

MBZSCF

Final Report

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India

Conservation
of Endemic and
Critically Endangered
Buchanania barberi
in India



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Cover Photos
Front: Inflorescence of *Buchanania barberi*
Back: Outreach programme at school

Photos
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Buchanania barberi seedlings ready for transplant

Summary

Buchanania barberi Gamble is an evergreen tree endemic to the Southern Western Ghats of Kerala, India. The species was rediscovered in 2003 after a lapse of 97 years from Palode region of Thiruvananthapuram district of Kerala. The report describes the result of a study designed to conduct field surveys to locate more individuals, record associate species, identify threats, collect seeds to germinate and raise seedlings for transplantation in near natural habitats and awareness raising program. In Palode, two mature and two juvenile trees were recorded with an area of occupancy of lower than 5 Km². The survey resulted in the discovery of one more reproductively mature tree of *B. barberi* at Navodaya School Campus, Nanniyodu about four kilometres south-east to the current location of the species. The tree grows in association with *Suregada laneolata*, *Hydnocarpus pentandrus*, *Cayratia trifolia*, *Gnetum ula*, *Chassalia curviflora*, *Piper nigrum*, *Ixora nigricans*, *Madhuca neriifolia*, *Clidemia hirta* and *Dregea volubilis*. Major threats to the species are low fruit production, low seed germination and

development programs. We collected seeds and stored in air-tight containers in the seed bank of Jawaharlal Nehru Tropical Botanic Garden and Research Institute. Seed germination experiments revealed that more than 80% seeds germinated by circa 2 weeks of incubation at 30°C. These seedlings attained a height of circa 12 cm and 8 leaves after six months in the garden. The saplings transplanted to near natural habitat showed 60-70% survival after one year and 40-50% after two years. We delivered presentations and conducted quiz activities for students and the local community, foresters, policy makers and colleagues on the current conservation status, threats and future interventions of *B. barberi*.



Young plants of *B. barberi*



Introduction

The genus *Buchanania* belongs to the family Anacardiaceae and comprises of 25 species (Mabberley, 2008). It is distributed from India to Indo-China, Taiwan, Thailand, Malaysia, Southern China, Australia and the Pacific regions (Jessup, 1985; Sosef et al., 1998; Chandrasekaran, 2005). They grow in diverse habitats from lowland forest to freshwater swamps. Genus *Buchanania* consist of small to medium sized evergreen trees but a few species such as *B. lanceolata* attains a height of 35–50 m. The timber has been used for making furniture, drawers, interior finish, household implements, canoes, cigar-boxes and pulp is

used as a fire wood. Some species are valuable as medicine and some have edible importance (Sosef et al., 1998). For example, In India, fruit of *B. lanzan* are widely consumed as dry fruits with a market rate of Rs. 600–2000/kg. In Malaysia, tannin extracted from the bark of *Buchanania arborescens* is used for fortifying fishing nets and the plant is used as a shade tree for sunny dry sites in Australia (Sosef et. al., 1998). Papua New Guinea exported approximately 59,150 m³ of pink satinwood at a price of US\$ 115/m³.

Considering the multiple uses and anthropogenic pressure on natural habitat of genus *Buchanania*, six species have been placed under different threat categories in the IUCN Red List of Threatened Species. Among these, *Buchanania barberi* is assessed as Critically Endangered, the category of extremely high risk of extinction on the IUCN Red List, while *B. vitiensis*, *B. lanceolata*, *B. platyneura* are assessed as Vulnerable and *B. obovata* and *B. insignis* as Least Concern (Dhyani et al., 2022).

Genus *Buchanania* is represented by eight species and one variety in India. Out of these, four species viz., *Buchanania arborescens*, *B. lancifolia*, *B. sessilifolia* and *B. splendens* are distributed in Andaman Islands (Karthikeyan et al., 2009). *Buchanania barberi* and *B. lanzan* var. *palodensis* are found only in Kerala (Kumar et al., 2002; 2020). *Buchanania lanceolata* is seen in India and Myanmar. *B. axillaris* occurs both in India and Sri Lanka while *B. lanzan* is distributed from India, Myanmar, Indonesia and Malaysia. Among these, *B. barberi* is categorized as Critically Endangered, *B. lanceolata* Vulnerable, *B. arborescens* and *B. sessilifolia* as Least Concern on the IUCN Red List. Fossil pollen studies revealed that *Buchanania* species were present in the tropical deciduous forests in south western Madhya Pradesh and Uttar Pradesh of India about 2400 years ago.

