RIPARIAN PHYTODIVERSITY AND ECOLOGICAL ATTRIBUTES OF BAJAUR, PAKISTAN

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Abstract

In the present study, the riparian flora of district Bajaur, Khyber Pakhtunkhwa, Pakistan, was documented. The entire area was surveyed in 2022 and a total of 65 species belonging to 34 families were collected. Family Asteraceae was found as the most dominant contributing 10 species (15.3 %), followed by the Poaceae with 7 species (10.76%), Salicaceae with 4 species (6.15%), Moraceae, Euphorbiaceae, Amaranthaceae and Solanaceae with 3 species (4.61%) each. The habit of the flora was dominated by herbs with 46 species (70.76%) followed by trees with 13 species (20%) and shrubs with 6 species (9.32%). The characteristic life form of the flora was therophytes with 33 species (50.76%) and the leaf size class was nanophyll (23 species). The majority of plants (41 species) bloom in the spring season. This is the first-ever report from the area and the collected information may help different researchers in the identification of plants in the nearby riparian ecosystem.

Keywords: Floristic composition, habit, biological spectrum, phenology, monsoon

1. Introduction

Flora is the sum of all the plant species of a specific geographical region (Ali, 2008). The floristic diversity of an area is always different from another. In a particular geographic region, there is always variation in genetic diversity, species diversity, ecosystem diversity and ecological diversity (Kilic and Arsalan, 2010). Inventory of flora is a common practice throughout the world for gathering information about plants and their distribution (Qureshi et al., 2011). The study of flora and their ecological characteristics are useful for evaluating ecological issues and will give insight into the future plantation, species monitoring and management in a given region (Hussain et al., 2015; Haq and Badshah, 2021).

The word riparian is derived from the Latin 'Ripa' meaning river bank. The term riparian land refers to land adjoining a nearby water body (Khan et al., 2016). Riparian vegetation, habitats, or ecosystems depend on the permanent or occasional surface or subterranean water and are connected to bodies of water like streams, springs, or ponds (National research council, 2002). The riparian zones are among the most diverse and dynamic habits for plants (Capon and Dowi, 2007). They are distinctly different from surrounding lands because of the unique soil and vegetation characteristics that are strongly influenced by the presence of water (National research council, 2002). In a variety of climatic, hydrologic, and ecological

conditions, riparian habitats can be found. Riparian communities can vary greatly depending on latitude and altitude (Dodds et al., 2019). Riparian zones typically have higher soil moisture and nutrient content than neighboring upland systems and this may favor plant biomass production (Megonigal et al., 1997). Frequent flooding damages the riparian vegetation's community structure, which produces a dynamic and fluctuating landform (Pollock et al., 1998). For describing such a plant community, the ecological and environmental study is crucial (Iqbal et al., 2008).

The rivers' sides have a dynamic floristic diversity with unique ecological characteristics that s remain unexplored, so there is an immense need to identify and explore them.

2. Materials and Methods

2.1 Study area

Bajaur is located in the North-West of Pakistan. It is surrounded by district Mohmand in the southwest, Kunar province of Afghanistan in the northwest, district Dir in the northeast and district Malakand in the southeast. Bajaur shares a 52 km border with the Afghan province Kunar, which consists of hills, valleys and passes. Winter is very cool and harsh with snowfall on mountain peaks, while the summers are hot and humid, with monsoon rain. The natural resources of water in the area are springs and rivers. The famous rivers come from Charmang and Mamond, which united at Musa Kas to form the river Khar, which then met with the river Pashat in Jar to form the river Bajaur, which flows into the Dir lower (Fig. 1).

