United Nations Decade on Biodiversity

Pharmacognosy of Negative Listed Plants

भारतीय वनस्पति सर्वेक्षण
BOTANICAL SURVEY OF INDIA

Botanical Survey of India
Ministry of Environment and Forests

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FOREWORD

Pharmacognosy, an ancient branch of herbal science, stretched its horizon to be all inclusive of all facets of medicinal plants research. It is well known fact that many of the medicinal plants which possess very effective therapeutic properties have become threatened in the wild, either due to over exploitation or due to loss of habitats as a whole. Such plants have been placed under Negative list of Exports, so as to regulate their trade on one hand and to check unplanned and illegal exploitation from wild sources on the other. Botanical knowledge of the Negative listed plants is necessary to identify them in their crude form when they are illegally traded, exported or smuggled.

The present illustrative manual provides information on twenty one Negative listed plants on various pharmacognostic parameters that comprise morphology, organoleptic study, anatomy, scanning electron microscopy, powder microscopy and fluorescence analysis. Dr. A.B.D. Selvam has put in serious efforts to prepare this manual with detailed descriptions and quality microphotographs for all the twenty one species. The epigrammatic diagnostic characters of these species have been provided in a tabular form at the end of this manual, which can be used as ready referance for identification of the enlisted species either in their fresh or dried form. Further, a glossary of botanical and therapeutic terms have also been furnished, which would facilitate quick and easy understanding of the subject especially for those who are not familiar with the terms.

This manual is the first attempt of the Botanical Survey to bring out such a publication that has a direct relevance in confirming the correct botanical identity of twenty one Negative listed plants thereby arming the customs officials, crude drug dealers/traders and other concerned stake holders with the needed scientific information to see that these plants don't pass through various Indian ports under different trade names/dubious names.

Kolkata
Date : 30th Nov. 2012

Paramjit Singh

IDENTIFICATION PROTOCOL FOR RED SANDERS

RED SANDERS, RED SANDALWOOD

15. Pterocarpus santalinus L. f.

The genus *Pterocarpus* belongs to the family Papilionaceae, which comprises of about 15 species worldwide and are widely distributed in the Tropics, of which 5 species occur in India. *Pterocarpus santalinus* is one of the most valuable plant species found in Southern parts of India. Owing to the reddish colour of the heartwood of this plant, it is popularly known as 'Red sandalwood'. It is otherwise known as 'Red Sanders' in trade.

Naturally, this plant species is occurring in the tropical dry deciduous forest. However, considering its usefulness and demand in the market, it is described under a separate forest sub-type 'The Red sanders forest'. This plant is referred to as 'the pride of Eastern Ghats'. Since the plant species is resistant to drought, it is considered as an excellent species for planting in hot and dry areas of South India (Sanjappa, 1992; Verma et. al., 1993; Pullaiah and Chennaiah, 1997; Prasad & Reshmi, 2003).

The heartwood of this plant is heavily impregnated with red dye called 'santalin', for which it is valued. It is immune to white ants and other insects and does not require antiseptic treatment. This tree is earning maximum foreign exchange to Andhra Pradesh State government (Anonymous, 1969; Naidu and Mastan, 2001).

Etymology: The generic name *'Pterocarpus'* is derived from the Greek root words, *'pteron'* means a wing and '*karpos*' means a fruit, referring to the winged pot or feathery fruits. The specific epithet '*santalinus*' is derived from noun base 'Sandal' and Latin adjectival suffix '*inus*' means like, which hints that this plant is possessing the characteristics of or resembling to that of Sandal or Sandalwood (Stearn, 1983).

Botanical Synonyms: *Ligonium santalinum* (L.f.) O. Kuntze

Trade names: English - Red Sanders; Hindi - Lal-chandan; Sanskrit - Rakta-chandana; Tamil - Sivappu-chandanam; Arabic - Sandal-e-Ahmar; Telugu - Yerra-chandanamu.

Distribution: This plant occurs as an endemic species in the hills of Cuddapah, Kurnool, Chittoor, Nellore and Prakasam districts of Andhra Pradesh and sporadically occurring in some pockets of adjoining states of Tamil Nadu and Karnataka at an altitude range of 200 – 900 m (Pullaiah and Chennaiah, 1997).

