

## Research Paper

# Red - Wood tree species and their endemicity in Chhattisgarh, Central - India

Shukla R.V., \*Shukla Kamalesh K., R. Sukumar<sup>2</sup>

Department of Botany, C. M. D. College Bilaspur, Chhattisgarh, INDIA

<sup>1</sup>School of studies in Biotechnology, Pt. R. S. University Raipur, Chhattisgarh, INDIA

<sup>2</sup>Center for Ecological Science, Indian Institute of Science Bangaluru (KA), INDIA

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## Abstract

Chhattisgarh state in Central-India represents for maximum varieties of tree species. This explains a positive relationship of tree diversity in a pristine habitat of ancient Gondawana land. Besides the geographic variation, we speculate how the most important factors i.e., climate and the soil, responding to varieties of tree species, which differs with other neighbouring states. In a perspective approach the large biomass tree plants absorbing more volume of water, producing more energy and accumulating more toxic chemicals and heavy metals. The appearance of reddish colouration in tree species mostly *Shorea robusta* (Sal) and its wild relative tree species such as *Pterocarpus marsupium* and innumerable *Terminalia spp* explains their adaptive behavior against the metal rich rocks. The purpose of present investigation is to explain identical value and habitat relationship of native tree species accumulating higher percentage of toxic chemicals, heavy metals etc.

## Introduction

In Central India, Satpuda Maikal landscape spreading across Madhya Pradesh, Chhattisgarh, Maharashtra, Jharkhand and Andhra Pradesh of which a major part is covered by the tropical forests. Chhattisgarh is the richest tract of tropical forests and wildlife, where a myriad of indigenous people live since time immemorial. This is one of the most important state of the country, surrounded by Satpuda in the west, and Maikal hill ranges covering the east areas <sup>[1]</sup>.

Chhattisgarh is basically a hilly state with ranges running from east to west & north to south. Much of the state lies on plateaus of Bastar, Jashpur, Mainpat, Pendra, and Amarkantak area. Geologically the state can be divided into three main regions, viz., the north hilly region (Plate-2), the plains and the great Bastar plateau. The topography of the state lies in two distinct types, a cluster of weathered forests blocks at low - land plain having flat or undulating terrain and the hilly ranges in up-land areas.

In reference to higher diversity in tree species there are so many expected factors that are leading to occurrence of many more tree species but, the knowledge of plant community within the forest is so poor that it is difficult to get accurate information on any tree species. Even the Sal tree that has potential lead to its endemicity (Plate-3) could not be projected as an important tree as per the current trend of afforestation program. Numbers of tree species studied in northern and southern part of the country along with their wild relative groups viz. insect, lichen, mushroom, wild life etc. but, study on indigenous tree species or animal of Chhattisgarh still lying unattended so far.



**Plate 1: Open necked land exhibits soil type**



**Plate 2: Men-pat plateau in Sarguja district**

In tropical forests, tree species a large group of producer vary in place to place <sup>[2]</sup>. In this concern the biogeographical information system that provides species-specific and site-specific information is an important aspect in way of sustainable use of biological resources, their conservation, monitoring and eco-restoration <sup>[3]</sup>. In tropical forests a tree plant with larger biomass conduits more water and energy <sup>[4]</sup> and represents for the greater productivity <sup>[5, 6, 7, 8]</sup>. Therefore, study on the area specificity and to count the richness of tree species is an essential aspect <sup>[9]</sup>.

In tropical forests the study on degree of habitat degradation impacting regeneration in tree species has greater importance rather than documentation <sup>[10,11]</sup>. In reference to above the investigations conducted on the species composition to explain habitat degradation in Similipal biosphere reserve Odisha state <sup>[12,13]</sup> some of them are to work out species diversity and their dominance in Achanakmar wild sanctuary <sup>[14,15]</sup> and many others carried out for comprehensive study on the structural parameters i.e. Phyto-sociology of tree, shrub and herb species <sup>[16,17]</sup>. Nevertheless, the study were conducted on basal cover values of tree species in Vindhyan region <sup>[17,18]</sup> and effect of closure in Sal forest relating soil properties and population of soil fungi <sup>[19]</sup>, and preliminary investigation on tree cover types relating the mushroom diversity in Achanakmar forests <sup>[20, 21]</sup>.