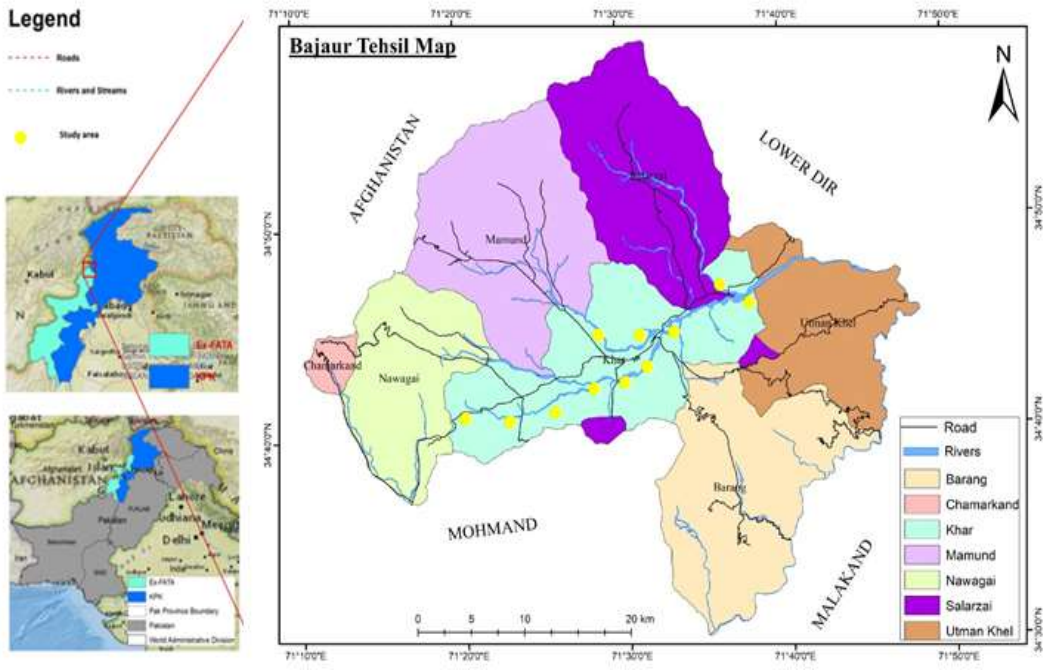

Figure 1. Map of the area

2.2 Floristic composition

Regular study visits were undertaken to the research area in the April-October months of 2022. Plant specimens were collected, processed, preserved and identified with the flora of Pakistan (Ali and Qaiser, 1995-2020) and verified with the plant list and plants of the world online. The digital camera was used to take the picture of plants on the spot. The specimens were given voucher numbers and submitted to the Department of Botany, Govt. Post Graduate College Khar Bajaur.

2.3 Biological spectrum

The life form and leaf size spectra of the species were determined with slandered method following (Raunkiaer, 1934; Mueller-Dombois and Ellenberg, 1974; Hussain, 1989; Badshah et al., 2013). The flowering phenology of the species was observed and recorded in the field during the survey (Mclaren and Mcdonald, 2005).

3. Results and Discussion

3.1 Floristic description and its ecological attributes

The present study documented the floristic diversity of the riparian vegetation, which included 65 species belonging to 34 families distributed in 55 genera. The most abundant family was Asteraceae which contributed 10 species (15.3 %), followed by the Poaceae with 7 species (10.76%), Salicaceae with 4. species (6.15%), Moraceae, Euphorbiaceae, Amaranthaceae, and Solanaceae with 3 species each (4.61% each), and the remaining families with one or two species each (Table 1, Fig. 2). Close to the results of present finding, Khan et al. (2013) also reported Asteraceae and Poaceae as the leading families in their respected area. The habit of the flora was dominated by herbs with 46 species (70.76%), trees with 13 species (20%) and shrubs with 6 species (9.32%) as shown in (Fig. 3). Herbaceous habit of the flora also reported from lower Tanwal Khyber Pakhtunkhwa, Pakistan (Bibi et al., 2019).

Table 1. Floristic composition and ecological characteristics of the flora

Species	**Voucher No**	**Family**	**Habit**	**Life form**	**Leaf size**	**Flowering phenology**
Achyranthes aspera L.	UAT. GPGCK.01	Amaranthaceae	H	Th	Mes	Apr-May
Adiantum capillus-veneris L.	UAT. GPGCK.02	Adiantaceae	H	Hem	Nan	Jun-Jul
Ailanthus altissima (Mill.) Swingle	UAT. GPGCK.03	Simaroubaceae	T	Megp	Nan	Jul-Aug
Alternanthera pungens Kunth.	UAT. GPGCK.04	Amaranthaceae	H	Hem	Mic	May-Jun
Amaranthus viridis L.	UAT. GPGCK.05	Amaranthaceae	H	Th	Mic	Apr-May
Ammannia baccifera L.	UAT. GPGCK.06	Lathyraceae	H	Th	Mic	Mar-Aug
Ammophila arenaria L.	UAT. GPGCK.07	Poaceae	S	Th	Nan	May-Aug

