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Unique features of mangrove ecosystems in India

Mangroves in India cover a total area of 4639 km^2, occupying 0.14% of the land area. They represent 3% of the global mangroves and 8% of Asian mangroves (SFR, 2009; FAO, 2007). About 60% of the mangroves occur on the east coast along the Bay of Bengal, 27% on the west coast bordering the Arabian Sea, and 13% on Andaman & Nicobar Islands. Differences in the distribution can be attributed to two reasons: i) the east coast has large estuaries with deltas formed due to runoff and deposition of sediments, whereas the west coast has funnel-shaped estuaries with the absence of deltas; and ii) the east coast has gentle slopes with extensive flats for colonization of mangrove, whereas the west coast has steep slopes.

Most extensive mangroves are found in Sundarbans in West Bengal (46.4%), followed by Gujarat (22.5%), and Andaman & Nicobar Islands (13.3%). The mangrove forests are very dense in 1405 km^2 (30.3%), moderate in 1659 km^2 (35.8%) and sparse in 1575 km^2 (33.9%). In the last two decades, mangrove coverage in India has maintained as a result of effective conservation measures, in spite of growing threats by man and natural calamities such as cyclone, flood and tsunami. In fact, there was an increase of 58 km^2 in the country between 2005 and 2007 (SFR, 2009). This is due to the efforts of Government of India in implementing effective conservation measures in 38 core mangrove forest areas.

Mangrove forest ecosystems in India support diverse groups of organisms comprising 920 species of flora and 3091 species of fauna (Table 1). The faunal component is 3.5 times greater than the flora component. This is perhaps the largest biodiversity record in the world mangrove ecosystems. The dense mangrove forests in Sundarbans are home to globally threatened species such as Bengal tiger, sea turtle, fishing cat, estuarine crocodile, Gangetic dolphin and river terrapin.

Mangrove forests in India are endowed with 125 plant species of which 39 are true mangroves and 86 are mangrove associates. Species of mangrove associates comprise 30 trees, 24 shrubs, 18 herbs, 6 climbers, 4 grasses and 4 epiphytes (Kathiresan *et al.*, 2009). They account for 56% of the world's mangrove species.

Table 1. Total number of species of flora and fauna reported in mangrove ecosystems of India (Kathiresan & Qasim, 2005)

No.	Groups	No. of Species
Flora		
1	Mangroves	39
2	Mangrove associates*	86
3	Sea grasses	11
4	Marine algae**	557
5	Bacteria	69
6	Fungi	103
7	Actinomycetes	23
8	Lichens	32
Fauna		
9	Prawns and lobsters	55
10	Crabs	138
11	Insects	707
12	Molluscs	305
13	Other invertebrates	745
14	Fish parasites	7
15	Fin fish	543
16	Amphibians	13
17	Reptiles	84
18	Birds	426
19	Mammals	68
	Total number of species	4011

* Plants that occur in the coastal environment and are also found within mangroves

** Include phytoplankton and seaweeds

Of special interest is *Rhizophora x annamalayana* Kathir., which is endemic to the Pichavaram mangrove in south east India (Kathiresan, 1999). It is a natural hybrid of *R. mucronata* and *R. apiculata* (Fig. 1). This critically endangered hybrid is recorded in the global list of mangrove species (FAO, 2007). At Pichavaram, the hybrid population is estimated at 170 trees of 9–12 m in height with broad, dark green leaves and well-developed stilt roots. The hybrid produces very few propagules, making its propagation very difficult. The presence of a similar hybrid was reported on Lombok, Bali, Indonesia (Baba, 1994) and in the Merbok Mangrove, Peninsular Malaysia (Ong, 2003).

Fig. 1. Natural hybrid *Rhizophora x annamalayana* (tall tree in the middle with dark green leaves) at Pichavaram mangrove in India

It is likely that natural hybrids occur in the families of Rhizophoraceae and Sonneratiaceae, but their parental species are yet to be understood. Ecological varieties of *Avicennia marina* and *Ceriops tagal* exist. For example, four species of *Avicennia* are locally identified in the Gulf of Kachchh of Gujarat, but it is difficult to relate their local names with botanical names.

Some mangrove species are restricted in distribution. *Pemphis acidula* is restricted to coral islands. *Acanthus ebracteatus* and *Lumnitzera littorea* are known to occur only on Andaman & Nicobar Islands. *Scyphiphora hydrophylacea* (Fig. 2a) occurs only in Krishna and Godavari estuaries, Sundarbans, and on Andaman & Nicobar Islands. *Brownlowia tersa* has patchy distribution in Sundarbans, Mahanadi delta and east Godavari District. The mangrove palm *N. fruticans* is restricted to Andaman & Nicobar Islands, and Sundarbans. The fern *Acrostichum speciosum* is found only in Orissa, and on Andaman & Nicobar Islands. In Sundarbans, due to the reduction in freshwater inputs, populations of *Nypa fruticans* and *Heritiera fomes* (Fig. 2b) are declining.

Mangroves protect shores against wind, waves and currents. The Bhitarkanika mangroves in India reduced human death, livestock loss and property damage during the October 1999 super cyclone. Similarly, the role of mangroves in coastal protection against the 26 December 2004 tsunami was remarkable. Mangroves and *Casuarina* plantations buffered the impact of the tsunami waves and protected the shoreline against damage in southeast India (Kathiresan & Rajendran, 2005; Danielsen *et al*., 2005).

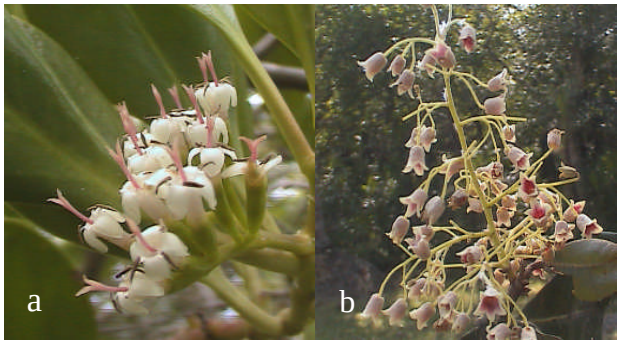

Fig. 2. Inflorescences of *Scyphiphora hydrophylacea* (a) and *Heritiera fomes* (b)

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K. Kathiresan

Professor, Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai 608 502, India

E-mail: kathirsum@rediffmail.com