Buchanania barberi Gamble is a small evergreen tree endemic to Southern Western Ghats of Kerala, India. It is locally known as *Malamavu*. The species was previously reported only from its type locality, Nadarai in Thiruvananthapuram district of Kerala. Now the species survives with four trees seen along Vamanapuram river in Palode region (Thiruvananthapuram District of Kerala State) from where the species was last reported. Two of the trees are mature and two juveniles. The species is on the verge of extinction due to low fruit production, no record of seedling establishment and impact of road expansion and development programmes (Dhyani and Anilkumar, 2017).

Objectives

The present study was undertaken against the pressing need to conserve this species from the edge of extinction. It is a part of the broad aim to conserve *B. barberi* in *in-situ* and *ex-situ* conditions and also to strengthen its population by introducing individuals to potential near natural habitats. The specific objectives of this study are:

1. Conduct survey and identify *Buchanania barberi* distribution, population size, habitat characterization, threats to determine conservation status in Southern Western Ghats.
Visit herbaria, study of literature, interactive talks with field botanist and application of IUCN Red List categories and criteria (version 3.1) would be used to achieve the objective.
2. Collect and store seeds of this rare species in the seed bank of Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI).
Standard methodology would be followed: International Rules for Seed Testing (ISTA, 2017), Baskin and Baskin (2014) and 'Seed Conservation Course' obtained by Team leader from Botanic Gardens Conservation International (BGCI).

3. Identify seed dormancy, develop methods to overcome it and produce seedlings in greenhouse at JNTBGRI.

Standard methodology would be followed: International Rules for Seed Testing (ISTA 2017), Baskin and Baskin (2014).

4. Examine the feasibility of augmentation.
Seedlings of *B. barberi* will be transplanted to the near natural habitats at JNTBGRI. Seedlings will be raised in greenhouse to four leaf stage and later would be transplanted and monitored.
5. Develop an environment education campaign with local community and stakeholders.
Forest officers, students and village people nearby natural habitat of the species would be selected to conduct environment education campaign.

Geographical Setting

B. barberi is distributed in the southern part of Kerala state. Kerala is a part of the Western Ghats of India, an important geographical region in the world. The Western Ghats form a chain of low mountains running 1,600 kilometres parallel to India's western coast from the state of Gujarat to Kerala between 30-50 kilometres inland. They have some of the finest tropical evergreen forests in the world with very high levels of endemism. Believed to originate by the rupture of ancient Gondwanaland in the Jurassic period, 200-150,000 million years ago, the Western Ghats are geologically older than the Himalayas.

The climate along the Western Ghats varies with elevation and distance from the equator: the coast and lower foothills are humid and tropical and elevations above 1500 m in the north and higher in the south are more temperate. It is a biodiversity hotspot, recognized by Conservation International as one of the world's eight hottest hotspots for biological diversity. This hotspot area has at least 4,780 vascular plant species, of which 2,180 are endemic (0.7% of the world's



An evergreen forest in the Western Ghats

plants), and 1,073 vertebrate species, of which 355 are endemic to the hotspot (1.3% of the world's vertebrates) (Myers et al., 2000). They shelter at least 325 globally threatened species including 51 Critically Endangered.

The Western Ghats are divided into two subdivisions based on the distribution of endemic species: the Southern Western Ghats and the Northern Western Ghats. The Southern Western Ghats is a continuous complex hill system comprising Nilgiris, Anamalai, Palani, Agasthyamalai and

Anaphyllum, *Smithsonia* and *Willisia*. The Southern Western Ghats comprise of 62% of the total endemic plants of the Western Ghats, while the Northern Western Ghats contributed 32%. The southern part which corresponds to former Travancore (Idukki, Kottayam, Alappuzha, Pathanamthitta, Kolam and Thiruvananthapuram districts and some parts of Ernakulam district of the present Kerala State), the hill south of Palakkad gap and Agasthyamalai comprise 64% of the total endemic tree species of the Western Ghats. The target species, *B. barberi* is endemic to the Southern Western Ghats.



Balanophora fungosa sub sp. *indica*, a root parasite in the Western Ghats' forests.

