WOOD SPECIES DIVERSITY AND POPULATION STRUCTURE ALONG THE ALTITUDINAL GRADIENT IN JHAJJAR WATERSHED IN NORTHWESTERN HIMALAYA: AN EMPHASIS ON THEIR ETHNO-BOTANICAL USES

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ABSTRACT

The study focused on cataloging and investigating the woody flora of the Jhajjar watershed in the Reasi district of Jammu and Kashmir, an area previously under-researched in terms of forest ecology and woody plant diversity. A total of 80 woody species were recorded, with 56% being shrubs and 44% trees. The plants were used in 36 different ways, primarily for medicinal, edible, and timber purposes, with various preparations (e.g., powders, decoctions, extracts). Parts commonly used included bark, leaves, and roots. 39 species were exclusively medicinal, 8 species were both medicinal and edible, and 5 species were used for medicine and timber. The study found that the watershed is rich in species diversity, with 63 genera and 36 families, dominated by Moraceae, Rosaceae and the genus *Ficus*. The distribution pattern of species was mostly random, indicating varying availability across the watershed. People's in the region rely on these plants for medicinal, timber, fodder, and fuel needs, highlighting the importance of sustainable plant use. Recommendations included further ethno-botanical studies in nearby areas, sustainable utilization of the plants, and assessing the populations of rare species to guide conservation efforts.

Keywords: Altitude; Diversity; Jhajjar; Medicinal; Watershed; Wood,

INTRODUCTION

Both the stability and functioning of ecosystems and human livelihood depend on biodiversity (Singh, 2002). According to McNaughton (1977), a varied ecosystem is less

vulnerable to the severe or abrupt effects of environmental disruption. Science has identified over 3,91,000 vascular plant species, of which 3,69,000 species are considered blooming plants. A total of 31,128 plant species are thought to be beneficial to living things; the majority of these are used for medical purposes (17,180), followed by the production of materials (11,365), environmental purposes (8,140), human food (5,538), animal food (3,649), poison (2,503), fuel (1,621), social purposes (1,382), and 683 plant species that are used as food for invertebrates (SOTWP, 2016). Land plants (angiosperms, gymnosperms, ferns, lycophytes, and bryophytes) are thought to number 500,000 species, with a significant concentration of diversity found in the wet tropics. Science still doesn't fully understand many species. Roughly one-third of all land plants are threatened with extinction, including a large number that have neither been described nor have been described but lack sufficient data. Though many more species may be extinct because they have not been discovered recently, there have only been a small number of known global extinctions to date. While many plant species are crucial to natural ecosystems and the services they offer, only a small percentage of plant species are specifically used by humans. Additionally, uncommon plants are more likely to possess unexpected features that may be helpful in the future. The main dangers to plant diversity are overexploitation, invasive species, pollution, human climate change, habitat loss, fragmentation, and degradation. Plant diversity conservation is a huge undertaking when considered worldwide, but anyplace in the world, *ex situ* gap-filling and backup should be combined with a well-thought-out protected area system. In order to effectively focus both *in situ* and *ex situ* conservation, the completion of the global botanical inventory and an evaluation of the conservation status of the 94% of plant species that have not yet been assessed are of utmost importance. Attention needs to be directed toward the hyper-diverse lowland tropical regions, which have the largest conservation gap in the world.

Biodiversity, or plant diversity, is essential to an ecosystem's health. Every organism has a significant function and aids in the regulation of growth cycles and other natural processes in a biodiverse ecosystem. This implies that if one aspect of a natural environment takes on an excessive amount of dominance, another aspect will restore equilibrium to the system. Adaptive change is one of the several reasons for plant variety. Many ecological services, such as shade, wildlife habitat, clean water, healthy soil, and pure air, are provided by plants when they are employed in landscape design. The landscape will take a long time to recover if we just utilize a limited selection of plants and those plant kinds get sick or are attacked by a bug. Despite the fact that plants are significantly more vital to us than animals, there isn't the same urgency or financing for plant conservation as there is for animal conservation. In addition to offering a vast array of other goods and services, such as wood, fiber, clean water, erosion control, and wood-producing species, plants also serve as our primary source of food for humans and livestock. Even urban dwellers use a broad variety of other plant species for varied purposes, and rural people typically use many more. This is despite the fact that the majority of commercial plant products originate from a very restricted range of plant species. Living solely on these species would be unhealthy and boring. Numerous other species have significance in traditional medicine, and wild plant foods contribute to nutrition and food security. Furthermore, plants provide the three-dimensional framework for animal life and movement as well as the food that the majority of animals eat, making them the foundation of all terrestrial ecosystems. Woody plants are those that have a hard stem and produce wood as their structural component. They might be members of various gymnosperm, angiosperm, and pteridophyte groups. Typically, they are woody climbers, trees, or shrubs. One of the main constituents of the floristic wealth in a region is the woody plant species, among the other components of biodiversity. These plants not only help to maintain the earth's physical features but also stop soil erosion, lessen the

impact of floods, allow streams to flow permeably, and support river flows. They also aid in preserving the ecological balance and offer refuge to a variety of living species (Bennie *et al.* 2008). Plants are the primary suppliers of biochemical energy and habitat structure in terrestrial ecosystems (Mayer *et al.* 2016). According to FitzJohn *et al.* (2014), woody plants make up roughly 45–48% of the world's vascular flora alone. The development of entire communities is directly impacted by the presence of these plants. They are also important for managing forests and shaping the landscape. Additionally, a number of studies have demonstrated a substantial correlation between woody and non-woody species, raising the potential that the woody flora may serve as a proxy for the entire vascular flora of a given location (Abbate *et al.,* 2015). The tree canopy controls features that control the richness and abundance of a biotic community in addition to influencing the microclimatic conditions in the understorey, nutrient cycles, and resource distribution (Molder *et al.,* 2008; Burrascano *et al.,* 2011; Abbate *et al.,* 2015). Therefore, it is crucial to understand woody plants for these reasons. India is one of the world's 17 mega diversified nations, home to a wide variety of plants and with a forest covering 24.62% of its total land area. Despite making up only 2.4% of the world's geographical area, it represents 8% of biodiversity worldwide (Reddy, 2008; Hajra & Chauhan, 1997). In terms of biodiversity research, the Himalaya is still understudied, despite being acknowledged as a worldwide biodiversity hotspot by Mittermeier *et al.* (2005) and Zachos & Habel (2011).

The Himalaya, which means "abode of the snow" in Sanskrit, are the young Asian mountain ranges that divide China's Tibetan Plateau from the Indian subcontinent. The Himalayan ranges are significant because they are home to a wealth of biological, ecological, and extreme cultural diversity, all of which highlight the pressing need for sustainability and preservation of these complex concerns. The Himalayan range spans an area of roughly 600,000 km2 and is located in the east-west arc between 2500 and 3000

km2. Along with its subranges, the Karakoram, Pamir, and Hindu Kush, the Himalaya encompasses parts of India, Pakistan, Afghanistan, China, Bhutan, and Burma. The Himalayan region is known for its verticality, and its elevations range from a few dozen meters to 8,850 meters above mean sea level at Mount Everest, the highest point in the globe. The Himalaya presents challenges for agricultural operations, infrastructure development, and transportation infrastructures because to the region's extremely harsh climate, landslides, avalanches, and earthquakes. The Himalayan region, while rich in biodiversity and cultural legacy, is also a vulnerable territory facing severe repercussions from deforestation, biodiversity loss, pollution, and climate change. The most beautiful mountain woods are the Himalayan forests, which are located in a tropical latitudinal zone of the world but have a temperate climate inside. Even though numerous taxa are found in both temperate and Himalayan forests, there are significant functional differences between the two, with Himalayan forests exhibiting many functional similarities that are closer to tropical than temperate forests worldwide. Based on latitudinal zones, three types of forest divisions are allocated globally: tropical forests, temperate forests, and boreal forests. Mountain forests, in addition to all other forests, are regarded their sections (Singh, 2013). Temperate forests also include the mountain forests found in tropical and subtropical latitudinal zones, which grow between 2000 and 3000 meters above sea level. Higher altitude tropical latitude mountain forests, such the Himalayan moist temperate woods (Champion and Seth, 1968). Because they affect a greater percentage of the planet and make up around 24% of the vegetation cover worldwide, mountain forest ecosystems demand special consideration and studies at the biosphere level (Singh, 2014).

The development of the global biodiversity information infrastructure has been acknowledged to depend on an annotated and constantly updated inventory of biota (Khuroo *et al.* 2007). At the local, regional, and global levels, this has taken on great relevance for

accomplishing the difficult objectives of biodiversity recording, conservation, and sustainable usage (Dar *et al.* 2012, 2014). However, just 1.7% of the planet Earth's biota is known to science due to its immense worldwide diversity (Dar & Farooq 1997). The need for a global taxonomic inventory of biodiversity has increased significantly in light of these compelling circumstances. According to Khuroo *et al.* (2008), the situation is especially bad in the developing world, which also happens to have the richest but most vulnerable biodiversity. To document the biodiversity in various places, new research programs have been launched globally in line with this. Despite the Himalaya being acknowledged as a global hotspot for biodiversity (Mittermeier *et al.* 2005; Zachos & Habel 2011), vital diversity and floristic data for many of its locations remain unavailably lacking. One such area, which has been identified by the Botanical Survey of India (Dar *et al.* 2012) as floristically underexplored and where the documenting of biodiversity has immediate precedence, is the Indian State of Jammu and Kashmir (J & K) in the Western Himalaya. Rich plant diversity of great scientific interest and enormous economic potential is bestowed upon the State (Singh *et al.* 1998; Dar *et al.* 2002; Malik *et al.* 2010, 2012, 2015; Dar & Khuroo 2013). Among the many constituents of the State's floristic wealth, woody plant species—also referred to as arboreal species—represent one of the main groups. The first list of arboreal plant species found in the State was published in Lambert's (1933) "List of trees and shrubs for Kashmir and Jammu forest circles, Jammu and Kashmir State." Since then, an updated taxonomic inventory of this significant floristic component in the State has been necessary due to newly accessible taxonomic data and nomenclatural modifications. The revised taxonomic data-sets on arboreal plants have proven to be immediately beneficial for the preservation of biodiversity and its sustainable utilization in the area. This is because a great deal of exotic arboreal species have been introduced for cultivation, many of which are now naturalizing. On the one hand, this has increased the risk of extinction for a large

number of arboreal species in forests due to habitat degradation and other unsustainable developmental activities (Kaul & Handoo 1998; Oza 2003). After Kashmir, the region of Jammu in J & K State has a vast floral diversity. Over the past thirty years, a number of taxonomic research pertaining to the floristic diversity of this area have been conducted. The Flora of Jammu and neighboring areas was published by Sharma & Kachroo, who also provided taxonomic facts in volume 1 (1981) and drawings in volume 2 (1982). The Trikuta hills' flora was covered by Kapur and Sarin (1990), who provided a thorough floristic description of the species that grow in these hills and the area around Shri Vaishno Devi Shrine. The Flora of Udhampur district, written by Swami and Gupta (1998), is a helpful guide to the higher plants found in this region. Malik *et al.* (2015) focused on the floristic diversity of the Warwan valley, whereas Bhellum & Magotra (2012) compiled a list of flowering plants in the Doda, Kishtwar, and Ramban districts, addressing the floristic richness of these three nearby districts in the Chenab Valley. Reasi, on the other hand, is the Jammu province's least surveyed district floristically, with little to no information on its flora now accessible. None of these publications—all of which are brief, early communications—have attempted to compile a comprehensive list of all the woody plants found in the districts. The goal was to catalog and investigate the woody flora of the Jhajjar watershed in the Reasi district in order to close this information gap. Knowing the knowledge gap and paucity of such works from the selected study area (Jhajjar watershed of district Reasi, Jammu and Kashmir) the present study was set forth with following objectives; i). To explore, collect, describe and identify the woody plants of Jhajjar watershed in district Reasi and substantiate by visual documentation; ii). To work out correct nomenclature of each plant with recent nomenclature and Vernacular name; iii). To map the occurrence and distribution of woody species in study area; iv). To document the economic importance of woody species of the study area; v). To prepare an inventory of

plants existing in the study area; vi). To deposit the collected specimens in the recognized herbarium as a repository.

