Assessment of floristic diversity in the mountain ecosystem of Marghazar Valley, Hindukush Range, Swat, Pakistan

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Abstract. Khan MN, Ali S, Razak SA, Zaman A, Iqbal M, Shah SN. 2022. Assessment of floristic diversity in the mountain ecosystem of Marghazar Valley, Hindukush Range, Swat, Pakistan. Biodiversitas 23: 1000-1013. Marghazar Valley, a part of the Hindukush Range, is an area with a rich diversity of plant resources. Geoclimatically and ecologically, this valley is characterized by a moist temperate and subalpine zone with a Sino-Japanese type of vegetation. A comprehensive survey was carried out from April 2019-June 2020 to explore the biodiversity and ecological aspects of plants in Marghazar Valley, Swat District, Khyber Pakhtunkhwa, Pakistan. The study recorded a total number of 307 taxa (161 herbs, 45 shrubs, 46 trees, 37 grasses, 10 climbers, 2 shrubby herbs, 1 subshrub, 1 tree-like herb, 1 hollow tufted tree, 1 climbing shrub, 1 parasitic herb and 1 woody climber) belong to 94 families and 236 genera that consisted of Pteridophytes (14 species, 9 genera, 7 families), Gymnosperms (5 species, 4 genera, 2 families) and Angiosperms (288 species, 223 genera and 85 families). Families with the highest number of species were Poaceae (38 species) and Asteraceae (29 species), followed by Rosaceae (22 species), Brassicaceae (13 species) and Lamiales (11 species), while the rest of the families had less than 11 species. Dicots were the most abundant group with 217 species (75.24 %), followed by Monocots (18.56 %), Pteridophytes (4.54 %) and Gymnosperms (1.62 %). Cousinia bupthalmoides was recorded from the area for the first time and are a novel addition to the flora of Swat. Phenology of vegetation revealed that 173 taxa (56.35%) recorded as perennial followed by 134 taxa as annual plants (43.50%). Bio-spectrum classes were represented by 126 species as therophytes (40.90%) and 122 species as microphylls (39.61%) in life form and leaf size respectively, while 2 species i.e. Cuscata reflexa and Equisetum arvense are aphyllus which possesses no leaves.

Keywords: Cousinia, floristic checklist, Hindukush range, Marghazar valley, phenology

INTRODUCTION

The Hindukush mountainous region of Swat Valley, Pakistan, is one of the most picturesque places on the subcontinent and is frequently referred to as Pakistan’s "little Switzerland." The valley is located near the summits of three huge mountains: the Hindukush, the Himalayas, and the Karakorum, and as a result, it has diverse and unique fauna and vegetation. Swat is located at the northwest junction of Pakistan (Hamayun et al. 2006). Mount Elum, located between Swat and Buner, is the valley's highest point, rising 1780 meters above sea level (asl). This valley is characterized by the vegetation of the most temperate and subalpine zones, with snowfall and heavy rain while the weather is so severe that it has a pleasant summer all year (Yousufzai et al. 2010). The picturesque Marghazar Valley has emerged as a major tourist destination in Swat Valley with thousands of tourists visiting it every year. Besides the remarkable locations, greenery, and serene environment, the valley that is positioned around 12 km from Mingora City is also known for walnut cultivation.

Mountain ecosystems offer a diverse range of products and resources to humans, both to those who live in the mountains and those who do not (MA, 2005). For example, more than half of the human population depends on freshwater collected, preserved, and filtered in mountainous areas. Mountainous areas are hotspots for biodiversity. Besides, mountains are of global importance as major tourism and leisure destinations. Mountains are valuable resources for rapid global development (Schroeter al. 2005). Changes in land management policies, infrastructure construction, unhealthy tourism, forest fragmentation, and global climate change are the main threats to mountain ecosystems (Grêt-Regamey et al. 2012). Traditional conservation approaches became some extent of contention, and therefore the principle of ecosystem services (ESS) has risen to prominence (Naidoo et al. 2008), including the importance of preserving mountain habitats.
Phytodiversity is the variety of plant species in a geographical area (Gifford 1989). The importance of plant diversity is widely recognized at the moment, and it has been properly described as "life insurance for our changing environment." It is also acknowledged as critical in ensuring our nutritional security in the face of an aging population. Wildlife diversity may decline as a result of decreased vegetation (Njeri et al. 2017). Natural diversity is defined as the inconsistency between current living organisms, including terrestrial, marine, and other submarine environments, and the environmental developments of which they are a part; this includes variation within species, between species, and between environments (Ertu 2006). It contains all of the biosphere's vegetation, making the ecosystem flawless (Dar and Farooq 1997). Flora documentation is commonly acknowledged as essential over the world since it plays an important part in preserving the region's national assets (Amber et al. 2019). The documentation of local flora, combined with an explanation of a place, is critical since it can provide specific species of the native area, mounting season, species rigidity, any new species identified in the region, and the influence of climatic settings (Ali 2008). It has been found that about 308,312 species of vascular plants are currently being described and accepted, in which 295,383 are Angiosperms (74,273 are Monocots and 210,008 are Eudicots), Gymnosperms 1079, Ferns 10,560 and remaining 1,290 species of Lycopsids (Maarten et al. 2016). The leading vascular plant family is Orchidaceae having 736 genera and 28,000 species and Asteraceae having 1,623 genera and 24,700 species throughout the world (Chase et al. 2015).

The floristic element of plants has long been recognized, but the concept of growth forms emerged after Humboldt by classifying vegetation based on physiognomic characteristics (Mack 2003). This is a representation of the harmony that exists between plants and their surroundings (Ewald 2003). Floristic analysis of any given location aids in determining plant wealth and potential values (Shaheen et al. 2016). A floristic inventory not only identifies and describes local and regional species, but also provides evidence of plant phenology, the invasion of new species, and vegetative stress (Ali 2008; Saand et al. 2019). Plant biodiversity conservation necessitates stable and solid quantitative and qualitative botanical data archives that are organized (Clubbe et al. 2010). The biological scale is the proportion ratio of plant species' life form adaption in any place. The life form scale denotes an area's microclimates (Danin and Orshan 1990; Hussain et al. 2014). The floristic checklists of a certain region are the primary source of botanical materials for that region (Saifidkon et al. 2003). After floristic arrangement studies, the understanding of living forms is the second most important component of vegetation explanation (Cain 1950). Plant adaptation to specific environmental settings describes life forms, which is an indicator of micro and macroclimate (Shimwell 1971). Raunkiaer (1934) stated that flora are also categorized on the source of life form and leaf sizes spectrum and this has been unusually helpful for relationship plotting of vegetation. The leaf size information represents the flora's physical processes (Oosting 1956; Rahman et al. 2019). Biotic activities, for example, are the primary causes of changes in the phytoclimatic spectrum in a specific floristic zone.

The first challenge in developing a checklist of vascular plants in mountainous places such as Marghazar Valley was deciding what area to cover. We have examined a lot of published literature about Swat District, Pakistan, and a lot of work has been done on occasion. However, the current valley is still unexplored and no written work is currently available. Therefore, this study aimed to provide a complete list of flora of Marghazar Valley, Swat District, Khyber Pakhtunkhwa, Pakistan through a comprehensive survey to collect information regarding the plant wealth, identification, description of local and regional species and its potential values (Ali 2008: Shaheen et al. 2016: Saand et al. 2019).

**MATERIALS AND METHODS**

**Site details**

The Swat has always remained self-sufficient in its natural and agricultural resources (Khan et al. 2017). Marghazar Valley lies in Hindu Kush Himalaya (HKH) region of Swat District, Pakistan, having 34°34' to 35°55' N latitudes and 72°08' to 72°50' E longitudes. It is confined on the North by district Chitral, East by district Kohistan, South by district Malakand, and West by district Dir (Anonymous 1998), as shown in Fig 1. Marghazar Valley. The area has an altitude about 2,000 meters above sea level, average relative humidity around 60%, and annual rainfall of 1004 mm. With this climatic condition, Marghazar Valley is a lush green part of Hindukush Range. It is comprised of five main villages named Spal Bandai, Kukrai, Marghazar, Sher Athraf and Islampur. The valley is surrounded by green mountains. It covers an area of 8220 km² of land (Ahmad et al. 2015) (Fig 2).

