CHAPTER-16

FROM BLOOM TO BREATHE: BOTANICAL ASSESSMENT OF ALSTONIA SCHOLARIS (L.) R. BR IN URBAN ENVIRONMENTS

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Summary

Many avenue plants are planted in urban area under the afforestation program by the social forestry. This plant helps to increase the green cover and beautification of urban area, but many time due to the lack of knowledge and pattern of plantation some plant species may create a problem in future.

Present study investigates the morphological, anatomical, and phenological aspects of *Alstonia scholaris* (L.) R. Br. an evergreen, winter-blooming tree species commonly planted in urban areas. Key findings from the study reveal that its floral traits, such as dusk anthesis, pungent odor, in the favour of insect pollination, contribute to its ecological significance. In *A. scholaris*, the pungent odor of flowers causes mild breathing problems and sleeping difficulty in dry and winter season only in the areas where this tree is planted massively. However, the tree's profuse flowering and odor release may adversely impact people, particularly for individuals with respiratory sensitivities which marks the question on the existence of the plant in the urban area. The study emphasizes the need for a balanced planting strategy i.e. scattered plantation instead of mass plantations in urban areas which mitigating the health problems.

Keyword: *Alstonia scholaris* (L.) R. Br.*,* Avenue Plants, Botanical Sssessment, Urban Environment

Introduction

In urban areas, the afforestation programs spearheaded by social forestry have led to the planting of various avenue plants, significantly enhancing the green

E-Book ISBN: 978-81-981814-9-7, DOI: https://doi.org/10.34256/adbor.25.16.123

cover and aesthetic appeal. However, without proper knowledge and planting patterns, some plant species may pose future problems. One such example is *Alstonia scholaris* (L.) R. Br., an evergreen tree native to tropical and subtropical Africa, now widely distributed in India, China, Southeast Asia, and Australia. This tree can grow up to 40 meters tall, with greyish bark, milky sap, cylindrical branches, and clusters of seven large leaves and small light green flowers. It is often planted for its ornamental value and the shade it provides.

While *Alstonia scholaris* (L.) R. Br is revered in Theravada Buddhism as the tree under which Lord Buddha attained enlightenment, it is also considered a "Devil's tree" by tribal people in the Western Ghats. The tree's name has an interesting history, originally called *Echites scholaris* by Linnaeus and later renamed by Robert Brown in honor of botanist Prof. Alston. Known as 'Saptaparni' or 'Devil's tree' in India, the tree holds cultural significance and is designated as the State Tree of West Bengal. Despite its name, it is classified as "Least Concern" by the IUCN Red List of Threatened Species.

Alstonia scholaris (L.) R. Br is not just limited to ornamental use; it has been traditionally utilized in various medicinal systems for its antibacterial, antimicrobial, astringent, and anti-asthmatic properties. With its array of medicinal benefits, including anti-inflammatory, analgesic, antibacterial, antianxiety, anticancer, and antidiabetic effects, this tree holds immense value in both ecological and cultural contexts.

Morphology

Stem: The stem was either smooth or slightly rough with whorled branches, greyish brown bark that was lenticulate and released milky latex when the bark was damaged. The young stem was glabrous and greenish black. Leaves: Leaves are seven in a whorl, coriaceous, glabrous, elliptic to oblanceolate, entire margin, acute base and rounded apex. The leaf blade was 11.3–18.6 cm in length and 3.9–5.8 cm in breadth with a greyish green abaxial surface and a dark green adaxial surface. The petiole is brownish green, glabrous, flattened and slightly winged.

Inflorescence: The inflorescence is umbellate cyme. The peduncle was green, glabrous with 2–5 cm long and 0.3–0.5 cm wide. The bracts are pubescent, rounded lobes, light green.

Flower: Flowers are numerous, small, bisexual, salverform, light green, pubescent, strongly perfumed, 1.4–1.7 cm length and 0.8–1.2 cm breadth. The pedicel was typically shorter than the calyx and it was green, pubescent and 0.1 cm long and wide. The mature bud formed as an ovoid head, cylindrical shape, green lobe and light green tube.