MATERIAL AND METHODS

Study area

In the Indian union territory of Jammu and Kashmir, Reasi is a town, notified area committee, and tehsil. The Reasi district headquarters are located on the Chenab River's bank. Reasi was a part of the Bhimgarh realm that Rajput ruler Bhim Dev Rasyal founded in the ninth century. The town's previous name, "Rasyal," is whence the name Reasi originates. One of the eight recently established districts in the Jammu and Kashmir UT, Reasi came into being on April 1st, 2007. The district is primarily hilly and has a range of climates, from semi-temperate to sub-tropical. Based on the District's geographic location, it can be classified as a "Hilly" or "Low Lying Hilly" region. There are 22 Niabats and nine Tehsils in the district. There are 153 Panchayat Halquas in 12 Development Blocks. The district is economically underdeveloped, with agriculture and related activities being the main source of income for the local population. The primary crops farmed in the district are maize and wheat, but farmers are also starting to plant a wider variety of vegetables and horticulture. The district is surrounded by the following districts: district Jammu on its southern ends; district Rajouri on its western and northwestern ends; district Ramban on its northern and eastern outskirts; and district Shopian on its northern fringes. One of the nation's principal rivers, the Chenab, passes through the district and serves as a physical divide between the Tehsils Reasi and Mahore. The district is home to several small rivers and streams, including the Ans, Rudd, Plassu, Ban Ganga, Pai, Anji, and others, all of which eventually join into Chinab. Five major religious groups are represented in Reasi City: (i) Christianity (3.5%), (ii) Sikhism (0.05%), Islam (10.66%), Hinduism (85.74%), and Not Stated (0.05%) (Census, 2011). The coordinates of Reasi are 33.08°N 74.83°E. It is located at an average

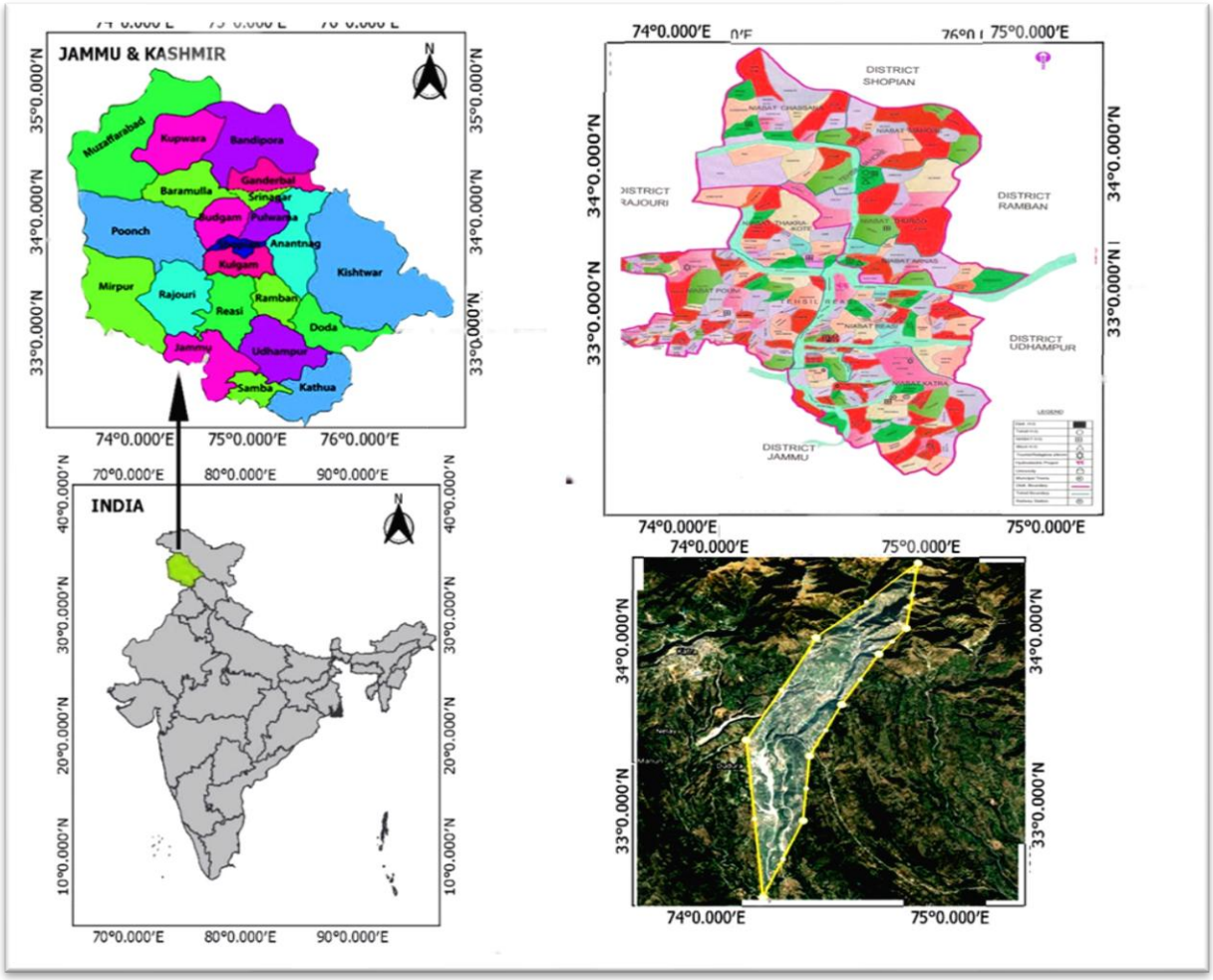

Figure 1. Map of the study area.

elevation of 1,529 feet, or 466 meters. Jammu is 64 miles away from the district of Reasi. The majority of people survive on meager incomes from government work, small businesses, and agriculture. 1011 hectares of the 12293 hectares of arable land in the region are irrigated. Paddy, bajra, wheat, and maize are important crops. There is also vegetable growing. The majority of the region is in the subtropical zone, with the remaining portion being in the temperate zone. Generally speaking, summers are pleasant and winters are chilly with snowfall on the higher elevations.

Jhajjar watershed

The Jhajjar watershed in district Reasi is located in the Jammu division of Jammu and Kashmir, close to the foothills of the Trikuta hills. It is found between N 32°53'32"; E 74°57'34" to N 33°01'25"; E 75°00'55" and N 32°57'25"; E 74°57'08" to N32°59'57"; and E

75°00' 40". The Jhajjar watershed in the Devi Pindiyan valley was chosen for this study due to its rich floristic variety.

Methodology

To evaluate the diversity of wood species, extensive field surveys were carried out in a number of locations within the Jhajjar watershed area, including road edges, village edges, and watershed sides. With the aid of the local flora, plant specimens were gathered, pressed, dried, and identified (Singh *et al.,* 2002). During the field surveys, data were acquired regarding the local names of the specimens, their life form, the fruiting and flowering period, their elevational distributions, and their availability status. Locals in the area provided information about local names in their native tongues. Occasionally, field visits are conducted to record life forms, fruiting, and flowers. For every species in the region, the distribution range in terms of elevation (m) has been documented.

Quadrates of 10×10 m size for tree and 5×5 m size for shrubs were laid down randomly in various sites to gather the ecological data for woody layers. Data is further analyzed to obtain IVI and distribution pattern of plant species. Distribution pattern of plant species was categorized into ‘random’ ‘regular’ and ‘contiguous’ on the bases of abundance/frequency ratio. Based on field observations made after previous research, the availability status or occurrence (common, uncommon, or rare) of each species was established (Rawat *et al.,* 2016, Bagri *et al.,* 2023). The term "rare" was used to characterize species that were reported as the lone specimen or with very few individuals in the area, "uncommon" status indicated species that only occurred in patches or scattered forms, and "common" status was assigned to species that grew abundantly in the area. Information about regional plant uses was gathered from local residents, including healers. Bentham and Hooker's system of categorization was used to classify plants, and taxonomical categories (species and genera) within a family were sorted alphabetically (Rawat *et al.,* 2016, Bagri *et*

al., 2023). The following online plant databases—the tropicos data base (https://www.tropicos.org/home), the international plant names index (https://www.ipni.org), and the plants list (http://www.theplantlist.org)—provide only one recently accepted name for each taxon (apart from synonyms).

RESULTS

Wood species diversity

The floristic analysis of the studied region revealed a rich amount of wood species diversity with a total of 80 woody species belonging to 63 genera and 36 families (Table 12). Among the plant reported plant species 56% were shrubs and 44% trees (Figure 2). The dominant genera of the study area were *Ficus* (10 species), *Rubus* (4 species) followed by *Debregeasia, Grewia, Indigofera, Senegalia, Solanum, Ziziphus* (2 species each) whereas remaining 55 genera's were represented by a single species (Figure 4). Top families were Moraceae (10 species), Rosaceae (6 species) followed by Anacardiaceae, Euphorbiaceae, Miomosaceae, Rutaceae (4 species each), Lamiaceae, Oleaceae, Rhamnaceae, Rubiaceae, Urticaceae (3 species each), Apocynaceae, caesealpiniaceae, Fabaceae, Malvaceae, Meliaceae, Phyllanthaceae, Solanaceae, Tiliaceae (2 species each) while remaining 17 families were reperesented by a single species (Figure 3.)

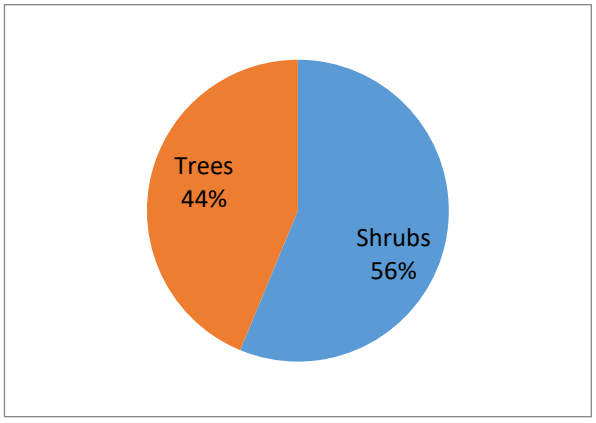

Figure 2. Pia chart showing life for in percentage.

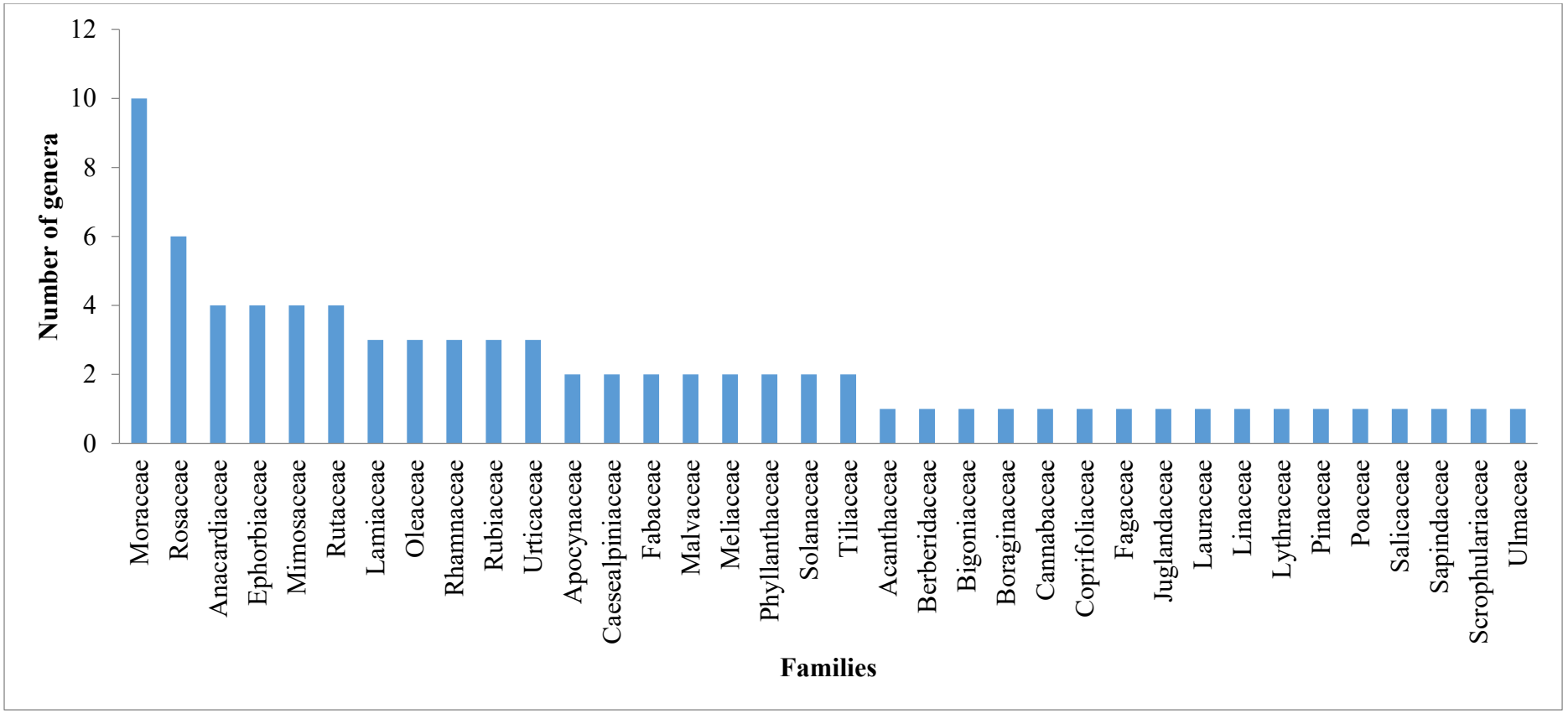

Figure 3. Families with their representive species numbers.

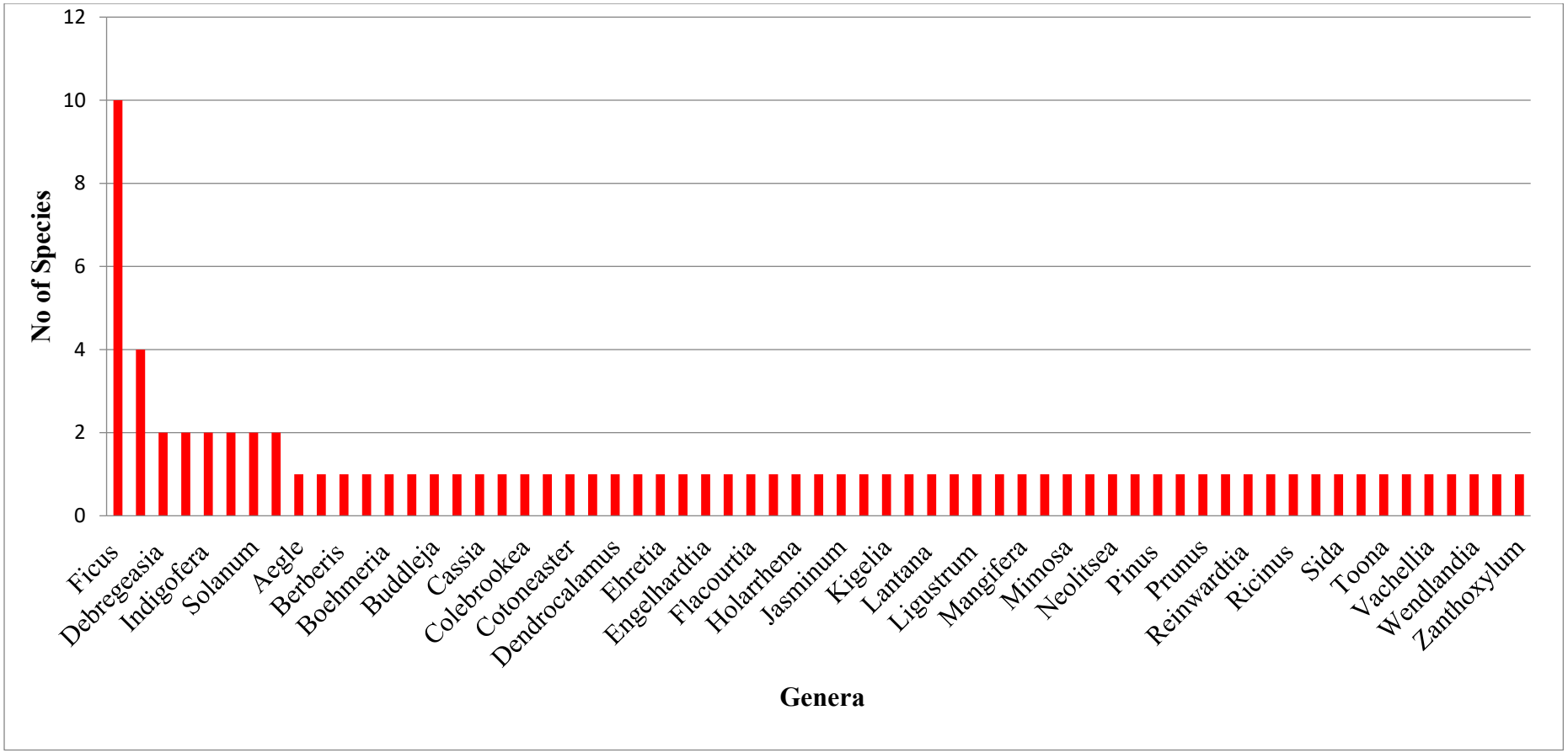

Figure 4. Genera with their respective species numbers.

