

Phyto-sociological studies of woody vegetation of Purandar Tahsil Dist. Pune, M.S. (India)

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Abstract

Vegetation ecology is the study of both structure of vegetation and vegetation systematics. This contains the investigation of species composition and the sociological interface of species in communities. In a phyto-sociological study, field sampling is the first step. The quadrat methods were used for studying the plant community/synecology. In all 170 quadrats (30m x 30m) for woody vegetation were laid down in the Purandar tehsil. GPS was noted for every quadrat placed at various locations. Based on the data recorded by quadrat method, qualitative and quantitative structures analysed were Frequency, Abundance, Density, Girth at Breast Height, and IVI. The highest Simpson species diversity for woody vegetation reported was 0.94 and Shannon's 3.27; thus, illustrating the rich plant diversity.

According to the Raunkiaer's law of frequency classes Purandar tehsil represents heterogenous vegetation. The primary and secondary compositions were noted for the other 17 locations of the tehsil where perennial vegetation was studied.

Keywords: Phytosociology, woody, quadrat, raunkiaer's law, importance value index

Introduction

The quantitative structure of the study of vegetation has been called as 'Phyto-sociology' (Odum, 1971) [2]. Phytosociology is also called a Vegetation science, Vegetation ecology, Sociological geobotany, ecological geobotany etc. Plants naturally occur together in repetitive groups of associated plants and most frequent and abundant plants describe them well (Mueller- Dombois, 1974) [3]. Vegetation is an assemblage of plants growing together in a particular location and may be characterised either by its species composition or by combination of structural and functional characters that describe the appearance or physiognomy of vegetation (Goldsmith *et al.* 1992) [4]. Vegetation form is a significant feature of the given area (Arey, 2010). Phytosociological and floristic studies are

widely recognised as being important in acquiring baseline data for the planning and management of any area (Mahajan, Shinde, 2021) [7]. Species composition patterns and outcrop communities are Influenced by multiple environmental factors like soil type, elevation, aspect of rock outcrop and micro-environments. Complete diversity on the plateaus in the northern western ghats is not yet revealed satisfactorily (Rahangdale, 2014) [9].

Phytosociological studies are necessary for protecting the biodiversity and natural plant communities (Rao S.D., Murthy, *et al.*, 2015) [5]. Phytosociological studies are very essential components for understanding the changes accomplished in the past and future (Hamzaoglu, 2006) [8]. Quadrats were laid down in different localities of the tehsil. Fig. 1

