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Re-colonizing Mangrove species in tsunami devastated habitats at Nicobar Islands, India

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Abstract: Mangrove habitats are crucial for maintaining the biodiversity of coastal ecosystem. Climatic change, sea level rise and anthropogenic pressures are the major threats to mangrove forests. The Nicobar Islands comprised one of the pristine mangrove stands in India. The mega earthquake of >9 M and subsequent tsunami during 2004 caused destruction of over 70% of mangrove vegetation in Nicobar Islands. The present study was carried out in the Central Nicobar Group of Islands (Camorta, Nancowry, Katchall and Trinkat), where tsunami has entirely wiped out the mangrove vegetation. Re-colonization started on its own course. We enumerated nine species of mangrove plants and 30 species of mangrove associates from the surveyed locations. *Lumnitzera racemosa* has been recorded for the first time from the study area. *Rhizophora mucronata* and *Bruguiera gymnorrhiza* were the common pioneer mangrove species. Long-term monitoring of re-colonization process will help us in understanding succession of mangrove forests.

Introduction

Mangrove habitats in the tropical coasts confined between latitudes 25° N and 30° S represent a unique ecosystem, which is vital for the maintenance of marine biodiversity (Valiela *et al.* 2001). Inhabiting the interface between land and sea at low latitudes, mangroves occupy a harsh environment, being subjected to daily tidal changes, temperature, salt exposure and varying degrees of anoxia. Therefore mangroves exhibit a high degree of ecological stability in the water-logged saline zone between sea and terrestrial environment (Tomlinson 1986; Alongi 2008; Giri *et al.* 2008). Mangrove habitat supports the survival of plant species that are adapted to live in the high salinity conditions.

Mangrove forests occupy 14,650,000 ha of coastline around the globe (Wilkie and Fortuna 2003). Bountiful information is available on the status of mangrove habitats, their extent and biodiversity (Sidhu 1963; Chapman 1976; Dagar *et al.* 1991; Duke 1992; Saenger and Bellan 1995; Li and Lee 1997; Spalding *et al.* 1997; Valiela *et al.* 2001; Jayatissa *et al.* 2002; Wilkie and Fortuna 2003). These tidal forests are often important nursery grounds and breeding sites for birds, mammals, fish, crustaceans, shellfish and reptiles; a renewable resource of wood; and sites for accumulation of sediment, nutrients, and contaminants (Sasekumar *et al.* 1992; Kathiresan and Bingham 2001). Mangrove forests protect land from hurricanes and tsunamis by acting as a physical barrier along the coast (Barbier 2006; Chang *et al*. 2006).

However, the mangrove forests have been declining at an alarming rate–perhaps even more rapidly than inland tropical forests and much of what remains is in degraded condition (Valiela *et al.* 2001; Wilkie *et al.* 2003). The remaining mangrove forests are under immense pressure from felling, encroachment, hydrological alterations, chemical spills, farm land conversion, storms and climate change (Menesveta 1997; Blasco *et al.* 2001; Valiela *et al.* 2001; McKee 2005; Giri *et al.* 2008).

The mega earth quake and the subsequent tsunami in the Indian Ocean during December 2004 had an adverse effect on the mangrove forests of Asian countries such as India, Sri Lanka, Thailand, and Indonesia. Mangrove forests suffered severe damage during tsunami by breaking and uprooting (UNEP 2005; IUCN 2005; Sankaran 2005; Giri *et al.* 2008). The Nicobar Islands of India situated very close to the epicenter of the earthquake suffered a major loss in terms of human lives and biodiversity. The mangrove forests of Nicobar Islands considered to be one of the pristine forests in India had been badly ravaged during tsunami. It was variously estimated that 62 – 70% of mangrove forests of Nicobar Islands were destroyed (Ramachandran *et al.* 2005; Roy and Krishnan 2005; Sankaran 2005; Sridhar *et al.* 2006).

The resilience and dynamics of mangrove forests to human induced disturbances have been studied in many parts of the world (Ball 1980; Sherman *et al.* 2000; Giri *et al.* 2008), but the information available on the succession of mangroves after natural disasters like hurricane and tsunami are scanty (Roth 1992; Ross *et al.* 2000). The present study describes the species richness of mangrove re-colonizing habitats in the Central Nicobar group of Islands, which were completely destroyed by the tsunami, 2004.

