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Original Research Article

Examining the timber yielding plants of district Bilaspur of Himachal Pradesh, India

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ABSTRACT
Anogeissus latifolia, *Cedrus deodara*, *Dalbergia latifolia*, *Dalbergia sissoo*, *Eucalyptus teriticornis*, *Pinus patula*, *Pinus roxburghii*, *Pinus wallichiana*, *Santalum album*, *Shorea robusta*, *Tectona grandis*, *Terminalia alata*, and *Toona ciliata* are the 13 plant species that produce timber and are the subject of this paper. Nine of them are Hard Wood (Angiosperms), while four are Soft Wood (Gymnosperms). To identify the common species that generate timber, a personal study of the district was conducted. Using accepted practices, plants were identified after being gathered from various locations throughout the district. In addition to taking pictures of the plants in the field, significant vegetative and floral characteristics were observed. Plants were processed as herbarium mounts for identification and documentation. The terms used for plant identification and description are in line with The Plant List (2013) and the International Plant Names Index.

1. Introduction

People have been using wood to make houses and later furniture since the beginning of time. Because wood is the secondary xylem of woody plants, trees are therefore extremely important to humans. Wood comes in two varieties based on the kind of plant: soft wood and hard wood. Gymnosperms provide soft wood, whilst angiosperms provide hard wood. Each variety of wood has a special meaning. Wood is utilized for both commercial and residential applications.

Of the twelve districts in Himachal Pradesh, Bilaspur is the second smallest. Hamirpur and Mandi districts border Bilaspur on the north, Mandi and Solan districts border it on the east, Punjab State and Solan district border it on the south, and Una and Hamirpur districts border it on the west. This is located in the outer Himalayan hills between latitudes 310 12/30// and 310 35/45// North and longitudes 760 23/45// and 760 55/ 40// East. About 90 kilometers of the Satluj River pass through the Bilaspur district. At Karahi Ka Gharaat, next to the hamlet Kasol and the Kol dam, this river enters the district of Bilaspur. It exits at the village Neila, close to the Bhakhra dam. That's 1167 square kilometers. There are significant differences in the flora of Bilaspur due to its elevation, which ranges from 290 to 1980 meters.

This paper's goal is to identify the common timber-producing plants in the Himachal Pradesh district of Bilaspur. It will also include information about the plants' morphological characteristics, flowering and fruiting seasons, common names, vernacular names, citations, distribution throughout the world, India, and Himachal Pradesh, as well as their economic and ethnobotanical uses. In the field, colored photos of flora are also taken. The purpose of this study is to raise readers' and researchers' awareness of the value of plant conservation for future generations and to inspire them to do so.

2. Materials and methods

From 2019 to 2024, a thorough field assessment of various locations in the district of Bilaspur at various dates was conducted. Plants are collected, preserved, and identified according to standard procedures. Significant floral and vegetative traits of plants have been identified, and field photos of them have also been obtained. These plants are processed as herbarium mounts for identification and documentation. This study follows the Natural System of Classification of Spermatophytes.

3. Observations

A thorough survey of the district of Bilaspur has been conducted at various times of the year in order to list the plants that produce timber. There are 13 species in all, spread across 10 genera and 8 families. Nine plant species are angiosperms from seven separate families. There are two genera and four species in the gymnosperm family Pinaceae. The remaining five families — Dipterocarpaceae, Meliaceae, Myrtaceae, Santalaceae, and Verbenaceae — have one species each, while the angiospermic families Combretaceae and Papilionaceae have two species each.

There have been reports of *Pinus patula* from ACC Limited's nursery garden in Barmana. According to reports, *Eucalyptus teriticornis*, *Toona ciliata*, and *Dalbergia sissoo* are all flourishing rather well over the district. While *Anogeissus latifolia* is less common in the Sadar Forest Range, it is more prevalent in the Swarghat Forest Range and the Kotdhar area of the Kalol Forest Range. In the Jhandutta Forest Range, *Terminalia alata* is widely distributed. Pinus roxgurghii is a highly abundant species in this district, although *Cedrus deodara* and *Pinus wallichiana* are found in Bahadurpur.

Figure 1: Himachal Pradesh.

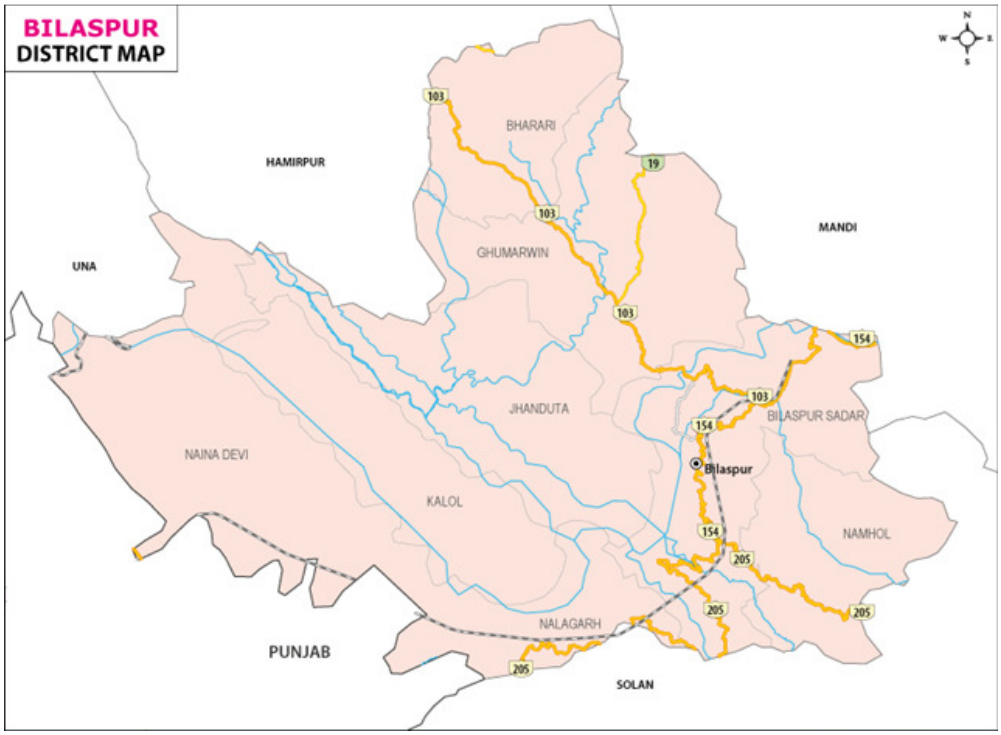

Figure 2: District Bilaspur of Himachal Pradesh.

