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Community Structure of Lesser Known Tree Species, *Dalbergia lanceolaria* L. f., in Tropical Deciduous Forest

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Abstract**:** *Dalbergia lanceolaria* is an underutilised tree species having anti-inflammatory and anti-rheumatic properties being used in the ayurvedic system. The present study is framed to study the community structure of the species in the Northern western ghats region by laying out 20m x 20m plots in the identified patches of *D. lanceolaria* and regeneration pattern was studied by plotting 1m x 1m plots around the selected trees. *D. lanceolaria* occupied the upper storey of the deciduous forests, the close associates for the species were found to be *Tectona grandis*, *Terminalia tomentosa*, *Madhuca longifolia* and *Garuga pinnata* in the study area. Most of *D. lanceolaria*'s population was concentrated in the vicinity of streamlets or other water sources. The population showed a negatively skewed distribution of individuals, with maximum individuals in the 160-190 cm girth class while not even a single pole-stage individual was recorded. *D. lanceolaria* was observed regenerating by root suckers like other *Dalbergia* species. Its regeneration was observed to be more near the base and reduced later without any pattern. The study reveals threat to *D. lanceolaria* survivability in the future hence urgent attention should be paid towards the protection of natural regeneration and creating awareness among the local people.

Keywords**:** *Dalbergia lanceolaria*, Dang forest, Important value index, Natural regeneration, Stand structure

India harbours 11.4 per cent of plant diversity within its land mass 2.4 per cent of the world geographic area (Arisdason and Lakshminarasimhan 2020). Diversity of species is a sign of sustainability, especially tree diversity. Loss of tree diversity can ultimately lead to ecosystem collapse (Rivers et al 2022). Increased anthropogenic pressure on the natural forests as well as climate change drives many plant species into the threatened category (Primack 2006). In the last five decades, the world has faced an extreme rate of species extinction (loss of 137 species per day) which is 1000-10000 times the natural process of species extinction rate (Hilton-Taylor 2000, Moram et al 2011). A large number of tree species which were abundant or stable in the ecosystem once upon a time are declining now without any knowledge. *Dalbergia lanceolaria* L. f. could be one such lesser known species and population of this species is decreasing throughout the world (IUCN Red list 2022). It is a medium-sized lesser-known tree species belonged the Rosewood family, Fabaceae and the species is distributed in tropical deciduous forests of Bhutan, Nepal, Sri Lanka, Bangladesh, Myanmar, Thailand, Cambodia, Laos and Vietnam including different parts of India *viz.,* peninsular, eastern and some portions in the central India (Sam et al 2004, Dholariya et al 2019). In Sri Lanka, *D. lanceolaria* has entered into Red Data Book and is categorized as 'Vulnerable' (BGCI 2021). IUCN recently assessed its population status globally and categorised as least concerned (LC) (IUCN red list 2022). Even in Gujarat, this species is recognizing as one of the rare plants (Anonymous 2011). Documentation of population characters and community structure including auto-ecology play a vital role in categorizing the species into conservation concern, and also for its sustainable management in the wild (Hegde et al 2018). Therefore, the present study was undertaken to understand the composition, community structure, demography and natural regeneration of *D. lanceolaria* in one of the natural forest areas of South Gujarat.

MATERIAL AND METHODS

To study ecological attributes of *D. lanceolaria,* a reconnaissance survey was carried out in the natural forest of Unai forest range, Vyara division, South Gujarat in 2021. The study area spreads in northern most region of Western Ghats, India, near the Vansda National Park and Purna Wildlife Sanctuary (Anonymous 2020). The study area is recognized as forest type 3B/C1c of Slightly Moist Teak Forest (Champion and Seth 1968). The area is lateritic, deep black soil and alluvial soil along the Ambica river with gentle slope to moderate landmass, and receives 1344 mm average annual rainfall with temperature range of 6°C in January to 39°C in April (Pandya and Yadav 2014). In the present study, a focal population of *D. lanceolaria* distributed in the Unai