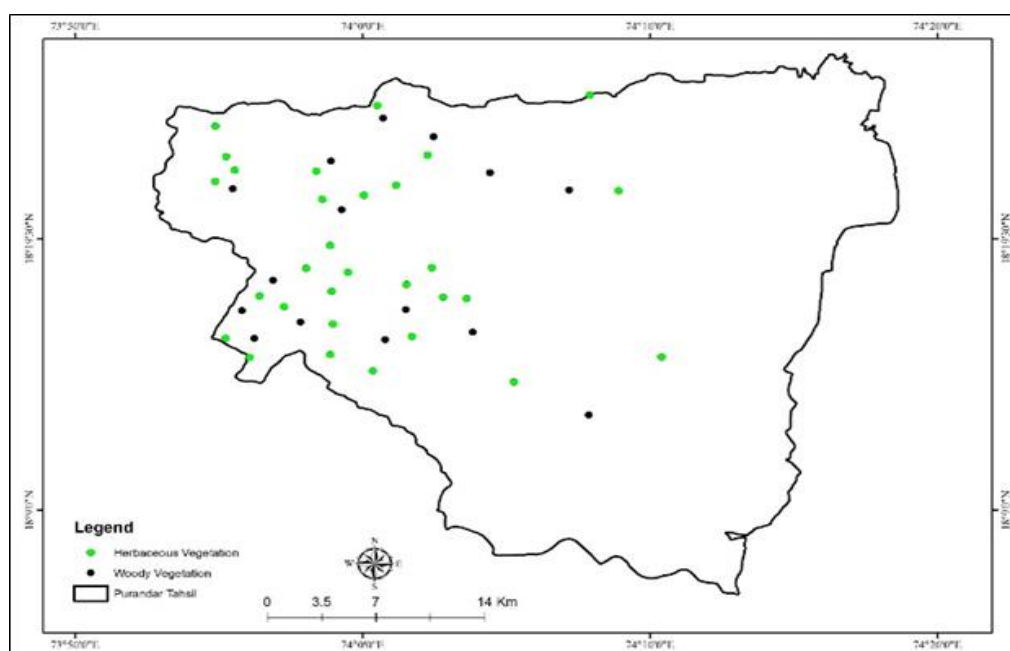


Fig 1: Locations for woody and herbaceous vegetation

Materials and Methods

In a phyto-sociological study, field sampling is the first step. Naturalists use different implements and skills. The different ranges of considerations are in use as they are investigated to understand the vegetation structure. To learn the multiplicity of plant communities in the Purandar tehsil, following techniques of sampling were followed.

Quadrat of 30 x 30 m. for woody vegetation, Scale-tape, GPS Instrument, Paint, Rope, String nails, Plastic rods (04), Notebook and Field diary, Pen, Pencil, Eraser, Ruler etc. are essential.

Plant communities or vegetation are best described by perceiving the identity and growth form of most abundant species. A community is characterised by detailing those species which most contribute to its characteristic structure and composition. The study of the structure and composition of each and every plant community is practically impossible. Therefore, rough estimate of species content of

a locality has been done by observing the plant species at variety of places, in the habitat. The quadrat method was used for studying the plant community/synecology. The size of a quadrat varies with the type of vegetation studies. The methods used by Misra, (1968); Odum, (1971) [2]; Muller-Dombios (1974); Michael, (1984); and Trivedi, Goel, *et al.*, (1988) were followed for the quantification of the data.

Field Sampling

A quadrat is a square sample plot or unit of applicable size for detailed analysis of vegetation. It is actually a sample plot method (Weaver, and Frederic, *et al.*, 1938) [6]. For the woody vegetation communities 30 x30 m. size quadrats were used. 170 quadrats were laid down for woody vegetation in the Purandar tehsil. GPS were noted for each and every locality Fig. 2 and GBH was also noted of each and every tree species having thickness of stem more than 15 cm. Fig.3



Fig 2: Vegetation sampling using GPS



Fig 3: Girth / Diameter at Breast Height

Table 1: Raunkiaer’s frequency classes and its percentage for woody vegetation

Locations of quadrats placed	Class A		Class B		Class C		Class D		Class E	
	No.	%	No.	%	No.	%	No.	%	No.	%
Pingori	37	72.72	6	12.76	3	6.38	0	0	1	2.13
Mandhar	24	75.61	7	21.21	2	6.06	0	0	0	0
Askarwadi	31	75.86	9	21.95	1	2.43	0	0	0	0
Vanpuri	22	76.42	4	13.79	1	3.45	1	3.45	1	3.45
Pargaon (Me.)	24	75.67	3	9.67	3	9.67	1	3.23	0	0
Garade	28	82.75	6	16.22	1	2.7	2	5.4	0	0
Chambli	24	79.25	3	10.34	0	0	2	6.89	0	0
Chivhewadi	42	78.41	9	16.98	1	1.88	1	1.88	0	0
Kodit	21	57.45	5	17.24	2	6.89	1	3.45	0	0
Kumbhshi	27	63.15	10	21.27	7	14.89	3	6.38	0	0
Panwadi	24	76.47	6	15.78	5	13.16	2	5.26	1	2.63
Misalwadi	26	69.69	5	14.71	2	5.88	1	2.94	0	0
Diveghat	27	69.23	4	10.26	2	5.13	5	12.82	1	2.56
Sonori	27	77.14	3	8.57	3	8.57	2	5.71	0	0
Devadi	29	72.5	6	15	2	5	2	5	1	3.44
pagewadi	29	60.41	13	27.08	4	8.33	2	4.16	0	0
Pokharbill	29	64.44	11	24.44	3	6.66	2	4.44	0	0
	471	1227.17	110	277.27	42	107.08	27	71.01	5	14.21
		72.18		16.31		6.29		4.17		0.83

