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Phytodiversity in Umphyrnai Private Forest of East Khasi Hills District, Meghalaya

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A study was carried out at Umphyrnai village (1578m) in the East Khasi Hills District of Meghalaya to identify and assess the angiosperm and gymnosperm diversity during 2021-2022. A total of 187 unique trees from 18 different species have been identified. 4 gymnosperm species and 14 angiosperm species were identified among them. The trees belong to 11 different families. The most dominant gymnosperm species was found to be *Pinus kesiya*, and the most dominant angiosperm species appeared to be *Alnus nepalensis*. *Pinus kesiya* has the highest IVI.

Keywords: Angiosperms; gymnosperms; diversity; umphyrnai; private forests.

1. INTRODUCTION

Umphyrnai is a settlement in the Mawryngkneng sub-division of Meghalaya's East Khasi Hills District. It has a total population of 2,997 people, 1461 of whom are male and 1536 of them are female. All of the forests in this community are owned by individual inhabitants, families, or clans, and there is no protected forest or sacred groove. The ancestors of this community have passed down the forests from generation to generation. Mrs. E. Kharkongor, a village resident, owns the study area, which is a natural forest.

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Positioned in the North Eastern part of the country, Meghalaya covers an area 22,429 sq.km which is 0.68% of the geographical area of the country. The State lies between 24°58'N and 26°07'N latitude and 89°48' E to 92°51' E longitude and is framed by Assam in the north and east and shares a transnational boundary with Bangladesh in the south and west. The State has three distinct regions, videlicet, Garo Hills, Khasi Hills, and Jaintia Hills.

The state, owing to the different ecological conditions similar to wide variation in downfall, temperature, altitude as well as soil conditions, supports luxuriant growth of different types of foliage, viz., tropical evergreen, tropical semi-evergreen, tropical wet and dry deciduous, tropical broad-leaved hill forest, tropical pine forest , temperate forest, and champaigns [1], (Rao and Hajra 1968).

According to ISFR, 2021, Meghalaya has 8,389 square kilometers of unclassified forest. These sorts of forests are often tiny in size and are spread within the village boundaries. They are handled and used in accordance with the owner's needs and desires. These forests are generally kept in order to produce wood. According to Tiwari, et al. [2], private forests in Meghalaya are the primary source of 76,870 m3 of timber valued at INR 284.5 million (USD 5.7 million) taken from Meghalaya's forests per year. Owners of poorly supplied private forests frequently transfer them to other land uses (for example, agriculture or charcoal burning).

Many private forests are secondary forests or pine (*Pinus kesiya*) plantations. In some cases, the owners have converted these forests into agricultural land, agroforests or home gardens. While collection of forest products by people other than the owners' family members is strictly prohibited, in few cases the owners allow fellow villagers to extract dead and fallen wood, and Non-timber Forest Products (NTFPs) for their personal use.

2. METHODS AND MATERIALS

2.1 Study Area

The research was conducted in private forest land with a total area of roughly 6 acre in Umphyrnai village, in Mawryngkneng Block East Khasi Hills District, at a height of 1,578 m, during the years 2021-2022. The study area's geographic coordinates are 25.5359°N and 91.9590°E.

The village has 502 households and a population of 3,357 in 2021-2022; total workers are 1,214, with 760 men and 454 women; total cultivators are 299 (men 176 and women 124); and total agricultural labour is 394 (men 255 and women 139). Agricultural is the main occupation of the village and almost every household has their own home garden, and agrosilvopastoral is a common practise.