**Data collection and observations**

Different field surveys were carried out in both blooming and flowering seasons during April 2019-June 2020 in Marghazar Valley, Hindukush Range, Swat areas (Pakistan). Study trips were arranged to five different valley villages, including Spal Bandai, Kukrai, Marghazar, Sher Athraf and Islampur to collect different plant species. The field survey included observations and field walks. The valley was divided into five main sites and each site was surveyed two times for collection, observation, documentation and exploration. Major threats and factors were examined during field survey like habitat loss, over-collection of plants, overgrazing, soil erosion, over browsing, over-harvesting, land sliding, snow sliding, excessive rain, unpleasant weather, overexploitation, land use, agriculture expansion, natural disaster and other anthropogenic activities.
Plant preservation and identification

Collected and preserved plant samples provide authentic information regarding diversity, classification, distribution and taxonomic identification. Therefore, it gives evidence for plant existence in a specific area and time. Hence plants were preserved in a suitable arrangement. The samples were collected from five different localities after being dried in a proper way in a newspaper (roots, stems, leaves), preserved and pressed all the collected samples, regarding blotting papers in between the adjacent samples. Polythene bags, newspapers and blotting papers were changed after a week to avoid fungus attack, free moisture and rotting. The specimens were treated with HgCl₂ solution in Ethylene to protect them from insect and fungal attacks. The specimens were mounted on (standard) herbarium sheets about (37.05 cm x 31.05 cm). Tools and materials used in data collection in the field included a compass, GPS, ruler, plastic bottles, polythene bag, newspaper, pencil, tags, eraser, highlighter, scissor, small knife, digital camera, permanent marker, surgical gloves, field diary, glue and remover. During collection, localities of each specimen were written in newspapers and field diaries as well. Photographs of each and every species were taken by digital camera. Certain parameters like habit, life cycle, life form and leaf size were observed during field works.

Specimens (flowering plants) were identified with the help of native flora (flora of Pakistan) and other available literature (Ali and Nasir 1989-1991; Ali and Nasir 1991-1993; Ali and Qaiser 1986; Ali and Qaiser 1993-2017; Ali and Qaiser 2000-2012; Ali 1978; Ali 1980; Ali et al. 2001; Cronquist 1968; Nasir 1981; Stewart 1967; Stewart 1972), grasses identified with the manual of (Cope 1982; Ahmad et al. 1958). Fern and their allies (Pteridophytes) was identified from (Gul et al. 2017; Lellinger 2002; Nakaikai and Malik 1992; Nakaikai and Malik 1993; Nayar 1964; Stewart 1957), flora of China (Zhang et al. 2013) and other available literature (Beddome 1866; Beddome 1873; Clarke 1973; Fraser-Jenkins 2014; Hope 1899-1902; Shah et al. 2020, 2021). Plant samples were also confirmed from snapshots existing on the international herbaria website. Certain unidentified specimens were identified from various Taxonomists, Herbarium botanists, curators from the department of Botany, University of Peshawar and Government degree college Matta. Swat for his valuable information and knowledge. After identification and observation of taxonomic data, ecological data were successfully noted. For taxonomic classification, genera and taxon ranked first after family fern and their allies (Pteridophytes) were placed first, according to the standard classification of Ching and Christenhuz then placed non-flowering plants (Gymnosperm) second while flowering plants (Angiosperms) were placed at last using a standard phylogenetic scheme of classification associated with Angiosperm Phylogeny Group (APG) by Judd et al. 1999. All taxon voucher numbers will be given and then arranged alphabetically after being submitted to the Herbarium of the Department of Botany, Bacha Khan University, Charsadda (HBKU) for strengthening and further research.
Biological spectrum

Biological spectra are important in comparing geographically, habitually, and widely separated plants and are considered an indicator of prevailing environmental conditions. These changes are due to biotic impacts like agricultural practices, grazing, deforestation, trampling and climatic changes (Badshah et al. 2013). Therefore, Raunkiaerian biological spectrum was used for life form and leaf size class and plants were identified according to the method of Raunkiaer (1934) which was followed by Hussain (1989) and Badshah et al. (2013) as follow.

Life form classes

Life form class’s concept backs to Von Humboldt (1806) that was initially created for comparisons of non-taxonomical vegetation of different districts of the globe (Abbas et al. 2017). It gives proper climatic information. Plant species adaptation to its surrounding climate is revealed by the life form of an ecosystem (Bano et al. 2017). Life form based on Raunkiaer (1934) classification is much dependable, which is based on the perennating bud protection amid the adverse and unfavorable condition.

(Th) Therophytes: The annual plant that possesses seeds completes its life cycle in a year and survives the harsh seasons through spores and seeds. These plant species are broadly distributed in dry and hot deserts.

(G) Geophytes / (Cr) Cryptophytes: They are basically perennating buds found below the soil surface or submerged in water. These are also known as Earth plants. The plants included in this class are deep rhizomes, tubers, bulbs, emergent, corm, submerged, or floating hydrophytes rooted in the muddy substratum.

(H) Hemicyrptophytes: These are perennials herbaceous plants of which aerial portion of plant demolished at the end of growing season parting shooting buds on or just below the soil surface i.e. grasses, biennial plants and rosette.

(Ch) Chamaephytes: These parenting buds lie close to the ground level and reach up to 25 cm. They are also called Surface plants. They may be low woody, low stem succulent, trailing, herbaceous and cushion plants.

(Ph) Phanerophytes: This group includes trees and shrubby species that borne perennating buds on the aerials surface of plants and gain height more than 25 cm above soil surface.

Leaf size classes

According to leaf size spectra plant specimen were classified into different classes (Raunkiaer 1934) as follows: (L) Leptophyll: leaf area up to 25mm² (i), (N) Nanophyll: leaf area from 25 to 225 mm² (ii), (Mic) Microphyll: leaf area from 225 to 2025mm² (iii), (Mes) Mesophyll: leaf area from 2025 to 18225mm² (iv), (Mac) Macrophyll: leaf area from 18225 to 164025mm² (v), (Meg) Megaphyll: leaf area large then class V (vi).

Raunkarian spectrum was determined as follows:

Leaf size spectrum = Number of species falling in a particular leaf size class
Total number of all the species for that community or area X 100

RESULTS AND DISCUSSION

Taxonomic studies

Marghazar Valley is a lush green part of the Hindukush Range with a greater diversity of plant resources. A comprehensive survey was carried out during April 2019-June 2020 to explore, identify and observe ecological aspects of plants of Marghazar Valley, Hindukush Range, Swat, Pakistan. Geo-climatically and ecologically, this valley is characterized by the vegetation of moist temperate and subtropical zone having snowfall with heavy rain and lies within Sino-Japanese type of vegetation.

The explorations revealed a total of 307 plant taxa belonging to 236 genera under 94 families. Among them, 14 taxa within 9 genera and 7 families were recognized as Pteridophytes, 5 taxa were segregated under 4 genera and 2 families as Gymnosperms and the remaining 288 taxa were classified under 223 genera and 85 families were Angiosperms in which 57 taxa, 50 genera and 13 families were recorded as Monocots while 231 taxa distributed over 173 genera and 72 families were recorded as Dicots (Table 1-2).

Dryopteridaceae and Pteridaceae shared 3 taxa and 2 genera each and are considered as dominant families in Pteridophytes, followed by Aspleniaceae with 3 taxa and 1 genera, Athyriaceae with 1 genera and 2 species, Equisetaceae, Dennstaedtiaceae and Marsileaceae with 1 genera and 1 species each. The number of taxa within families in Pteridophytes ranged from 1 to 14 (Tables 1 and 2).

Pinaceae, with a total of 2 genera and 3 species is the largest family in Gymnosperms, followed by Cupressaceae which contributed 2 genera and 2 species. The number of taxa within families in Gymnosperms ranged from 1 to 5.

Poaceae shared 33 genera and 38 species and was the largest family in Monocots, followed by Araceae (3 genera, 3 species), Cyperaceae (2 genera, 3 species) and Alliaceae (1 genera, 2 species), Asphodelaceae and Liliaceae (2 genera and 2 species) while Amaryllidaceae, Asclepiadaceae, Asparagaceae, Commelinaceae, Convallariaceae, Musaceae and Smilacaceae comprised of only 1 genera and 1 species each. The number of taxa within families in Monocots ranged from 1 to 57.