Structure and Composition

Tree layer

S1 (700-900 m asl): The absolute tree density was recorded as 570 trees ha^{-1} (Table 1). The highest density was recorded for *Pinus roxburghii* (100 trees ha^{-1}) followed by *Holoptelia integriifolia* (50 trees ha^{-1}) while lowest density was recorded for *Melia azadirach* and *Sapium subiferum* (10 trees ha^{-1} each). The value of total basal cover (TBC) in this forest site was recorded as 18.73 m^2 $ha^{-1,}$ out of which highest value (4.66 m^2 ha^{-1}) was recorded for *Pinus roxburghii* followed by *Neolitsea umbrosa* (2.54 m^2 ha^{-1}) and lowest value for *Sapium subiferum* (0.11 m^2 ha^{-1}). The importance value index (IVI) value was highest for *Pinus roxburghii* (54.84), followed by *Holoptelia integriifolia* (25.11) and minimum for *Melia azadirach* (5.01). Abundance/frequency ratio indicate that majority of tree species in this site showed random distribution (76%) and remaining species showed contiguous and regular distribution (12 % each) (Figure 6).

Table 1. Phytosociological attributes of tree layer in S1.

Species	**Den ha-1**	**TBC m2 ha-1**	**IVI**	**A/F**	**Dis**
Acacia modesta	40	0.484	17.29	0.025	R
Acacia catechu	40	0.555	17.67	0.025	R
Aeagle marmelos	30	0.840	15.52	0.033	R
Bombax ceiba	20	1.754	18.65	0.022	RE
Cassia fistula	40	0.630	16.15	0.044	R
Ficus arnottiana	30	1.379	18.39	0.033	R
Glochidion velutinum	20	0.179	8.308	0.050	R
Holoptelea integrifolia	50	1.619	25.11	0.031	R
Lannea coromandelica	40	0.368	14.75	0.044	R
Mallotus philippensis	30	0.947	16.09	0.033	R
Mangifera indica	40	1.034	20.23	0.025	R
Melia azadirach	10	0.249	5.01	0.100	C
Neolamarkiana cadamb	20	0.836	11.82	0.050	R
Neolitsea umbrosa	30	2.548	24.64	0.033	R
Pinus roxburghii	100	4.463	54.84	0.020	RE
Sapium subiferum	10	0.115	4.291	0.100	C
Toona ciliata	20	0.725	11.23	0.050	R
Total	**570**	**18.73**	**300**		

S2 (900-1100 m asl): The absolute tree density was recorded as 280 trees ha^{-1} (Table 2). The highest density was recorded for *Pinus roxburghii* (90 trees ha^{-1}) followed by *Engelhardtia spicata* (60 trees ha^{-1}) while lowest density was recorded for *Bombax ceiba* and *Ficus semicardata* (10 trees ha^{-1} each). The value of total basal cover (TBC) in this forest site was recorded as 15.56 m^2 $ha^{-1,}$ out of which highest value (6.64 m^2 ha^{-1}) was recorded for *Pinus roxburghii* followed by *Engelhardtia spicata* (1.80 m^2 ha^{-1}) and lowest value for *Ficus semicardata* (0.14 m^2 ha^{-1}). The importance value index (IVI) value was maximum for *Pinus roxburghii* (95.06) followed by *Engelhardtia spicata* (48.17) and minimum for *Ficus semicardata* (7.04). Abundance/frequency ratio indicate that majority of tree species in this site showed random distribution (64%) and remaining species showed contiguous distribution (36%) (Figure 6).

Table 2. Phytosociological attributes of tree layer in S2.

Species	**Den ha-1**	**TBC m2 ha-1**	**IVI**	**A/F**	**Dis**
Bombax ceiba	10	1.204	13.83	1	C
Ehretia acuminata	20	0.662	16.44	0.5	R
Engelhardtia spicata	60	1.805	48.17	0.167	C
Ficus auriculata	20	0.414	14.85	0.5	R
Ficus palmate	30	0.766	23.21	0.333	R
Ficus religiosa	30	0.369	20.66	0.333	R
Ficus semicordata	10	0.147	7.041	1	C
Grewia asiatica	20	0.315	11.72	2	C
Grewia optiva	30	0.414	20.95	0.333	R
Mallotus philippensis	30	0.483	21.39	0.333	R
Pinus roxburghii	90	6.644	95.06	0.141	C
Prunus cerasoides	30	0.483	21.39	0.333	R
Pyrus pashia	20	0.592	16	0.5	R
Toona ciliata	20	1.26	20.29	0.5	R
Total	**280**	**15.56**	**300**		

S3 (1100-1300 m asl):

The absolute tree density was recorded as 500 trees ha^{-1} (Table 3). The highest density was recorded for *Pinus roxburghii* (140 trees ha^{-1}) followed by *Quercus leucotrichophora* (90 trees ha^{-1}) while lowest density was recorded for *Mallotus philippensis, Bombax ceiba, Ficus hispida* and *Ficus pumila* (10 trees ha^{-1} each). The value of total basal cover (TBC) in this forest site was recorded as 22.63 m^2 $ha^{-1,}$ out of which highest value (11.33 m^2 ha^{-1}) was recorded for *Pinus roxburghii* followed by *Prunus cerasoides* (1.57 m^2 ha^{-1}) and lowest value for *Mallotus philippensis* (0.10 m^2 ha^{-1}). The importance value index (IVI) value was maximum for *Pinus roxburghii* (96) followed by *Quercus leucotrichophora* (39.33) and minimum for *Mallotus philippensis* (5.02). Abundance/frequency ratio indicate that majority of tree species in this site showed random distribution (77%) and remaining species showed contiguous distribution (23%) (Figure 6).

Table 3. Phytosociological attributes of tree layer in S3.

Species	**Den ha-1**	**TBC m2 ha-1**	**IVI**	**A/F**	**Dis**
Bauhinia variegata	20	0.632	11.92	0.05	R
Bombax ceiba	10	2.521	18.27	0.025	R
Ficus bengalensis	20	2.068	18.27	0.05	R
Ficus hispida	10	0.249	5.666	0.1	C
Ficus pumila	10	0.121	5.099	0.1	C
Mallotus philippensis	10	0.103	5.02	0.1	C
Olea paniculata	30	0.512	15.96	0.033	R
Pinus roxburghii	140	11.33	96.01	0.029	R
Pistacia chinensis	40	1.089	23.07	0.025	R
Prunus cerasoides	70	1.573	33.77	0.028	R
Quercus leucotrichophora	90	1.344	39.33	0.025	R
Trema politaria	30	0.376	15.35	0.033	R
Wendlandia heynei	20	0.714	12.28	0.05	R
Total	**500**	**22.63**	**300**		

S4 (1300-1500 m asl):

The absolute tree density was recorded as 410 trees ha^{-1} (Table 4). The highest density was recorded for *Pinus roxburghii* (160 trees ha^{-1}) followed by *Quercus leucotrichophora* (90

trees ha^{-1}) while lowest density was recorded for *Bombax ceiba, Prunus cerasoides* and *Olea paniculata* (10 trees ha^{-1} each). The value of total basal cover (TBC) in this forest site was recorded as 22.31 m^2 $ha^{-1,}$ out of which highest value (15.72 m^2 ha^{-1}) was recorded for *Pinus roxburghii* followed by *Quercus leucotrichophora* (2.84 m^2 ha^{-1}) and lowest value for *Olea paniculata* (0.17 m^2 ha^{-1}). The importance value index (IVI) value was maximum for *Pinus roxburghii* (134.47) followed by *Quercus leucotrichophora* (55.52) and minimum for *Olea paniculata* (7.39). Abundance/frequency ratio indicate that majority of tree species in this site showed contiguous distribution (56%) and remaining species showed random distribution (44%) (Figure 6).

Table 4. Phytosociological attributes of tree layer in S4.

Name	**Den ha-1**	**TBC m2 ha-1**	**IVI**	**A/F**	**Dis**
Bauhinia variegata	20	0.602	11.742	0.2	C
Bombax ceiba	10	0.496	8.831	0.1	C
Olea paniculata	10	0.176	7.3933	0.1	C
Pinus roxburghii	160	15.72	134.47	0.044	R
Pistacia chinensis	40	0.963	26.571	0.044	R
Prunus cerasoides	10	0.232	7.6454	0.1	C
Quercus leucotrichophor	90	2.842	55.521	0.036	R
Viburnum nervosum	30	0.645	18.543	0.075	C
Wendlandia heynei	40	0.637	29.279	0.025	R
Total	**410**	**22.31**	**300**		

S5 (1500-1700 m asl):

The absolute tree density was recorded as 470 trees ha^{-1} (Table 5). The highest density was recorded for *Quercus leucotrichophora* (190 trees ha^{-1}) followed by *Pinus roxburghii* (150 trees ha^{-1}) while lowest density was recorded for *Pistacia chinensis* (20 trees ha^{-1} each). The value of total basal cover (TBC) in this site was recorded as 44.05 m^2 $ha^{-1,}$ out of which highest value (23.92 m^2 ha^{-1}) was recorded for *Quercus leucotrichophora* followed by *Pinus roxburghii* (14.93 m^2 ha^{-1}) and lowest value for *Prunus cerasoides* (0.71 m^2 ha^{-1}). The importance value index (IVI) value was maximum for *Quercus leucotrichophora* (119.72)

followed by *Pinus roxburghii* (94.99) and minimum for *Pyrus pashia* (20.06). Abundance/frequency ratio indicate that majority of tree species in this site showed random distribution (83%) and remaining species showed random distribution (17%) (Figure 6).

Table 5. Phytosociological attributes of tree layer in S5.

Species	Den ha-1	TBC m2 ha	IVI	A/F	Dis
Pinus roxburghii	150	14.93335	94.99	0.031	R
Pistacia chinensis	20	1.005609	14.87	0.05	R
Prunus cerosoides	40	0.710442	22.62	0.044	R
Pyrus pashia	30	0.757385	20.6	0.033	R
Quercus leucotrichopho	190	23.91701	119.7	0.053	C
Viburnum nervosum	40	2.722753	27.19	0.044	R
Total	**470**	**44.04655**	**300**		

Shrub layer

S1 (700-900 m asl):

The total shrub density was recorded as 3480 shrubs ha^{-1} (Table 6). The maximum shrub density (480 shrubs ha^{-1}) was recorded for *Justicia adhatoda*, followed by *Dodonea viscosa* (280 shrubs ha^{-1}) and minimum (40 shrubs ha^{-1}each) for *Kigelia africana* and *Vachellia nilotica*. The IVI was recorded maximum (28.64) for *Justicia adhatoda*, followed by *Kigelia africana* (28.50) and minimum (9.21) for *Coleebrokia oppositifolia.* 58 % species showed contiguous distribution, followed by random distribution (37% species) and regular distribution (5% species) (Figure 7).

Table 6. Phytosociological attributes of shrub layer in S1.

Species	Den ha -1	IVI	A/F	Dis
Bergera koenigii	240	13.42	0.067	C
Catunaregam spinosa	200	12.48	0.056	C
Colebrookea oppositifolia	120	9.213	0.075	C
Cotinus coggygria	240	16.56	0.038	R
Debregeasia longifolia	200	16.31	0.056	C
Debregeasia saeneb	160	11.65	0.044	R
Dendrocalamus strictus	160	14.62	0.10	C
Dodonaea viscosa	280	16.23	0.044	R
Euphorbia royleana	160	16.44	0.044	R

Flacourtia indica	200	12.48	0.056	C
Holarrhena pubescens	240	15.23	0.038	R
Indigofera cassioides	120	11.03	0.033	R
Justicia adhatoda	480	28.65	0.024	RE
Kigelia africana	40	28.50	0.10	C
Lantana camara	160	14.62	0.10	C
Leptopus cordifolius	160	18.21	0.10	C
Ligustrum nepalense	200	16.31	0.056	C
Mimosa himalayana	80	18.70	0.05	R
Vachellia nilotica	40	9.352	0.1	C
Total	**3480**	**300**		

S2 (900-1100 m asl):

The total shrub density was recorded as 5850 shrubs ha^{-1} (Table 7). The maximum shrub density (640 shrubs ha^{-1}) was recorded for *Sida rhombifolia*, followed by *Solanum torvum* (520 shrubs ha^{-1}) and minimum (200 shrubs ha^{-1}each) for *Spermadictyon suaveolense* and *Flacourtia indica*. The IVI was recorded maximum (34.99) for *Flacourtia indica* followed by *Ziziphus oenopolia* (28.50) and minimum (11.30) for *Ziziphus jujuba.* 60 % species showed random distribution, followed by regular distribution (40 % species) (Figure 7).

Table 7. Phytosociological attributes of S2.

