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Diversity, phenology and biological spectrum of tree flora in upper Tanawal, district Mansehra, KP, Pakistan

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ABSTRACT

Upper Tanawallies is in the middle of the Western part of Hazara division, and includes the remote areas of four districts, *i.e.* Mansehra, Abbottabad, Haripur, and Tor-Ghar, having latitude 34°34.40' N to 34°48.88' N, and 72°84.27' E to 73°10.50' E longitude. This area is loaded with a plant diversity, and tree species in this area vary in their life form, leaf spectra, and phenological behavior. There is no prior record of plants diversity in the area, hence, this study was conducted to explore the tree diversity, life form, leaf spectrum, and phenology of the tree flora. A total 127 sampling stands (10 × 10 m²) were put into place in different locations in Upper Tanawallies to collect field data using the quadrat method. As an outcome, we learned that the region hosts 53 different tree species of 39 genera belonging to 25 tree families. The biological spectra of the trees were constructed according to Raunkiaer (1934). Results showed that Mesophanerophytes was the dominant life form class, contributing 34 (64%) of all tree species encountered, while Mesophyll and Microphyll were the dominant leaf size spectrum classes, each contributing to a count of 18 (34%) of all tree species. Frequent field visits were also carried out during the flowering and fruiting seasons in 2016/17. The results indicate that most tree species of the area show flowering during April-May (32%), while maximum fruitings were recorded in June-July (36%). Our study concludes that anthropogenic activities on these forests should be reduced to overcome deforestation. This work will be the baseline for a new research in the study area.

Keywords: Floristic checklist, Phanerogamic plants diversity, Upper Tanawal, Mansehra, Pakistan

1. INTRODUCTION

Upper Tanawal lies in Khyber Pakhtunkhwa province of Pakistan, 170 km north from the federal, Islamabad. It lies in the mid of Western part of Hazara division, having 34°.34.40' N to 34°.48.88' N latitude, and 72°.84.27' E to 73°.10.50' E longitude, and having the altitude ranging from 500 m to 2700 m above the mean sea level. Total area of Upper Tanawal is 528 square kilometers. On North, Upper Tanawal is bounded by Torgarh and Agror Valley, on South side it is bordered with Bhadanak tract of District Haripur, on its West Indus River is present, while the areas of Pakhal valley and parts of District Abbottabad are on East (Farooq *et al.*, 2017).

Research area is a part of Himalayan belt. Great Himalayas are one of the world's highest mountains, possessing diverse floristic composition and containing important locations for research in ecology and biodiversity conservation (Pei, 2001).

2. MATERIALS AND METHODS

The initial field survey of the study area was conducted in 2016 to identify and select various vegetation stands on the basis of general physical appearance of vegetation. Quadrature method was used for vegetation analysis in Upper Tanawal. Total 127 strands were taken from different locations. While laying the quadrature, representation of the forest types and also variation in their altitudinal distribution were also considered. Structural data were collected from sample quadrature of 10×10 m² sizes laid in different forest types. Biological spectra of all the collected tree specimens were also observed and determined following Raunkiaer (1934). Phenological stages of life cycle, including flowering and fruiting of total 53 tree species, were determined from different sampling stations during different months of the year (Duckworth, 2000; El-Demerdash, 1994; El-Ghani, 1998; Gao, 1998; Mushta, 2014; Abbasi, 2010; Sheikh, 2002).

3. RESULTS

The present study was carried out to find out the tree diversity in Upper Tanawal of District Mansehra, Pakistan. Total 53 different tree species, belonging to 39 genera and 25 families were recorded from 127 different stations. In the selected stands, Angiosperms were represented by 23 families and 45 (88%) tree species, while Gymnosperm comprises 2 families and 6 (12%) tree species, whereas 2 tree species were remained unidentified (**Fig. 1** and **Fig. 2**). The dominant family was Moraceae with 7 (13%) tree species, followed by Fabaceae and Rosaceae with 6 (12%) tree species each, Pinaceae having 5 (10%) tree species, Salicaceae comprises 4 (8%) of tree species, each Fagaceae, Malvaceae, and Sapindaceae were represented by 2 (4%) tree species (**Table 1** and **Fig. 3**). In Upper Tanawal, the results show that out of 53 tree species, the most dominant life form class was Mesophanerophytes contributing 34 (64%). The Mesophanerophytes were followed by Megaphanerophytes with 13 (25%) tree species, and Microphanerophytes with 6 (11%) tree species (**Fig. 4**). The presence of high percentage of Mesophanerophytes in the sampling stations means that the environmental conditions of the study area are well suited for Mesophanerophytes.

