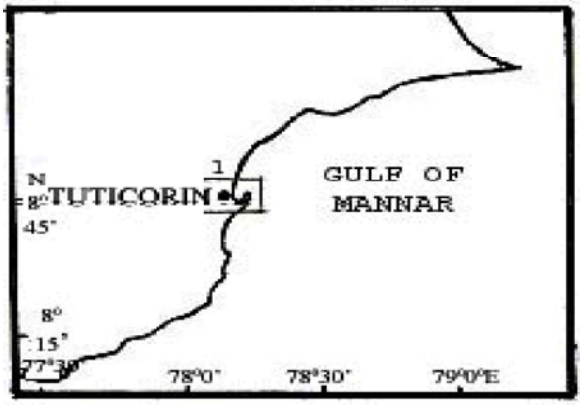

Fig. 1: Showing the study area Tuticorin in Gulf of Mannar.

Fig. 2: Showing Station 1, 2, 3and 4 in Tuticorin coast.

materials were submerged in fresh seawater and left to stand for about an hour without any disturbance. A pinch of menthol crystals was then added to the corner of the tray for narcotization. Samples were then left undisturbed for two to three hours after which they were preserved in 10% formalin in sea water for identification. The preserved samples were identified up to species level by using classification chart [14-16] and the identified species were categorized into native or alien based on available literature and the website (www.sealifebase.org).

RESULTS

Totally 32 ascidian species were recorded from four different stations in Tuticorin coastal waters (Table1). Of these, 22 species which include 10 (45%) simple ascidians and 12 (55%) colonial ascidians were believed to be invasive/alien. Ten species such as *Ecteinascidia venui, E. krishnani, Distaplia nathensis, Diplosoma swamiensis, Lissoclinum fragile, Eudistoma lakshmiani, E. laysani, Polyclinum indicum*, *P.madrasensis* and *Aplidium indicum* were native to Indian coastal waters.

Table 1: Distribution of Invasive/Alien and native Ascidian species at Station 1, 2, 3 and 4 during the year August 2007 to July 2008

S. no	Species	S/C	Station 1	Station 2	Station 3	Station 4
FAMILY: ASCIDIDAE						
1	*Ascidia sydneiensis* Stimpson,1855	S	A			
2	*A. gemmata* Sluiter 1895	S	A			
3	*Phallusia nigra* Savigny,1816	S	A			
4	*P. arabica* Savigny,1816	S	A			
5	*P. polytrema* Herdman,1906	S	A			
FAMILY: PYURIDAE						
6	*Herdmania pallida* Savigny,1816	S	A			
7	*Microcosmus curvus* Tokioka, 1954a	S	A	A		A
8.	*M. squamiger Michaelsen, 1927*	S	A			
9.	*M. exasperatusHeller, 1878*	S	A			
FAMILY: PEROPHORIDAE						
10	*Ecteinascidia venui* Meenakshi,1999	C	N			
11	*E.krishnani* Renganathan and Krishnaswamy,1985	C		N		
12	*Perophora formosana(* Oka,1931)	C	A			A
FAMILY: STYELIDAE						
13	*Eusynstyela tincta* Van Name, 1902	C	A			
14	*Styela canopus* (Savigny,1816)	S	A	A		A
15	*Symplegma oceania* Tokioka,1961	C	A		A	A
16	*S. viride Herdman, 1886*	C			A	
17	*Botrylloides magnicoecum* Hartmeyer.1912	C	A		A	A
18	*B. leachi*i (Savigny,1816)	C			A	
19	*B. chevalensis* Herdman,1906	C		A		

