



## POPULATION STRUCTURE AND REGENERATION OF *DALBERGIA LATIFOLIA* ROXB. AND *D.SISSOIDES* WIGHT & ARN. IN KERALA AND TAMIL NADU, INDIA

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### ABSTRACT

*Dalbergia latifolia* Roxb. and *D.sissoides* Wight & Arn. are the two important precious timber tree species of India. *D. latifolia* is distributed in many parts of the country from the sub-Himalayan tract to Southern India, whereas *D.sissoides* has a restricted distribution in the Western Ghats, from the hills of Karnataka southwards to Pulneys and Kerala. Of late, the populations of *D. latifolia* and *D.sissoides* have been dwindling considerably in the forest areas and *D.latifolia* has been categorised as “Vulnerable” in the Red Data book of IUCN. The study on regeneration of forest trees has important implications for the management of forest genetic resources, especially that of precious timber species like *D.latifolia* and *D.sissoides*. In this context, a study was undertaken during 2011 to 2017 in the forest areas of two States - Kerala and Tamil Nadu to assess the natural regeneration and population structure, so as to determine the status of these species, so that suitable managerial interventions could be made to conserve them. Out of 14 Forest Divisions of Kerala surveyed, natural regeneration of *D.latifolia* was found to be good in only six divisions viz. Thrissur, Kannur, Munnar, Malayattoor, Nilambur South and Nemmara. In rest of the eight divisions, saplings were not recorded and only seedlings were available. Of the seven Forest Divisions of Tamil Nadu studied, *D.latifolia* was recorded in six divisions. Salem division exhibited good regeneration, whereas it was fair in Erode, Coimbatore and Tirunelveli divisions and there was no regeneration in Theni and Dharmapuri divisions. Presence of *D.sissoides* was recorded in only seven divisions of Kerala and among them in five divisions viz. South Wayanad, Chalakudy, Thrissur, Palakkad and Munnar there was no regeneration. In Mannarkad and Nemmara divisions, only seedlings were present and saplings were totally absent. Among the seven forest divisions surveyed in Tamil Nadu, there was no regeneration of *D.sissoides* in Coimbatore, Theni and Tirunelveli divisions. Saplings were not recorded in Gudalur division and only seedlings were available. Thus, overall natural regeneration of *D.sissoides* in both the States was found to be in an “alarming” situation. The girth class-wise population of *D.latifolia* trees in Kerala revealed that nine divisions namely Mannarkad, Chalakudy, South Wayanad, North Wayanad, Kannur, Malayattoor, Munnar, Ranni and Thiruvananthapuram had healthy population structure and the rest of the five divisions viz. Palakkad, Nemmara, Nilambur South, Konni and Thrissur had unhealthy population structure. In Tamil Nadu, *D.latifolia* populations of Coimbatore, Erode and Theni divisions were of healthy nature, while other divisions like Salem, Dharmapuri and Tirunelveli did not have healthy populations. The population structure of *D.sissoides* occurring in Mannarkad and Nemmara divisions of Kerala was found to be healthy, while in rest of the five divisions like Chalakudy, Thrissur, Palakkad, South Wayanad and Munnar, it was not of healthy nature. *D.sissoides* in Theni and Gudalur divisions of Tamil Nadu had more or less healthy

populations, whereas Coimbatore and Tirunelveli division did not have healthy population structure. The overall population structure of Dalbergias showed that the contribution of seedlings to the population of saplings and trees was very poor. The seedling and sapling stages were much vulnerable to the impact of fire, grazing and weed competition. An enumeration of the important tree associates of both the species revealed that they have species association characteristic to the respective forest types which harbour them. The present population structure of both the species in Kerala and Tamil Nadu has indicated that they are likely to encounter severe threat in future due to various biotic and abiotic factors, including the climate change, if timely managerial interventions are not made. Therefore, both the species should be prioritized as important “Forest Genetic Resources” and get the required attention for *in-situ* and *ex-situ* conservation. Artificial regeneration of these species has also to be taken up so as to augment the declining population in the natural forests.

**Keywords:** Natural regeneration, population structure, conservation, forest genetic resources

## INTRODUCTION

*Dalbergia latifolia* Roxb. and *D.sissoides* Wight & Arn. are two precious timber species of India. They are normally distributed in the moist deciduous and dry deciduous forests or sometimes in the semi-evergreen forests of the country. *D.latifolia* occurs in the sub-Himalayan tract from Oudh eastwards to Sikkim, Bihar, Orissa, Central, Western and Southern India. *D. sissoides* is a closely allied species of *D. latifolia* and is distributed in the Western Ghats, from the hills of Karnataka southwards to Pulneys and Kerala.

There are many factors, which are intervening in the reproduction and establishment of tree species in the natural habitats, which could be either biotic or abiotic or both. Further, the habitat destruction and depriving of the required ecological conditions for the species to continue their life cycle often leads to their population decline. Regeneration is one of the processes, which make the vegetation to attain its equilibrium and it is also essential for the survival of the species. Competition is greater among the individuals of the same species than others, as individuals of the same species need similar environmental conditions such as nutrients, moisture and light. Regeneration is the starting stage of population, which in due course undergoes the process of sylvigenesis and builds up the stand. It leads to the increase in population number (Krebs, 1972).

