

POPULATION STUDIES ON TWO SPECIES OF BRUGUIERA OF RHIZHOPHORACEAE IN SELECTED AREAS OF KERALA AND TAMILNADU

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Abstract

Over the past twenty years approximately 35% of the world's mangroves have been lost. They fix CO₂ greater than any other ecosystem. Thus planting and restoration of mangroves is being internationally recognized as one of the options for the prevention of global warming. The extinction vortex to floristic diversity in the West is attributed to loss of habitat. On the contrary, in the East Coast of India Mangroves are with the forest departments and revenue lands conserved by Government. Their ecosystem services is worth about 10,500 US\$ per hectare. The phenological patterns of the *Bruguiera* populations studied in Kerala are in harmony with the monsoon pattern. Flowering occurs during September – December (North East) and fruit dispersal is during June – August (South West). Very rare species such as *B. sexangula* that occur only in the Kumbalam and Kumbalangi Panchayaths of Kerala should be documented and their existence should be brought to the notice at the level of Panchayath members. Shrimp farmers, and fishermen cooperatives should be encouraged to participate in developing new mangrove plantations in panchayat owned wetlands. Finally, it is concluded that species recovery through controlled pollination is highly successful. Thus intervention in terms of human assisted reproduction seems to be a reality in recovery of species in critical ecosystems.

Keywords: Mangroves, *Bruguiera*, Phenology

Introduction

Over the past twenty years approximately 35% of the world's mangroves have been lost (Valiela et al., 2001). They fix CO₂ greater than any other ecosystem (Kathiresan and Bingham, 2001). Thus planting and restoration of mangroves is being internationally recognized as one of the options for the prevention of global warming (Tateda, 2002). Their ecosystem services is worth about 10,500 US\$ per hectare (Khaleel and Jhaleel, 2009). Indian mangroves can be broadly divided into deltaic (East Coast) and non deltaic (West Coast) types (Rao et al., 1999). In this work we try to highlight about the status of few mangroves in the East (Pichavaram, TamilNadu) and West (Ernakulam, Kerala) Coasts of India and discuss about the possible conservation and restoration strategies.

In the West Coast, particularly in Kerala, Ramachandran et al (1986) observed that mangroves are highly fragmented. The total extent is estimated to be less than 50km² (Chand Basha, 1992). Mohanan (1999) reported that 32 mangrove species occur in Kerala inclusive of some prominent associates. In terms of ownership large Mangrove patches are privately owned. In recent times, Anupama and Sivadasan (2004) recorded over 49 species of which 15

are true mangroves. About four species namely *Bruguiera eriopetala*, *B. malabarica*, *B. parviflora* and *Ceriops tagal* could not be located (Anupama and Sivadasan, 2004). It is presumed that the said species are locally extinct. The extinction vortex to floristic diversity in the West is attributed to loss of habitat.

On the contrary, in the East Coast of India Mangroves are with the forest departments and revenue lands conserved by Government. Though in terms of vegetation cover the mangroves in the East Coasts look healthy the floristic composition is slowly altered. A major constraint in the deltaic mangroves is lack constant influx of fresh water. Since 1921 the policy of water sharing between states in the East Coasts started threatening the life of mangroves. Over the years with more and more upstream areas being converted for agricultural purposes influx of fresh water has been slowly cutoff in the estuary areas. This has led to selective elimination of certain taxa from the floristic composition. Particularly those species that grow towards landwards are the ones have got locally extinct over these years. It is presumed these are resultant of hypersalinity and land compacting.

An interesting adaptation noticed in true mangroves is that or those belonging to the family Rhizophoraceae reproduce through a unique biological phenomenon called vivipary. In this mode of reproduction in the post fertilization the zygotes stay on the mother plant for a period 3-10 months until they mature in to seedlings also called as propagules. Any abiotic or biotic disturbance to the process of reproduction eventually leads to localized extinction.

Materials and Methods

Studies on phenology, floral biology, pollen biology and reproductive success were carried out in selected mangrove species across the east and west coasts of India in the following locations (Table 1).