4. Results and discussion

The district Bilaspur in Himachal Pradesh is the site of the collection and identification of thirteen distinct species of timber-producing plants, including *Anogeissus latifolia*, *Cedrus deodara*, *Dalbergia latifolia*, *Dalbergia sissoo*, *Eucalyptus teriticornis*, *Pinus patula*, *Pinus roxburghii*, *Pinus wallichiana*, *Santalum album*, *Shorea robusta*, *Tectona grandis*, *Terminalia alata*, and *Toona ciliata*. The following is an alphabetical description of these plant species that produce timber:

1. *Anogeissus latifolia*

The tree is big, deciduous, smooth and greenish-white bark. Petioles are 0.5 – 1 cm long, secondary nerves are 8 – 14 pairs, tertiary nerves are noticeable beneath, and the leaves are elliptic, whole, sub-coriaceous, acute or obtuse, glabrous, and alternating or inconstantly opposite. The peduncles are 0.5 – 1 cm long, and the flower heads are axillary and 5 – 10 mm across. The calyx is a campanulate tube that is 0.4 to 0.5 mm long, has two wings laterally, is long and narrowed above the ovary, and has tiny, triangular, and persistent teeth. There are no petals. Stamens 10 were exserted in two sets. One cell makes up an ovary. There are two pendulous ovules. The fruit is a dry drupe that is 4 – 5 mm long, has two wings, a beak that is 2.5 – 3 mm long, and is densely packed ±1 cm across the heads.

Figure 3: *Anogeissus latifolia*

Flowering and Fruiting: May- June.

Specimens Examined: Swarghat, 26 July, 2024.

Habitat: Common.

Distribution: Himalayas to Sri Lanka; India. Himachal Pradesh: Bilaspur, Sirmaur (Saketi, Kala Amb, Nahan, Renuka), Kangra (DD, RRL).

Altitude: 400-1100 meters.

Economic and Ethnobotanical Uses: Axles, shafts, poles, batons, agricultural tools, and tool handles are all made of wood, which is also appropriate for furniture and building [1]. The tree produces gum that is used for calico printing, sizing paper, and pharmaceutical preparations. Its leaves are consumed by tasar silkworms. Root is beneficial for vitiated "kapha," "vata," and abdominal ailments. Bark increases appetite and taste, eliminates "kapha" and "vata," and is used to treat skin conditions and erysepelas as well as anemia, urine discharges, wounds, ulcers, inflammations, diabetes, hemorrhages, and dysentery. Juice from leaves is administered as purulent ear discharges. Fruit is cooling and astringent to the bowels; it relieves kapha and biliousness and raises vata [2, 3].

2. *Cedrus deodara*

Large, long-lived, evergreen trees that can reach heights of 80 – 90 m and girths of 12 – 15 m. Young trees have a cone-like look, while older trees typically have flattened, rounded tops. Young trees have green or gray bark that is thin and smooth, but older trees have rough, deeply furrowed bark that is 0.5 – 3 cm thick, dark brown, often reddish or black, and divided into irregular oblong scales or plates with both vertical and diagonal fissures. Blaze is pinkish brown and measures 3.8 – 5 cm. Branch tips and leading shoots typically droop, and branches are uneven, horizontal, and slightly ascending, falling, or spreading. They are never in whorls. In March or early April, young or new branches with grayish down and pale green leaves emerge. Branchelets (shoots) are dimorphic, lengthy shoots or shoots with infinite growth are thin, lengthy, and bear foliar leaves that are spirally organized, scaly, and dwarf. The short, thick tufts of leaves (15–20) in pseudo whorls are characteristic of dwarf or limited-growth shoots. It grows a little longer each year and adds a new whorl of leaves; a ring of recurved bud scales marks each new growth year. It occasionally produces flowers or grows into long branches. Even after the emergence of young leaves, the little, ovoid, brown-scaled winter buds remain on the shoots. With two rows of peripheral resin canals on the inner surface, the dark green, 2.5 – 5 cm long, acicular, stiff or inflexible, sharply pointed, triquetrous (3-sided), glaucous or silvery leaves are amphistomatic and durable, lasting one to six years. When the cones ripen in May, or occasionally in October or November, leaves begin to shed. Cones or flowers, or strobili, are terminal, erect, solitary, and borne on short stems. They develop in July and August and mature in late September. They are unisexual, dioecious, and occasionally monoecious; in the latter case, they are borne on distinct branches. Male cones are solitary, terminal on dwarf shoots, oblong, ovoid, or cylindrical, 2.5 – 4.5 cm long and 1 – 1.5 cm in diameter. They are pale green when young, turning yellowish green with purplishtinge when mature. Each stamen is made up of many microsporophylls, or stamens, arranged in a spiral pattern on a broad central axis. Each stamen has two oblong microsporangia, or pollen sacs, which are positioned abaxially, and produce connective tissue that flattens into an ovate, obtuse, upturned, beak-like appendage with an irregularly crenulate margin. Male cones appear from March to June and release their pollen from September to October, depending on the season, location, and altitude. They quickly grow to 5 – 7.5 cm in length and turn yellow prior to shedding. The pollen grains are yellow and have wings. In October, pollination takes place. A broad central axil with spirally arranged bract scales and fan-shaped ovuliferous scales bearing two inverted ovules on the adaxial surface are the features of the young female strobili or cones, which appear in August. They are erect, solitary, terminal on dwarf shoots, and they grow progressively each year towards the terminal end on the upper side of horizontal branches. At the base and apex, a large number of ovuliferous scales are sterile. Due to their inconspicuousness and partial concealment

by leaf rosettes, the cones are challenging to locate during pollination. The bract scales, which are larger than the ovuliferous scales and frequently enlarge after flowering, are constricted to a claw-like process at the base. They are oblong or ovoid, 1.2 – 2 cm length, 0.6 cm in diameter, and pale glaucous green. However, because the ovules are visible and the scales are oriented perpendicular to the axis, they are in an open position to receive pollen grains. Following pollination, the cone compacts and eventually closes, and the sporophylls expand somewhat. Growth stops until March of the next year, which is the next spring. They take on a barrel shape by the beginning of May and grow to 8 – 12 cm in length and 5 – 8 cm in diameter. Their ovuliferous scales are fan-shaped and 3 – 3.5 cm wide. They reach maximum size and turn a pale bluish green by the end of June or early July. They turn chocolate-brown in August, ripen from September to November, and then turn brown and woody. Therefore, it takes roughly 12 – 13 months from the female strobili's initial appearance to the cones ripening. Mature and ripe Large, 10 – 15 cm by 7.5 – 10 cm, erect, barrel-shaped, ovoid, ellipsoidal or cylindrical, brown, resinous, on short, sturdy stalks, with tiny or nonexistent bracts and woody, closely overlapping, fan-shaped ovuliferous scales with a claw resembling a basal stalk. The cone scales and winged seeds break off from the tree and fall off, with the central axis remaining on the tree for a long time. The seeds are triangular, pale brown, have two ovuliferous scales, and are winged. They are each 0.8 – 1.6 cm long (with wings 2.5 – 3.8 cm long), with a broad, membranous apical wing that is larger than the seeds (1.7 – 2.5 cm). Epigeous germination. Cotyledons 9 – 11. In some places, seed shedding continues until December. When the tree sheds, the cone disintegrates, releasing scales and seeds to the ground and leaving a persistent woody axis on the branches for years.