Wadt *et al.* (2005) worked on the population structure and nut yield in Brazil nut (*Bertholletia excelsa*) in south west Amazonia and noticed that the tree population had a much greater tendency towards randomness than clumping or uniformity. Klimas *et al.* (2007) worked on the population structure of *Carapa guianensis* in two forest types in the south western Brazilian Amazon and noticed high densities and clumped distribution of this species in both the forest types.

Chograni *et al.* (2008) studied the genetic diversity and population structure of *Lavandula stoechas* L. and *L. multifida* L. (Lamiaceae) and observed variation in the genetic diversity within populations and a high differentiation among populations. Venter and Witkowski (2010) studied the population trends of Baobab (*Adansonia digitata* L.) in four land use types in South Africa and found that the population of this tree species was stable.

Several workers have contributed to the knowledge of regeneration in natural forests of India. Some of the most referred works include studies conducted on natural regeneration of Rosewood-*Dalbergia latifolia* (Balasundaram *et al.* 1979; Deshmukh, 1985); *Dipterocarpus* spp. (Thangam, 1982); Sal-*Shorea robusta* (Bor, 1930; Champin, 1933; Chakravarthi, 1948;

Chaudhuri, 1960; Bhatnagar, 1961; Sharma *et al.* 1985; Teak- *Tectona grandis* (Kadambi, 1957) and *Xylia xylocarpa* (Arora, 1960).

Of late, the populations of *Dalbergia latifolia* and *D.sissoides* have been dwindling considerably in the forest areas and *D.latifolia* has been categorised as “Vulnerable” in the Red Data book of IUCN. In this context the future condition of the species could be predicted by understanding the regeneration status and structure of existing populations, so as to make appropriate managerial intervention, so that the valuable genetic resources are conserved for posterity and with this background the present research work was undertaken.

## MATERIALS AND METHODS

Populations of *D. latifolia* and *D. sissoides* were identified in the forest areas of Kerala and Tamil Nadu States by referring to herbarium / floristic records, Forest Working Plans and Vegetation Maps, followed by reconnaissance survey carried out in seven Forest Divisions in Tamil Nadu and 14 Forest Divisions of Kerala (Map-1&2).

The locations of *Dalbergia* populations were marked with GPS and quadrats of size 50m x 50m (5 Nos) were randomly laid out in the selected areas along a transect and various growth stages like seedlings (20 cm height), saplings ( $\geq 10 < 30$  cm Girth at Breast Height [GBH]) and mature trees ( $\geq 30$  cm GBH) of both *D. latifolia* and *D. sissoides* enumerated.

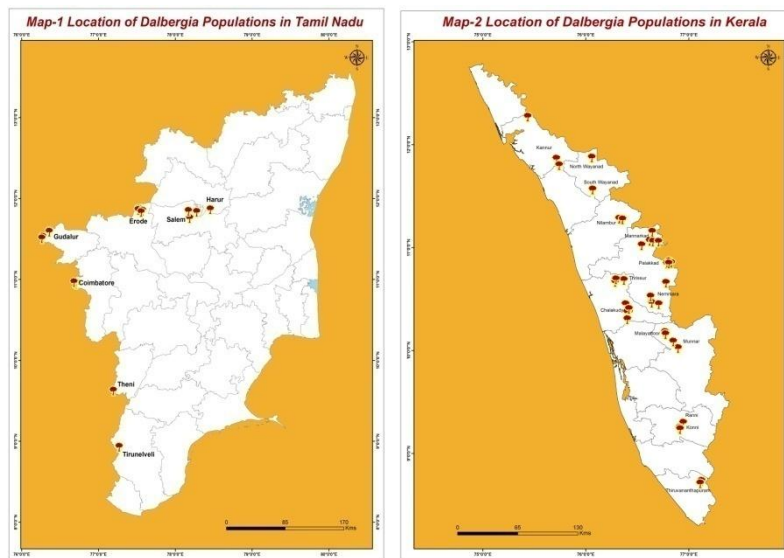
Other tree species occurring in the quadrats were also enumerated to find out important associates. The GBH of *D. latifolia* and *D. sissoides* trees occurring in the quadrats were recorded and subsequently grouped them into different girth classes and the population structure determined, following Jayakumar and Nair (2013).

To study the regeneration status, 10 quadrats of size 5m x 5m were laid out as nested quadrats in each main quadrat and the number of seedlings / saplings available therein assessed.

Density is a measure of dominance, an expression of numerical strength of a species in a community and relates to the availability of individuals per unit area. It was worked out for different tree species as well as seedlings and saplings of the targeted species, using the formula (Misra, 1968):

$$\text{Density (No. of individuals/ ha)} = \frac{\text{No. of individuals encountered} \times 10,000}{\text{Total area sampled in m}^2}$$

The methodology followed by Uma Shankar (2001) was adopted to assess the natural regeneration. The regeneration was considered as (i) Good, if seedling > sapling > adult (ii) Fair, if seedling > saplings  $\leq$  adult (iii) Poor, when the species was survived in only sapling stage or sapling population was less than that of adult and (iv) No regeneration, if only adult individuals were present in the population.