There are several studies to reveal that plants as per the area specificity determines species specific differences in qualitative parameters (colour, taste, flavour, medicinal value etc.). In general the soil nutrients, radiation, humidity, and the warmer conditions ascertain dark coloration in flora & fauna. The

tree species known as hyper metal accumulator namely red-wood tree species (RTS) found in acidic iron rich soil (Plate-1 & 2) of the state are more reddish than that of tree plants found alkaline soil of other areas. Similarly the cow as domestic animal and many wild animals i.e., spotted deer, barahsingha, Samhar, which prefer drier conditions are also darker reddish in colour. Furthermore, the mammals, birds, insects, in warm and humid area are often more melanic and darker rather races of the same species inhabiting in cooler temperate dry climate.



**Plate 3: Red - wood Sal tree in true-Sal forest**



**Plate 4: Die-back process in Sal tree**

The RTS have greater socio - economic importance and showed a positive relationship with the semi - arid geographical conditions and the geochemical rocks. They are counted pharmacopeia of drug efficacy as they bind metallic and other chemical constituents at an adequate proportion. The deep root system, broad leaves and dense canopy cover, of the tree species provide shelter and food to the forest dwellers (wild animal and tribals). In dry season the deep root of a tree plant may not only release the water, but rather take out it from the deep soil in order that the plant may transpire and survive. Moreover, the RTS within the state have striking features for maintaining water equilibrium rather than other type of plants (Pine, Teak, Eucalyptus, Jatropha etc.) that throw away more water from the forest ecosystem. Since, the

environmental conditions and their effects on richness of (RTS) couldn't be evaluated in a framework of statistical analysis therefore idea comes out to narrate the importance of RTS and prominent cause for appearance of brown reddish coloration in flora & fauna.

**Study Site ABR:** Achanakmar-Amarkantak Biosphere Reserve (ABR), a 14<sup>th</sup> biosphere reserve falls in the sub-area of Maikala Range of which Lamni ranges located at the highest point of 1040m. 450 meter in Achanakmar. This is one of the premium biosphere reserve located in wide area 2059.38 sq of Chhattisgarh state and partly an area of 1224.98 sq. km in Madhya Pradesh (21). ABR is the most species diversity rich terrestrial ecosystems representing tropical semi ever-green Sal forests and consisting mostly deciduous tree species. The Achanakmar wild life sanctuary nearer to Bilaspur represents as the core zone of the biosphere reserve and rest of the area counted as buffer zone.

**Climate:** Climate of the state remains almost dry from September to June. In open necked dry land the soil, is too poor to retain the water for a longer period. The warmer conditions within the ABR exert a substantial burden for excessive evapo-transpiration for too little soil moisture to seed germination.

**Rainfall:** The biosphere reserve has a typical monsoon climate, with three distinctly defined seasons including a short post-monsoon season in the month of October. The summer season begins from April and lasts up to the middle of June. The monsoons (rains) commence from the middle of June and continue until the end of September. The winter or cold season begins from November and last up to March. A few rain showers occur, generally, in every season, and throughout the year. The annual rainfall is from 1322.0 to 1624.3 mm <sup>[21]</sup>.

**Soil:** The soil is generally dark red, red-black or grey-brown in colour rich in heavy metals with neutral to acidic in pH. There is higher percentage of ferrous oxide, which after evaporation of soil moisture precipitates and gives red colour. The red-soil (Plate-3) a common type of soil which has lesser water retention capacity is found in major portion of Chhattisgarh and parts of many other neighboring states.