Artemisia absinthium L.	UAT. GPGCK.08	Asteraceae	H	Th	Nan	Jul-Aug
Artemisia vulgaris L.	UAT. GPGCK.09	Asteraceae	H	Th	Nan	Aug-Sep
Arundo donax L.	UAT. GPGCK.10	Poaceae	S	Geo	Mes	Jul-Oct
Broussonetia papyrifera L.	UAT. GPGCK.11	Moraceae	T	Mesp	Mes	Apr-May
Cajanus cajan (L.) Millsp	UAT. GPGCK.12	Papilionaceae	T	Th	Mic	Jul-Aug
Calotropis procera (Ait.) Ait.f., Hort.	UAT. GPGCK.13	Asclepiadaceae	S	Ch	Mes	Apr-May
Cannabis sativa L.	UAT. GPGCK.14	Cannabaceae	H	Th	Mes	May-Jun
Cedrela serrata L.	UAT. GPGCK.15	Meliaceae	T	Megp	Nan	May-Jun
Celtis australis L.	UAT. GPGCK.16	Cannabaceae	T	Th	Mic	Apr-May
Chenopodium botrys L.	UAT. GPGCK.17	Chenopodiaceae	H	Th	Mic	Apr-May
Cichorium intybus L.	UAT. GPGCK.18	Asteraceae	H	Th	Nan	July-Aug
Cirsium arvense (L.) Scop.	UAT. GPGCK.19	Asteraceae	H	Hem	Mes	July-Aug
Cleome viscosa L.	UAT. GPGCK.20	Capparidaceae	H	Th	Nan	Jun-July
Cucumis melo subsp. agrestis (Naudin) Pangalo.	UAT. GPGCK.21	Cucurbetaceae	H	Th	Mes	Jul-Aug
Cyperus rotundus L.	UAT. GPGCK.22	Cyperaceae	H	Th	Lep	May-Jun
Dactyloctenium aegyptium L.	UAT. GPGCK.23	Poaceae	H	Th	Nan	May-Jun
Eichhornia crassipes Mart.	UAT. GPGCK.24	Pontederiaceae	H	Geo	Nan	May-July
Eucalyptus camaldulensis Dehnh.	UAT. GPGCK.25	Myrtaceae	T	Megp	Mic	Aug-Sep
Euphorbia helioscopia L.	UAT. GPGCK.26	Euphorbiaceae	H	Th	Nan	Mar-Apr
Euphorbia hirta L.	UAT. GPGCK.27	Euphorbiaceae	H	Th	Mic	Jul-Aug
Euphorbia prostrata Ait.	UAT. GPGCK.28	Euphorbiaceae	H	Th	Lep	Mar-Apr
Helianthus tuberosus L.	UAT. GPGCK.29	Asteraceae	S	Geo	Mic	Aug-Sep
Heliotropium europaeum L.	UAT. GPGCK.30	Boraginaceae	H	Th	Mic	Mar-Apr
Imperata cylindrica (L.) Raeuschel	UAT. GPGCK.31	Poaceae	H	Hem	Mic	Mar-May
Lactuca serriola L.	UAT. GPGCK.32	Asteraceae	H	Th	Mes	Apr-May
Marsilea quadrifolia L.	UAT. GPGCK.33	Marsileaceae	H	Hem	Mes	Jul-Sep
Mentha arvensis L.	UAT. GPGCK.34	Lamiaceae	H	Geo	Nan	Jun-Jul
Mentha longifolia L.	UAT. GPGCK.35	Lamiaceae	H	Geo	Nan	May-Jun
Misopates orontium (L.) Raf.	UAT. GPGCK.36	Plantaginaceae	H	Th	Mic	Mar-Apr
Morus alba L.	UAT. GPGCK.37	Moraceae	T	Mesp	Mes	Apr-May
Morus nigra L.	UAT. GPGCK.38	Moraceae	T	Mesp	Mes	Apr-May
Nasturtium officinale R. Br.	UAT. GPGCK.39	Brassicaceae	H	Geo	Mic	Apr-May
Oxalis corniculata L.	UAT. GPGCK.40	Oxalidaceae	H	Th	Nan	Mar-Apr
Parthenium hysterophorus L.	UAT. GPGCK.41	Asteraceae	H	Th	Mes	Sep-Aug
Persicaria hydropiper (L.) Spach	UAT. GPGCK.42	Polygonaceae	H	Th	Nan	May-Jun
Phegopteris connectilis (Michx.)Watt	UAT. GPGCK.43	Thelpteridaceae	H	Hem	Mic	Mar-May
Plantago major L.	UAT. GPGCK.44	Plantaginaceae	H	Th	Mes	Jun-Jul
Populus nigra L.	UAT. GPGCK.45	Salicaceae	T	Megp	Mes	Mar-Apr
Potamogeton nodosus L.	UAT. GPGCK.46	Potamogetonaceae	H	Geo	Nan	Apr-Aug