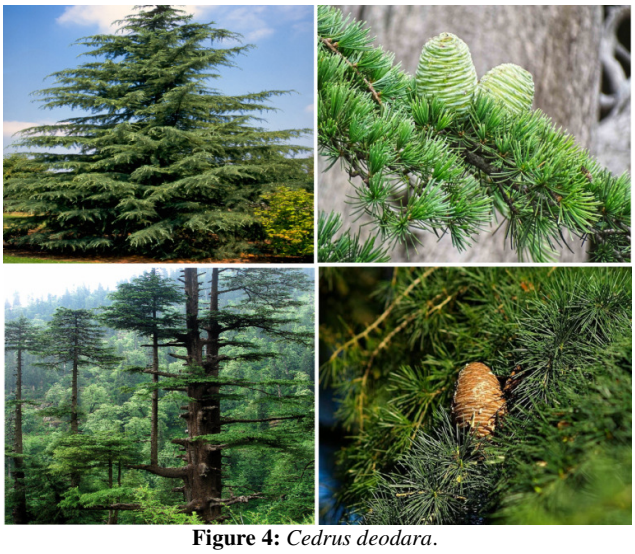

Figure 4: *Cedrus deodara*.

Specimens Examined: Bahadurpur, 18 April 2024.

Habitat: Usually gregarious, evergreen pyramidal trees are frequently found in pure stands on temperate slopes. They are also occasionally found with oaks, maples, cherries, chestnuts, and other broadleaved species, and they are frequently planted in hill stations across Europe, America, and other continents.

Distribution: Cyprus, the Mediterranean mountains, Afghanistan, Asia Minor, the Atlas Mountains (Africa, Algeria), Pakistan, Syria, the Western Himalayas, and Nepal. India: Jammu & Kashmir, Uttarakhand. Himachal Pradesh.

Altitude: 1200 – 3300 m.

Economic and Ethnobotanic Uses: Among coniferous woods, its timber is the best, strongest, and most valuable. It is a valuable building material that is widely used for railway sleepers, beams, flooring, posts, cooperage, door and window frames, furniture, packing boxes, spars, and shingles. Along with many other uses, it is also utilized in the construction of wagons, carriages, brush backs, and bridges. It can be used for second-grade pencils, battery separators, poles for transporting high tension lines, and pattern manufacturing [1, 4, 5]. White ants and fungi rarely attack seasoned heartwood because of its oil content, which makes it resilient [6]. Needles produce an essential oil and contain ascorbic acid [7, 8, 9].

3. *Dalbergia latifolia*

It is a big deciduous tree with a spreading crown and strong boughs. Smooth, gray, or less wrinkled bark. Longer-rachised leaves; 3–7, 1-7.5 cm long, widely elliptic, obtuse, orbicular or elliptic-obovate, and occasionally emarginate leaflets. White, 0.5 cm long flowers in short, axillary, heavily branching panicles on pedicels almost as long as the calyx tube. There are nine stamens. The glabrous, thin ovary is almost as long as the ovary itself. Broad, oblong-lanceolate fruits (pods) with one to four seeds. May to August is when it flowers and bears fruit.

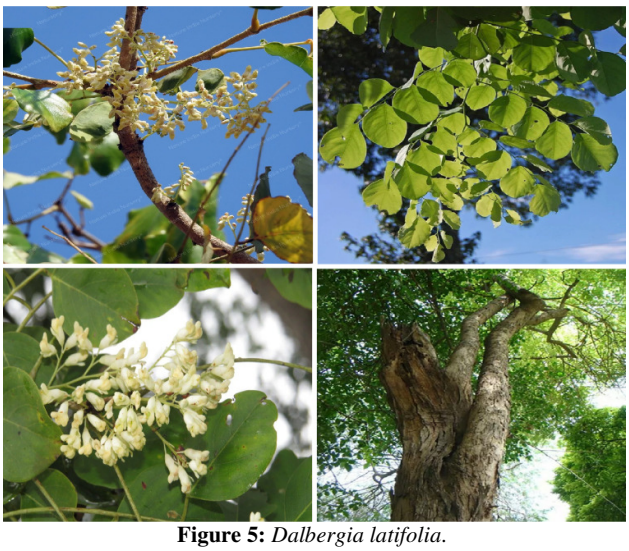

Figure 5: *Dalbergia latifolia.*

Specimens Examined: Chamog, 5 June 2024.

Habitat: Dispersed across the Indian Penninsula's arid deciduous woodlands.

Distribution: Grown in Kenya, Malaysia, Myanmar, Nepal, Nigeria, the Philippines, Sri Lanka, and Vietnam; originally from India and Indonesia. India: Bengal, Bundelkhand, Bihar, Madhya Pradesh, C. W. & S. India, Rajasthan, Sikkim, the Gangetic plains, the Sub-Himalayan tract.

Altitude: 600 meters or more.

Economic and Ethnobotanical Uses: Timber is worth more than wood. It is considered one of the best woods for furniture and cabinetry. It is a priceless ornamental wood that

may be used for veneers, plyboards, and carving. Additionally, paneling, joinery for the inside and exterior, and furniture are made with it. Pattern-making, calico-printing blocks, gun carriages, wagons, pulleys, picture frames, shoe lasts, hairbrush backs, screws, and musical instruments (such as violin keys) are among its many applications. Ammunition boxes, naves, boat knees, combs, agricultural tools, boat construction, shuttles, etc. are some of its other uses. When it is available, it is utilized for posts, rafters, flooring, and door and window frames, but it is too costly for ordinary building work [10, 11]. The tannin industry uses bark. Fodder is made from leaves. In gardens, it is frequently planted. For avenues, it is a good shade tree. It prevents environmental particle contaminants from spreading [9, 12, 13].

4. *Dalbergia sissoo*

This huge deciduous tree can grow up to 30 meters in height. Young branches are pubescent and thick. Heartwood is dark brown or blackish, and the wood is very hard and brown; tough bark with mostly longitudinal furrows. The leaves are pubescent, 8–20 cm long, with petioles that are 1 – 3 cm long; the rachis is zigzag; the leaflets are 3 – 5, alternate, obliquely ovate, 3.9–9 × 3–7 cm, acuminate or caudate–abundant, glabrous, tomentose when young, pale green, entire, abruptly pointed, terminal one-stemmed, with petiolules that are 4 – 5 mm long; the margins are subsessile. Stipules are caducous, lanceolate, and 5 mm long. Small, 7–10 mm long, yellowish-white, subsessile, and hairy, the flowers are found in axillary or terminal panicles. Bracts are caducous, hairy, linear-subulate, and about 2 mm in length. 5–6 mm long, bell-shaped calyx; 5-small, ciliate teeth; 2-uppers joined except at tip; laterals obtuse, lowest longest. The corolla is 7.5 – 8 mm long, pale yellow, with five petals that are significantly longer than the calyx. It is glabrous, ovate, and has standard long claws. The wings are 7 mm long and oblong, and the keel is almost straight, obtuse, and almost as long as the wings. Stamens 9: tube divided along upper side, all joined (monadelphous). The hairy, 7–8 mm long, short-styled ovary has a capitate stigma. Fruits (pods): 3.8–8.5 × 0.7–1.3 cm, long stalked, linear-oblong, glabrous, cuneate at base, rounded tip, 1–4 seeded, flat or strap-shaped. The seeds are reniform, compressed, glabrous, dark to brownish black, and measure 7–9 × 4.5–7 mm.

Figure 6: *Dalbergia sissoo*.

Flowering and Fruiting: March-February next.

Specimens Examined: Bhager, 16 April 2024.

Habitat: Scattered in forests and widely planted along the roadside.

Distribution: widely distributed in the Terai of Nepal, India, Pakistan, Baluchistan, and the western Himalaya. India: Sikkim, Assam, and all of India. It is widely cultivated all over India.