Table 1: Continued

FAMILY; HOLOZOIDAE						
20	*Distaplia nathensis* Meenachi, 1997	C	N			
FAMILY:DIDEMNIDAE						
21	*Diplosoma swamiensis* Renganathan,1986c	C	N	N		N
22	*Didemnum psammatodes* (Sluiter,1895)	C	A	A	A	
23	*Lissoclinum fragile* (Van Name,1902)	C	A	A		A
24	*Tridemnum clinides* Kott,1977	C	A	A		A
25	*T. savignii(Herdman,1886)*	C	A			
FAMILY: POLYCITORIDAE						
26	*Eudistoma lakshmiani* Renganathan, 1986	C				N
27	*E. viride* Tokioka,1955	C		A		
28	*E. laysani (Sluiter, 1900)*	C	A			
FAMILY: POLYCLINIDAE						
29	*Polyclinum indicum* Sebastian, 1954	C		N	N	
30	*P. madrasensis* Sebastian, 1952	C	N	N	N	
31	*Aplidium indicum(Renganthan and Monniot, 1984*	C	N			
32	*A. multiplicatum Sluiter, 1909*	C	A			

A-Alien species N-Native species S-Simple ascidian C-Colonial ascidian

Table 2: Distribution of Invasive/ Alien ascidian species.

S. no	Species	Distribution
FAMILY: ASCIDIDAE		
1	*Ascidia sydneiensis* Stimpson,1855	Indo-Pacific and Atlantic ocean, Sub Antarctic region, East South America
2	*A. gemmata* Sluiter 1895	Indo-West Pacific
3	*Phallusia nigra* Savigny,1816	Panama, USA, Indo-Pacific, Atlantic and the Mediterranean
4	*P. arabica* Savigny,1816	Indo West Pacific and North east Atlantic
5	*P. polytrema* Herdman,1906	Indo-West Pacific Region, East South America, Pan tropical throughout the Caribbean
FAMILY: PYURIDAE		
6	*Herdmania pallida* Savigny,1816	Atlantic Ocean, Indo-West Pacific and the Mediterranean: Sub Antarctic region.
7	*Microcosmus curvus* Tokioka, 1954a	Pacific ocean
8.	*M. squamiger* Michaelsen, 1927	Indo-Pacific, Southwest Atlantic and the Mediterranean Sea,: Sub Antarctic region
9.	*M. exasperatus* Heller, 1878	Indo-West Pacific, Atlantic Ocean and the Mediterranean: East Africa, Subantarctic, southeast America
FAMILY: PEROPHORIDAE		
10	*Ecteinascidia venui* Meenakshi,1999	Eastern Indian Ocean: India
11	*E.krishnani* Renganathan and Krishnaswamy,1985	Eastern Indian Ocean: India
12	*Perophora formosana (*Oka,1931)	Indo-West Pacific and Atlantic Ocean
FAMILY: STYELIDAE		
13	*Eusynstyela tincta (*Van Name, 1902)	Atlantic Ocean and Indo West Pacific: East South America
14	*Styela canopus* (Savigny,1816)	Indo Pacific, Atlantic Ocean and the Mediterranean: South and South east America,
15	*Symplegma oceania* Tokioka,1961	Indo-West Pacific
16.	*S. viride Herdman, 1886*	Atlantic Ocean, Indo West Pacific and the Mediterranean: Sub Antarctic East South America
17	*Botrylloides magnicoecum* Hartmeyer.1912	Indo-West Pacific and Western Central Atlantic
18	*B. leachii (* Savigny,1816)	Northeast Atlantic, Indo West Pacific and Mediterranean and Black sea: Australia and Europe
19	*B. chevalense* Herdman,1906	Eastern Indian Ocean: India
FAMILY; HOLOZOIDAE		
20	*Distaplia nathensis* Meenakshi, 1997	Eastern Indian Ocean: India
FAMILY:DIDEMNIDAE		
21	*Diplosoma swamiensis* Renganathan,1986c	Eastern Indian Ocean: India
22	*Didemnum psammatodes (*Sluiter,1895)	Indo-West Pacific and Eastern Atlantic:Subantarctic region, Malaya and West Africa
23	*Lissoclinum fragile (*Van Name,1902)	Indo-Pacific and Western central Atlantic
24	*Tridemnum clinides* Kott,1977	Indo-West Pacific
25	*T. savignii* (Herdman,1886)	Indo-Pacific and Western Central Atlantic
FAMILY: POLYCITORIDAE		
26	*Eudistoma lakshmiani* Renganathan, 1986	Eastern Indian Ocean: India.
27	*E. viride* Tokioka,1955	Western Central Pacific and Indian Ocean
28	*E. laysani (Sluiter 1990)*	Pacific Ocean and Indian Ocean
FAMILY: POLYCLINIDAE		
29	*Polyclinum indicum* Sebastian, 1954	Eastern Indian Ocean: India
30	*P. madrasensis* Sebastian, 1952	Eastern Indian Ocean: India.
31	*Aplidium indicum* Renganthan and Monniot, 1984	Eastern Indian Ocean: India
32	*A.multiplicatum* Sluiter, 1909	Indo-West Pacific