forest range was identified. A total of fifteen quadrates of 20 m x 20 m size were laid out randomly across the populations. Species composition, tree height, GBH (Girth at Breast Height @1.37 m) and crown diameter of all the trees having ≥ 30 cm girth within the quadrates were recorded. Checklist of species was prepared. For studying the regeneration pattern of *D. lanceolaria,* a single tree in each plot (*i.e.,* total 15 trees) was selected, 1 m x 1 m subplot around the selected trees at different distances *viz.,* 2, 4, 6, 8 and 10 m from tree base in all the four directions of the standing tree (North, South, East and West) was laid out (Gunaga et al 2012). Numbers of regenerating individuals and their growth parameters in each plot were recorded. Further, the regenerating individuals were classified into regeneration classes *viz.,* Class-I = seedling height < 40 cm, Class-II = seedling height 40-100 cm, Class-III = seedling height > 100 cm with girth < 10 cm, and Class-IV = height > 100 cm with girth 10- 30 cm (Behera et al 2014, Patwardhan et al 2017). Data recorded in the quadrates were used for assessing ecological parameters such as density, relative density, frequency, relative frequency, basal area, relative dominance and importance value index (IVI) as per standard formulae (Sharma 2017).

RESULTS AND DISCUSSION

Spread of *D. lanceolaria* in a population is showed clumped distribution and mostly they are thriving near the streamlets and other water bodies located in the deciduous forest. Considering species composition, total 102 individuals were recorded, composed of 20 species including *D. lanceolaria,* from 17 genera belonged to 13 families (Table 1). Fabaceae is the most prominent family represented by six different species. Moreover, other two species of *Dalbergia i.e., D. latifolia* and *D. paniculata* also co-existed in the studied plots. *Tectona grandis* and *Terminalia tomentosa* were represented in almost 80% of the studied plots, followed by *Garuga pinnata*. The upper strata is occupied by *T. grandis, T. tomentosa, Madhuca longifolia, Miliusa tomentosa* and *G. pinnata,* whereas in the middle strata, *Diospyrus melanoxylon, Butea monosperma, Wrightia tinctoria* were represented*;* however, *Carissa carandus* and Bamboo occupied the lower strata. Density of tree species ranged from 1.67 to 61.67 ha^{-1}, and the total tree density and basal area of the studied stands were 170 trees ha^{-1} and 27.69 m^2 ha^{-1}, respectively (Table 1). The highest density (61.67 ha^{-1}), frequency (100 %) and basal area (13.25 ha^{-1})

Table 1. Species composition and phyto-sociological attributes of *Dalbergia lanceolaria* populations in Vyara forest

Species	Family	*n*	Density (ha^{-1})	Frequency	Basal area (m^2/ha)	IVI
Dalbergia lanceolaria	Fabaceae	37	61.67	100.00	13.25	108.31
Associated species						
Adina cordifolia	Rubiaceae	2	3.33	13.33	0.42	6.71
Bahunia malbarica	Fabaceae	1	1.67	6.67	0.11	3.01
Butea monosperma	Fabaceae	5	8.33	20.00	0.60	11.91
Casearia spp.	Flacourtiaceae	2	3.33	6.67	0.19	4.25
Dalbergia latifolia	Fabaceae	6	10.00	20.00	0.95	14.14
Dalbergia paniculata	Fabaceae	1	1.67	6.67	0.25	3.51
Diospyrus melanoxylon	Ebenaceae	2	3.33	13.33	0.18	5.82
Garuga pinnata	Burseraceae	6	10.00	26.67	1.08	16.22
Gmelina arborea	Lamiaceae	1	1.67	6.67	0.09	2.92
Madhuca longifolia	Sapotaceae	6	10.00	26.67	1.81	18.88
Mangifera indica	Anacardiaceae	1	1.67	6.67	0.42	4.11
Miliusa tomentosa	Annonaceae	5	8.33	33.33	0.79	15.81
Ougeinia oojeinensis	Fabaceae	1	1.67	6.67	0.33	3.77
Schliechera oleosa	Sapindaceae	1	1.67	6.67	0.07	2.84
Spathodea roxburghii	Bignoniaceae	2	3.33	13.33	0.33	6.37
Tectona grandis	Lamiaceae	12	20.00	46.67	3.11	34.27
Terminalia bellirica	Combretaceae	2	3.33	6.67	2.36	12.08
Terminalia tomentosa	Combretaceae	8	13.33	40.00	1.28	22.15
Wrightia tinctoria	Apocynaceae	1	1.67	6.67	0.08	2.89
Total		102	170	413.33	27.69	