Habit and habitat: A tall deciduous tree; it grows typically on dry, hilly, often rocky ground and is occasionally found growing on precipitous hillsides. It cannot withstand water logging.

Phenology: Flowering period from April to July; fruiting period from September to February.

Botanical description: Tree, attains a height of 12 m; branchlets glabrous; bark deeply cleft, brownish black. Leaves 3-foliolate, rarely 4 or 5, leaflets ovate-orbicular or oblong, 4.0 – 8.5 x 3.5– 8.0 cm, base obtuse-subcordate, apex emarginated, margin entire. Inflorescence axillary or terminal raceme or panicle. Fruits are pods, orbicular, compressed, narrowly winged along margins, ca. 5 x 4.5 cm. Seed 1, reddish brown (Plate - 62, figures A – C).

Field characters: A moderate-sized deciduous tree, bark blackish-brown, deeply cleft into rectangular or square shaped plates (cork cells); bark resembles to that of crocodile's skin in appearance. Leaflets usually 3, rarely 4 or 5, broadly ovate or nearly orbicular, slightly emarginated, surface glossy. Flowers yellow; pod round with a broad wing. The tree is leafless during January – March. The heartwood of this plant naturally bright orange brown or dark red in colour; upon exposure to air, it turns into very dark brown or black colour. The heartwood is quite heavy and sinks in water (Dutt, 1928; Neginhal, 2004; Sarin, 2008).

Plant part used: Heartwood, used in Siddha, Ayurveda, Unani, Tibetian and folk medicines.

Medicinal properties and uses: The heartwood of *P. santalinus* is considered as cooling, astringent, antipyretic, diaphoretic, febrifuge and tonic in action. It is employed in drug formulations used in the treatment of dysentery, bilious affections and diseases of blood. The wood paste is externally applied to cure skin inflammation, headache, fever, scorpion sting, skin diseases and to strengthen eyesight.

It has remarkable property of healing pimples, scars, boils, wounds, burnt marks, black spots, eczema and other blemishes of skin. It can make the skin smooth and attractive. A red chemical substance, *Santalin* present in the heartwood of this plant is used as a dyeing / staining agent. In European medicine, it is used as a colouring agent. It is well known ingredient of French polish (Dutt, 1928; Dey, 1980; Ahmed & Nayar, 1984; Anonymous, 1992; Prasad & Reshmi, 2003; Sheth, 2005; Sarin, 2008).

Substitutes and adulterants: Heartwood of *Adenanthera pavonina* Willd. (Family: Mimosaceae) known as 'Ranjana' and 'Raktakambal' in West Bengal and 'Bari Gumchi' in the Northern parts of India, is often sold as a substitute for Red sanders. Artificially coloured wood shavings and saw dusts of some other trees is also sold in the market as cheap substitutes (Sarin, 2008).

Trade details: It is traded illegally in local, regional, national and global markets. The collection of the heartwood of this plant from forests is restricted and is regulated by the forest department. The bulk raw material (heartwood) available in the market is supplied by Andhra Pradesh Forest Department. Supply of smaller amount of this raw material is now obtained from cultivated sources (Sarin, 2008).

Major threats: Illegal felling of trees for trade.

Current status: This plant species is ranked 'critically endangered' due to its restricted natural distribution and depleted population (Sarin, 2008).

Conservation and cultivation details: Natural regeneration takes places through seeds. Seeds regenerate satisfactorily under favourable conditions such as loose soil, enough moisture, free from forest fire and animal grazing. For artificial regeneration, one-year old seeds are used. Dry pods (seeds) are collected from the trees and are dried in the sunlight for about 3 days, stored in bamboo baskets or in gunny bags, it can retain viability for 8 to 12 months. To increase germinative capacity, seeds can be pre-treated by soaking them in ordinary cold water for 3 days or immersed in cow dung slurry for 48 hours before sowing.

This plant can be raised by direct sowing, in nursery beds, or by stumps. Stump planting gives highest percentage of results. Two-year old seedlings give best results when transferred to the field. It is a highly shade intolerant plant species, it requires plenty of sunlight for proper growth. Large-scale plantations of this tree species have been established in recent years in Andhra Pradesh (Prasad & Reshmi, 2003).