**Temperature:** The mean daily maximum temperatures range from 24 to 39 C, and mean daily minimum temperatures range from 10 to 25 C, depending on the season. The radiation budget in lower altitudinal ranges is of drought augmentation which has represented winter less days and nights without fog and dew-fall. The average temperature in a day 25-28°C even more vary slightly throughout the year. The ambient day-time average is usually more than 30°C and night temperature averages around 25°C. The mean temperature of the coldest month lies between 15-20°C and occasionally even less than 15°C.

## Materials and Methods

The topography of the state lies in two distinct types; the hilly ranges mostly having true Sal forests in up-land and the undulating terrain with a cluster of mixed Sal forests blocks in low-land. In present investigation Achanakmar wild sanctuary a core zone of ABR was selected to record the abundance of RTS. Apart from the Achanakmar sanctuary 56km. in North-West of Bilaspur there are Chhapparwa (62 km.) and Lamni (70 Km.) forest ranges, where later one lying at the highest point of 1040 meters above the sea level.

The average rain fall 146 cm recorded with in the 2000-2008 (21). The average relative humidity was 60 % and 52 % in the morning and evening respectively. During long term monitoring of tree plants particularly RTS, a regular systematic and periodical survey program was designed to cover all the three sites (Achanakmar, Chhapparwa, Lamni) of the Biosphere and teak dominated habitat of Shivatarai village. An area of 500 x 5 meters was selected in each site to record the occurrence and distribution of tree species.

## Results and Discussion

The Sal and Sal type RTS viz. *Adina cordifolia*, *Albizia lebbek*, *Boswellia serrata*, *Bombax malabarica*, *Dalbergia sissoo*, *Dillenia pentagyna*, *Eugenia jambolana*, *Lagerstroemia parviflora*, *Madhuca longifolia*, *Mangifera indica*, *Pithecolobium dulce*, *Pterocarpus marsupium*, *Saccopetalum tomentosum*, *Schleichera*

*oleosa*, *Tamarindus indica*, *Terminalia arjuna*, *T. belerica*, *T. chebula*, *T. tomentosa* existing in metalliferous rocks (Table1) exhibit reddish colouration in their bark, wood and other organs of their part are quite different with that of other types of tree species (Pine, Teak, *Jatropha*, *Acacia australiana*, *Eucalyptus*.) introduced under the afforestation program in forest land of the state.

The study site in low-land area of Achankmar range located at 450 meter in Achanakmar is characterized by the presence and the prominence of Sal a key-stone tree species. Besides, Sal tree the *Anogeissus latifolia*, *Buchnanania lanzan*, *Diospyros melanoxylon*, *Eugenia jambolana*, *Lagerstroemia parviflora*, and *Terminalia tomentosa* etc. growing abundantly in the area. The site is distinguished for mixed-Sal forest consisting *A. latifolia*, *D. melanoxylon*, and *L. parviflora* etc. However, some part of the forest site showed decreasing order in overall population of old tree species, their density, and seedling to adult stage.

The sites at the most of plane surface area in between Chhapparwa and Lamni ranges representing true - Sal forest (Plate 3), where Sal tree dominates over other tree species. The Sal tree is capable to maintain its uniformity in a part of the area where it grows but, there are different variables in the density of tree species in the same region and at the same altitude. At some places it showed uniformity due to suitable habitat and in other places showed the non uniformity exhibiting inadequate ecological conditions.

The sites of secondary forest in Achankmar, Chhapparwa and Lamni, ranges showed a general cause of wider range of stress symptoms to *Tectona grandis* (Teak) which is of alkaline soils. The site reflects an issue to over-look potential values of RTS. Because, conversion of primary Sal forest to Teak forest alters the soil texture due to a large canopy gaps in between the Teak plants, which allow too much light accelerating vertical movement of water and energy<sup>[22]</sup>. Obviously, the sun rays reaching to the soil surface heated-up soil strata causing extremes of evaporation of water from the ground surface. The acidic and light – textured, soil of a deforested area prone to iron toxicity not only limits the growth of tree species, but also limits the biodiversity in the above and below the ground. The soil is not nitrogen rich as calcium deficient conditions deprive the population of nitrogen fixing bacteria. Since the leaf litter of Teak is not being consumed by wild life and without microbial degradation this over burden has only way to be lost by fire burnt.

