Carijoa riisei (Cnidaria : Octocorallia : Clavulariidae), a newly observed threat to Gulf of Mannar coral biodiversity?

Introduction of non-indigenous alien species is being reported nowadays as one of the most serious and potential sources of stress to the marine systems[1]. They cause disruptions of native communities and detrimental economic impacts on fisheries in many temperate marine areas[2]. This also leads to loss of biodiversity, including species extinction, and changes in hydrology and ecosystem function. Biological invasions now operate on a global scale and will undergo rapid increase in this century due to increasing globalization of markets, travel and tourism[3]. Information regarding the presence and impact of alien invasive species from Indian waters is less. There have been 24 invasive species reported from the Indian waters, which include 11 alien species[4]. Of these, a single report of a bioinvasive alga, *Kappaphycus alvarezii* was recorded from Kurusadai Island in the Gulf of Mannar region[5]. Since the Gulf of Mannar is unique within the Indo-Pacific Oceanic realm by harbouring one of the richest biodiversity, there should be field studies to evaluate the invasive species. This communication reports the presence of an invasive species of an octocoral, which probably is a threat to the coral biodiversity of the Gulf of Mannar Biosphere Reserve.

In 2009, an underwater survey was carried out around ten Islands of the Gulf of Mannar, seven from the Keelakarai group (78°31′00″–78°35′00″E and 9°05′30″–9°06′30″N) and three from the Vembar group of Islands (78°41′50″–78°49′20″E and 9°09′02″–9°11′17″N) to assess coral biodiversity (Figure 1). Line intercept transect survey method was deployed following the methodology of English *et al.*[6], using SCUBA diving. In each survey station, three replicate transects of 20 m were laid. The percentage cover of each life-form category was calculated using the formula:

$$\text{Percentage cover of life-form category} = \frac{\text{Total length of category} \times 100}{\text{Length of transect}}.$$

The survey of the ten islands resulted in the observation of ubiquitous distribution of invasive octocoral species in the seaward sides. Colonies were predominantly found on shaded parts of the rocks and dead corals (Figure 2). They were found in crevices and even on live massive corals and cup corals as fouling growth and among seaweed beds on both sides of reef crests at a depth of 4–12 m (Figure 3). In terms of the number of colonies, they were the most dominant species. Colonies were yellow, brown or red in colour. Some unusual green-colour colonies were also reported in the present study from Thalayari and Anaipar islands (Figure 4). Stem was hollow, thin, erect, stick-like and usually unbranched. Surface of the colony and the surface of the calyces have longitudinal grooves. The

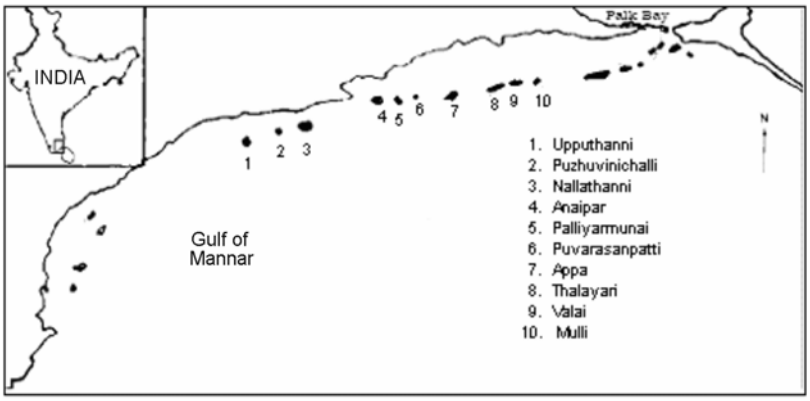

Figure 1. Map showing the study area.

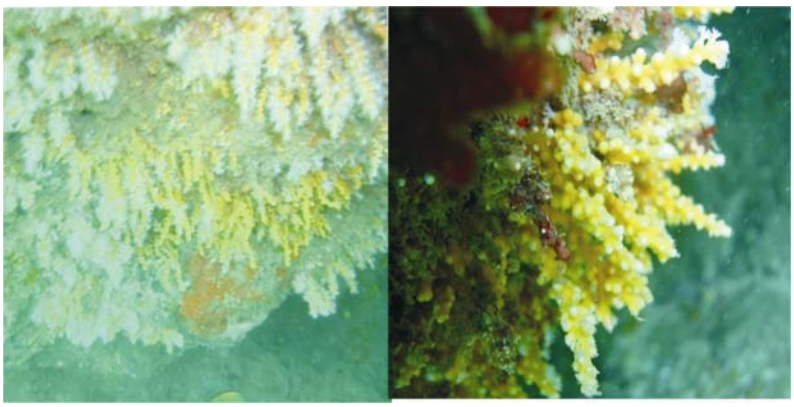

Figure 2. Underwater photographs of *Carijoa riisei* colonies beneath a rock – Gulf of Mannar.