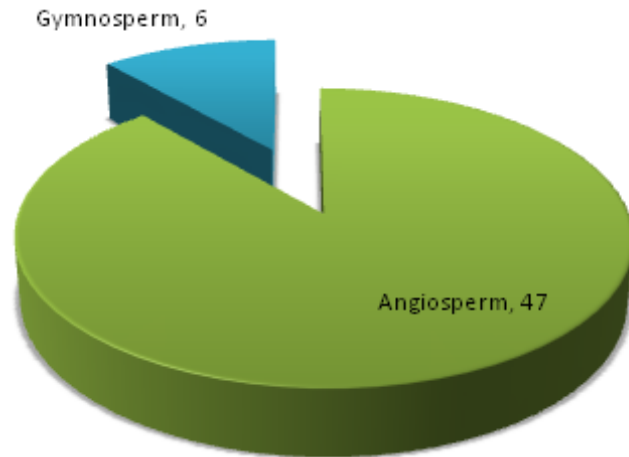


Fig. 1. Division of the tree species of Upper Tanawal.

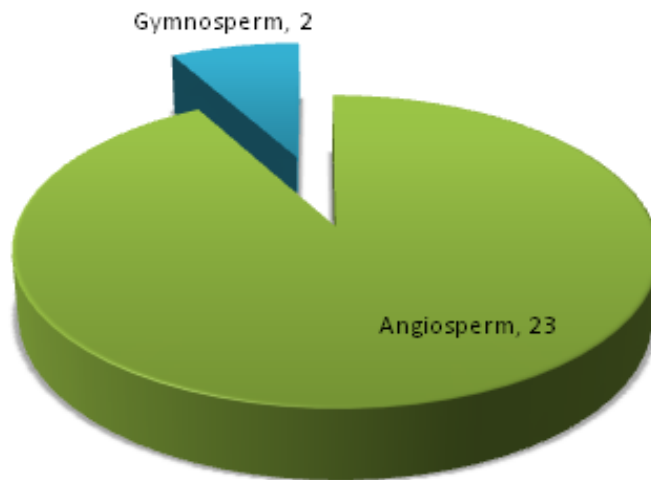


Fig. 2. Angiosperm and Gymnosperm families of the tree species in the study area.

Table 1. Dominant tree families of Upper Tanawal.