The RTS have adaptability to grow and survive in every possible habitat within the state. These are found distributed widely growing well in acidic soil and retaining plenty of moisture and humus soil. Quite obviously, they have developed specific ability through evolutionary changes to control over the up-take or rejection of metal elements i.e. iron, aluminum, manganese, etc. This explains so much of climate and edaphic factors under which a tree plant differs in chemical configuration if compared with its own species growing in northern states.

In response to fastened bio-geochemical cycle in tropical conditions the RTS govern ecological equilibrium over the iron rich rocks as they bind metal elements in their tissues very efficiently. The Teak and some other types of tree plants may have some desirable characteristics to tolerate adverse soil conditions (richness of metal elements, dryness, soil pH etc.), but not like that of RTS. The deep root system and dense foliage of RTS provide unusual longevity and to survive against consistent water and nutritional stresses. Despite accumulating excessive amount of heavy metals the varieties of native tree species growing together stabilize the soil, reduce runoff, absorb water from deep soil horizon and recapture leached down inorganic contents particularly calcium and phosphorus through their deep root.

Indeed, very few researches deal with the aspect relating to iron toxicity as inflow of ferrous iron from the upper slopes result accumulation of the metal in the low-land. The current trends of erratic rains drop over the open land causing sedimentation of fine materials to compact the soil surface in to a hard crust when it dries out. Moreover, the precipitation of iron concentrations as a general hardening make the soil unfit for any form of cropping<sup>[23,24]</sup>. The iron rich deposit soil becomes hard and impermeable to water leaving rust-red iron stain leading major loss in paddy crop<sup>[24]</sup>. Since the lateritic soil with less organic matter do not have water holding capacity, the un-bind iron, aluminum, manganese, metals and their solubility exists as a major problem in the soil and in water bodies.

**Table 1: List of Red - Wood Tree Species**

<b>Name of Species</b>	<b>Abundance</b>
<i>Aegle marmelos</i>	++
<i>Anogeissus latifolia</i>	+++
<i>Adina cordifolia</i>	+++
<i>Albizia lebbeck,</i>	+
<i>A. procera,</i>	+
<i>Acacia arabica</i>	+++
<i>A. catechu</i>	+
<i>Bridelia retusa</i>	+++
<i>Butea monosperma</i>	+++
<i>B. superba</i>	+++
<i>Boswellia serrata</i>	++
<i>Bombax malabarica</i>	++
<i>Buchanania lanzan</i>	+++
<i>Bauhinia malabarica</i>	+++
<i>Cassia fistula</i>	+++
<i>Caryota urence</i>	+
<i>Diospyros melanoxylon</i>	+++
<i>Dillenia pentagyna</i>	++
<i>Dendrocalamus strictus</i>	++
<i>Emblica officinalis</i>	++
<i>Eugenia jambolana</i>	++
<i>Lagerstroemia parviflora</i>	++
<i>Lannea coromandelica</i>	+++
<i>Madhuca longifolia</i>	++
<i>Mangifera indica</i>	+
<i>Metragyna sp.</i>	++
<i>Phoenix acaulis</i>	+
<i>Pterocarpus marsupium</i>	+
<i>Pithecolobium dulce</i>	+
<i>Shorea robusta</i>	+++
<i>Saccopetalum tomentosum</i>	+
<i>Schleichera oleosa</i>	++
<i>Semecarpus anacardium</i>	+
<i>Tamarindus indica,</i>	++
<i>Terminalia tomentosa</i>	+++
<i>T. bellerica</i>	++
<i>T. chebula</i>	++
<i>T. Arjuna</i>	++
<i>Unidentified tree spp. 1- 5</i>	

