Observation on Distribution and Population Structure of *Pterocarpus santalinus* L.f. in Guvvalachervu Ghat Forest area of Seshachalam Biosphere Reserve of Andhra Pradesh, India

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ABSTRACT

Pterocarpus santalinus (Red Sanders), an endangered and economically vital tree endemic to the Southern Eastern Ghats of India, faces severe threats from over-exploitation and illegal trade. This study investigated its distribution and population structure in the Guvvalachervu Ghat forest area of the Seshachalam Biosphere Reserve, a critical habitat for the species. Quantitative analysis of 10 plots revealed a mean density of 9.8 ± 6.61 individuals/plot, with a range of 3-22 individuals. While no significant correlation was found between *P. santalinus* density and total tree density, the study highlighted its preference for hill slopes and flat terrains with quartzite rock formations. The population exhibited a Shannon index of 0.9458, a Simpson index of 0.486, and an Evenness index of 0.4292. Girth class distribution showed that 49% (72 individuals) were in the 31-60 cm gbh class, with 14% (21 individuals) exceeding 60 cm gbh, and 36% in the 15-30 cm gbh category. The presence of numerous seedlings and saplings suggests *P. santalinus* is an early successional and shade-intolerant species, capable of re-sprouting after disturbances like annual fires. However, illegal logging, particularly of mature trees (51-70 cm gbh), significantly impacts fruit set and overall population biology. Despite its resilience, sustained demand, restricted distribution, and poor natural regeneration necessitate urgent conservation efforts. These include large-scale plantations, sustainable trade policies involving all stakeholders, and strict management of exploitation, especially in protected areas, to ensure the long-term survival of this culturally and economically significant species, which is currently categorized as Endangered by IUCN and listed in CITES Appendix II.

Keywords: *Red Sanders, Endangered, Seshachalam Biosphere, Southern Eastern Ghats and Population Structure.*

INTRODUCTION

The genus *Pterocarpus* (Family: Fabaceae) comprises trees and woody climbers distributed across the three major tropical regions of the world—Neotropics, tropical Africa, and Indomalaya (which includes the Indian subcontinent and the Malay Peninsula/Archipelago). While the genus includes 35 to 40 formally recognized species, estimates suggest the number could reach up to 60. Species within *Pterocarpus* are highly valued for their ethnomedicinal properties and economically significant bioactive compounds.

In India, four species of *Pterocarpus* occur: *P. dalbergioides*, *P. indicus*, *P. marsupium*, and *P. santalinus*. Of these, *P. indicus* and *P. marsupium* are listed as vulnerable, while *P. santalinus* is classified as endangered by the International Union for Conservation of Nature (IUCN, 2014). *P. dalbergioides*, endemic

to the Andaman Islands, remains unclassified due to data deficiency. However, growing threats to its habitat make it a candidate for threatened status. In Sri Lanka, species of *Pterocarpus* have become increasingly rare due to overexploitation, highlighting the urgent need for conservation across its native range.

Among these, *Pterocarpus santalinus*, commonly known as Red Sanders, Red Sandalwood, Almug, or Saunders wood, is of particular conservation concern. Endemic to the tropical dry deciduous forests of the southern Eastern Ghats in Andhra Pradesh, this species is confined to hilly terrains and dry slopes at altitudes ranging from 200 to 900 meters, notably in the Kadapa and Seshachalam hill ranges (Raju & Nagaraju, 1998). Its distribution spans approximately 5,160 km² across scattered forest patches in Chittoor, Kadapa, and Nellore districts, with limited occurrence in parts of Tamil Nadu and Karnataka. Although reports of its presence in countries such as China, Pakistan, Sri Lanka, and Taiwan exist, these are likely instances of introduction rather than natural distribution (GOI, 2014).

Pterocarpus santalinus is renowned for its distinctively colored heartwood, which is in high demand both domestically and internationally, particularly in Japan and China. Its timber is used in the manufacture of luxury furniture, intricate carvings, and musical instruments due to its fine acoustic properties. The species also contains a natural dye, santalin, widely used in pharmaceuticals, food, textiles, and leather industries. In traditional medicine, Red Sanders is used to treat ailments such as diabetes, skin diseases, fever, and eye disorders (Jadhav, 2008). The heartwood possesses therapeutic properties such as antipyretic, anti-inflammatory, anthelmintic, hypoglycemic, and astringent effects. It has even been used in remedies for snake bites and scorpion stings. Phytochemical investigations have revealed a diverse profile of bioactive compounds, including alkaloids, phenols, saponins, glycosides, flavonoids, sterols, tannins, and anti-tumor lignans like savinin and calocedrin.

