

Dioecious *Caesalpinia bonduc* (L.) Roxb. calls for conservation in Burachapori Wildlife Sanctuary, Assam

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Abstract: Present study reports an endangered dioecious species *Caesalpinia bonduc* from Assam, north eastern India. Few individuals of male and female plants of *Caesalpinia bonduc* (L.) Roxb. were recorded along the ecologically fragile bank of mighty river Brahmaputra floodplains while surveying the Burachapori wildlife sanctuary, north eastern India for livelihood dependence of local people. *C. bonduc* faces a very high risk of extinction due to unsustainable harvesting for extracting medicine for treating malaria, flood, pollen availability and habitat fragmentation. This warrants immediate appropriate conservation measures; vegetative propagation through stem cuttings and tissue culture could rescue shortage of quality plant materials in the present case.

Resumen: El presente estudio es un reporte sobre *Caesalpinia bonduc* (L.) Roxb., una especie dioica en peligro de Assam, nordeste de la India. Se registraron pocos individuos de plantas masculinas y femeninas de *Caesalpinia bonduc* a lo largo de la ribera ecológicamente frágil de la planicie de inundación del poderoso río Brahmaputra durante un estudio de la dependencia de la subsistencia de los habitantes locales en el Santuario para la Vida Silvestre Burachapori. *C. bonduc* enfrenta un riesgo de extinción muy alto debido a una cosecha no sostenible para la extracción de medicina para tratar la malaria, a inundaciones, a la disponibilidad de polen y a la fragmentación del hábitat. Esta situación hace que se requieran medidas de conservación apropiadas e inmediatas; la propagación vegetativa por medio de esquejes del tallo y el cultivo de tejidos podrían mitigar la escasez de material vegetal de buena calidad en el presente caso.

Resumo: O estudo atual relata uma espécie dioica *Caesalpinia bonduc* (L.) Roxb. ameaçada em Assam, nordeste da Índia. Durante uma pesquisa ao santuário da vida selvagem de Burachapori, nordeste da Índia, para análise da dependência de meios de subsistência das populações locais, registaram-se poucos exemplares de plantas masculinas e femininas de *Caesalpinia bonduc* ao longo das margem ecologicamente frágeis das várzeas do poderoso rio Brahmaputra. A *C. bonduc* enfrenta um risco muito elevado de extinção devido à exploração não-sustentável para a extração de medicamentos para o tratamento de malária, às inundações, à disponibilidade de pólen e de fragmentação do habitat. Isso requer medidas imediatas e adequadas de conservação; no caso presente a propagação vegetativa por meio de estacas e a cultura de tecidos podem suprir a escassez de materiais de plantio de qualidade.

Key words: *Caesalpinia bonduc*, biodiversity, dioecious, extinction.

Handling Editor: Madhoolika Agrawal

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Dioecious flora comprises nearly 6 % (14,620 of 240,000) of the world's flowering plants (Renner & Ricklefs 1995). In India, ca. 6.7 % (1005 of 15,000) of flowering plants are dioecious (Bawa 1980); and have lower species richness than their non-dioecious sister groups. The proportion of dioecious plants species in the world's flora is small due to a lower speciation rate or a higher extinction risk than non-dioecious plants, but the proximate explanation for this pattern remains a mystery (Vamosi & Otto 2002). Evidently the dioecious plant families contain fewer species than hermaphroditic sister taxa in 79 % of 28 paired comparisons (Heilbut 2000). Moreover, dioecy is not evenly distributed among different regions, life forms or families of the angiosperms (Bawa 1980). While dioecious systems are strongly correlated with tropical environments (Renner & Ricklefs 1995), it has also been correlated with a number of ecological attributes (Bawa & Opler 1975; Flores & Schemske 1984), such as woodiness (Bawa *et al.* 1985; Croat 1979; Oliveira 1996; Ormond *et al.* 1991; Sakai *et al.* 1995), climber habit (Renner & Ricklefs 1995), entomophily (Bawa 1974; Oliveira & Gibbs 2000), anemophily (Givnish 1980), and formation of fleshy fruits dispersed by animals (Ibarra-Manríquez & Oyama 1992). Recent large-scale molecular phylogenetic analyses confirm some of the correlations between dioecy and ecological traits and highlight the diversification of dioecious lineages associated with above-mentioned ecological features (Vamosi *et al.* 2003; Weller & Sakai 1999).