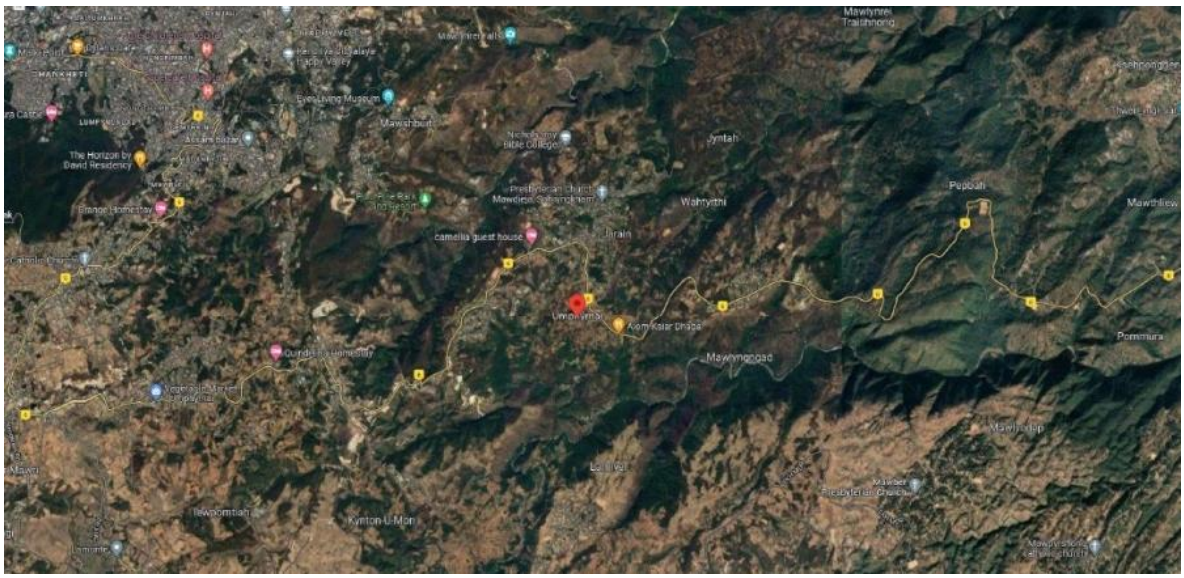

Fig. 1. Location map of the Study Area

2.2 Methodology

2.2.1 Standardized belt transects survey

For this study, a standardized belt transect method where a series of quadrats are placed in the studying area. This method was preferred since it supplies more data than a line transect method and it is mostly used for natural forests.

The forest was divided into four square sample plots, each measuring 20×20 m. All of the species found in these plots were recorded. Each angiosperm or gymnosperm tree's botanical description was documented independently in each of these plots. All tree species were identified and recorded with the assistance of an informed individual, Dr. A.M. Wani, Associate Professor, College of Forestry, Sam Higginbottom University of Agriculture, Technology, and Sciences. The phytodiversity of the study region was calculated by adding all of the species found in all of the plots. The diameter at breast height of trees in each plot was measured at 1.37 m. A measuring tape was used for this purpose.

In the forest, vegetation data were quantitatively examined for density, frequency, and abundance [3]. The total of the relative values was utilized for the Importance Value Index, namely frequency, density, and dominance [4]. The diameter at breast height (Dbh) of the tree was used to calculate the basal area, which was given in Square Meter (m^2). The Shannon-Weiner information index was used to calculate the diversity index [5]. Simpson's Index was used to calculate dominance concentration [6]. Pielou's evenness index was used to calculate species' evenness [7]. Margalef's Index of Species Richness was used to calculate species richness [8].

2.2.2 Quantitative analysis

In each forest community, field data was analysed for abundance, density, and frequency [3]. The total of the relative values utilised for the important value index, namely frequency, density, and dominance, are used to express a community's traits. Quantitative traits are analytical in nature and are typically expressed on a 5-point scale. These include characteristics such as frequency, density, quantity, cover, basal area, and so on.

Frequency: This term refers to the degree of dispersal of each species in a given area, which is usually stated as a percentage of occurrences. It will be examined by randomly sampling the research region and recording the names of the species that occur in each sampling unit. It is calculated by the following equation:

> **Frequency (%)** = (Number of quadrats in which the species occurred / Total number of quadrats) × 100

Density: The numerical strength of a species within the community is represented by its density. The diversity of a species is defined by the number of individuals in any given unit area. The degree of competitiveness is indicated by density. It is called by the following formula

> **Density** = (Total no. of individuals of a species in all quadrats / Total no. of quadrats sampled) × 100

Abundance: This is the number of individuals per quadrat of occurrence of any species. It is calculated as follows:

> **Abundance** = (Total no. of individuals of a species in all quadrats / No. of quadrats in which the species occurred) × 100

Relative Frequency: The proportion of individual species in an area in relation to the total number of species observed.