Kalakkad hills which provides unique habitat and suitable niche for endemic taxa. Out of 58 endemic flowering plant genera found in India, 21 are exclusively endemic to this region: all genera are monotypic except

***Buchanania barberi*: Taxonomy, Distribution and Ecology**

B. barberi is a small tree up to 15 m tall with smooth bark. Leaves crowded toward the branch tip, elliptic-oblong, 11-14 × 3-4.5 cm, obtuse at base, obtuse or shortly acuminate at apex, glabrous above, villous along the nerves beneath. The terminal branched inflorescence often 3–12 cm long with several creamy-white flowers with 5 mm in diameter, pedicel to 2.5 mm long, bracteate ovate-acute, puberulent. The triangular



A. Habitat, B. Inflorescence, C. Fruits, D. Seeds, E. Pollen grain, F. Seed germination

creamy-white calyx lobes are 0.8 mm long and are five in number. Petals 4–5, creamy-white, to 2.5 mm long, oblong, round at apex and glabrous. Stamens 8–10, filaments are glabrous and 1–3 mm long with triangular-ovate anthers. The copular disc with 10 ridges and are pilosely hairy. Carpels are free, 4–6 immersed in the disc. Only one carpel develops to fruits and others are suppressed. Fruit is drupe, 1.5 cm across, sub-globose, slightly compressed laterally, glabrous. Seeds are ovoid, 1.3 × 1 cm with copious endosperm (Santhosh Kumar et al., 2002). Pollen grains monads, perprolate to prolate spheroidal, 28(30.9)34 µm, equatorial outline broadly elliptic, polar outline circular, tricolporate, faintly microreticulate. Colpi linear, 25(27.33)30 µm long, 1.5(1.8)2 µm wide at equator, sides

almost running parallel toward apocolpia, tips acute. Ora lalongate, 8 (9.73) 11 µm long, 5 (5.2) 6 µm at meridian, sides tapering toward the equator. Mesocolpium 8 (10.7) 14µm wide. Apocolpium 3(3.3)4 µm across. Exine 1 (1.25) 1.5 µm thick, sexine 1 (1.25) 1.5 µm thick. Nexine 0.5 µm. Tectum faintly microreticulate.

In 1916, J.S. Gamble described *B. barberi* on the basis of a single collection made by C.A. Barber in 1904 from Nadarai in the present Thiruvananthapuram district of Kerala. The species was listed as Endangered in the Red Data Book of Indian Plants in 1990 and Critically Endangered on IUCN Red List in 1998. After the first collection, this species was an enigma for almost over a century and rediscovered from Palode, Thiruvananthapuram district in 2001.

The species is included in the national priority list of endangered plants of India in 2005. It is a terrestrial subtropical/tropical moist lowland tree found at an altitude of 74 m a.s.l. (Dhyani and Anilkumar, 2017; Barstow, 2018). It has been reported in both coastal (Kumar *et al.*, 2002; Chandrasekaran, 2005) and midland slopes (Palode) (Dhyani and Anilkumar, 2017). At present the species is not found in the type locality (Nadarai), and is surviving with only a few individuals in the Palode region of Thiruvananthapuram district. The species occupies an area of less than 5 km² (Dhyani

and Anilkumar, 2017). The species is found in association with *Lophopetalum wightianum* Arn., *Terminalia paniculata* Roth., *Olea dioica* Roxb., *Holigarna arnottiana* Hook. f. and *Pterocarpus marsupium* Roxb. in the Palode region. The current population trend of this species is decreasing (Barstow, 2018). It is mentioned in the literature that the flowering and fruiting period is between October and January. Unfortunately the flowering and fruiting ratio is very low and majority of the fruits are consumed by birds and rest fall on highway road (Dhyani 2021).



A branch of *B. barberi*



Fruits of *B.a barberi*

Methodology

1. Objective one (Conduct survey and identify *Buchanania barberi* distribution, population size, habitat characterization, threats to determine conservation status in Southern Western Ghats) was addressed by conducting field surveys, visiting herbaria, studying literature, interactions with botanists and local people. The data gathered were applied to the IUCN 2012 Red List categories and criteria (version 3.1) for assessing the conservation status of the species.

Field Survey, Visit of Herbaria, Study of Literature, Interactions with Botanists and Local People

We collated information about distribution of *B. barberi* from Atlas of Endemics of the Western Ghats (Ramesh and Pascal 1997), Red Data Book of Indian Plants (Nayar and Sastry 1988), Flowering Plants of the Western Ghats (Nayar et al., 2014), IUCN Red List (for 2 assessments in 1998, and one in 2017) and other published literature

(Gamble 1916; Henry et al., 1978; Vajravelu and Daniel 1983; Vajravelu 1988; Kumar et al., 2002; Dhyani and Anilkumar 2017). *Buchanania barberi* specimens were examined in Madras herbarium (MH) and Jawaharlal Nehru Tropical Botanic Garden and Research Institute (TBGT) to identify potential localities of the species. Scientific and popular articles on *B. barberi* were collected and studied. Botanists and local people who know the species were consulted to understand the past distribution, potential locations, phenological characteristics and reason of threatened status.