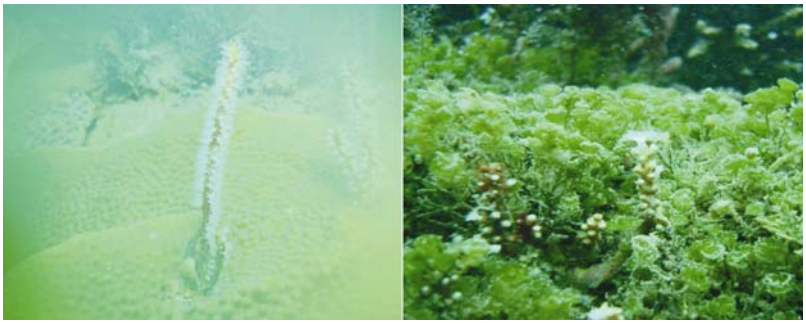

Figure 3. Fouling growth of *C. riisei* on live cup corals and among seaweed beds.

lengthiest colony measured up to 11 cm and breadth of the branch measured up to 3.5 mm. Calyces were bud-like and always facing upward. Polyps of live colony were white in colour (Figure 5). Surface of the colony was covered by a thin encrusting sponge which is a characteristic feature of this octocoral species. All these taxonomic analysis and sclerites characters revealed that the specimens belonged to the species *Carijoa riisei*[7], classified under the phylum Cnidaria, class Anthozoa, subclass Octocorallia, order Telestacea and family Clavulariidae.

Figure 4. Green-coloured colonies of *C. riisei* from Thalayari Island.

Figure 5. Stereo-zoomed microscopic image of polyps.

Table 1. Total coverage (%) of *Carijoa riisei* surveyed in Vembar and Keelakarai groups of island

Island	Percentage cover of *Carijoa riisei*	Relative abundance of *Carijoa riisei*	Total life-form cover (%)
Upputhanni	1.12	0.189	66.1
Puluvinichalli	0.87	0.248	61.0
Nallathanni	0.84	0.259	61.3
Anaipar	0.93	0.352	65.7
Valimunai	0.86	0.221	67.0
Poovarasanpatti	2.16	0.199	54.5
Appa	1.81	0.220	62.7
Thalayari	0.62	0.244	64.9
Valai	0.94	0.208	61.8
Mulli	1.40	0.228	59.2

C. riisei is a non-reef-forming, non-photosynthetic, shallow-water octocoral species and is commonly called 'snowflake coral'. It is found predominantly in turbid coastal areas, most commonly as fouling organisms on jetties and wrecks. Its distribution is unintentional, most likely as fouling on the hull of ships. It was first found in 1972 in the fouling community in Pearl Harbor[8]. It is native to the tropical western Atlantic Ocean, where it commonly occurs from Florida to Brazil and throughout the Caribbean[9]. Muzik (pers. commun.) noted that a species of *Carijoa* is now also known from Chuuk, Palau, Philippines, Indonesia, Australia and Thailand. Although its zoogeographical distribution is reported to be widespread in both tropical and temperate waters, there have been no reports about its presence in Indian waters earlier. It is believed to have been transported to India through the ship hull or as larvae in the ballast water of ships. This may make the Gulf of Mannar more susceptible to invasion, as it lies between the major ports in the east, viz. Tuticorin and Chennai.

As a voracious eater, *C. riisei* consumes large quantities of zooplankton, although the ecological impacts of its appetite are not yet known. As a highly successful invasive species, *C. riisei* threatens the biodiversity of Hawaii by monopolizing food and space resources and by displacing native species[10]. Under favourable conditions, it out-competes the other organisms and saturates the available space. It exhibits high fecundity, producing hundreds of eggs per axial polyp and appears to reproduce continuously. Under favourable conditions in shallow water, *C. riisei* is regularly observed saturating the substrata and attaining densities of over 1600 axial polyps per square metre[11]. It has hermaphrodite and ahermaphrodite colonies, and is also capable of single-parent reproduction. It also spreads via vegetative growth using horizontal 'runners' or stolons, which are used to quickly colonize adjacent territory in all directions. It has been described as a fast-growing, shallow-water species in its native habitat[9,12]. In terms of introduced biomass and displacement of native species, *C. riisei* may be the most invasive of the non-indigenous marine invertebrate in Hawaii. In 2001, deep-water surveys of the Maui black coral bed discovered *C. riisei* overgrowing and killing over

60% of the black coral trees between 80 and 105 m depth, and it is reported to threaten the US$ 30 million precious coral industry in Hawaii[13,14].

Out of total biotic components surveyed around the islands, *C. riisei* covered a minimum of 0.62% in Thalayari Island and a maximum of 2.16% in Poovarasanpatti Island (Table 1). A maximum of 2.16% area of an island covered by a fouling species is a serious threat to the biodiversity of the islands. Many of the *C. riisei* fouled cup corals were observed about to bleach. Probably they might have spread to all the Gulf of Mannar islands, Palk Bay and even to the east coast of India. If this persists, it will be a threat to the coral diversity of the Gulf of Mannar. So the impact of the species has to be studied in all the islands of the Gulf of Mannar Biosphere Reserve in detail. Though ballast water from ships was claimed as the most important factor in translocation of non-native species, hull fouling has been demonstrated to be an efficient vector for benthic organisms. Ferreira *et al.*[15] confirmed hull fouling as an efficient vector to species introduction, thus deserving special managing strategies. Use of precautionary principle must be considered when treating the hull fouling vector and monitoring programmes should be established along the coast. In order to achieve effective vector control, we must continue to develop and implement approaches for dealing with the many vectors of marine invasion, such as new techniques for treating ballast water and hull fouling. These efforts must be backed by effective policy for addressing invasion in the sea.

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