## RESULTS

### Natural regeneration

Out of 14 Forest Divisions of Kerala surveyed, the regeneration of *D.latifolia* was good in six divisions namely, Thrissur, Kannur, Munnar, Malayattoor, Nilambur South and Nemmara. In rest of the eight divisions, saplings were not recorded and only seedlings were available. Of the seven Forest Divisions of Tamil Nadu studied, *D.latifolia* was recorded from six divisions only. Salem Division exhibited good regeneration, whereas the regeneration was fair in Erode, Coimbatore and Tirunelveli divisions and there was no regeneration in Theni and Dharmapuri divisions.

Out of 14 Forest Divisions surveyed in Kerala, occurrence of *D.sissoides* was detected in only seven divisions and among them in five divisions namely, South Wayanad, Chalakudy, Thrissur, Palakkad and Munnar, there was no regeneration. In Mannarkad and Nemmara divisions, only seedlings were available and saplings were totally absent. Of the seven forest divisions studied in Tamil Nadu, there was no regeneration of *D.sissoides* in Coimbatore, Theni and Tirunelveli divisions. The species was not represented in Erode, Salem and Dharmapuri Divisions of Tamil Nadu, which are located in the Eastern Ghats. Thus, overall natural regeneration of *D.sissoides* in both the States was found to be in an “alarming” situation.

### Population structure

#### i) Kerala

The density of different growth stages of *D.latifolia* and *D.sissoides* in 14 Forest Divisions of Kerala is given in Table-1 and that of mature trees shown in Fig.1. The highest density of *D.latifolia* was noticed in South Wayanad with 77.6 individuals ha<sup>-1</sup> and lowest in Nemmara division with 0.8 individuals ha<sup>-1</sup>. The Girth class-wise population density of trees is shown in Fig.3 to Fig.18. An analysis of the data showed that nine divisions namely Mannarkad, Chalakudy, South Wayanad, North Wayanad, Kannur, Malayattoor, Munnar, Ranni and Thiruvananthapuram had healthy population structure of *D.latifolia*, consisting of trees of different girth classes from lower to higher, which more or less correspond to their age groups.

The girth-classes of *D.latifolia* present in other five divisions viz. Palakkad, Nemmara, Nilambur South, Konni and Thrissur showed that there was absence of trees belonging to some of the girth classes / age groups and as such the population structures of trees in these divisions were not healthy.

The populations of *D.sissoides* were present only in seven divisions such as Palakkad, Mannarkad, Nemmara, Chalakudy, South Wayanad, Thrissur and Munnar, out of 14 divisions surveyed in Kerala. The highest tree density was recorded in Mannarkad with 30.4 individuals ha<sup>-1</sup> and lowest density of 0.8 individuals ha<sup>-1</sup> in three divisions like Chalakudy, Thrissur and Palakkad. The population of the species in these three divisions were represented by a few trees of only one girth-class / age group only.

The population structure of *D.sissoides* occurring in Mannarkad and Nemmara were found to be healthy, having representation from lower to higher girth classes. The population of this tree species in South Wayanad and Munnar were falling under medium or higher girth classes and in the lower girth-classes / age classes trees were absent, indicating that the population structure was not healthy.

## ii) Tamil Nadu

The density different growth stages of *D.latifolia* and *D.sissoides* in six Forest Divisions of Tamil Nadu is given in Table-2 and that of mature trees shown Fig.2. The highest density of *D.latifolia* was noticed in Erode division with 28 individuals ha<sup>-1</sup> and the lowest in Tirunelveli division with 5 individuals ha<sup>-1</sup>.

The Girth class-wise population density of trees is shown in Fig.19 to Fig.27. Among them, the populations in Coimbatore, Erode and Theni divisions had trees falling under different girth-classes / age groups (healthy), while other divisions like Salem, Dharmapuri and Tirunelveli had tree representation from a few girth classes / age groups and as such they are not healthy populations.

Out of seven Forest Divisions surveyed in Tamil Nadu, the populations of *D.sissoides* were present in four divisions like Coimbatore, Theni, Tirunelveli and Gudalur. The highest density with 18 individuals ha<sup>-1</sup> was noticed in Gudalur division and the lowest in Coimbatore division with 3.2 individuals ha<sup>-1</sup>.

Among these divisions, Theni and Gudalur divisions had moderately healthy population structure with absence of trees in the two lower girth-classes / age groups. Coimbatore division had limited number of trees in a few girth-classes with trees of intermediate girth-classes absent, which is not the sign of a healthy population structure. The trees in Tirunelveli division fell under medium girth-classes with total absence of lower and higher girth-classes, exhibiting an unhealthy nature.