Field visits were conducted to explore and identify the populations of *B. barberi* in Thiruvananthapuram district from January 2019 to December 2019. The population location and altitude were recorded with global positioning system (GPS). We identified and recorded associated species with the help of a field taxonomist. Frequent field visits were made to observe the flowering and fruiting period of the species.

2. To address the objectives two (Collect and store seeds of this rare species in the

seed bank of JNTBGRI) and three (Identify seed dormancy, develop methods to overcome it and produce seedlings in greenhouse at JNTBGRI), the following methods were used.

Seed collection and preparation

Ripe fruits were collected with the help of tree climber using plucking and shaking technique during the last week of March up to the second week of April 2019 from Palode and Nanniyodu at 20-125 m a.m.s.l. We restricted our collection to a minimum of 500 fruits taking into account 20% rule to ensure enough seeds are available for natural regeneration. The fruits were brought



to the seed bank of JNTBGRI and placed in plastic trays at ambient room temperature for less than a week and thereafter used for morphological observations and germination experiments. Standard methodology was followed for the study proposed by the International Seed Testing Association and Millennium Seed Bank Partnership resources.

Morphological parameters

To study morphology, 100 fruits were randomly selected and their length and width were measured to the nearest 0.01mm. Weight of 10 fruits in ten replicates was determined using an analytical balance measured to the nearest 0.0001g (Anamed, Model no- AA-2200DS). To study seed morphology, fruit rind was removed manually and washed in tap water for removing the juicy pulp from the seed coat. Length and width of 100 seeds (four replicate of 25 seeds) were measured using digital vernier calliper (Mitutoyo CD-6"CS Japan Made). Seeds' weight (10 replicates of 10 seeds) were recorded as per the method described above.

Viability test

Seed viability test is used to determine if the collected seeds are dead or alive. This was assessed using Tetrazolium test (TTC) and 10 seeds were used. Seeds were cut into two equal halves and soaked in 1% 2,3,5-triphenyl tetrazolium chloride (TTC) solution for 24 hrs. They were then observed for



colouration and on the basis of the gradient of red colour the viability of each seed was analysed.

Moisture content

Moisture content is the amount of water present in the seed and expressed in percentage. Moisture content of 50 seeds

(10 lots of 5 seeds) was carried out. The seeds were weighed freshly and then cut down into pieces. These pieces were placed in a hot air oven at 103°C for 17 hrs (ISTA, 2017). Moisture was calculated on the basis of dry weight.

Water imbibition

To determine water uptake by seeds during imbibition, 10 non scarified and 10 scarified seeds were used. Each seed was measured individually for weight at 4h intervals for first 24h and at daily intervals for 4 days. Each individual seed was placed in a petri dish on moist filter paper. At time zero and at the intervals stated above, each seed was taken out of petri dish, quickly surface-dried with tissue paper, weighted to the nearest 0.001 mg, and returned to the dish.

Seed storage

Seeds were stored in air-tight containers in the seed bank of JNTBGRI. To determine the effect of storage conditions on seed viability, 480 seeds were placed at two temperatures i.e., 5°C and at 30°C. Viability of stored seeds was tested using germination method at one month interval. There were four lots of 20 seeds at each trial. The seeds were placed in trays with sand and kept at 30°C for incubation.

Seed germination in laboratory

For seed germination study, manually scarified and non-scarified seeds were used. In each category 150 seeds were incubated in plastic trays on moist sand at 20°C and 30°C (12h/12h). Each germination treatment had three replicates of 50 seeds. The sand

in petri dishes was moistened with water at regular intervals. Petri dishes were wrapped with plastic film to reduce the water loss by evaporation. The seeds were observed daily and considered germinated when radicle reached >2 mm in length. Germination was monitored weekly for 6 weeks. The seeds were manually lifted and examined for radicle emergence, and the number of germinated seeds were recorded and moved to other trays.

Seed germination in Field

Phenology of radicle emergence was monitored in natural conditions at JNTBGRI garden. Seeds were placed in plastic mesh bags (0.80 mm mesh diameter) and buried



approximately 2 cm deep in soil in pots. Five replicates of 50 seeds were used for this study. The pots received natural sunlight and rainfall. The bags were exhumed twice in a week and germinated and decayed seeds were counted and removed.

Seedling growth and survival

After germination, the seedlings were moved into black polythene bags with a sterilized mixture of sand and cow dung in 3:1 ratio as a growing medium. The seedlings were placed in Tropical Botanic Garden nursery for growth and adaptation. The seedlings were monitored for growth, watering,



weeding and insect pest attack every fortnight.