Calyx: The calyx consists of five sepals, synsepalous with quincuncial aestivation. The sepals are green, obtuse lobes, pubescent outside, glabrous inside of about 0.2 cm length and 0.2 cm width.

Corolla: The sympetalous corolla has the corolla tube and single whorl of five petal lobes. The corolla is light green of about 1.3–1.6 cm length and 0.8–1.2 cm breadth. The corolla lobe was rounded, pubescent. The corolla tube was almost cylindrical and widened slightly towards the base, around the anther and ovary. It was light green on both sides, mouth with ring of hairs, pubescent inside, the corolla has twisted aestivation and overlapping to the left side.

Androecium: The androecium consists of five epipetalous stamens; it was situated near the throat of the corolla tube. The anthers are ovate, glabrous, yellow with about 0.1 cm length and 0.1 cm width. The filaments are small, filiform.

Gynoecium: The gynoecium consists of two carpels. The stigma was green, conical. The style was light green. The ovary was superior, pubescent, white, Bicarpellary, syncarpous ovary with several ovules on the marginal placentation.

Fruit: The fruits are two slender follicles which are long, pendulous, cylindrical, linear, green, 42–45 cm long and 0.3–0.5 cm wide. The mature fruit was brown and dehisced longitudinally from the base into two halves and released large number of compressed small seeds.

Anatomical Characterization

Stem anatomy

Epidermis: Upper Epidermis: it is made up of a single layer compactly arranged parenchyamatous cells. Cells are covered by a thick cuticle to reduce water loss. Less stomata seen on upper epidermis. Lower Epidermis: Similar structure to the upper epidermis but thinner contains and abundant stomata compare to upper epidermis.

Hypodermis: A layer of collenchyma cells present below the epidermis in the midrib area provides mechanical flexibility.

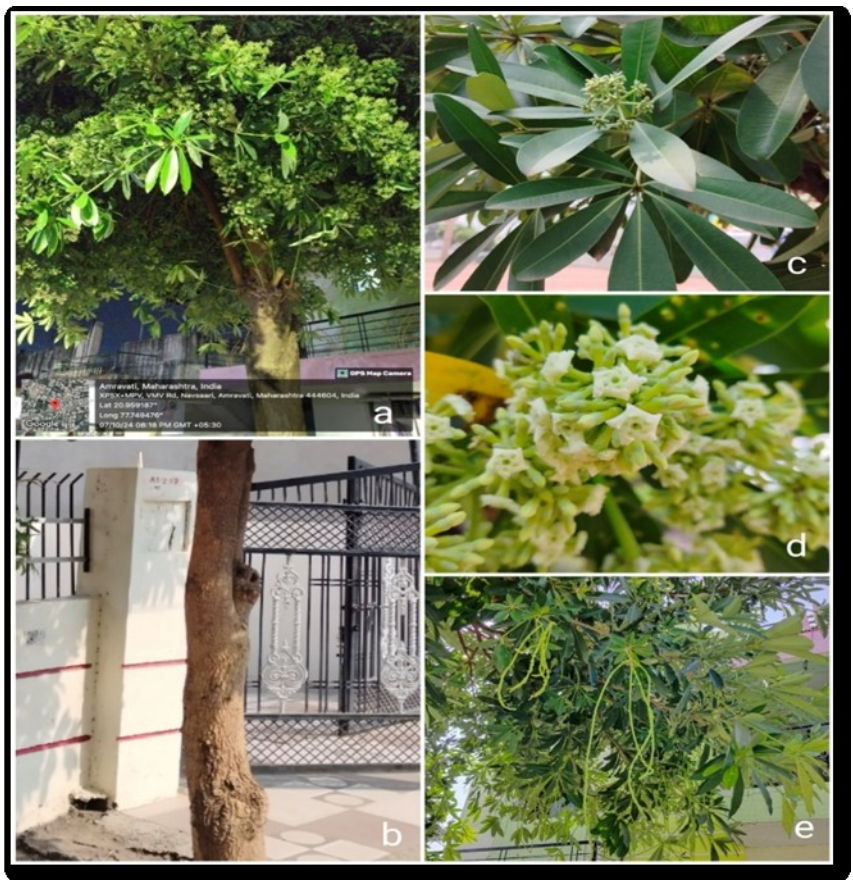
Latex Canals: Present in the mesophyll and vascular regions, contributing to the secretion of milky latex.