Despite its cultural, economic, and medicinal significance, *P. santalinus* is severely threatened by habitat loss, overharvesting, and illegal logging. The indiscriminate extraction of heartwood from even remote forest interiors has disrupted natural regeneration, seed dispersal, and population age structure. Conservation concerns are further compounded by the lack of updated population data and baseline ecological information necessary for formulating effective management strategies. As pressures on forest resources grow, there is an urgent need to document, conserve, and sustainably manage species like *P. santalinus*.
Given its restricted distribution, ecological vulnerability, and commercial value, comprehensive field-based studies are essential to assess the population dynamics and distribution patterns of *P. santalinus*. The current study focuses on the Guvvalachervu Ghat forest region of the Seshachalam Biosphere Reserve an area that serves as one of the core habitats for this endangered tree species.

The primary objective of this study is to generate baseline ecological data on *Pterocarpus santalinus* (Red Sanders) in its natural habitat. Specifically, the study aims to assess the current status of the species in the selected region by examining its distribution and population dynamics, analyze its population structure based on girth class distribution, estimate tree density across different habitat zones, and provide scientific insights to support future conservation strategies and the sustainable management of *P. santalinus* within the Seshachalam Biosphere Reserve.

MATERIALS AND METHODS

Study Area

The Seshachalam Biosphere Reserve (SBR), designated in 2010, is the first biosphere reserve of Andhra Pradesh, situated in the southern Eastern Ghats, encompassing parts of Chittoor and Kadapa districts. Spanning an area of 4,755.99 km², SBR is a rich floristic hotspot known for its ecological diversity, harboring numerous endemic and endangered plant species. Geographically, the reserve lies between 13°38′ and 13°55′ N latitudes and 79°07′ and 79°24′ E longitudes (**Figure-1**). Approximately 50% of its area falls under the jurisdiction of reserve forests, including divisions such as Chittoor East, Tirupati Wildlife Management, Rajampet, and Kadapa.

For effective biodiversity conservation and sustainable development, the reserve is divided into three zones: the Core Zone (750.5 km²), which is strictly protected and free of human habitation; the Buffer Zone (1,865 km²), which includes parts of the Sri Venkateswara Wildlife Sanctuary; and the Transition Zone, which lies within a 5 km radius of the buffer zone and includes forest beats and human settlements, including the Tirumala temple complex.

Biogeographically, SBR falls within the Deccan Peninsula zone and is classified under the tropical dry deciduous forest biome. The terrain is rugged and hilly, with elevation ranging from 200 m to 1,150 m above sea level. The region is named after the seven peaks of the Seshachalam Hills Seshadri, Neeladri, Garudadri, Anjanadri, Vrishabhadri, Narayanadri, and Venkatadri associated with the mythological serpent Adisesha. These hills are also home to the Tirumala temple, one of India's most revered pilgrimage sites.

The climate of the reserve is dry and varies with elevation. The hot season extends from March to May, with temperatures ranging from 18°C in January to 36°C in May. The region experiences both the southwest monsoon (June–September) and the northeast monsoon (October–December), with annual rainfall ranging from 569.43 mm to 1230.81 mm.

Seshachalam forests are classified into various types based on Champion and Seth (1968), including dry deciduous mixed forests, dry deciduous scrub, red sanders-bearing forests, and Hardwickia forests. Dominant species include *Pterocarpus santalinus*, *Hardwickia binata*, *Anogeissus latifolia*, and *Lagerstroemia parviflora*. Forest disturbances such as grazing, fire, fuelwood collection, and lopping are common, particularly in low rainfall zones. The reserve hosts over 1,750 species of flowering plants across 879 genera and 176 families. Notable endemic and endangered species include *Boswellia ovalifoliolata*, *Terminalia pallida*, *Shorea tumbaggala*, *Pterocarpus santalinus*, *Syzygium alternifolium*, and *Cycas beddomei*. Critically endangered plants include *Rauvolfia serpentina* and *Litsea glutinosa*.

