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ASSESSING THE SOCIAL, ECOLOGICAL AND ECONOMIC IMPACT ON CONSERVATION ACTIVITIES WITHIN HUMAN-MODIFIED LANDSCAPES: A CASE STUDY IN JHARGRAM DISTRICT OF WEST BENGAL, INDIA

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Abstract

Sacred groves are tracts of virgin or human- modified forest with rich diversity, which have been protected by the local people for the centuries for their cultural, religious beliefs and taboos that the deities reside in them and protect the villagers from different calamities. The present study was conducted Copraburi (CSG) and Kawa-Sarnd (KSG) sacred grove in Nayagram block of the Jhargram district under west Bengal, in appreciation of its role in biodiversity conservation. The study aimed at the documentation and inventory of sacred groves, its phytodiversity, social, ecological and economical role with mild threats. A total of 120 species belonging to 113 genera distributed 43 families from 24 orders were recorded from the sacred groves according to the APG IV (2016) classification, which covering 47, 26, 23, 24 species of herbs, shrubs, tree, climbers respectively. Moreover, both groves support locally useful medicinal plants for various ailments. This is the first ethnobotanical study in which statistical calculations about plants are done by fidelity level (FL) in the study area. Therefore, there is an urgent need not only to protect the sacred forest, but also to revive and reinvent such traditional way of nature conservation.

Keywords*: APG IV; Biodiversity; Conservation; Ethnobotany; Sacred grove; West Bengal*

Introduction

Extensive areas of the tropics have been heavily degraded by inappropriate land use, especially extensive cattle grazing [1]. An estimated 350 million ha in the tropics is classified as degraded due to inappropriate use of fire, land clearing, poor grazing management, and destructive harvesting of ecosystem resources [2]. Biodiversity surveys and ecological studies have understandably focused on areas with a high concentration of plant and animal diversity-intact biological reserves and protected areas with low current levels of human intervention [3]. But these areas are not typical of most of the world's tropics, where more than 90 percent of tropical forest area lies beyond the borders of reserves and parks [4].

Tropical landscapes have been shaped by the people who have lived in them and used them in both sustainable and unsustainable ways over past centuries [5-7]. Traditional as well as modern forms of sustainable land-use emphasize the values of ecosystem services derived from productive landscapes. The Millennium Ecosystem Assessment framework proposed that ecosystem services affecting human wellbeing [8].

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Over the last decade, relationships between biodiversity and ecosystem function have been heavily studied in grassland systems, with a primary focus on relationships between biomass accumulation and nutrient retention in relation to plant diversity [9]. Yet, understanding relationships between all types of biodiversity and all ecosystem functions and services in human-modified landscapes are extremely important.

Planning sustainable production landscapes require evaluation of trade-offs and synergies [10], so that appropriate schemes can be created to ensure adequate financial benefits, equity, rights, and choices for rural people whose livelihoods and well-being depend upon sustainable production or resource extraction. Further, assessments of the social or economic impact of existing conservation efforts can help to refine and improve them within a framework of adaptive management [11, 12].

Ecologists traditionally have sought to study pristine ecosystems to try to get at the workings of nature without the confounding influences of human activity. But that approach is collapsing in the wake of the scientist's realization that there are no places left on Earth that doesn't fall under humanity's shadow [13]**.**

In India as well as in parts of Asia and Africa, care and respect for nature has been influenced by religious beliefs and indigenous practices. The existence of sacred groves has been reported in many parts of Asia, Africa, Europe, Australia and America [14]. India is a land rich in biodiversity. Besides ecological and economic uses, bio-resources are important for their religious, spiritual and other cultural values [15]. Many animals and plants are worshipped or held sacred by people for their association with some spirits or deities [16-19]. However, in addition to propitiation and preservation of isolated trees like *Aegle marmelos*, *Ficus bengalensis*, *Ficus religiosa* etc., there exists a practice of nature worship in the form of a cluster of trees or forest patches known as sacred groves [20]. The phenomenon of sacred groves is a glaring example, how the traditional cultural heritage of India down the centuries shapes and conserves forests and their creators. But the network of sacred groves socially protected by the village institutions in India is gradually vanishing. While the grassroots initiative to protect the sacred groves is still alive, outside support, including government action is urgently needed to strengthen and boost-up the traditional non-government institution which is perhaps in the best position to act as guardian of local resources [21].

The traditional Indian society has evolved many conservation practices such as restriction of exploitation of resources to a certain season, exploitation in certain stages of the life history, limited exploitation of certain resources, protection of certain sacred species, and protection of entire ecosystems [22]. The almost notable among such traditions are sacred groves totally inviolate to any human interference and village groves where limited or regulated use by members of local communities is permitted [23]. Today, such groves occur in many parts of India, mainly in tribal tracts and protected by the local people through religious and cultural practices evolved to minimize the destruction [16, 24-29]. With this premise, the present study is an attempt to discuss how the village-based organizations located along the forest belt of the Jhargram district in West Bengal conserve sacred groves. This study also highlights the traditional uses of sacred groves and their plant resources from economic, social and ecological point of view.

Material and methods

Study area

The study was conducted in the two isolated sacred groves located in the south-west side of a forest-fringe tribal dominated Patina village under Nayagram police station in Nayagram Block of Jhargram district. The total geographical area of the village is 395.73 hectares. Patina has a total population of 884 people (male 445 and female 439). There are about 176 houses in Patina village. These groves are spread over in a forest land along the outskirt of the said village

on the southwestern bank of the perennial *Subarnarekha* River and situated about 14 km away from the small town Nayagram and 65 km south-west of the district headquarters of Jhargram town (latitude 22° 26' 33" N and longitude 86°59'50" E). The geographical location of this district comes under the middle tribal zone of India. On the north, it is bordered by the districts of Purulia and Bankura and on the east, it is bordered by the river Kangsabati (from the western border of West Midnapore district) and partly by the river Subarnarekha from the western border of West Midnapore district. It has common borders with the state of Odisha on the south and in the west with the Jharkhand state (Fig. 1).

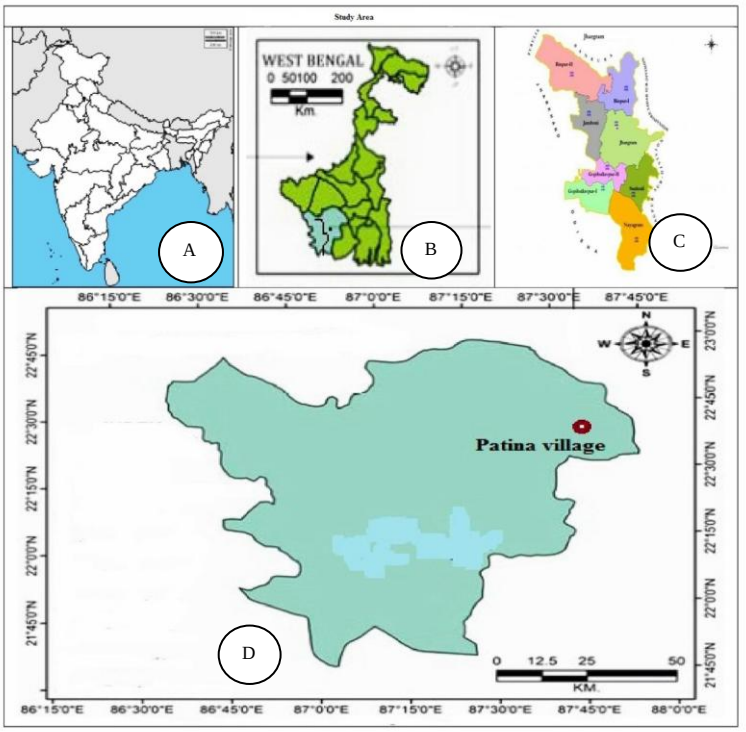

Fig. 1. Location of the study area (A: India, B: West Bengal, C: Jhargram district, D: Nayagram block)

Jhargram district covers an area of 3037.64km^2 and had a population of 1136548 in the 2011 census. 96.52% of the total population were rural and only 3.48% were urban population. 20.11% of the total population belonged to scheduled castes and 29.37% belonged to scheduled tribes. Its population growth rate over the decade 2001-2011 was 10.9%. The literacy rate was 72% in 2011, where the male literacy rate was 81% and female at 64%. The sex ratio was 979 females per 1000 males [30].

The strategic position of the district between the plateau of Chotanagpur and the plains of lower Bengal forms a continuum, facilitating plant and human migration. On account of its unique location, a large portion of the district is covered with pre-dominant dry-deciduous forests with naturally regenerating *Shorea robusta* plantations. Since the area comes under the middle tribal zone of India, it supports a substantial population of different ethnic groups like *Bagdi*, *Kora*, *Munda*, *Sabar*, *Santal* and other people, who reside in the forest-fringe villages. These people have distinct socio-cultural attachments with the surrounding plants and forests. They not only depend on the forest resources, but also protect and conserve plant resources in the form of sacred groves [20, 31-32].

The sacred groves

Copraburi Sacred Grove (CSG)

The CSG (popularly known as *Copraburi*) is situated (latitude 22º 09′16.82′′- 22º 09′17. 92′′ N and longitude 87º01′19.28′′- 87º01′19.72′′E, altitude 65.53m asl.) along the north-eastern side of Dhankamra-Rameswar metalloid road. This 250-year-old grove is spread over 0.81 acre land and houses the local folk deity *Copraburi* (a wild variation of goddess Durga/Kali), mainly worshipped by *Sabar* and protected by schedule tribes (*Munda*, *Sabar* and *Santal*) communities. The deity is aniconic, represented by stones smeared with vermillion lying below the *Azadirachta indica* and *Diospyros cordifolia* trees and fenced by upsized rocks.