> **Relative frequency** = (Number of quadrats in which the species occurs / Total number of quadrats in which all the species occurred) × 100

Relative Density: Relative density is the study of numerical strength of a species of a species in relation to the total number of individuals of all the species and can be calculated as:

> **Relative density** = (Total no. of individual of a particular species in all quadrat / Total no. of individuals of all species in all quadrats) × 100

Relative Dominance: The value of a species' entire basal cover determines its dominance. The coverage value of a species in relation to the total coverage of the other species in the area is known as relative dominance.

> **Relative Dominance** = (Total basal area of a particular species / Total basal area of all species) × 100

Basal Area: Basal Area is one of the primary determinants of community dominance. The girth of the tree stems at breast height (DBH) at 1.37m above ground level will be used to calculate the basal area.

Basal Area (m^2) = ($\pi \times (DBH)^2$) / (4 × 10000)

Importance Value Index (IVI): This index is used to determine each species' overall relevance in the community structure. In order to calculate this index, the percentage values of relative frequency, relative density, and relative dominance are added together, and the resulting value is known as the Importance Value Index (IVI) of the species [4].

IVI = Relative Frequency + Relative Density + Relative Dominance

Species Richness: 'Margalef's index of richness (Dmg) [9]

Dmg = (S-1 / ln N)

Where, S = Total number of species, N = Number of individuals.

Species Diversity: Shannon and Weiner [5]

$H' = - \Sigma (Pi \ln Pi)$

Where,

Pi = n/N (proportion of each species in the sample)
n = Number of individual species
N = Total number of individuals

Evenness Index: [7]

$E = H'/\ln S$

Where,

H' = Shannon Index Value
ln = Bits per individual

Index of Dominance (D): Simpson [6]

$D = \Sigma (n/N)^2$

Where,

D = Simpson index of dominance
n = Number of individual species
N = Total number of individuals

3. RESULTS AND DISCUSSION

The vegetation composition observed in 4 quadrats of 20×20 m size at random locations revealed a total of 187 unique trees representing 18 species. 4 species of gymnosperms and 14 species of angiosperms were found. The trees were discovered to be members of eleven separate families (Table 1). Table 1 lists the species, along with their scientific names, local/common names, and families [10-12].

Table 1. Taxonomic status of trees at Umphyrnai Private Forest of East Khasi Hills District

Sl. No.	Scientific name	Local/Common Name	Family	No. of Individuals
1	*Pinus kesiya* Royle Ex Gordon	Dieng Kseh Khasi	Pinaceae	58
2	*Pinus roxburghii* Sarg. (syn. *Pinus longifolia* Roxb.)	Dieng Kseh Bilat	Pinaceae	19
3	*Cryptomeria japonica* (Thunb. Ex. L.f) D. Don	Dieng Cedar	Cupressaceae	8
4	*Juniperus phoenica* L.	Juniper	Cupressaceae	5
5	*Alnus nepalensis* D. Don	Dieng iong	Betulaceae	23
6	*Alnus glutinosa* (L.) Gaertn.	Dieng lieh	Betulaceae	10
7	*Myrica esculenta* Buch. – Ham. Ex. D. Don	Dieng Sohphie Heh	Myricaceae	4
8	*Rhus chinensis* Mill.	Dieng Sohma	Anacardiaceae	15
9	*Schima khasiana* Dyer.	Dieng ngan	Theaceae	5
10	*Pyrus pashia* Buch.-Ham. Ex. D.Don.	Dieng Sohjhur	Rosaceae	6
11	*Prunus cerasoides* D.Don	Dieng Cherry (Jew)	Rosaceae	7
12	*Prunus nepalensis* Ser. (Steud)	Dieng Cherry (Thiang)	Rosaceae	11
13	*Cinnamomum glaucescens* (Nees.) (syn. *Cinnamomum cecicodahne*)	Dieng Pingwait	Lauraceae	7
14	*Quercus serrata* Murray.	Jolcham Oak	Fagaceae	1
15	*Acacia dealbata* Link	Dieng Baibl	Fabaceae	3
16	*Celtis tetrandra* Roxb,	Nilgiri Elm	Ulmaceae	3
17	*Pyrus calleryana* Decne.	Dieng Sohphoh	Rosaceae	1
18	*Pourthiaea arguta* (Wall. Ex. Lindl.)	Sohryngkham	Rosaceae	1