Pterocarpus santalinus, the focal species of this study, is a key component of the forest ecosystem. It is traditionally used for its antipyretic, anti-inflammatory, anthelmintic, anti-hyperglycemic, tonic, and diaphoretic properties. Its presence in the reserve highlights the urgent need for in situ conservation and sustainable management initiatives in the region.

Methodology:

This study on deciphering the population structure of *Pterocarpus santalinus* in Seshachalam Biosphere Reserve is part of the thorough inventory being carried out in Eastern Ghats. One of the main objectives of this quantitative inventory is to identify the distribution and abundance pattern of rare, threatened and economically useful species. The quantitative characters of *Pterocarpus santalinus* were studied by constructing quadrates in Guvvalachervu forest areas. One one-hectare plots were laid down randomly; all the plant species encountered in the plots were listed (**Table-1** & **Photo Plats-1&2**)

Trees were analyzed in 10x10m plots; Regeneration in 5x5m plots, nested within 10x10m plot. In 10 such plats in Guvvalacheruvu forest areas all trees >10cm girth at breast height (gbh), including *Pterocarpus santalinus* tree individuals, were considered for the analysis. The physical soil features, slope and disturbance level prevailing in the grids were noted in the field. Individuals of each tree species was recorded Vegetation data were quantitatively analyzed for density, frequency and abundance using standard methodologies Curtis & McIntosh (1950) and Mueller- Dombois & Ellenberg (1974).

$$\text{Abundance} = \frac{\text{Total number of individuals in all sampling units}}{\text{Total number of sampling units in which species occur}}$$

$$\text{Density} = \frac{\text{Total number of individuals in all sampling units}}{\text{Total number of sampling units studied}}$$

$$\text{Frequency} = \frac{\text{Number of sampling units in which species occur}}{\text{Total number of sampling units}} \times 100$$

The important value Index (IVI) was determined as the sum of the relative density (Rd) relative frequency (Rf) and relative abundance (Ra) were calculated for each species following Curtis & McIntosh (1950).

$$\mathbf{IVI = RD + RF + RA}$$

$$RD = \frac{\text{Density value of species}}{\text{Sum of density value of all species}} \times 100$$

$$RF = \frac{\text{Frequency value of species}}{\text{Sum of frequency value of all species}} \times 100$$

$$RA = \frac{\text{Abundance value of species}}{\text{Sum of abundance value of all species}} \times 100$$

The species dominance was measured by using Simpson's index; $\mathbf{Cd = \sum (ni/N)^2}$ The species diversity was determined by Shannon – Wiener index: $\mathbf{H' = - \sum (ni/N) \log (ni/N)}$ Where, ni = number of individuals belonging to the ith species. N = Total number of individuals in the sample. Evenness index was determined according to Pielou (1969, 1975).

RESULTS AND DISCUSSION

Floristic Studies:

The **Red Sanders** (*Pterocarpus santalinus*), a medium-sized deciduous tree endemic to the Southern Eastern Ghats of India (Nayar, M.P, 1996), is a highly valued species facing significant threats due to over-exploitation and illegal trade. This "wing fruit" tree, named for its unusually shaped seed pods, is one of 35 currently accepted *Pterocarpus* species found globally, with many concentrated in Africa and some in Asia.

Botanical Characteristics and Distribution

Pterocarpus santalinus is primarily found in the hills of Andhra Pradesh (Cuddapah, Chittoor, and parts of Nellore), with smaller pockets in Karnataka and Tamil Nadu (North Arcot hills). It's also cultivated in Maharashtra, Odisha, and West Bengal, and has been introduced to Sri Lanka. The tree thrives in dry, rocky ground at altitudes between 150 and 900 meters.

Its distinguishing features include extremely hard, dark purple heartwood with a bitter flavor. The bark is blackish-brown, thick, and deeply cracked, exuding a copious red, sticky gum. The leaves are typically trifoliate, and the yellow, fragrant flowers appear in racemes. The flat, orbicular pods usually contain one, or rarely two, kidney-shaped, reddish-brown seeds (**Figure-2**).