Robinia pseudoacacia L.	UAT. GPGCK.47	Papilionaceae	T	Mesp	Mic	Apr-May
Rosa brunonii Lindl.	UAT. GPGCK.48	Rosaceae	S	Np	Nan	Apr-May
Saccharum spontaneum L.	UAT. GPGCK.49	Poaceae	H	Ch	Nan	Jul-Sep
Salix acmophylla Boiss.	UAT. GPGCK.50	Salicaceae	T	Mesp	Mes	Feb-Mar
Salix babylonica L.	UAT. GPGCK.51	Salicaceae	T	Mesp	Nan	Apr-May
Salix laevigata Bebb	UAT. GPGCK.52	Salicaceae	T	Mesp	Nan	Dec-Jun
Setaria pumila (Poir.) Roem. & Schult	UAT. GPGCK.53	Poaceae	H	Th	Lep	Jun-Jul
Solanum nigrum L.	UAT. GPGCK.54	Solanaceae	H	Th	Mic	Apr-May
Solanum surattense Brum.f.	UAT. GPGCK.55	Solanaceae	H	Th	Mic	Apr-Aug
Solanum villosum (L.)Moench	UAT. GPGCK.56	Solanaceae	H	Th	Nan	Jun-Aug
Sonchus asper (L.) Hill	UAT. GPGCK.57	Asteraceae	H	Th	Mic	Mar-Apr
Sonchus oleraceus L.	UAT. GPGCK.58	Asteraceae	H	Th	Mic	Mar-Dec
Sorghum halepense (L.) Pers.	UAT. GPGCK.59	Poaceae	H	Hem	Nan	May-Oct
Trianthema portulacastrum L.	UAT. GPGCK.60	Aizoaceae	H	Th	Lep	Dec-Apr
Typha angustifolia Bory & Chaub	UAT. GPGCK.61	Typhaceae	H	Geo	Mes	May-Jun
Verbascum Thapsus L.	UAT. GPGCK.62	Scrophulariaceae	H	Th	Mes	May-Jun
Veronica anagallis aquatica L.	UAT. GPGCK.63	Scrophulariaceae	H	Geo	Nan	Mar-Apr
Vitex negundo L.	UAT. GPGCK.64	Verbenacea	S	Np	Mes	Apr-May
Xanthium strumarium L.	UAT. GPGCK.65	Asteraceae	H	Ch	Mic	Jun-Jul

Keys: H- Herb, S-Shrub, T- Tree, Th- Therophyte, Geo- Geophyte, Hem- Hemicryptophytes, Np- Nanophanerophyte, Ch-Chamaephyte Mesp- Mesophanerophyte, Megp- Megaphanerophyte, Nan- Nanophyll, Mic- Microphyll, Mes- Mesophyll, Lep- Leptophyll