Mesophyll: Palisade Parenchyma: Located just below the upper epidermis. Composed of one or two layers of tightly packed cells, columnar cells rich in chloroplasts for photosynthesis.

Spongy Parenchyma: It presents beneath the palisade layer, closer to the lower epidermis. Made up of loosely arranged parenchymatous cells with intercellular spaces for gas exchange. Also contains chloroplasts but in a lesser concentration.

Vascular Bundle: Located in the midrib region, forming the main vein, Vascular bundles are collateral and closed. Xylem: Present on the upper side (adaxial side) of the vascular bundle. Conduct water and minerals. Xylem composed of tracheids, vessels, xylem Fibers, and xylem parenchyma.

Phloem: Located on the lower side (abaxial side), conduct of food and organic nutrients.



Photoplate- 1: Morphology of *Alstonia scholaris* (L.) Br. a. Plant in flowering stage b. Stem c. Leaves and inflorescence bud d. Inflorescence e. Fruit

Leaf Anatomy

The transverse section of the stem of *Alstonia scholaris* consist of various layers of tissues organized to provide structural strength, storage, conduction of water and nutrients, and other physiological functions. Its anatomical structure reflects its adaptation for growth and environmental resilience.

1. Epidermis The epidermis forms the outermost protective layer of the stem. It consists of a single layer of compactly arranged parenchymatous cells. The epidermal cells are covered by a thick cuticle, which minimizes water loss and protects against mechanical injury and microbial attack. In young stems, trichomes (hair-like outgrowths) present for additional protection. The epidermis acts as the first line of defence against environmental stress, such as desiccation and herbivory.

2. Cortex

Collenchyma: Situated just beneath the epidermis. Composed of elongated, thick-walled cells with unevenly thickened walls. Provides mechanical strength and elasticity to the stem. The cortex is located immediately beneath the hypodermis and is differentiated into two distinct regions:

Parenchyma: Found below the collenchyma layer. Composed of loosely arranged, thin-walled cells with intercellular spaces. The cells often store starch and other nutrients.

Sclerenchyma: Sclerenchyma is a plant tissue that provides structural support and strength to plants. It composed of sclereids and fibers. Sclereids: Sclereids are hard, irregularly shaped cells that provide compression strength to tissues. Fiber are narrow, long cells that are commonly found in the inner bark, wood, and leaf veins. Phloem fibres, also known as bast fibres, are flexible sclerenchyma cells that make up the soft fibres of flax.

Laticiferous Canals: Scattered within the parenchymatous cortex. These canals secrete milky latex, which is characteristic of *Alstonia scholaris* and has medicinal properties. The cortex provides mechanical support, stores nutrients, and contains secretory canals for latex production. These are prominent in the cortex and vascular tissues and secrete milky latex, which has significant medicinal and ecological roles.

3. Endodermis

The endodermis marks the inner boundary of the cortex. It is composed of a single layer of barrel-shaped cells. The endodermis regulates the movement of substances between the cortex and the vascular tissues.

4.Vascular Bundles

The vascular system of the stem consists of conjoint, collateral, and open vascular bundles.

Xylem: Located towards the inner side (adaxial region) of the vascular bundle. Composed of vessels, tracheids, xylem fibres, and xylem parenchyma. It conducts water and dissolved minerals from roots to other parts of the plant.

