Meridian
Vol. 9 (1). 45-55. January 2020
ISSN: 2278-750x

Phenology, Association and Seedling Establishment of Endangered *Canarium Strictum* Roxb., Sholayar Forests, Western Ghats

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Abstract

Canarium strictum Roxb. (Burseraceae) is an important and endangered evergreen forest trees distributed in India and Upper Myanmar at an elevation of 750 m – 1400m. This tree is getting depleted due to degradation of evergreen forest and also due to dying off due to extraction of resin for medicinal and commercial use. The present study in the Vazhachal forests with in the Anamalai landscape of Western Ghats brings low its lowest elevation distribution ever recorded 235m at Vazhachal, its threat, seedling establishment and phenology. Flowering and fruiting of *Canarium strictum* ranges from December to January. Early dying off of mature trees due to over extraction for resin as a result of forest conversion and increased intensity of extraction within the available locations are the reasons for less number of mature individuals. The sapling density in the forest indicate it as a rare tree when compare with other associated species such as *Palaquium ellipticum, Litsea floribunda*, *Cullenia exerillata* etc. Lesser density near parent trees. Comparatively less sapling density near the parent trees, also in the forest areas indicate the through light on the role of dispersal agents. The Great hornbills and smaller mammals such as civets found to depend on fruits and disperse seeds.

Key words: *Canarium strictum*, Endangered, Phenology, Seedling and sapling establishment.

Introduction

Canarium strictum Roxb. is an important rainforest tree species coming under the Burseraceae family distributed within the wet tropical forests of India and Upper Myanmar (theplantlist.org). The tree is well known for the medicinally and commercially important resin 'Black Dammar' extracted from the bole. Black dammar has been used traditionally to cure numerous ailments including rheumatism, cough, asthma, epilepsy, syphilis, hernia, fever, chronic skin diseases and hemorrhage (Revikumar and Ved, 2000). Distribution of this 35-40 m tall tree is reported to be in the wet forests at an elevation of 750-1400m (envis@frlht.org).

Understanding the events of flowering and fruiting phenology is important for understanding the ecology and evolution of plant communities (Newstrom *et*

*al.,*1994, Okullo *et al.,* 2004). Phenology is a critical history trait that strongly influences reproductive success (Rathcke and Lacey, 1985). Phenological events are mainly constraints by the seasonal climatic variables such as maximum temperature and rainfall (Venkatesh *et al.,* 2011).

The study area the forest areas of Vazhachal forest division comes under the Anamlai part of Western Ghats within the Kerala state. The area represents continuous rainforest stretches with adjacent forest ares of the Parambikulam Tiger Reserve, Nelliyampathy forests, Emalayar Valley within Kerala and Valparai part of Indira Gandhi National park in the Tamil Nadu Part. The Vazhachal forest contains nearly 84 % evergreen primary forests (Bachan, 2019) within the 400 km^2 total area suitable for *Canarium strictum* Roxb. The indigenous people like Kadars, Malayar and Mudhuvans are frequently depending on this this tree for the resin as a Minor Forest Produce for their livelihood. for the resin for commercial purpose. Since the resin extracted from *Canarium strictum* is of high importance in commercial field, the plant is getting exploited tremendously in recent years. It results in a high mortality rate of this plant. The plant is considered mainly due to its extraction (Tambat *et al.,*2005). There is no detailed published information on the demography of *Canarium strictum* (Varghese and Ticktin, 2008). The present study purports to study the association, seedling density and phenology of *Canarium strictum*.

Study Area

The Vazhachal division comes under the Central Circle Kerala Forest Department, Thrissur. It is located between 10”5.5’and 10”23’N and 76”9’and 76” 53’E along the Western Ghats of Kerala with an area of 413.93km”. The areas of this Vazhachal forest division were formerly parts of Chalakkudy division and industrial plantation division of Perumuzhi and Vazhachal. The present Vazhachal forest division came into existence with the effect from 01-08-1981, with its headquarters at Chalakkudy (Fig 1). The present vazhachal forests division has a total forest area of 353.413 sq. Kms of which 298.841 sq.kms are natural forests, 37.8078 sq. Kms teak plantations, 16.7642 sq.kms of teak and elavu mixed plantations (Bachan, 2019).