3. To address the fourth objective (Examine the feasibility of augmentation) seedlings of *B. barberi* were transplanted to natural or near natural habitats.

Reintroduction of seedlings

The grown-up saplings were transplanted to near natural habitat in Tropical Botanic Garden, Palode. Some saplings were transplanted to the RET (Rare Endangered and Threatened plants) Species Park and in the Arboretum areas of JNTBGRI. More than 300 seedlings were transplanted. The saplings were labelled and monitored for watering, weeding, and insect pest every fortnight from April to September (6 months) and no horticulture treatment were adopted. The transplanted seedlings were monitored approximately every 2 months for their height and survival.

4. The fifth objective (develop an environment education campaign with local community and stakeholders) was achieved conducting outreach programmes.

Awareness raising programmes on the conservation of *B. barberi*

Information were disseminated through popular and research articles on propagation and conservation of *B. barberi* and also through developing awareness materials i.e., poster, mug, bottle, cotton bags and talks. Forest department officials, school students and village people nearby natural habitat of the species were selected to conduct awareness raising activities. Talks were conducted for local people and school children in local language (Malayalam) to enlighten them to conserve this Critically Endangered tree.



Team members in the field



Results

Field Survey, Visit of Herbaria, Study of Literature and Interactions with Botanists and Local People

Published literature revealed, *B. barberi* was described by J.S. Gamble in 1916 based on a single specimen collected by C.A. Barber in 1904 from Nadarai, Thiruvananthapuram district of Kerala.



Inflorescence

Gamble did not describe its fruits by saying '*fructus matures adhucignotus*' which means 'mature fruits still unknown'. Even after best efforts the species was not collected from the type locality or the adjacent areas.

Fortunately, during a floristic exploration in 2001 E.S. Santhosh Kumar rediscovered *B. barberi* after a lapse of 97 years from Palode region in Thiruvananthapuram district of Kerala (Kumar *et al.* 2002). Herbarium specimens available in Madras herbarium (MH) and Jawaharlal Nehru Tropical Botanic Garden and Research Institute (TBGT) reinforced us to identify the species. A total of 21 field surveys were conducted in Palode and adjacent areas to identify trees of *B. barberi*. In Palode two mature and two juvenile trees were recorded with an area of occupancy of lower than 5Km². The survey resulted in the discovery of one more reproductively mature tree of *B. barberi* at Navodaya School Campus, Nanniyodu about four kilometres south-east to the current location of the species.

Phenology

The flowering and fruiting period was observed during October and January. Fruits began to ripe after the middle of March.

Table 1. Location details of *B. barberi*

Locations	Altitude (masl)	Aspect	Associated species	Threats
Palode	74	South West	<i>Suregada laneolata</i> , <i>Hydnocarpus pentandrus</i> , <i>Cayratia trifolia</i> , <i>Gnetumula</i> , <i>Chassalia curviflora</i> , <i>Piper nigrum</i> , <i>Ixora nigricans</i> , <i>Madhuc aneriifolia</i> , <i>Clidemia hirta</i> , <i>Dregea volubilis</i>	Low fruit production, no record of seedling establishment, low seed germination, development programmes i.e., road expansion
Naniyodu	129	South West	-	Low fruit production and human activities

Seed morphology

Fruits were brownish red, obliquely ovoid or elliptic, smooth, measured to a length of 16.18 ± 1.34 mm and width of 15.68 ± 1.12 mm. Seeds were ovoid, curved inward at one end, rough, greyish black, had a length of 12.26 ± 0.73 mm and width of 11.27 ± 0.71 mm. Variation in the seed size was observed from the seeds collected from Navodaya school campus: small ones measured 10.23 ± 1.03 mm width and 11.56 ± 1.34 mm length. Weight of 10 seeds was recorded 20.68 ± 3.84 g. Seed purity was recorded 60% and chaff seeds were empty.

Table 2: Fruit/seed morphological characters

Character	Observation
Fruit colour	Brownish red
Fruit shape	Obliquely ovoid or elliptic
Surface texture	Smooth
Fruit size	16.18 ± 1.34 mm length x 15.68 ± 1.12 mm width
Seed colour	Greyish black
Seed shape	Bean-shaped
Surface texture	Rough
Seed size	12.26 ± 0.73 mm length x 11.27 ± 0.71 mm width