Table 2: Summary of Raunkiaer’s frequency classes’ distribution for woody vegetation

Sampling Area	Class A	Class B	Class C	Class D	Class E
Purandar Tehsil	471	110	42	27	5
Raunkiaer	53	14	9	8	16

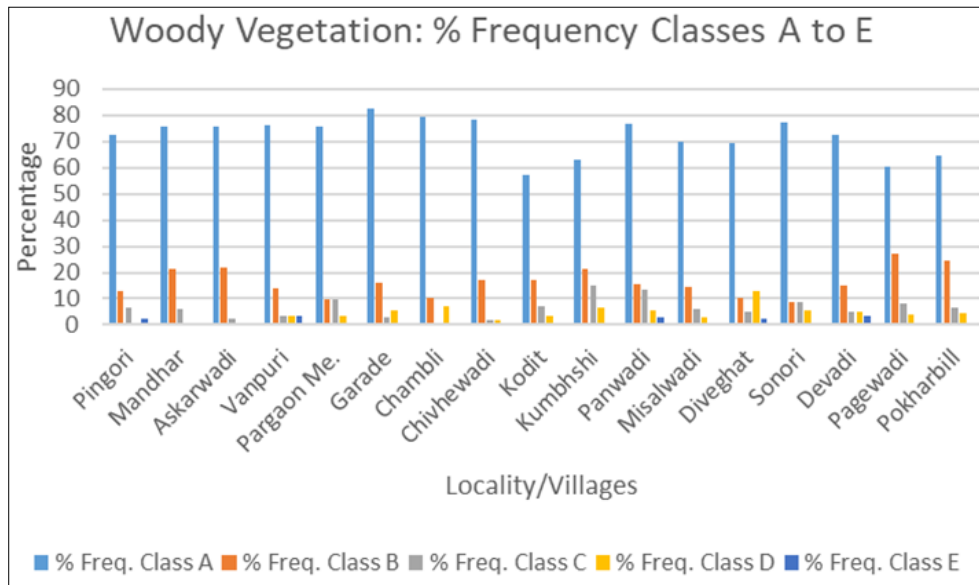


Fig 4: Woody Vegetation- Percentage Frequency Classes

Table 3: Woody Vegetation: Simpson and Shannon’s Index

Sr.	Location for woody vegetation	Simpson index	Shannon index
1.	Pingori	0.82	2.61
2.	Mandhar	0.78	3.09
3.	Askarwadi	0.94	3.15
4.	Vanpuri	0.87	2.49
5.	Pargaon Mem.	0.90	2.71
6.	Garade	0.92	2.91
7.	Chambali	0.71	1.85
8.	Chivhewadi	0.87	2.81
9.	Kodit Bk.	0.91	2.66
10.	Kumbhoshi	0.95	3.27
11.	Panwadi	0.93	3.10
12.	Misalwadi	0.89	2.66
13.	Diveghat	0.87	2.59
14.	Sonori	0.89	2.72
15.	Devadi	0.85	2.60
16.	Pagewadi	0.85	2.71
17.	Pokharbil	0.89	2.87