Species	Den ha-1	IVI	A/F	Dis
Dodonaea viscosa	360	17.13	0.036	R
Flacourtia indica	200	34.99	0.02	RE
Indigofera cassioides	400	19.85	0.0204	RE
Reinwardtia indica	320	19.50	0.032	R
Rhamnus triquetra	240	16.85	0.024	RE
Ricinus communis	240	20.53	0.0375	R
Rubus ellipticus	400	24.80	0.0156	RE
Sida rhombifolia	640	26.70	0.0327	R
Solanum hazenii	320	12.18	0.05	R
Solanum torvum	520	19.45	0.0265	R
Spermadictyon suaveolens	200	21.96	0.0313	R
Woodfordia fruticosa	320	13.77	0.032	R
Zanthoxylum armatum	240	12.48	0.0167	RE

Ziziphus jujube	240	11.30	0.024	R
Ziziphus oenopolia	440	28.50	0.0172	RE
Total	**5080**	**300**		

S3 (1100-1300 m asl):

The total shrub density was recorded as 4320 shrubs ha^{-1} (Table 8). The maximum shrub density (800 shrubs ha^{-1}) was recorded for *Justicia adhatoda* followed by *Rubus ellipticus* (560 shrubs ha^{-1}) and minimum (120 shrubs ha^{-1}) for *Rhamnus triquetra*. The IVI was recorded maximum (38.24) for *Justicia adhatoda*, followed by *Coleebrokea oppositifolia* (35.07) and minimum (10.04) for *Ricinus communis.* 54 % species showed random distribution, followed by regular distribution (46% species) (Figure 7).

Table 8. Phytosociological attributes of S3.

Species	**Den ha-1**	**IVI**	**A/F**	**Dis**
Colebrookea oppositifolia	320	17.95	0.0222	RE
Debregeasia longifolia	160	22.27	0.025	R
Debregeasia saeneb	240	18.41	0.024	RE
Dodonaea viscosa	240	35.07	0.0375	R
Indigofera cassioides	360	19.97	0.025	R
Justicia adhatoda	800	38.24	0.0247	RE
Lantana camara	440	25.63	0.0136	RE
Reinwardtia indica	480	21.49	0.0245	RE
Rhamnus triquetra	120	13.53	0.0333	R
Ricinus communis	160	10.04	0.025	R
Rubus ellipticus	560	30.15	0.0286	R
Woodfordia fruticosa	240	20.91	0.0375	R
Zanthoxylum armatum	200	26.34	0.02	RE
Total	**4320**	**300**		

S4 (1300-1500 m asl):

The total shrub density was recorded as 2240 shrubs ha^{-1} (Table 9). The maximum shrub density (520 shrubs ha^{-1}) was recorded for *Indigofera cassioides* followed by *Reinwardtia indica* (400 shrubs ha^{-1}) and minimum (80 shrubs ha^{-1}) for *Zanthoxylum armatum*. The IVI was recorded maximum (71.51) for *Rubus ellipticus* followed by *Indigofera cassioides*

(41.02) and minimum (16.05) for *Rubus rosifolius.* 70% species showed random distribution, followed by regular distribution (30% species) (Figure 7).

Table 9. Phytosociological attributes of S4.

Species	**Den ha-1**	**IVI**	**A/F**	**Dis**
Dendrocalamus strictus	120	20.7	0.0333	R
Elsholtzia fruticosa	200	22.79	0.02	RE
Indigofera cassioides	520	41.02	0.0265	R
Reinwardtia indica	400	35.25	0.0204	RE
Rubus ellipticus	280	71.51	0.0438	R
Rubus niveus	160	20.8	0.025	R
Rubus paniculatus	200	31.86	0.02	RE
Rubus rosifolius	120	16.05	0.0333	R
Woodfordia fruticosa	160	21.87	0.0444	R
Zanthoxylum armatum	80	18.14	0.05	R
Total	**2240**	**300**		

S5 (1500-1700 m asl):

The total shrub density was recorded as 1640 shrubs ha^{-1} (Table 10). The maximum shrub density (320 shrubs ha^{-1} each) was recorded for *Indigofera cassioides* and *Elsholtzia fruticosa* followed by *Rubus paniculatus* (240 shrubs ha^{-1}) and minimum (80 shrubs ha^{-1}) for *Debregeasia saeneb*. The IVI was recorded maximum (62.6) for *Indigofera cassioides* followed by *Elsholtzia fruticosa* (45.85) and minimum (19.79) for *Debregeasia saeneb.* 75% species showed random distribution, followed by contiguous and regular distribution (Figure 7).

Table 10. Phytosociological attributes of S5.

Species	**Den/ha**	**IVI**	**A/F**	**Dis**
Debregeasia saeneb	80	19.79	0.0222	RE
Elsholtzia fruticosa	320	45.85	0.032	R
Indigofera cassioides	320	62.66	0.032	R
Reinwardtia indica	160	29.52	0.0444	R
Rubus ellipticus	160	34.30	0.0444	R
Rubus paniculatus	240	35.74	0.0667	C
Rubus rosifolius	160	36.23	0.0444	R
Zanthoxylum armatum	200	35.90	0.0313	R
Total	**1640**	**300**		

Occurrence or availability status

Occurrence analyses of woody plants showed that highest 54% species showed “common” occurrence followed by “uncommon”(34% species) while remaining 12% species showed “rare” occurrence (Figure 5)

Table 11. List of species with their habitat and occurence.

Species	Family	Habitat	Occurrence
Aegle marmelos (L.) Corrêa	Rutaceae	RS, F	Un
Bauhinia variegata L.	Caesealpiniaceae	F,CF	Un
Berberis lycium Royle	Berberidaceae	RS,CF,WP, UF	Co
Bergera koenigii (L.) Spreng.	Rutaceae	WP,CF,RS	Co
Boehmeria virgata	Urticaceae	CF,WP	Un
Bombax ceiba L.	Malvaceae	OF	Un
Buddleja crispa Benth.	Scrophulariaceae	WP,RS	Ra
Carissa spinarum L.	Apocynaceae	Wo, OS	Co
Cassia fistula L.	Caesealpiniaceae	OS	Co
Catunaregam spinosa (Thunb.) Tirveng.	Rutaceae	OS,UF,F, RS	Un
Colebrookea oppositifolia Sm.	Lamiaceae	CF,RS,F	Co
Cotinus coggygria Scop.	Anacardiaceae	OS, UF,F	Un
Cotoneaster bacillaris	Rosaceae	F,CF,RS,UF	Co
Debregeasia longifolia (Burm.f.) Wedd.	Urticaceae	WP, WS, OS	Un
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	Urticaceae	WP, WS, OS	Un
Dendrocalamus strictus (Roxb.) Nees	Poaceae	UF, F,CF	Co
Dodonaea viscosa (L.) Jacq.	Sapindaceae	RS,OS	Co
Ehretia acuminata R.Br.	Boraginaceae	RS, FE	Ra
Elsholtzia fruticosa (D.Don) Rehder	Lamiaceae	UF,RS,CF	Un
Engelhardtia spicata Lechen ex Blume	Juglandaceae	RS,OF	Un
Euphorbia royleana Boiss.	Ephorbiaceae	RS,OS	Ra
Ficus arnottiana (Miq.) Miq.	Moraceae	OS, FE	Ra
Ficus auriculata Lour.	Moraceae	CF	Co
Ficus benghalensis L.	Moraceae	RS,CF	Co

Ficus hispida L.f.	Moraceae	RS,FE,OF	Co
Ficus palmata Forssk.	Moraceae	CF,RS,WP	Co
Ficus pumila L.	Moraceae	WP,CF	Ra
Ficus racemosa L.	Moraceae	CF,RS, FE	Ra
Ficus religiosa L.	Moraceae	CF,OF,FE	Co
Ficus sarmentosa Buch.-Ham. ex Sm.	Moraceae	CF,FE	Un
Ficus semicordata Buch.-Ham. ex Sm.	Moraceae	FE,WP,CF,RS	Un
Flacourtia indica (Burm.f.) Merr.	Salicaceae	RS, OS	Un
Glochidion heyneanum (Wight & Arn.) Wight	Phyllanthaceae	OS,FE	Co
Grewia asiatica L.	Tiliaceae	CF,RS	Ra
Grewia optiva (Buch.-Ham. ex Roxb.) J.R.Drumm. ex Burret	Tiliaceae	CF	Co
Holarrhena pubescens Wall. ex G.Don	Apocynaceae	RS	Un
Holoptelea integrifolia (Roxb.) Planch.	Ulmaceae	RS, F	Co
Indigofera cassioides DC.	Fabaceae	UF,CF,RS,WP,OS	Co
Indigofera heterantha Wall. ex Brandis	Fabaceae	OS,UF	Un
Jasminum grandiflorum L.	Oleaceae	FE,RS,UF	Un
Justicia adhatoda L.	Acanthaceae	OS,CF,RS,WP	Co
Kigelia africana (Lam.) Benth.	Bigoniaceae	RS,FE	Co
Lannea coromandelica (Houtt.) Merr.	Anacardiaceae	FE,RS,CF	Un
Lantana camara L.	Lamiaceae	CF,FE,RS,WP	Co
Leptopus cordifolius Decne	Phyllanthaceae	CF	Un
Ligustrum sinense	Oleaceae	RS,WP	Co
Mallotus philippensis (Lam.) Müll. Arg.	Ephorbiaceae	RS,FE,CF	Co
Mangifera indica L.	Anacardiaceae	CF, F	Co
Melia azedarach L.	Meliaceae	CF	Co
Mimosa himalayana Gamble	Mimosaceae	RS,WP	Un
Neolamarckia cadamba (Roxb.) Bosser	Rubiaceae	RS,FE	Co
Neolitsea pallens	Lauraceae	F	Co
Olea paniculata R.Br.	Oleaceae	F	Un
Pinus roxburghii Sarg.	Pinaceae	F, RS	Co

Pistacia chinensis Bunge	Anacardiaceae	F,CF	Un
Prunus cerasoides Buch.-Ham. ex D.Don	Rosaceae	CF,F	Co
Quercus leucotrichophora D.Don	Fagaceae	F, CF	Co
Reinwardtia indica Dumort.	Linaceae	CF,RS,OF,WP	Co
Rhamnus triquetra (Wall.) Brandis	Rhamnaceae	CF,FE	Un
Ricinus communis L.	Ephorbiaceae	CF,RS,WP	Co
Rubus ellipticus Sm.	Rosaceae	CF,RS,UF,WP	Co
Rubus niveus Thunb.	Rosaceae	CF,RS,UF,WP	Co
Rubus paniculatus Sm.	Rosaceae	WP,UF,RS	Co
Rubus rosifolius Sm.	Rosaceae	F,RS	Co
Sapium sebiferum (L.) Roxb.	Ephorbiaceae	CF,F,RS	Ra
Senegalia modesta Wall.	Mimosaceae	F	Un
Senegalia catechu (L.f.) Willd.	Mimosaceae	F	Co
Sida rhombifolia L.	Malvaceae	RS,WP,OS	Co
Solanum hazenii Britton	Solanaceae	WP	Ra
Solanum torvum Sw.	Solanaceae	WP,RS	Ra
Spermadictyon suaveolens Roxb.	Rubiaceae	RS,UF,FE,WP	Un
Toona ciliata M.Roem.	Meliaceae	CF,F	Co
Trema politoria (Planch.) Blume	Cannabaceae	CF,RS	Un
Vachellia nilotica (L.) Delile	Mimosaceae	RS,WP,UF	Co
Viburnum nervosum D.Don	Coprifoliaceae	F,OS	Co
Wendlandia heynei (Schult.) Santapau & Merchant	Rubiaceae	OS,RS	Un
Woodfordia fruticosa (L.) Kurz	Lythraceae	CF,RS,WP,UF	Co
Zanthoxylum armatum DC.	Rutaceae	CF,RS,OS	Co
Ziziphus jujuba Mill.	Rhamnaceae	RS,WP	Co
Ziziphus oenopolia (L.) Mill.	Rhamnaceae	WP,RS,UF	Un

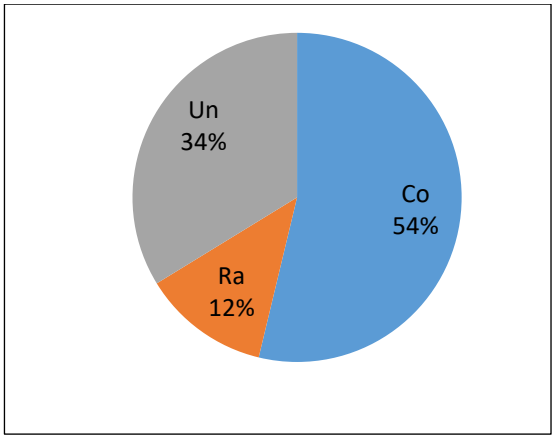

Figure 5. Species showing various type occurrences in percentage.

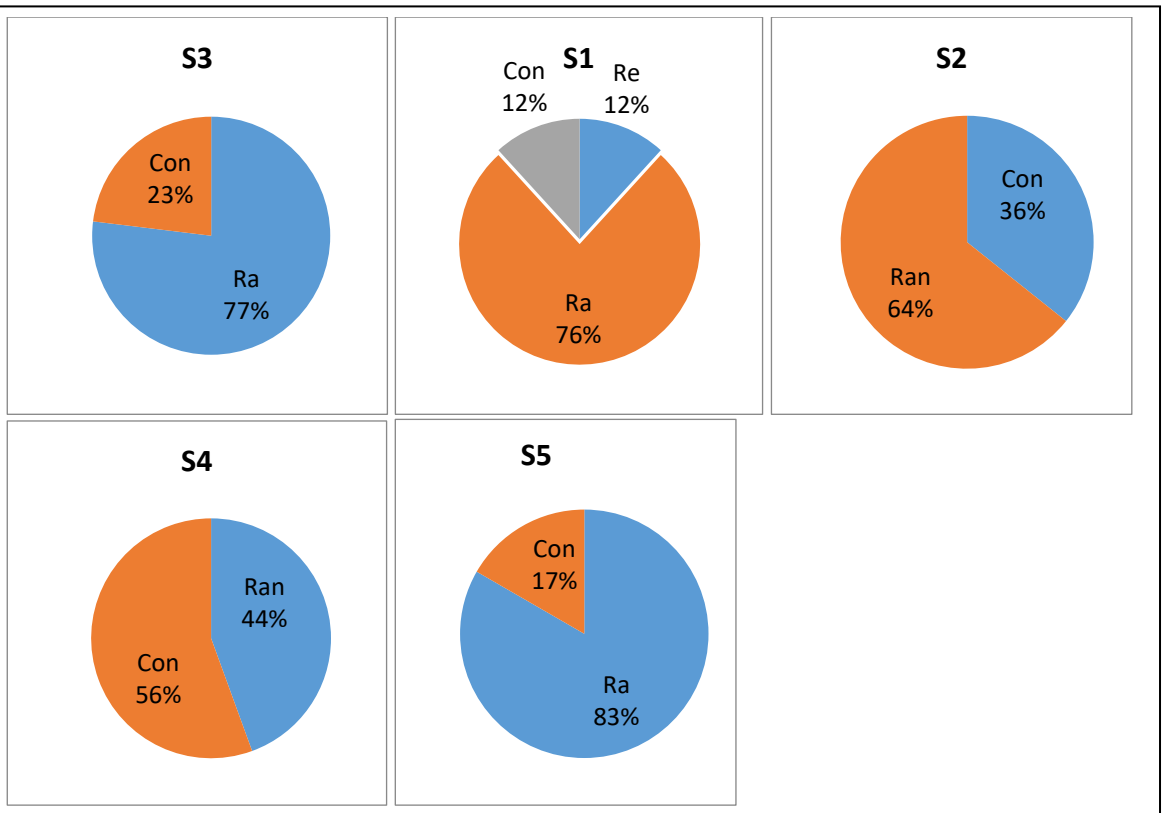

Figure 6. Pie charts showing percentage of species represented distribution pattern in tree layer of various sites.