Viability test

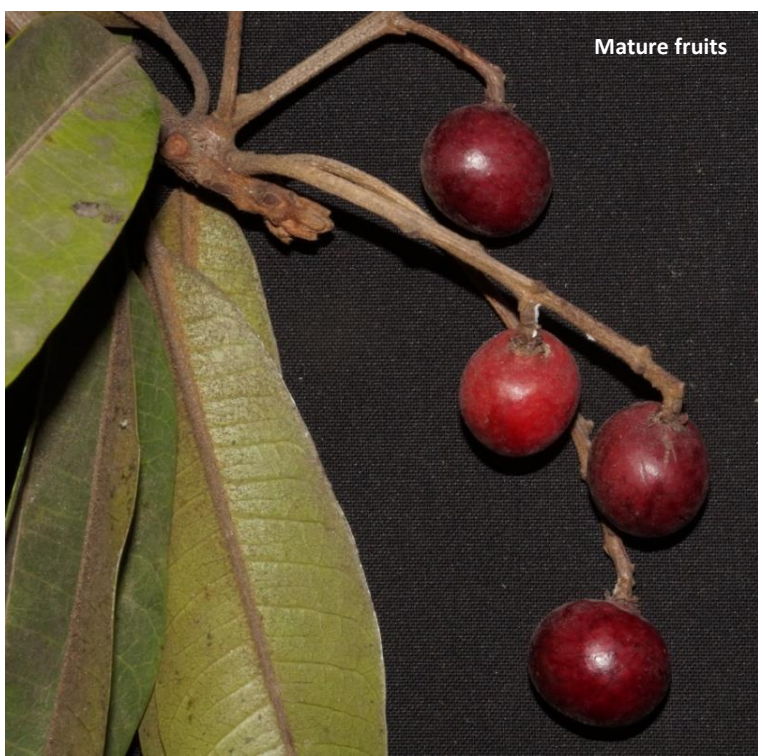
Seed viability test revealed that the seeds of *B. barberi* hold 100% viability at the time of collection.

Moisture content

Moisture content of fresh seed was recorded as $11.00 \pm 0.23\%$.

Water imbibition

Seeds started to absorb water as soon as they were placed on a moist substrate. After 24 h of imbibition, moisture content increased to 11.18 % of the initial seed weight. By 48 h seeds



Mature fruits



moisture content was 42.37%. After 72 h seeds become fully imbibed with a moisture content of circa 47.41%.

Seed storage

One hundred seeds were stored in air-tight containers in the seed bank of JNTBGRI. At the time of collection 100% seeds were viable. The viability of seeds stored at room temperature (30°C) remained 47.5% (germinated seeds) after 2 months. Seeds stored in the refrigerator at 5°C did not show viability.

Seed germination in Laboratory

Radicle emerged from more than 50% of the seeds at 30°C. In non-scarified seeds, the percentage of radicle emergence was 86% by circa 2 weeks of incubation at 30°C. In scarified seeds, radicle emerged from 52% of the seeds after circa 2 weeks of incubation at 30°C. Seeds placed at 20°C did not produce radicle after 3 months of incubation.

Seed germination in Field

Seeds in field condition did not produce radicles and were found damaged. It was due to heavy rain fall after the day of sowing. It indicates that excess water

may injure the seeds and prevent germination in nature.

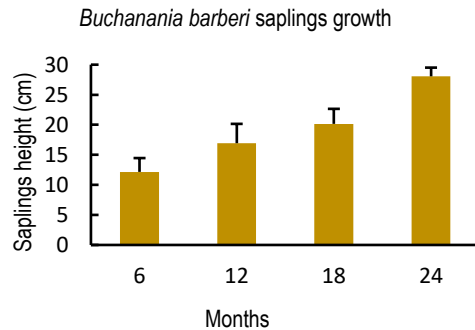
Table 3: Seed germination in laboratory and field conditions

Treatment	Germination %
Field	0
20°C	Scarified – 0 Non-scarified – 0
30°C	Scarified – 52±9.17 Non-scarified - 86±2.65

Seedling growth, Reintroduction and Survival

Germinated seeds were planted in black polythene bags with sand and cow dung as medium. The saplings attained a height of circa 11-12 cm and 7-9 leaves (7.91 x 2.74 cm) after six months in the garden. These saplings have a well-developed root system and transplanted to near natural habitat. Plants show 16cm height with 70% survival after one year and 40-50% survival with 28 cm height after two years of transplantation. Due to covid-19 pandemic data collection was affected during 2020-21. Now the plants are growing well with 24 cm height and 40% survival rate. From the observation, seedling growth and

survival was found better due to protection and less human disturbance like human trampling for firewood collection, seedlings grazing by wild and domestic animals.