Studies on Reproduction

About 40 individuals were tagged in *B. cylindrica* and *B. gymnorrhiza*. Ten branches from each plant were tagged for observing bud initiation, flower production and fruit set (Dafni, 1992). In case of *B. sexangula* observations were limited to five reproductively matured individuals. Time and duration of anthesis, flower life and pollen output was quantified using methods described by Dafni (1992). Studies on fertility were carried out using differential staining method (Alexander, 1969). Standard procedures were used to analyze pollen morphology. (Radford et al., 1974). Pollen ovule ratio was calculated using procedures developed by Cruden (1977). Pollinator behaviour in plants and their effectiveness in pollination were studied according to standard procedures described by Dafni (1992). Pre-Emergent Reproductive Success (PERS) was derived from fruit to flower ratio and seed to ovule ratio using methods described by Wiens et al., (1987)

Controlled pollination: Controlled pollination was carried out in five individuals. Flowers were emasculated using a clean fine tip forceps and dusted with pollen using a dry painting brush or needle after 5 days. Depending on the receptivity 20-50 flowers were operated per day. All flowers were double dusted. Operated flowers were caged in paper bags (in size of 12x7 cm) and were tagged properly. Bags were removed on the third day for recording fruit setting.

Results and Discussion

Phenology, Floral Biology and Reproductive Success

In general flowering in *B. cylindrica*, *B. gymnorrhiza* and *B. sexangula* occurs between Octobers – February. In all the Bruguieras only the well lit parts of the crown flower profusely. The *B. cylindrica* populations flower during October – November. Among the species *B. cylindrica* was the earliest to flower and the fastest in terms of fruit maturation and dispersal. *B. gymnorrhiza* starts flowering during early October while *B. sexangula* flowers during late October. In *B. cylindrica* each reproductive shoot produces 6-18 flowers. Flowers are in cymes and opposite decussate. Flowers are small dull yellow in colour, not showy, bisexual, strongly protandrous, large (2.5cm in length), dichogamous and short lived (>or = 4 days). Flowers are mildly scented (attractants to Thrips) and last for 3-6 days. In the case of *B. gymnorrhiza* and *B. sexangula* reproductive shoots consists 2-4 flowers.

The flowers are large varying 1.75 – 2.0 cm in length having a deep calyx cup that stores about 25-40 μ l of thin nectar with a life of about 14 – 20 days. In *B. sexangula* and *B. gym-*

norhiza after the trigger the pollen is released explosively as small clumps on to the beaks and heads. The number of anthers/flower varies from 20 to 24. Each anther in turn produces 70,000-80,000 pollen grains. The pollen is bi-nucleate and storable over three months at 4°C. Both species exhibit very high pollen fertility of about 95%. The pollen ovule ratio is very high (Table 2). *B. sexangula* and *B. gymnorrhiza* are pollinated by sunbirds (*Nectarinia asiatica* and *N. zoylonica*). The birds usually forage in pairs; visits are random and performed throughout the day. Usually 4-6 visits were recorded an hour. The visit of the birds is continuous and random in nature. However, in the case of *B. gymnorrhiza* during the month of October *Apis dorsata* and *Ceratina* were also recorded as frequent visitors. Among the three species *B. cylindrica* exhibited the highest reproductive success followed by *B. gymnorrhiza* and *B. sexangula* (Table 3). In *B. cylindrica* the period of maturation in 3-4 months in the case of *B. gymnorrhiza* and *B. sexangula* propagules mature within a period of 6-8 months.

In all the species above large amount of open pollinated flowers were found unpollinated particularly in the ornithophilous species. Fruit set was higher in *B. cylindrica* which is largely a thysanopterous species. High levels of flower abortions were common to all the three species.

Controlled pollination and species recovery

Among the said three species *B. sexangula* was reportedly thought to be extinct in Kerala. Following its rediscovery at Ernakulam region in order to conserve the living asset in its natural habitat, reconnaissance surveys were carried out



Figure 1 - Controlled Pollination work in *B. sexangula*



Planting of *Bruguiera sexangula* in degraded areas

Table 1. Details of Geographical Position and Climatic details of the study sites.