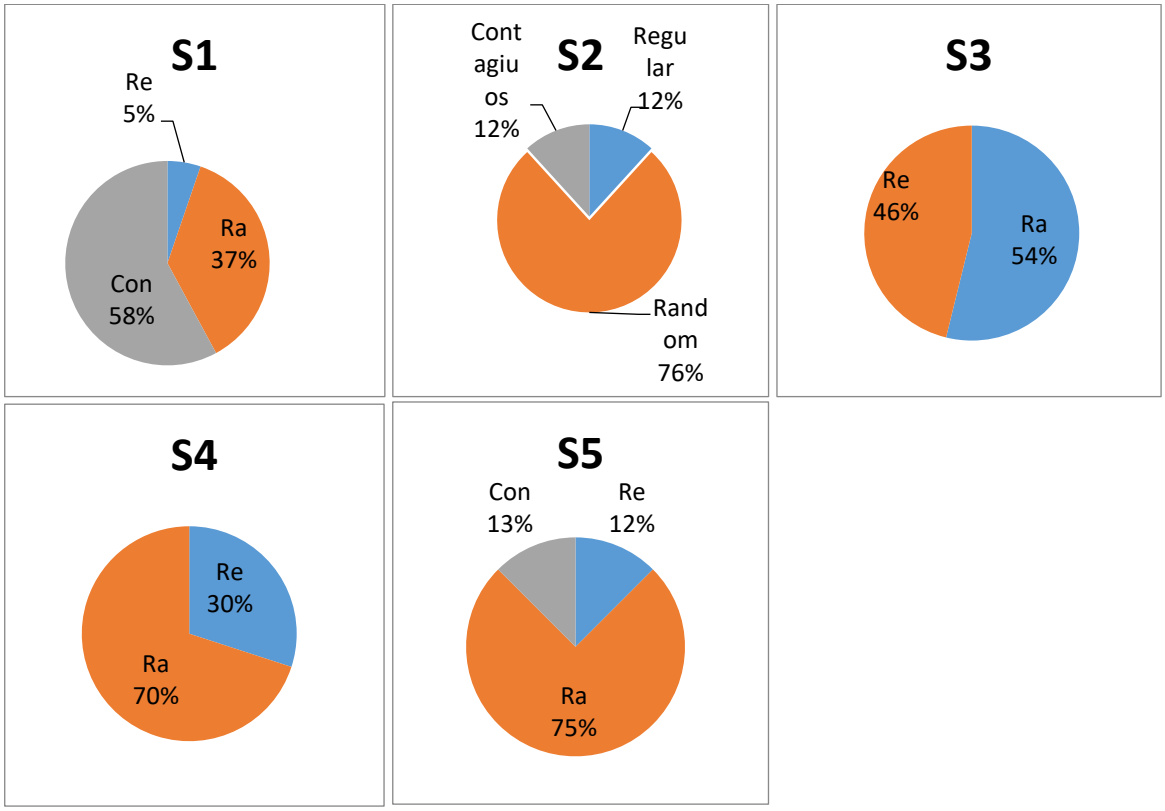

Figure 7. Pie charts showing percentage of species represented distribution pattern in shrub layer of various sites.

Total of 25 categories' were reported from the study area (Figure 8). Out of reported 80 woody species 39 was used only for medicinal purpose only, 8 species used as a medicine and edible, 5 species used only as a edible, 5 species used for medical and timber yielding whereas remain categories was represented by a single species (Table 11).

Mode of use

Total 36 mode of utilization was reported out of which 8 species consumed as a paste and powder, 5 species consumed as a decoction, 5 species used as decoction and raw, 4 species used as paste, powder and raw, 4 species consumed as a extract, 3 species used as decoction and powder, 3 species as a powder, 2 species as a decoction, extract, juice, paste and raw, 2 species as a extract, paste and raw, 2 species as a extract and raw, 2 species as a powder and raw, while remaining modes were represented by a single species (Figure 9).

Part used

Bark, leaves and roots were reported predominantly used parts. Total 44 categories were reported on the bases of various types of uses (Figure 10). 8 species were recorded representing the category bark and leaves, followed by 7 species (Leaves), 6 species (Fruits), 6 species

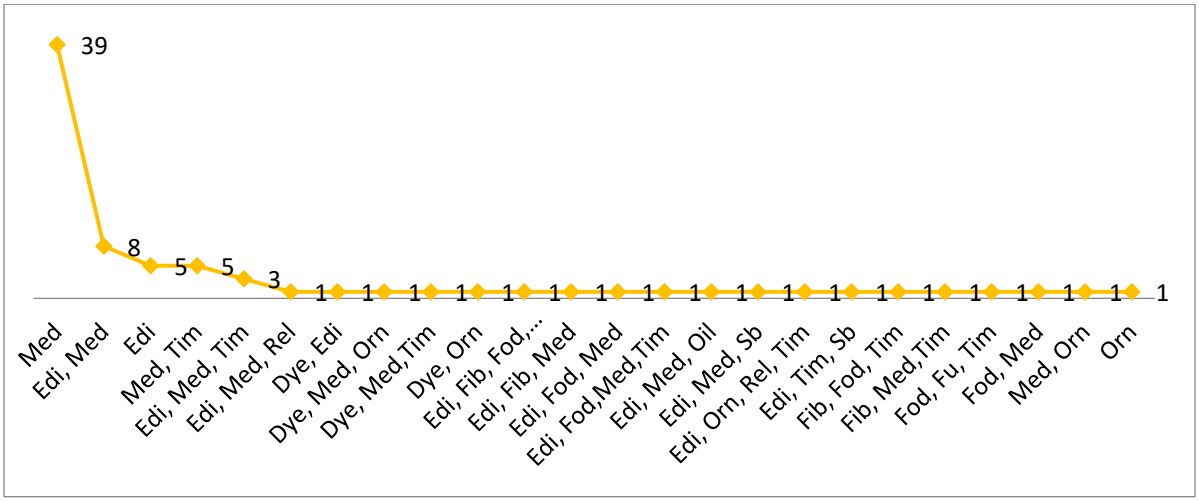

Figure 8. Plant species representing various ethno-botanical categories.

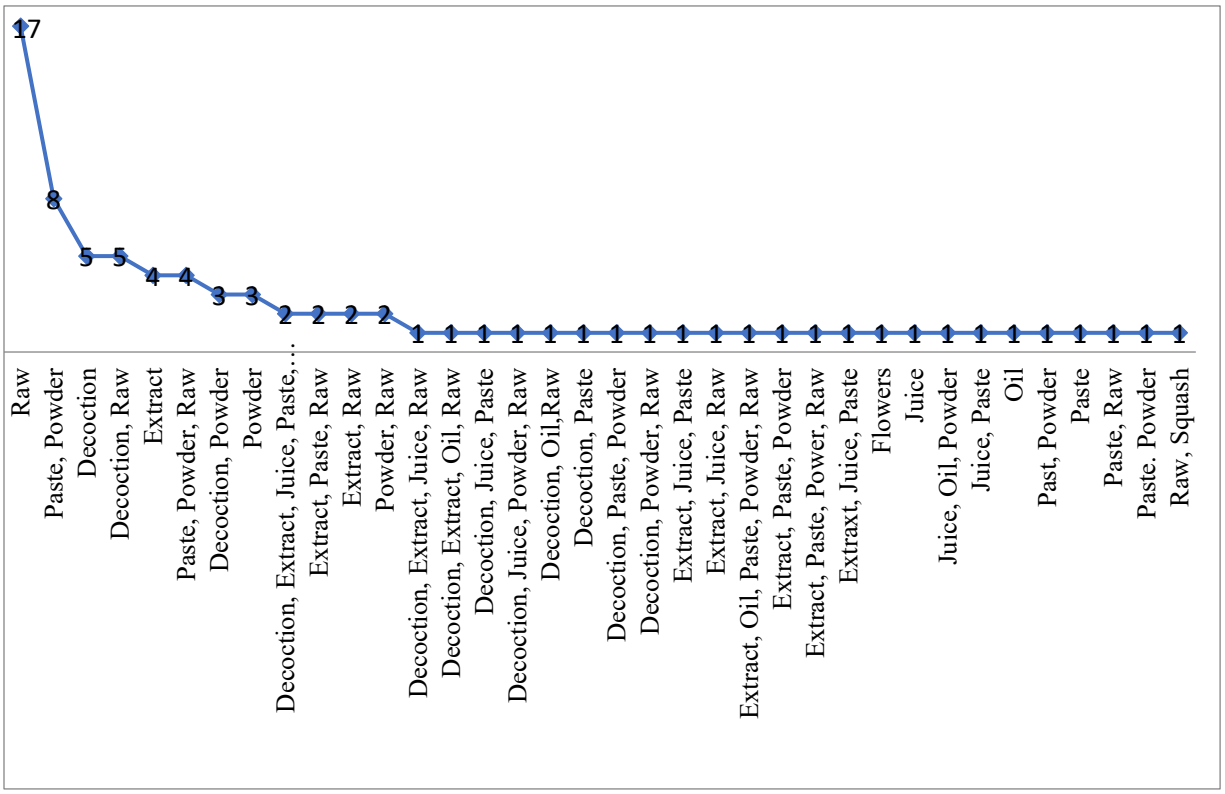

Figure 9. Number of species showing their mode of use.

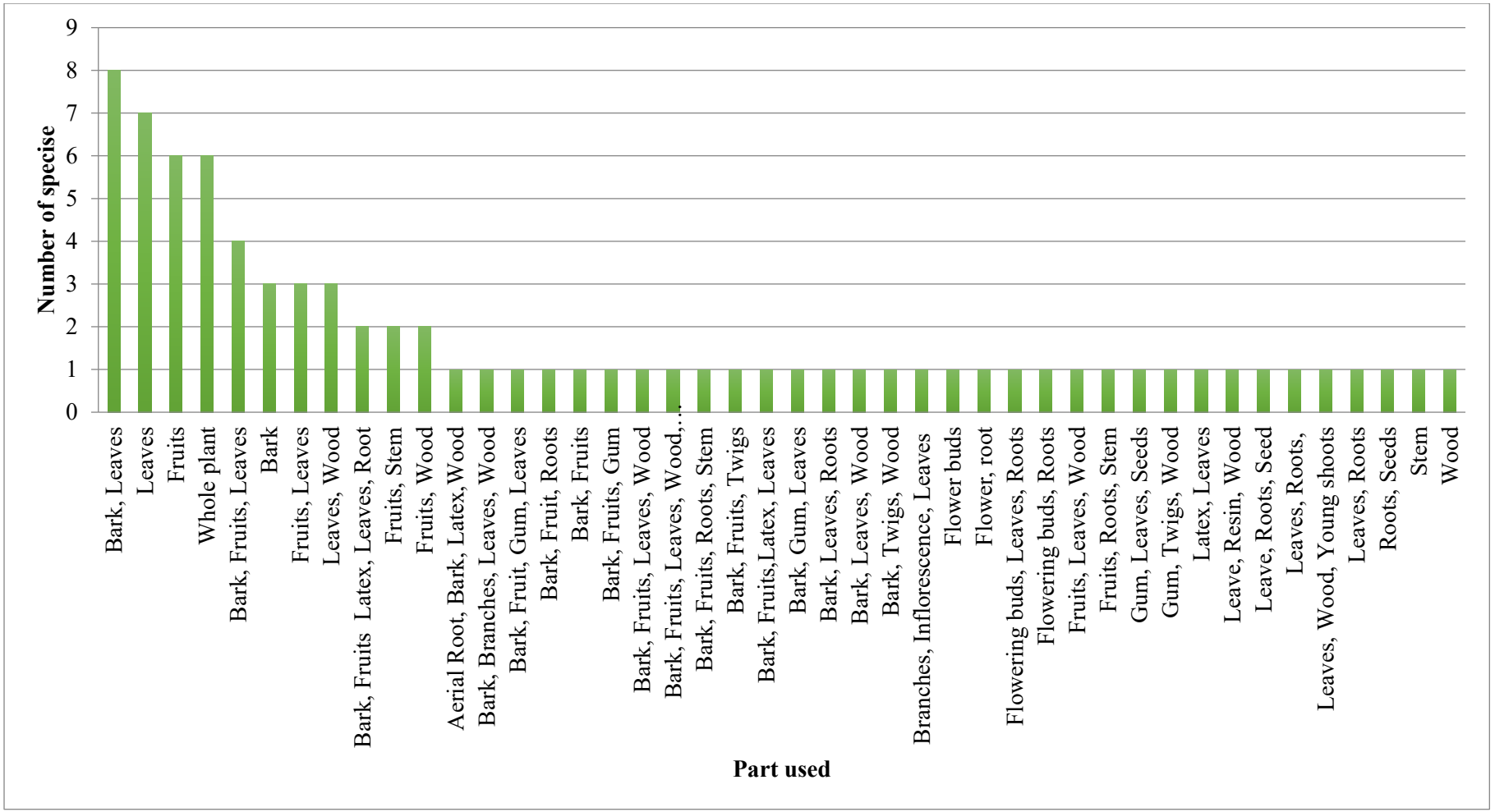

Figure 10. Number of species representing their various parts used.