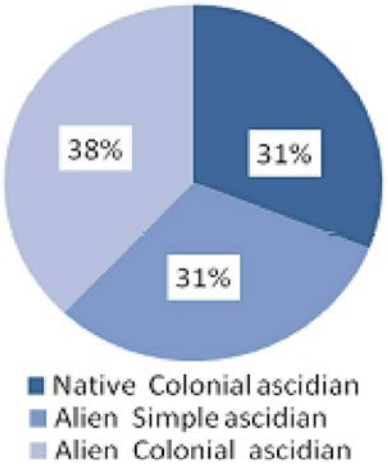

Fig. 3: Distribution of alien/native ascidians in Tuticorin coast.

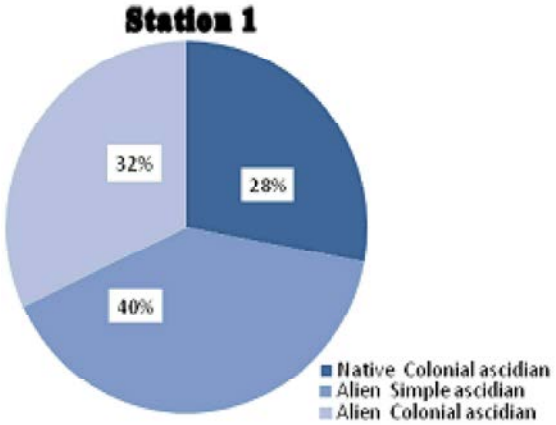

Fig. 4: The percentage of alien/native ascidian species at Station 1 in Tuticorin coast.

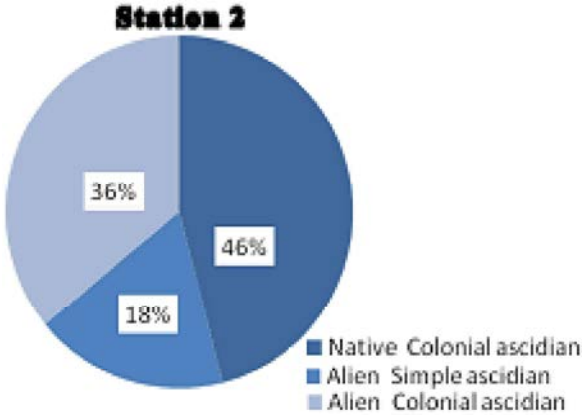

Fig. 5: The percentage of alien/native ascidian species at Station 2 in Tuticorin coast.

Twenty two species such as *Ascidia sydneiensis, A. gemmata, Phallusia arabica, P. nigra and P. polytrema*, *Microcosmus squamiger, M.curvus,*

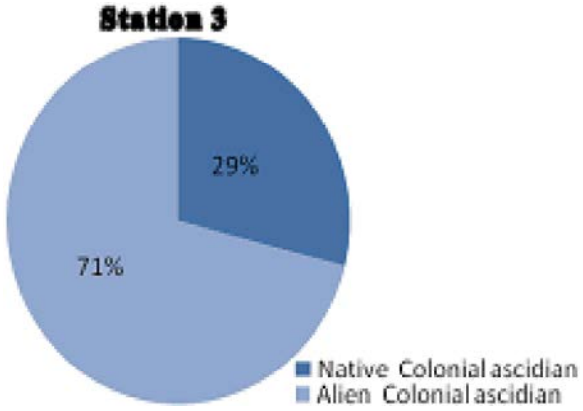

Fig. 6: The percentage of alien/native ascidian species at Station 3 in Tuticorin coast.