Altitude: 600–1500 meters.

Economic and Ethnobotanical Uses: An extremely important tree for timber. Wood is excellent for building homes, furniture, and musical instruments since it is strong and long-lasting. It is also highly regarded for plywood, railroad sleepers, and other materials. The paper business uses pulp. Fodder is made from leaves [13, 14, 15]. The leaf juice is beneficial for eye conditions. The leaves' decoction helps treat gonorrhea. The astringent roots are beneficial for treating dysentery and diarrhea [2, 16].

5. *Eucalyptus teriticornis*

It is a tall, attractive tree that grows straight and compactly. The bark is tough at the branchlets, grey or white, and exfoliates in long flakes. Wood is close-grained, firm, and reddish brown. When dried, it feels slightly greasy or moist. Petioles are terete, 1.3–2.4 cm long; the secondary nerve and intra-marginal vein are slender and distinct; the leaves are falcate, ovate or roundish, and infrequently lanceolate, 10–20 cm long, and highly glossy and brilliantly green on both surfaces. The peduncles can reach a length of 2.5 cm, the hypanthium is hemispherical, 2–3 mm long, and 4–5 mm wide, and the flowers are 7–11, small, white, and in umbels on very short pedicels. The operculum is significantly longer than the calyx, which has a mouth diameter of 0.64 cm and no tube formed past the ovary. Globose capsules with a diameter of 5–7 × 4–8 mm and four closed valves.

Figure 7: *Eucalyptus teriticornis*.

Flowering and Fruiting: March-June.

Specimens Examined: Chamaog, 4 March 2024.

Economic and Ethnobotanical Uses: Wood is used for flooring, shipbuilding, sleepers, and engineering construction.

Additionally, its wood is utilized as timber for tool handles and agricultural equipment. Additionally, it contains essential oil [1, 12, 17].

6. *Pinus patula*

With a height of 40 meters and a diameter of 1 meter, this tree is a big evergreen; lower than breast height; stem in closed canopy stands that often has a single, straight, thin trunk. Higher order branches are slender and drooping, while the final branches are pendent. First-order branches are long, slender, spreading, or slightly ascending. When the leaf fascicles have fallen, the foliage shoots are yellow or red-brown, with noticeable, decurrent pulvini, and they are rough and scaly. Cataphylls are dark, early deciduous, subulate, recurved at the apex, scarious, and have erose-cliate margins. The terminal bud is 15–20 mm long, while the lateral buds are shorter, brown, and non-resinous. The vegetative buds are oblong-cylindrical. The subulate scales have ciliate borders and are spreading. Fascicle sheaths are originally 20–30 mm long, with 6–8 imbricate, chartaceous, white-yellow or orange-brown scales. They are persistent, but in adult fascicles, they shorten to 12–15 mm, and they weather gradually to a grey-brown color. Young trees have thin, scaly, reddish-brown bark; adult trees have thick, dark grey-brown, rough, scaly bark with huge, elongated plates and deep longitudinal cracks. Thin, lax, drooping-pendent, serrulate at the margins, acute, pale-dark green, triangular in outline, with stomata on both sides, the leaves are found in fascicles of three, occasionally four, five, or six, in drooping tufts, in two rows on either side of the upturned plant, and they last for two to three years. Male cones are ovoid-oblong to cylindrical, 15–20 × 5–6 mm, pink-yellow, and eventually yellow-brown. They are clustered close to the proximal end of young shoots, spreading, and supported by scarious bracts. Female Cones Peduncles up to 20 mm long, subterminal or lateral in position, in whorls of two to many, seldom solitary, persistent, or decisduous. Young cones are ovoid, grow in two seasons, and have persistent calaphylls on recurved peduncels. They are purple at first, then pale brown. Mature cones are 5–12 × 3–6 cm when open, narrowly oval when closed, and slightly bent at the base. The proximal megasporophylls are connate, purple, brown to dark brown, with adaxial light brown lines left by the seed wings. The megasporophylls are woody, oblong, serotinous or separating sometime after mature, tenacious or deciduous with the peduncle, and typically curved while spreading. The apophysis is rhomboid, flat to slightly elevated, transversely keeled, gibbous on proximal sporophylls, and has a smooth or striate, glossy, or yellow-brown abaxial surface. The top border is either acute or obtuse-rounded. Dorsal, flat or raised, umbo is recessed into the apophysis and measures 3–7 mm in width. It is grey and has a tiny, deciduous prickle. Dark grey, 4–6 × 2–4 mm, obliquely ovoid, flattened seeds. The articulate seed wings are obliquely ovate-oblong, 12–18 × 5–8 mm, light brown with dark stripes, and are attached to the seed by two oblique claws that partially cover the seed on one side.

Specimens Examined: Barmana, 24 May 2024.

Distribution: Originated in Mexico. Ecuador, Bolivia, Colombia, Kenya, Tanzania, Angola, Zimbabwe, Papua New Guinea, and Hawaii are among the countries that plant it at high elevations. It is grown at lower elevations in Argentina, India, South Africa, and Brazil.

Economic and Ethnobotanical Uses: Board and furnishings are made from wood. It is also employed in the manufacturing of pulp and paper. The stem is used to make gum and resin.