Table 12. Ethnobotanical uses of woody species.

Species	Family	Voucher no.	Economic use	Mode of use	Part used	Way of Use
Aegle marmelos (L.) Corrêa	Rutaceae	HBJU-17298	Med, Wor, Edi,	Juice, Extract, Raw	Fruits, Leaves	Raw or cooked, the pulp of ripe fruits is typically used to make juices. In addition to its laxative properties, the pulp is regarded as a therapeutic remedy for constipation and indigestion. Hindus hold this plant in very high regard. They use the leaves for worshipping Lord Shiva. Sherbet can be made by combining the laxative core of the ripe fruit with milk and sugar, and then freezing the mixture. It is a remedy for digestive issues, specifically indigestion and constipation. To make a remedy for diarrhea and dysentery, the raw fruit is typically boiled or roasted before consumption. A type of beverage known as "Bel tea" is prepared by sun-drying slices of immature fruit, which is then used to make a beverage that is said to be therapeutic for heart weakness.

Bauhinia variegata L.	Caesealpiniaceae	HBJU-17299	Edi, Med,	Raw	Flower buds	Kachnar is a regional term used in India and other countries on the subcontinent to refer to the edible buds that are harvested from the tree. These buds are a common component in many of the culinary traditions of the subcontinent. The traditional ingredients for preparing kachnar curry include kachnar buds, yoghurt, onions, and native spices. In numerous regions across the Indian subcontinent, kachnar buds are consumed both as fried vegetable recipe and as an ingredient in the production of achaar, a type of pickle. It demonstrates a high anti-oxidant and anti-carcinogenic activity.
Berberis lycium Royle	Berberidaceae	HBJU-17300	Med, Edi	Extract, Raw	Roots, Stem, Fruits	Rasaunt, a brown extract made from the plant's roots and lower stem, is combined with water and used as a tonic or cooling agent. Also used as an eye lotion. Fruits are edible.
Bergera koenigii (L.) Spreng.	Rutaceae	HBJU-17301	Med, Edi,	Raw	Leaves	The leaves are an essential component of both the cuisine of India and the traditional medicine practiced there. They are used in cooking most frequently in the southern and western regions of India, and the initial step in the preparation process typically involves frying them together with mustard seeds, vegetable oil, and chopped onions.
Boehmeria virgata	Urticaceae	HBJU-17302	Med	Extract	Whole plant	Used as a tonic, for treating boils and for dermatitis.

Bombax ceiba L.	Malvaceae	HBJU-17303	Med, Edi, Fib	Decoction, Raw, Oil	Whole plant	Used to treat fractures, cholera, toothaches, coughs, urinary issues, snake bites and influenza, are treated using parts of plant like young roots, flowers, leaves, shoots, gum and bark because they contain therapeutic characteristics. When cooked, the blooms are delectable and are prized as a vegetable. Young leaves can be cooked and eaten like vegetables and are also edible. Additionally, young roots and ripe seeds are roasted. The seed contains edible oil, the inner bark contains fiber, and the sapling root and bark both contain gum that contains tannins. Making soap also involves the use of seed oil.
Buddleja crispa Benth.	Scrophulariaceae	HBJU-17304	Med	Paste, Powder	Leaves, Bark	Buddleja have been used in the management of various health conditions including pain and inflammation.

Carissa spinarum L.	Apocynaceae	HBJU-17305	Med, Edi	Decoction, Extract, Raw, Juice paste	Stem, Fruits, Bark, Roots	In traditional medicine Carissa spinarum is used as a diuretic, purgative, antiviral, antibacterial, antiplasmodial, febrifuge, hypotensive, antioxidant and cardiotonic. The branches and leaves decoction are used for headache, chest pains, rheumatism, syphilis, dysentery and fever. The boiled root extract is drunk for chest pain, indigestion, diarrhea, typhoid fever, nose bleeding, lower abdominal pains in pregnant mothers, headache and fever in children. The juice of the fresh plant is used for infected wounds that refuse to heal. The Ayurvedic Pharmacopoeia of India indicated the stem bark in obstinate skin diseases and the root in urinary disorders. Fruits are edible.
Cassia fistula L.	Caesealpiniaceae	HBJU-17306	Tim, Med	Raw	Stem, Fruits	The heartwood of the C. fistula tree, also known as ahala, was utilised in the construction of "Ehela Kanuwa," a site located near Adam's Peak in Sri Lanka. This heartwood was employed because of the tree's exceptionally hard and long-lasting wood. The Cassia fistula tree is referred to as aragvadha in Ayurvedic medicine, which literally translates as "disease destroyer." It is strictly discouraged in Ayurvedic scriptures for patients to attempt self-medication or any other form of use without the guidance of a physician because the fruit pulp is regarded a purgative.

Catunaregam spinosa (Thunb.) Tirveng.	Rutaceae	HBJU-17307	Med	Paste. Powder	Fruit, Bark, Roots	The ripe fruit with seeds are said to be poisonous. The fruit have useful emetic, diaphoretic and antispasmodic properties. It is useful in cases of acute bronchitis and asthma and it is applied externally in fever. The bark is abortifacient, astringent, sedative and analgesic. It is given internally and externally in the treatment of fevers. The bark root infusion is used as an emetic. The bark is also used to treat diarrhoea and dysentery
Colebrookea oppositifolia Sm.	Lamiaceae	HBJU-17308	Med	Decoction and powder	Roots, Leaves	The plant is used traditionally as such as dermatitis, dysentery, fever, headache, peptic ulcer, haemostatic, wounds, as anti-fertility agent, fungicide, and the roots of the plant has been most widely used for the treatment of epilepsy.
Cotinus coggygria Scop.	Anacardiaceae	HBJU-17309	Orn, Dye	Flowers	Stem, Fruits	It is a common practice to cultivate this plant for its attractive qualities, and there are various varieties available. Several are chosen specifically for their purple flowers and foliage. Young fustic, also known as fisetin, is a yellow dye that was formerly made from this wood but has since been supplanted by synthetic dyes
Cotoneaster bacillaris	Rosaceae	HBJU-17310	Orn	-	Whole plant	Cotoneaster nummularius is frequently used as a ground cover plant, to curb erosion, and as a decorative plant in gardens and parks. The plant can survive in full sun to light shade and is tolerant of a variety of soil types

Debregeasia longifolia (Burm.f.) Wedd.	Urticaceae	HBJU-17311	Med	Juice	Leaves	The juice of the leaves is applied to areas of the skin affected by scabies.
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	Urticaceae	HBJU-17312	Tim. Med	Powder, Raw	Wood, Leaves	Its stems are used for fibre and fuel wood. The powder form of leaves mixed with mustard oil is used for antifungal activity to curing skin rashes, dermatitis (inflammation of the skin) and eczema
Dendrocalamus strictus (Roxb.) Nees	Poaceae	HBJU-17313	Tim, Med, Edi	Raw, Decoction	Wood, Young shoots, Leaves	IT is extensively used as raw material in paper mills and also for a variety of purposes such as light construction, furniture, musical instruments, bamboo board, mats, sticks, agricultural implements, rafts, baskets, woven wares and household utensils. Young shoots are edible and used as food. Leaves are used as forage, and decoction of leaves and nodes and silicious matter is used in traditional medicine

Dodonaea viscosa (L.) Jacq.	Sapindaceae	HBJU-17314	Tim, Med, Dye	Raw, Decoction	Wood, Leaves, Bark	The leaves are astringent, insecticidal, anthelmintic, anti-inflammatory, antibacterial and hypotensive. The leaf decoction is used for killing intestinal worms. The leaves and twigs decoction is used for colds, asthma, influenza, fevers, stomach troubles, swellings, burns, wounds and arthritis. The dried and burned leaves are taken in throat irritation. The bark is astringent and used in dysentery.The twigs of Dodonaea viscosa can be used to make dyes (pale green, yellow green or bright gold). The wood of Dodonaea viscosa is hard and light and takes a good polish
Ehretia acuminata R.Br.	Boraginaceae	HBJU-17315	Med	Decoction, Paste	Leaves, Bark	The leaves decoction are applied on muscular pains. They are given in cough and asthma. The tender leaves paste is applied to treat eczema. A decoction of bark is used internally and as gargle in throat infections
Elsholtzia fruticosa (D.Don) Rehder	Lamiaceae	HBJU-17316	Med, Edi			The powdered seeds are used as a condiment for flavouring foodstuffs. An edible oil is obtained from the seed. The juice of the roots is used to relieve headaches.
Engelhardtia spicata Lechen ex Blume	Juglandaceae	HBJU-17317	Med	Decoction, Powder	Bark	The bark is used against diarrhea and piscidal.

Euphorbia royleana Boiss.	Ephorbiaceae	HBJU-17318	Med,	Powder, Raw	Latex, Leaves	It is used for breathing disorders including asthma, bronchitis, and chest congestion. It is also used for mucus in the nose and throat, throat spasms, hay fever, and tumors. Some people use it to cause vomiting. It is also used for treating worms, severe diarrhea (dysentery), gonorrhea, and digestive problems.
Ficus arnottiana (Miq.) Miq.	Moraceae	HBJU-17319	Med,	Past, Powder	Bark, leaves	IT used against the wound healing, Aphrodisiac, Burning sensation, Diabetes.
Ficus auriculata Lour.	Moraceae	HBJU-17320	Edi, Med,	Raw, Paste, Powder	Bark, Root, Leaves, Fruits Latex	Used to cure dysentery, diarrhoea, diabetes, stomach ache, piles and as carminative, astringent and also as antioxidant and anticancer agent. Latex is widely used for curing warts, skin ulcers and sores, and taken as a purgative and vermifuge. Fruits are edible.

Ficus benghalensis L.	Moraceae	HBJU-17321	Tim, Med, Fib	Raw	Wood, Latex, Bark, Aerial Root	The latex is externally applied for pains and bruises and in rheumatism and lumbago inflammations. It is applied to the soles of the feet when cracked or inflamed.The gum is used as a remedy for tooth-ache. The prop-roots are (or were) used to make tent and poles, cheap furniture, cart yokes and boxes... (the wood of accessory trunks is stronger than that of the main stem). The wood of Ficus benghalensis is moderately hard but it is durable under water, so it is used for well curbs. A paper pulp can be prepared from the wood. The bark and aerial roots yields fibres used for making ropes.
Ficus hispida L.f.	Moraceae	HBJU-17322	Med	Paste, Powder	Leave, Bark, Fruits	It used for the treatment of ulcers, psoriasis, anemia, piles jaundice, vitiligo, hemorrhage, diabetes.
Ficus palmata Forssk.	Moraceae	HBJU-17323	Med, Edi	Raw, Decoction, Powder	Leaves, Bark, Latex, Fruits	Used for the treatment of various diseases such as tumor, diabetes, ulcer, gastrointestinal and fungal diseases. Fruits are edible.
Ficus pumila L.	Moraceae	HBJU-17324	Med	Decoction	Leaves, Bark	F. pumila as herbal medicine or beverage to treat diabetes and high blood pressure.

Ficus racemosa L.	Moraceae	HBJU-17325				Fruits are used as a remedy for visceral obstruction, diarrhea and constipation. An infusion of bark is employed as mouth wash in spongy gum condition, dysentery, menorrhea, hemoptysis, and diabetes.
Ficus religiosa L.	Moraceae	HBJU-17326				The bark of Ficus religiosa is astringent, antiseptic, alterative, laxative, haemostatic, vaginal disinfectant. It is used in diabetes, diarrhoea, leucorrhoea, menorrhagia, nervous disorders and in skin diseases. The bark infusion is used to treat scabies. The paste of the powdered bark is used to treat inflammatory swellings and burns. The juice of the bark is used as a mouthwash to cure toothache and to strengthen gums.
Ficus sarmentosa Buch.-Ham. ex Sm.	Moraceae	HBJU-17327	Med	Paste, Powder	Leaves, Bark ,Fruits	Used in the treatment of peptic ulcers, piles, jaundice, haemorrhage, diabetes, asthma, diarrhoea.
Ficus semicordata Buch.-Ham. ex Sm.	Moraceae	HBJU-17328	Fod, Edi, Medi	Paste, Powder, Raw	Bark, Root, Leaves, Fruits Latex	Used against the leprosy, diarrhea, headache, fever, earache, ulcer and gastric problems, boils.

Flacourtia indica (Burm.f.) Merr.	Salicaceae	HBJU-17329	Edi, Tim, Med	Paste, Extract, Juice	Bark, Fruits, Leaves, Wood, Young shoots	The leaves and young shoots of Flacourtia indica are stringent and stomachic and they are prescribed in diarrhoea and weakness. The leaves infusion is used to cure fever, coughs, dysentery, cholera. They are also used to treat asthma and as a tonic for anaemia. The leaf juice is given orally for liver ailments. The bark paste is taken for cholera, for chest pain and it is applied to eczema.Wood is used for making small agricultural implements, walking sticks, combs and small turnery articles.
Glochidion heyneanum (Wight & Arn.) Wight	Phyllanthaceae	HBJU-17330	Med	Decoction	Leaves, Bark	The beverage made from leaves and bark is used as a diuretic.

Grewia asiatica L.	Tiliaceae	HBJU-17331	Edi, Med,Fod, Fib, Tim,	Raw, Squash	Fruits, Leaves, Bark, Wood	It is widely grown for its acidic, sour, and sweet fruits, which are marketed as "Falsa" in the marketplace of Indian subcontinent during the summer. The fruit pulp is transformed into the tasty sharbat, or squash, which is also stomachic, an astringent, and cooling agent. To treat pustular outbreaks, the leaves are used. According to legend, the stem bark can be used to make ropes, refine sugar, and as a demulcent when brewed. Bark can be used to make a fiber that is used to make paper and rope but is not particularly durable. The fibers are between 1 and 1.6 mm long. Wood is a strong and elastic material, but when initially cut, it has a very terrible odour. Its wood is used in manufacturing oar shafts, tool handles, and other things from it.
Grewia optiva (Buch.-Ham. ex Roxb.) J.R.Drumm. ex Burret	Tiliaceae	HBJU-17332	Fod, Fib, Tim	Raw	Leaves, Wood, Bark, Branches	Cattle, sheep, and goats are fed leaves and new shoots to increase milk production. Women use the green bark to clean their hair. The rough bast fibers are employed to make cot strings and subpar ropes for tying down livestock. Older branches are utilized to make oar shafts, cot frames, axe handles, bows (ghalel), spears, and shoulder sticks because they are sturdy and elastic (banghey poles).