**Table 1. Density of *D.latifolia* and *D.sissoides* across different forest divisions in Kerala**

S. No.	Division	Density of <i>D.latifolia</i> (individuals ha <sup>-1</sup> )			Density of <i>D.sissoides</i> (individuals ha <sup>-1</sup> )		
		Trees	Saplings	Seedlings	Trees	Saplings	Seedlings
1	South Wayanad	77.6	0	496	4.8	0	0
2	North Wayanad	46.4	0	32	-	-	-
3	Ranni	40.0	0	2000	-	-	-
4	Chalakydy	35.2	0	120	0.8	0	0
5	Thrissur	32.8	264	968	0.8	0	0
6	Kannur	23.2	48	320	-	-	-
7	Thiruvananthapuram	20.0	0	424	-	-	-
8	Mannarkkad	16.8	0	824	30.4	0	136
9	Konni	12.0	0	600	-	-	-
10	Palakkad	10.4	0	152	0.8	0	0
11	Munnar	9.3	33	180	3.3	0	0
12	Malayattoor	8.0	8	760	-	-	-
13	Nilambur South	7.0	40	410	-	-	-
14	Nemmara	0.8	8	184	21.6	0	176

**Table 2. Density of *D.latifolia* and *D.sissoides* across different forest divisions in Tamil Nadu**

S. No.	Division	Density of <i>D.latifolia</i> (individuals ha <sup>-1</sup> )			Density of <i>D.sissoides</i> (individuals ha <sup>-1</sup> )		
		Trees	Saplings	Seedlings	Trees	Saplings	Seedlings
1	Erode	28	8.0	48	-	-	-
2	Coimbatore	24	8.0	16	3.2	0	0
3	Theni	9.3	0	0	14.7	0	0
4	Salem	6.4	24.0	112	-	-	-
5	Dharmapuri	5.6	0	0	-	-	-
6	Tirunelveli	5.0	64	16	5.0	0	0
7	Gudalur	-	-	-	18.0	0	640

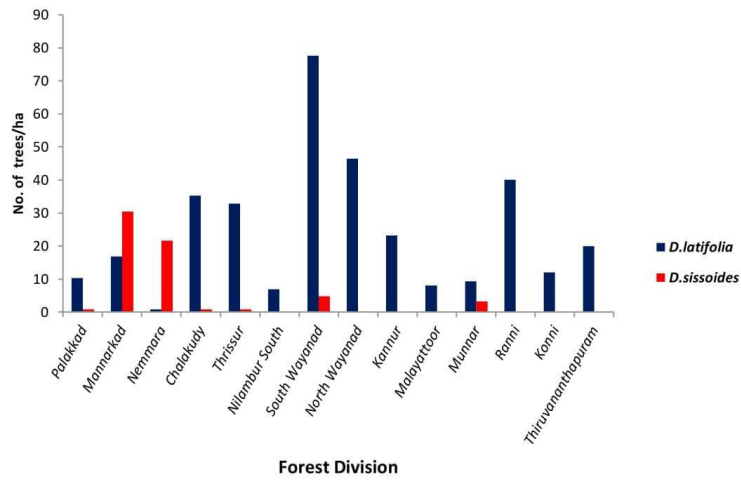


Fig.1 Density of *D.latifolia* and *D.sissoides* in different forest divisions of Kerala

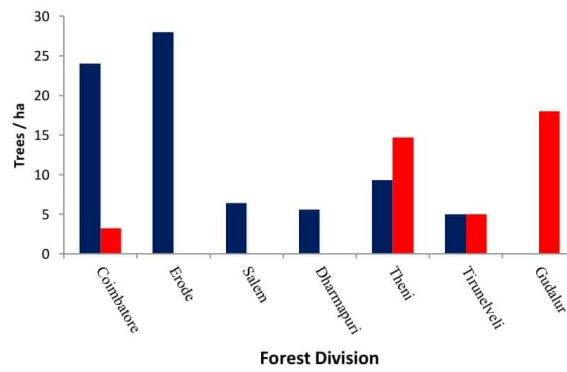


Fig.2 Density of *D.latifolia* and *D.sissoides* in different forest divisions of Tamil Nadu

KERALA

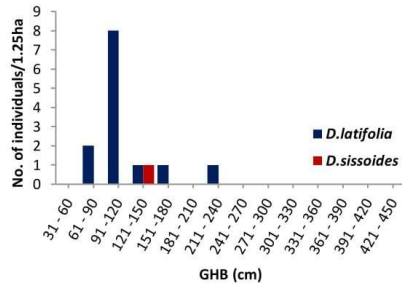


Fig.3 Girth class distribution of *D.latifolia* & *D.sissoides* trees in Palakkad Division

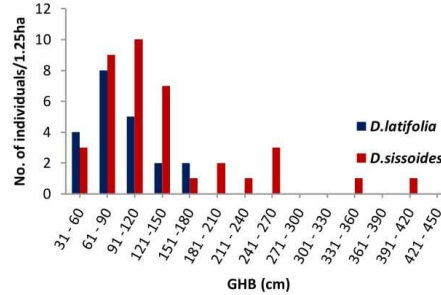


Fig.4 Girth class distribution of *D.latifolia* & *D.sissoides* trees in Mannarkad Division

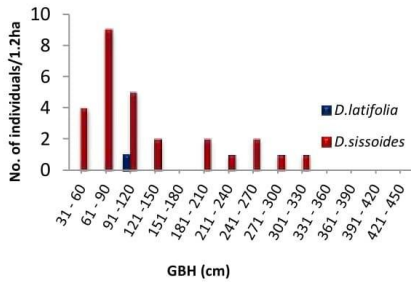


Fig.5 Girth class distribution of *D.latifolia* & *D.sissoides* trees in Nemmara Forest Division