Table 4: Woody Vegetation- Shannon-Wenier and Simpson Diversity Indices

Sr. No.	Location	Coordinates: for Woody vegetation
1.	Pingori	N 18° 12.680' E0 74° 07.865'
2.	Mandhar	N 18°15.587' E0 74° 0.787'
3.	Askarwadi	N 18° 23.856' E0 73° 54.884'
4.	Vanpuri	N 18° 22.049' E0 74° 04.427'
5.	Pargaon Mem.	N18° 21.384' E0 74° 07.187'
6.	Garade	N 18° 22.304' E0 73° 55.318'
7.	Chambali	N18° 21.889' E0 73° 58.477'
8.	Chivhewadi	N 18° 16.863' E0 73° 57.271'
9.	Kodit Bk.	N 18° 21.258' E0 73° 58.615'
10.	Kumbhoshi	N 18° 17.884' E0 73° 56.885'
11.	Panwadi	N18° 16.749' E0 74° 01.508'
12.	Misalwadi	N 18° 15.646' E073° 56.237'
13.	Diveghat	N 18°24.911' E074° 00.225'
14.	Sonori	N 18° 22.971' E074°02.141'
15.	Devadi	N 18° 17.280' E073° 56.414'
16.	Pagewadi	N 18° 15.715' E0074° 01.718'
17.	Pokhar	N 18° 18.353' E0 73° 58.040'