Materials and Methods

Study site

Nicobar group of Islands consists of 24 Islands situated in the Bay of Bengal between Latitude 06°45' – 9°15' N and Longitude 92°42' – 93°50' E. Of the 24 islands, 12 are inhabited by the humans. The temperature ranges from 22°C – 32°C and annual rainfall from 3,000 mm – 3,800 mm (Sinha 1999).

The study was carried out in the Central Nicobar group of Islands (Figure 1). Tsunami ravaged mangrove forests of four islands namely Camorta, Nancowry, Katchall and Trinkat were studied for species diversity in the mangrove re-colonizing habitats during January- May 2010. The latitudes and longitudes of the four Islands are as follows: Camorta 07°59'12"–8°14'43" N, 93°25'49"– 93°34'36" E, Katchall 07°51'50"– 08°01'56" N, 93°17'41"– 93°28'47" E, Nancowry 07°55'04" – 08°01'57" N, 93°29'23" – 93°35'01" E, and Trinkat 08°01'45" – 08°08'48" N, 93°37'04" – 93°37'30" E (Ramachandran *et al.*, 2005).

Data Collection

The entire coastal lines of the above-mentioned islands were surveyed. Mangrove re-colonizing sites were selected for detailed study. Plant specimens were collected whenever identification was not possible in the field. The collected specimens were identified with the help of the publications on the Flora of Andaman & Nicobar Islands (Dagar *et al.* 1991; Hajra *et al.* 1999; Sinha 1999). Nomenclatures of the identified species were checked with the International Plant Naming Index (IPNI).

Results and Discussion

A total of nine species of mangroves belonging to six families and 30 species of mangrove associates belonging to 21 families were enumerated (Table 1). The most common mangrove species in the re-colonizing vegetation are *Rhizophora mucronata* (Figure 2) and *Bruguiera gymnorrhiza* (Figure 3B). The common mangrove associates include *Wedelia biflora, Dolichandrone spathacea, Cyperus javanicus, Ischaemum muticum* and

Table 1. List of Mangroves and Mangrove associates observed from the re-colonizing mangrove habitats of Central Nicobar Islands (Ca- Camorta, Ka- Katchall, Na- Nancowry and T- Trinkat).

FAMILY	SPECIES	HABIT	ISLAND
	Mangroves		
Sterculiaceae	*Heritiera littoralis* Dryand.	Tree	Ka
Rhizophoraceae	*Bruguiera gymnorrhiza* (L.) Savigny	Tree	Na, Ca, Ka, T
	Rhizophora mucronata Poir.	Tree	Na, Ca, Ka, T
	Ceriops tagal (Perr.) Robins	Tree	T
Combretaceae	*Lumnitzera racemosa* Willd.	Tree	T
	Lumnitzera littorea (Jack) Voigt.	Tree	Ca, Ka, T
Sonneratiaceae	*Sonneratia caseolaris* (L.) Engler	Tree	Na, Ca, Ka, T
Euphorbiaceae	*Excoecaria agallocha* L.	Tree	Ca, T
Arecaceae	*Nypa fruticans* Wurmb.	Shrub	N, Ca, Ka, T
	Mangrove Associates		
Malvaceae	*Hibiscus tiliaceus* L.	Tree	N, Ca, Ka, T
	Thespesia populnea (L.) Soland ex Correa	Tree	T
Celastraceae	*Salacia chinensis* L.	Shrub	Ca
Anacardiaceae	*Lannea coromandelica* (Houtt.) Merr.	Tree	Ca, T
Fabaceae	*Derris scandens* Benth.	Liana	Ka
	Pongamia pinnata (L.) Pierre	Tree	Ca, Ka
	Derris trifoliata Lour.	Liana	Ka
	Vigna marina (Burm.f.) Merr.	Climber	N, Ca, Ka, T
Caesalpiniaceae	*Caesalpinia bonduc* (L.) Roxb.	Straggler	N, Ca, Ka, T
	Intsia bijuga (Colebr.) O.Kunze	Tree	N, Ca, Ka
Combretaceae	*Terminalia catappa* L.	Tree	N, Ca, Ka, T
Myrtaceae	*Syzygium samarangense* (Bl.) Merr. & Perry	Tree	N, Ca, Ka, T
Barringtoniaceae	*Barringtonia racemosa* Bl.	Tree	Ka
Rubiaceae	*Guettarda speciosa* L.	Tree	N, Ca, Ka, T
	Morinda citrifolia L.	Tree	N, Ca, Ka, T
Asteraceae	*Wedelia biflora* DC.	Herb	N, Ca, Ka, T
Goodeniaceae	*Scaevola sericea* Vahl	Shrub	N, Ca, Ka, T
Myrsinaceae	*Ardisia solanacea* Roxb.	Shrub	Ca
Sapotaceae	*Planchonella obovata* (R.Br.) Pierre	Tree	Ca
Boraginaceae	*Cordia subcordata* Lam.	Tree	N, Ca, Ka, T
Bignoniaceae	*Dolichandrone spathacea* (L.f.) K.Schum.	Tree	N, Ca, Ka, T
Verbenaceae	*Clerodendrum inerme* (L.) Gaertn.	Shrub	Ca, Ka
	Premna corymbosa (Burm.f.) Rottb. & Willd.	Shrub	T
Hernandiaceae	*Hernandia nymphaeifolia* (Presl.) Kubitzki.	Tree	Ka, T
Casuarinaceae	*Casuarina equisetifolia* L.	Tree	Ca, T
Flagellariaceae	*Flagellaria indica* L.	Straggler	N, Ca, Ka
Cyperaceae	*Fimbristylis dichotoma* (L.) Vahl	Sedge	T
	Cyperus javanicus Houtt.	Sedge	N, Ca, Ka, T
	Scirpus littoralis Schrad.	Sedge	N, Ca, Ka, T
Poaceae	*Ischaemum muticum* L.	Grass	N, Ca, Ka, T