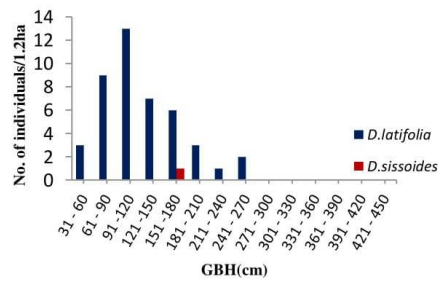


Fig.6 Girth class distribution of *D.latifolia* & *D.sissoides* trees in Chalakudy Forest Division

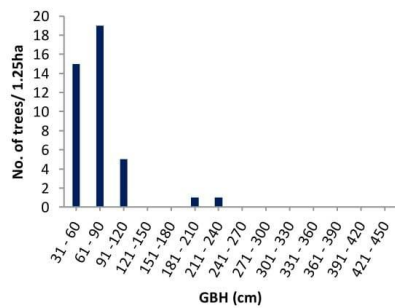


Fig.7 Girth class distribution of *D.latifolia* trees in Thrissur Forest Division

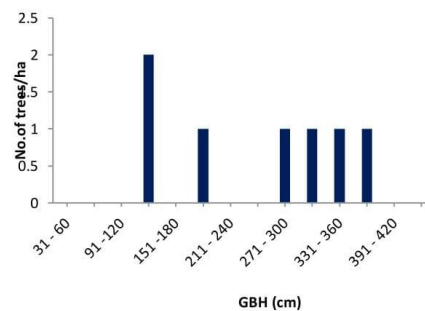


Fig.8 Girth class distribution of *D.latifolia* trees in Nilambur South Forest Division

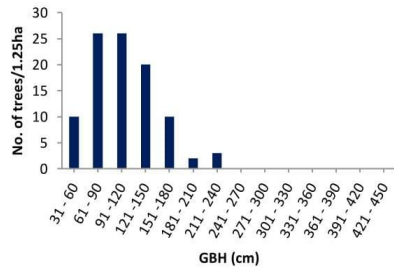


Fig.9 Girth class distribution of *D.latifolia* trees in South Wayanad Forest Division

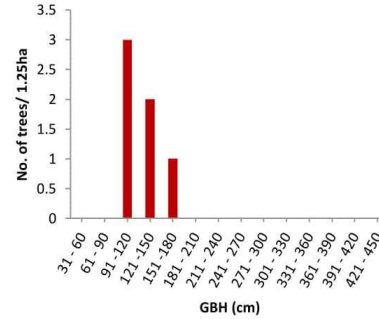


Fig.10 Girth class distribution of *D.sissooides* trees in South Wayanad Forest Division

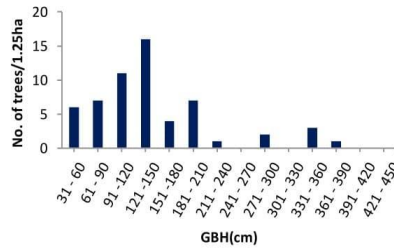


Fig.11 Girth class distribution of *D.latifolia* trees in North Wayanad Forest Division

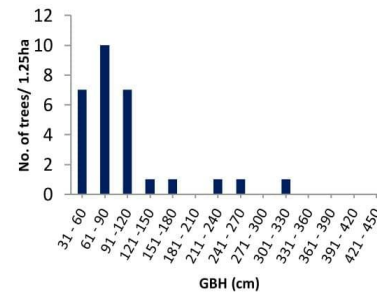


Fig.12 Girth class distribution of *D.latifolia* trees in Kannur Forest Division

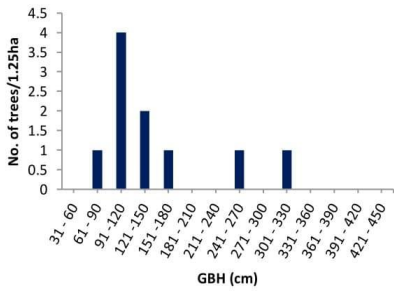


Fig.13 Girth class distribution of *D.latifolia* trees in Malayattoor Forest Division