Kawa-sarnd Sacred Grove (KSG)

The KSG (popularly known as *Kawa-sarnd*) is situated (latitude 22º 09′16.22′′- 22º 09′17. 61′′ N and longitude 87º01′31.16′′- 87º01′31.23′′E, altitude 59.74m asl) along the eastern side of the said road. This 200-year-old grove is spread over 0.62 acre land and houses the local folk deity *Kawa-sarnd* (a wild variation of God Shiva), mainly worshipped by *Bagdi* and protected by schedule castes (*Bagdi*, *Jele* and *Raju*) communities. The deity is aniconic, represented by stones smeared with vermillion lying under the *Alangium salviifolium* trees.

These groves are situated outside the village boundary and contain cluster of woody (trees and lianas) along with less woody (shrub) and non woody (herb and climber) ground flora. Both grove deities (god/goddess) are often presented with votive offerings of burnt clay made brick red colored idols (locally known as *Chhalans*) of horses and elephants. Fourteen days after the annual *Paus Sankranti* (28-29 January), local people gather inside the groves and worship the deities. Animal sacrifices (cock and goat) are offered during the rituals when the localized village fair is held for one day in the same place. Moreover, these deities are also propitiated on every *Sankranti* (last day of each Bengali month) or any day deemed auspicious by the people. Since each of the groves is abode of deities and spirits, people neither do cut any plant of the grove or nor disturb the area, being strictly adhered to the taboos and ethics. The folklore about worshiping the deities and their heralds are till now in vogue for the wellbeing and prosperity of the villagers.

Field survey and data collection

During the course of the investigation for a period of three years (January, 2014-December, 2016), these sacred groves were surveyed in different seasons for the estimation of floral wealth and its role in conservation. Information about the history of the groves, peoples' socio-religious rituals and values around them was collected by direct intensive observation, interviews in local dialect (i.e., *Bengali* in *Oriya* accent) through PRA (Participatory Rural Appraisal) method and from local literature. A brief floristic survey has been carried out through "spot identification" basis. Form unknown plants, samples of plants with flowers and or fruits were collected. After collection, the specimens were processed, preserved, poisoned and mounted on herbarium sheets following the standard and modern herbarium techniques [33]. The specimens have been deposited and identified by matching with correctly annotated materials available at the Vidyasagar University Herbarium. For identification purpose, different relevant floras [34-38], monographs [39-42], revision works [43] and other literature [44-45] were consulted.

In the systematic enumeration of the taxa, clade, order, family, species along with habit, life-span, Raunkiaer life-form with sub-type, distribution of plants in the sacred groves and importance (s) and part (s) used, Fidelity Level (FL) and IUCN status [46] were arranged according to Angiosperm Phylogeny Group IV classification [47]. Information about local economic as well as medicinal plants was collected through literature [48-60] and by interviewing and cross-interviewing the local people. All the species were categorized into various Raunkiaer's life form categories depending on the position of regenerating parts or propagules in all the collected species, and a biological spectrum was prepared for the grove,

that was subsequently compared with the Raunkiaer's normal spectrum to determine the phytoclimate of the grove [61].

Analyses of quantitative data

Measuring the importance of plants and vegetation to people is a central concern in quantitative ethnobotany [62]. Quantitative ethnobotanical techniques have great scientific interest as they provide relative importance of plant species to different ethnic groups, preference information on different species and many also aid in the conservation of biodiversity.

Fidelity Level (FL)

Fidelity level helps in identification of species according to their relative effectiveness. It is calculated as follows [62]:

$$FL = \frac{\text{Number of informants who independently suggested the use of a species for same major purpose}}{\text{Total number of informants who mentioned the plant for the treatment of any given disease}} \times 100$$

Results and discussion

Demographic characteristics of informants

The present survey has been done among 55 adjoining villagers/ informants who cited different use (s) of the plants especially for the preparation of traditional remedies. Among the informants, 23 (41.82%) respondents were men and 32 (58.18%) were women. This repartition is not unusual in ethnobotanical investigations in India, as a consequence of the importance of women in the domestic context, which is where most plant resources, especially alimentary and medicinal plants, are managed. This is also means that, in the current investigation, women proved to be main upholders of traditions linked to domestic life. 39 (70.91%) were younger than 60; 12 (21.82%) were 61-75 years old, and 4 (7.27%) were over 75. Most of them (47, i.e. 85.45% of all the informants) were agriculturally employed; only 8 (14.55%) employed in government sectors. As for educational qualifications, 29 (52.73%) had only primary school education; 15 (27.27%) a secondary school education; 9 (16.36%) a high school education and only 2 (3.64%) had a university degree (Table 1 and Figure 2).

Table 1. Informants – demographic data

Variable	Informants (N) =55	%
Age		
15-60	39	70.91
61-75	12	21.82
Above 75	4	7.27
Sex		
Men	23	41.82
Women	32	58.18
Education		
Primary school	29	52.73
Secondary school	15	27.27
High school	9	16.36
University degree	2	3.64
Occupation		
Agriculture	47	85.45
Others	8	14.55

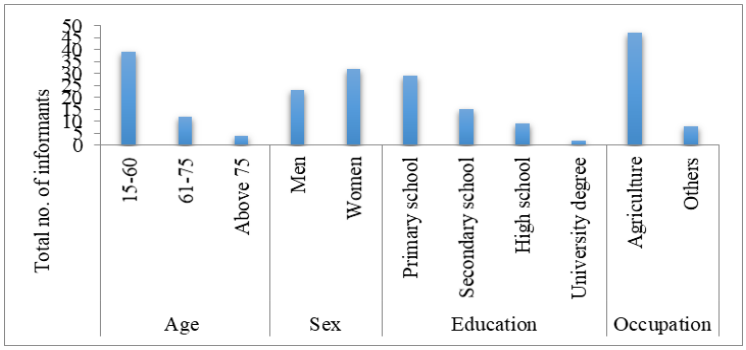

Fig. 2. Demographic characteristics of informants

Different plant taxa

In the present study, a total of 120 species (including infraspecific taxa) belonging to 113 genera distributed in 43 families from 24 orders were recorded from the sacred groves according to the APG IV (2016) classification. More than 70% of the flora are represented by orders of Eudicot and Core Eudicot, of which the major contributions in terms of descending species number (≥5) are from Gentianales 17 (14.17%), Fabales 14 (11.67%), Poales 13 (10.83%), Lamiales 12 (10%), Malpighiales 10 (8.33%), Malvales 8 (6.67%), Caryophyllales 6 (5%), Asterales 6 (5%), Rosales 5 (4.17%) and Sapindales 5 (4.17%). Similarly, more than 80% of the monocot taxa is represented by a single order namely Poales 13 (10.83%) (Table 2, 3; Fig. 3). Gnanasekaran et al. [63] showed a similar study on angiosperms of Sendirakillai sacred grove, Cuddalore district, Tamil Nadu, India. Similar types of contribution of orders highlighted by *Mygatt and Medeiros* [64] and *Pérez-Luque et al*. [65].

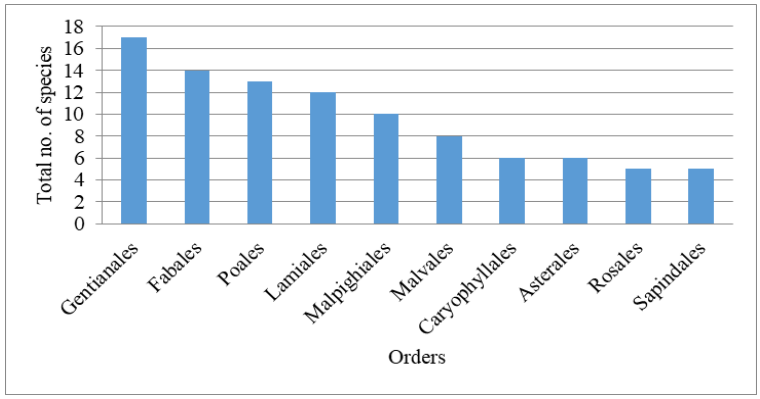

Fig. 3. Contribution of orders containing species (≥5 species)

The ten well represented families in species quantity are: Fabaceae (14 spp.), Apocynaceae (11 spp.), Poaceae (10 spp.), Malvaceae (8 spp.), Asteraceae (6 spp.), Euphorbiaceae (6 spp.), Acanthaceae (5 spp.), Lamiaceae (5 spp.), Rubiaceae (5 spp.) and Amaranthaceae (4 spp.) (Tables 2 and 3; Figure 4). Cyperaceae, Phyllanthaceae and Vitaceae each carried the number of (3 ssp.). Convolvulaceae, Ebenaceae, Menispermaceae, Moraceae, Rhamnaceae, Rutaceae and Solanaceae with each two species, other twenty-three (23) families with one species each (Table 2 and 3). Fabaceae, Apocynaceae and Poaceae were among the richest families in these areas which is due to the high compatibility of these families with the arid and semiarid climate conditions. They are common compared to other plant families in the

15.1/12.3-Agro-eco sub region and 3-Agro-climatic zone of West Bengal state [66], especially in the eastern region of India [38, 67].