Dioecious plants, particularly female plants suffer higher mortality in stressful habitats, such as in nutrient-deficient soil, locations with strong competition from other plants, or in climatically stressed environments (Gehring & Linhart 1993). Further, biased sex-ratio of male and female plants was quite evident in the present case as a small populations of male and female *Caesalpinia bonduc* in Burachapori wildlife sanctuary (BCWLS) due to soil nutrients and pollen limitation which might also lead to genetic drift and local extinction of the population (Barthelemy *et al.* 2014; Hilfiker *et al.* 2004; Ramachandran *et al.* 2014); In the present study, population of, *C. bonduc* was found in three patches on the bank of Brahmaputra river (Table 1). We found only 12 individual (10 female and 2 male) of *C. bonduc*. This biased sex-ratio of male and female plants and along with other natural and anthropogenic activities would totally wipe out the population of *C. bonduc* in BCWLS. Further, soil analysis during

pre and post flood showed that lower nutrient availability may have affected the survival of plants (Table 2).

The Burachapori wildlife sanctuary (BCWLS) is located in the south bank of mighty river Brahmaputra floodplains in Assam, north-eastern India (latitude 26° 30' 32" N to 26° 33' 40" N and longitude 92° 35' 54" E to 92° 46' 07" E). The total area of BCWLS is 44.06 sq. kms and has a mosaic of landuse systems that inhabits diverse flora and fauna. This habitat experiences submergence every monsoon, thereby creating small wetlands that ranges from 50 m² to 750 m² in area. It is observed that the species richness of riverine vegetation in and around Burachapori sanctuary is threatened due to flood and other anthropogenic activities such as channelization, agriculture, cattle grazing and nutrient discharge. Nonetheless, the vegetal systems found along the river banks help reduce soil loss and nutrients from runoff. Incidentally, we spotted approximately half-a-dozen individuals of the dioecious *Caesalpinia bonduc* (L.) Roxb. distributed along the riverbank while surveying the BCWLS for livelihood dependence of local people.

C. bonduc is a woody scrambling dioecious thorny shrub that belongs to family Caesalpinaceae. It is distributed widely in the tropics and subtropics, and is one of the rare and endangered species in India (Harden 2002; Sharma *et al.* 1991). Elsewhere, the plant is sparsely distributed in the deciduous forests of Singapore, Malaysia and Australia. *C. bonduc* faces a very high risk of extinction and was classified as an endangered species in the IUCN Red List of threatened species (Assogbadjo 2009).

C. bonduc grows up to 6 meters in height, stems are armed with prickles, leaves are bipinnate, large with 3 - 8 pairs of leaflets, racemose inflorescence and yellow flower. Fruit pods are covered with prickles all around and the seeds are oblong, hard and grey (Fig. 1). Seed(s) per pod varies from 1 to 3.

The local people (mostly immigrants), settled in and around the BCWLS use *C. bonduc* as an herbal medicine to treat malaria by roasting and grinding seeds before boiling it and consumed orally. The seeds are also used to treat diuretic (Kapoor 2005), antipyretic (Dhar *et al.* 1968), febrifuge and asthmatic (Nadkarni & Nadkarni 1976) and as an antispasmodic agent (Chopra *et al.* 1956). The leaves are used as a remedy for emmenagogue (Baquar 1989). It has also been reported that *C. bonduc* helps in checking soil

Table 1. Population structure of *C. bonduc* in Burachapori Wildlife Sanctuary.

Sites	Landuse	Patch size (m ²)	<i>C. bonduc</i> Population			Density
			Male	Female	Total	
S1	Riparian Forest	8	1	5	6	0.75
S2	Riparian Forest	4	0	2	2	0.50
S3	Riparian Forest	7	1	3	4	0.57

Table 2. Soil physico-chemical and biological properties before and after flood.