Phloem: Positioned towards the outer side (abaxial region) of the vascular bundle. Composed of sieve tubes, companion cells, phloem parenchyma, and phloem fibres. Responsible for the translocation of organic nutrients like sugars.

Cambium: Found between the xylem and phloem layers. This meristematic tissue is responsible for secondary growth, leading to an increase in the girth of the stem over time.

Medullary Rays: Medullary rays are radially arranged bands of parenchymatous cells extending between the vascular bundles and help in lateral conduction of water, nutrients, and food materials and it also provides storage for nutrients.

Pith: The pith occupies the central region of the stem. Composed of large, thin-walled, parenchymatous cells with intercellular spaces. These cells are filled

with starch, water, and other reserve materials. The pith functions as a storage tissue and helps maintain the shape and structure of the stem.

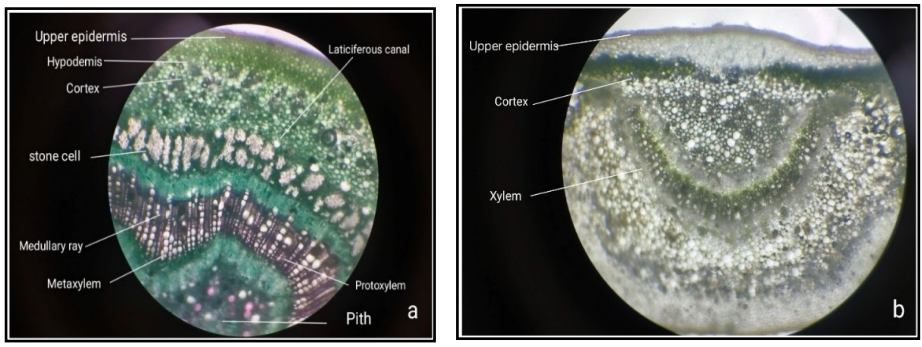


Photo 2: Anatomical structures of *Alstonia scholaris* (L.) R. Br. a T. S. of stem. T. S b. T.S of leaf

4. Floral Biology

Flower morphology is an important characteristic for identification. Proper recording of these morphological traits aids in the easy identification and distinction of ornamental species and their utilization in suitable designs. The flowering period varies from tree to tree, even at the same or different sites. Typically, flowering occurs from November to December, but some individuals may extend flowering up to February. The inflorescence is a much-branched, pedunculate terminal panicle or compound compact umbel, consisting of about 300-400 flowers. The flowers are pedicellate, small, creamy white or greenish white, tubular, actinomorphic, bisexual, and produce a pungent odor.

The calyx is cupular with five green ovate ciliate lobes. The corolla is salver-shaped, with a tube that is villous inside, and its throat has a ring of downwardly pointed hairs. The throat extends into five cuneate, oblong pubescent twisted spreading lobes with rounded apices. The stamens are five in number, inserted near the corolla throat and connate with the tube of the corolla. The anthers are creamy white, introrse, basifixed, and dehisce soon after anthesis by longitudinal slits. The pollen grains are tricolporate, prolate spheroidal, with a granulate surface. The ovary comprises two free carpels, each containing many ovules arranged on parietal placentation. The styles are two, filiform and hollow but gradually fuse to form a bilobed conical wet stigma. Nectar secretion is initiated from the mature bud stage.

Fruits mature within three weeks. During fruit development, the fruit is distinctly two-follicled. The follicles are linear, pendulous, many-seeded, initially green, and later brown. Each follicle dehisces longitudinally into two halves to release seeds. The fully formed and mature seeds are very small and compressed, with a fringe of long brown silky hairs at each end, adapted for wind dispersal.