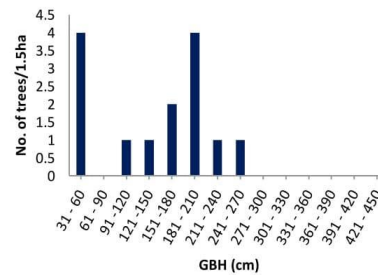


Fig.14 Girth class distribution of *D.latifolia* trees in Munnar Forest Division

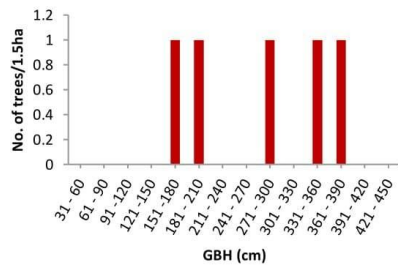


Fig.15 Girth class distribution of *D.sissoides* trees in Munnar Forest Division

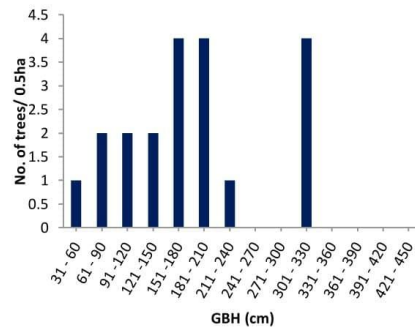


Fig.16 Girth class distribution of *D.latifolia* trees in Ranni Forest Division

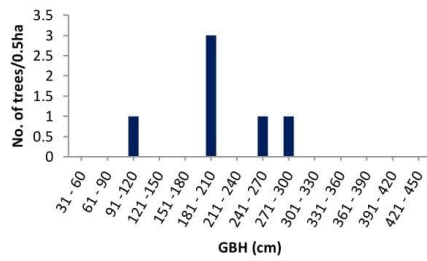


Fig.17 Girth class distribution of *D.latifolia* trees in Konni Forest Division

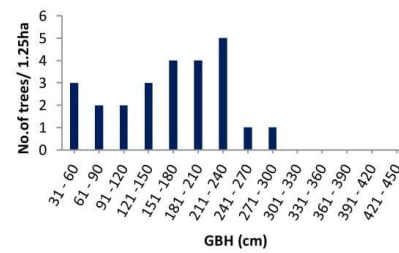


Fig.18 Girth class distribution of *D.latifolia* trees in Thiruvananthapuram Forest Division

TAMIL NADU

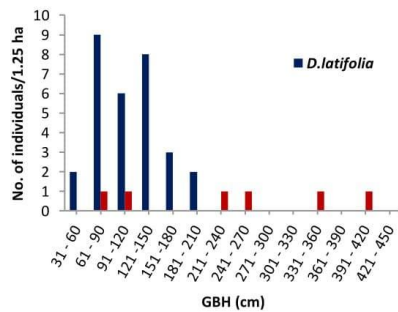


Fig.19 Girth class distribution of *D.latifolia* & *D.sissoides* trees in Coimbatore Division