Asteraceae/Compositae shared the highest number of genera (22) and species (29) and observed as dominant family in Dicots followed by rose family Rosaceae with 11 genera and 22 species, Brassicaceae with 10 genera and 13 species, Lamiaceae with 10 genera and 11 species, Papilionaceae with 8 genera and 10 species while rest of families had less than 10 species and the remaining 29 families were monogenic and monospecific that consisted of only single genera and single species each, i.e., Aceraceae, Aquifoliaceae, Araliaceae, Berberidaceae, Betulaceae, Buddlejaceae, Buxaceae, Campanulaceae, Cannabaceae, Caprifoliaceae, Casuarinaceae, Crassulaceae, Cucurbitaceae, Elaeagnaceae, Fumariaceae, Guttiferae, Hippocastanaceae, Juglandaceae, Meliaceae, Myrsinaceae, Oleaceae, Onagraceae, Paeoniaceae, Platanaceae, Polygalaceae, Sapindaceae, Saxifragaceae, Simaroubaceae and Zygophyllaceae. The number of taxa within families in Dicots ranged from 1 to 231 (Table 1).
| Division/family/taxa          | Voucher no. | Habit | Life cycle | Biological spectra          | Life form | Leaf size | Locality         |
|-----------------------------|-------------|-------|------------|------------------------------|----------|-----------|------------------|
| **PTERIDOPHYTES**           |             |       |            |                              |          |           |                  |
| Athyriaceae                 |             |       |            |                              |          |           |                  |
| Athyrium attenuatum (Clarke) | HBKU-748    | H     | Perennial  | G                            | Mic      |           | Marghazar        |
| Athyrium oxyphyllum (Wall. ex Hook.) T. Moore ex Bedd. | HBKU-597 | H     | Perennial  | G                            | Mic      |           | Marghazar        |
| Aspleniaceae                |             |       |            |                              |          |           |                  |
| Asplenium adiantum-nigrum L. | HBKU-808    | S     | Perennial  | G                            | Nan      |           | Sher Athraf      |
| Asplenium dalhousiae Hook.  | HBKU-633    | S     | Perennial  | G                            | Lep      |           | Marghazar        |
| Asplenium trichomanes L.    | HBKU-584    | S     | Perennial  | G                            | Lep      |           | Marghazar        |
| Equisetaceae                |             |       |            |                              |          |           |                  |
| Equisetum arvense L.        | HBKU-706    | H     | Perennial  | G                            | Aph      |           | Spal Bandai      |
| Dennstaedtiaceae            |             |       |            |                              |          |           |                  |
| Pteridium aquilinum (L.) Kuhn. | HBKU-739    | H     | Perennial  | G                            | Mic      |           | Marghazar        |
| **DRYOPTERIDACEAE**          |             |       |            |                              |          |           |                  |
| Cyrtomium caryotidenum (Wall. ex Hook. & Grev.) C. Presl. | HBKU-728 | H     | Perennial  | G                            | Mic      |           | Marghazar        |
| Dryopteris juxtaposita Christ. | HBKU-726    | H     | Perennial  | G                            | Mic      |           | Marghazar        |
| Dryopteris ramosa (C. Hope) C. Chr. | HBKU-725  | H     | Perennial  | G                            | Lep      |           | Marghazar, Spal Bandai |
| **MARSILEACEAE**             |             |       |            |                              |          |           |                  |
| Marsilea minuta L.          | HBKU-745    | H     | Perennial  | Hyd                          | Nan      |           | Kukrai           |
| **PTERIDACEAE**              |             |       |            |                              |          |           |                  |
| Adiantum capillus-veneris L. | HBKU-577    | H     | Perennial  | G                            | Nan      |           | Marghazar        |
| Pteris cretica L.            | HBKU-721    | H     | Perennial  | G                            | Mic      |           | Spal Bandai, Marghazar |
| Pteris vittata L.            | HBKU-720    | H     | Perennial  | G                            | Mic      |           | Spal Bandai, Marghazar |
| **GYMNOSPERMS**              |             |       |            |                              |          |           |                  |
| Cupressaceae                 |             |       |            |                              |          |           |                  |
| Cupressus sempervirens L.    | HBKU-583    | T     | Perennial  | Megp                         | Lep      |           | Marghazar        |
| Thuja orientalis L.          | HBKU-541    | S     | Perennial  | NP                           | Lep      |           | Islampur         |
| **PINACEAE**                 |             |       |            |                              |          |           |                  |
| Cedrus deodara (Roxb. ex D. Don). | HBKU-793    | T     | Perennial  | Megp                         | Nan      |           | Marghazar, Sher Athraf |
| Pinus wallichiana A. B. Jackson. | HBKU-773  | T     | Perennial  | Megp                         | Nan      |           | Islampur         |
| Pinus roxburghii Sargent.    | HBKU-628    | T     | Perennial  | Megp                         | Nan      |           | Marghazar        |
| **ANGIOSPERMS**              |             |       |            |                              |          |           |                  |
| **MONOCOTS**                 |             |       |            |                              |          |           |                  |
| Alliaceae                    |             |       |            |                              |          |           |                  |
| Allium cepa L.               | HBKU-776    | H     | Annual     | G                            | Lep      |           | Sher Athraf, Islampur, Marghazar |
| Allium sativum L.            | HBKU-775    | H     | Annual     | G                            | Lep      |           | Sher Athraf, Islampur, Marghazar |
| Amaryllidaceae               |             |       |            |                              |          |           |                  |
| Narcissus tazetta L.         | HBKU-746    | H     | Annual     | G                            | Lep      |           | Sher Athraf, Islampur, Marghazar, Kukrai |
| **ARACEAE**                  |             |       |            |                              |          |           |                  |
| Acorus calamus L.            | HBKU-778    | H     | Annual     | G                            | Mic      |           | Sher Athraf      |
| Arisiaena jacqemontii Blume. | HBKU-779    | H     | Annual     | G                            | Mac      |           | Sher Athraf      |
| Colocasia esculenta (Linn.) Schott. | HBKU-545  | H     | Annual     | G                            | Mac      |           | Spal Bandai      |
| **ASCLEPIADACEAE**           |             |       |            |                              |          |           |                  |
| Calotropis procera (Ait.) Ait. f. | HBKU-819    | S     | Perennial  | Np                           | Mac      |           | Sher Athraf, Islampur, Marghazar, Kukrai, Spal Bandai |
| **ASPARAGACEAE**             |             |       |            |                              |          |           |                  |
| Asparagus adscendens Roxb.    | HBKU-780    | SS    | Perennial  | HC                           | Nan      |           | Sher Athraf      |
| **ASPHODELACEAE**            |             |       |            |                              |          |           |                  |
| Aloe vera (L.) Burm. F.       | HBKU-811    | H     | Perennial  | HC                           | Mac      |           | Sher Athraf      |