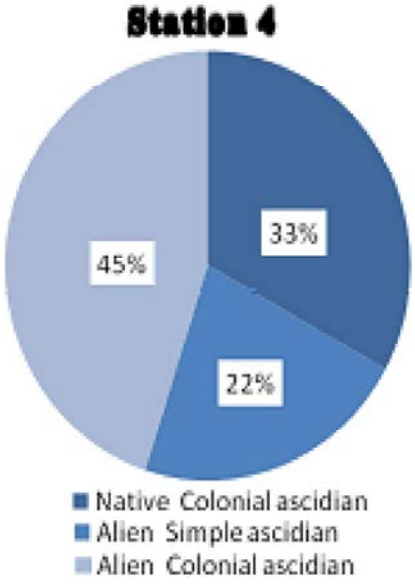

Fig. 7: The percentage of alien/native ascidian species at Station 4 in Tuticorin coast.

M. exasperates and Herdmania pallida, Perophora formosana and *Eusynstyela tincta, Styela canopus, Symplegma oceania, S. viride, Botrylloides magnicoecum, B. leachi* and *B. chevalensis, Didemnum psammathodes, Tridemnum clinids and T. savigny, Eudistoma viride* and *Aplidium multiplicatum* belong to the diverse families Ascididae, Pyuridae, Perophoridae, Styelidae, Didemnidae, Polycitoridae and Polyclinidae respectively are non native to the Indian coastal waters. The occurrence of invasive/alien species were high (72%) at Station 1 followed by Station 3 (71%), Station 4 (67%) and Station 2 (55%). The percentage of occurrence and distribution of alien species are shown in Figures (3-7) and Tables (1 and 2).

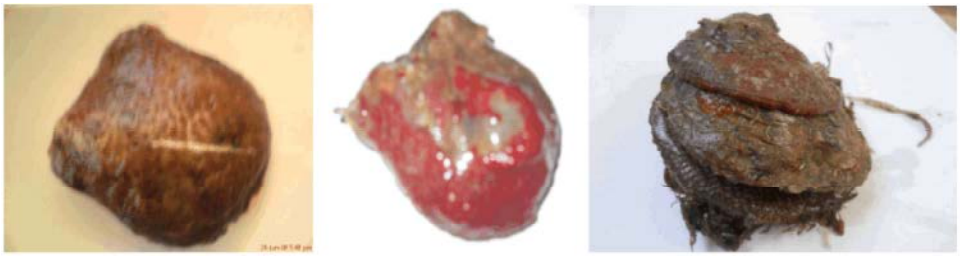

Fig. 8,9,10:Shows the colonial ascidian *Symplegma oceania* covers entire surface and epibiotic on *Pinctada vulgaris*

DISCUSSION

Ascidians are very useful bioindicators of invasion due to the sedentary nature and short larval life. In the present study maximum number of alien species were recorded at Station 1. As this Station is being a major cargo handling port, subsequent heavy transportation may be the reason for alien species to settle here. Moreover this Station is being in protected area with reduced wave action and anthropogenic activities, along with the presence of concrete submerged blocks, marine floats, pilings, buoys, pebbles, corals, boulders, prolonged unused barges, etc., provide suitable substratum and condition for ascidians to settle and disperse. The ascidians as foulers, attaching with ship hulls, could be transported to other ports around the world very easily. Number of evidences support this fact that World wide shipping has introduced exotic species into many ports [17-20]. Annual introductions of non-indigenous ascidians into harbors in both tropical and temperate waters are now, with the increasing rate [9, 19, 21, 22]. Aquaculture has become an important industry along the coastal line of Tuticorin particularly at Station 1. The pearl oyster *Pinctada vulgaris,* one of the economically important bivalve species are being cultured in this area. Here, ascidians are nuisance to pearl oyster culture as they foul the nets, cages of shell fish suspended from rafts even on the shell fish and cause mortality resulting in decline of the productivity. Tunicates are commonly an important part of the benthic sessile communities associated with bivalves and while they do not compete with bivalves for food [23,24], they compete for substrate, space and may even cause bivalve mortality by growing over them [25]. Figures 8,9 and 10 show the fouling of invasive species *Symplegma oceania* over the shell of pearl oyster *P. vulgaris*.