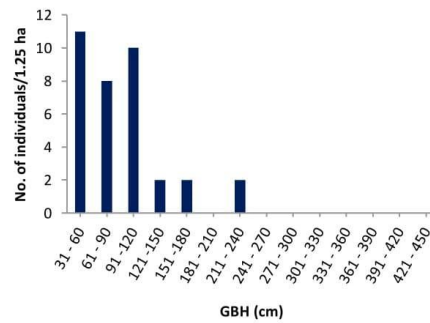


Fig.20 Girth class distribution of *D.latifolia* trees in Erode Division

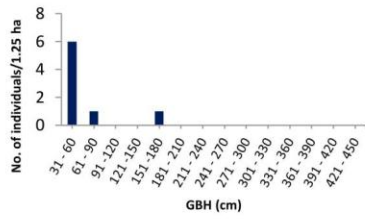


Fig.21 Girth class distribution of *D. latifolia* trees in Salem Division

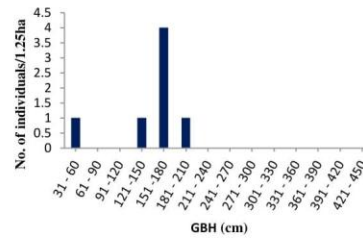


Fig.22 Girth class distribution of *D. latifolia* trees in Dharmapuri Division

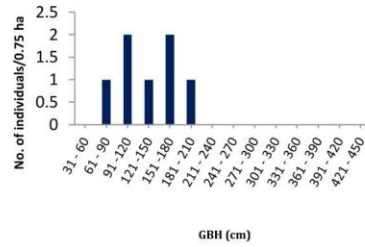


Fig.23 Girth class distribution of *D. latifolia* trees in Theni Division

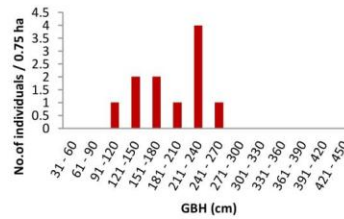


Fig.24 Girth class distribution of *D. latifolia* trees in Dharmapuri Division

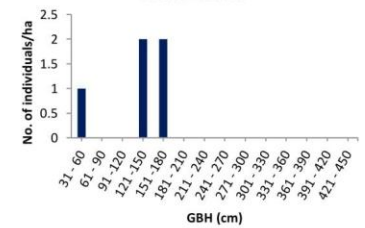


Fig.25 Girth class distribution of *D. latifolia* trees in Theni Division

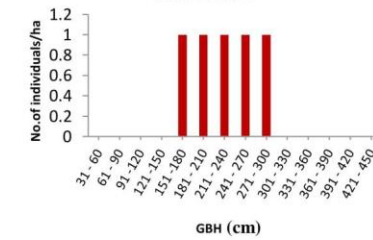


Fig.26 Girth class distribution of *D. latifolia* trees in Theni Division

Fig.25 Girth class distribution of *D. latifolia* trees in Tirunelveli Division

Fig.26 Girth class distribution of *D. latifolia* trees in Tirunelveli Division

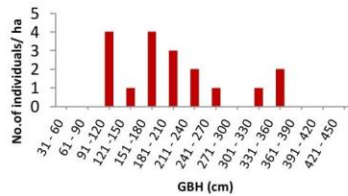


Fig.27 Girth class distribution of *D. latifolia* trees in Gudalur Division

### Associated species

The dominant tree associates of *D. latifolia* in different Forest Divisions of Kerala and Tamil Nadu are provided in Table-3 and Table-4 respectively. The common associates of Dalbergias in moist deciduous forests include *Terminalia paniculata*, *Terminalia alata*, *Dillenia pentagyna*, *Wrightia tinctoria*, *Grewia tiliifolia*, *Xylia xylocarpa*, *Pterocarpus marsupium*, *Macaranga peltata*, *Lagerstroemia lanceolata*, *L. speciosa*, *Bombax ceiba*, *Tabernaemontana heyneana* and *Tectona grandis*. In dry deciduous forests, especially in Tamil Nadu, the associates were totally different, which include *Anogeissus latifolia*, *Alangium salvifolium*, *Canthium dicoccum*, *Strychnos nux-vomica*, *Naringi crenulata*, *Terminalia bellirica*, *Erythroxylum monogynum* and *Wrightia tinctoria*. In semi-evergreen

forests, the important associates noticed were: *Hydnocarpus pentandra*, *Myristica dactyloides*, *Acronychia pedunculata*, *Aporosa lindleyana*, *Olea dioica*, *Artocarpus integrifolia*, *Terminalia paniculata*, *Lagerstroemia speciosa* and *Schleichera oleosa*.

**Table 3. Dominant tree associates of *D.latifolia* in different Forest Divisions of Kerala**

S.No.	Division	Density of dominant tree associates (individuals ha <sup>-1</sup> )
1	South Wayanad	<i>Dalbergia sissooides</i> (4.8); <i>Persea macrantha</i> (4); <i>Grewia tiliifolia</i> (3.2); <i>Lannaea coromandolica</i> (3.2)
2	North Wayanad	<i>Schleichera oleosa</i> (13.6); <i>Stereospermum colais</i> (12); <i>Pterocarpus marsupium</i> (7.2); <i>Wrightia tinctoria</i> (4.8)
3	Ranni	<i>Terminalia paniculata</i> (56); <i>Terminalia alata</i> (12); <i>Dillenia pentagyna</i> (6); <i>Wrightia tinctoria</i> (6)
4	Chalakyudy	<i>Tectona grandis</i> (36.8); <i>Terminalia paniculata</i> (24); <i>Macaranga peltata</i> (23.2); <i>Xylia xylocarpa</i> (20.8)
5	Thrissur	<i>Terminalia paniculata</i> (38.4); <i>Grewia tiliifolia</i> (34.4); <i>Tectona grandis</i> (20.8); <i>Bombax ceiba</i> (19.2)
6	Kannur	<i>Myristica dactyloides</i> (25.6); <i>Terminalia paniculata</i> (18.4); <i>Olea dioica</i> (12.8); <i>Mangifera indica</i> (8)
7	Thiruvananthapuram	<i>Terminalia paniculata</i> (36); <i>Careya arborea</i> (34.4); <i>Dillenia pentagyna</i> (28.8); <i>Tabernaemontana heyneana</i> (20.8)
8	Mannarkkad	<i>Dalbergia sissooides</i> (30.4); <i>Grewia tiliifolia</i> (24.8); <i>Xylia xylocarpa</i> (19.2); <i>Kydia calycina</i> (9.6)
9	Konni	<i>Macaranga peltata</i> (50); <i>Terminalia paniculata</i> (26); <i>Lagerstroemia lanceolata</i> (10); <i>Wrightia tinctoria</i> (6)
10	Palakkad	<i>Alangium salvifolium</i> (56); <i>Xylia xylocarpa</i> (36); <i>Terminalia paniculata</i> (18.4); <i>Holoptelea integrifolia</i> (16.8)
11	Munnar	<i>Terminalia paniculata</i> (22.7); <i>Terminalia alata</i> (7.3); <i>Litsea coriacea</i> (5.3); <i>Stereospermum colais</i> (5.3)
12	Malayattoor	<i>Terminalia paniculata</i> (25.6); <i>Xylia xylocarpa</i> (18.4); <i>Careya arborea</i> (17.6); <i>Terminalia alata</i> (12)
13	Nilambur South	<i>Hydnocarpus pentandra</i> (28); <i>Terminalia paniculata</i> (20); <i>Lagerstroemia speciosa</i> (13); <i>Schleichera oleosa</i> (13)
14	Nemmara	<i>Wrightia tinctoria</i> (24.8); <i>Dalbergia sissooides</i> (21.6); <i>Lagerstroemia lanceolata</i> (14.4); <i>Grewia tiliifolia</i> (10.4)

**Table 4. Dominant tree associates of *D.latifolia* in different Forest Divisions of Tamil Nadu**

S. No.	Division	Density of dominant tree associates (individuals ha <sup>-1</sup> )
1	Erode	<i>Anogeissus latifolia</i> (73.6); <i>Canthium dicoccum</i> (37.6); <i>Erythroxylum monogynum</i> (14.4); <i>Stereospermum colais</i> (8.8)
2	Coimbatore	<i>Pterocarpus marsupium</i> (60); <i>Terminalia paniculata</i> (12); <i>Sapindus laurifolius</i> (11.2); <i>Terminalia alata</i> (10.4)
3	Theni	<i>Tectona grandis</i> (117.3), <i>Dalbergia sissooides</i> (14.7); <i>Strychnos nux-vomica</i> (14.7); <i>Wrightia tinctoria</i> (8)
4	Salem	<i>Naringi crenulata</i> (22.4); <i>Strychnos nux-vomica</i> (20.8); <i>Tectona grandis</i> (17.6); <i>Wrightia tinctoria</i> (14.4)