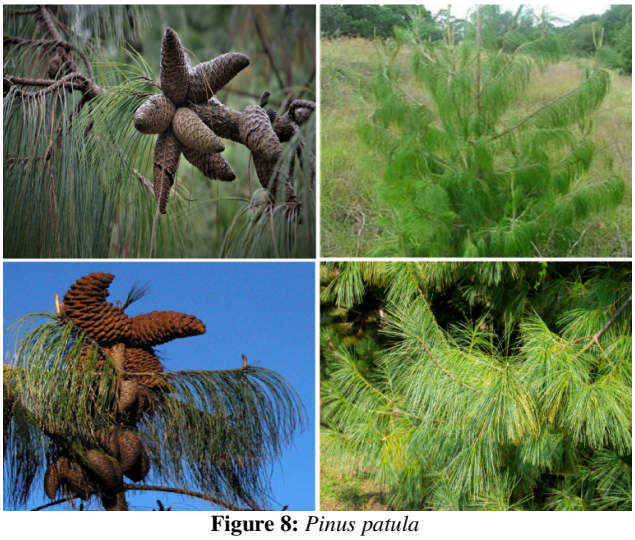

Figure 8: *Pinus patula*

7. *Pinus roxburghii*

This big tree, which may reach heights of 55 m and girths of 4 m, is primarily evergreen but can occasionally become partially deciduous in arid regions. Tall and straight, the trunk can occasionally be twisted and stunted. Up until middle age, the plant's crown is long and roughly pyramidal; after that, it becomes spreading, rounded, or umbrella-shaped, with a huge branch system. The bark of older trees is darker, reddish or reddish brown, turning light grey when exposed, and shedding in large plates up to 61 cm in length and 23 cm in width. The bark of young trees is dark grey, deeply and irregularly fissured, and up to 6 cm thick. In mature trees, branches up to middle age whorled, had poorly defined verticals, and spread out. There are two types of dimorphic shoots. Long or infinitely growing stems that are grey or pale brown when young and covered in scale leaves that last for years; they also have buds and foliar spurs. Dwarf or limited-growth stems have three leaves and are surrounded by two prophylls and eight to fifteen spirally organized, imbricate, chartaceous, acuminate, fimbricate cataphylls (scales), which are initially white or green before turning brown or grey. Prophylls and cataphylls make up the persistent basal sheath that surrounds the leaves, which is 1.3–2.5 cm long. Dwarf shoots emerge in April, shortly after pollen shedding, however they first appear in March or April. Developed in October or November, winter buds are small, ovoid, non-resinous, and light-reddish brown. They are shielded by tightly packed brown scales with fibrillar borders, but growth doesn't resume until December or early January. Fascicles of three1 leaves, borne on dwarf shoots, are light to deep green, nonglaucous, needle-like, slender, and 15–40 cm long. The apex narrows into a long, fine point, and the margins are minutely but closely serrulate (i.e., finely toothed). The leaves are obscurely triquetrous, with one side rounded and two sides flat, and have marginal resin canals and several faint lines of stomata on all three surfaces. The needles last for one and a half to three years, with new ones emerging in January. In May and June, leaves start to fall off. In January, male strobili are found at low elevations in groups, spirally arranged on the current year's shoots in 5/8 phyllotaxy. The

entire inflorescence is 2.5–10.2 cm long by 3.8–5.1 cm in diameter, with each male cone taking the place of a dwarf shoot and being carried in the axil of a prominent brown scale or a scale leaf (which falls as soon as the cone matures). Four prominent and numerous small, light-brown, acuminate scales with fimbricate margins protrude. Because they are trapped between the closely spaced other cones, these bracts continue to grow. Each cone has two abaxial microsporangia and 90–140 spirally organized microsporophylls with scaly, upward-bending tips. The microsporophylls are born on a central axis. Cones are yellowish green and globular when young, 1.3–1.8 cm long when ripening, and light brown, acuminate scales with fimbriate borders that are cylindrical, ovoid, elongated, and light-reddish brown once the pollen is shed. The central axis elongates significantly just before shedding, reaching a length of 3–4 cm, particularly at the base. Depending on the season, location, and elevation, pollen shedding occurs from February to April. Large amounts of pollen are released, which guarantees pollination through wind. On the apices of new shoots, female strobili that emerge in early February at low elevations are carried individually or in pairs in one or two whorls of three each. Prior to pollination, young cones are erect, ovoid, covered in involucral bracts (in 5/8 phyllotaxy), and initially pale-green or faintly purplish. These bracts last for a year. Both bract and ovuliferous scales are found in the cone. The ovuliferous scales quickly surpass the bracts, but before pollination, the bract scales are longer than the ovuliferous scales and roughly perpendicular to the cone axis. Cones are 1.5–2 cm long and turn green within a month following pollination. By the end of October, they are 1.8–2.6 cm long by 1.5–2 cm in diameter, turn grayish or light brown on the outside while staying green on the inside, and are pretty soft (they cut readily with a knife). The cone is subsequently pushed horizontally from its upright position by a reddish-light-brown bud that develops at the tip of the cone bearing shoot. Throughout the winter, they stay in this horizontal orientation, hidden among the fully developed new leaves. Primordial needles are solitary, acicular, glaucous green, strongly serrulate, and range in length from 1.5 cm (in immature seedlings) to 6.5 cm. Cones shut as a result of the ovuliferous scales' quick growth and enlargement (thickening of cell walls). This closure is further aided by copious resin secretion, which keeps the immature ovules from drying out and appears as big, gleaming drops on the scales. Cones turn green and active once more. Cones that are a year old by March are soft, green, and measure 2.5–4.6 cm by 2.5–3.8 cm. They have brown tips and subtly bent scales, which are remnants of the winter stage. They are delicate, green, 7.5–10.5 cm long, and have recurved scales. By mid-April, they resemble adult cones in general. The cones are still green by June or July, but they have grown to their full size. Cones are completely grown, hard, and brown at the start of winter. Throughout the winter, they stay in this state. When compared to cones at lower heights, the cones at higher elevations may emerge six weeks later. Mature female cones (in the spring of the third season, 24 months after pollination) Light brown, long, ovoid, 11.5–21 cm long, 6.4–14 cm in diameter, on short, sturdy stalks, solitary or 2–5 together horizontally, pendulous or erect on branches, each with a central axis and 95–115 spirally arranged pairs of bracts and ovuliferous scales, the former a membranous structure at the base of ovuliferous scales, which are very thick, hard, and woody, pyramidal or rhomboidal, with two winged seeds at the base on the abaxial side and a prominent exposed part (umbo) with a pyramidal, pointed curved or reflexed beak. Cones only open in dry weather during the third-year months of March through May, closing again in the event of rain. Cones that are open can measure up to 24 cm by 18 cm. Despite the quick opening, seeds need a breeze to shake them well and need two to three weeks (or up to July in cold climates) to fully escape. Therefore, it takes about 26–27 months from the time female cones first develop till they ripen and open. Cones that are empty and dry can stay on the tree for a year or more. These seeds are 0.7–1.6 cm long by 0.5–0.6 cm wide. They have wings that are 2.5–4.5 cm long and have a long, thin, membranous wing that is 0.7–1 cm wide.

Figure 9: *Pinus roxburghii*.

Germination: epigeous. Cotyledons 10–14. January-February (male cones), February-April (pollen shedding), February-April (first year female cones, pollination), March (second year green, fertilized cones), and March-July (third year brown, mature, woody female cones ready for seed shedding) are the three-year life cycle for flowering and fruiting. The dry cones stay on the tree for a long time.

Specimens Examined: Chanjhiar, 28 August 2024.

Habitat: Because Himalayan chir pines need monsoon rainfall, they are not found in inner valleys where the monsoon does not reach. As soon as the monsoon season begins, the seeds that fall in the hot weather begin to sprout. It is a gregarious species that, although it occurs intermingled with other species at lower and upper limits, produces pure forests to a large extent. With an approximate total area of 8730 kilometers over the tropical, subtropical, and temperate Himalayas, it is the most significant pine. Twisted-fibered trees are also found in Uttarakhand and Himachal Pradesh.

Distribution: Afghanistan, Bhutan, Nepal, Pakistan, West and East Himalayas. India: Jammu & Kashmir, NEFA along the Kameng Frontier division, Siwalik hills flanking the Himalayas, Uttarakhand, Himachal Pradesh.

Altitude: 450–2450 m, thriving best at 610–1525 m.

Economic and Ethnobotanic Uses: Joinery, shingles, packing cases, building, light furniture, home furnishings, pattern manufacturing, lamin board cores, drawing boards, and plane tables are all made of wood [1, 3, 4, 18, 19]. Railway

sleepers are made of treated wood [4]. It creates resin with significant commercial value. Rosin is utilized in the production of linoleum, sealing wax, oil cloth, lubricating compounds, and inks, as well as in the making of soap and paper and fabric sizes [8, 19]. Turpentine oil is utilized as a solvent for paints and varnishes, as well as in the pharmaceutical, fragrance, synthetic pine oil, disinfectant, insecticide, and denaturant industries [20]. Oil from the chir pine needles is said to have antibacterial properties against a variety of organisms. For tanning, bark is utilized [18, 20, 21].