Table 1: Number of flowers per inflorescence

Sr. No.	Number of flowers per inflorescence	Mean flower
1	293	247.4
2	254	
3	174	
4	240	
5	276	

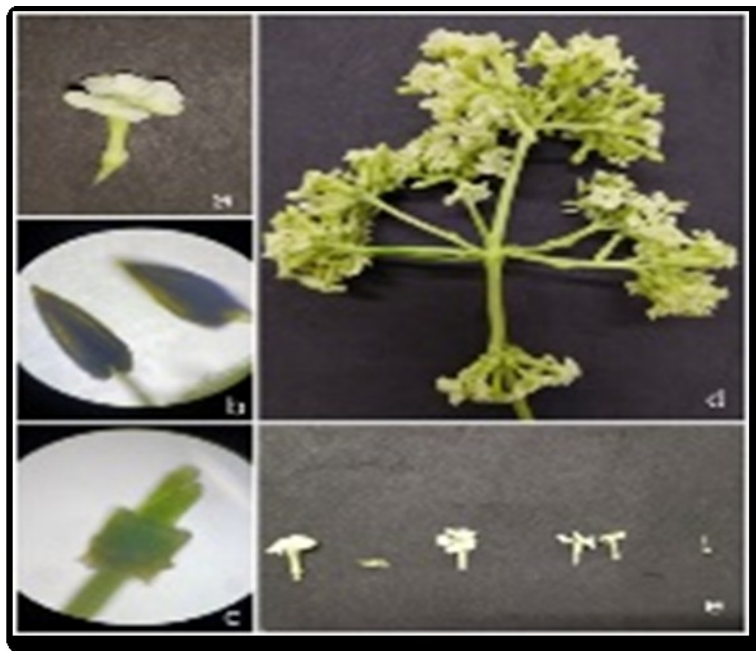


Photo 3: Floral structures of *Alstonia scholaris* (L.) Br. **a.** Flower **b**. Stamen **c**. Carpel **d.** Inflorescence **e.** flower dissected parts calyx, corolla, androecium and Gynoecium.

Table 2: Number of follicles per inflorescence

Sr. No.	Inflorescence	Number of follicles per inflorescence	Mean fruit
1.	I	47	25.6
2.	II	19	
3.	III	40	
4.	IV	12	
5.	V	10	

The flowering rate seen is high near about 1237 flowers in five inflorescences, the mean of flowers 247.4 found, but the fruits rate is highly reduced in five inflorescence 128 follicles are arises and the mean of fruit is 25.6 **(Table 1 and Table 2).**

Pollinators of *Alstonia scholaris* (L.) R. Br.

The flowers of *Alstonia scholaris* attract a variety of pollinators, including bees, flies, butterflies, ants, beetles, and moths. Diurnal hawk moths, such as *Macroglossum gyrans* and *Cephonodes hylas,* start foraging as soon as the flowers open and continue until sunset, resuming activity the following morning at sunrise for about two hours. The Jasmine moth, *Palpita vitrealis*, visits the flowers after sunset. Other insect visitors, including bees, flies, and butterflies, are active during the daytime. Bees, particularly *Apis dorsata*, are effective nectar collectors and gather pollen easily due to the anthers' placement near the corolla tube's throat. Flies, such as *Helophilus*, with shorter proboscises primarily collect pollen, while butterflies and moths, with longer proboscises, easily access nectar at the corolla base. During foraging, these insects contact the stamens and stigma, enabling self- or cross-pollination.

Foraging behaviors vary among insect groups. Bees and flies typically forage on the same tree, promoting autogamy and geitonogamy, whereas butterflies and moths forage more randomly, moving between inflorescences and nearby trees, facilitating xenogamy and geitonogamy. Moths are unique in visiting newly opened flowers, while other insects prefer flowers the following day. Bees account for 40% of visits, flies 9%, butterflies 29%, and moths 22%. Despite their abundance, bee visits predominantly result in self-pollination.

Photoplate 4 : Pollinator of *Alstonia scholaris* (L.) R. Br. *a. Camponotus japonicus b. Spodoptera litura* (Tobacco cutworm) *c. Achaea Janata* (castor semi-looper or croton caterpillar) *d. Amata huebneri* (Hübner's wasp moth).