Awareness raising programmes on the conservation of *B. barberi*

We used different approaches to disseminate and communicate the results of this project for raising awareness on threat factors and need for conservation of *B. barberi*. We delivered presentations and conducted quiz activities for students and the local community, foresters, policy makers and colleagues on the current conservation status, threats and future interventions of *B. barberi*. Besides, project results were published as articles in BG Journal- Journal of Botanic Gardens Conservation

International, Imperiled: The Encyclopedia of Conservation Vol. 1, Elsevier, The IUCN Red List of Threatened Species, Plant Conservation Report- BGCI. The tree conservation need featured in different national and international Media such as IUCN Red List, Global Tree Campaign, The Art Exhibition 'The Endangered- Can Art Save Them' USA 2021, The Hindu newspaper.

A poster describing the status, threats and conservation actions of *B. barberi*, water bottles, mugs and bags carrying the messages of conservation were developed as a part of this programme. JNTBGRI team visited the Forest Range Office, Palode, Kerala forest Department, Thiruvananthapuram, three schools (1. Government High School, Jawahar Colony, Palode, 2. Upper Primary School, Karimancode, Palode, 3. Govt. Lower Primary School, Karimancode, Palode- all in Thiruvananthapuram District) and distributed saplings, awareness posters, bags mugs and bottles. Approximately 150 students participated in the talks that were carried out at their schools. Quiz programmes



Outreach programme in a school



Conclusion and Recommendations

Buchanania barberi occurs only in two locations at present, one at Palode and other at Navodaya School Campus, Nanniyodu, together within an area of 5km². Developmental activities in the region erased the subpopulation of the species from its original type location. There are many reasons for the drastic decline in number of individuals of *B. barberi* and the assessment of the species as Critically Endangered. Developmental activities in the coastal areas from where the type specimen was collected may be the cause of local extinction. We also reported very low fruit setting when compared to the total numbers of flowers produced. Data on seedling establishment in the natural habitat has not been observed in the present survey. Fruit predation by birds and other predators is also very high. In addition, seed germination is delayed or restricted due to dormancy issues and unfavorable natural conditions, causing regeneration pressure for the species. Additionally, climate change is impacting the species causing the falling of premature seeds due to unexpected summer rain and extreme temperature. Fungal attack on the dispersed fruits also leads to a lower rate of seed germination and contributes to decline in population size. Predation of immature fruits prevents after ripening and fungal attack reduces the scope of the soil seed bank. Human threats continue to the species in the form of increasing developmental programs like road expansion, which causes the death of young plants and trees. These threats have pushed the species to the verge of extinction. The species persists in the wild with a very small number of mature individuals and



were also conducted for students on the conservation of this species based on our awareness classes. Awareness posters, bags, mugs and bottles were presented to the winners as the token of appreciation. Students and teachers planted seedlings in their schools and have been monitoring and informing the growth of planted seedlings.



Transplanted seedling in the field

juveniles, which remain in a small area that is still threatened by habitat loss. Another observation was rat attack. They damaged stored seeds as well as incubated seeds by making holes and ate endosperm along with embryo. Also during the initial stages of seedlings they consumed the cotyledons and thus damaged seedlings.

One of the most important and immediate actions that should be taken to save *B. barberi* is to protect the current remaining trees and habitat in the wild. However, this is not an easy process as there are multiple limiting

factors in terms of the species biology and variety of human stakeholders in the area. The first step should be to continue to raise conservation awareness through a variety of programs with the local people and children regarding the importance of conserving this species and the habitat. In addition basic training needs to be given to children and local people to identify the trees and seedlings of *B. barberi* so that new individuals if any in the locality can be discovered. The second major step, is to work toward solving the biological issues that limit the species survival. This will involve continue the production of a large number of saplings and transplanting them to the nearby natural forests, school campuses, government offices, homes and other areas. The survival of planted seedlings should be monitored and arrangements may be made for protecting the seedlings from any kind of destruction. Besides raising seedlings from seeds other propagation methods like micro propagation, air layering and grafting may also be explored for *B. barberi* to enhance propagation. Such efforts would help to save one of the endemic and Critically Endangered trees of the Western Ghats.



Transplanted seedlings



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2011-2020
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The Exhibition

The art exhibition titled “The Endangered – Can Art Save them” was organized by the US-based organization called Art Impact International. It was held in seven 3-D online galleries from November 7, 2020 to January 9, 2021. As many as 127 artists who cared about the environment from across the world, participated in the show in an attempt to raise concerns and spread awareness about the disappearing biodiversity.