Methodology

In the study, comparatively dense medium elevation, evergreen areas of Sholayar Range of Vazhachal forest division was selected for sampling. Area was gridded into 4×4 km grids. Sampling *Canarium strictum* locations were taken based on previous occupancy data (Pers. Comm.). Four grids are then selected for sampling, where at least three *Canarium* trees are seen. Plots were then laid in these twelve locations.

Meridian
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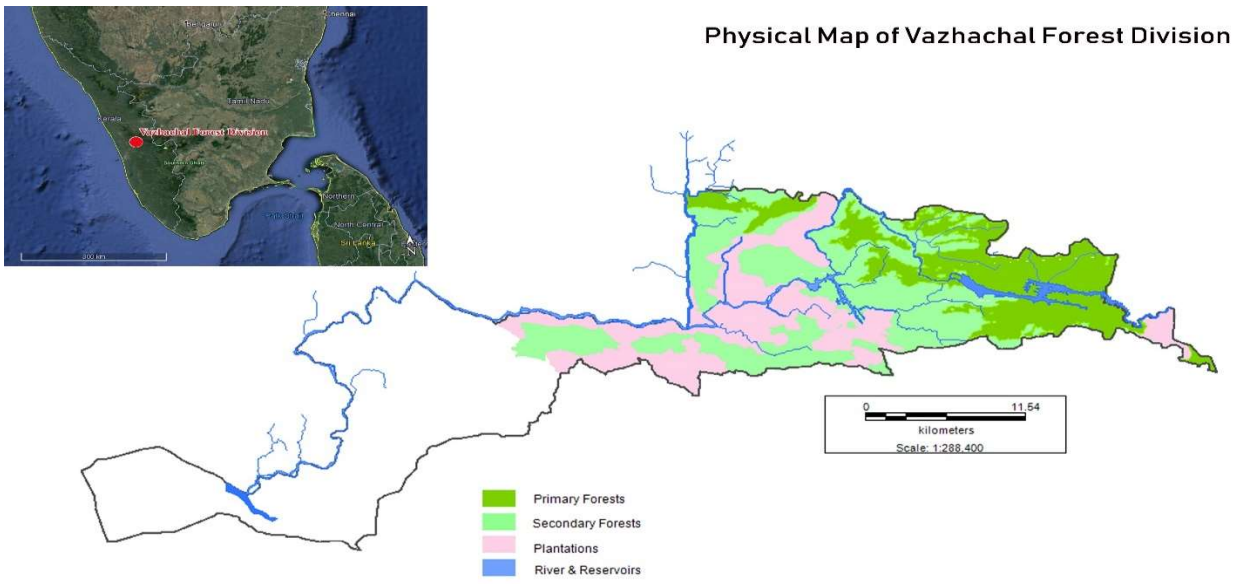

Fig: 1 Study area: Vazhachal Forest Division

Flowering phenology

As the study limited to a short period the method used in phenological studies was field level observation and collecting secondary data. Field level observation could not find good outputs for it was not in flowering season. Collection of data from herbarium records was preferred to study flowering phenology, according to Boulter *et al.,* 2006 and the method is more convenient to study flowering phenology in short periods. Data concerning flowering season, altitude, distribution, local names, characteristics of flower and type of soil were collected from herbarium records of University of Calicut (CALI), and Kerala Forest Research Institute (KFRI), Peechi.

Characterization of associated vegetation

Plots having 10m radius with centrally located mature *Canarium* tree was selected in predetermined twelve locations. Number of species, girth at breast height (GBH), height, etc. was recorded from each plot. Plot data were then subjected to cluster analysis for species similarity, dissimilarity in order to understand the heterogeneity of associated vegetation. Each then obtained clusters were analyzed for phytosociological analysis like frequency, distribution, basal area, IVI etc. From IVI, important species were listed out as the characteristics of the associated vegetation.

Seedling establishment

3×1m quadrates were laid three each at all the twelve sampling locations near to the mature Canarium tree. Species were listed out for the seedlings and saplings. Seedlings of previous season having less than 1m height were considered as seedlings. Seedlings

greater than 1m considered as saplings of seedlings with one- or two-year maturity. All these also analyzed for composition, phytosociological analysis such as frequency, distribution, basal area, IVI etc. Seedling establishment for *Canarium strictum* is observed separately and analyzed and that of other important species are also analyzed for a comparison.