8. *Pinus wallichiana*

It is regarded as one of "the most beautiful" pines in the world and is a tall, evergreen, graceful, or elegant tree that can reach 50 meters in height and 3 meters in girth. Branches are uninodal or multinodal, whorled, spreading, and typically rising in young trees. In older trees, they may be horizontal or drooping with upturned tips. Young trees have thin, smooth, resinous bark that is 1.3–2.8 cm in length, greenish-white, greenish-grey, or slate-colored; older trees have grey or greyish-brown, corky, rough, scaly bark that is superficially or shallowly fissured and divided into tiny, rectangular plates. Small, cylindric-conic winter buds that are 0.6–1.3 cm long and have many lanceolate, fibrillar margined scales that can be free or matted with resin. There are two types of dimorphic shoots. Long or infinitely growing shoots that develop in March or early April (depending on the location), glaucous, green or light-brown, then deepen with maturity. Persistent, less than a millimeter in length, dwarf shoots or shoots of limited growth or foliar spurs are carried on long shoots in the axils of scaly leaves. They have five needles and are surrounded by two prophylls and eight to ten spirally arranged (in 2/5 phyllotaxy) cataphylls, with the innermost being the largest and the outermost the smallest. Both prophylls and cataphylls are deciduous, measuring 1.3–2.3 cm in length, and form a basal sheath around the needles, which has a prominent midrib. The leaves are persistent, lasting three to four years, erect and pointed upwards in young trees, but spreading or drooping and slightly bent in older trees; slender (thin and delicate), triquetrous, convex surface green, bluish or greyish-green, and glaucous on the inner surface, giving the foliage its characteristic bluish tinge (color); 10 to 21 cm long, shorter in stunted and diseased trees; ridged (ridges are epidermal projections between which the stomata are arranged in longitudinal rows); white stomatic lines on flat surfaces; or resin canals marginal. Leaf shedding happens from May to July, and occasionally from October to December. In March or April, new shoots emerge, and by August or September, they reach their maximum size. Strobili, which include flowers, catkins, and cones, are monoecious and unisexual. At the base of current year's young long shoots, male strobili in catkins appear in October-November in 15–35 spirally arranged clusters, 1.3–5.1 cm long. Each cone replaces a dwarf shoot and arises in the axil of a green, scaly leaf, surrounded by involucres of 8–12 equally prominent greenish-white, imbricate scales that stick to the catkins when they fall. When the cones are young, they are typically green, occasionally dark reddish-purple, ovoid or oblong, 0.7–1 cm long; when ripe, they are yellow, light-brown or dark-brown, and frequently pink towards the apex, elongated, and fall shortly after ripening. On a central axis, each cone is made up of 85–115 spirally arranged microsporophylls, or stamens. Each stamen is 0.1–0.15 cm long, with its tip twisted and stretched upward, and it has two microsporagia, or pollen sacs, on its abaxial side. Depending on the location, time of year, and height, pollination occurs from April to June (the lower the altitude, the earlier the cones shed their pollen). When they replace the terminal or sub-terminal bud(s) of the current year's young, long shoots, which are pale green, erect, and protected by an involucre of bracts, the female strobili terminal or sub-terminal, solitary or 2–3 together, and occasionally more forming a whorl around the terminal bud, appear in February. At the time of pollination, the pale or glaucous green turns to deep-pink or reddish purple, and finally to greenish-brown. The cone axis elongates in April, and cones that are 1.5–2 cm long and 0.8–1 cm in diameter with scales open to collect pollen emerge from the involucre. The cones close after pollination, which occurs at the end of April or the beginning of June. By August, they are 2.5–5.1 cm long by 1–1.3 cm in diameter, with a 2.5–3.8 cm long peduncle or stalk that elongates significantly. The cones are pendulous and bluish-green, with a small, crude brown umbo at the tip of each scale. The female cones are pendulous on stalks that are 3.3–7.5 cm long, cylindrical, 15–33 cm long, and 3.0–6.5 cm in diameter before expansion. They are light-brown, highly resinous, and have 80–90 pairs of bracts and ovuliferous scales (megasporophylls) arranged in a spiral pattern on a central axis. The ovuliferous scales are fleshy, measuring about 3.8–6.5 cm long and 2.0–3.8 cm wide, wedge-shaped, rhomboidal or spathulate, exposed portion longitudinally grooved with a thickened apex; the basal ones are occasionally reflexed, and each has two winged seeds on its abaxial side. Later on, ovuliferous scales get woody and hard, though not as hard as those of *Pinus roxburghii*. The second year's September through November is when the seeds ripen, open, and shed. About 18 months pass between the female flower's initial appearance and the cone's maturing, and another 22 months pass between the seeds being shed. Compressed, ovoid, 0.5–1 cm by 0.3–0.5 cm, winged, 0.7–1 cm broad with wings, membranous, obliquely truncate, roughly three times the length of the seeds, bluish or dark-brown, compressed, acute at both ends, and the size of the seeds with wings is 1.5–4 cm. Seed germination is epigeous.

Figure 10: *Pinus wallichiana*.

Flowering and Fruiting: Three-year life cycle: October–November for male cones, February for female cones in their

first year, April–June for pollen shedding and pollination, and September–November for fertilization in the second year, while the third year is spent ripening, opening, and shedding seeds. Cones stay on the branches for a long time after the seeds have fallen.

Specimens Examined: Bahadurpur, 18 April, 2024.

Habitat: Common in pure and mixed forests on alpine slopes; also found with Abies pindrow and Picea smithiana. Due to bending with snow, it becomes stunted and takes on a shrubby prostrate form at higher elevations. It can grow in areas where the annual rainfall is as less as 25 cm as in Suliman range or in areas where the annual rainfall is 510 cm as in Apa Tanang in E. Himalayas. Its altitudinal range (1200-3700 m) is also greater than any other Himalayan conifer.

Distribution: Native of temperate Himalayas occurs throughout the greater Himalaya (West, Central and East) extending from Kafiristan (Baluchistan, Afghanistan) in the West to Arunachal Pradesh (India) in the east through the hills of Pakistan, Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Nepal, Sikkim, Bhutan and SE. Tibet. Its latitudinal and longitudinal ranges are 25^0N-36^0N (latitude) and 68^0E-100^0E (longitude). In West Himalayas, it is abundant between 1830-2555 m, and extends westwards from Garhwal through Jaunsar, Chakrata, Mussoorie, Shimla, Bushahr, Kullu, Chamba, Kashmir (in India); Murree hills, Waziristan, Hazara (in Pakistan); and Kafiristan (in Afghanistan). In Central Himalayas it occurs at an altitude as high as 3600 m along the regions of Namchebazar and Thengopoche (in Nepal). In East Himalayas it extends eastwards from Chumbi valley across Sikkim border through lower Rangeet valley above the river Tista and then through Bhutan, where it is in abundance to small scattered patches on the north and east of Brahmputra in the NEFA at 1500-1830 m at Kameng division, Khalaktang area, Rupa valley, Dirang-Dzong valley (500 m), Subansri division, and Apatanang valley.

Altitude: 1200-3800 m or more.