Caesalpinia bonduc which were found in all the four Islands. *Lumnitzera racemosa* (Figure 3E) was recorded for the first time from the Central Nicobar Islands. The species richness of mangroves and mangrove associates are more or less similar among the three islands namely Camorta (6, 23), Katchall (6, 22) and Trinkat (8, 20). Lesser species richness was observed in Nancowry (4, 16). The lesser species richness could be due to the highest damage occurred in this island as reported by Ramachandran *et al.* (2005).

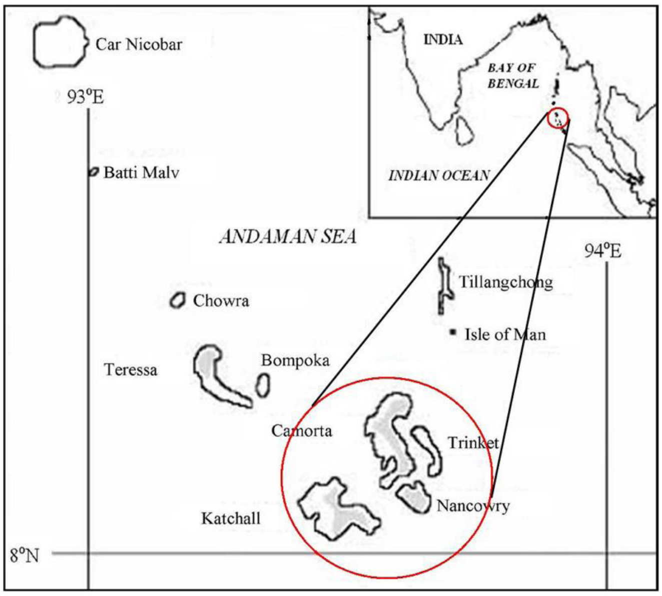

Figure 1. Map showing the Central Nicobar Group of Islands.

The observed species richness for the Central Nicobar Islands is lower than the earlier record of 17 and 85 for the mangrove and mangrove associates respectively (Dagar *et al.* 1991). Loss of mangrove habitats by the perennial submergence of the Nicobar Islands into the sea for about 1m due to the earth quake formed a major constraint for the re-colonizing species (Figure 4). However, the present study gives the first hand information on the plant diversity of re-colonizing mangrove habitats, which will eventually help in the long term monitoring of mangrove species in the Islands.

Figure 2. Saplings of *Rhizophora mucronata* observed in the regenerating habitat at Trinkat Island (Photo by P Nehru).

Figure 3. Mangrove species observed in the regenerating habitats. A) Flowering twigs of *Lumnitzera littorea*; B) Sapling of *Bruguiera gymnorrhiza*; C) *Nypa fruticans* saplings at Nancowry Island; D) S*onneratia caseolaris* twig showing immature fruits; E) Flowering twig of *Lumnitzera racemosa* (Photos by P Nehru).

Figure 4. A vast stretch of Mangrove snags near Dering village, Camorta Island (Photo by P Nehru).

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