Result and Discussion

1. Flowering Phenology of Canarium

Nomenclature and description

CANARIUM Linnaeus, Amoen. Acad. 4: 121. 1759.

Canarium strictum Roxb., Fl. India 3: 138. 1832; Bennett in Hook. f., Fl. Brit. India 1: 534. 1875; Gamble, Fl. Pres. Madras 172. 1915; Manilal, Fl. Silent Valley 47. 1988; Cook, Fl. Bombay 1:202. 1902; Saldanha, Fl. Karnataka 2: 199. 1996. Sasidh. & Sivar., Fl. Pl. Thrissur For. 86. 1996; Chithra & A. N. Henry in Hajra *et al*., Fl. India 4: 440. 1997; N. Mohanan & Sivad., Fl. Agasthyamala 147. 2002; Sasidharan, Biodiversity documentation for Kerala- Flowering Plants, part 6: 86. 2004; Anil Kumar *et al.,* Fl. Pathanamthitta 115. 2005; A. N. Henry & Chithra in P. Daniel Fl. Kerala 1: 628. 2005.

Vernacular names: Tamil: Karunkungiliyam. Karagkunthrikam. Malayalam: Pantham, Pnathappayan, Thelli, Viraka, Thellippayin, Kannada: Nalla rojanamu. English; Black dammar, Doopa, Black dhup, Indian white-mahogony.

Large buttressed trees to 30 m high; resinous; exudation aromatic, brownish-black, branchlets velvety-tomentose. Leaves imparipinnate, alternate; rachis 22-35 cm long, tomentose, swollen at base; leaflets 7-11, opposite; ovate, ovate-lanceolate; acute or oblique at base, acuminate at apex, to 26 x 11 cm, crenulate, glabrous above, rusty tomentose beneath, coriaceous; lateral nerves 15-20 pairs, parallel. Flowers polygamous, small to 5 mm across, bright yellow in large axillary panicles. pedicles elongate; calyx 4 mm, pubescent; lobes 3, valvate; petals 3, white, 1 cm long, oblong, pubescent without; disc obscurely lobed, pilose above; staminal tube to 3 mm; filaments 0.5 mm; anthers subequal; ovary superior, to 3.5 mm, 3-celled. Fruit a drupe, 3.5 x 1.5 cm, ellipsoid, dark blue, 1-3-celled; seeds 1-3.

Flowering & Fruiting: December-January.

Distribution: India and Upper Myanmar. Evergreen forests, riparian evergreen vegetation. Indian Subcontinent: India - Arunachal Pradesh, Assam, Karnataka, Kerala, Meghalaya, Orissa, Sikkim, Tamil Nadu.

Ecology: Occasionally canopy trees in the evergreen forests up to 1600 m.

Economic importance: Gum/resin, wood and folklore.

Specimens Examined: *Amitha Bachan 98904* (Karanthodu-Vazhachal, riparian vegetation, banks of Chalakkudy river, 400 m), *Philip Mathew 33942* (Thalichola), *Sasidharan 475*, (Nadukani, way to Gudallur, evergreen forest,) 757 (Walayar, evergreen forest, 400m), *K.S Prasannakumar* SV10291

(Valiyaparathode,1350m) & 5036 (Karadippara, Peechi, Thrissur, evergreen forest 300m) & *Somy Augustine 13479* (Uppupara, evergreen forest, 1200m).

Note: From the herbarium and secondary data, flowering and fruiting phenology of *Canarium strictum* ranges from December – January.

Fig 2. *Canarium strictum* Sapling

Fig 3. Mature *Canarium strictum*

2. Important Associated Tree species of *Canarium strictum* Roxb.

Based on the IVI data of trees in 12 plots having 10m radius, associated species of *Canarium strictum are Cullenia exarillata, Palaquium ellipticum, Vateria indica, Diospyros, montana, Litsea floribunda, Alseodaphne semicarpifolia, Aglaia perviridis, Mesua ferra and Callophyllum polyanthum. Cullenia exarillata* and *Palaquium ellipticum* shows the highest IVI values of 33.31 and 29.30 respectively (Fig 4).