Table 2: Outline of angiosperms in the sacred groves of Jhargram district according to APG IV (2016) classification

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Clade	Order	Family	H	S	T	C	Total	
							Genus/ Genera	Species
MESANGIOSPERMS								
MAGNOLIIDS	Piperales Dumortier	Aristolochiaceae Juss.				1	1	1
MONOCOTS	Asparagales Link	Hypoxidaceae R. Br.	1				1	1
		Asparagaceae Juss.		1			1	1
	Arecales Bromhead	Arecaceae Bercht. & J. Presl			1		1	1
	Poales Small	Cyperaceae Juss.	3				2	3
		Poaceae Barnhart	10				9	10
EUDICOTS	Ranunculales Juss. ex Bercht. & J. Presl	Papaveraceae Juss.	1				1	1
		Menispermaceae Juss.				2	2	2
CORE EUDICOTS								
ROSIDS	Vitales Juss. ex Bercht. & J.Presl	Vitaceae Juss.				3	3	3
	Zygophyllales Link	Zygophyllaceae R. Br.	1				1	1
	Fabales Bromhead	Fabaceae Lindl.	4	5	4	1	12	14
	Rosales Bercht. & J.Presl	Rhamnaceae Juss.				2	2	2
		Ulmaceae Mirb.			1		1	1
		Moraceae Gaudich.			2		1	2
	Cucurbitales Juss. ex Bercht. & J.Presl	Cucurbitaceae Juss.				1	1	1
	Celastrales Link	Celastraceae R. Br.				1	1	1
	Oxalidales Bercht. & J. Presl	Oxalidaceae R. Br.	1				1	1
	Malpighiales Juss. ex Bercht. & J.Presl	Salicaceae Mirb.		1			1	1
		Euphorbiaceae Juss.	2	3		1	5	6
		Phyllanthaceae Martinov	1	1	1		3	3
	Myrtales Juss. ex Bercht. & J.Presl	Combretaceae R. Br.				1	1	1
	Sapindales Juss. ex Bercht. & J.Presl	Anacardiaceae R. Br.			1		1	1
		Sapindaceae Juss.				1	1	1
		Rutaceae Juss.			2		2	2
		Meliaceae Juss.			1		1	1
	Malvales Juss. ex Bercht. & J.Presl	Malvaceae Juss.	1	5	2		8	8
	Brassicales Bromhead	Capparaceae Juss.				1	1	1
		Cleomaceae Bercht. & J. Presl	1				1	1
SUPERASTERIDS	Caryophyllales Juss. ex Bercht. & J.Presl	Amaranthaceae Juss.	4				4	4
		Nyctaginaceae Juss.	1				1	1
		Cactaceae Juss.		1			1	1
ASTERIDS	Cornales Link	Cornaceae Bercht. ex J. Presl			1		1	1
	Ericales Bercht. & J.Presl	Ebenaceae Gurke			2		1	2
	Gentianales Juss. ex Bercht. & J. Presl	Rubiaceae Juss.	2	1	2		5	5
		Loganiaceae R. Br. ex Mart.			1		1	1
		Apocynaceae Juss.		2	1	8	11	11
	Solanales Juss. ex Bercht. & J.Presl	Convolvulaceae Juss	1			1	2	2
		Solanaceae Juss.	1	1			2	2
	Lamiales Bromhead	Martyniaceae Horan.	1				1	1
		Acanthaceae Juss.	2	3			5	5
		Verbenaceae J. St.Hil.		1			1	1
		Lamiaceae Martinov	3	1	1		5	5
	Asterales Link	Asteraceae Bercht. & J. Presl	6				6	6
	24	**43**	**47**	**26**	**23**	**24**	**113**	**120**

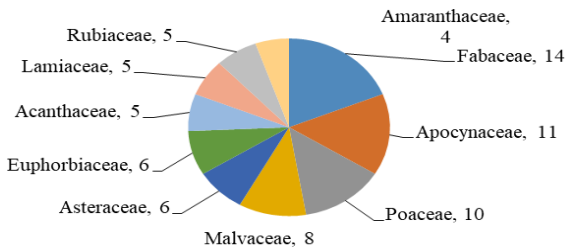

Fig. 4. Contribution of families containing species (≥4 species)

The 10 dominant plant families with descending genera (≥4) are Fabaceae 12 (10.62%), Apocynaceae 11 (9.73%), Poaceae 9 (7.96), Malvaceae 8 (7.08%), Asteraceae 6 (5.31%), Euphorbiaceae, Rubiaceae, Acanthaceae, Lamiaceae contain 5 (4.42%) genera each and Amaranthaceae 4 (3.54%) (Table 3 and Figure 5). The seven well represented genera are *Cassia*, *Chrysopogon*, *Cyperus*, *Diospyros*, *Euphorbia*, *Ficus* and *Mimosa* contain two species each respectively. The KSG (108 species) shows the higher amount of species richness in terms of species content than a CSG (103 species). 90 species are similar in both the groves (Table 3).

Table 3. Enumeration of angiosperms of sacred groves of Jhargram district according to APG IV (2016) classification

Clades/Orders/Families	Scientific Name	Habit	Life-span	Raunkiaer's Life-form	Sub-type	Distribution in sacred groves	Importance(s) and Part(s) used	FL	IUCN Status
MESANGIOSPERMS									
MAGNOLIIDS									
Piperales Bercht. & J.Presl									
Aristolochiaceae Juss.	*Aristolochia indica* L.	C	A	Cr		C,K	**M:**Le,Ro,Se	94.55	NA
MONOCOTS									
Asparagales Link									
Hypoxidaceae R.Br.	*Curculigo orchioides* Gaertn.	H	P	Cr		C,K	**M:**Ro	87.27	NA
Asparagaceae Juss.	*Agave vivipara* L.	S	P	Ch		C	**Fi:**Le,St;**M:**Ro	47.27	NA
Arecales Bromhead									
Arecaceae Bercht. & J. Presl	*Borassus flabellifer* L.	T	P	Ph	MM	K	**E:**Fr,Se;**M:**J;**Ti:**St	92.73	NA
Poales Small									
Cyperaceae Juss.	*Cyperus difformis* L.	H	P	He		C,K	**Fo:**Le;**M:**Ro,Tu	36.36	LC
	Cyperus rotundus L.	H	P	He		C,K	**Fo:**Le;**M:**Ro,Tu	58.18	LC
	Fimbristylis cymosa R.Br.	H	P	He		C,K	**Fo:**Le; **M:**Ro,Tu	21.82	LC
Poaceae Barnhart	*Aristida setacea* Retz.	H	P	He		K	**Fo:**Le;**M:**Rh	25.45	NA
	Chrysopogon aciculatus (Retz.) Trin.	H	P	He		C,K	**Fo:**Le;**M:**Rh	32.73	NA
	Chrysopogon zizanioides (L.) Roberty	H	P	He		C,K	**M:**Rh	40.00	NA
	Cynodon dactylon (L.) Pers.	H	P	He		C,K	**Fo:**Le;**M:**Rh,W;**Sa:**Le,W	100.00	NA
	Eleusine indica (L.) Gaertn.	H	P	He		K	**Fo:**Le,St;**M:**Ro	38.18	LC
	Eragrostis amabilis (L.) Wight & Arn.	H	P	He		C,K	**Fo:**Le;**M:**Ro	27.27	NA
	Eulaliopsis binata (Retz.) C.E.Hubb.	H	P	He		C,K	**Fi:**Le;**Fo:**Le;**M:**Ro	58.18	NA
	Imperata cylindrica (L.) P. Beauv.	H	P	He		C,K	**Fo:**Le;**M:**Ro	23.64	NA
	Paspalum scrobiculatum L.	H	P	He		C,K	**Fo:**Le;**M:**Ro	16.36	LC
	Sporobolus indicus (L.) R.Br.	H	P	He		C,K	**Fo:**Le;**M:**Ro	14.55	NA
EUDICOTS									
Ranunculales Juss. ex Bercht. & J. Presl									
Papaveraceae Juss.	*Argemone mexicana* L.	H	A	Th		C,K	**M:**Fr,Ro	32.73	NA
Menispermaceae Juss.	*Stephania japonica* (Thunb.) Miers	C	P	Ph	N	C,K	**M:**Le,Ro	83.64	NA
	Tinospora cordifolia (Willd.) Miers ex Hook. f. & Thomson	C	P	Ph	N	C,K	**M:**W	94.55	NA
CORE EUDICOTS									
ROSIDS									
Vitales Juss. ex Bercht. & J.Presl									
Vitaceae Juss.	*Ampelocissus latifolia* (Roxb.) Planch.	C	P	Ph	N	C,K	**M:**Le,Ro	81.82	NA
	Cayratia trifolia (L.) Domin	C	P	Ph	N	C,K	**M:**Le,Ro,St	50.91	NA
	Cissus quinquangularis Chiov.	C	P	Ph	N	K	**M:**Le,St	96.36	NA
Zygophyllales Link									
Zygophyllaceae R. Br.	*Tribulus terrestris* L.	H	A	Th		C,K	**M:**Fr,Le,Ro,Se	70.91	NA
Fabales Bromhead									
Fabaceae Lindl.	*Abrus precatorius* L.	C	P	Ph	N	C,K	**I:**Se;**M:**Se;**Or:**Se	100.00	NA
	Adenanthera pavonina L.	T	P	Ph	M	C	**M:**Sb,Se;**Or:**Se;**Sa:**St;**Ta:**Fr	83.64	NA
	Butea monosperma (Lam.) Taub.	T	P	Ph	M	C	**M:**Fl,Rb;**Or:**Fl;**Ta:**Sb;**Ti:**St	87.27	NA
	Cassia fistula L.	T	P	Ph	M	C	**M:**Fr,Se;**Ta:**Fr,Sb,Se	69.09	NA
	Cassia occidentalis L.	S	P	Ch		C,K	**M:**Le,Ro	74.55	NA
	Dendrolobium triangulare (Retz.) Schindl.	S	P	Ph	N	C,K	**M:**Le,Ro	47.27	NA
	Desmodium gangeticum (L.) DC.	H	A	Th		K	**M:**Le,Fr	58.18	NA
	Flemingia strobilifera (L.) R. Br.	S	A	Ch		C,K	**M:**Le,Ro	74.55	NA
	Indigofera tinctoria L.	H	A	Th		C,K	**D:**P,Se;**M:**Le,Ro,W	67.27	NA
	Mimosa pudica L.	S	P	Th		C,K	**M:**Le,Ro	92.73	LC
	Mimosa rubicaulis Lam.	S	P	Ch		C,K	**M:**Le,Ro	70.91	NA
	Pongamia pinnata (L.) Pierre	T	P	Ph	M	K	**Oi:**Se;**M:**Fl,Fr,Le;**Ti:**St	54.55	LC
	Tephrosia purpurea (L.) Pers.	H	P	Th		C,K	**D:**P,Se;**M:**Le,Ro	78.18	NA
	Zornia gibbosa Span.	H	A	Th		C,K	**M:**W	50.91	NA
Rosales Bercht. & J.Presl									
Rhamnaceae Juss.	*Ventilago denticulata* var. *bifida* Bhandari & Bhansali	C	P	Ph	N	C,K	**D:**Rb,Sb;**M:**Rb,Sb	89.09	NA
	Ziziphus oenopolia (L.) Mill.	C	P	Ph	N	K	**M:**Fr,Ro,St	83.64	NA
Ulmaceae Mirb.	*Holoptelea integrifolia* Planch.	T	P	Ph	MM	C,K	**M:**Le,Sb;**Ti:** St	21.82	NA
Moraceae Gaudich.	*Ficus benghalensis* L.	T	P	Ph	MM	K	**E:**Fr;**Fi:**Ro;**Fo:**Le;**M:**Fr,La,Le,Ro,Sb,Se;**Or:**W;**Sa:**Le,W;**Ti:**St	32.73	NA
	Ficus religiosa L.	T	P	Ph	MM	K	**E:**Fr;**Fi:**Ro;**Fo:**Le;**M:**Fr,La,Le,Ro,Sb,Se;**Sa:**Le,W;**Ti:**St;**Or:**W	41.82	NA
Cucurbitales Juss. ex Bercht. & J.Presl									
Cucurbitaceae Juss.	*Momordica dioica* Roxb. ex Willd.	C	P	Ph	N	K	**M:**Fr,Le,Ro	50.91	NA
Celastrales Link									
Celastraceae R. Br.	*Celastrus paniculatus* Willd.	C	P	Ph	N	C,K	**M:**Le,Ro,Sb,Se	80.00	NA
Oxalidales Bercht. & J. Presl									
Oxalidaceae R. Br.	*Oxalis corniculata* L.	H	A	Th		C,K	**M:**Le,W	74.55	NA
Malpighiales Juss. ex Bercht. & J.Presl									
Salicaceae Mirb.	*Flacourtia indica* (Burm. f.) Merr.	S	P	Ph	N	C,K	**E:**Fr;**M:**Fr,La,Le,Ro,Se	70.91	NA
Euphorbiaceae Juss.	*Acalypha indica* L.	H	A	Th		C,K	**M:** W	60.00	NA
	Croton bonplandianus Baill.	S	A	Th		C,K	**M:** La	92.73	NA
	Euphorbia antiquorum L.	S	P	Ph	N	C,K	**M:**La,St	85.45	NA
	Euphorbia hirta L.	H	A	Th		C,K	**M:**La,Ro,W	70.91	NA
	Jatropha gossypiifolia L.	S	P	Ch		C,K	**G:**Sb;**M:**La,Le,Ro,Se;**Oi:**Fr,Se	94.55	NA
	Tragia involucrata L.	C	P	Ph	N	C,K	**M:**Fr,Ro	52.73	NA
Phyllanthaceae Martinov	*Breynia vitis-idaea* (Burm.f.) C.E.C.Fisch.	S	P	Ph	N	C,K	**M:**Fr,Le	85.45	NA