| Asphodelus tenuifolius Cav.   | HBKU-727    | H     | Annual     | Th                           | Nan      |           | Marghazar        |
| **COMMELIACEAE**             |             |       |            |                              |          |           |                  |
| Commelina benghalensis L.    | HBKU-694    | H     | Annual     | Th                           | Mic      |           | Spal Bandai      |
| **CONVALLARIACEAE**          |             |       |            |                              |          |           |                  |
| Polygonatum verticillatum (L.) All. | HBKU-791  | H     | Annual     | G                            | Mic      |           | Sher Athraf      |
| **CYPERACEAE**               |             |       |            |                              |          |           |                  |
| Bolboschoenus glaucus (Lam.) S.G. Smith. | HBKU-724    | H     | Perennial  | HC                           | Mic      |           | Marghazar        |
| Cyperus eleusinoideus Kunth. | HBKU-709    | H     | Perennial  | HC                           | Lep      |           | Spal Bandai      |
| Cyperus niveus Retz.          | HBKU-649    | H     | Perennial  | HC                           | Lep      |           | Kukrai           |
| Family       | Species                                                                 | HBKU Code | Life Form | Size  | Location       | Reference |
|--------------|--------------------------------------------------------------------------|-----------|-----------|-------|----------------|-----------|
| Liliaceae    | *Nototholithon thomsonianum* (D. Don) Stapf.                             | HBKU-568  | Annual    | G     | Mic            | Marghazar |
|              | *Tulipa clusiana* DC.                                                    | HBKU-567  | Annual    | G     | Mic            | Marghazar, Islampur |
| Musaceae     | *Musa paradisiaca* L.                                                    | HBKU-762  | Perennial | HC    | Meg            | Kukrai    |
| Smilacaceae  | *Smilax glauco phylla* Klotzch.                                          | HBKU-576  | Perennial | C     | Np             | Spal Bandai, Marghazar |
| Poaceae      | *Acrachne racemosa* (Heyne ex Roem. & Schult.) Ohwi                      | HBKU-645  | Perennial | HC    | Lep            | Kukrai    |
|              | *Agrostis sp.*                                                           | HBKU-729  | Perennial | HC    | Lep            | Marghazar |
|              | *Agrostis viridis* Gouan.                                                | HBKU-600  | Perennial | HC    | Lep            | Marghazar |
|              | *Apluda mutica* L.                                                      | HBKU-651  | Perennial | HC    | Lep            | Spal Bandai |
|              | *Aristida cyanantha* Nees ex Steud.                                      | HBKU-672  | Perennial | HC    | Nan            | Kukrai    |
|              | *Arundo donax* L.                                                       | HBKU-815  | Perennial | HC    | Lep            | Sher Athraf |
|              | *Avena fatua* L.                                                        | HBKU-599  | Annual    | Th    | Lep            | Marghazar |
|              | *Bothriochloa pertusa* (L.) A. Camus                                     | HBKU-659  | Perennial | HC    | Nan            | Kukrai    |
|              | *Bromus japonicus* Thunb. ex Murr.                                       | HBKU-794  | Perennial | HC    | Lep            | Sher Athraf |
|              | *Bromus pectinatus* Thunb.                                               | HBKU-552  | Perennial | HC    | Nan            | Marghazar |
|              | *Brachypodium sylvaticum* (Huds.) P. Beauv.                             | HBKU-685  | Perennial | HC    | Lep            | Spal Bandai |
|              | *Cynodon dactylon* (L.) Pers.                                           | HBKU-534  | Perennial | HC    | Lep            | Spal Bandai, Kukrai, Marghazar, Islampur |
|              | *Dactylis glomerata* L.                                                  | HBKU-635  | Perennial | HC    | Lep            | Spal Bandai, Marghazar |
|              | *Dendrocalamus strictus* (Roxb.) Nees.                                  | HBKU-767  | Perennial | HC    | Nan            | Spal Bandai |
|              | *Dichanthium annulatum* (Forssk.) Stapf.                                | HBKU-683  | Annual    | Th    | Mic            | Kukrai, Spal Bandai |
|              | *Digitaria ciliaris* (Retz.) Koel.                                       | HBKU-684  | Annual    | Th    | Mic            | Kukrai, Spal Bandai |
|              | *Echinochloa colona* (L.) Link                                           | HBKU-658  | Perennial | HC    | Nan            | Kukrai, Spal Bandai |
|              | *Eleusine indica* (L.) Gaertn.                                           | HBKU-689  | Perennial | HC    | Lep            | Spal Bandai |
|              | *Enneapogon persicus* Boiss.                                             | HBKU-741  | Annual    | Th    | Mic            | Marghazar |
|              | *Hemarthria sibirica* (Gandog.) Ohwi                                     | HBKU-696  | Perennial | HC    | Lep            | Kukrai, Spal Bandai |
|              | *Heteropogon contortus* (L.) P. Beauv. ex Smirnov                       | HBKU-671  | Perennial | HC    | Lep            | Kukrai    |
|              | *Roe. & Schult.*                                                         |            |           |      |                |           |
|              | *Lolium temulentum* L.                                                   | HBKU-598  | Annual    | Th    | Mic            | Marghazar |
|              | *Paspalum paspalodes* (Michx.) Scribn.                                   | HBKU-711  | Perennial | HC    | Lep            | Spal Bandai, Kukrai |
|              | *Pennisetum glaucum* (L.) R. Br.                                         | HBKU-525  | Perennial | HC    | Lep            | Islampur |
|              | *Pennisetum orientale* L.C. Rich.                                       | HBKU-718  | Perennial | HC    | Lep            | Kukrai    |
|              | *Phleum paniculatum* Huds.                                               | HBKU-589  | Annual    | Th    | Mic            | Marghazar |
|              | *Piptatherum laterale* (Munro ex Regel) Rozhev.                          | HBKU-653  | Annual    | Th    | Mic            | Kukrai, Spal Bandai |
|              | *Poa bulbosa* L.                                                        | HBKU-581  | Annual    | Th    | Mic            | Marghazar |
|              | *Polygongon fugax* Ness ex Steud.                                       | HBKU-810  | Annual    | Th    | Mic            | Sher Athraf |
|              | *Polygongon mopsellensis* (L.) Desf.                                     | HBKU-812  | Perennial | HC    | Lep            | Sher Athraf |
|              | *Sachcharum filiforme* Nees ex Steud.                                    | HBKU-702  | Perennial | HC    | Lep            | Kukrai, Spal Bandai |
|              | *Setaria pumila* (Poir.) Roem. & Schult.                                | HBKU-655  | Perennial | HC    | Lep            | Spal Bandai |
|              | *Sorghum bicolor* (L.) Moench.                                           | HBKU-533  | Perennial | HC    | Nan            | Islampur |
|              | *Sorghum halepense* (L.) Pers.                                           | HBKU-670  | Perennial | HC    | Lep            | Kukrai    |
|              | *Triticum aestivum* L.                                                   | HBKU-754  | Perennial | Th    | Lep            | Kukrai    |
|              | *Zea mays* L.                                                            | HBKU-523  | Annual    | Th    | Mac            | Islampur |