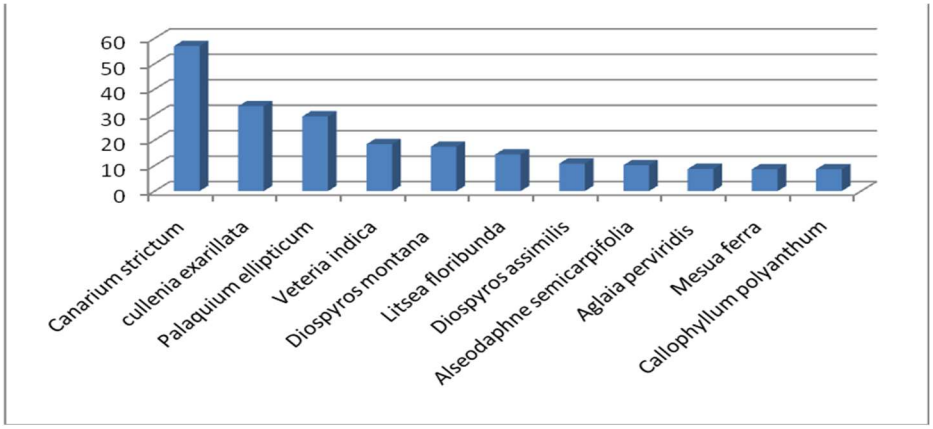

Fig 4. IVI of *Canarium* and associated species

3. Associated Dominant Seedlings with *Canarium strictum* Roxb.

From the IVI values of seedlings in 36 rectangular plots having 3×1m, associated seedlings with *Canarium strictum* are *Strobilanthes species, Schleichera oleosa, Calamus thwaitesii, Palaquium ellipticum Litsea floribunda Chennari* and *Syzygium mundagam. Strobilanthes* and *Schleichera oleosa* shows the highest IVI values of 22.68 and 15.5 respectively (Fig 5).

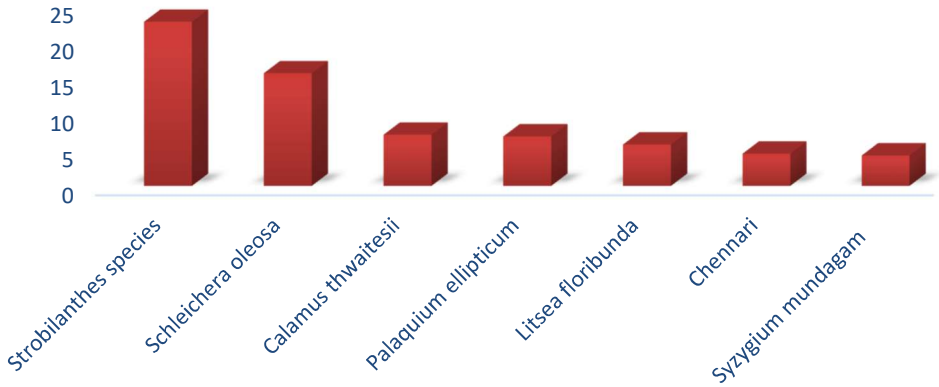

Fig 5. IVI seedlings

Meridian
Vol. 9 (1). 45-55. January 2020
ISSN: 2278-750x

4. Associated Dominant Saplings *with Canarium strictum* Roxb.

Based on the IVI of saplings in 36 plots having 3×1m, associated saplings with *Canarium strictum.*are *Chionanthus mala-elangi, Strobilanthes sps, Schleichera oleosa Syzygium mundagam, Aglaia perviridis, Palaquium ellipticum, Pterygota alata, Agrostistachys borneensis, Peenari, and Diospyros assimilis. Chionanthus mala-elangi* and *Chennari* shows the highest IVI of 12.49 and 11.51 respectively. *Canarium strictum* shows the least IVI value of 1.39 (Fig 6).