	Bridelia tomentosa Blume	T	P	Ph	M	C	**M:**Fr,Le;**Ta:**Sb;**Ti:**St	23.64	NA
	Phyllanthus virgatus G.Forst.	H	A	Th		C,K	**M:**Fl,Fr,Le,Ro	32.73	NA
Myrtales Juss. ex Bercht. & J.Presl									
Combretaceae R. Br.	*Combretum decandrum* Jacq.	C	P	Ph	N	C,K	**D:**Rb,Sb;**M:**Fl,Rb,Sb;**Ta:**Fr,Sb;**Ti:**St	40.00	NA
Sapindales Juss. ex Bercht. & J.Presl									
Anacardiaceae R. Br.	*Lannea coromandelica* (Houtt.) Merr.	T	P	Ph	M	K	**M:**Ba,Le,G;**Ti:**St	38.18	NA
Sapindaceae Juss.	*Cardiospermum halicacabum* L.	C	A	Ph	N	K	**M:**Le,Ro,Se	85.45	NA
Rutaceae Juss.	*Aegle marmelos* (L.) Corrêa	T	P	Ph	M	C	**D:**Fr;**E:**Fr,Le;**M:**Fr,Le;**Sa:** Fr,Le,W	100.00	NA
	Naringi crenulata Nicolson	T	P	Ph	N	C	**E:**Fr;**M:**Sb,Le;**Ti:**St	70.91	NA
Meliaceae Juss.	*Azadirachta indica* A.Juss.	T	P	Ph	M	C,K	**E:Le;I:**Fr,Le,Sb,Se;**M:**Fr,Le,Sb,Se, St;**Sa:**W;**Ta:**Sb;**Ti:**St	100.00	NA
Malvales Juss. ex Bercht. & J.Presl									
Malvaceae Juss.	*Azanza lampas* (Cav.) Alef.	S	P	Ch		C,K	**Fi:**St;**M:**W	69.09	NA
	Bombax ceiba L.	T	P	Ph	MM	C	**Fo:**Le;**M:**Fl,Sb; **Oi:**Se;**Ti:**St	74.55	NA
	Corchorus aestuans L.	H	A	Th		K	**E:**Le;**M:**Le,Se	50.91	NA
	Helicteres isora L.	S	P	Ph	N	C,K	**M:**Fr,Le,Ro,Sb	60.00	NA
	Hibiscus vitifolius L.	S	A	Ch		K	**M:**Ro	58.18	NA
	Pterospermum acerifolium Willd.	T	P	Ph	M	C,K	**Oi:**Fl;**M:**Fr,Le,Se;**Ti:**St	87.27	NA
	Sida cordifolia L.	S	A	Th		C,K	**M:**Fr,Le,Ro	81.82	NA
	Urena lobata L.	S	A	Ch		C,K	**M:**Fl,Le,Ro,St	70.91	NA
Brassicales Bromhead									
Capparaceae Juss.	*Capparis zeylanica* L.	C	A	Ph	N	C,K	**M:**Le,Ro,Se,St;**Or:**W	80.00	NA
Cleomaceae Bercht. & J. Presl	*Cleome gynandra* L.	H	A	Th		K	**M:**Le,Ro,Se	58.18	NA
SUPERASTERIDS									
Caryophyllales Juss. ex Bercht. & J.Presl									
Amaranthaceae Juss.	*Achyranthes aspera* var. *indica* L.	H	P	Th		C,K	**D:**W;**M:**W	100.00	NA
	Aerva lanata (L.) Juss. ex Schult.	H	A	Th		C,K	**M:**Fr,Ro	89.09	NA
	Alternanthera sessilis (L.) R. Br. ex DC.	H	A	Th		C,K	**M:**W	74.55	LC
	Amaranthus spinosus L.	H	A	Th		K	**M:**W	96.36	NA
Nyctaginaceae Juss.	*Boerhavia diffusa* L.	H	A	Th		C,K	**M:**Ro,W	67.27	NA
Cactaceae Juss.	*Opuntia stricta* (Haw.) Haw.	S	P	Ch		C	**M:**St;**Sa:**St	81.82	LC
ASTERIDS									
Cornales Link									
Cornaceae Bercht. ex J. Presl	*Alangium salviifolium* (L.f.) Wangerin	T	P	Ph	N	C,K	**E:**Fr;**M:**Fr,Le,Rb,Sb,Se;**Ti:**St	92.73	NA
Ericales Bercht. & J.Presl									
Ebenaceae Gurke	*Diospyros exsculpta* Buch.-Ham.	T	P	Ph	MM	C,K	**E:**Fr;**M:**Fr;**Ti:**St	81.82	NA
	Diospyros montana Roxb.	T	P	Ph	M	C,K	**M:**Fr,Sb;**Ti:**St	87.27	NA
Gentianales Juss. ex Bercht. & J. Presl									
Rubiaceae Juss.	*Oldenlandia corymbosa* L.	H	A	Th		C,K	**M:**Le	74.55	LC
	Meyna spinosa Roxb. ex Link	S	P	Ch		C,K	**M:**Fr,Le,Ro	85.45	NA
	Morinda citrifolia L.	T	P	Ph	N	C	**M:**Fl,Fr;**Or:**Fl;**Ti:**St	90.91	NA
	Spermacoce articularis L.f.	H	A	Th		C,K	**M:**W	58.18	NA
	Tamilnadia uliginosa (Retz.) Tirveng. & Sastre	T	P	Ph	N	C	**Oi:**Fr;**M:**Fr,Le;**Ti:**St	34.55	NA
Loganiaceae R. Br. ex Mart.	*Strychnos nux-vomica* L.	T	P	Ph	MM	C,K	**I:**Fr,Se;**M:**Le,Rb,Se;**Ti:**St	100.00	NA
Apocynaceae Juss.	*Calotropis gigantea* (L.) Dryand.	S	P	Ch		C,K	**Fi:**Ba,Se;**M:**Fl,La,Le,Rb,Ro	100.00	NA
	Carissa spinarum L.	C	P	Ph	N	C,K	**E:**Fr;**M:**Fr,Ro	52.73	NA
	Cryptolepis dubia M.R.Almeida	C	P	Ph	N	C,K	**M:**La,Le,Ro	58.18	NA
	Hemidesmus indicus (L.) R. Br. ex Schult.	C	P	Ph	N	C,K	**M:**Ro	81.82	NA
	Ichnocarpus frutescens (L.) W.T.Aiton	C	P	Ph	N	C,K	**M:**Le,Ro	87.27	NA
	Marsdenia sylvestris (Retz.) P.I.Forst.	C	P	Ph	N	C,K	**M:**Le,St	90.91	NA
	Pergularia daemia (Forssk.) Chiov.	C	A	Ph	N	C,K	**M:**La,Le,Se,W	74.55	NA
	Rauvolfia tetraphylla L.	S	P	Ch		C,K	**M:**Ro,W	92.73	NA
	Tylophora indica (Burm. f.) Merr.	C	A	Ph	N	C,K	**M:**Le,Rb,Ro	96.36	NA
	Vallaris solanacea (Roth) Kuntze	C	P	Ph	N	C,K	**M:**La,Le,Ro	76.36	NA
	Wrightia antidysenterica (L.) R.Br.	T	P	Ph	N	C,K	**M:**Le,Ro,Sb,Se;**Oi:**Fl	100.00	NA
Solanales Juss. ex Bercht. & J.Presl									
Convolvulaceae Juss	*Evolvulus alsinoides* (L.) L.	H	A	Th		C,K	**M:**W	52.73	NA
	Rivea ornata Choisy	C	P	Ph	N	C,K	**M:**Le,Ro	58.18	NA
Solanaceae Juss.	*Datura metel* L.	S	P	Ch		C,K	**M:**Le,Ro,Se;**Sa:**Fl	87.27	NA
	Solanum americanum Mill.	H	A	Th		C,K	**M:**Fr,Le,Ro,Se	89.09	NA
Lamiales Bromhead									
Martyniaceae Horan.	*Martynia annua* L.	H	A	Ch		C,K	**M:**Fr,Le	78.18	NA
Acanthaceae Juss.	*Andrographis echioides* Nees	H	A	Th		C,K	**M:**Le,Ro,W	94.55	NA
	Barleria prionitis L.	S	P	Ch		C,K	**M:**Le,Ro,Sb	78.18	NA
	Ecbolium viride Alston	S	P	Ch		C,K	**M:**Le,Ro	70.91	NA
	Justicia gendarussa Burm. f.	S	A	Th		C,K	**M:**Le	80.00	NA
	Rungia pectinata (L.) Nees	H	A	Th		C,K	**M:**Le,Ro,W	67.27	NA
Verbenaceae J. St.Hil.	*Lantana camara* L.	S	P	Ch		C,K	**I:**Fr,Le,Sb;**M:**W	32.73	NA
Lamiaceae Martinov	*Anisochilus carnosus* (L. f.) Benth.	H	A	Ch		C	**M:**Le	41.82	NA
	Clerodendrum indicum (L.) Kuntze	S	A	Ch		C,K	**M:**Le,Ro	58.18	NA
	Hyptis suaveolens (L.) Poit.	H	A	Ch		C,K	**M:**Fl,Le,Ro	85.45	NA
	Ocimum americanum L.	H	A	Th		C, K	**M:**Le,Ro,Se**;Sa:**Le,W	100.00	NA
	Vitex negundo L.	T	P	Ph	N	K	**I:**Le,St;**M:**Fl,Fr,Le,Rb,Ro,Sb,Se	100.00	NA
Asterales Link									
Asteraceae Bercht. & J. Presl	*Ageratum conyzoides* (L.) L.	H	A	Th		C,K	**M:**Le,Ro	20.00	NA
	Blumea lacera (Burm.f.) DC.	H	A	Th		C,K	**M:**Le,Ro,W	23.64	NA
	Chromolaena odorata (L.) R.M.King & H.Rob.	H	A	Ch		C,K	**I:**Le,St;**M:**W	40.00	NA
	Enydra fluctuans DC.	H	A	Th		C,K	**E:**Le,St;**M:**Le	96.36	LC
	Vernonia anthelmintica (L.) Willd.	H	A	Th		C,K	**M:**Fl,Ro,Se	87.27	NA
	Xanthium strumarium L.	H	A	Th		C,K	**M:**Fr,Le,Ro,Se	74.55	NA