Holarrhena pubescens Wall. ex G.Don	Apocynaceae	HBJU-17333	Med,	Powder, Raw, decoction, juice	Bark	Holarrhena pubescens is antiplasmodial, antibacterial and the plant is used to treat fever, tuberculosis, malaria and amoebic dysentery. The bark is tonic, expectorant, astringent, anthelmintic, febrifuge, antidysentery. The dried bark powder is given in amoebic dysentery, diarrhea, headache, vitiligo and dog's bite. The crushed bark is chewed by a person bitten by a snake. The bark juice is given orally as hepatoprotective, for liver ailments. The bark decoction is given to expel threadworms.
Holoptelea integrifolia (Roxb.) Planch.	Ulmaceae	HBJU-17334	Med	Raw, Extract, Decoction, Paste, Juice	Bark, Leaves	The bark is antimicrobial, antioxidant, wound-healing. It is used to cure rheumatism, rheumatic swellings, joint pains, piles, jaundice, fevers, laryngitis, ringworm and scabies. The crushed stem bark is applied on forehead in meningitis and headache. The stem bark extract is used for ringworm. The leaves decoction is given to regulate fat metabolism. The leaves along with garlic are used externally to treat ringworm, eczema and cutaneous diseases. The leaf juice is used for scorpion bite.
Indigofera cassioides DC.	Fabaceae	HBJU-17335	SB, Edi, Med,	Raw, Decoction	Leaves, Flowering buds, Roots	It fixes nitrogen in soil. Craftspeople in the area make a blue dye from the plant's leaves. On occasion, the blooms are consumed in the same manner as a vegetable. Coughs can be alleviated with the help of a decoction that is made from the

						roots.
Indigofera heterantha Wall. ex Brandis	Fabaceae	HBJU-17336	Med	Decoction, Poweder	Roots, Flowering buds	Decoction of roots used for a variety of conditions, including stomach pain, gastrointestinal issues, as a diuretic, headaches, and pain in chest. Powder of flowering buds utilized for the treatment of skin allergies, warts, leprosy, as an anti-cancer agent, asthma, toothaches, cough, abdominal pain, as well as muscular pain.
Jasminum grandiflorum L.	Oleaceae	HBJU-17337	Med	Paste, Juice	Roots, Leaves	The roots of Jasminum angustifolium are used for external applications in ringworm and herpes. The juice of the leaves is given as an emetic in cases of poisoning
Justicia adhatoda L.	Acanthaceae	HBJU-17338	Med	Decoction, Juice, Paste	Whole plant	The plant is used to treat fever, hemorrhage, cough, asthma, obesity, edema, skin diseases, difficult labor, vomiting, piles, retention of urine, diseases of mouth. It is also used for setting broken bones and relieving pain. The leaves decoction is taken against fever. The leaves and roots are used in chronic bronchitis. The leaves juice is given for respiratory diseases. The leaves juice along with ginger juice is given in cough, diabetes and respiratory diseases

Kigelia africana (Lam.) Benth.	Bigoniaceae	HBJU-17339	Med, Orn	Decoction	Leaves	Leaves decoction is used for the treatment of dysentery, venereal diseases.
Lannea coromandelica (Houtt.) Merr.	Anacardiaceae	HBJU-17340	Med,	Decoction, Extract, Oil, Raw	Gum, Bark, Leaves	Lannea coromandelica has properties that make it effective as an anti-inflammatory, an anti-microbial, a hypotensive, a wound healer, and an aphrodisiac. Jingini Gum is the name given to the gum that can be extracted from the bark of the jingini plant. Shoulder and neck pain can be alleviated with the use of gum for nasal instillation. Nirayasa, also known as gum, can be obtained by making small cuts in the bark of the tree. When taken orally, a decoction of bark can alleviate both excessive thirst and diarrhoea. The toothache, cough, and sore throat can all be alleviated by gargling the bark decoction. The chronic wounds are treated topically with the oil that is extracted from the bark decoction. The leaves are then tied over swellings after being boiled in the solution.
Lantana camara L.	Lamiaceae	HBJU-17341	Med, Tim,	Paste, Powder, Raw	Wood, Leaves	Leaves is mostly used in herbal medicine for wound healing, fever treatment, cough treatment, influenza. Wood is used to make small hadicrafts like cheers etc.
Leptopus cordifolius Decne	Phyllanthaceae	HBJU-17342	Med	Powder	Leaves	Leptopus cordifolius is used to control diabetes in folkloric medicine. Bit it is poisionous for cattles.

Ligustrum sinense	Oleaceae	HBJU-17343	Med	Paste, Powder, Decoction	Roots, Leaves, Bark	Used for promoting growth and darkening of hair, reducing facial dark spots, rapid heartbeat (palpitations), achy joints (rheumatism), swelling, tumors, dizziness (vertigo), common cold, congestion, constipation, deafness, fever, headache, liver disease (hepatitis), trouble sleeping (insomnia), chronic fatigue syndrome (CFS), promoting youthfulness, and extending lifespan. It is also used to induce sweating, as a tonic, for improving immune function.
Mallotus philippensis (Lam.) Müll. Arg.	Ephorbiaceae	HBJU-17344	Med	Paste Powder	Fruits, Leaves, Bark	The plant is useful in treatment of respiratory, digestive, psychological, excretory, reproductive, skeletal and skin disorders.

Mangifera indica L.	Anacardiaceae	HBJU-17345	Edi, Tim, Wor, Orn	Raw	Fruits, Wood	Because of the plant's delicious and pulpy fruit, farms across the globe are planted with Mango trees. When the tree is no longer able to produce fruit, the lumbar from it can be harvested to be utilized in the production of musical instruments. The leaves in India are presented as gifts to God and employed as decorative elements in a variety of religious ceremonies and occasions. They play a significant role in a variety of key religious practices as well. The fruit of the tree is what brings more attention to it than the tree itself as a source of lumber. On the other hand, mango trees that have reached the end of their fruit-bearing lifespans can be harvested for their lumber. Plywood, and inexpensive pieces of furniture are some of the products that benefit from the use of this wood.
Melia azedarach L.	Meliaceae	HBJU-17346	Medi,	Paste, Powder	Bark, leaves	Melia azedarach is used for wide biological activities such as analgesic, antibacterial, and antifungal effects and is used to treat a wide range of diseases such as diarrhea, malaria, and various skin diseases.

Mimosa himalayana Gamble	Mimosacea e	HBJU-17347	Med, Tim,	Paste, Raw	Fruits, Leaves, Wood	In traditional medicine, it is employed in the treatment of peptic ulcers, bone dislocations, sprains, backaches, haemorrhoids, wounds, and fever. Hedgerows are thought to benefit from its application. Both tent pegs and the charcoal used in gunpowder production can be made from this wood. The therapeutic value of the root, the leaves, and the fruits is on the low end.
Neolamarckia cadamba (Roxb.) Bosser	Rubiaceae	HBJU-17348	Med	Juice, Raw, Extract, Decoction	Gum, Bark, Leaves, Fruit	*Neolamarckia cadamba* is hepatoprotective, nematicidal, tonic, febrifuge and astringent. The leaves extract is used as a mouth gargle. The leaves decoction is used as a gargle to treat aphthae and stomatitis. The dried bark is used to relieve fever, burning sensation and as a tonic. The bark juice is used in eyes inflammation. The stem is used as a tooth brush in gum infection and dental caries. The fresh juice of the fruit is used to kill worms in sores.
Neolitsea pallens	Lauraceae	HBJU-17349	Med, Edi	Raw, Decoction	Leaves, Bark	Its leaves and bark are used as spices, and the plant is valued in preparing a hair tonic and as well as leaves used and anti-bacterial and anti-fungal.
Olea paniculata R.Br.		HBJU-17350	Med	Extract	Leaves	Leaf extracts are often used in traditional medicine for their reputed immune-boosting and cardiovascular health-promoting properties.

Pinus roxburghii Sarg.	Oleaceae	HBJU-17351	Med, Tim, Edi	Raw, Extract, Paste	Leave,Wood, Resin	Use for the treatment of cough, ulceration and genito-urinary disorders, inflammations, asthma, chronic bronchitis, piles, diseases of the liver and spleen, urinary discharges, toothache, tuberculosis, scabies and epilepsy. Resin is used to treat the cracked heels. Wood is used house and house implements
Pistacia chinensis Bunge	Anacardiaceae	HBJU-17352	Edi, Oil, Med,	Raw, Extract, Power, Paste	Leaves, Seeds, Gum	Cooked leaves and young shoots of the plant are consumed in the form of a vegetable. The seeds are roasted. Either it is consumed after being roasted, or it is utilized in the production of sweets. Oil that can be consumed can be extracted from the seed. Each and every component of the plant has the potential to be utilised therapeutically to treat a wide variety of illnesses, such as psoriasis, rheumatism, inflammatory swelling, and dysentery. Analgesic, antitussive, expectorant, and sedative properties can be found in the resin of the related *Pistacia lentiscus* species.
Prunus cerasoides Buch.-Ham. ex D.Don	Rosaceae	HBJU-17353	SB, Edi, Tim	Raw	Fruits, Wood	The tree is able to withstand harsh winds and avoid soil erosion thanks to its enormous root system, which is both deep and wide. The tough and long-lasting wood of the *Prunus cerasoides* tree is put to use in the manufacture of a variety of things, including flooring, furniture, and other building supplies.

Quercus leucotrichophora D.Don	Fagaceae	HBJU-17354	Tim, Fod, Fu	Raw	Wood, Leaves	Leaves and twigs are used as a fodder. Wood is used in house making, bads, cardboards, handicrafts etc.
Reinwardtia indica Dumort.	Linaceae	HBJU-17355	Med, Orn, Dye	Extract	Branches, Leaves, Inflorescence	This plant is commonly cultivated for its attractive qualities. Both the branches as well as the leaves have medicinal properties. The blooms can be used to extract a yellow dye, which can then be utilised for dying fabrics and producing paints.
Rhamnus triquetra (Wall.) Brandis	Rhamnaceae	HBJU-17356	Med	Extract	Bark, Leaves, Fruits	Due to their potent antibacterial, deobstruent, anti-inflammatory, astringent, and antioxidant characteristics, R. triquetra's bark, leaves, and fruits are used to treat intestinal worms, malaria, and hemorrhagic septicemia in livestock.
Ricinus communis L.	Ephorbiaceae	HBJU-17357	Med	Oil	Leave, Roots, Seed	Its leaf, root, and seed oil are used in inflammation treatment, liver disorders, hypoglycemic, and as a laxative.
Rubus ellipticus Sm.	Rosaceae	HBJU-17358	Edi	Raw	Fruits	Fruits are edible.
Rubus niveus Thunb.	Rosaceae	HBJU-17359	Edi	Raw	Fruits	Fruits are edible.
Rubus paniculatus Sm.	Rosaceae	HBJU-17360	Edi	Raw	Fruits	Fruits are edible.
Rubus rosifolius Sm.	Rosaceae	HBJU-17361	Edi	Raw	Fruits	Fruits are edible.
Sapium sebiferum (L.) Roxb.	Ephorbiaceae	HBJU-17364	Med	Paste, Powder	Leaves	It has been used in to treat eczema, shingles, edema, swelling, ascites, scabs, and snakebites.

Senegalia modesta Wall.	Mimosaceae	HBJU-17362	Tim, Med	Raw, Extract, Paste	Wood, Gum, Twigs	The wood is extremely dense and long-lasting. It is utilized in the production of cane crushers. In addition to that, it is a fuel source. Both the gum and the sensitive twigs of the plant have medicinal and tooth-cleaning use.
Senegalia catechu (L.f.) Willd.	Mimosaceae	HBJU-17363	Med, Edi, Fod, Tim	Extract, Raw	Wood, Twigs and Bark	An Its heartwood extracts known as katha (catechu), which is utilized as an ingredient, gives paan its signature flavour as well as its distinctive red colour. Chewing areca nut, betel (Piper beetle) leaf along with paste of slaked lime is a traditional practice in India as well as other parts of Southeast Asia. This practice is known as paan. The tree branches are frequently cut down and used as fodder for goats, and they are also occasionally fed to cattle. Traditional medicine makes use of the heartwood, as well as the bark and an extract of the wood called catechu. The astringent properties of the concentrated extract are recognized by the names khayer gum or cutch. The wood of the tree is highly prized for use in the construction of furniture and tools, which is one reason why it is commonly planted for these purposes.

Sida rhombifolia L.	Malvaceae	HBJU-17365	Med	Extract, Powder, Paste	Whole plant	The plant has moisturizing properties and is used to treat ulcers, high fevers, and diarrhea. It is effective against cardiac ailments such ovarian illnesses and pulmonary catarrh. A serum is made to fight the poison of black widow spiders and rattlesnakes using its root as an anticrotalic.
Solanum hazenii Britton	Solanaceae	HBJU 17366	Med	Extract	Whole plant	The plant extracts have been widely used to treat fever, wounds, tooth decay, reproductive problems, and arterial hypertension.
Solanum torvum Sw.	Solanaceae	HBJU-17367	Med	Raw, Paste, Powder	Fruits, Leaves	The fruits, leaves are used as medicine for fever, cough, wounds, pain, liver problems, tooth decay.
Spermadictyon suaveolens Roxb.	Rubiaceae	HBJU-17368	Med	Powder	Stem	The stem. powder of this plant is used by herbal medicinal practitioners for control of viral infections like herpes as well as to diabetes
Toona ciliata M.Roem.	Meliaceae	HBJU-17369	Tim	Raw	Wood	The wood has a deep red colour, is simple to work with, and commands a very high price. It is referred as "red gold" because of its widespread application in the manufacture of furniture, wood paneling, and construction, including shipbuilding.
Trema politoria (Planch.) Blume	Cannabaceae	HBJU-17370	Med	Paste	Leaves	Leaf paste applied locally for healing of wounds.
Vachellia nilotica (L.) Delile	Mimosaceae	HBJU-17371	Med, Fod	Raw	Leaves, Fruits	Animals are especially interested in pods that have been dried out. Branches used as fodder is a popular practice. The pods and leaves are believed to have anthelminthic qualities on small ruminants.