Table 3: Pollinator visited to the plant

Sr. No.	Pollinator visited to the plant	During day time	During night time
1.	Moth	-	Yes
2.	Butterfly	Yes	-
3.	Beetle	Yes	Yes
4.	Bat	-	Yes
5.	Ant	Yes	Yes

House sparrows (*Passer domesticus*) also feed on the flowers, plucking them to extract nectar. However, their activity is negligible due to the tree's high flower production and has minimal impact on the tree's reproductive success. The flowers eventually wither and fall beneath the tree's canopy.

In the study the *Alstonia scholaris* (L.) R. Br.is pollinated by moths, bees, flies, butterflies as well beetles, Ants, Bats, Birds during night and day time respectively. **(Table 3).** The information was collected from local peoples of various location of city many peoples are say that the pungent Odor of its flowers can cause mild respiratory and sleep issues during cool weather, especially in urban areas with extensive plantations.

Ethnobotanical uses

Alstonia scholaris is used in traditional medicine for various purposes. It serves as a tonic for stomach aches, recurrence of various diseases, and as a stimulant. It is also used to treat fever (Rajakumar and Shivanna, 2010), arthritis (Yusuf et al., 2006), impotence, leucorrhoea (Bhandary, 1995), animal bites (Prusti and Behera, 2007), as an antidote to poison, malaria, and skin diseases (Mollik et al., 2010). Furthermore, it is employed in treating leprosy, toe cracks, cellulitis (Saikia, 2006), hypertension (Chhetri, 2005), swelling (Deb et al., 2009), and delivery-related pain (Sharma and Kumar, 2011). The bark of this plant is specifically used for treating gastrointestinal problems such as diarrhea, fever, dysentery, jaundice, hepatitis, and ulcers. Additionally, it is traditionally used to treat heart-related disorders (Singh and Sangwan, 2011).

Biological activities of Alstonia scholaris (Kevin J. D'cruza and Mugdha V. Ambatkara 2016).

Phytochemical constituents

Chromatographic studies of A. scholaris showed various types of phytochemicals like alkaloid, monoterpenoids, flavonoids, tannins, triterpenes, sterol, esters etc (Singh *et al.,* 2017). HPLC study of methanolic extract revealed that A. scholaris contains variety of phenolic acid like gallic acid, ellagic acid catechin and kaempferol (Shang *et al.,* 2010). Ethanoic acid and 10% aqueous ammonia with acidic solution adjusted to pH 9–10 was extracted to give TA fraction (10 g). Scholaricine (6%), 19-epischolaricine (2%, picrinine

(10%) and vallesamine (6%) (Zhao *et al..,* 2017) were isolated and showed airways antiallergic effect and down-regulation of inflammatory cells, cytokines, and the balance of antioxidants (Zhao *et al..,* 2017, Zhao *et al..,* 2018, Hadi *et al..,* 2009). Some Phytochemicals have been reported in *Alstonia Scholaris's* given below (Deena Prakash *et al.,*2020).

Table 4. Biological activities of *Alstonia scholaris* (L.) R. Br.

Activity	Plant part used	References
Antidiarrhoeal	Bark	Patil *et al,* (1999)
Antimicrobial	Leaf, stem and root bark	Goyal *et al,* (1995)
Anticancer	Root bark	Keawpradub *et al,* (1997) and (Jagetia and Baliga, 2005)
Antiasthamatic	Leaves	Channa *et al*, (2005)
Analgesic and anti-inflammatory	Leaves	Arulmozhi *et al,* (2012)
Anti-allergic effect	Leaves	(Zhao *et al..,* 2017)
Anti-fertility activity	Bark	(Gupta *et al..,* 2002)
Antidiabetic activity	Leaves	(Nkono *et al..,* 2014)
Free Radical scavenging activity	Bark extract	(Ravishankar *et al..,* 2008)
Hepatoprotective Activity	Aqueous extract	(Lin *et al..,* 1996)
Antivenom Activity	Bark	(Gosh *et al..,* 2018)

Impact of Floral Pungent Odor, Airborne Pollen, and Dispersal of Comose Seeds of *Alstonia scholaris* on Human Health