Table 2. Quantitative analysis of tree species at Umphyrnai Private Forest

Sl no.	Name of species	No. of species in each quadrat				Total no. of individuals	Total no. of quadrat in which the species occurred	Total no. of quadrats studied	Basal Area (m^2)	Frequency	Density	Abundance	Relative frequency	Relative density	Relative dominance	IVI
		I	II	III	IV											
1.	*Pinus kesiya* Royle Ex Gordon	11	14	11	22	58	4	4	4.045	100	14.5	14.5	7.547	31.01	36.52	75.077
2.	*Pinus roxburghii* Sarg. (syn. *Pinus longifolia* Roxb.)	4	5	4	6	19	4	4	1.219	100	4.75	4.75	7.547	10.16	11.00	28.707
3.	*Cryptomeria japonica* (Thunb. Ex. L.f) D. Don	2	2	2	2	8	4	4	0.498	100	2	2	7.547	4.27	4.49	16.307
4.	*Juniperus japonica* L.	1	0	4	0	5	2	4	0.318	50	1.25	2.5	3.773	2.67	2.87	9.313
5.	*Alnus nepalensis* D. Don	5	7	5	6	23	4	4	1.51	100	5.75	5.75	7.547	12.29	13.63	33.467
6.	*Alnus glutinosa* (L.) Gaertn.	2	5	2	1	10	4	4	0.644	100	2.5	2.5	7.547	5.34	5.81	18.697
7.	*Myrica esculenta* Buch. – Ham. Ex. D. Don	1	0	1	2	4	3	4	0.193	75	1	1.4	5.66	2.13	1.74	9.53
8.	*Rhus chinensis* Mill.	4	3	4	4	15	4	4	0.439	100	3.75	3.75	7.547	8.021	3.96	19.528
9.	*Schima khasiana* Dyer.	1	3	1	0	5	3	4	0.419	75	1.25	1.7	5.66	2.67	3.78	12.11
10.	*Pyrus pashia* Buch.-Ham. Ex. D.Don.	1	2	0	3	6	3	4	0.294	75	1.5	2	5.66	3.208	2.65	11.518
11.	*Prunus cerasoides* D.Don	1	3	2	1	7	4	4	0.262	100	1.75	1.75	7.547	3.74	2.36	13.647
12	*Prunus nepalensis* Ser. (Steud)	3	5	2	1	11	4	4	0.678	100	2.75	2.75	7.547	5.882	6.12	19.549
13	*Cinnamomum glaucescens* (Nees.) (syn. *Cinnamomum cecicodahne*)	1	2	4	0	7	3	4	0.329	75	1.75	2.4	5.66	3.743	2.97	12.373
14	*Quercus serrata* Murray.	1	0	0	0	1	1	4	0.056	25	0.25	1	1.886	0.534	0.50	2.92