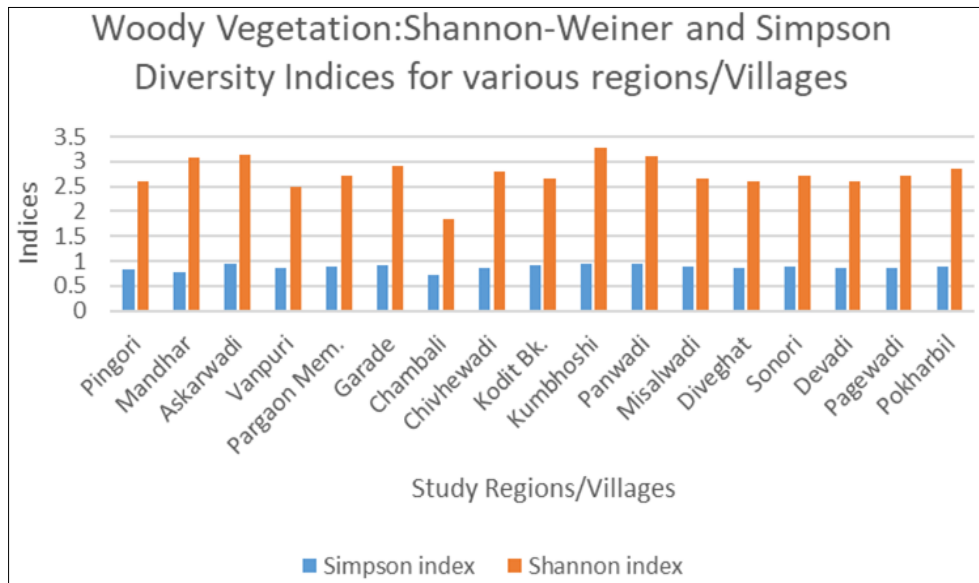


Fig 5: Diversity indices for various locations

Table 5: Tree, shrub and Climber community structure

Village	Plant community	
	Primary Composition	Secondary Composition
Pingori	<i>Azadirachta indica</i> - <i>Ziziphus mauritiana</i> - <i>Moringa oleifera</i>	<i>Acacia nilotica</i> - <i>Vitex negundo</i> - <i>Cassia auriculata</i>
Mandhar	<i>Eucalyptus globosus</i> - <i>Gliricidia sepium</i> <i>Acacia auriculiformis</i>	<i>Gnidia glauca</i> - <i>Ailanthus excelsa</i> - <i>Cissus woodrowii</i>
Askarwadi	<i>Garuga pinnata</i> - <i>Diospyros montana</i> - <i>Grewia tiliifolia</i>	<i>Zizyphus mauritiana</i> - <i>Syzygium cumini</i> - <i>Azadirachta indica</i>
Vanpuri	<i>Azadirachta indica</i> - <i>Dalbergia sissoo</i> - <i>Albizia lebbek</i>	<i>Bauhinia acuminata</i> - <i>Lantana camara</i> - <i>Acacia nilotica</i>
Pargaon	<i>Zizyphus mauritiana</i> - <i>Acacia nilotica</i> - <i>Cassia auriculata</i>	<i>Cissus woodrowii</i> - <i>Ailanthus excelsa</i> - <i>Azadirachta indica</i>
Garade	<i>Garuga pinnata</i> - <i>Cissus woodrowii</i> - <i>Grewia tiliifolia</i>	<i>Flacourtia indica</i> - <i>Acacia leucacephala</i> - <i>Acacia catechu</i>
Chambli	<i>Leucaena leucacephala</i> - <i>Acacia nilotica</i> - <i>Lantana camara</i>	<i>Vitex negundo</i> - <i>Pongamia pinnata</i> - <i>Albizia saman</i>
Chivhewadi	<i>Cassia fistula</i> - <i>Mitragyna parviflora</i> - <i>Rotheca serrata</i>	<i>Lantana camara</i> - <i>Cissus woodrowii</i> - <i>Eucalyptus globosus</i>
Kodit	<i>Alstonia scholaris</i> - <i>Brugmansia sanguinea</i> - <i>Roystonea regia</i>	<i>Acacia nilotica</i> - <i>Vitex negundo</i> - <i>Azadirachta indica</i>
Kumbhshi	<i>Semecarpus anacardium</i> - <i>Ficus religiosa</i> - - <i>Tectona grandis</i>	<i>Santalum album</i> - <i>Grewia tiliifolia</i> - <i>Madhuca latifolia</i>
Panwadi	<i>Ailanthus excelsa</i> - <i>Syzygium cumini</i> - <i>Bahunia racemosa</i>	<i>Celastrus paniculata</i> - <i>Madhuca latifolia</i> - <i>Acacia nilotica</i>
Misalwadi	<i>Gliricidia sepium</i> - <i>Tectona grandis</i> - <i>Leucaena leucacephala</i>	<i>Flacourtia indica</i> - <i>Semecarpus anacardium</i> - <i>Lannea coromandelica</i>
Diveghat	<i>Cissus woodrowii</i> - <i>Gliricidia sepium</i> - <i>Acacia leucophloea</i>	<i>Azadirachata indica</i> - <i>Tecoma stans</i> - <i>Lantana camara</i>
Sonori	<i>Acacia leucophloea</i> - <i>Acacia nilotica</i> - <i>Azadirachata india</i>	<i>Jatropha curcus</i> - <i>Ziziphus mauritiana</i> - <i>Lantana camara</i>
Devadi	<i>Acacia auriculiformis</i> - <i>Cassia siamia</i> - <i>Ailanthus excelsa</i>	<i>Pongamia pinnata</i> - <i>Phyllanthus emblica</i> - <i>Cryptolepis buchanani</i>
pagewadi	<i>Givotia moluccana</i> - <i>Tectona grandis</i> - <i>Grewia asiatica</i>	<i>Catunaregum spinosa</i> - <i>Rhus mysorensis</i> - <i>Terminalia bellerica</i>
Pokharbill	<i>Gnidia glauca</i> - <i>Cissus woodrowii</i> - <i>Lantana camara</i>	<i>Argyria cuneata</i> - <i>Rotheca serrata</i> - <i>Carissa congesta</i>