Reproductive Biology and Conservation Concerns

Despite producing thousands of flowers per season, *P. santalinus* has a **very low natural fruit set (around 6%)**. This is attributed to several factors:

- **Selective elimination of weak offspring:** The tree tends to abort fruits from self-pollinated flowers, although self-compatibility through geitonogamy provides a "fail-safe" for fruit production when pollinators are scarce.
- **Low genetic variation:** As an endemic species with restricted population size, it has reduced opportunities for out-crossing, potentially leading to inbreeding and genetic bottlenecks.
- **Low maternal energy investment:** Limited energy is available for rapidly growing offspring during the dry season.

- **Vulnerability to dry and hot conditions:** Pollinator activity is often absent during the day, with natural fruit set relying on activity during moonlit nights and early morning hours.

Traditional vegetative propagation techniques like grafting and air-layering have limited success for large-scale multiplication. However, in-vitro propagation has shown promise, producing plants with no significant growth differences compared to seedlings. This method, including micropropagation techniques like axillary shoot multiplication, offers a way to produce large numbers of uniform plants, and potentially improve traits through genetic engineering.

Economic Importance and Uses

Red Sanders wood is highly valued both domestically and internationally. Its uses are diverse:

- **Timber:** Used for carvings, furniture, agricultural implements, poles, and house posts. A rare wavy grain variant is particularly prized, especially in Japan, where it's used to make traditional musical instruments like the "shamisen" due to its unusual acoustic properties.
- **Dye:** The heartwood yields santalin, a red pigment widely used as a natural dye in the furniture and crafts industry, and increasingly as a colorant in foods. In Europe, it's classified as a "spice extract" rather than a food colorant, meaning its presence doesn't require declaration on packaging.
- **Traditional Medicine:** In India, it has multiple uses in traditional medicine, including treating skin diseases, bone fractures, leprosy, spider poisoning, and general debility. Wood paste is applied to boils and skin eruptions, and decoctions are used for chronic dysentery and dermatological conditions. It's also believed to alleviate vision defects.
- **Incense:** Used as an incense base for its fragrance in Myanmar and in Tibetan medicine.
- **Cultural Significance:** Historically, it has been used in China since the tenth century for highly valued furniture, particularly "rosewood" (Hong mu) furniture, which was culturally significant for Ming and early Qing dynasties. Buddhists also prefer this wood for cremation.

The wood and leaves of Red Sanders have also been found to accumulate various elements, including rare earth elements. For instance, heartwood can accumulate strontium (750-3,500 ppm), cadmium (5-28 ppm), zinc (50-6,000 ppm), and copper (105-1,025 ppm). Uranium concentrations average 1.22 ppm in heartwood and 0.03 ppm in leaves, significantly higher than in other *Pterocarpus* species.

Trade and Smuggling

The demand for Red Sanders wood has a long history, with exports to European countries dating back to the 16th century. While the demand for its dye decreased with the advent of synthetic dyes, Japanese merchants in the 1930s rekindled its value in the international market. Currently, Red Sanders costs around US$ 150,000 per cubic meter in the international market (Wenbin and Xiufang, 2013), making it as expensive as gold. This immense demand has fueled extensive illegal harvesting and smuggling, despite bans on felling and trade by the Indian government. Smugglers exploit alternative routes, and international syndicates are involved in the illicit trade. In Andhra Pradesh alone, 1,488 forest offense cases were booked for Red Sanders in 2012-13, resulting in the seizure of 1,002 vehicles and 1,390 tonnes of wood. The frequent seizures of large quantities of smuggled wood globally highlight the severe threat to the species' survival.

Conservation Status

Due to its restricted distribution, slow regeneration, illegal harvest, and habitat destruction, *Pterocarpus santalinus* has been categorized as Endangered by the IUCN and listed in Appendix II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) Ahmedullah, M. & M.P. Nayar (1984), Mulliken, T.T. & P. Crofton (2008) and Ahmedullah, M. (2021). This listing aims to ensure that international trade in Red Sanders is strictly regulated to prevent its over-exploitation. In Andhra Pradesh, it is further protected under state forest acts as a "reserved tree".