Pharmacognostic studies

The macroscopic, microscopic, powder, organoleptic characters and fluorescence properties of the heartwood of *Pterocarpus santalinus* have already been studied (Youngken, 1948; Rao & Purkayastha, 1972; Anonymous, 2001; Billore et. al., 2005; Sarin, 2008). Meanwhile, data available on the macroscopic, powder, organoleptic characters and

fluorescence properties of the heartwood of *P. santalinus* is fragmentary, which requires a detailed study. Further, maceration and SEM (Scanning Electron Microscope) studies have not been carried out so far. Hence, to reconfirm the available data and to provide a consolidated data on the heartwood of this plant, all the above-mentioned parameters have been worked out in the present study.

The structural and qualitative data observed in the present study have been furnished below in detail with illustrations, which will be useful in the identification of the heartwood of *P. santalinus* in its crude form.

A) Exomorphic and Organoleptic features

The scattered information available on the exomorphic (macro morphological) features and organoleptic characters of the heartwood of *P. santalinus* were collected and reviewed (Dey, 1980; Shiva *et. al.*, 2002; Khare, 2004; Sarin, 2008). They are furnished in a tabular form along with the personal observations (Table - 29; Plate - 62, figure D).

B) Endomorphic features

A small piece of heartwood of *P. santalinus* was taken up for microscopical observation. In transectional view, it shows the following features. Growth rings are not evident. Vessels diffuse in distribution, vessels wide, fairly thick walled, circular or elliptical, mostly solitary or less frequently in short radial multiples of 2 or 3; often filled with dark gummy material. Vessels show bordered pits on the lateral walls. Diameter of the vessels ranges from 75 μm to 200 μm.

Axial xylem parenchyma, paratracheal, banded, forming wing like lateral expansion or wavy tangential lines of 3 – 5 cells wide. Xylem fibres thin walled with wide lumen, walls lignified. Prismatic calcium oxalate crystals occasionally seen within the fibres. In TLS view, xylem rays thin, straight, storied and uniseriate (Plate - 63).

C) Powder Microscopy

Under polarised light, the powdered heartwood of *P. santalinus* exhibits fibres, vessel elements, xylem (wood) parenchyma, starch grains and calcium oxalate crystals. Abundance of wood fibres is seen in the powdered preparation. They are narrow, elongated with tapering ends. The vessel elements are narrowly cylindrical and fairly thick walled with dense, circular or elliptical, wide, lateral wall pits. Non-lignified broken pieces of xylem parenchyma cells are often seen in the powder.

Two types of starch grains are seen very rarely in the powder; concentric starch grains with central hilum and plus (+) shaped dark markings; elliptical starch grains with eccentric hilum, 'V' and 'YY' shaped dark lines/markings. The presence of starch grains is reported for the first time in this plant species. Prismatic calcium oxalate crystals of varying sizes and shapes are occasionally seen in the powder (Plate – 64).

D) Maceration

The macerated heartwood of *P. santalinus* exhibits wood fibres, xylem (vessel) elements, ray parenchyma and crystals. Vessel elements are frequently seen in the macerated preparation, which are wide, short, cylindrical with vertical or horizontal, parallel rows of pits. Xylem fibres thick walled with reduced lumen and walls lignified, which ranges from 480 to 950 μm in length. Fibres with ray parenchyma cells attached on the lateral walls are also seen. Prismatic calcium oxalate crystals occasionally seen in the macerated preparation (Plate - 65).

D) SEM studies

A small piece of heartwood of *P. santalinus* from the peripheral region (last formed tissue) was taken up for the study. In cross sectional view, it shows wide, thick walled, circular or elliptical vessels in radial multiples of three. Some of the vessel elements filled with gummy material. The diameter of the vessels ranges from 75 – 200 μm. Lateral wall pits of the vessels elliptical, narrow and alternated, which range from 3 to 11 μm in length. Xylem fibres are heavily thick walled with reduced lumen. Xylem rays narrow, straight, undilated, parallel to each other (Plate - 66).