Economic and Ethnobotanical Uses: It has decent timber. The heartwood is light brown, while the sapwood is white. In addition to being used for various construction purposes, inexpensive pencils, battery separators, violins, joinery work, pattern making, cores for lamin boards, drawing boards, and plane tables, Kail wood is regarded as the best wood after deodar for internal fittings and planking of residential homes, furniture, packing cases, match boxes, drawing boards, fermentation vats, truck bodies, shingles, and railway sleepers. Sleepers on railroads are made of treated wood. It produces high-quality charcoal [1, 18, 19]. A substantial amount of coloring pigment is present in bark [19]. People in the area gather cones for medical purposes and use them to light fires. The needles (leaves) make excellent litter, and in some places, they are used with cement and mortar for construction. In addition to being utilized as animal beds, the needles are added to plastering mud to give it consistency [18, 22].

9. *Santalum album*

This is a tiny, glabrous, evergreen tree that typically reaches a height of 10 meters and has thin, drooping branches. The parasite is a half root. The petiole is 1.3 cm long, and the leaves are glabrous, opposite, thin, and often 3–6 × 1.5–3 cm, elliptic-lanceolate or ovate. Terminal and axillary paniculate cymes with brownish-purple flowers that are about 4 mm wide. Companulate, the perianth is a limb with four valvate triangular segments. Four exserted stamens alternate with four rounded, obtuse scales that could be thought of as the disc's lobes or petals. Drupes are purple-black, globose fruits with a firm endocarp that measure ± 1.3 cm in diameter.

Figure 11: *Santalum album.*

Flowering and Fruiting: September-April next.

Specimens Examined: Koshrian, 19 July, 2024.

Habitat: Wild, in forests in S. India; cultivated elsewhere.

Distribution: India: Tamil Nadu, Karnataka, Cultivated in Rajasthan, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Orissa, Himachal Pradesh.

Altitude: Up to 1200 m.

Economic and Ethnobotanical Uses: Both sandal wood and sandal wood oil, which is derived from the heartwood of the tree, are found in it. One of the best materials for carving is sandal wood, which is also used to create beautiful curios [10, 11]. In addition to being used extensively in soap, cosmetics, and perfumery, sandal wood oil serves as the foundation for Indian-made attars, or ottos, and is also utilized as a base for the co-distillation of certain other essential oils with subtle fragrances [24]. Sawdust is used to fragrance clothing and cupboards and as incense in agarbattis. Bark can treat malaria [12, 18].

10. *Shorea robusta*

The tree is big and sub-deciduous. Young trees have blackish-brown bark that is smooth or has a few longitudinal fissures; older trees have very thick, dark-grey bark that is rough and has irregular furrows. Petiole terete, 1–2 cm long; stipules 7–8 mm long, pubescent, caducous; lateral nerves 12–15 pairs, prominent beneath; broad, ovate-oblong, 10–20 × 5–13 cm, rounded-cordate, undulate or whole, acuminate, glabrous, shiny when fully mature. The yellow flowers measure approximately 1 cm in length and 1.5–2 cm in diameter. They form panicles that are 15–20 cm long in terminal and axillary racemes, with grey-tomentose rachis and branches. With segments that are oblong, obtuse, gray tomentose, and accrescent in fruit, the calyx tube is 3–4 mm long and adnate to the torus. The yellow, narrow-oblong, silky-tomentose petals are around 1 cm long and have an orange inside. Up to 50 stamens are present, each measuring around 1 mm in length. The lobes are hairy, connective, and have

subulate, bearded appendages. The ovary has three cells and a subulate style. Wings of fruiting calyx 5–8 cm long, rectangular or spathulate, obtuse, brown when dry, uneven, with 10–15 longitudinal nerves connected by numerous transverse nerves; fruit ± 1 cm, ovoid, acute, succulent, indehiscent, white-pubescent.

Figure 12: *Shorea robusta*.

Flowering and Fruiting: March-July.

Specimens Examined: Naswal, 22 April, 2024.

Distribution: The Southern or Central India belt stretches from the Coromandel coast west to the Panchmari sandstone hills and south to the Godavari river. Tropical Asia, Malaya, and the Sub-Himalayan belt stretch from Himachal Pradesh to Bhutan. India: Central and South India, Himachal Pradesh, Uttarakhand, and Assam. Sirmaur (Paonta Sahib, Nahan) in Himachal Pradesh.

Altitude: Up to 1,500 meters.

Economic and Ethnobotanical Uses: One of the best sleeper woods in India, sal wood is used for beams, scantlings, rafters, floors, piles, bridges, mining, shipbuilding, dug-out boats, carriage and wagon building, fellows, wheel hubs and spokes, agricultural implements, tool handles, liquid storage vats, bear and oil casks, and agricultural implements [25–28]. Leaves and bark are utilized for tanning. Boards are made from bark, and cellulose is separated from it. Leaves are used to make cups and platters, make bidis, and occasionally serve as feed for lac insects. Honey can be found in flowers [29–31]. Sal Dammar, also known as Bengal Dammar (Laldhuna, ral, dhup, guggal), is an oleoresin that is used as an incense, in paints and varnishes, and for caulking boats. It is also used to harden softer waxes that are used in ribbons, carbon sheets, and shoe polish. Chua Oil, an essential oil extracted from sal resin, is used as a fixative and to flavor chewing and smoking tobacco [32–35].

11. *Tectona grandis*

It is a huge deciduous tree with flutes around the base. When freshly cut, the heartwood is golden yellow, but when touched, it turns brown and oily. The thin, fibrous, light-brown or gray bark peels off in long, thin strips. Branchlets have a huge quadrangular pith and are channeled. Simple, opposite, elliptic or obovate, with a rough upper side and a dense, stellate, grey or tawny tomentum covering the underside, the blade is 30–60 cm long and narrowed into a petiole that is 2.5–3.8 cm long. The leaves of seedlings and coppice shoots are typically 60–90 cm long, smaller, and bract-like in the inflorescence, with 8–12 pairs of lateral nerves. White, regular, bracteolate, sweet-scented flowers are borne in upright panicles that are 30–90 cm long and have dichotomously or trichotomously branching cymes. Bracts are thin and tiny. In open flowers, the calyx is salver-shaped, 3–4 cm broad, globose in bud, stellatepubescent, and campanulate; in fruit, it is expanded. Short, limb-spreading, evenly 5- and 6-lobed, and somewhat pubescent is the corolla tube. There are six exserted stamens. The hairy, four-celled ovary with a short 2-4 fid style. Nuts are hard, bony fruits with a thick, spongy covering made of a dense felt of branching hairs; the endocarp is extremely rigid and has four cells. There are one, two, and infrequently four seeds, with a center hollow that resembles a fifth cell. Usually ovoid, 2.5–3.8 cm in diameter, reticulate, and roughly corrugated, the inflated calyx encloses the fruit like a bladder.

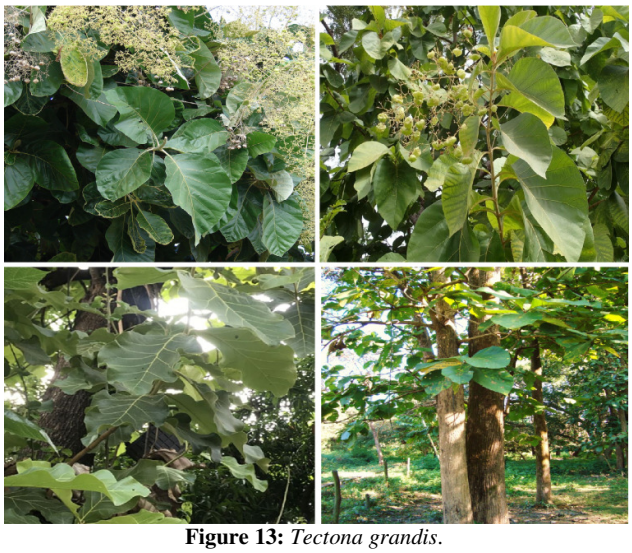

Figure 13: *Tectona grandis*.