n=Number of individuals

was recorded for *D. lanceolaria* and appeared to be dominant in the studied population, since all those plots were laid out in the populations of *D. lanceolaria* by following selective sampling method. Among the associated species, maximum tree density was recorded in *Tectona grandis* (20.0 ha^{-1}), followed by *Terminalia tomentosa* (13.3 ha^{-1}) and least (1.6 ha^{-1}) in *Bauhinia malabarica*, *Dalbergia paniculata*, *Gmelina arborea*, *Mangifera indica*, *Ougeinia oojeinensis*, *Schleichera oleosa* and *Wrightia tinctoria*. Again, *Tectona grandis* (47 %) and *Terminalia tomentosa* (40 %) recorded the maximum frequency of occurrence followed by *Miliusa tomentosa* (33 %). The basal area of individual tree species varied from 0.07 to 13.25 m^2 ha^{-1}. *D. lanceolaria* recorded highest basal area of 13.25 m^2 ha^{-1}, followed by *Tectona grandis* and *Terminalia bellirica* and it was least in *Schleichera oleosa* (0.07 m^2 ha^{-1}). IVI, Importance Value Index varied from 2.84 (*Schliechera oleoasa*) to 108.31 (*D. lanceolaria*). Among the associates, *Tectona grandis* (34.27) exhibited highest IVI followed by *Terminalia tomentosa*, *Madhuca longifolia* and *Garuga pinnata*. In the present study, *D. lanceolaria* represents almost 35% of the population, followed by *Tectona grandis*, *Terminalia tomentosa*, *Madhuca longifolia* and *Garuga pinnata,* which shares 30%. However, remaining 35 % composition is from the rest of 15 species. The composition and growth of associated species in a stand are influenced by the combined effect of site factors *viz*. climatic, edaphic, topographic and biotic factors (Khanna 2009). A study carried out nearby Purna Wildlife sanctuary by Kumar et al (2018) also recorded that *Tectona grandis* and *Terminalia tomentosa* are the dominant species which represents IVI values of 44.53 and 43.83, respectively. Such pattern was also observed in Mahua populations of Gujarat (Hegde et al 2018). Furthermore, composition study carried out in the dry deciduous forest of Karnataka also recorded the *D. lanceolaria* with 45 associated species including *Terminalia paniculata*, *T. tomentosa*, *Tectona grandis* and *Dalbergia latifolia* (Prakasha et al 2008).

Girth class distribution of *D. lanceolaria* exhibits an unimodular, negatively skewed distribution (Fig. 1). The maximum proportion of individuals *i.e.,* 48.64 per cent was in 160-190 cm GBH class, followed by 21.62% in 130-160 cm class and 13.51% in 100-130 cm class. In both extreme girth classes (70-100 cm and 220-250 cm), the proportion of *D. lanceolaria* individuals was least with 2.70% representation. Surprisingly, there was no single individual observed within the 70 cm girth class. Lack of individuals in the lower girth classes poses a conservation risk for the species in the coming days. In undisturbed natural forests, good regenerating species usually exhibit inverted J shaped curve (Gonçalves et al 2017). The largest density of *D. lanceolaria* falls within 130-160 cm girth class may signifies quite even-aged stand in the forest. Absence of lower sized individuals of this species could be attributed by anthropogenic pressure like over-grazing of cattle in the stand, since leaf is palatable in nature (Dholariya et al 2019) and/or use of pole stage individuals for making of handles for agriculture tools by local people, that is why locally called as 'Dandoshi' means 'stick or pole' for this tree.