E) Fluorescence analysis

The characteristic fluorescent properties (in the form of colours) emitted by the coarsely powdered heartwood of *P. santalinus* under ultraviolet radiation @ 254 nm and the colours observed in visible light, before and after treating with various reagents were recorded and are presented in Table - 30.

The powdered heartwood of this plant as such appeared reddish orange in visible light and deep reddish orange under ultraviolet radiation. After treating with various reagents, in visible light, it showed different shades of yellow in most of the cases except hexane, methanol, acetone, aqueous and alcoholic 1*N* sodium hydroxide extracts. The hexane extract did not show any colour. However, the methanol and

acetone extracts revealed deep brownish red and deep orange colours respectively. Though the water extract did not show any solid colour (appears almost colourless), a very pale brown colour with light yellow tinge was observed. The aqueous and alcoholic 1*N* sodium hydroxide extracts, showed reddish brown colours.

Under ultraviolet radiation, chloroform, acetone, 50% sulphuric acid and 50% nitric acid treated extracts fluoresced different shades of yellow. The water and methanol extracts showed pale green and magenta or deep orange colours respectively. The aqueous and alcoholic 1*N* sodium hydroxide extracts, revealed dark violet colour, but the hexane and 1*N* hydrochloric acid treated extracts fluoresced no colours.

Table – 29

Exomorphic features and Organoleptic characters of the heartwood of *Pterocarpus santalinus*.

Exomorphic features	
Occurrence	Commercial samples of the heartwood of Pterocarpus santalinus consist of transversely cut pieces in various shapes, sizes and thickness. The heartwood also occurs in the form of wood shavings and saw dust (coarse powder).
Size	Heartwood about a meter long and 7 – 15 cm in diameter, deprived of both the rugged bark and pale sapwood.
Shape	Irregularly shaped, mostly cylindrical.
Surface	Hard, mild ridges and furrows at different angles with longitudinal striations.
Organoleptic characters	
Colour	Transversely cut surface shows darker and lighter zones with varying colours, both internally and externally viz. deep red or reddish brown or dusky red to dark reddish brown or black.
Odour	It has no specific odour (inodorous) except mild woody smell.
Taste	Slightly astringent and bitter.
Fracture	The heartwood is very hard, but can be easily split longitudinally. Fracture very hard, splintery.
Texture	Fractured surface uneven, fibrous or horny.
Peculiarities, if any.	Heartwood shows apparently visible deep reddish brown colour in its crude form (cut pieces and coarse powder), which is one of the constant characters, helpful in spot identification.

Table - 30

Fluorescence properties of the heartwood of *Pterocarpus santalinus* under visible light vis-à-vis Ultraviolet radiation @ 254 nm

Tests	**Visible light**	**UV radiation**
Plant powder	Reddish orange	Deep reddish orange
Plant powder treated with water	Colourless (or) Very pale brown with Pale green	light yellow tinge
Plant powder treated with hexane	Colourless	Colourless
Plant powder treated with chloroform	Lemon yellow	Pale lemon yellow
Plant powder treated with methanol	Deep brownish red	Magenta or deep orange
Plant powder treated with acetone	Deep orange	Deep chrome yellow
Plant powder treated with 1N NaOH in water	Reddish brown	Dark violet
Plant powder treated with 1N NaOH in methanol	Reddish brown	Dark violet
Plant powder treated with 1N hydrochloric acid	Pale yellow	Colourless
Plant powder treated with 50% sulphuric acid	Chrome yellow	Light ochre yellow
Plant powder treated with 50% nitric acid	Golden yellow	Light ochre yellow

Note: 1 gm of plant powder (heartwood) treated with 10 ml of reagent solution. The tests pertaining to the serial numbers 4, 5, 6, 7, 8, 10 and 11 showed immediate reactions by yielding colours that were observed in daylight.