Fruiting and Flowering: July through January.

Specimens Examined: Bilaspur, 19 July, 2024.

Distribution: Indigenous to both Penninsulas of India; Java, Indian Archipelago India: Jhansi in North to Mahanadi in Central India; cultivated in Bengal, Assam, Dehradun and now in Himachal Pradesh.

Economic and Ethnobotanical Uses: Wood is utilized for poles, beams, trusses, columns, roofing, doors, window frames, flooring, planking, paneling, stairs, and other construction projects because it is incredibly resilient and fungal-resistant. It is among the best woods for wagons, railroad carriages, and furniture and cabinetry. Teak is widely used in marine construction and is a class apart for boat and ship building, especially for decking, because of its superior shape-retention ability [10, 12]. Teak wood products are utilized in chemical industries and to make laboratory bench tops because of their chemical resilience. They are also appropriate for storing vegetable oils, fruit syrups, chutneys, and other corrosive liquids in vats and casks. Teak is used for various plywood grades as well as sound boards for musical instruments, keys, etc. Chipboard, fiberboard, and plastic boards are made from

wood waste, such as wood shavings and sawdust. About 6% tannin and a dye are found in leaves, which are also used for packing, thatching, and plates. Colored matting is made from root bark [19].

12. *Terminalia alata*

The immature sections of this huge deciduous tree are rusty-pubescent, and the trunk can reach a height of 33 meters. The dark-grey or black bark is heavily furrowed along its length and exfoliates in small, rectangular pieces. Ten to twenty pairs of lateral nerves; a petiole that is 7 to 10 mm long with one or two glands on the sides; leaves that are 12 to 25 by 6 to 10 cm, alternate or sub-opposite, upper alternate, oblongelliptic or obovate, rigid, coriaceous, glabrescent above, tomentose below, base unequal-sided, tip acute or rounded. They have apetalous, sessile, bisexual, dull-yellow flowers that are lower on axillary branches and in upright, terminal, paniculate spikes. The free portion of the tube is salver-shaped, and the calyx lobes are elliptical, broad-acute, glabrous, or hairy. Five broad, transversely striated coriaceous wings with a crenulate margin adorn the 3–6.5 cm long fruits (drupes).

Figure 14: *Terminalia alata*.

Flowering and Fruiting: August-March next.

Specimens Examined: Sargal (Berthin), 3 June, 2024.

Distribution: Sub-Himalayan tracts and Deccan Peninsula, Burma, Nepal, Sri Lanka. India: Himachal Pradesh, Uttarakhand. Himachal Pradesh: Sirmaur (Reuka), Mandi (DD), Una (BSD).

Altitude: 400-1100 m.

Economic and Ethnobotanical Uses: Beams, joints, rafters, door and window frames, boarding, cart assembly, toys, furniture, oil mills, rice pounders, engine brake blocks, electric casing, tool handles, agricultural implements, and plywood production are all made of wood. Wood produces pulp, which is used to make wrapping and printing paper. Wood produces high-quality charcoal and is employed in fire-resistant constructions [10, 11]. Bark is used to color and tanning. The leaves are fed to tasarsilkworms and used as fodder [36–41]. The tree's gum is used in cosmetics, incense, and as an adhesive [41–45].

13. *Toona ciliata*

The deciduous tree can reach a height of 30 meters. stem with wood that is fragrant and crimson in color. Up until middle age, the bark is smooth; beyond that, it becomes rough, thin, dark grey, and exfoliates in uneven scales. Petioles are 5–10 cm long, the leaflets are 8–30, 5–15 cm long, opposite or sub-opposite or alternate, ovate-lanceolate or lanceolate, 6–15 × 2.5–-6 cm, base oblique, margins entire or faintly sinuate, tip acuminate, glabrous, rachis pubescent, and petiolules 1–2 mm long. The leaves are paripinnate, 30-60 cm long. Fruits are pubescent or puberulous, 4–6 cm long, sweet-scented, cream-colored, and have big, drooping panicles that are shorter than the leaves. The peduncles are 5–6 cm long, papillose near the base, and the pedicels are 1.5–2 mm long. Sepals are ciliate, obtuse, and oblong; calyx is five lobed; lobes are 1–1.5 mm long. Five creamy-yellow, ciliate, ovate-oblong, sub-acute, obovate petals measure 3–6 mm in length. Five stamens are inserted on the disc's five fleshy, orange-colored lobes; the anther lobes are oval, dorsifixed, and have filaments that are 0.3–0.5 cm long and free of hair. The rectangular, winged seeds are reddish-brown, 1.3 cm long, and abundant.

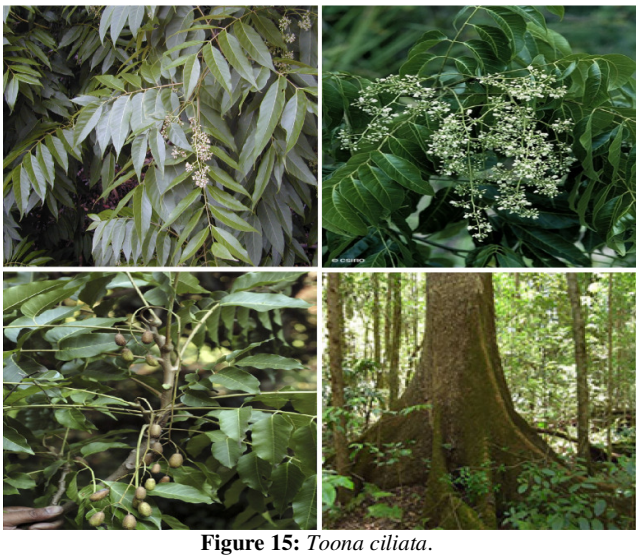

Figure 15: *Toona ciliata*.

Flowering and Fruiting: March-July.

Specimens Examined: Bilaspur, 19 July, 2024.

Habitat: Forests, road sides and waste places.

Distribution: Extends between Pakistan and Australia, occurring widely in almost all the countries in between such as India, Bangladesh, Nepal, Bhutan, China, Burma, Thailand, Java, Malaya, Laos, Kampuchea, Vietnam, the Philippines, Malaysia, Indonesia and New Guinea. India: Throughout India, in the forests of the sub-Himalayan tract and valleys of the outer Himalaya up to an altitude of 1500 m and in most of the plains of India.

Altitude: 500-1500 m.

Economic and Ethnobotanical Uses: The Toon's wood is soft, red, even-grained, and easy to work. White ants do not eat it. Wood is utilized as a high-value timber for plywood manufacturing, furniture, floors, doors, windows, and other items that are valued for building. An essential oil is produced from wood. It is a significant social forestry tree. It serves as a tree for fodder.

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