The Painting – *Buchanania barberi* flowers: The artist (Reema Abraham) was in total awe to hear the story of *Buchanania barberi*, how there were only two flowering trees in the whole wide world, how critically endangered it was and how the conservation scientists at the Jawaharlal Nehru Tropical Botanic Garden and Research Institute persisted with their efforts and successfully raised the seedlings. What would have gone extinct without so much as the slightest whimper was brought back to life and the artist thought it was something the world

should know about. And that was how the white and gold flowers of the near-extinct *Buchanania barberi* became the subject of the painting for the International art exhibition.

About the artist: Reema Abraham fell in love with colours at a very young age. If rainbows delighted her as a child, the microscopic world of science and its colours filled her with wonder. As a student of science, Reema was fascinated by the brilliantly-hued flame tests, the very colourful ash tests and the way tissues took up different biological stains. A National Award-winning journalist, Reema gave up journalism to explore the world of oil and acrylic colours. Prior to journalism, Reema, who holds a Masters degree in Genetics and Plant Breeding, had worked as a guest lecturer in the Department of Botany, University of Kerala. She was also a research scholar both at the University of Kerala and at the Jawaharlal Nehru Tropical Botanic Garden and Research Institute.



Painting of *B. barberi* by Reema Abraham

Team Members



Anurag Dhyani, PhD is Scientist in the Division of Conservation Biology at Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI) since 2016. He worked as Senior Researcher for Dabur India Limited, Uttar Pradesh during 2010-2012, Scientist at Institute of Horticulture Technology, Greater Noida, Uttar Pradesh from 2012-2013, and Assistant Professor of

Botany at Mekelle University, Mekelle, Ethiopia during 2013-2016. His specialization includes conservation assessment, seed storage, propagation, domestication and translocation of threatened plants. He is Research Coordinator for Royal Botanic Gardens, Kew, United Kingdom and Focal Point for Ex-Situ Conservation, Seed Conservation Specialist Group IUCN (2016-2020). He received funding from The New Phytologist Foundation UK, The Mohamed Bin Zayed Species Conservation Fund UAE, Botanic Gardens Conservation International UK, Mekelle University Ethiopia and Rufford Small Grants for Nature Conservation London UK. He is recipient of Indian National Science Academy (INSA) Visiting Scientist Award 2017 and 2021 and Alice J. Murphy Outstanding Award USA 2009. He is a member of Global Tree Specialist Group IUCN, Partner of Tree Conservation Fund Botanic Gardens Conservation International, North American Lily Society. Dr. Dhyani is serving as Editor for Plants People Planet, Associate Editor for Conservation Science and Practice and Frontiers in Conservation Science, Editorial Board member of Journal of Seed Science, Journal of Sustainable Forestry, Neotropical Biology and Conservation.



Bindu S, PhD is serving as Technical Officer in JNTBGRI for the past 22 years, mainly focusing on seed conservation activities including seed collection, dormancy, storage and germination aspects. She has authored/co-authored one book, 19 research articles and 14 oral/poster presentations. She is member of IUCN SSC Seed Conservation

Specialist Group IUCN.



Santhosh Kumar ES, PhD is working as a Technical Officer in the Garden Management Division of JNTBGRI. His areas of expertise are Plant Taxonomy, floristic study, ex situ conservation of wild plants genetic resources, gardening, etc. He described 50 novel taxa from the Western Ghats and has authored/co-authored 2 books, more than 150 research papers and several popular

articles. He is a Fellow of the Linnaean Society, London and a member of IUCN Western Ghats Plants Specialist Group.



Suresh S, PhD is working as a Technical Officer in the Division of Conservation Biology at JNTBGRI for the last thirty years. Specialised in the areas of seed dispersal ecology, pollination ecology, plant population demography and analysis of pollen morphology in relation to plant animal interaction in the tropical evergreen

forest ecosystems of the Western Ghats. He has authored/co-authored 30 research articles and 20 oral/poster presentations.



Abinlal KC, is a Ph.D. student at Division of Conservation Biology, JNTBGRI. He is working in field and laboratory to understand population structure, seed storage, propagation methods and translocation to conserve a Critically Endangered and Endemic tree, *Garcinia gamblei* in the Western Ghats of India. He is also engaged in raising large number of

seedlings of *Santalum album* to transplant in natural habitat.



Vincy K Wilson, is a Ph.D. student in the Department of Ecology and Environmental Sciences at Pondicherry University. She does research in Forest ecology and functional trait analysis. She is currently working in Uppangala (Pushpagiri WS) - Central Western Ghats in association with the French Institute of Pondicherry. She is interested in understanding the relationship between environmental

and edaphic features with plant diversity, composition, distribution, and biomass.

MBZSCF Final Report



Conservation of Endemic and Critically Endangered **Buchanania barberi** in India