S. No	Families	No. of tree species	Percentage
1	Moraceae	7	13
2	Fabaceae	6	12
3	Pinaceae	5	10
4	Rosaceae	5	10

5	Salicaceae	4	8
6	Sapindaceae	2	4
7	Malvaceae	2	4
8	Fagaceae	2	4

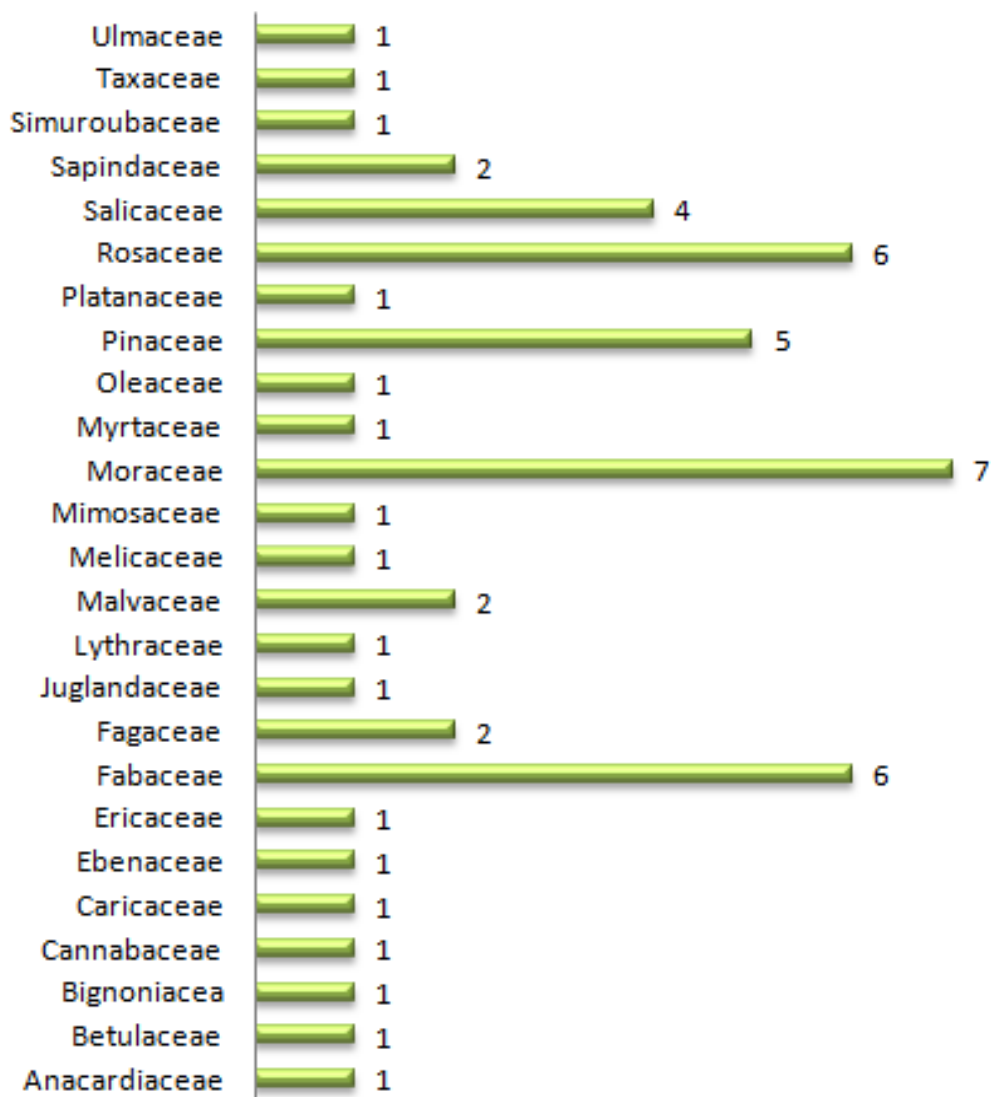


Fig. 3. Family wise distribution of trees from the study area.

Table 2. Altitude wise distribution of sampling stations.

S. No	Altitude in metres	No. of samples	Percentage
1	500-1000	41	32
2	1050-1500	34	27
3	1550-2000	27	21
4	2050-2500	23	18
5	Above 2500	2	2

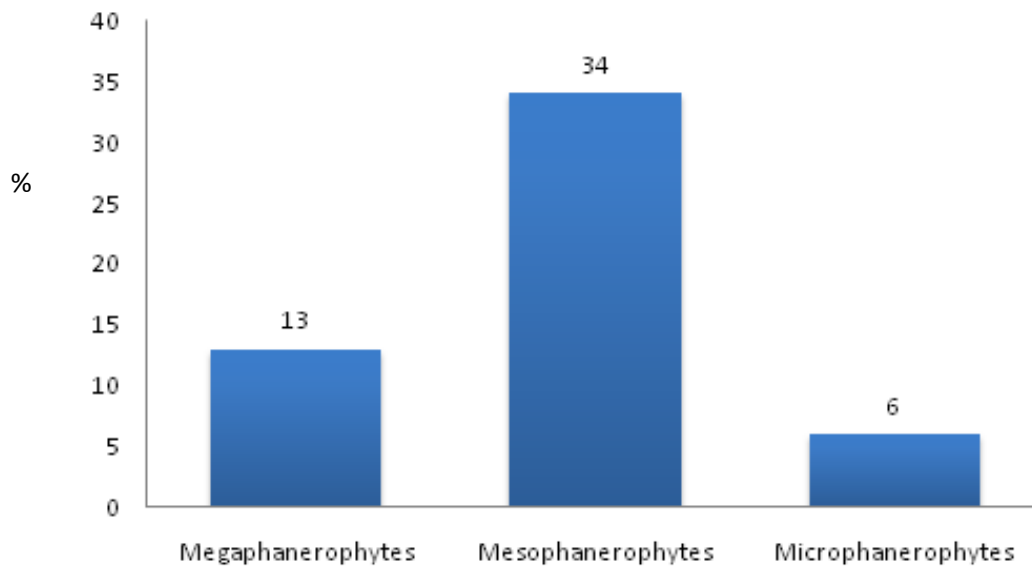


Fig. 4. Life forms of the tree species in the study area.