Viburnum nervosum D.Don	Coprifoliaceae	HBJU-17372	Med	Paste, Powder	Leaves, Fruits, Bark	Used primarily in traditional medicine for the diseases such as rheumatoid arthritis, cough, diarrhea, tumefaction, swelling.
Wendlandia heynei (Schult.) Santapau & Merchant	Rubiaceae	HBJU-17373	Med	Powder	Bark	Bark is used to treat colds and high fevers.
Woodfordia fruticosa (L.) Kurz	Lythraceae	HBJU 17374	Med	Paste, Powder	Flower, root	Flower and root used in the treatment of rheumatism, dysentery, foot and mouth disease, lumbar and rib fracture.
Zanthoxylum armatum DC.	Rutaceae	HBJU-17375	Med	Paste, Powder, Raw, Extract, Oil	Fruits, Twigs, Bark	Medicinal applications in cases of dyspepsia and fever, an aromatic tonic made from Tejbal's fruits, seeds, and bark can be very helpful. Because they can be helpful in treating tooth issues, seeds and fruits are often ground up and used to make dental powder and paste. The essential oil that is extracted from fruits is called Wartara oil, and it contains antibacterial and deodorant characteristics.
Ziziphus jujuba Mill.	Rhamnaceae	HBJU-17376	Edi	Raw	Fruits	Fresh and candied dried fruit are eaten as snacks or with coffee. Water-crushed pulp makes a drink.
Ziziphus oenopolia (L.) Mill.	Rhamnaceae	HBJU-17377	Dye, Edi	Raw, Decoction	Fruits	The bark of the tree is used for tanning, and the berries can be eaten.

(Whole plant), 3 species (Bark), 3 species (Fruits and leaves), 3 species (Leaves and wood), 2 species (Bark, fruits, latex, leaves and roots), 2 species (Fruits and stem), 2 species (fruits and wood), remaining categories were represented by only a single species ((Figure 7).

DISCUSSION AND CONCLUSION

In present study we have selected Jhajjar watershed for analyzing the woody flora of the area. We have reported 80 woody plant species belonging to 63 genera and 36 families (Figure 11&12). Joshi et al., 2019 also reported 34 woody species belonging to 25 families while assessing ethno-botanical uses of the woody flora of a watershed in western Himalaya. Present study was well supported by Bhat *et al.,* 2020 who also reported a total of 81 woody species, including 33 trees (28 genera and 22 families) and 48 shrub species (39 genera and 24 families) from along the altitudinal gradient in Kedarnath wildlife sanctuary. Tamiru *et al.,* 2021 reported a total of 61 woody species belonging to 34 families; 8.2% of the species were endemic to Ethiopia. Angessa *et al.,* 2020 identified 104 woody plants belonging to 52 families, where 74.5% were indigenous and 16.7% were endemic to Ethiopia. Sop *et al.,* 2012 also reported 90 woody species belonging from 64 genera and 32 from Burkina Faso. In all three ethnic groups, more than 80 % of the reported species were used for energy, 60 % for medicine and 40–50 % for food. Woody plants are more prone to the deforestation, over exploitation because of their higher use as a fodder, fuel and timber. Fodder is one of the daily need of livestock holders in villages for which they mostly relies on woody plants especially on trees such as *Grewia* spp., *Bauhinia* spp. and so on.

Total of 25 categories were reported from the study area. Out of reported 80 woody species 39 was used only for medicinal purpose only, 8 species used as a medicine and edible, 5 species used only as a edible, 5 species used for medical and timber yielding whereas remain categories was represented by a single species. Amjad and Arshad, 2014 reported 22 woody plant species have medicinal value, among which 21 were used as fuel

wood species, 16 as fodder species, 4 as timber wood species, 12 as edible fruit species, 6 as fence or hedge plant, 7 as ornamental species, and 12 species had other uses. Most of the researcher documented the woody plants for was dominantly used as a fuel, fodder, timber but edibility of their fruits might be a possible reason for their declining population. Seeds of certain plants are utilized for their oil containing properties as well as their sweetness and nutritional properties. Consuming seeds extensively may decrease the populations of seed bearing woody plants. Neelo *et al.,* 2015 reported uses of woody plants and grouped into eight categories, namely construction, fuelwood, furniture, medicine, human food, fodder, farm implements, and shade and also reported that some of them were used for more than one purpose.

Total 36 mode of utilization was reported out of which 8 species consumed as a paste and powder, 5 species consumed as a decoction, 5 species used as decoction and raw, 4 species used as paste, powder and raw, 4 species consumed as a extract, 3 species used as decoction and powder, 3 species as a powder, 2 species as a decoction, extract, juice, paste and raw, 2 species as a extract, paste and raw, 2 species as a extract and raw, 2 species as a powder and raw, Bark, leaves and roots were reported predominant modes of utilization. Hussain *et al.,* 2023 reported paste and powder as a dominant mode of utilization. In present study the paste and powder were reported dominant most of woody species possesses hardwood or wood that was not contain that secondary metabolites or if contain it is very low so most of the woody plants parts used are bark, leaves, roots. However most of the Himalayan local villagers were hardworking people who work in crop lands where natural barriers like stones, rocks as well as weather or climatic condition like cold etc are predominant so the major injuries are either cuts and wounds or fever cough and colds. So they make these utilization strategies to cope with this all in paste and which were passing from one generation to another in present world.

Total 44 categories were reported on the bases of various types of mixed uses. 8 species were recorded representing the category bark and leaves, followed by 7 species (Leaves), 6 species (Fruits), 6 species (Whole plant), 3 species (Bark), 3 species (Fruits and leaves), 3 species (Leaves and wood), 2 species (Bark, fruits, latex, leaves and roots), 2 species (Fruits and stem), 2 species (fruits and wood). Neelo *et al.,* 2015 also reported that the most commonly used plant parts were the roots, bark, leaves, and stems. In present study we have reported bark which was dominantly used by locals this is may be because of the chemical constituents possesses necessary metabolites which heal the injuries as diseases. Leaves as a producers of food for plant contains higher amount of nutrient and chemical compounds due to which they are consumed by animals as well human beings for their needs so consuming variety of proposes make it dominantly used plant part.

Top genera's of the study area were *Ficus* (10 species), *Rubus* (4 species) followed by *Debregeasia, Grewia, Indigofera, Senegalia, Solanum, Ziziphus* (2 species each). Parmanik, 2016 reported about 24 species and three infra-specific taxa from Uttarakhand. Ficus remains unexplored for its fodder value (Roder *et al*. 2003) since long. Ficus-based system is more bio-diverse as well as economically sustainable. The members of the genus provide multiple products (fodder, shade, fuelwood) and ecosystem-services (enhance soil fertility, prevent soil erosion). In spite of ability of the species of *Ficus* to survive under difficult natural conditions, cultural acceptability, multiple benefits and vital ecological services, declining trend in planting *Ficus* has been noted in India. *Rubus* is well known for its edible fruits all over the world several researchers have reported them from Himalayan region for their edibility as well as medicinal values. Sharma and Chandel, 1996 reported 32 species and 4 varieties of *Rubus* from Indian Himalaya. Top families were Moraceae, and Rosaceae. Sisodiya & Dutt (2020) reported the bark, Euphorbiceae, Mimosaceae, Fabaceae,

Anacardiaeae as the dominant family while studying some tehsils of district Barwani Madhya Pradesh. Tamiru *et al.,* 2021 reported the highest number of species from families Euphorbiaceae, Rubiaceae, Rutaceae, Oleaceae while study woody flora. Angessa *et al.,* 2020 also reported Asteraceae, Fabaceae and Rosaceae were the most species-rich families.

Bauhenia variegata, Flacourtia indica, Grewia optiva, Pinus roxburghii, Prunus cerasoides, Pyrus pashia, Q. leucotricophora, Rhamnus triquetra, were found as fuel wood yielding plant species. Mitra *et al.,* 2017 reported ten species (five species each trees and shrubs) from Bhotiya community of Niti valley these values are little bit lower than the values reported in present study. While Hussain *et al.,* 2017 reported twenty one fuel wood yielding species which are well in the range of present study. Chandra *et al.,* 2008 reported *Bauhenia* sp., *Flacourtia* sp., *Grewia optiva* and *Quercus leucotricophora* as a fuel-wood yielding species. Shaheen *et al.,* 2016 reported *Pinus roxburghii, Pyrus pashia* and *Quercus sp.* as major fuel wood producing species. In the past fuel wood is preferred by lot of villagers is because of its easy availability from nearest forest or agricultural fields, low values or zero cost related, low socio-economic status and unavailability of other energy sources. Now day's electricity, bio-gas (gas cylinders) and connectivity with cities is getting better day by day due to which little pressure is decreased on fuel-wood yielding plants in some extent in economically good families but affording modern energy sources is not easy for economically poor families as well for those which are residing in far away from roads or connectivity. In winters locals faced too extreme colder conditions and for which almost every family restore fuel wood.

Bauhenia variegata, Ficus auriculata, Ficus palmata, Grewia optiva, Prunus cerasoides, Pyrus pashia, Q. leucotricophora and *Rhamnus triquetra* were the fodder yielding plant species. Nautiyal *et al.* (2018) also reported *Bauhenia* sp., *Grewia optiva, Ficus* spp., *Quercus* spp. and *Rhamnus triquetra* as a major fodder yielding species. Paliwal

& Maurya, 2021 reported 34 fodder species and found *Bauhenia variegata, Quercus leucotricophora, Ficus palmata* as a major fodder yielding tree species. The fodder trees are important due to their usefulness as a fodder during drought and especially extreme colder condition during snowfall period. It was observed that in this region paddy straw is not preferred by locals individuals as a fodder indeed *Echinochloa fruementacea* and *Eluesine coracana* straw was used as a fodder in winters. Due to unavailability of market based fodder (especially Paddy straw) local of this region still using plants as a fodder reproducing species. Sustainable utilization would be recommended for these species so that their future population will remain un-threatened.

Bauhenia variegata, Flacourtia indica, Grewia optiva, Pinus roxburghii, Prunus cerasoides, Pyrus pashia, Q. leucotricophora and *Rhamnus triquetra* were recorded as timber yielding plants. Dobhal *et al.,* 2010 reported 37 timber yielding species from various regions of Himalaya and found *Grewia optiva, Prunus cerasoides* and *Q. lecotricophora* as common timber yielding species. It was observed that *Pinus roxburghii* was highly used for making houses and huts in this region. Whereas some species was used for making agricultural implements as well as home-kitchen implements. In recent years after corona period wooden utensils are in trend and it can cause pressure on plant species which are utilized for making kitchen utensils or agricultural implements. It was also observed that in recent years home-stays are in trend and this region is also a centre of tourism due to which this community also following the trend and it cause pressure on local environment and plants also. Sustainable consumption of timber wood for house making is recommended. Gautam (2012) observed that it is used for ornamental, fuel, fodder, timber, food, gum and resin, tannin and dye and medicinal purposes. Kumar et al. 2021 also found that it is used as fodder, fiber and fuel as well as making of shampoo. Kaushik *et al.,* 2010 quoted that it was used for medicine, food and fuel proposes. Om prakash *et al.,* 2021 also reported it for

various proposes such as food, fodder, fuel and medicine. Uniyal *et al.*, 2002 reported that it is used for medicine and food proposes.

Occurrence analyses of woody plants showed that highest 54% species showed "common" occurrence followed by "uncommon" (34% species) while remaining 12% species showed "rare" occurrence. Rawat *et al.,* 2016 and Bagri *et al.,* 2023 also reported similar pattern from Garhwal Himalaya. The occurrence of a species can be limited by several factors such as habitat loss, climate change, pollution, over-exploitation, invasive species, genetic factors, reproductive challenges and ecological interactions. Destruction or alteration of natural habitats due to urbanization, agriculture, and deforestation can lead to decreased in the plant populations. Changes in temperature and weather patterns can affect the survival of certain species, especially those with specific habitat requirements. Contaminants in the environment can harm species, leading to decreased reproductive success or increased mortality. Unsustainable harvesting can reduce population sizes to critical levels. Non-native species can compete with, prey on, or bring diseases to native species, disrupting local ecosystems. Small populations can suffer from inbreeding, which reduces genetic diversity and adaptability.

On the bases of abundance/frequency ration present findings showed dominance of random distribution followed by contiguous distribution pattern. Ballabha *et al.,* 2020 also reported similar pattern on both the trees and shrub layers. The dispersal limitation is an important ecological factor for controlling species distribution pattern and a connection between biotic and abiotic ecological factors (Hubbell *et al.,* 1999). Regular and random distribution is indicative of uniform environment (Pande *et al.,* 2001), while contagious distribution is common in nature (Odum 1971). Connell (1978) suggested that the uniform dispersion pattern of species in tropical forests largely enable the maintenance of high levels

of diversity. The changes in the distribution patterns may reflect the reactions of species to disturbance as well as to changes in the habitat conditions (Sagar *et al.,* 2003).

The study highlights a significant diversity of woody plant species in the region. Shrubs dominate the composition over trees with Moraceae and Rosaceae being the most prominent families. Structurally, the tree layer exhibits variation across elevations, with *Pinus roxburghii* and *Quercus leucotrichophora* being the most dominant species, showing high density and importance value indices (IVI). Tree species distribution was largely random, though contiguous patterns increased with altitude. Shrub density also varied across sites, with *Justicia adhatoda* and *Indigofera cassioides* being particularly dominant. The ethno-botanical significance of these species is notable. Overall, the study underscores the region's rich biodiversity, emphasizing the need for conservation efforts, particularly for rare species, while also recognizing the ecological and ethno-botanical importance of these plant species.

CONFLICT OF INTREST

The authors declare no conflict of interest.

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Figure 11. Trees of the study area.
(A) *Ficus semecordata* (B) *Grweia optiva (C) Quercus leucotrichophora* (D) *Toona ciliata* (E) *Pinus roxburghii* (F) *Bombax ceiba.*

Figure 12. Shrubs of the study area.
(A) *Bergera koenigii* (B) *Reinwardtia indica* (C) *Rubus ellipticus* (D) *Berberis lycium* (E) *Rubus niveus* (F) *Mimosa himalayana.*