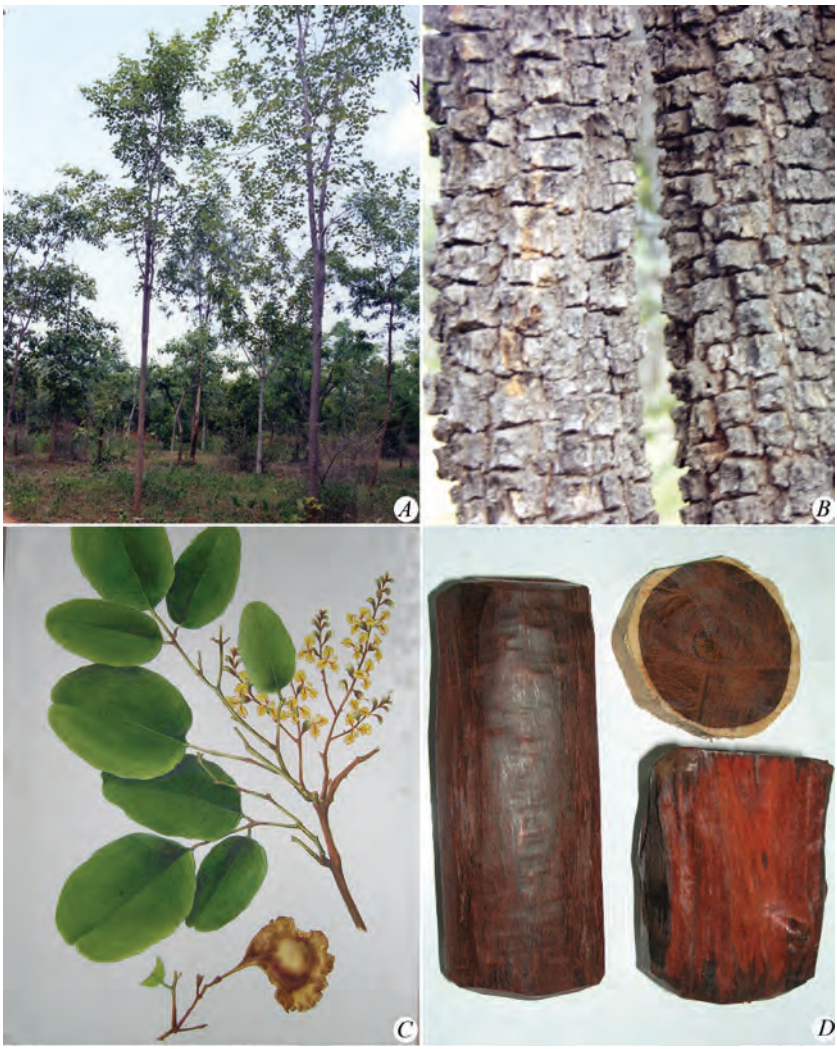

Plate - 62. *Pterocarpus santalinus*. A. Trees in their natural habitat; B. Tree trunks with deeply cleft bark showing rectangular plates; C. Illustration of a flowering branch and fruit (source : BSI Archival painting), D. Cut pieces of heartwood in trade.