QUANTITATIVE STUDIES

An inventory across 10 plots in the Seshachalam Biosphere Reserve yielded a total of 98 *Pterocarpus santalinus* tree individuals. The mean density was 9.8 ± 6.61 individuals per plot, with a range of 3 to 22

individuals. Notably, the proportion of *P. santalinus* within the overall tree density varied significantly, from 0% to 63.3%. Interestingly, a rank correlation analysis showed no significant relationship between the abundance or proportion of *P. santalinus* and the total tree density in a given plot. This suggests that the presence or absence of Red Sanders does not necessarily dictate the overall tree population density in these areas (Kennard, D.K. *et.all*, 2002).

The study assessed community structure using diversity indices. The Shannon index was 0.9458, the Simpson index was 0.486, and the Evenness index was 0.4292. Analysis of the density distribution of *P. santalinus* revealed that most plots (67%) contained between 6 and 22 individuals. Specifically, 33% of the plots showed a higher density (more than 12 individuals), while 40% of the plots (4 grids) had fewer than 6 individuals.

The girth class distribution of *P. santalinus* showed a significant difference across size classes ($\chi 2(2)=1311$, $P<0.05$). The majority of individuals, 72 trees (49%), were found in the 31-60 cm girth at breast height (gbh) class. Twenty-one individuals (14%) had a gbh greater than 60 cm, while the remaining 36% were in the lower 15-30 cm gbh category. The proportion of trees within these girth categories varied considerably across different plots: 15-30 cm gbh: 17% to 86%, 30-60 cm gbh: 13% to 87% and >60 cm gbh: 0% to 39% This variation highlights the differing population structures within the sampled areas (**Figure-3**).

The basal area of *P. santalinus* ranged from 0.002 to 1.88 m2/0.1 ha. A positive and significant relationship ($rS(2),10=0.516$, $0.05<P<0.1$) was observed between plots with high basal area and their corresponding density. However, no significant relationship ($rS(2),10=0.272$, $P>0.05$) was found when considering plots with high *P. santalinus* abundance. This discrepancy could be attributed to selective logging of large trees in some areas, compensated by a high density of smaller-girth trees, potentially multi-stemmed from past cutting, in others.

Importance Value Index (IVI)

The Importance Value Indexis a crucial ecological parameter used to assess the dominance and ecological significance of plant species or families in a given area.The IVI of tree species ranged from 5.43 to 186.50 (**Table-2**). The analysis revealed the top dominant species in the forest stand: *Pterocarpus santalinus* with the highest IVI of 186.50 (62.17%), followed by *Croton scabiosus* 59.40 (19.80%), *Cassia fistula* with 37.50 (12.50%), and *Ziziphus xylopyrus* with 6.67 (2.22%). These species contribute significantly to the forest composition (Sagar, 2023).

Environmental Factors Influencing Distribution

The study found a strong correlation between the occurrence of *P. santalinus* and specific physical conditions. All ten plots with high basal area values were located in areas with slopes and flat terrains characterized by quartzite rock boulders and good drainage. This supports previous observations by Raju and Nagaraju (1998) that 80% of *P. santalinus* growth occurs on quartzite outcrops. Conversely, none of the eight plots where *P. santalinus* was absent featured quartzite rock formations; instead, they contained shale-type calcareous rocks with poor drainage. Furthermore, three out of four plots with fewer than five *P. santalinus* individuals were found on shale, two of which were degraded forests near roads with high disturbance, and one had deep alluvium soil.

These findings suggest that hill slopes and flat terrains with quartzite rock formations are the most suitable habitats for *P. santalinus*. However, even within these ideal conditions, significant differences in girth class distribution and basal area values exist. Plots within protected areas often exhibited higher basal area values, while many high-abundance plots showed lower basal area values, likely due to a high density of multi-stemmed, low-girth trees resulting from past logging activities.

The Future of Red Sanders: A Path to Revival and Sustainable Use

Despite centuries of over-exploitation, Red Sanders (*Pterocarpus santalinus*) has shown remarkable resilience, indicating that its revival is a serious and achievable goal. The key to its conservation lies in a multi-pronged strategy that goes beyond simply protecting existing wild populations.

A crucial step is to establish large-scale, seedling-based plantations. These should not only be in the species' natural habitats but also in regions with similar growing conditions Khurana, E. & J.S. Singh (2001). This approach will create secure repositories for its genetic material, safeguarding the species for future generations. Furthermore, these plantations can serve as a vital source of plant material for ongoing tree improvement programs, ensuring healthier and more robust populations.