Natural regeneration pattern varies from species to species, place to place, and local habitat in accordance with availability of growing conditions like moisture, soil, *etc*. (Khanna 2009). Based on available regeneration data, more regeneration count (0.13 per m^2; 41.87 per 10 m radius) was represented from Northern direction and minimum (0.09 per m^2; 29.31 per 10 m radius) in the Eastern direction (Table 2). In terms of distance from the tree trunk towards end crown, maximum regeneration (0.23 per m^2; 73.27 per 10 m radius) was at 2m distance from the tree, followed by distance at 6m (0.17 per m^2; 52.33 per 10 m radius), and the lowest (0.02 per m^2; 5.23 per 10 m radius) at 8 m distance. Among the

Table 2. Natural regeneration of *Dalbergia lanceolaria* in the Vyara forest

Distance from tree	Direction									
	North		South		East		West		Overall mean	
	Recruit per m^2	Recruit in 10 m radius*	Recruit per m^2	Recruit in 10 m radius	Recruit per m^2	Recruit in 10 m radius	Recruit per m^2	Recruit in 10 m radius	Recruit per m^2	Recruit in 10 m radius
2m	0.27	83.73	0.33	104.67	0.20	62.80	0.13	41.87	0.23	73.27
4m	0.20	62.80	0.00	0.00	0.13	41.87	0.00	0.00	0.08	26.17
6m	0.13	41.87	0.13	41.87	0.13	41.87	0.27	83.73	0.17	52.33
8m	0.07	20.93	0.00	0.00	0.00	0.00	0.00	0.00	0.02	5.23
10m	0.00	0.00	0.13	41.87	0.00	0.00	0.13	41.87	0.07	20.93
Overall mean	0.13	41.87	0.12	37.68	0.09	29.31	0.11	33.49	0.11	35.59

*Extrapolate to 10 m radius (Crown area) = 314.16 m^2; regeneration count is from 15 trees

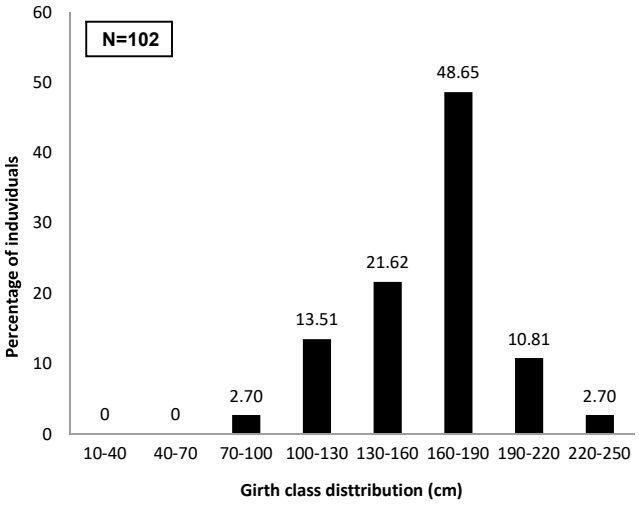

Fig. 1. Girth class distribution of *Dalbergia lanceolaria* in Vyara forest

regeneration, 27.41 per cent belonged to regeneration class IV followed by 26.47, 23.53 and 20.59 per cent of recruits belonged to I, II and III regeneration classes, respectively. The findings of the regeneration pattern are in line with the regeneration pattern of *Terminalia chebula* where maximum regeneration was encountered within 3 m distance from the tree and it reduced thereafter (Gunaga et al 2011, 2012). There is no clear decreasing trend of recruits from tree trunk towards end of the tree canopy. Being a light weight of pod, it was expected more regeneration towards tree canopy; however, the trend was reversed, where most recruits recorded near the tree, which could be due to root suckers, in contrast, recruits recorded near the edge of crown could be from seeds. The overall result showed that the natural regeneration count was poor (overall mean of 0.11 recruits per m^2 and 35.59 recruits per 10 m radius of crown). Seed-lots collected from tree are infested with seed pests in *D. lanceolaria* and that could be one of the reasons for poor germination, which may be associated with other few anthropogenic factors.

CONCLUSIONS

Study shows that with *Dalbergia lanceolaria* populations, species such as *Tectona grandis, Terminalia tomentosa*, *Madhuca longifolia* and *Garuga pinnata* are closely associated in terms of its presence, density, frequency, basal area and Importance value index. Demography and natural regeneration data of *D. lanceolaria* indicated that poor regeneration coupled with negligible number of trees in lower girth class may lead to threat of this species. Further, detailed study may be useful to address such issues as well as proper conservation/management plan to recuperate population of *D. lanceolaria*. Ecological data provided here could be useful for such action plan.

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AUTHORS CONTRIBUTIONS

M.S., L.K.B. -conceptualised the work; M.S., A. A.M., and D.N. -field data collection; S.M.P.-manuscript preperation.

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