Next to Station 1, maximum number of alien ascidian species was recorded at Station 3 followed by Station 4. This may be due to the fact that these Stations 3 and 4 are situated near the fish landing centre with plenty of seagoing mechanized boats and Station 4 has direct connection with the open sea. Recreational boats and aquaculture operations are the source for spreading alien species to smaller bays, including marine reserves [26]. These alien species might have entered through fishing vessels and also by shore currents, flowing from South to North, connecting Station 1 and 4. Besides, the presence of plenty of boulders, pebbles etc at Station 4 are also probably providing suitable substratum for the settlement of larval forms of ascidians.

Station 2 is situated at the break water areas and is separated partially by Port and so direct connection with the open sea is restricted. Further at this Stations variety of substratum like boulders, pebbles, concrete structures etc. are lacking. Besides, anthropogenic pressures, such as various traditional fishing activity alters the distribution and growth of tunicates in this area. These disturbances might have affected the settlement of larvae. So the invasions of alien species at this station was comparatively lesser than at Stations 1, 3 and 4 due to less availability of suitable environmental conditions.

In the present study, colonial ascidians were higher than simple ascidians. This could be correlated with the planktonic and settling behaviour of colonial ascidians. When colonial ascidians are damaged and torn they may be transported by water currents, tides and waves. Thus fragmentation can act as means of asexual reproduction and dispersal mechanisms for colonial ascidians. Similar observation was made and reported that the fragmented colony reattach to appropriate substratum [27].

The present study showed the distribution of some non-native ascidians, at Station 1, 2, 3 and 4 of Tuticorin coast in India. The non-native ascidian *Ascidia sydneiensis* is native to Anguilla, Belize, Cuba, Curacao I, Grenada, Guadeloupe, Puerto Rico, US Virgin Is [28] Brazil [29], Cape Verda,Sierra Leone[19], China Main [30], Hong Kong [31], Japan, South Africa [32] Mozambique [33], New Zealand [34], Palau, Papua N Guin, Tonga [35] and Panama [36]. Similarly *Ascidia gemmata* to Australia, [31], Caroline, Micronesia, Palau, Papua N Guin, Wake I [35]