**DICOTS**

| Family     | Species                                                                 | HBKU Code | Life Form | Size  | Location       | Reference |
|------------|--------------------------------------------------------------------------|-----------|-----------|-------|----------------|-----------|
| Acanthaceae| *Dichiptera bupleuroides* Nees in Wall.                                   | HBKU-638  | Annual    | Th    | Mic            | Kukrai    |
|            | *Justicia adhatoda* L.                                                   | HBKU-774  | Perennial | NP    | Mes            | Sher Athraf |
| Aceraceae  | *Acer cappadocicum* Gleditsch.                                            | HBKU-707  | Perennial | MegP  | Mes            | Spal Bandai |
| Aizoaceae  | *Portulaca oleracea* L.                                                  | HBKU-763  | Annual    | Th    | Mic            | Kukrai    |
|            | *Triandema portulacastrum* L.                                             | HBKU-515  | Annual    | Th    | Mic            | Islampur, Kukrai |
| Amaranthaceae| *Achyranthes aspera* L.                                                  | HBKU-710  | Annual    | Th    | Mic            | Spal Bandai |
|            | *Alternanthera pungens* Kunth.                                            | HBKU-717  | Annual    | Th    | Mic            | Spal Bandai |
|            | *Amaranthus caudatus* L.                                                 | HBKU-639  | Annual    | Th    | Mic            | Kukrai    |
|            | *Amaranthus retroflexus* L.                                              | HBKU-698  | Annual    | Th    | Mic            | Kukrai, Spal Bandai |
|            | *Celosia argentea* L.                                                    | HBKU-695  | Annual    | Th    | Mic            | Spal Bandai |
| Anacardiaceae| *Cotinus coggyria* Scop.                                                  | HBKU-686  | Perennial | NP    | Mic            | Spal Bandai |
|            | *Mangifera indica* L.                                                    | HBKU-521  | Perennial | MegP  | Mes            | Islampur  |
| Scientific Name | Code | Life Form | Notes |
|-----------------|------|-----------|-------|
| *Pistacia chinensis* Bunge. | HBKU-605 | Perennial | Mes | P | Kukrai, Islampur, Marghazar |
| *Apocynaceae* | | | |
| *Nerium oleander* L. | HBKU-818 | Perennial | NP | Mes | Sher Athraf |
| *Vincia major* L. | HBKU-569 | Annual | Th | Mic | Marghazar |
| *Aquifoliaceae* | | | |
| *Ilex diphyra* Wall. | HBKU-740 | Perennial | MegP | Mes | Marghazar |
| *Araliaceae* | | | |
| *Hedera nepalensis* K. Koch. | HBKU-571 | Perennial | NP | Mes | Marghazar, Kukrai |
| *Asteraceae* | | | |
| *Achillea millefolium* L. | HBKU-770 | Perennial | HC | Mes | Marghazar |
| *Artemisia absinthium* L. | HBKU-626 | Perennial | HC | Mes | Marghazar |
| *Artemisia brevifolia* Wall. ex DC. | HBKU-781 | Perennial | HC | Mes | Sher Athraf |
| *Artemisia santolinifolia* Turcz. ex Krasch. | HBKU-624 | Perennial | HC | Mes | Marghazar |
| *Artemisia scoparia* Waldst. & Kit. | HBKU-625 | Perennial | HC | Mes | Marghazar |
| *Artemisia vulgaris* L. | HBKU-627 | Perennial | HC | Mes | Kukrai, Marghazar |
| *Aster subulatus* Michaux | HBKU-715 | Perennial | HC | Mes | Spal Bandai |
| *Bidens tripartita* L. | HBKU-666 | Perennial | HC | Mes | Spal Bandai, Kukrai |
| *Calendula arvensis* L. | HBKU-575 | Perennial | HC | Mes | Marghazar |
| *Carpesium abrotanoides* L. | HBKU-674 | Perennial | HC | Mic | Kukrai |
| *Erigeron bonariensis* L. | HBKU-765 | Perennial | HC | Mes | Spal Bandai |
| *Erigeron canadensis* L. | HBKU-643 | Perennial | HC | Mes | Kukrai |
| *Coasnia buphthalmoides* Regel. | HBKU-766 | Annual | HC | Mes | Spal Bandai |
| *Cichorium intybus* L. | HBKU-699 | Perennial | HC | Mic | Spal Bandai |
| *Cirsium vulgare* (Savi) Ten. | HBKU-691 | Annual | Th | Mic | Spal Bandai |
| *Eclipta alba* (L.) Hassk. | HBKU-681 | Annual | Th | Lep | Spal Bandai |
| *Helianthus annuus* L. | HBKU-769 | Annual | Th | Mac | Kukrai |
| *Lactuca tatarica* (L.) C. A. Mey. | HBKU-673 | Annual | Th | Mes | Kukrai |
| *Launaea procumbens* (Roxb.) Ramayya & Rajagopal. | HBKU-579 | Perennial | HC | Lep | Marghazar |
| *Berberidaceae* | | | |
| *Berberis lyricum* Royle. | HBKU-561 | Perennial | NP | Mic | Marghazar |
| *Betulaceae* | | | |
| *Ainus nita* (Spach) Endl.Gen. | HBKU-692 | Perennial | MegP | Mic | Spal Bandai |
| *Boraginaceae* | | | |
| *Cynoglossum lanceolatum* Forssk. | HBKU-697 | Annual | Th | Mic | Spal Bandai |
| *Onosma dichroantha* Boiss. | HBKU-650 | Annual | Th | Mic | Kukrai |
| *Brassicaceae* | | | |
| *Arabis pterosperma* Edgew. | HBKU-733 | Annual | Th | Mic | Marghazar |
| *Brassica rapa* subsp. *campestris* (L.) C. L. Chlapham. | HBKU-782 | Annual | Th | Mes | Sher Athraf |
| *Brassica rapa* subsp. *rapa* | HBKU-744 | Annual | Th | Mic | Sher Athraf |
| *Capsella bursa-pastoris* (L.) Medik. | HBKU-634 | Annual | Th | Mic | Marghazar |
| *Coronopus didymus* (L.) Smith. | HBKU-813 | Perennial | HC | Mic | Sher Athraf |
| *Eruca sativa* Mill. | HBKU-612 | Annual | Th | Mic | Marghazar |
| *Lepidium sativum* L. | HBKU-783 | Annual | Th | Mic | Sher Athraf |
| *Nasturtium officinale* R. Br. | HBKU-555 | Annual | Th | Mes | Spal Bandai, Marghazar |
| *Neslia apiaculata* Fisch. | HBKU-609 | Annual | Th | Lep | Marghazar |
| *Raphanus raphanistrum* L. | HBKU-652 | Annual | Th | Mic | Kukrai |
| *Raphanus sativus* var. *sativus* | HBKU-738 | Annual | Th | Mic | Sher Athraf |
| *Sisymbrium irio* L. | HBKU-554 | Annual | Th | Mic | Marghazar |
| *Sisymbrium orientale* L. | HBKU-582 | Annual | Th | Mic | Marghazar |
| *Buddlejaceae* | | | |
| *Buddleja crispa* Benth. | HBKU-587 | Perennial | NP | Mes | Marghazar |
| *Buxaceae* | | | |
| *Sarcococca saligna* (D. Don) Muell.-Arg. | HBKU-814 | Perennial | NP | Mes | Sher Athraf |
| *Campanulaceae* | | | |
| *Campanula pallida* Wall. | HBKU-602 | Annual | Th | Mic | Kukrai, Marghazar |
| Family               | Species                          | Code   | Life Form | Subsp. | Collection | Location                  | Notes                   |
|---------------------|----------------------------------|--------|-----------|--------|------------|---------------------------|-------------------------|
| Cannabaceae         | *Cannabis sativa* L.             | HBKU-806 | Annual    |        |            | Kukrai, Sheer Athraf, Marghazar |
| Caprifoliaceae      | *Lonicer a japo nica Thunb.*     | HBKU-768 | Perennial | NP     | Mes        | Spal Bandai               |                         |
| Casuarinaceae       | *Casuarina equisetiformis* L.    | HBKU-620 | Perennial | MegP   | Nan        | White Palace Marghazar    |                         |
| Caryophyllaceae     | *Ceras ti um glomeratum* Thuill. | HBKU-560 | Annual    | Th     | Mic        | Marghazar                 |                         |
| Silene conoeidea L. | HBKU-613                         |        | Annual    | Th     | Mes        | Marghazar                 |                         |
| *Stellaria media* (L.) Vill. | HBKU-784 | Annual    | Th       | Mes    |            | Sheer Athraf              |                         |
| Chenopodiaceae      | *Cheno podium ambrosioides* L.   | HBKU-687 | Annual    | Th     | Mic        | Spal Bandai               |                         |
| *Cheno podium botrys* L. | HBKU-700 | Annual    | Th       | Mic    |            | Spal Bandai               |                         |
| *Cheno podium murale* L. | HBKU-785 | Annual    | Th       | Mic    |            | Sheer Athraf              |                         |
| Convolulaceae       | *Convolulus arvensis* L.         | HBKU-546 | Annual    | Th     | Mic        | Kukrai                    |                         |
| *Ipomeoa erio carpa* R. Br. | HBKU-662 | Annual    | Th       | Mic    |            | Kukrai                    |                         |
| *Ipomeoa hederacea* Jacq. | HBKU-731 | Annual    | Th       | Mes    |            | Marghazar                 |                         |
| *Ipomeoa purpurea* (L.) Roth. | HBKU-678 | Annual    | Th       | Mic    |            | Spal Bandai               |                         |
| Crassulaceae        | *Sedum hispanicum* L.           | HBKU-749 | Annual    | Th     | Lep        | Marghazar                 |                         |
| Cucurbitaceae       | *Cucumica melo subsp. argestis* (Naud.) Grebenc. | HBKU-646 | Annual    | Th     | Mac        | Islampur                  |                         |
| *Luffa Cylindrica* (L.) Roem. | HBKU-539 | Annual    | Th       | Mes    |            | Islampur                  |                         |
| Cuscutaceae         | *Cuscata reflexa* Roxb.          | HBKU-526 | Perennial | Th     | Aph        | Islampur                  |                         |
| *Ebenaceae*         | *Diospyros kaki* L.             | HBKU-750 | Perennial | MegP   | Mac        | Islampur                  |                         |
| *Diospyros lotus* L. | HBKU-616                         |        | Perennial | MegP   | Mes        | Marghazar                 |                         |
| *Elaeagnaceae*      | *Elaeagnus angustifolia* L.      | HBKU-617 | Perennial | NP     | Mes        | Marghazar                 |                         |
| Euphorbiaceae       | *Andrachne cordifolia* (Wall. Ex Decne.) Muell. | HBKU-714 | Perennial | NP     | Mes        | Spal Bandai               |                         |