Table 6: Some important figures and characters of the woody vegetation

Place/ Village	No. of Qd's	No. of Sp.	No. of Ind.	Total GBH (Cm)	Dominant & Abundant species	Raunkiaer's Frequency Equation
Pingori	10	47	294	9784	<i>Azadirachta</i> , <i>Ziziphus</i> , <i>Moringa</i> , <i>Acacia</i> , <i>Vitex</i> , <i>Cassia</i>	A > B > C > D < E
Mandhar	10	33	292	8788	<i>Eucalyptus</i> , <i>Gliricidia</i> , <i>Acacia</i> <i>Gnidia</i> , <i>Ailanthus</i> , <i>Cissus</i>	A > B > C > D = E
Askarwadi	10	41	218	6818	<i>Garuga</i> , <i>Diospyros</i> , <i>Grewia</i> , <i>Zizyphus</i> , <i>Syzygium</i> , <i>Azadirachta</i>	A > B > C > D = E
Vanpuri	10	29	778	6425	<i>Azadirachta</i> , <i>Dalbergia</i> , <i>Albizia</i> <i>Bauhinia</i> , <i>Lantana</i> , <i>Acacia</i>	A > B > C = D = E
Pargaon	10	31	345	6467	<i>Zizyphus</i> , <i>Acacia</i> , <i>Cassia</i> <i>Cissus</i> , <i>Ailanthus</i> , <i>Azadirachta</i>	A > B = C > D > E
Garade	10	37	438	5418	<i>Garuga</i> , <i>Cissus</i> , <i>Grewia</i> , <i>Flacourtia</i> , <i>Acacia leucacephala</i> , <i>Acacia catechu</i>	A > B > C < D > E
Chambli	10	29	437	6003	<i>Leucaena</i> , <i>Acacia</i> , <i>Lantana</i> <i>Vitex</i> , <i>Pongamia</i> , <i>Albizia</i>	A > B > C < D > E
Chivhevadi	10	53	448	7024	<i>Cassia</i> , <i>Mitragyna</i> , <i>Rotheca</i> <i>Lantana</i> , <i>Cissus</i> , <i>Eucalyptus</i>	A > B > C = D > E
Kodit	10	29	423	5192	<i>Alstonia</i> , <i>Brugmansia</i> , <i>Roystonea</i> , <i>Acacia</i> , <i>Vitex</i> , <i>Azadirachta</i>	A > B > C > D > E
Kumbhshi	10	47	544	6139	<i>Semecarpus</i> , <i>Ficus</i> , <i>Tectona</i> , <i>Santalum</i> ,	A > B > C > D > E

					<i>Grewia, Madhuca</i>	
Panwadi	10	38	282	4518	<i>Ailanthus, Syzgium, Bahunia Celastrus, Madhuca, Acacia,</i>	A > B > C > D > E
Misalwadi	10	34	338	6251	<i>Gliricidia, Tectona, Leucaena, Flacourtia, Semecarpus, Lannea</i>	A > B > C > D > E
Diveghat	10	39	588	3174	<i>Cissus, Gliricidia, Acacia, Azadirachata, Tecoma, Lantana</i>	A > B > C < D > E
Sonori	10	35	360	4272	<i>Acacia leucophloea, Acacia, Azadirachata, Jatropa, Ziziphus, Lantana</i>	A > B = C > D > E
Devadi	10	40	442	4492	<i>Acacia, Cassia, Ailanthus, Pongamia, Phyllanthus, Cryptolepis</i>	A > B > C = D > E
pagewadi	10	48	465	10259	<i>Givotia, Tectona, Grewia, Catunaregum, Rhus, Terminalia</i>	A > B > C > D > E
Pokharbil	10	45	475	2570	<i>Gnidia, Cissus, Lantana, Argyria, Rothecca, Carissa</i>	A > B > C > D > E
	170 Qu.	655 Sps.	7167 Ind.	103 594		

Woody vegetation

Raunkiaer's frequency (Table 1 and 2) Class A and B contributed maximum (72.18 % and 16.31% frequency class each). It designates that number of species that plunge in class A and B were more in number, but less abundant; indicating heterogeneity (Variations) in vegetation. However, Class C and D were also represented by sizable number (6.29 % and 4.17% respectively) of species signifying the abundance of few common species. Class E was poorly characterised (0.83%). The frequency class equation is A > B > C > D > E. It does not follow the Raunkiaer's law of frequency distribution i.e. A > B > C > D > E. Raunkiaer's law propose that species in a community are one or the other, infrequent or common, with only some species having intermediary possessions. Raunkiaer's law of frequency consists frequency distribution of species in plant communities. According to the Raunkiaer's law of frequency classes Purandar tehsil represents heterogenous vegetation Figure 4 and 5.