and Indonesia [30], *Phallusia nigra* to Belize, Bermuda, Cuba, Curacao, Grenada, Goudeloupe, Jamaica, NethAntilles, Puerto Rico, St Vincent, US Virgin IS, USA, Venesuela [28] Oman [37] and Panama [36], *P. arabica* to Australia, Sri Lanka [31], Palau and Philippines [35], P. polytrema to Australia, Fr Polynesia and Sri Lanka [31], *Herdmania pallida* to Australia, Fiji, Fr.Polynesia, Indonesia, Philippines, Singapore [31], Belize [38], Brazil [29], Cape Verde [21], Cyprus, Djibouti, Egypt, Mosambique, Yemen [39], Japan, New Zealand, South Africa [34], N Marianas [40], Oman [34], Somalia [41] and Viet Nam [42], Microcosmus curvus to Australia, Japan, N Marianas, Palau, Tahiti [31], Polynesia [43] and Marquasas Is [44], *M. squamiger* to Australia, Mozambique, South Africa [39], France, Gibralter, Hawaii, Italy, Spain, Tunisia [45] and New Zealand [34], *M. exasperatus* to Aruba, Belize, Bermuda, Cuba, Jamaica [28], Australia, Egypt, Madagascar, New Caladonia, Yemen [39], Brazil, Fiji, Indonesia [31], China Main [40], Japan, New Zealand [34], Liberia [46] and Panama [36], *Perophora formosana* to Australia, Indonesia, Japan [31], Belize, Cuba, Guadeloupe and Jamaica [28], *Eusynstyela tincta* to Belize,, Bermuda, Curacao, Guadeloupe,, Jamaica, USA [28], Mosambique [33] and South Africa [34], *Styela canopus* to Aruba, Belize, Cuba, Grenada, Guadeloupe, Jamaica, Puerto Rico, Venezuela [28], Ascension I, France, Hong Kong, Indonesia Japan, Korea [31], Australia, Palau [35], Bermuda,Brazil, Panama [36], Mosambique [47], Senegal [48], South Africa- [34] and Yemen [39], *Symplegma oceania* to Australia [49], Fiji [43] and Hong Kong [32], S. viride to Australia [34], Bermuda, Cayman IS, Cuba, Curacao I, Grenada, Guadeloupe, Jamaica, USA [28, Brazil [29], China Main [40], Mozambique [49] Palau [40], South Africa [34] and Thailand [40] Botrylloides magnicoecum to Australia, Hong Kong South Africa [31], Belize [50], Bermuda, Goudeoupe [28] and New Zealand [51], B. leachii to Australia [31], Didemnum psammatodes to Aruba, Belize, Grenada, Guadeloupe, Jamaica, Panama, Saint Lucia, St Vincent, [28], Australia, Palau, Tonga [35], Fr. Guiana [48], Indonesia, Japan, Malaysia, New Zealand [31] Micronesia, Mosambique, Sri Lanka, Tanzania [52] and South Africa [34], *Trididemnum clinides* native of Australia [53], Fiji, Fr Polynesia, Guam, Marshall IS and Philippines [31], *T. savignii* to Australia, Jamaica, Indonesia [53], Bermuda, Cuba, Guadeloupe, Panama, Philippines, Puerto Rico, USA [28], Japan, N Marianas [52] and Palau [40], Eudistoma viride to Fiji, Korea Rep, Micronesia, Palau, and Philippines [35] and Aplidium multiplicatum to Australia, Hong Kong, Indonesia, Kiribati, Marshall IS, Micronesia, Palau and Philippines [31].

Though the non-native ascidian *Botrylloides chevalense* is recorded at Station 2 in Tuticorin coast in India, its origin is yet to be ascertained. 2. The colonial ascidian *Symplegma viride* at Station 3 was not previously recorded during the year 2000 April to 2001 March [54], whereas the same was recorded at Station 1 in between 1993 and 1994 [55]. This species might have probably migrated at Station 3 through local fishing activity and via the hull and served as an important corridor for the regional spread of this species.

Invasive/alien species are recognized as one of the leading threats to biodiversity and also inflict enormous costs on fishing, fisheries and as well as on human health. The threat to biodiversity due to invasive alien species is considered second only to that of habitat destruction. In contrast to the fear by all over the world not all alien species are harmful. Some of the ascidians are also used as food in the form of various preparations in many parts of the world such as Chile (Probecho), France (Figueodemer, violet), Korea (Meongge), Italy (limone di mare, uova di mare), Japan (hoya, maboya) etc., ET 743, a new anticancer drug is obtained from *Ecteinascidia turbinate and Polyclinum indicum*, used to treat breast cancer [56] and cervical cancer [57] respectively. Tyrosine derived bactericidal compound was isolated from the alien species *Phallusia nigra*, native to the Red sea[58] and a value added product, pickle was prepared from the mantle bodies of non-native simple ascidian *Herdmania pallida,* native to Red sea [59].

As Tuticorin is one of the major ports in India, a thorough prolonged future investigation is needed to distinguish the harmful from the harmless invasive/alien species and to identify the impacts of the former on native biodiversity. This will also help in detecting new invasion of exotic species and documenting significant range and extensions of damage to the habitat at the regional level. Without a concerted effort to conserve the local native nothing will be achieved at a global level. This type of early warning at regional level will be helpful to restore the diversity of species in different habitats of the Tuticorin coast which is very close to the Gulf of Mannar National Marine Park, a well preserved area for its rich marine diversity with rich corals.

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