In the study area, a total 53 tree species were analyzed for the leaf size spectra (**Figure 5**). The leading leaf spectra were recorded for Mesophyll and Microphyll, contributing 18 (34%) tree species each, followed by Nanophyll with 13 (24%) tree species, while Leptophyll contributing 3 (6%) tree species. Nanophyll contributes only 1 (2%) tree species.

The dominant leaf size spectrum classes, Mesophyll and Microphyll indicate that a large portion of Upper Tanawal receives a high amount of annual rainfall. In addition, the results indicate that the Upper Tanawal has a moderate temperature with moist conditions. Detailed leaf size spectra of the tree species of the study area are shown in **Table 3**.

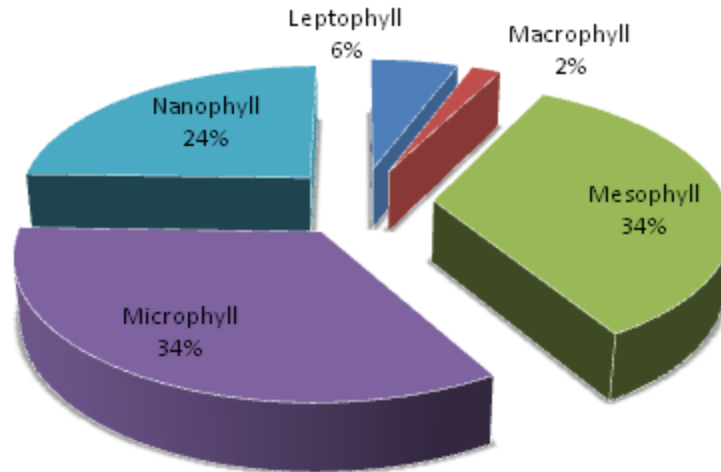


Fig. 5. Leaf size spectrum of the tree species of the study area.

In the investigated area, phenological behavior was observed during different months of the year. Maximum trees show blooming during April and May. The flowering has been reduced at the end of May. Blooming of the flowers was delayed in shady places and higher altitudes of the study area while, the blooming of flowers was observed first in lower altitudes and open areas of Upper Tanawal. The maximum flowering stages were recorded from April-May (32%), followed by the months of March-April (19%) and May-June (15%). The minimum flowering stages were recorded for the months of January, February, October, November, and December.

Table 3. Phenology, Life forms, and Leaf spectra of different tree species of Upper Tanawal, District Mansehra.

S. No.	Botanical Name	Family	Phenology		Life Form	Leaf Spectra
			Flowering	Fruiting		
1	<i>Abies pindrow</i> (Royle ex D. Don) Royle	Pinaceae	Apr-May	May-Jun	MG	Na
2	<i>Acacia modesta</i> Wall.	Fabaceae	Mar-May	July	MS	Le
3	<i>Acacia nilotica</i> (L.) Delile	Fabaceae	June	July	MS	Le
4	<i>Aesculus indica</i> (Wall. ex Camb.) Hook.	Sapindaceae	May-Jun	Jul-Aug	MS	Mi
5	<i>Ailanthus altissima</i> (Mill) Swingle	Simaroubaceae	Mar-Apr	May-Jun	MG	Na