Abbreviation:
***In Habit*: T**-Tree, **S**-Shrub, **H**-Herb, **C**-Climber.
***In Life-Span*: A**- Annual, **P**-Perennial.
***In Raunkiaer's Life-form and Sub-type*: Ch**- Chamaephytes, **Cr**- Cryptophytes, **He**-Hemicryptophytes, **MM**- Megaphanerophytes, **M**- Mesophanerophyte, **N**-Nanophanerophytes, **Ph**- Phanerophytes, **Th**-Therophytes.
***In Distribution*: C**-Copraburi, **K**-Kawa Sarnd
***In Importance (s) and Part (s) used:* B**-Bulb, **D**-Dye, **E**-Edible, **Fi**-Fiber, **Fl**-Flower, **Fo**-Fodder, **Fr**-Fruit, **G**-Gum, **I**-Insecticidal, **J**-Juice **La**-Latex, **Le**-Leaf, **M**-Medicinal, **Oi**-Oil, **Or**-Ornamental, **P**-Pod, **Rb**-Root bark, **Rh**-Rhizome, **Ro**-Root, **Rs**-Root stock, **Sa**-Sacred, **Sb**- Stem bark, **Se**-Seed, **St**-Stem, **Ta**-Tannin, **Ti**-Timber, **Tu**-Tuber, **W**-Whole plant.
***In IUCN Status*: LC**- Least Concern, **NA**-Not Accessed

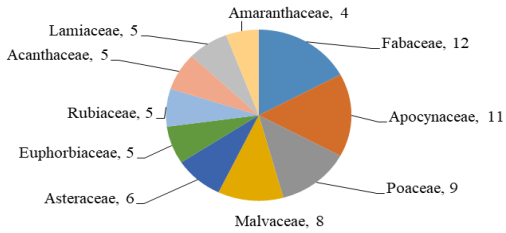

Fig. 5. Contribution of families containing genera (≥4 genera)

Species diversity in different growth form

The present floristic study of these sacred groves shows that they harbor a total of 120 plant species (dicots 104 and monocots 16) belonging to 113 genera under 43 families. Of them, 43 (35.83%) annual and 77 (34.17%) are perennial species. Among these, 47 (39.17%) of the reported species are herb. Other highly reported species are shrub 26 (21.66%), climber 24 (20%) and tree 23 (19.17%) respectively (Table 4 and Figure 6).

Table 4. Summary of different angiospermic taxa.

Group	Families	Genera	Species				
			Herbs	Shrub (s)	Tree (s)	Climber	Total
Dicots	38	99	33	25	22	24	104
Monocots	05	14	14	1	1	0	16
Total	**43**	**113**	**47**	**26**	**23**	**24**	**120**

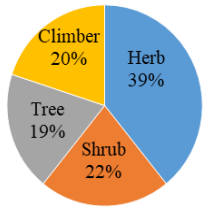

Fig. 6. Percentage of habits of angiosperm plants

Of the 43 families, dicots are represented by 38 (88.37%) families; monocots consist of 5 (11.63%) families. Amongst the total dicots (86.67%) and monocots (13.33%), herbs, shrubs, trees and climbers represent 33, 25, 22, 24 and 14, 1, 1, 0 species respectively, representing 27.5%, 20.83%, 18.34%, 20% and 11.67%, 0.83 %, 0.83%, 0 % of the total species (Table 4; Fig. 7).

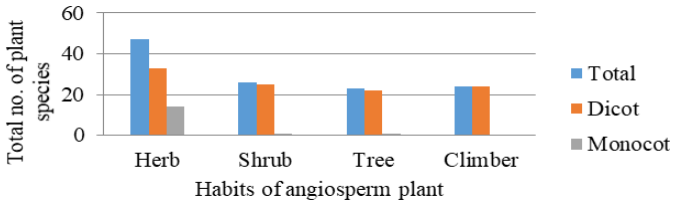

Fig. 7. Species diversity of different angiosperm plant habit

These species have formed diverse communities tailored to their ecological needs and the management imposed by humans over the past years. It seems that high plant diversity in these areas is due to edaphic, topographic, and physiographic conditions. Of course, the climatic factor is also effective in this regard, but variations in climatic conditions of the area are less

than the other factors. The common use of herbaceous medicinal angiosperm plants was also reported in other parts of the world and attributed to their wide range of bioactive ingredients. Traditional healers used herbs and trees most commonly as medicine due to the availability in nature [68-69].

Canopy trees

The canopy is composed of 10-12 tree species. For instance- *Adenanthera pavonina*, *Aegle marmelos*, *Azadirachta indica*, *Bombax ceiba*, *Diospyros exsculpta*, *Diospyros montana*, *Ficus benghalensis*, *Ficus religiosa*, *Holoptelea integrifolia*, *Lannea coromandelica*, *Pterospermum acerifolium* and *Strychnos nux-vomica*. The presence of several climax species such as *Diospyros montana*, *Ficus benghalensis*, *Pterospermum acerifolium* and *Strychnos nux-vomica* suggest these groves are the remnants of the primary forest of the area (Table 3).