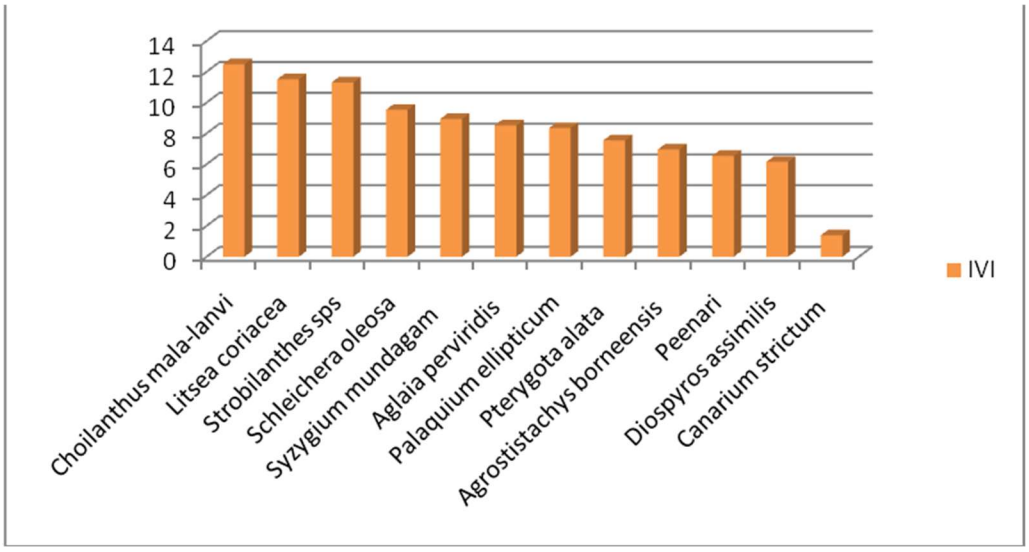

Fig 6. IVI saplings

5.Seedling and Sapling Establishment of C*anarium strictum* Roxb.

From the density analysis of *Canarium strictum* with respect to its seedling, sapling and trees, it is observed that maximum density of mature *Canarium strictum* trees can be 13.8 per hector in its habitat. Density of *Canarium* saplings beneath a mature tree bears a very poor value of 0.03and its seedling beneath a mature tree are negligible. This shows that establishment of seedling and sapling of *Canarium strictum* beneath its parent plant is very poor (Fig 7).

Some of the possible reasons for the observations are:

- Role of seed dispersal agents in dispersal and germination
- There could be some kind kind of inhibition to gem nation near parent tree otherwise
- Less number of effectively seed producing mature *Canarium* trees due to over increased threat of extraction

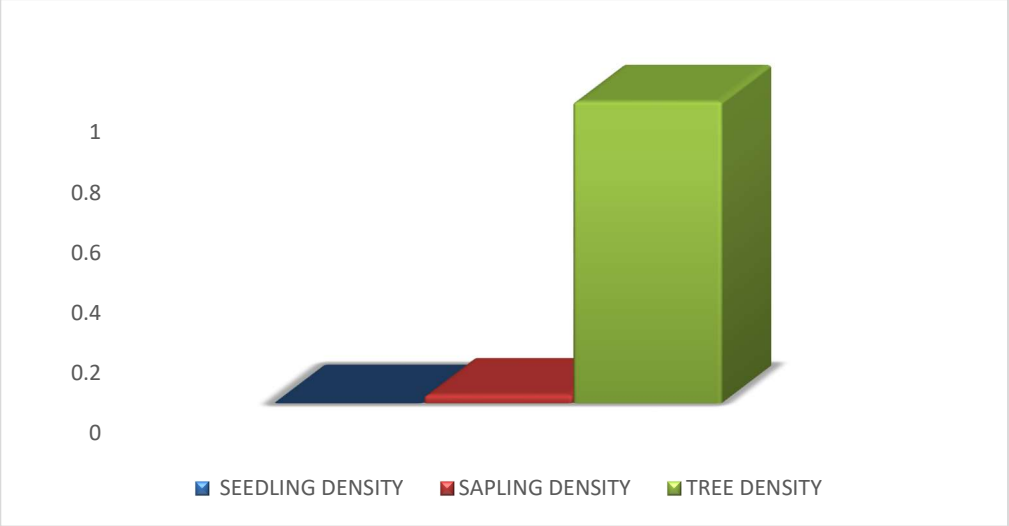

Fig 7. Graph Seedling and sapling establishment of *Canarium strictum*.

6. Seedling establishment rate for important species

On comparing the density data of *Canarium strictum* with some other important associated species, *Palaquium ellipticum*, *Litsea floribunda* shows high number of seedling as well as sapling near the parent tree as usual in the case of evergreen forest trees. In *Cullenia exarillata*, a species which is being dispersed by Lion tailed macaque and with few years of dormancy shows a similar data for the seedling and sapling establishment (Fig 8).