5	Dharmapuri	<i>Anogeissus latifolia</i> (30.4); <i>Schleichera oleosa</i> (12); <i>Terminalia bellirica</i> (8); <i>Gmelina asiatica</i> (7.2)
6	Tirunelveli	<i>Tectona grandis</i> (24); <i>Terminalia paniculata</i> (13); <i>Pongamia pinnata</i> (9); <i>Phyllanthus emblica</i> (8)
7	Gudalur	<i>Acronychia pedunculata</i> (28), <i>Aporosa lindleyana</i> (24), <i>Olea dioica</i> (16), <i>Artocarpus integrifolia</i> (9).

### A few *Dalbergia* populations



Coimbatore



North Wayanad



South Wayanad



Munnar



Ranni



Kannur

### DISCUSSION

Regeneration is the process of silvigenesis by which trees and forests survive over time (Bhuyan *et al.* 2003). Regeneration of any species is confined to a peculiar range of habitat conditions and the extent of those conditions is a major determinant of its geographic distribution (Grubb, 1977). The population structure, characterized by the presence of sufficient population of seedlings, saplings and adults, indicates successful regeneration of forest species (Saxena and Singh, 1984). The presence of saplings under the canopies of adult trees also indicates the future composition of a community (Austin, 1977). Regeneration status of trees can be predicted by the age structure of their populations (Vablen *et al.* 1979; Khan *et al.* 1987; Tripathi and Khan, 2007). Regeneration of a particular species is poor if seedlings and saplings are much less than the mature trees.

During the present study, in majority of the locations, both *D.latifolia* and *D.sissoides* had either fair or poor regeneration. Locations with good regeneration have been only few. The forest stands characterized by the abundance of only adults of the species or absence or very low population of seedlings and saplings are expected to face local extinction (Dalling *et al.* 1998). Densities of seedlings are influenced by the densities of large trees (Rao *et al.* 1990).

The density/girth class distribution of both the species of *Dalbergia* in many study areas indicate decline in density of trees under small diameter class and prevalence of trees under higher diameter class. It shows that smaller diameter class individuals were less in number and only a small fraction of the seedling and sapling stages survived to pole or young tree stage. The density of trees also showed a decreasing trend with increase in girth class size, which is in conformity with the studies made in the Western Ghats, India by Parthasarathy and Karthikeyan (1997) and Saikia and Khan (2013) in North-eastern India.

The overall population structure of *Dalbergias* shows that the contribution of seedlings to the population of saplings and trees is very poor. One of the reasons for low natural regeneration in *D.latifolia* and *D.sissoides* is the occurrence of fire in the forest areas during summer season. Most of the seedlings and saplings get destroyed during the devastating fire, with no possibility of their survival. Another factor affecting the natural regeneration is the invasion of exotic species like *Lantana camara*, *Mikania micrantha*, *Chromolaena odorata* and *Cassia spectabilis*, which suppress the growth and establishment of seedlings. Regeneration of a species is dependent on several internal forest processes and exogenic disturbances (Barker and Kirk Patrick, 1994). There are reports on regeneration of species affected by anthropogenic factors (Barik *et al.* 1996; Tripathi and Khan, 2007) as well as natural phenomena (Welden *et al.* 1991). Jayakumar and Nair (2013) attributed poor tree regeneration in Tropical deciduous forests of the Western Ghats to fuel wood collection, frequent fires and grazing by cattle. Sometimes, seedlings fail to reach sapling stage may be due to competition for resources, alleopathic effects as well as external disturbances, as reported by Rao *et al.* (1990) and Khumbongmayum (2004). Tripathi and Khan (1992) made a different observation during their studies on regeneration in the disturbed and protected (undisturbed Sacred Groves) occurring in the sub-tropical wet hill forests of Meghalaya, North-East India, in which they reported higher regeneration (through both seedlings and sprouts) and survival of tree species in disturbed forests, compared to protected forests. *D.latifolia* also regenerates through root suckers, apart from seeds. Balasundaram *et al.* (1979) has reported that the root suckers of Rosewood failed to establish because of frequent fire and browsing by cattle, in the Gudalur-Wayanad tract of the Western Ghats. Hence there are enough evidences to prove that the forest disturbances can adversely affect the natural regeneration and successful establishment of *Dalbergia* spp., in the forests of Southern India.

## CONCLUSION

The present population structure of both the *Dalbergia* species in the forest areas of Kerala and Tamil Nadu has shown that these species are likely to encounter severe threat in future due to various biotic and abiotic factors, including the climate change, if timely managerial interventions are not made. Therefore, they should be prioritized as important “Forest Genetic Resources” and get the required attention for *in-situ* and *ex-situ* conservation. Artificial regeneration of these species has also to be taken up so as to augment the declining population in the natural forests.

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