Soil properties	Site 1		Site 2		Site 3	
	PRF	POF	PRF	POF	PRF	POF
Physical						
Sand (%)	65.41 ± 10.35	69.19 ± 7.61	63.18 ± 9.10	67.22 ± 10.04	66.54 ± 9.05	67.73 ± 6.11
Silt (%)	23.17 ± 3.02	26.51 ± 2.84	26.75 ± 3.16	30.64 ± 2.18	24.17 ± 2.05	28.36 ± 2.34
Clay (%)	11.42 ± 1.13	4.30 ± 1.03	10.07 ± 2.04	2.14 ± 0.94	9.29 ± 1.11	3.91 ± 1.04
Textural Class	SL	SL	SL	SL	SL	SL
BD (g cm ³)	1.14 ± 0.09	0.98 ± 0.05	1.17 ± 0.04	0.97 ± 0.09	1.12 ± 0.07	0.97 ± 0.05
WHC (%)	45.21 ± 5.46	44.07 ± 3.05	45.87 ± 4.69	43.24 ± 5.03	45.62 ± 5.13	43.75 ± 4.02
SMC (%)	37.83 ± 5.12	44.20 ± 4.97	38.54 ± 4.34	44.56 ± 4.18	37.15 ± 5.02	42.31 ± 4.61
Chemical						
pH	5.46 ± 0.16	6.07 ± 0.45	5.41 ± 1.02	6.03 ± 1.13	5.52 ± 1.43	6.09 ± 0.96
SOC (%)	1.58 ± 0.04	1.24 ± 0.05	1.61 ± 0.03	1.18 ± 0.05	1.55 ± 0.05	1.21 ± 0.04
SOM (%)	2.79 ± 1.02	2.20 ± 0.95	2.81 ± 0.92	2.06 ± 0.78	2.70 ± 0.91	2.15 ± 0.95
TKN (%)	0.12 ± 0.003	0.09 ± 0.001	0.19 ± 0.001	0.11 ± 0.002	0.15 ± 0.001	0.09 ± 0.001
C/N	13.17 ± 2.34	13.78 ± 2.16	8.47 ± 3.01	10.73 ± 2.56	10.33 ± 2.91	13.44 ± 4.02
Available P (µg g ⁻¹)	5.68 ± 1.15	4.96 ± 0.93	5.74 ± 1.07	4.91 ± 0.57	5.71 ± 0.89	4.88 ± 0.97
NH ₃ -N (µg g ⁻¹)	0.87 ± 0.05	0.79 ± 0.01	0.83 ± 0.02	0.77 ± 0.02	0.85 ± 0.01	0.74 ± 0.03
NO ₃ -N (µg g ⁻¹)	0.29 ± 0.01	0.15 ± 0.001	0.26 ± 0.001	0.14 ± 0.003	0.28 ± 0.001	0.15 ± 0.001
Biological Properties						
<i>Microbial Population (no. of colonies × 10⁴ per g dry soil)</i>						
Bacteria	245 ± 34.90	137 ± 31.04	256 ± 25.80	142 ± 19.67	261 ± 22.90	134 ± 25.56
Fungi	54 ± 7.68	33.5 ± 4.91	60 ± 9.19	40 ± 9.03	58 ± 8.76	35.7 ± 4.78
<i>Microbial Biomass (µg g⁻¹ dry soil)</i>						
Carbon	746 ± 56.11	454 ± 54.02	753 ± 51.93	440 ± 39.20	749 ± 45.09	447 ± 36.15
Nitrogen	61 ± 4.37	47 ± 5.09	63 ± 5.82	50 ± 4.01	65 ± 5.86	52 ± 4.33
Phosphorus	37 ± 2.19	30 ± 4.85	44 ± 3.05	25 ± 3.17	40 ± 3.11	31 ± 2.98

PRF - Pre-Flood; POF - Post-Flood; ± S.E. (n = 5).

BD - Bulk density; WHC - Water holding capacity; SMC - Soil moisture content; SOM - Soil organic matter; TKN - Total kjeldahl nitrogen.

erosion (www.fs.fed.us/global/iitf/pdf/shrubs/Caesalpinia%20bonduc.pdf, last accessed - 22 January 2013). As seeds were collected in large quantities, this severely affects the natural regeneration of *C. bonduc*.

Despite biological and environmental benefits,

no conservation effort has been undertaken at both formal and informal levels to rejuvenate *C. bonduc*. Notwithstanding, the immigrant populations are concerned with diminishing population of *C. bonduc* due their importance in curtailing soil erosion beside medicinal properties. In the present