Sub canopy and small trees

The subcanopy and small or shade tolerant trees was composed of fewer species. The commonly found species in this group are *Alangium salviifolium*, *Bridelia tomentosa*, *Butea monosperma*, *Cassia fistula*, *Morinda citrifolia*, *Naringi crenulata*, *Pongamia pinnata*, *Tamilnadia uliginosa*, *Vitex negundo* and *Wrightia antidysenterica* (Table 3).

Shrubs

The large shade tolerant and small perennial shrubs are represented by 26 (21.66%). Taxa like *Barleria prionitis*, *Breynia vitis-idaea*, *Calotropis gigantea*, *Cassia occidentalis*, *Clerodendrum indicum*, *Datura metel*, *Euphorbia antiquorum*, *Flacourtia indica*, *Flemingia strobilifera*, *Hibiscus vitifolius*, *Jatropha gossypiifolia*, *Lantana camara*, *Meyna spinosa*, *Mimosa rubicaulis*, *Opuntia stricta* and *Rauvolfia tetraphylla* are abundant in these groves (Table 3).

Herbs

Herbaceous species, 47 (39.17%), including the secondary species are found in these groves. The secondary invasive species are confined to the periphery and in disturbed patches of these groves. Some interesting herbaceous plants found inside these groves include *Achyranthes aspera* var. *indica*, *Amaranthus spinosus*, *Andrographis echioides*, *Anisochilus carnosus*, *Argemone mexicana*, *Chromolaena odorata*, *Corchorus aestuans*, *Curculigo orchioides*, *Cynodon dactylon*, *Desmodium gangeticum*, *Enydra fluctuans*, *Hyptis suaveolens*, *Indigofera tinctoria*, *Martynia annua*, *Ocimum americanum*, *Rungia pectinata*, *Solanum americanum*, *Tribulus terrestris*, *Vernonia anthelmintica* and *Xanthium strumarium* (Table 3).

Climber/Lianas

This group is constituted mechanically dependent plant requiring strong, erect plants to support, twine or climb. There are 24 (20%) species of such plants. Some of common species in this category are *Abrus precatorius*, *Aristolochia indica*, *Capparis zeylanica*, *Cayratia trifolia*, *Celastrus paniculatus*, *Cissus quinquangularis*, *Combretum decandrum*, *Cryptolepis dubia*, *Hemidesmus indicus*, *Ichnocarpus frutescens*, *Marsdenia sylvestris*, *Pergularia daemia*, *Stephania japonica*, *Tinospora cordifolia*, *Tylophora indica*, *Vallaris solanacea*, *Ventilago denticulata* var. *bifida* and *Ziziphus oenopolia* (Table 3).

Plant part(s) used for NTFPs and ethnomedicine

Both groves support 19 timber- yielding plant species and a good number of NTFPs (Non Timber Forest Products), of which, 12 species bear edible parts, 6 species produce fiber, 15 species have fodder value, 2 species yield gum, 6 species produce dye, 6 species have insecticidal properties, 120 species have medicinal properties, 6 species yield oil, 7 species have ornamental value, 6 species are tannin-yielding and 9 species have sacred value (Table 3 and Figure 8).

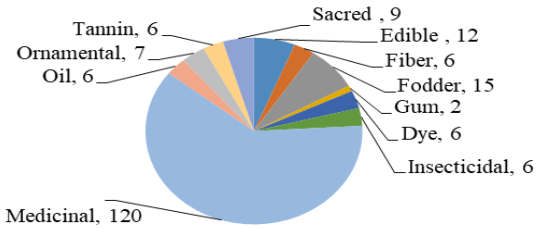

Fig. 8. NTFPs of different plant species

A total of 120 ethnomedicinally important plants was collected and identified belonging to 24 orders, 43 families and 113 genera, of which 104 are dicots and remaining 16 species are monocots. In both groves, herbs are represented by 47 species and are found to be a more prominent growth-form for treatment of various ailments followed by shrubs (26 species), climbers (24 species) and trees (23 species). The local people of the groves recognized the plant species by the various vernacular names and suggested of the medicinal of these plant (s) part(s). Of the various plant part (s) used for the treatment of ailments, the leaves were being used maximum represented by 82.5%, followed by root (58.33%), Fruit (41.67%), seed (32.5%), stem (30%), whole plant (25.83%), stem bark (21.67%), flower (13.33%), latex (9.17%), root bark (8.33%), rhizome (3.33), tuber (2.5%), pod (1.67%) and juice (0.83%) respectively (Table 3 and Figure 9). Most of the ethnomedicinal plants are common among the different sacred groves and the way of using the medicinal plants is quite similar among the different local communities of the sacred groves with several taboos. All over the world tribal communities, utilized for the preparation of herbal medicine using leaves [70-71]. The reason why the leaves were used most that they are collected very easily than underground parts, flowers and fruits etc. and in a scientific point of view leaves are active in photosynthesis and production of metabolites [72-73].

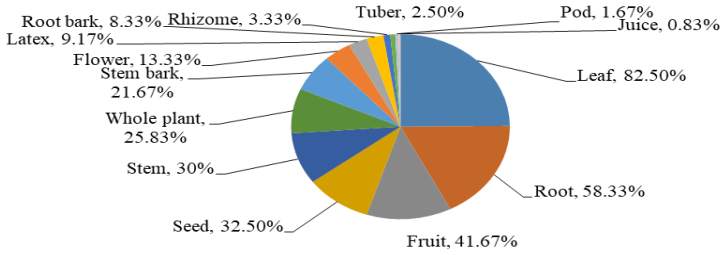

Fig. 9. Plant parts used for indigenous medicine

Biological spectrum

The life form was an important physiognomic attribute that had been widely used in vegetation studies and also it indicates macro and microclimate, as well as human disturbance of a particular area [74]. However, the system of Raunkiaer [61] is the most accepted which is based upon the principle of position and degree of protection of the perennating organs during the unfavorable or adverse seasons. A biological spectrum is formed when all the species of higher plants of a community are classified into life forms of an area and their ratio, expressed in numbers or percentage; reflects its phytoclimatic conditions, adaptation of plant to environment and primary climate [75].

The biological spectrum shows that phanerophytes (51 spp., 42.5%) is the dominant followed by therophytes (33 spp., 27.5%), chamaephytes (21 spp., 17.5%), hemicryptophytes (13 spp., 10.83 %) and cryptophytes (2 sp., 1.67%) (Tables 3 and 5).

Table 5. Biological spectrum (% of all life forms) of the sacred groves and its comparison with Raunkiaer's normal spectrum.

Life forms	Total no. of species	Biological spectrum of sacred groves (%)	Raunkiaer's normal spectrum (%)	Difference=(Raunkiaer's normal spectrum-Biological spectrum)
Phanerophytes (Ph)	51	42.50	46.00	-3.5
Megaphanerophytes (MM)	*07*	*5.84*	*3.00*	2.84
Mesophanerophyte (M)	*10*	*8.33*	*28.00*	-19.67
Nanophanerophytes (N)	*34*	*28.33*	*15.00*	13.33
Chamaephytes (Ch)	21	17.50	9.00	8.5
Hemicryptophytes (He)	13	10.83	26.00	-15.17
Cryptophytes (Cr)	02	1.67	6.00	-4.33
Therophytes (Th)	33	27.50	13.00	14.5
Total	**120**	**100.00**	**100.00**	

It reveals that therophytes and chamaephytes constitute the higher percentage 14.5% and 8.5% respectively than the normal spectrum exhibiting "thero-chamaephytic" phytoclimate. Further the number of hemicryptophytes 15.17%, cryptophytes 4.33% and phanerophytes 3.5% are comparatively smaller in percentage than the normal spectrum. Of the phanerophytes, nanophanerophytes (13.33%) and megaphanerophytes (2.84%) are somewhat larger and mesophanerophyte (19.67%) comparatively smaller value than the normal spectrum (Tables 3 and 5; Figure 10).

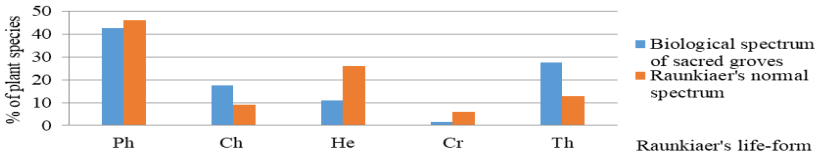

Fig. 10. Comparison of biological spectrum of the sacred groves with Raunkiaer's normal spectrum

The high percentage of therophytes and chamaephytes indicates high biomass turnover per year as most of the annuals complete their life cycle within a period of a few months and through their decay, nutrients return to the soil. The importance of life form classes in terms of species content may indicate adaptation and evolutionary diversification of flora in relation to climate because most of the therophytes are strictly seasonal. The dominance of therophytes and chamaephytes than the Raunkiaer's normal spectrum indicates that the investigated area is under biotic pressure. Many plant species are decreasing in the area. It should be the moral and ethical duty of the local people to protect the plant resources.

IUCN status

Among the 120 plants, 109 plants have not been evaluated still now (Table 3). There are 11 Least Concerned (LC) species. In view of the above phytosociological analysis with ecological information about IUCN Red Listed plants reveals that the plants are still present and regenerate in the sacred groves but locally endangered in nearby forests. This study would highlight the status and distribution of the species in the study area, the ecological characteristics necessary for its survival and the threats faced by some of the species designated by following the criteria devised by IUCN [46].