Vegetation structure

All together abundance and dominance in perennial vegetation was shown by the various plant species. The plant communities form primary and secondary compositions which includes various plant species like *Acacia auriculiformis, Acacia catechu, Acacia leucacephala, Acacia nilotica, Ailanthus excelsa, Albizia lebbeck, Albizia saman, Alstonia sanguinea, Carissa congesta, Cassia auriculata, Cassia fistula, Cassia siamiae, Catunaregum spinosa, Celastrus paniculata, Cissus woodrowii, Cryptolepis buehneri, Dalbergia sissoo, Diospyros montana, Eucalyptus globosus, Ficus religiosa, Flacourtia indica, Garuga pinnata, Givotia moluccana, Gliricidia sepium, Gnidia glauca, Grewia asiatica, Grewia tiliifolia, Jatropa curcus.*

Lannea coromandelica, Lantana camara, Leucaena leucacephala, Madhuca latifolia, Mitragyna parviflora, Moringa oleifera, Phyllanthus emblica, Pongamia pinnata, Rhus mysorensis, Rothecca serrata, Roystonea regia, Santalum album, Semecarpus anacardium, Syzgium cumini, Tecoma stans, Tectona grandis, Terminalia bellerica, Vitex negundo and Ziziphus mauritiana.

Based on the keen observations, it was coming to know that woody plant species occur in fragments depending upon uneven surface of the land, moisture level, rain fall (climatic conditions). The number, distribution of species is also

based on their habitat. Generally woody species were found on the hills, hill slopes, even at the base. The plants which grow around water reservoirs, in river belts are tall, healthy. While those found on rocky patches form scrub forest. At such places, xerophytic plants grow in good number.

Results and Discussion

The field surveys and samplings reveal that; the vegetation shows variations. Depending upon the climate, season, rainfall and soil type, luxuriant growth of climbers, shrubs, and trees found in different locations. Though the most of vegetation is similar in the entire tehsil, the growth and vigor of plants was more in hilly regions of the tehsil, this could be due to soil and rainfall variations.

Woody vegetation

For the Phyto-sociological studies, 170 quadrats were laid down (30 x 30m. size) at the 17 locations like Pingori, Mandhar, Askarwadi, Vanpuri, Pargaon Mem., Garade, Chambli, Chivhewadi, Kodit, Kumbhshi, Panwadi, Misalwadi, Diveghat, Sonori, Devadi, pagewadi, Pokharbill Table 3 and 4.

The overall result analysis for the woody vegetation studied through 170 quadrats is as follows: Among the 17 locations, more number (38 to 47 species) of Shrub and tree species were noted at the 9 locations which include Pingori, Askarwadi, Chivhewadi, Kumbhshi, Panwadi, Diveghat, Devadi, Pagewadi and Pokharbil, while less number (29 to 37 species) of woody species were found at 8 locations which include Mandhar, Vanpuri, Pargaon, Garade, Chambli, Kodit, Misalwadi and Sonori.

Pingori, Askarwadi, Chivhewadi, Kumbhshi, Panwadi, Diveghat, Devadi, Pagewadi and Pokharbil were very close to mountains. Among these 9 locations, Pingori, Chivhewadi, Kumbhshi, Panvadi were in proposed eco-sensitive zones while at Askarwadi, Diveghat, Devadi, Pagewadi and Pokharbil, almost no anthropogenic activities were noted. A village Pagewadi was very close to Lachundi sacred grove. The local villagers of Pagewadi have banned the tree cutting and conserved the forest.