Sl no.	Name of species	No. of species in each quadrat	Total no. of individuals	Total no. of quadrat in	Total no. of quadrats	Basal Area	Frequency	Density	Abundance	Relative frequency	Relative density	Relative dominance	IVI
15	*Acacia dealbata* Link	0 1 0 2	3	2	4	0.0143	25	0.75	1.5	3.773	1.604	1.29	6.667
16	*Celtis tetrandra* Roxb,	0 0 2 1	3	2	4	0.099	50	0.75	1.5	3.773	1.604	0.89	6.267
17	*Pyrus calleryana* Decne.	0 0 0 1	1	1	4	0.035	25	0.25	1	1.886	0.534	0.31	2.73
18	*Pourthiaea arguta* (Wall. Ex. Lindl.)	0 0 1 0	1	1	4	0.022	25	0.25	1	1.886	0.534	0.19	2.61
			187	**53**	**72**	**11.0743**							301.017

3.1 Gymnosperms

Table 1 indicates that out of 90 numbers of gymnospermic tree species found, 4 species were found and they belong to *Pinaceae* and *Cupressaceae*. The individual gymnosperms with the maximum number of individuals included *Pinus kesiya* Royle Ex Gordon (58), followed by *Pinus roxburghii* Sarg. (syn. *Pinus longifolia* Roxb.) (19). The gymnosperms with the least number of occurrences included *Cryptomeria japonica* (Thunb. Ex. L.f) D. Don (8) and *Juniperus phoenica* L. (5).

3.2 Angiosperms

Table 1 shows that from the occurrence of 97 angiospermic trees, 14 species belonging to 7 families- viz., Betulaceae, Myricaceae, Rosaceae, Fabaceae, Fagaceae, Anacardiaceae, and Ulmaceae were recorded. The species with the highest number of occurrence belongs to *Alnus nepalensis* D. Don (23), and followed by *Rhus chinensis* Mill. (15), whereas the individuals with the least number of occurrences include *Quercus serrata* Murray., *Pyrus calleryana* Decne. and *Pourthieae arguta* (Wall. Ex. Lindl.) each with one individual only.

3.3 Diversity Aspects

Various aspects were calculated on the basis of Shannon and Weiner index of species diversity (H'), Margalef's index of richness (Dmg), Pielou index of evenness (E), Simpson index of dominance (D).

3.4 Diversity Parameters in Umphyrnai Forest Stand

Table 3 shows that Shannon Weiner diversity index in the study site is greater in Angiosperms (2.30) than that of gymnosperms (0.99) which indicate that the angiosperms are more diverse.