Quantitative data analysis

Local people used different parts of the plant species to prepare herbal medicine. All parts of various plants are used in the traditional medication of different diseases; however, the most frequently used parts are leaves. These results are in agreement with Ugulu and Baslar [76], where leaves are found to be the most frequently used parts. The local people also used other ingredients to prepare the remedies. The highest FL (i.e., 100) value is recorded for 10

plants, but the number of informants usually differs; these are *Abrus precatorius*, *Achyranthes aspera* var. *indica*, *Aegle marmelos*, *Azadirachta indica*, *Calotropis gigantea*, *Cynodon dactylon*, *Ocimum americanum*, *Strychnos nux-vomica*, *Vitex negundo* and *Wrightia antidysenterica*. Lowest fidelity level (i.e., 14.55) showed by *Sporobolus indicus*. 94 (78.34%) of medicinal plants used by the sacred groves-based village peoples had a FL value of over 50 (Table 3). This indicates the general acceptance of inventoried plants as medicinal plants within the community.

Ecosystem services, management and threat

Ecosystem services are those benefits we human beings derive from nature. They can be divided into supporting, provisioning, regulating and cultural services. Plants are largely responsible for primary production and therefore are critical for maintaining human well-being, but they also contribute in many other ways [77]. The groves additionally provide cultural space to the communities as a common property resource. They act as platforms for assertion of group identity and group solidarity [78]. The local people form incipient coalitions while participating in the different sacred grove-predicated rituals and festivals. Propitiation of deities inside the grove has economic pertinence in terms of good rainfall, prosperous agricultural production, welfare of domestic animals and source of medicine, timber, fruits etc. during scarcity [20]. Moreover, the groves provide moral support and guidance to the communities. The local people do not harvest any plant or plant part, since the sacred groves are considered as abodes of deities but may collect plants after social sanction from the custodians of the groves, and that too in a sustainable way [79].

Sacred groves are the tracts of virgin forest that were left untouched by the local inhabitants, harbor affluent biodiversity, and are protected by the local people due to their cultural and religious notions and taboos that the deities reside in them [80]. Local communities believe that the deity will penalize them when they were taken plant components from the grove. Furthermore, these groves act as a social space where people aren't only exchanging their cultural identity, but additionally find community solidarity during festivals. The CSG and KSG sacred groves though fairly protects, are facing some threats due to rope producing (*Eulaliopsis binata*) grass-field encroachment, dying of old trees and exotic weed invasion. Therefore, there is an exigent need to protect these sacred groves.

Conclusion

The sacred grove in essence represents the traditional Indian way of *in-situ* conservation of biodiversity. It is also indicative of the rich vegetation that had subsisted around the area in the past. Moreover, the grove and socio-religious practices centering on it act as a social institution where villagers and the local people not only exchange their cultural identity but additionally find community solidarity. Various social and religious rituals and celebrations are performed in the groves, and except for the medicinal purpose, none of the plant species are harmed by human beings. Indubitably, the sacred groves are a refuge for the infrequency and endemism of several plant species and can be termed as a treasure house of threatened species, dispensary of medicinal plants and gene bank for economically important species [28]. In the present study, the species in the sacred grove were utilized medicinally towards the health care of indigenous rural people settled in the vicinity. The convivial customs and management traditions, techniques of local communities proved largely prosperous in the past and ergo have the potential to protect sacred groves in the future.

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References

[1] D. Lamb, P.D. Erskine, J.A. Parrotta, *Restoration of degraded tropical forest landscapes*, **Science**, **310**, 2005, pp. 1628-1632.
[2] S. Maginnis, W. Jackson, *Balancing restoration and development*, **ITTO Tropical Forest Update, 15,** 2005, pp. **4-6.**
[3] Fazey, J. Fischer, D.B. Lindenmayer, *What do conservation biologists publish*? **Biological Conservation, 124**, 2005, pp. 63-73.
[4] * * *, **Forest Management Outside Protected Areas**, Position Paper, Gland: WWF, 2002.
[5] T.M. Whitmore, B.L. Turner, **Cultivated Landscapes of Middle America on the Eve of Conquest**, Oxford University Press, Oxford, 2001.
[6] M.J. Heckenberger, A. Kuikuro, U.T. Kuikuro, J.C. Russell, M. Schmidt, C. Fausto, B. Franchetto, *Amazonia 1492: pristine forest or cultural parkland*?, **Science**, **301**, 2003, pp. 1710-1714.
[7] V.M. Toledo, B. Ortiz-Espejel, L. Cortés, P. Moguel, M.D.J. Ordoñez, *The multiple uses of tropical forests by indigenous peoples in Mexico: a case of adaptive management*, **Conservation Ecology**, **7**(3), 2003, Article no. 9.
[8] S.R. Carpenter, R. DeFries, T. Dietz, H.A. Mooney, S. Polasky, W.V. Reid, R.J. Scholes, *Millennium ecosystem assessment: research needs*, **Science**, **314**, 2006, pp. 257-258.
[9] M. Loreau, S. Naeem, P. Inchausti, J. Bengtsson, J.P. Grime, A. Hector, D.U. Hooper, M.A. Huston, D. Raffaelli, B. Schmid, D. Tilman, *Biodiversity and ecosystem functioning: current knowledge and future challenges*, **Science**, **294**, 2001, pp. 804-808.
[10] K. Brown, **Addressing Trade-Offs in Forest Landscape Restoration, Forest Restoration in Landscapes: Beyond Planting Trees** (Editors: S. Mansourian, D. Vallauri, N. Dudley), Springer, USA: New York, 2005, p. 59–62.
[11] S. Pagiola, A. Arcenas, G. Platais, *Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America*, **World Development**, **33**, 2005, pp. 237-253.
[12] P.F. Donald, A.D. Evans, *Habitat connectivity and matrix restoration: the wider implications of agri-environment schemes*, **Journal of Applied Ecology**, **43**, 2006, pp. 209-218.
[13] R. Gallagher, B. Carpenter, *Human-dominated ecosystems*, **Science**, **277**, 1997, pp. 485-485.
[14] J.D. Hughes, M.D.S. Chandran, *Sacred groves around the earth: an overview*, **Conserving the Sacred for Biodiversity Management** (Editors: P.S. Ramakrishnan, K.G. Saxena, U.M. Chandrashekara), Oxford and IBH: New Delhi, India, 1998, p. 69-86.
[15] P.C. Phondani, R.K. Maikhuri, N.S. Bisht, *Endorsement of ethnomedicinal knowledge towards conservation in the context of changing socio-economic and cultural values of traditional communities around Binsar Wildlife Sanctuary in Uttarakhand, India*, **Journal of Agriculture and Environment Ethics**, **26**, 2013, pp. 573-600.
[16] K.C. Malhotra, Y. Gokhale, S. Chatterjee, S. Srivastava, **Cultural and Ecological Dimensions of Sacred Groves in India**, Indian National Science Academy & Indira Gandhi Rashtriya Manav Sangrahalaya: New Delhi & Bhopal, India, 2001.
[17] V. Jaryan, S.K. Uniyal, R.D. Singh, B. Lal, A. Kumar, V. Sharma, *Role of traditional conservation practice: highlighting the importance of Shivbari sacred grove in biodiversity conservation*, **Environmentalist**, **30**, 2010, pp. 101-110.

[18] H. Singh, T. Husain, P. Agnihotri, P.C. Pande, S. Khatoon, *An ethnobotanical study of medicinal plants used in sacred groves of Kumaon Himalaya, Uttarakhand, India*, **Journal of Ethnopharmacology**, **154**, 2014, pp. 98-108.
[19] V.V. Wagh, A.K. Jain, *Inventory of ethnobotanicals and other systematic procedures for regional conservation of medicinal and sacred plants*, **Environment Systems and Decisions**, **35**, 2015, pp. 143-156.
[20] R.K. Bhakat, U.K. Sen, *Sacred grove as an institution of culture and conservation*, **Indian Journal of Biological Sciences**, **18**, 2012, pp. 38-40.
[21] G. Pungetti, *Biocultural diversity for sustainable ecological, cultural and sacred landscapes: the biocultural landscape approach*, **Landscape Ecology for Sustainable Environment and Culture** (Editors: B. Fu, K.B. Jones), Springer: Netherlands: 2013, pp. 55-76.
[22] M. Gadgil, F. Berkes, C. Folke, *Indigenous knowledge for biodiversity conservation*, **Ambio**, **22**, 1993, pp. 151-156.
[23] E.I.O. King, C. Viji, D. Narasimhan, *Sacred groves: traditional ecological heritage*. **Journal of Ecology and Environmental Sciences, 23**, 1997, pp. 463-470.
[24] R.K. Bhakat, *Socio-cultural and ecological perspectives of a sacred grove from Midnapore district*, **Science and Culture**, **69**, 2003, pp. 371-374.
[25] R.K. Bhakat, *Chilkigarh Kanak Durga sacred grove, West Bengal*, **Current Science**, **9**, 2009, pp. 185.
[26] R.K. Bhakat, *Plant resources of Chilkigarh Kanak Durga sacred grove, West Bengal*, **Indian Journal of Forestry**, **33**, 2010, pp. 257-269.
[27] M.G. Chandrakanth, M.G. Bhat, M.S. Accavva, *Socio-economic changes and sacred groves in south India: Protecting a community-based resource management institution*, **Natural Resource Forum**, **28**, 2004, pp. 102-111.
[28] M.L. Khan, A.D. Khumbongmayum, R.S. Tripathi, *The sacred groves and their significance in conserving biodiversity: An overview*, **Journal of Ecology and Environmental Science**, **34**, 2008, pp. 277-291.
[29] U.K. Sen, R.K. Bhakat, *Sacred grove and plant conservation: An insight from taxonomy and ecology*, **Mutidisciplinary Approaches in Angiosperm Systamatics** (Editors: G.G. Maiti, S.K. Mukherjee), Department of Botany, University of Kalyani: West Bengal, India, 2012, pp. 410-421.
[30] Anon, **District Human Development Report, Paschim Medinipur**, Development and Planning Department, Government of West Bengal: Kolkata, India, 2011.
[31] R.K. Bhakat, U.K. Sen, *Conservation value of a sacred grove*, **West Bengal Biodiversity Board**, **4**, 2013a, pp. 6-7.
[32] R.K. Bhakat, U.K. Sen, *Conservation value of a sacred grove*, **Indian Journal of Forestry**, **36**, 2013b, pp. 217-226.
[33] S.K. Jain, R.R. Rao, **A Handbook of Field and Herbarium Methods**, Today and Tomorrow's Printers and Publishers: New Delhi, India, 1977.
[34] J.D. Hooker, **The Flora of British India** (vols. 1-7), Bishen Singh Mahendra Pal Singh: Dehra Dun, India, 1872-1897.
[35] D. Prain, **Bengal Plants** (vol. 1), Botanical Survey of India; Calcutta, India, 1903a.
[36] D. Prain, **Bengal Plants** (vol. 2), Botanical Survey of India; Calcutta, India, 1903b.
[37] H.H. Haines, **The Botany of Bihar and Orissa** (vols. 1-6) Botanical Survey of India; Calcutta, India, 1921–1925.
[38] M.N. Sanyal, **Flora of Bankura District,** Bishen Singh Mahendra Pal Singh: Dehra Dun, India, 1994.
[39] N.L. Bor, **The grasses of Burma, Ceylon, India and Pakistan (excluding Bambuseae)**, Pergamon Press: London, 1960.