+ Less than 5%, ++, more than 10%, +++ more than 25%

Virtually, in acidic soil the soluble iron oxide enters in plant tissues and later precipitates in periderm, wood, and the plant organs (leaf, flowers, fruits, seed etc.). The plant tissues usually have normal to narrow higher pH facilitates the mechanism of iron absorption and its precipitations <sup>[25]</sup>. The existing warmer conditions causing quick loss of water from tree bark appearing hard and reddish in colouration. Although, acidic soil type and values of the iron oxides may create consistent problem for the growth and survival of many tree species. Even though, the state represents for many more numbers of indigenous tree species which are quite efficient in absorption and translocation of heavy metals from their roots to top portion <sup>[26]</sup>. Surprisingly, RTS have never been thought a biological tool in way to phytoextraction of heavy metals and other toxic chemicals causing pollution in underground water and surface water bodies.

Within hot and humid conditions the process of decomposition remains so high that the soils almost entirely cease to act as store for nutrients. It consists mainly of iron and aluminium oxides compounds which have a very low adsorption capacity for plant nutrients. And the state suffers with vertical leaching of iron in ground water and with surface runoff in streams and flooded paddy fields<sup>[24,27]</sup>. This explains the removal of RTS (Plate 4) in a large area which are an important means of phytoremediation. The forests recognized as the Ecological Capital due to profound position of RTS, which also promote the ground flora viz. species of *Achyranthes*, *Amaranthus*, *Ammania*, *Alternanthera*, *Boerhaavia*, *Chenopodium*, *Euphorbia*, *Flemingia*, *Ludwigia*, *Malvastrum sylvestris*, *Polygonum*, *Portulaca*, *Phyllanthus nirurai*, *Spinach*, *Tephrosia*, etc. in a great extent to minimize heavy metals, other toxicants, in surface and ground water.

Evidently, planted Teak tree gives a light, weak and spongy wood of inferior quality than that of wood obtained from its natural primary forest<sup>[28]</sup>. In reference to the secondary forest of the Teak tree showed light brown marked wood growing on nitrogen deficient acidic soil of ABR. Probably, this is as much as the iron rich acidic soil that counter with the growth and quality of timber plant. No matter, if the primary Teak forest is found in a confined Mahanadi basin of the state of which light brown wood being considered inferior than that of dark brown marked wood of primary forests in Northern part of Madhya Pradesh. It is not so much climate as edaphic factor, to determine the distribution of a calcicolous Teak prefers to grow on natural or slightly alkaline nitrogen rich soil and the calcifuge RTS grow on acidic nitrogen deficient soil<sup>[29]</sup>.

The RTS regulate the hydrological cycle and store water release it after the monsoon. They have capability preventing drought and protecting thin top soil that promote seed germination. In ecological aspects such as temperature, rainfall, humidity, soil pH, and soil microorganisms, the RTS representing for greater availability of forest produce such as myrobalans, tubers, leaf, flower, fruits, seed, resin, lac, mushrooms, sulfi drink, silk-cocoon, honey, etc of commercial value. And the large tree canopy protects top strata of soil for the growth and development of ground flora & fauna. Some members (5-10 per cent) probably old trees of Sal and Saja (*Terminalia, tomentosa*) develop a large lateral ridge to store water in the stem of which tribal people knows how tap the water to quench their thirst in summer.

## Conclusion

The RTS make a substantial contribution to sustain ecological equilibrium and well being although the extent is not fully recognized. There are many opportunities for environmental improvement in conservation. A significant contribution of RTS is to provide ecological services to conserve biodiversity values and to improve the economy of Chhattisgarh. Surprisingly, the service and values of tree plants never been quantified as these are recognized an integral part of the forest ecosystem to sustain the availability of water, agricultural productivity, nutrient recycling, environment, and to control soil erosion. Although our investigation is not based on a thorough analysis of land-use impacts within the state, however it is based on studies conducted in forest areas since past a decade. The aim of this study is to project species-area relationship with special reference to RTS which are not merely indicator of iron and aluminum reserve, but are the bio-remedial means controlling excess release of heavy metals, fluorides, nitrates etc. from surface land to the surface and ground water-aquifer.

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