For individual growers, it's essential to understand that cultivating Red Sanders is a long-term investment, unlike annual agricultural crops. While the gestation period is longer, the ultimate yield and financial returns from such a valuable tree are significantly higher. Government agencies must play a leading role in educating and encouraging farmers and entrepreneurs to engage in Red Sanders cultivation (Kukrety et al., 2013).

As suggested by Kukrety et al. (2013), it's imperative to develop a sustainable wood trade policy that incorporates the perspectives of all stakeholders. To truly revive the "past glory" of this invaluable species, a collaborative effort is needed. Government agencies, farmers, entrepreneurs, and policymakers must work hand-in-hand to protect, conserve, and sustainably utilize Red Sanders for the benefit of humanity.

CONCLUSION

The escalating demand for Red Sanders (*Pterocarpus santalinus*) has placed immense pressure on its natural populations. Unsustainable exploitation, particularly by collectors of medicinal plants, poses a grave threat to the species' survival, compounded by its inherently low regeneration capacity and the nascent stage of large-scale cultivation efforts. Therefore, urgent conservation measures are essential for the long-term benefit of humanity. Effective conservation strategies must incorporate several critical elements. The ability to produce stable units for germplasm conservation, including through advanced techniques like synthetic seeds, is paramount. Furthermore, employing multicriteria decision-making tools, such as analytic hierarchy, can effectively integrate stakeholder perspectives into the planning of Red Sanders conservation and restoration.

Despite the current challenges, observations on its population structure offer some encouraging insights. Red Sanders exhibits resilience, with a good representation in regenerating and growth-phase girth-at-breast-height (gbh) classes within these dry forests. This suggests a tolerance to mild disturbances and a stable population with decent recruitment. The abundance of seedlings and saplings, along with evidence of re-sprouting from roots after annual fires, indicates that Red Sanders is an early successional and shade-intolerant species. However, the impacts of human activities are undeniable. The prevalence of cut stems and multi-stemmed trees points to localized logging practices. Crucially, the low density of larger trees and the high incidence of cut stems in the 51–70 cm gbh class (reproductively mature trees) due to illegal logging are severely affecting fruit set, recruitment, and the overall population biology. This, coupled with the absence of Red Sanders in unprotected forest areas and their presence predominantly in lower gbh classes within reserve forests, underscores the dire need for strict management of exploitation, especially within wildlife sanctuaries where biotic interferences are meant to be restricted.

In essence, while Red Sanders demonstrates a natural capacity for recovery, aggressive and coordinated conservation efforts, rooted in scientific understanding and stakeholder collaboration, are indispensable to secure its future.

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Table-1: List of top ten grids featuring of *Pterocarpus santalinus*

Quadrates-ID	Location GPS Points	Forest type/Area	Disturbance index*	Altitude (m)	Soil type	Terrain of the transect
Q-1	N14°18.676″ E78°′45.384″	D.D**/Guvvala chervu (SBR*)	Low	496	Red soil with boulders	Flat terrain
Q-2	N14°18.721″ E78°′45.401″	D.D**/Guvvala chervu (SBR*)	Low	493	Red soil	On slope
Q-3	N14°18.740″ E78°45.385″	D.D**/Guvvala chervu (SBR*)	Low	494	Red soil with boulders	Flat terrain
Q-4	N14°18.766″ E78°45.360″	D.D**/Guvvala chervu (SBR*)	Low	491	Red soil	Flat terrain
Q-5	N14°18.783″ E78°′45.332″	D.D**/Guvvala chervu (SBR*)	Low	492	Red soil on flat terrain	On slope
Q-6	N14°18.834″ E78°45.323″	D.D**/Guvvala chervu (SBR*)	Low	495	Red soil with boulders	On slope
Q-7	N14°19.040″ E78°45.459″	D.D**/Guvvala chervu (SBR*)	Low	494	Red soil with boulders	Flat terrain
Q-8	N14°19.074″ E78°45.499″	D.D**/Guvvala chervu (SBR*)	Low	493	Red soil with boulders	Flat terrain
Q-9	N14°18.704″ E78°48.371″	D.D**/Guvvala chervu (SBR*)	Low	494	Red soil with boulders	Flat terrain
Q-10	N14°18.692″ E78°45.316″	D.D**/Guvvala chervu (SBR*)	Low	499	Red soil with boulders	Flat terrain

- *An index based on the distance away from the road/human habitation/cut stems
- DD**- Dry deciduous forest
- SBR* - Seshachalam Biosphere Reserve

Table-2: Total number of individuals (TNI), Basal area (m^2 ha^{-1}), and Important Value Index (IVI) of the study area.