| *Euphorbia helioscopia* L. | HBKU-742 | Annual    | Th       | Mic    |            | Sheer Athraf              |                         |
| *Euphorbia heterophylla* L. | HBKU-721 | Annual    | Th       | Mic    |            | Spal Bandai               |                         |
| *Euphorbia hirta* L. | HBKU-807                         |        | Annual    | Th       | Mic        | Sheer Athraf              |                         |
| *Euphorbia prostrata* Ait. | HBKU-743 | Annual    | Th       | Mic    |            | Sheer Athraf              |                         |
| *Mallotus philippensis* (Lam.) Muell. | HBKU-786 | Perennial | NP     | Mes    |            | Sheer Athraf              |                         |
| *Ricinus communis* L. | HBKU-772                        |        | Perennial | NP     | Mac        | Kukrai                    |                         |
| *Fagaceae*          | *Quercus baloot* Griff.          | HBKU-630 | Perennial | NP     | Mic        | Marghazar                 |                         |
| *Quercus dilatata* Royle. | HBKU-787 | Perennial | MicP   | Mic    |            | Sher Athraf               |                         |
| *Quercus incana* Roxb. | HBKU-592                        |        | Perennial | MicP   | Mes        | Marghazar                 |                         |
| *Fumariaceae*       | *Fumaria indica* (Hausskn.) Pugsley. | HBKU-755 | Annual    | Th     | Lep        | Kukrai                    |                         |
| *Geraniaceae*       | *Geranium collarum* Steph. Ex Wildt | HBKU-636 | Annual    | Th     | Lep        | Marghazar                 |                         |
| *Geranium ocellatum* Camb. | HBKU-637 | Annual    | Th       | Mic    |            | Marghazar                 |                         |
| *Geranium wallichianum* D. Don ex Sweet. | HBKU-604 | Annual    | Th       | Mic    |            | Marghazar                 |                         |
| Guttiferae          | *Hypericum perforatum* L.        | HBKU-789 | Annual    | Th     | Lep        | Sher Athraf               |                         |
| *Hippocastanaceae*  | *Aesculus indica* (Wall.ex Camb.) Hook.f. | HBKU-788 | Perennial | MegP   | Mes        | Sher Athraf               |                         |
| *Juglandaceae*      | *Juglans regia* L.              | HBKU-802 | Perennial | MegP   | Mes        | Spal Bandai, Kukrai, Marghazar, Sheer Athraf, Islampur |                         |
| *Lamiaceae*         | *Ajuga bracteosa* Wall.ex Benth. | HBKU-578 | Annual    | Th     | Mes        | Marghazar                 |                         |
| *Clinopodium umbrosum* (M. Bieb.) C. Koch. | HBKU-644 | Annual    | Th       | Mic    |            | Spal Bandai, Kukrai       |                         |
| *Isodon rugosus* (Wall. Ex Benth.). | HBKU-557 | Perennial | Ch     | Mes    |            | Marghazar                 |                         |
| *Lami um amplexicaule* L. | HBKU-804 | Annual    | Th       | Mes    |            | Islampur                  |                         |
| *Mentha longifolia* (L.) Huds. | HBKU-594 | Annual    | G       | Mic    |            | Marghazar                 |                         |
| *Micromeria biflora* (Buch.-Ham. Ex D. Don) Benth. | HBKU-570 | Annual    | Th       | Mes    |            | Marghazar                 |                         |
| *Oximun basilicum* L. | HBKU-809                         |        | Perennial | Ch     | Mes        | Sher Athraf               |                         |
| *Ori gunum vulgare* L. | HBKU-677                        |        | Perennial | HC     | Mic        | Kukrai, Marghazar         |                         |
| Species                                    | Code   | Rating | Duration | Genus   | Family   | Location       |
|--------------------------------------------|--------|--------|----------|---------|----------|----------------|
| Salvia lanata Roxb.                        | HBKU-675 | H      | Perennial | HC      | Mic      | Kukraiz        |
| Salvia moorecroftiana Wall. ex Benth.      | HBKU-663 | H      | Annual   | Th      | Mes      | Islampur       |
| Thymus linearis Benth.                     | HBKU-790 | H      | Annual   | Th      | Nan      | Sher Athraf    |
| **Malvaceae**                              |        |        |          |         |          |                |
| *Abelmoschus esculentus* (L.) Moench.      | HBKU-536 | H      | Annual   | Th      | Mes      | Islampur       |
| *Hibiscus syriacus* L.                     | HBKU-664 | S      | Perennial | NP      | Mes      | Kukraiz        |
| *Malvastrum coronelium* (L.) Garcke        | HBKU-701 | H      | Annual   | Th      | Mes      | Spal Bandai    |
| *Malva neglecta* Wall.                     | HBKU-760 | H      | Annual   | Th      | Mes      | Kukraiz        |
| *Malva sylvestris* L.                      | HBKU-736 | H      | Annual   | Th      | Mes      | Marghazar      |
| **Meliaceae**                              |        |        |          |         |          |                |
| *Melia azedarach* L.                       | HBKU-524 | T      | Perennial | MegP    | Mic      | Kukraiz, Islampur |
| **Myrrhaceae**                             |        |        |          |         |          |                |
| *Myrsine africana* L.                      | HBKU-553 | S      | Perennial | NP      | Lep      | Marghazar      |
| **Myrtaceae**                              |        |        |          |         |          |                |
| *Callistemon lanceolatus* DC.              | HBKU-544 | T      | Perennial | MesP    | Lp       | Spal Bandai    |
| *Eucalyptus camaldulensis* Dehn.           | HBKU-771 | T      | Perennial | MegP    | Lep      | Kukraiz        |
| *Psidium guajava* L.                       | HBKU-519 | T      | Perennial | MesP    | Mes      | Islampur       |
| **Nyctantheae**                            |        |        |          |         |          |                |
| *Boerhavia procumbens* Banks ex Roxb.      | HBKU-716 | H      | Annual   | Th      | Nan      | Spal Bandai    |
| *Mirabilis jalapa* L.                      | HBKU-520 | H      | Annual   | Th      | Nan      | Islampur       |
| **Oleaeae**                                |        |        |          |         |          |                |
| *Olea ferruginea* Wall. ex Aitch.          | HBKU-593 | T      | Perennial | MegP    | Mic      | Marghazar      |
| **Onagraceae**                             |        |        |          |         |          |                |
| *Oenothera rosea* L.’ Her. Er. Ait.        | HBKU-588 | H      | Annual   | Th      | Mes      | Marghazar      |
| **Oxalidaceae**                            |        |        |          |         |          |                |
| *Oxalis corniculata* L.                    | HBKU-548 | H      | Annual   | Th      | Nan      | Islampur       |
| *Oxalis corymbosa* DC.                     | HBKU-563 | H      | Annual   | Th      | Nan      | Marghazar      |
| **Paeaniaceae**                            |        |        |          |         |          |                |
| *Paeonia enodi* Wall. ex Royle.            | HBKU-792 | H      | Perennial | Th      | Mic      | Sher Athraf    |
| **Papaveraceae**                           |        |        |          |         |          |                |
| *Papaver dubium* L.                        | HBKU-756 | H      | Annual   | Th      | Mic      | Kukraiz        |
| *Papaver pavaninum* Schrenk.               | HBKU-574 | H      | Annual   | Th      | Mic      | Marghazar      |
| **Papilionaceae**                          |        |        |          |         |          |                |
| *Acacia nilotica* (L.) Delile.             | HBKU-752 | T      | Perennial | MicP    | Mic      | Marghazar      |
| *Desmodium elegans* DC.                    | HBKU-648 | S      | Perennial | MicP    | Mic      | Kukraiz        |
| *Indigofera heterantha* var. gerardiana (Wall. ex Baker) Ali | HBKU-622 | S      | Perennial | NP      | Mes      | Marghazar      |
| *Indigofera heterantha* var. heterantha    | HBKU-615 | S      | Perennial | NP      | Mes      | Marghazar      |
| *Lathyrus aphaca* L.                       | HBKU-823 | H      | Annual   | Th      | Nan      | Marghazar      |
| *Medicago lupulina* L.                     | HBKU-590 | H      | Annual   | Th      | Lep      | Marghazar      |
| *Medicago polymorpha* L.                   | HBKU-611 | H      | Annual   | Th      | Lep      | Marghazar      |
| *Robinia pseudo-acacia* L.                 | HBKU-562 | T      | Perennial | MesP    | Mes      | Marghazar      |
| *Trifolium repens* L.                      | HBKU-573 | H      | Annual   | Th      | Lep      | Marghazar      |
| *Vicia sativa* L.                          | HBKU-632 | H      | Annual   | Th      | Mic      | Marghazar, Sher Athraf |
| **Platanaceae**                            |        |        |          |         |          |                |
| *Platanus orientalis* L.                   | HBKU-757 | T      | Perennial | MegP    | Mac      | Kukraiz        |
| **Polygalaceae**                           |        |        |          |         |          |                |
| *Polygalax abyssinica* R.Br. ex Fresen      | HBKU-708 | H      | Annual   | Th      | Mic      | Spal Bandai    |
| **Polygonaceae**                           |        |        |          |         |          |                |
| *Bistorta amplexicaulis* (D. Don) Green.    | HBKU-795 | H      | Perennial | HC      | Mes      | Sher Athraf    |