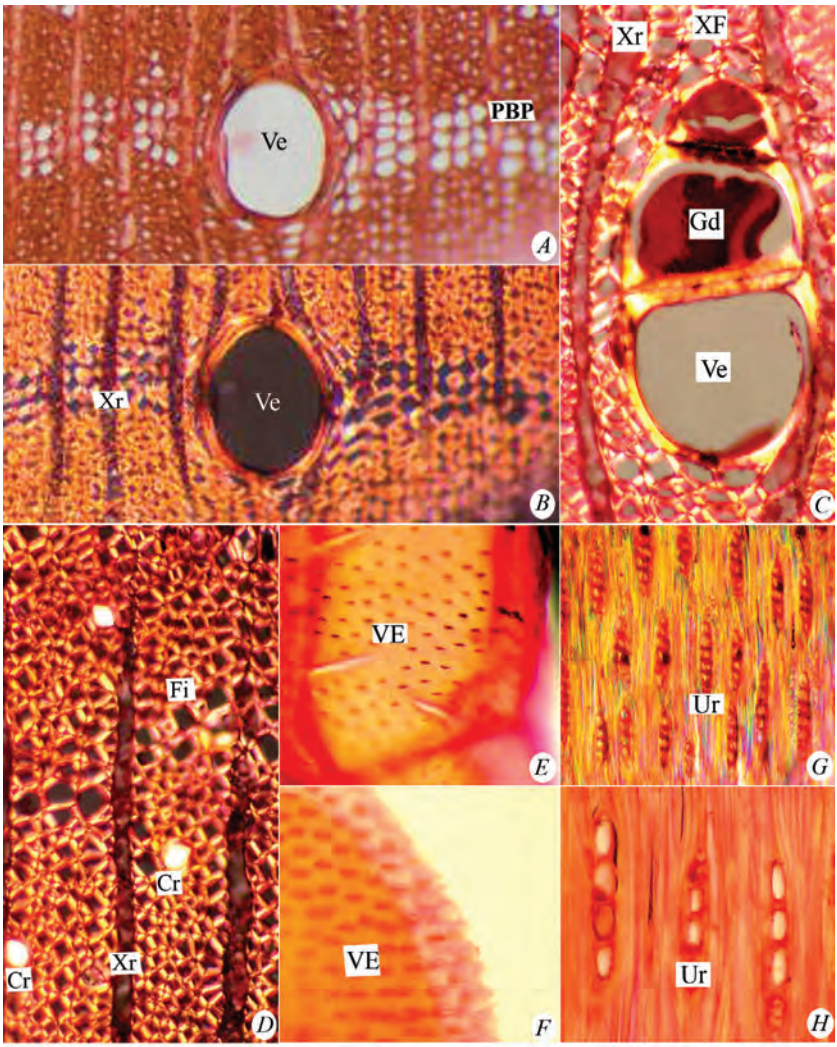

Plate - 63. T.S. and T.L.S. structure of heartwood of *Pterocarpus santalinus*. A & B. Vessels with paratracheal banded axial parenchyma; C. Vessles in radial multiples of three loaded with gummy substance; D. Xylem fibres, rays and crystals seen under polarized light; E & F. Vessels showing bordered pits; G & H. Uniseriate rays.