[40] V. Singh, **Monograph on Indian Leucas (Lamiaceae)**, Scientific Publishers: Jodhpur, India, 2000.
[41] V. Singh, **Monograph on Indian Subtribe Cassinae (Caesalpiniaceae)**, Scientific Publishers: Jodhpur, India, 2001.
[42] V. Singh, **Monograph on Indian Diospyros L. (Persimon, Ebony) Ebenaceae**. Botanical Survey of India: Kolkata, India, 2005.
[43] S.C. Datta, N.C. Majumdar, *Flora of Calcutta and vicinity*, **Bulletin of Botanical Society of Bengal**, **20**, 1966, pp. 16-120.
[44] S. Maji, J.K. Sikdar, *Sedges and grasses of Midnapore district, West Bengal*, **Journal of Economic and Taxonomic Botany, 4**(1), 1983, pp. 233-254.
[45] K.N. Nair, M.P. Nayar, **Rutaceae, Flora of India (Malpighiaceae-Dichapetalaceae)** (editors: P.K. Hajra, V.J. Nair, P. Daniel) Botanical Survey of India: Calcutta, India, 1997, p. 259-408.
[46] * * *, **The IUCN Red List of Threatened Species**, Version 2017-1. www.iucnredlist.org, downloaded on 17 May 2017.
[47] APG, *An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV*, **Botanical Journal of Linnaean Society**, **181**, 2016, pp. 1-20.
[48] K.R. Kirtikar, B.D. Basu, **Indian Medicinal Plants** (vols. 1-4), Bishen Singh Mahendra Pal Singh: Dehra Dun, India, 1935.
[49] M.P. Nayar, K. Ramamurthy, V.S. Agarwal, **Economic Plants of India** (vol. 1-2), Botanical Survey of India: Calcutta, India, 1989.
[50] A.Ghosh, **Paschimbanglar Udvid** (vol. 1), Botanical Survey of India: Kolkata, India, 1997.
[51] A. Ghosh, **Paschimbanglar Udvid** (vol. 2), Botanical Survey of India: Kolkata, India, 1998.
[52] Ghosh, **Paschimbanglar Udvid** (vol. 3), Botanical Survey of India: Kolkata, India, 2001.
[53] Ghosh. **Paschimbanglar Udvid** (vol. 4), Botanical Survey of India: Kolkata, India, 2005.
[54] M.P. Shiva, **Inventory of Forest Resources for Sustainable Management and Biodiversity Conservation**, Indus Publishing Company: New Delhi, India, 1998.
[55] A.B. Cunningham **Applied ethnobotany: people, wild plant use and conservation**, Earthscan Publications: London, 2001.
[56] S.C. Pakrashi, S. Mukhopadhya, **Medicinal and Aromatic Plants of Red Laterite Region of West Bengal (Bankura, Medinipore and Purulia)**, West Bengal Academy of Science and Technology: Kolkata, India, 2004.
[57] N. Paria, **Medicinal Plant Resources of South West Bengal** (vol.-1), Research Wing, Directorate of Forests in collaboration with Department of Environment, Government of West Bengal: Kolkata, India, 2005.
[58] R.K. Bhakat, U.K. Sen, *Ethnomedicinal plant conservation through sacred groves*, **Tribes and Tribals, 2**(Spl Vol), 2008, pp. 55-58.
[59] A. Ghosh, C. Ghara, S. Murmu, **Paschimbanglar Udvid** (vol. 5), Botanical Survey of India: Kolkata, India, 2008.
[60] Anon, **Medicinal Plant Resources of South West Bengal** (vol. 2), Research Wing, Directorate of Forests, Government of West Bengal: Kolkata, India, 2010.
[61] C. Raunkiaer, **The Life Forms of Plants and Statistical Plant Geography**, Clarendon Press: Oxford, 1934.
[62] Hoffman, T. Gallaher, *Importance indices in ethnobotany*, **Ethnobotany Research and Applications**, **5**, 2007, pp. 201-218.
[63] G. Gnanasekaran, P. Nehru, D. Narasimhan, *Angiosperms of Sendirakillai Sacred Grove (SSG), Cuddalore District, Tamil Nadu, India*, **Check List**, **8,** 2012, pp. 113-129.

[64] J. Mygatt, J. Medeiros, **Lab Manual to the Flora of New Mexico**, University of New Mexico: Albuquerque, USA, 2009.
[65] A.J. Pérez-Luque, F.J. Bonet, R. Pérez-Pérez, R. Aspizua, J. Lorite, R. Zamora, *Sinfonevada: Dataset of floristic diversity in Sierra Nevada forests (SE Spain)*, **PhytoKeys**, **35**, 2014, pp. 1.
[66] K.S. Gajbhiye, C. Mandal, **Agro-Ecological Zones, Their Soil Resource and Cropping Systems,** Status of farm mechanization in India, 2000, p. 1-32.
[67] R.K. Bhakat, U.K. Sen, P.K. Pandit, *Role of a sacred grove in conservation of plants*, **Indian Forester, 134**, 2008, pp. 866-874.
[68] M. Grieve, **A Modern Herbal: The Medicinal, Culinary, Cosmetic and Economic Properties, Cultivation and Folk-Lore of Herbs, Grasses, Fungi, Shrubs, & Trees With All Their Modern Scientific Uses** (vol. 2), Courier Corporation, 1971.
[69] Muthu, M. Ayyanar, N. Raja, S. Ignacimuthu, *Medicinal plants used by traditional healers in Kancheepuram District of Tamil Nadu, India*, **Journal of Ethnobiology and Ethnomedicine**, **2,** 2006, pp. 43.
[70] S. Prabhu, S. Vijayakumar, J.M. Yabesh, K. Ravichandran, B. Sakthivel, *Documentation and quantitative analysis of the local knowledge on medicinal plants in Kalrayan hills of Villupuram district, Tamil Nadu, India*, **Journal of Ethnopharmacology, 157**, 2014, pp. 7-20.
[71] J.M. Yabesh, S. Prabhu, S. Vijayakumar, *An ethnobotanical study of medicinal plants used by traditional healers in silent valley of Kerala, India*, **Journal of Ethnopharmacology**, **154**, 2014, pp.774-789.
[72] M. Giday, Z. Asfaw, Z. Woldu, *Medicinal plants of the Meinit ethnic group of Ethiopia: an ethnobotanical study*, **Journal of Ethnopharmacology**, **124**, 2009, pp. 513-521.
[73] A. Ghorbani, *Studies on pharmaceutical ethnobotany in the region of Turkmen Sahra, north of Iran:(Part 1): General results*, **Journal of Ethnopharmacology, 102**, 2005, pp. 58-68.
[74] S. Nautiyal, R.K. Maikhuri, K.S. Rao, K.G. Saxena, *Medicinal plant resources in Nanda Devi biosphere reserve in the central Himalayas*, **Journal of Herbs Spices and Medicinal Plants**, **8**, 2001, pp. 47-64.
[75] R.L. Smith**, Ecology and Field Biology**, Harper and Row Publishers: New York, USA, 1980.
[76] Ugulu, S. Baslar, *The determination and fidelity level of medicinal plants used to make traditional Turkish salves*, **Journal of Alternative and Complementary Medicine**, **16**, 2010, pp. 313-322.
[77] D. Raffaelli, P.C. White, *Ecosystems and their services in a changing world: an ecological perspective*, **Advance Ecological Research**, **48**, 2013, pp. 1-70.
[78] A. Agrawal, C.C. Gibson, *Enchantment and disenchantment: the role of community in natural resource conservation*, **World Development**, **27**, 1999, pp. 629-649.
[79] R.K. Bhakat, N.S. Kundu, *Social and conservation values of two sacred groves of Bankura district, West Bengal*, **Indian Journal of Biological Sciences**, **17**, 2011, pp. 1-5.
[80] V.D. Vartak, M.S. Kumbhojkar, D.S. Nipunage, *Sacred groves of tribal areas along the Western Ghats: Treasure trove of medicinal plants*, **Bulletin of Medico-Ethno Botanical Research**, **3**, 1987, pp. 77-84.

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