As compared to the above-mentioned locations, Mandhar, Vanpuri, Pargaon, Garade, Chambli, Kodit, Misalwadi and Sonori villages fall in non-hilly region. The villages like Vanpuri, Pargaon (Memane) and Sonori were located at the east of the tehsil which is rain shadow region. Garade, Chmbali and Kodit villages were very close to each other

where majority of the land is covered by agriculture. Mandhar and Misalwadi villages were close to each other but away from the hilly region i.e. Purandar fort. At majority of these villages, the forest type was of scrub type. The rainfall plays significant role in the overall status of the vegetation. The average annual rainfall in the tehsil during the year 2014 was 371.3mm, 2015 = 388.8mm., 2016 = 270.2mm., 2018 = 358.1mm. (Data Source: IMD Pune) Table 5 and 6.

The vegetation was analysed for Raunkiaer's frequency classes. Raunkiaer's frequency class A and B has contributed maximum for woody vegetation. It indicates that the number of species that fall in class A and B were more in number (72.18% and 16.31% respectively), but less abundant, indicating heterogeneity in vegetation. However, class C and D were represented by sizable number of species indicating the abundance of few most common species like *Acacia*, *Azadirachata*, *Jatropha*, *Ziziphus*, *Lantana*, *Cassia*, *Ailanthus*, *Pongamia*, *Phyllanthus*, *Cryptolepis*, *Syzigium*, *Bahunia Celastrus*, *Madhuca*, *Alstonia*, *Dalbergia*, *Albizia*, *Bauhinia*, *Cissus*, *Eucalyptus*, *Gliricidia*, *Tecoma*, *Gliricidia*, *Grewia*, *Tectona*, *Flacourtia*, *Lannea*, *Carissa*, *Semecarpus*, *Ficus*. Raunkiaer's law suggest that species in a community are either rare or common, with only few species having intermediate occupancies. It portrays a frequency distribution of species in plant communities which were heterogenous type.

The entire tehsil including fort region is rich in vegetation except the east region. The Simpson and Shannon diversity indices were calculated for the entire tehsil. Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon index increases as both the richness and evenness of the community increase. The fact that the index incorporates both components of biodiversity can be seen as both in strength and weakness. It is strength because it provides a simple, synthetic summary, but it is weakness because it makes it difficult to compare communities that differ greatly in richness. Simpsons index is based on the probability of any two individuals drawn at the random from an infinitely large community belonging to same species. It varies between zero and one. The highest Simpson species diversity for woody vegetation reported was 0.94 and Shannon's 3.27; thus, illustrating the rich plant diversity.

The overall abundance and dominance in perennial vegetation was noted location wise. At Pingori region of the tehsil *Azadirachta*, *Ziziphus*, *Moringa*, *Acacia*, *Vitex*, *Cassia* were abundant. Accordingly, abundance and dominance documented for the remaining 16 locations. The plant communities form primary and secondary compositions at Pingori region includes various plant species like *Azadirachta indica* - *Ziziphus mauritiana* - *Moringa oleifera* and *Acacia nilotica* - *Vitex negundo* - *Cassia auriculata* respectively. Likewise, the primary and secondary compositions were noted for the other 17 regions of the tehsil where perennial vegetation was studied.

Ecological relationship of plant Communities

The composition of plants consists of different kinds of physical set of the Plants. These dis-similar forms include trees, Lianas, Climbers, shrubs, bushes etc. The plants found on the Purandar fort and its twin fort (Vajrgad) and the plants found in the plains are not alike. Purandar tehsil has an edge over other tehsils due to the presence of forts. The

forest type present around the forts is comparatively thick but deciduous.

As twelve hundred fifty-two species has been reported in the entire tehsil in the studies undertaken, designate the wealth and variability of plant species. The various compositions of plant communities have not shown any similarity.

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