S.No	Locations	Geographical Position	Mangrove type	Annual Rainfall (mm)
1.	Kumbalangi, Ernakulam Dt., Kerala	09°53'26" N, 76°17'16" E	Non-Deltaic	1400-1600
2.	Panangad, Ernakulam Dt., Kerala	09° 56' 05" N, 76° 60' 19" E	Non-Deltaic	1400-1600
3.	Pichavaram, Cuddalore Dt., Tamil nadu	11° 43' 36" N, 79° 77' 37" E	Deltaic	800-1200

Table 2. Floral Characteristics in Bruguiera species

Characteristics	<i>B. cylindrical</i>	<i>B. gymnorrhiza</i>	<i>B. sexangula</i>
Flower type	Bisexual	Bisexual	Bisexual
Colour	White	Yellow	Red
Symmetry	Actinomorphic	Actinomorphic	Actinomorphic
Odour	Present	Absent	Absent
Nectar	Present	Copius	Copius
Anthers/ Flower	12	20 to 24	20 to 24
Pollen/Anther	6,000	80,000	70,000
Pollen/Flower	72,000	9,60,000	8,40,000
Pollen fertility	80-85%	90- 95%	90-95%
Stigma type	Wet, 2-3-fid	Wet - Trifid	Wet - Trifid
Ovules/ flower	6	6	6
Pollen/Ovule ratio	1:12000	1:1,60,000	1:1,40,000

Table 3. Floral Characteristics in Bruguiera species

Species	Flower/fruit ratio	Seed/ovule ratio	PERS*
<i>B. cylindrical</i>	0.30	0.25	0.070
<i>B. gymnorrhiza</i>	0.025	0.16	0.004
<i>B. sexangula</i>	0.010	0.16	0.001

in Panangad and Kumbalangi in Ernakulam (09° 52' 26" N; 76° 17' 16" E). Thirty individuals that are reproductively active have been GPS documented. Control pollination was attempted in Panangad using the pollen collections from Kumbalangi (Fig: 1). About 280 individuals were trans-

planted during June, 2011 at Puthuvype, Ernakulam region. The seedlings planted during June, 2011 have well established and have grown over 70 cm in height as of August, 2013.

Conclusion

The phenological patterns of the *Bruguiera* populations studied in Kerala are in harmony with the monsoon pattern. Flowering occurs during September – December (North East) and fruit dispersal is during June – August (South West). Pollen sterility is as low as 5% in *B. sexangula* and *B. gymnorrhiza* while it is 15-20% in *B. cylindrica*. *B. cylindrica* pollinated by thrips exhibited the highest reproductive success and strong family structure. *B. gymnorrhiza* and *B. sexangula* exhibit outcrossing adaptations such as high pollen output, high pollen to ovule ratio and are exclusively pollinated by birds. The number of reproducing individuals is only about six in the Ernakulam region. Based on the current study it appears that reproduction in bird pollinated *Bruguieras* is severely constrained. The following strategies could be considered for effective conservation of the *Bruguieras* in Kerala. The existing documentation on mangrove distribution is rudimentary. Hence, developing Mangrove Interpretation Centers (MIC) across the coastal districts is essential. Fragments less than 1 ha that are not currently included in vegetation cover due to lack of ground data. Panchayath administrations should be encouraged to quantify their existing mangrove and wetland resources using supportive GIS and internet tools provided by public domain such as www.keralawetland.org. Very rare species such as *B. sexangula* that occur only in the Kumbalam and Kumbalangi Panchayaths of Kerala should be documented and their existence should be brought to the notice at the level of Panchayath members. Shrimp farmers, and fishermen cooperatives should be encouraged to participate in developing new mangrove plantations in panchayat owned wetlands. Finally, it is concluded that species recovery through controlled pollination is highly successful. Thus intervention in terms of human assisted reproduction seems to be a reality in recovery of species in critical ecosystems.

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