6	<i>Alnus nitida</i> (Spach) Endl.	Betulaceae	Aug-Oct	Nov-Dec	MS	Me
7	<i>Bauhinia variegata</i> L.	Fabaceae	Mar-Apr	Apr-May	MS	Me
8	<i>Bombax ceiba</i> L.	Malvaceae	Mar-Apr	Apr-May	MS	Ma
9	<i>Broussonetia papyrifera</i> (L.) L'Hér. ex Vent.	Moraceae	Apr-Aug	Aug-Sep	MS	Me
10	<i>Carica papaya</i> L.	Caricaceae	Mar-Apr	Jun-Jul	MI	Me
11	<i>Cassia fistula</i> L.	Fabaceae	Apr-May	Sep-Nov	MS	Me
12	<i>Cedrus deodara</i> (Roxb. ex Lamb.) G. Don	Pinaceae	Jul-Sep	Oct-Nov	MG	Na
13	<i>Celtis australis</i> L.	Cannabaceae	Feb-Apr	May-Jul	MS	Mi
14	<i>Corymbia citriodora</i> (Hook.) K.D. Hill & L.A.S. Johnson.	Myrtaceae	Aug-Sep	Oct-Nov	MG	Mi
15	<i>Dalbergia sissoo</i> DC.	Fabaceae	May-Jun	Jul-Aug	MS	Mi
16	<i>Diospyros lotus</i> L.	Ebenaceae	Aug-Sep	Oct-Nov	MS	Mi
17	<i>Ficus benghalensis</i> L.	Moraceae	Apr-May	Sep-Nov	MS	Me
18	<i>Ficus carica</i> L.	Moraceae	Apr-May	Jun-Jul	MS	Me
19	<i>Ficus palmata</i> Forssk.	Moraceae	Jun-Jul	Aug-Sep	MS	Me
20	<i>Ficus racemosa</i> L.	Moraceae	Apr-May	Jun-Jul	MS	Me
21	<i>Flacourtia indica</i> (Burm. f) Merri.	Salicaceae	May-Jun	Jun-Jul	MI	Me
22	<i>Grewia villosa</i> Willd.	Malvaceae	Feb-Mar	Apr-May	MS	Me
23	<i>Juglans regia</i> L.	Juglandaceae	Jun-July	Jul-Aug	MS	Mi
24	Kaindroo	Un identified	Feb-Apr	May-July	MS	Mi
25	Kambel	Un identified	Mar-Apr	Apr-May	MS	Mi
26	<i>Leucaena leucocephala</i> (Lam.) de Wit	Mimosaceae	Jun-Aug	Sep-Nov	MS	Me
27	<i>Melia azedarach</i> L.	Meliaceae	Apr-May	May-Jun	MS	Na
28	<i>Morus alba</i> L.	Moraceae	Apr-May	Jun-Jul	MS	Me
29	<i>Morusnigra</i> L.	Moraceae	Apr-May	May-Jun	MS	Me
30	<i>Olea ferruginea</i> Royle	Oleaceae	Apr-May	Jun-Jul	MS	Na

31	<i>Picea smithiana</i> (Wall.) Boiss.	Pinaceae	Apr-May	Jun-Jul	MG	Na
32	<i>Pinus roxburghii</i> Sarg.	Pinaceae	Apr-May	Jun-July	MG	Na
33	<i>Pinus wallichiana</i> A.B. Jacks.	Pinaceae	May-Jun	Jun-Jul	MG	Na
34	<i>Pistacia chinensis</i> Bunge	Anacardiaceae	May-Jun	Jun-Jul	MG	Mi
35	<i>Platanus orientalis</i> L.	Platanaceae	Jun-Jul	Aug-Sep	MG	Me
36	<i>Populus alba</i> L.	Salicaceae	Apr-May	Jun-Jul	MG	Mi
37	<i>Populus ciliata</i> L. ex Royle	Salicaceae	Apr-May	Jun-Jul	MG	Mi
38	<i>Prunus serrulata</i> Lindl.	Rosaceae	Apr-May	Jun-Jul	MS	Na
39	<i>Prunus armeniaca</i> L.	Rosaceae	Mar-Apr	May-Jun	MS	Mi
40	<i>Prunus cornuta</i> (Wall. ex Royle) Steud	Rosaceae	Apr-May	Jun-Jul	MS	Mi
41	<i>Prunus persica</i> (L.) Batsch	Rosaceae	Mar-Apr	May-Jun	MS	Mi
42	<i>Punica granatum</i> L.	Lythraceae	Jun-Jul	Jul-Aug	MI	Na
43	<i>Pyrus bourgaeana</i> Decne.	Rosaceae	May-Jun	Jun-Jul	MS	Mi
44	<i>Pyrus pashia</i> Buch.-Ham. ex D. Don	Rosaceae	Mar-Apr	May-Jun	MS	Mi
45	<i>Quercus incana</i> Bartram	Fagaceae	Apr-May	Jun-Jul	MS	Mi
46	<i>Quercus robur</i> L.	Fagaceae	Apr-May	Jun-Jul	MS	Mi
47	<i>Rhododendron arboreum</i> Sm.	Ericaceae	Mar-Apr	May-Jun	MG	Me
48	<i>Robinia pseudoacacia</i> L.	Fabaceae	Mar-May	Jun-Jul	MS	Me
49	<i>Salix babylonica</i> L.	Salicaceae	May-Jun	Jun-Jul	MG	Na
50	<i>Sapindus marginatus</i> Willd.	Sapindaceae	May-Jun	Jun-Aug	MS	Na
51	<i>Taxus baccata</i> L.	Taxaceae	Mar-May	Jun-Aug	MI	Le
52	<i>Tecomella undulate</i> (Sm.) Seem.	Bignoniaceae	Mar-May	May-Jul	MI	Na
53	<i>Ulmus villosa</i> Brandis ex Gamble	Ulmaceae	Mar-Apr	Apr-May	MI	Me