The large-scale planting of *Alstonia scholaris* (L.) R. Br. as an ornamental and avenue tree has led to certain health concerns during its flowering and seed dispersal seasons. The profuse flowering produces a strong pungent odor, especially during the evening and night, which can cause mild respiratory discomfort (dyspnea) and sleeplessness in people nearby, particularly during the peak flowering period of 2–3 weeks. Although the flowers have limited potential for airborne pollen release due to their structure, some pollen may become airborne through insect activity or wilting flowers, but the cool winter conditions reduce this risk. Seed dispersal occurs from February to early April when dry,

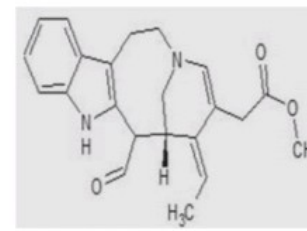
windy conditions facilitate the release of comose seeds and their silky hairs, which can fragment and become airborne. These fragments and the granular powder from decomposing follicles can trigger allergies, including sneezing, eye irritation, skin rashes, and respiratory issues, especially in asthmatics. The large-scale plantation of this species amplifies these effects for people living nearby.

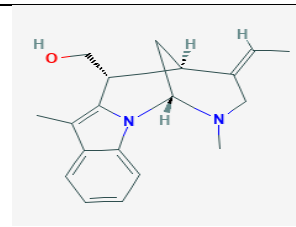
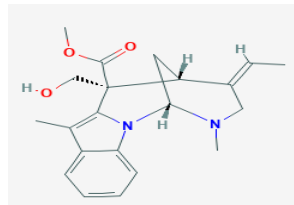
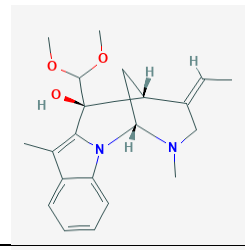
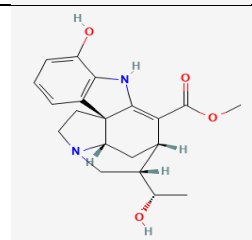
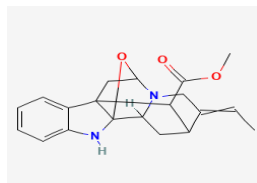
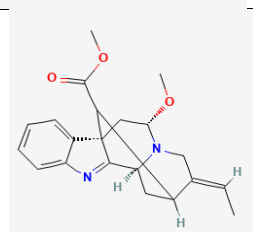
Table 5: Phytochemical Screening

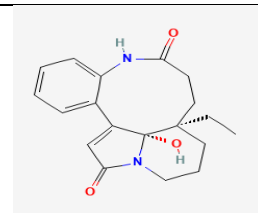
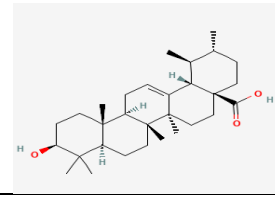
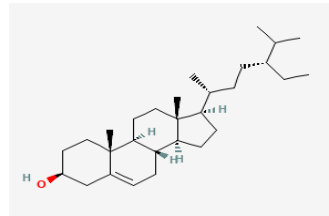
Compound	H	B	I.P	M	W	E	P. E	C
Alkaloids	++++	++++	++++	++++	++++	+++ +	--	+++
Carbohydrates	--	--	+++	+++	--	++	--	--
Amino acids	--	--	--	--	++	--	--	--
Fixed oil and Fats	+++	++	--	+	--	+++	--	--
Phenolic compounds	+++	++++	++	++++	--	--	--	--
Terpenoids	++++	--	+++	++++	++++	+++	--	--
Cardiac glycosides	--	+++	--	--	--	--	--	--
Steroids	++++	++++	++++	++	+++	++	++	--
Saponins	--	--	++++	++++	++++	--	--	--
Tannins	--	++++	++++	++++	--	+++ +	--	--
Flavonoids	++	++++	+++	++	+++	++	--	--