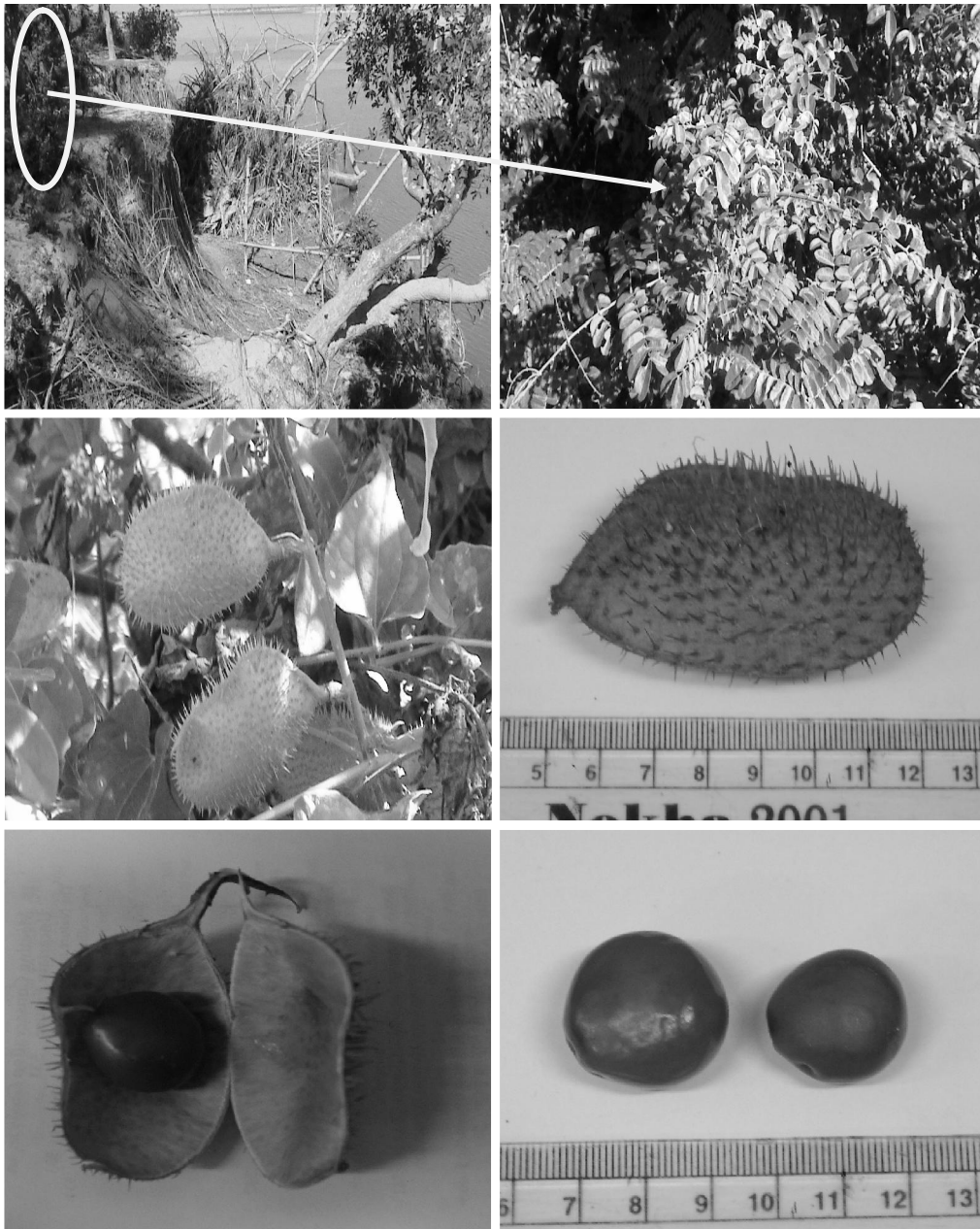


Fig. 1. Habitat and morphological characteristics of *Caesalpinia bonduc*.

study, we have observed only female plants and not a single male plant was found in the whole sanctuary area. This warrants rigorous awareness for its conservation and suitable method for propagation of both male and female plants of *C. bonduc* is required to help maintain its functional population in the fragile floodplains community. In this connection, attempts on vegetative propagation methods including stem cutting (Krishnamurthy *et al.* 2013; Tiwari & Das 2010) and tissue culture (Kumar *et al.* 2012; Sharma *et al.* 2009)

may be more useful for restoration of endangered *C. bonduc* population in nature. This further calls for a scientific blend of protected area management to imbibe principles of biological conservation for harnessing ecological benefits.

Acknowledgement

The authors thankfully acknowledge the financial support from the Council of Scientific and Industrial Research (CSIR), New Delhi.

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(Received on 03.01.2013 and accepted after revisions, on 14.03.2014)