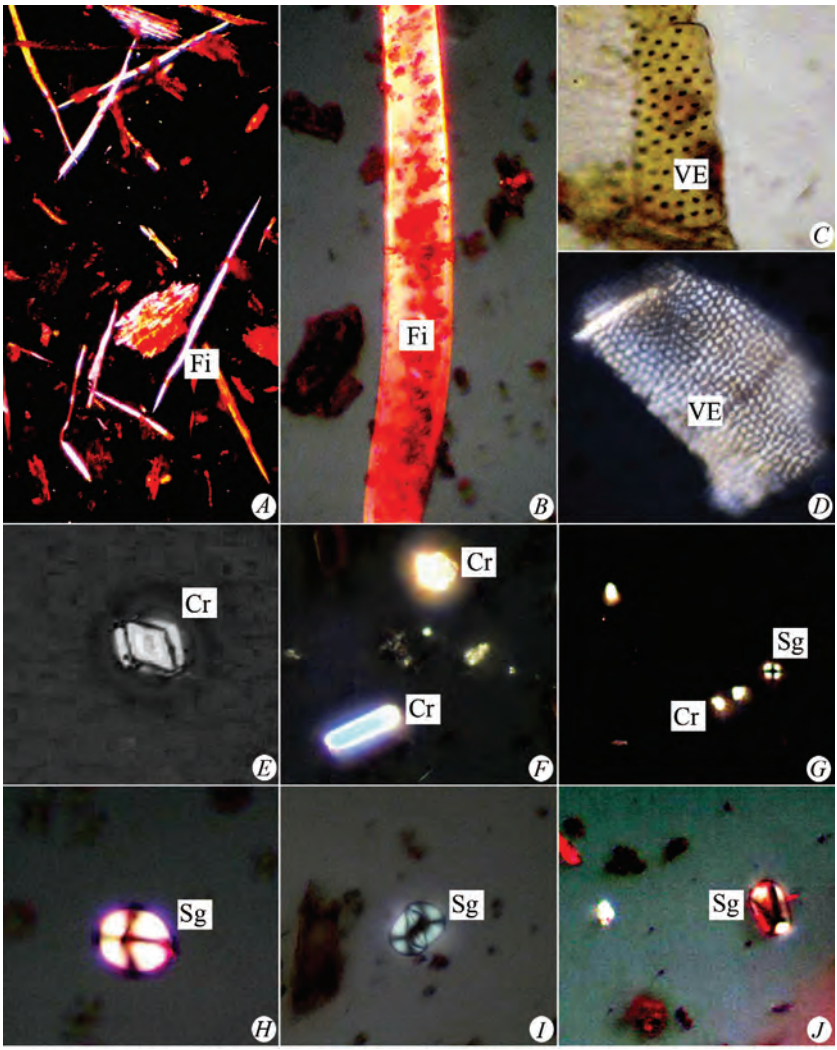

Plate - 64. Powdered heartwood elements of *Pterocarpus santalinus* in polarized light (except figure C). A. Xylem fibres; B. Close up view of a fibre; C & D. Pitted vessels; E & F. Crystals; G. Crystals and a starch grain; H. Starch grain with + shaped dark lines; I. Starch grain with YY shaped dark lines; J. Starch grain with V shaped markings.

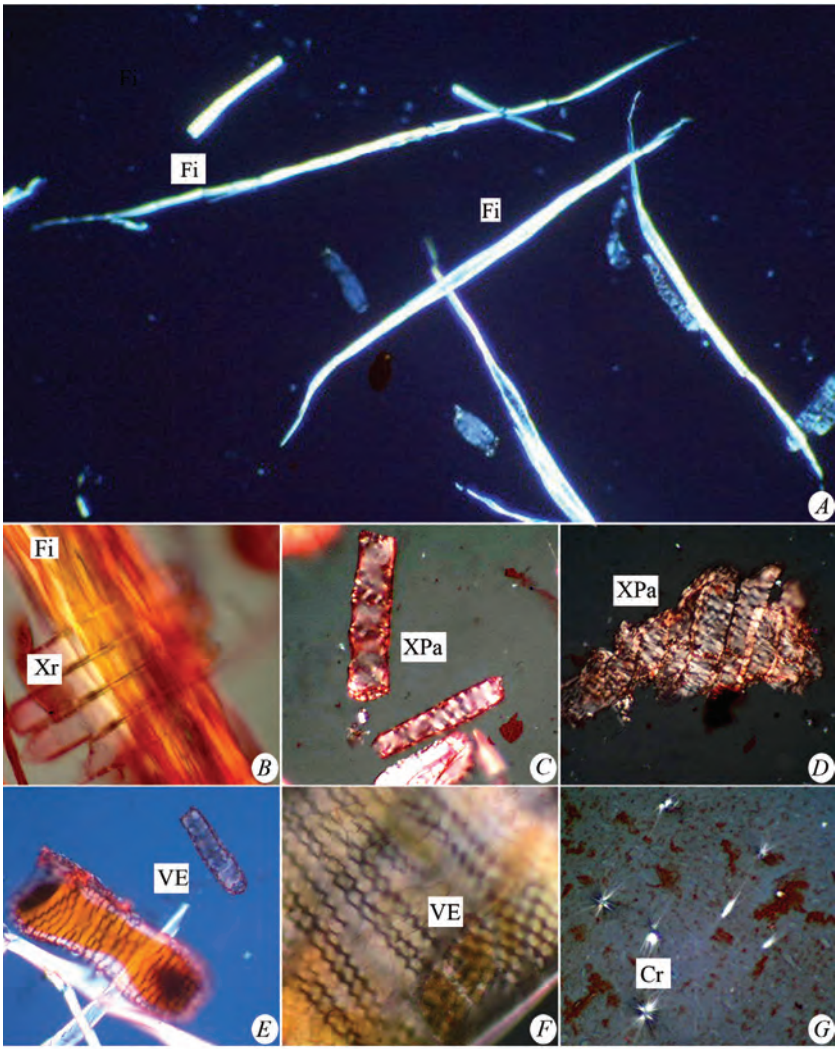

Plate - 65. Macerated heartwood of *Pterocarpus santalinus* under polarised light. A. Xylem fibres; B. Xylem fibres and xylem rays; C & D. Xylem parenchyma cells; E & F. Vessel elements showing pitted walls; G. Prismatic calcium oxalate crystals.