Weak (+), moderate (++) strong (+++) very strong (++++), absent (--) [H-Hexane; B-Benzene; I.P-Iso Propanol; M-Methanol; W-Water; E-Ethanol; P.E-Petroleum Ether; C-Chloroform]. Phytochemical Screening (Shrestha De *et al.,*2024)

Table 6: Phytochemical constituents

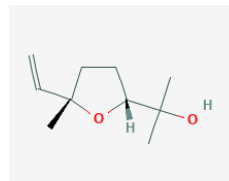
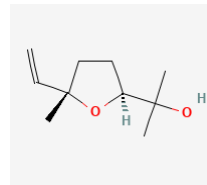
Sr. No	Phytochemical name	Structure
1.	Mataranine	

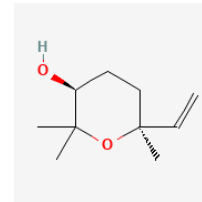
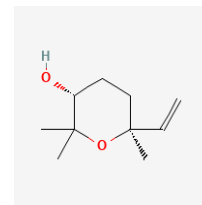
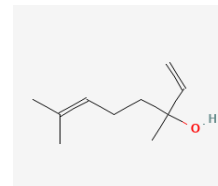
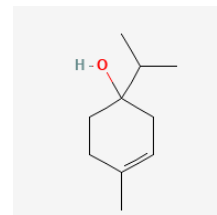
2.	Alstoscholarisines H	
3.	Alstoscholarisines I	
4.	Alstoscholarisines J	
5.	Scholaricine	
6.	Picrinine	
7.	5-methoxystrictamine	

8.	leuconolam	
9.	Ursolic acid	
10.	Beta-sitosterol	

Singh, M. K (*et al.,* 2020)

Table 7: Major Floral Volatile component

Sr. no	Compound name	Structure
1.	cis-Linalool oxide (furanoid)	
2.	trans-Linalool oxide (furanoid)	

3.	cis-Linalool oxide (pyranoid)	
4.	trans-Linalool oxide (pyranoid)	
5.	Linalool	
6.	Terpinen-4-ol	

Conclusions

Alstonia scholaris is an evergreen, winter-blooming, hermaphroditic tree species. Its floral traits, such as anthesis during dusk and early dark hours, creamy white or greenish-white color, pungent odor, and small amount of nectar, indicate moth pollination. The present study concludes that pollination occurs entomophilous.

The dry season provides an optimal and highly effective environment for the dispersal of seeds, benefiting many plant species, including *Alstonia scholaris* (L.) R. Br. However, this tree presents notable environmental and public health concerns under certain conditions. *A. scholaris* is known for its highly pungent flowers, which emit a strong odor. During periods of cool weather, this odor can

lead to mild respiratory discomfort and sleeping difficulties among individuals exposed to it, particularly in areas where the tree has been extensively planted as part of urban afforestation and beautification initiatives. These health issues are exacerbated by the tree's tendency to flower profusely. Each tree produces an exceptionally large number of flowers daily, amplifying the release of the pungent odor and potentially affecting the air quality in its vicinity. The combination of these factors makes massive plantations of *A. scholaris* (L.) R. Br in urban settings a matter of concern for the well-being of city residents, especially those with heightened sensitivity to air quality or respiratory ailments.

The study suggests that urban planners and environmentalists adopt a more balanced approach to planting this species. Instead of mass plantations, scattered planting of a small number of *A. scholaris* (L.) R. Br trees across urban areas is recommended. This strategy preserves the ecological and aesthetic benefits of the species while minimizing its potential health risks for urban populations. In a nutshell, a balanced approach to planting *Alstonia scholaris* (L.) R. Br., advocating for scattered plantations rather than mass plantations in urban areas, is recommended. The findings from morphology and phenology can help in conservation efforts, especially if the species is threatened or has specialized habitat needs.

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E-Book ISBN: 978-81-981814-9-7
Year April, 2025