Name of the Species	Family	TNI	BA	D	F	RA	RD	RF	IVI
Cassia fistula L.	Caesalpiniaceae	13	0.13	1.3	60	5.31	9.09	23.1	37.5
Croton scabiosus Bedd.	Euphorbiaceae	27	0.32	2.7	70	13.6	18.9	26.9	59.4
Gardenia gummifera L.f.	Rubiaceae	1	0	0.1	10	0.1	0.7	3.85	4.64
Murraya paniculata (L.) Jack	Rutaceae	2	0	0.2	10	0.18	1.4	3.85	5.43
Pterocarpus santalinus L.f.	Fabaceae	98	1.88	9.8	100	79.5	68.5	38.5	186.5
Ziziphus xylopyrus (Retz.) Willd.	Rhamnaceae	2	0.03	0.2	10	1.42	1.4	3.85	6.67
Grand Total		**143**	**2.37**	**14.3**	**260**	**100**	**100**	**100**	**300**

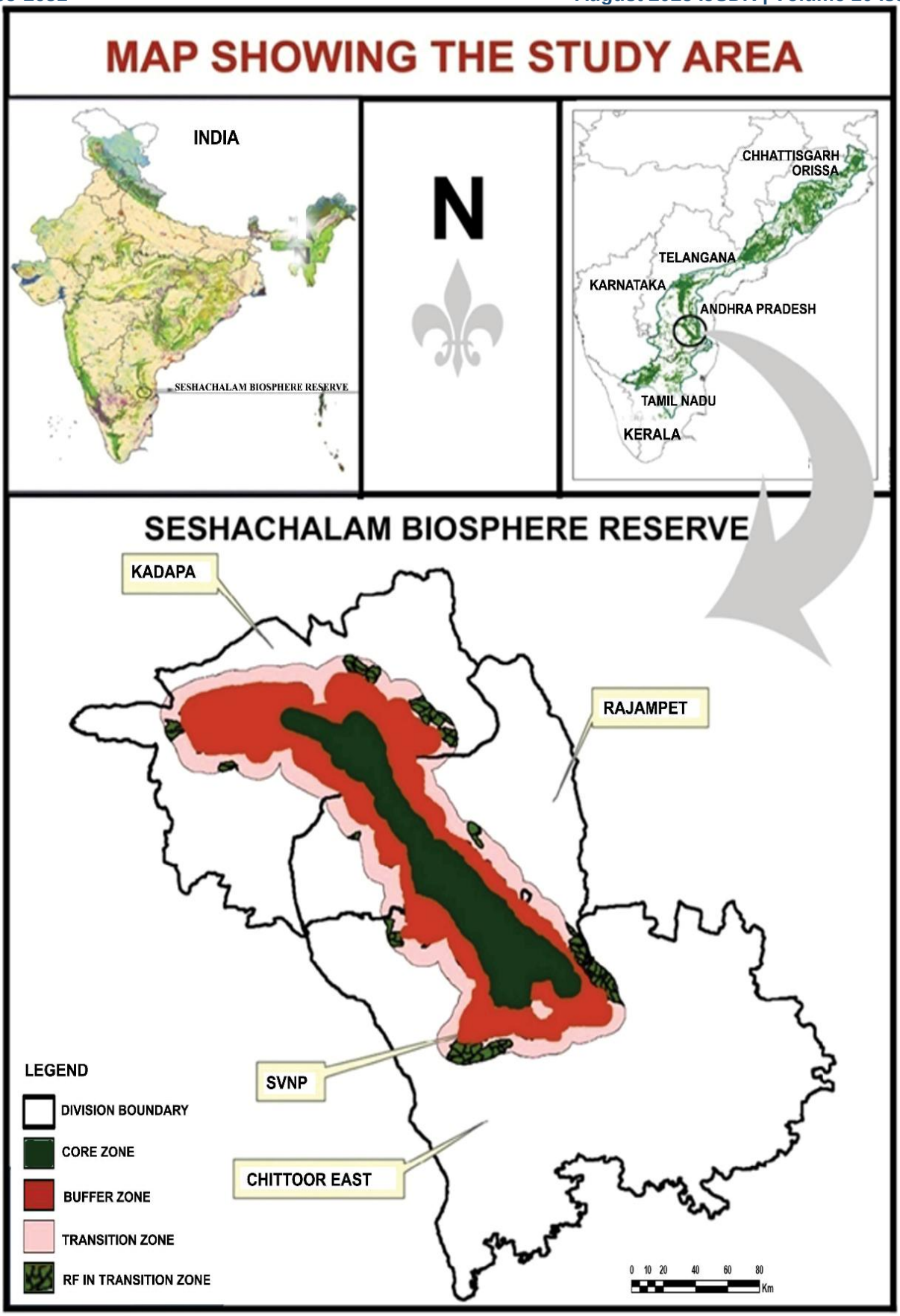

Figure-1: Map showing the study area

Figure-2: *Pterocarpus santalinus* Plant

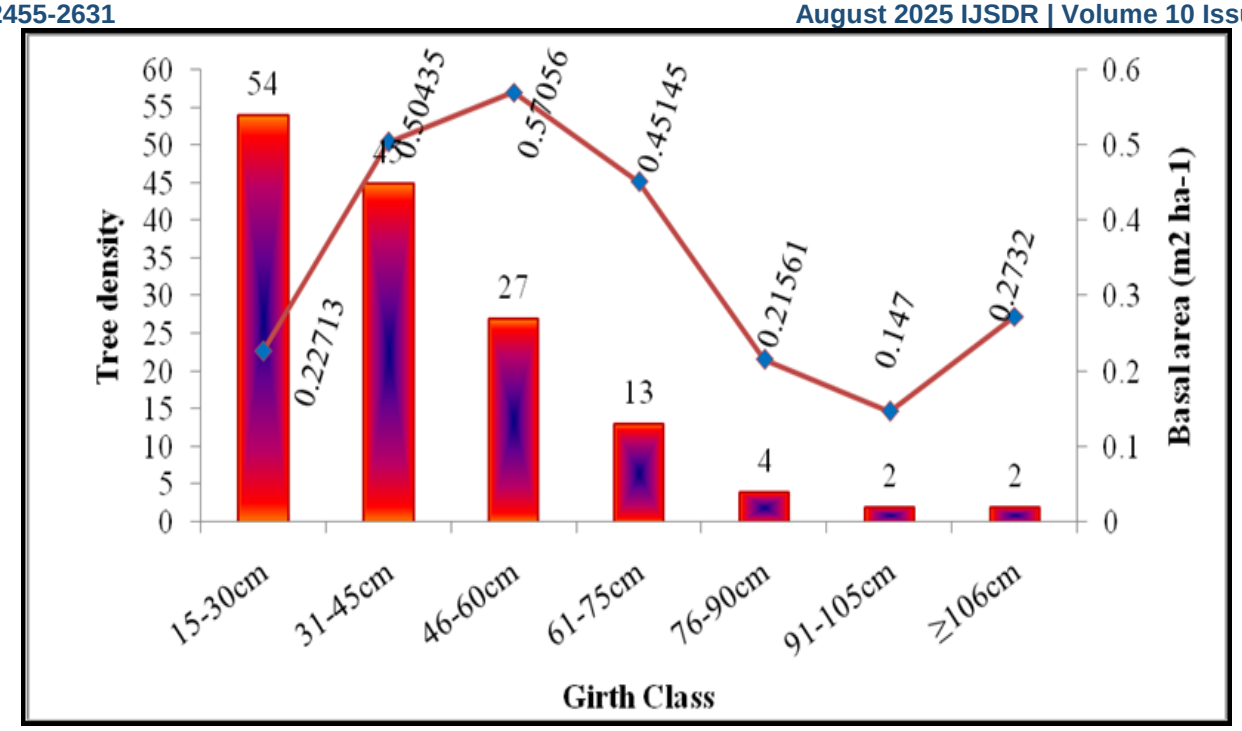

Figure-3: Population structure of *Pterocarpus santalinus* in the study area

Photo Plate-1: Field Methodology in the study area

Photo Plate-2: Field Methodology in the study area