| *Persicaria hydropiper* (L.) Spach.         | HBKU-647 | H      | Perennial | HC      | Mes      | Spal Bandai, Kukraiz |
| *Rumex dentatus* L.                        | HBKU-688 | H      | Annual   | Th      | Mic      | Spal Bandai    |
| *Rumex hastatus* D. Don.                   | HBKU-642 | H      | Annual   | Th      | Mic      | Kukraiz        |
| **Primulaceae**                            |        |        |          |         |          |                |
| *Androsace rotundifolia* Hardw.             | HBKU-803 | H      | Annual   | Th      | Mes      | Marghazar      |
| *Primula denticulata* Smith.                | HBKU-796 | H      | Annual   | Th      | Mic      | Sher Athraf    |
| **Punicaceae**                             |        |        |          |         |          |                |
| *Punica granatum* L.                       | HBKU-529 | T      | Perennial | MesP    | Mes      | Islampur       |
| Family               | Species Name                          | HBKU Code | Growth Form | Distribution          | Notes                               |
|----------------------|---------------------------------------|-----------|-------------|-----------------------|-------------------------------------|
| Ranunculaceae        | Clematis grata Wall.                  | HBKU-618  | C           | Perennial             | NP                                 |
|                      | Clematis graveolens Lindl.           | HBKU-631  | C           | Perennial             | NP                                 |
|                      | Ranunculus laetus Wall. ex Hook. f. & J.W.| HBKU-586  | H           | Perennial             | NP                                 |
| Rhamnaceae           | Sageretia thea (Osbeck) M.C.          | HBKU-621  | S           | Perennial             | NP                                 |
|                      | Ziziphus jujuba Mill.                 | HBKU-690  | T           | Perennial             | MesP                               |
|                      | Ziziphus nummularia (Burm. f.) Wight & Arn. | HBKU-798  | S           | Perennial             | MicP                               |
|                      | Ziziphus oxyphylla Edgew.             | HBKU-824  | S           | Perennial             | NP                                 |
| Rosaceae             | Dachneea indica (Andrews).            | HBKU-608  | H           | Annual                | Th                                 |
|                      | Eriobotrya japonica (Thunb.) Lindl.   | HBKU-522  | T           | Perennial             | MesP                               |
|                      | Fragaria nubicola (Hook.f.) Lindl.    | HBKU-623  | H           | Annual                | Th                                 |
|                      | Malus pamila Mill.                    | HBKU-764  | T           | Perennial             | MicP                               |
|                      | Potentilla supina L.                  | HBKU-730  | H           | Annual                | Th                                 |
|                      | Prunus armeniaca L.                   | HBKU-732  | T           | Perennial             | MesP                               |
|                      | Prunus domestica L.                   | HBKU-751  | T           | Perennial             | MicP                               |
|                      | Pyrus communis L.                     | HBKU-656  | T           | Perennial             | MesP                               |
|                      | Pyrus pashia Buch.-Ham. ex D. Don.    | HBKU-641  | T           | Perennial             | MesP                               |
|                      | Pyrus pseudopashia T. T. Yu           | HBKU-657  | T           | Perennial             | MesP                               |
|                      | Rosa alba L.                          | HBKU-543  | S           | Perennial             | NP                                 |
|                      | Rosa banksiae W. T. Aiton.            | HBKU-734  | S           | Perennial             | NP                                 |
|                      | Rosa brunnii Lindl.                   | HBKU-591  | S           | Perennial             | NP                                 |
|                      | Rosa chinensis Jacq.                  | HBKU-542  | S           | Perennial             | NP                                 |
|                      | Rubus ellipticus Smith.               | HBKU-667  | S           | Perennial             | NP                                 |
|                      | Rubus fruticosus L.                   | HBKU-668  | S           | Perennial             | NP                                 |
|                      | Rubus irrians Focke.                  | HBKU-595  | S           | Perennial             | NP                                 |
|                      | Rubus macilentus Camb.                | HBKU-654  | S           | Perennial             | NP                                 |
|                      | Rubus niveus Thunb.                   | HBKU-682  | S           | Perennial             | NP                                 |
|                      | Rubus ulmifolius Schott.              | HBKU-669  | S           | Perennial             | NP                                 |
|                      | Sibbalda procumbens L.                | HBKU-596  | H           | Annual                | Th                                 |
|                      | Spirea corymbosa Rafinesque.          | HBKU-737  | S           | Perennial             | NP                                 |
| Rubiaceae            | Gaulium aparine L.                    | HBKU-601  | H           | Annual                | Th                                 |
|                      | Rubia cordifolia L.                   | HBKU-564  | H           | Annual                | Th                                 |
| Rutaceae             | Citrus limon (L.) Burm. f.             | HBKU-537  | S           | Perennial             | NP                                 |
|                      | Citrus medica L.                      | HBKU-538  | T           | Perennial             | MicP                               |
|                      | Citrus sinensis (L.) Osbeck.          | HBKU-540  | T           | Perennial             | MesP                               |
|                      | Zanthoxylum armatum DC.               | HBKU-629  | S           | Perennial             | NP                                 |
| Salicaceae           | Populus alba L.                       | HBKU-517  | T           | Perennial             | MegP                               |
|                      | Populus nigra L.                      | HBKU-518  | T           | Perennial             | MegP                               |
|                      | Salix acmophylla Boiss.               | HBKU-610  | T           | Perennial             | MegP                               |
| Sambucaceae          | Sambucus nigra L.                     | HBKU-603  | T           | Perennial             | MegP                               |
|                      | Sambucus wightiana Wall. Ex Wight & Arn.| HBKU-723  | SH          | Perennial             | NP                                 |
| Sapindaceae          | Dodonaea viscosa (L.) Jacq.           | HBKU-753  | S           | Perennial             | NP                                 |
| Saxifragaceae        | Bergenia ciliata (Haw.) Sternb.       | HBKU-799  | H           | Annual                | Th                                 |
| Scrophulariaceae     | Mazus japonicus (Thunb.) O. Kuntze.   | HBKU-722  | H           | Annual                | Th                                 |
|                      | Verbascum thapsum L.                  | HBKU-565  | H           | Annual                | Th                                 |
|                      | Veronica anagallis-aquatica L.        | HBKU-705  | H           | Annual                | Th                                 |
|                      | Veronica polita Fr.                  | HBKU-614  | H           | Annual                | Th                                 |
| Simaroubaceae        | Ailanthus altissimus (Mill.) Swingle. | HBKU-532  | T           | Perennial             | MegP                               |
| Solanaceae           | Capsicum annuum L.                    | HBKU-551  | H           | Annual                | Th                                 |
|                      | Hyoscyamus niger L.                   | HBKU-800  | H           | Annual                | Th                                 |
|                      | Lycopersicon esculentum Mill.         | HBKU-820  | H           | Annual                | Th                                 |
|                      | Solanum nigrum L.                     | HBKU-559  | H           | Annual                | Th                                 |
|                      | Solanum surattense Burm. F.           | HBKU-516  | H           | Annual                | Th                                 |
|                      | Solanum tuberosum L.                  | HBKU-821  | H           | Annual                | Th                                 |
|                      | Withania somnifera (L.) Dunal.        | HBKU-801  | S           | Perennial             | NP                                 |
Thymelaeaceae
Daphne mucronata Royle. HBUK-556 S Perennial NP Mes Sher Athraf, Marghazar
Wistreaea canescens Meisn. HBUK-660 S Perennial NP Mes Kukrai