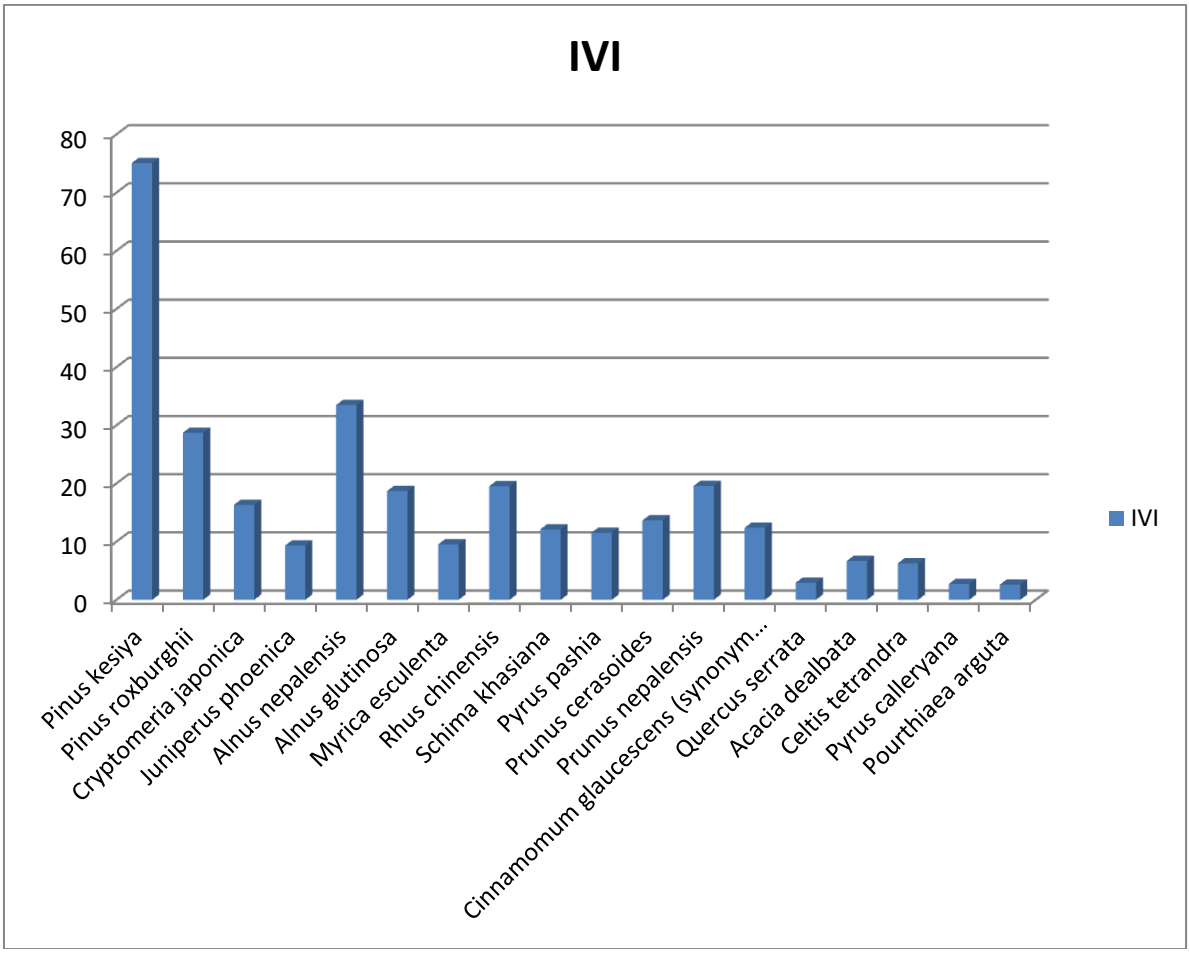

Fig. 2. Importance value index at Umphyrnai Private Forest

Table 3. Gymnospermic and angiospermic tree diversity in Umphyrnai Forest Stand

Sl. No.	Attributes/Parameters	Gymnosperms	Angiosperms
1.	**Shannon-Weiner Diversity**	0.990	2.30
2.	**Simpson index**	0.459	0.114
3.	**Evenness/Equitability Index**	0.712	0.872
4.	**Margalef's Richness Index**	0.666	2.841
5	**Dominance index**	0.540	0.885
6.	**Total no. of individuals**	90	97

Based on diversity indices values from Table 3, it was concluded that tree species diversity is greater in Angiosperms (2.30) than that of gymnosperms (0.99). Simpson index has been shown to be higher in gymnosperms (0.459) and lower in angiosperms (0.114). Margalef's Species richness is found to be higher in Angiosperms (2.841) and lower in Gymnosperms (0.666). As per dominance index, Angiosperms (0.885) are found to be higher than that of gymnosperms (0.540).

Based on the collected data and calculation, 22% of gymnosperms and 78% species of angiosperms were recorded in the study area. The maximum frequency, density, abundance, and IVI of gymnosperms were recorded for *Pinus kesiya (*Royle Ex Gordon) and that of angiosperms was recorded *for Alnus nepalensis* D. Don. Shannon Weiner diversity index in the study site is greater in Angiosperms (2.30) than that of gymnosperms (0.99) which indicate that the angiosperms are more diverse.

4. CONCLUSION

The phytodiversity of angiosperms and gymnosperms in the selected forest area was the focus of this study. The assessment of phytodiversity in this area is critical for learning about the existence of a wide range of important tree species. This study will help to understand the species richness and evenness in the study area, as well as the need to conserve existing privately owned forest areas.

Because the forests in this village are all privately owned and none of the forest areas are protected by the government, Human disturbances pose a serious threat to the forests. Therefore, this study will help to gain a better understanding of the importance of forests and their role in protecting and preserving the environment. Given the importance of forests in carbon sequestration, this study is critical for preserving private forests.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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