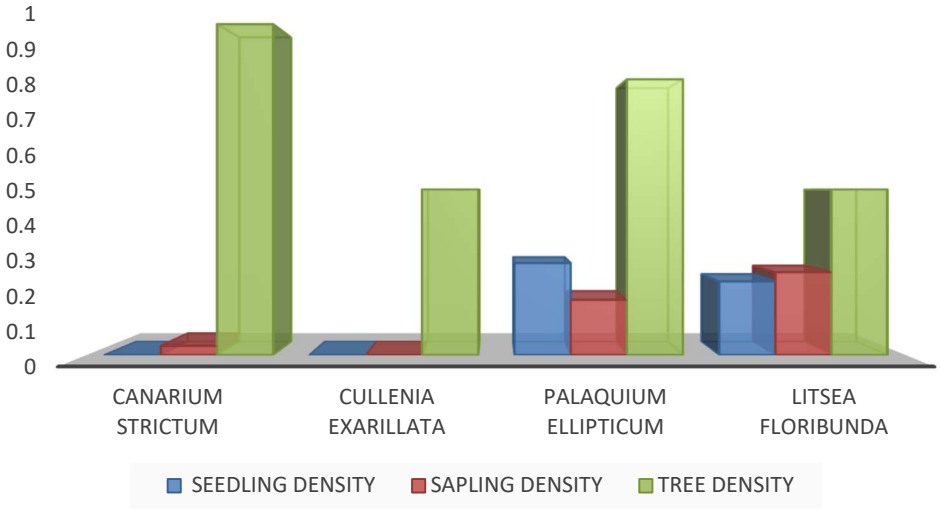

Fig 8. Density of standard trees

Fig 9. *Canarium* resin and its burned bark

Summary and Conclusion

Flowering and fruiting phenology of *Canarium strictum* ranges from December to January in the study area. Associated species of *Canarium strictum* are *Cullenia exarillata, Palaquium ellipticum, Vateria indica, Diospyros montana Litsea floribunda, Alseodaphne semicarpifolia, Aglaia perviridis Mesua ferra* and *Callophyllum polyanthum. Cullenia exarillata* and *Palaquium ellipticum* shows the highest IVI values of 33.31 and 29.30 respectively in its community. Associated seedlings with *Canarium strictum are Strobilanthes species, Schleichera oleosa, Calamus thwaitesii, Palaquium ellipticum Litsea floribunda Chennari* and *Syzygium mundagam.* Associated saplings with *Canarium strictum* are *Chionanthus mala-elangi, Strobilanthes sps, Schleichera oleosa Syzygium mundagam, Aglaia perviridis, Palaquium ellipticum, Pterygota alata, Agrostistachys borneensis, Peenari,* and *Diospyros assimilis.* The present study in the Vazhachal forests with in the Anamalai landscape of Western Ghats brings low its lowest elevation distribution ever recorded 235m at Vazhachal, Early dying off of mature trees due to over extraction for resin as a result of forest conversion and increased intensity of extraction within the available locations (Sabeena *et al.,* 2016) are the reasons for less number of mature individuals. The sapling density in the forest indicate it as a rare tree when compare with other associated species such as *Palaquium ellipticum, Litsea floribunda*, *Cullenia exerillata* etc. Lesser density near parent trees. Comparatively less sapling density near the parent trees, also in the forest areas indicate the through light on the role of dispersal agents. The Great

hornbills and smaller mammals such as civets found to depend on fruits and disperse seeds.

Being an important MFP resource of the local tribal people, medicinally and commercially important tree and important rare component wet evergreen forests proper conservation strategies has to be adopted for *Canarium strictum* Roxb. This can include 1. Studies on role of seed dispersal agents in germination, 2. Development of seedlings and ecorestoration process in the degraded forest areas, 3. Rotational harvesting practice for the tribal people and has to be discussed in the community level and can be included in the CFR management plans of the Tribal Grama Sabhas and forest Management Plans. 4. Engage tribal people in monitoring of the health of the trees (Bachan and Anitha, 2013; Bachan, 2019) and provide incentives for monitoring as a compensation for reduction in livelihood of indigenous people and the degradation of habitat due to developmental activities from the green funds including RED++.

Acknowledgement

The authors are grateful to DFO, Vazhachal Forest Division for the necessary permissions in carrying out the study. We thank the members and volunteers of Western Ghats Hornbill Foundation for the support.

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Received: 15th December 2019
Revised and accepted: 25th January 2020
Published: 31st January 2020