Ulmaceae
Celtis caucasia Wild. HBUK-607 T Perennial MesP Mes Spal Bandai, Marghazar
Celtis ericarpa Decne. HBUK-619 T Perennial MesP Mic Marghazar
Celtis tetandra Roxb. HBUK-712 T Perennial MicP Mes Spal Bandai

Umbrilliferae
Banium persicum (Boiss.) Fedtsch. HBUK-777 H Annual Th Mic Sher Athraf
Foeniculum vulgare Mill. HBUK-558 H Annual Th Mic Kukrai, Marghazar
Pimpinella stewartii (Dunn) E. Nasir. HBUK-679 H Annual Th Lep Spal Bandai
Torilis leptophylla (L.) Reichb. f. HBUK-606 H Annual Th Mic Marghazar

Urticaceae
Debregeasia salicifolia (D.Don). HBUK-572 S Perennial NP Mic Marghazar
Pilea umbrosa Blume. HBUK-676 H Annual Th Mes Spal Bandai
Urtica dioica L. HBUK-580 H Annual Th Mic Marghazar
Urtica pilidifera L. HBUK-566 H Annual Th Mes Marghazar

Verbenaceae
Verbena officinalis L. HBUK-680 H Annual Th Mic Spal Bandai
Vitex negundo L. HBUK-693 S Perennial NP Mes Spal Bandai

Violaceae
Viola canescens Wall. ex Roxb. HBUK-817 H Annual Th Mic Sher Athraf
Viola pilosa Blume. HBUK-816 H Annual Th Mic Sher Athraf

Vitaceae
Vitis jacquemontii Parker. HBUK-805 WC Perennial NP Mac Sher Athraf
Vitis vinifera L. HBUK-531 S Perennial NP Mac Islapur

Zygophyllaceae
Tribulus terrestris L. HBUK-549 H Annual Th Mic Kukrai

Note: Habit: C: Climbers; CS: Climbing shrub; G: Grasses; H: herbs; HTT: Hollow tufted tree; PH: Parasitic herb; SH: Shrub herbs; S: Shrubs; SS: Subshrub; TH: Tree-like herbs; T: Trees; WC: Woody climber. Life form classes: Ch: Chaemophytes; G: Geophytes; HC: Hemichryphophytes; Hyd: Hydrophytes; MegP: Megaphanerophytes; MesP: Mesophanerophytes; MicP: Microphanerophytes; NP: Nanophanerophytes; Th: Therophytes. Leaf size classes: Aphy: Aphyllus; Lep: Leptophylls; Mac: Macrophylls; Meg: Megaphylls; Mic: Microphylls; Nan: Nanophylls

Table 2. Taxonomic classification of plants of Marghazar Valley, Swat, Pakistan

| Taxonomic classification | Species | Genera | Families | Percentage |
|--------------------------|---------|--------|----------|------------|
| Pteridophytes            | 14      | 9      | 7        | 4.56%      |
| Gymnosperms              | 5       | 4      | 2        | 1.62%      |
| Monocots                 | 57      | 50     | 13       | 18.56%     |
| Dicots                   | 231     | 173    | 72       | 75.24%     |
| Total                    | 307     | 236    | 94       | 99.99%     |

Important and dominant taxonomic groups with the highest number of genera and species are Dicots (75.24%) followed by Monocots (18.56%), Pteridophytes (4.56%) and Gymnosperms (1.62%) as shown in Table 2. Cousinia buphaloides was recorded as new to Swat and Pakistan because no such information is available to our native flora, other floras and published literature.

Herbaceous plants were the highest growth form with 161 species, followed by trees with 46 species, shrubs (45 species), grasses (37), climbers (10 species), shrubby herbs (2 species), subshrubs (1 species), tree-like herb (1 species), hollow tufted tree (1 species), climbing shrub (1 species), parasitic herb (1 species) and 1 species of a woody climber in decreasing order (Table 3). The phenology of vegetation revealed that 174 taxa (56.35%) were perennial, followed by 134 annuals (43.50%), as shown in Table 4.

Floristic attributes and ecological studies
Bio-spectrum class represented by life form and leaf size classes as 126 species are therophytes (40.90%) as the leading class in life form followed by hemicryptophytes with 58 species (18.83%), nanophanerophytes with 47 species (15.25%), 26 species observed as megaphanerophytes (8.44%), geophytes 23 species (7.46%), mesophanerophytes 15 species (4.88%), microphanerophytes 9 species (2.92%), chaemophytes 2 species (0.64%) and 1 species recorded as hydrophytes and share 0.32% adaptation (Table 5A). The life form is the indicator of micro and macroclimate and it is described by plant adaptation to certain environmental situations. Leaf size class (Table 5B), observed that microphylls dominated by a total of 122 species (39.61%), followed by mesophylls 94 species (30.61%), leptomorph 50 species (16.23%), nanophylls 22 species (7.41%), macrophylls 16 species (5.19%), megaphyll 1 species (0.32%) and remaining 2 species (Cuscuta reflexa and Equisetum arvense) are aphylus species which possesses no leaves. The leaf size information helps in appreciative physical processes of flora.
taxa and 56 families. Among them, Poaceae with 34 taxa was the topmost dominating, followed by Papilionaceae with a total of 19 taxa. Capparis decidua and Periploca aphylla were recorded aphyllous taxa. Wariss et al. (2014) reported dicots (41 families), monocots (5 families), Pteridophytes (3 families). Ilyas et al. (2015) recognized a vegetation study of Kabal valley, Swat, Pakistan and documented 136 families including 31 ferns and their allies, 8 taxa of Gymnosperm, while the remaining 781 taxa were Angiospermic and share 597 taxa Dicotyledons and 184 Monocotyledons. Important and new species were Vernicia fischeri and Vernonia aphanes was reported for first time in Pakistan. Razzaq et al. 2018 explored 476 taxa of vascular plants from Malam Jabba Valley, Swat, Pakistan during 2013-17. A total of 112 flowering families were recorded with 334 genera, including Pteridophytes (26 families, 14 genera and 10 families), Gymnosperms with (11 taxa, 9 genera and 4 families), Angiosperm with 353 Dicots and 86 Monocots species. Athyraceae (Pteridophytes), Pinaceae (Gymnosperm) and Poaceae (Monocots), Asteraceae (Dicots) were the most important families within-species diversity and abundance. Herbs were also the highest in their study, followed by shrubs and trees and climbers.

Floristic study of any given area helps to evaluate the plant wealth and its potential values (Shaheen et al. 2016). The main source of botanical materials of a specific region is its floristic checklists (Safidkon et al. 2003). The life form is the indicator of micro and macroclimate and it is described by plant adaptation to certain environmental situations (Shimwell 1971). However, floristic studies from Pakistan and Swat region have been reported by many workers, but no such information of floristic study in Margazar is available, therefore this study will fulfill the current gap. Our present studies also agree with that of Khan et al. (2017) collected and identified a total of 90 known families and two hundred two genera from Ranizia Valley, Swat and highlighted family Poaceae as a dominant, while Khan et al. (2019) also agree with our results and reported 34 weedy species with Poaceae as a dominant family from Charbagh Valley, Swat. However, some attempts were also made by workers from other regions of KP. Khan et al. (2019) reported 51 grasses with 34 genera from district Charsadda, Pakistan, while Ibrahim et al. (2019) found Asteraceae and Poaceae as the dominant families in their study. Khan et al. (2019) also showed that Poaceae was the leading family in terms of a number of genera and species with 36 genera (19.04%) and 56 species (22.13%) followed by Asteraceae with 15 genera (7.936%) and 17 species (6.719%) from district Charsadda, Pakistan. Rahman et al. (2019) explored the comprehensive floristic checklist of Mahnoor Valley during 2015-2018 and classified a total of three hundred and fifty-four taxa with ninety-three families in which herbaceous cover was dominant followed by a shrubby layer with an important family of Asteraceae. Further they also identified therophytic (life form) and nanophylls (leaf size) as dominant. Our results also agree with Shaheen et al. (2019) reported one hundred thirty-two species from Deosai Plateau in North Pakistan.
To conclude, the study regarding plant resources of Marghazar Valley, Hindukush Range, Swat, Pakistan, revealed that the flora of Marghazar Valley comprised of 307 taxa belonging to 236 genera and 94 families. Based on the number of species, Asteraceae, Rosaceae, Brassicaceae, Lamiales, Papilionaceae were the most prevalent families, Phytoclimatic spectra of the area are Theropytic and Microphyllous type and the climatic conditions of the valley are influenced by grazing, snow sliding, excessive rain, unpleasant weather, land use, agriculture expansion, natural disaster and other anthropogenic activities which support short-lived species. This study offers baseline information on the flora, and further research is recommended for exploring quantitative vegetation attributes.

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