MG = Megaphanerophytes; MS = Mesophanerophytes; MI = Microphanerophytes
 Na = Nanophyll; Le = Leptophyll; Mi = Microphyll; M = Megaphyll; Ma = Macrophyll

Fruiting stages of different tree species were also determined from the study area. Our results showed that the maximum fruiting stages were recorded from the months of June-July (36%), May-June (15%), and April-May (9%). The least fruiting stages were recorded for the months of November-December (2%). The tree species, which are present in the lower parts of the study area, show early fruiting stages. Detailed phenology, leaf spectra, and life forms of different tree species of the study area, including their flowering and fruiting, are presented in **Table 3**.

3. DISCUSSION AND CONCLUSION

Total 53 tree species, belonging to 39 genera and 25 families were recognized. In terms of tree diversity, our study can be compared with those of other studies from Pakistan and neighboring, where the tree families, like Moraceae, Fabaceae, Pinaceae, and Rosaceae were the most representative of the tree flora (Agduma *et al.*, 2011; Siddiqui *et al.*, 2016). Our study confirms Moraceae with 7 (13%) tree species, Fabaceae with 6 (12%) tree species, Pinaceae and Rosaceae with 5 (10%) tree species each, Salicaceae with 4 (8%) tree species, Sapindaceae, Malvaceae and Fagaceae with 2 (4%) tree species each.

As regards the leaf size spectrum classes, Microphyll and Mesophyll were the dominant leaf size classes. Dolph and Dilcher (1980) concluded that the leaf size alone is not enough to identify specific climate or any particular life zone. The high percentage of Microphyll and Mesophyll reflects that sub-tropical and temperate climate is present in the study area. The next high percentage was that of Nanophylls which indicates the semi-arid nature of the study area. In terms of the leaf size classes, similar results were reported by Khan *et al.* (2013) from the vegetation of Sheikh Maltoon Town District Mardan, Pakistan. Baquar S.R. (1976) and R.B. Tareen, S.A. Qadir (2003) also reported high percentage of Microphylls for the flora of district Quetta. Similarly, Malik *et al.* (2007) confirm Microphyllous species the most representatives from the vegetation of Ganga Chotti and Bedori Hills.

Maximum tree species show the flowering from April to May. Our results are also in line with Shrestha *et al.* (1998), who reported that maximum plants flowered in the months of April and May. Our findings are also in support by Zhange *et al.* (1999), who report that the peak flowering occurred in May in different parts of China.

The fruiting of the tree species was at its peak during the dry season in the study area. Maximum fruiting for the tree species in Gujrat, India, was recorded during months of March, April, and December (Jadeja and Nakar, 2010). In our study area, fruiting of tree species was at peak in June and July. Our results in this regards disagree with their study which might be due to the presence of different types of tree species in Upper Tanawal.

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