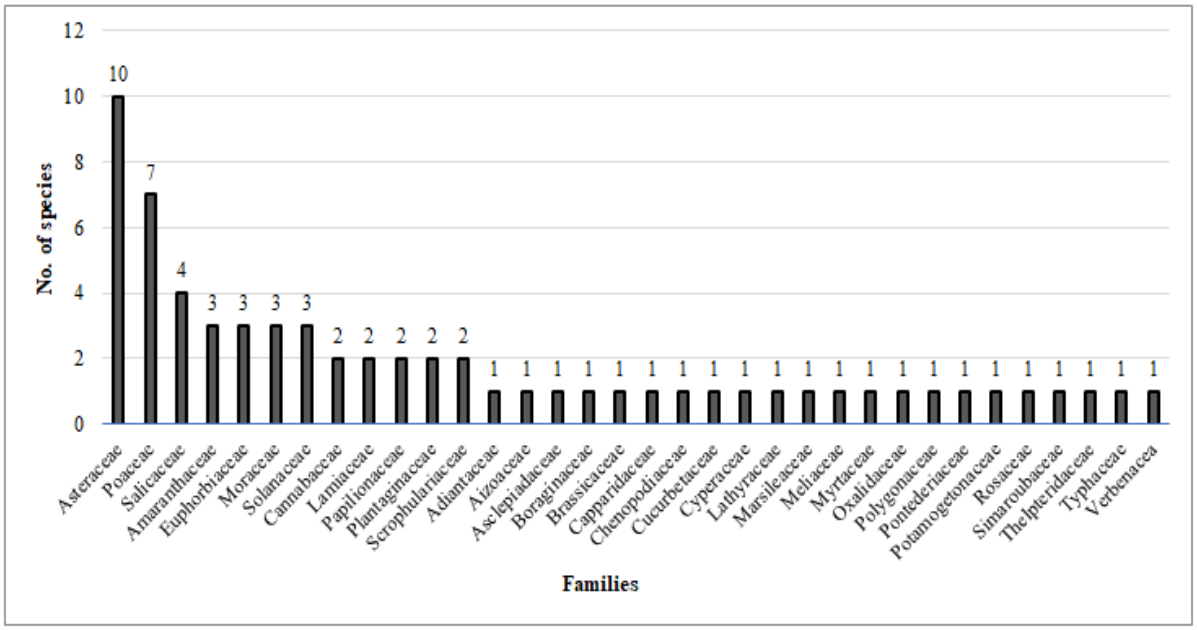

Figure 2. Family-wise distribution of plant species

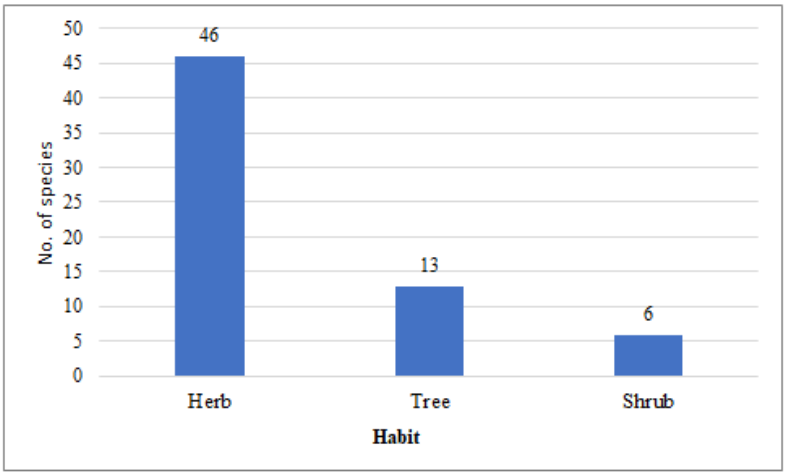

Figure 3. Habit of the flora

3.2 Biological spectrum

The life form of the flora was dominated by therophytes with 33 species (50.76%), geophytes with 9 species (13.84%) and hemicryptophytes with 7 species (10.76%) as shown in figure 4. Therophytes are the indicated species of the dry temperate ecosystem but also grow in moist conditions as well. Qureshi et al. (2014) conducted a similar study in the Khanpur dam and reported therophyte is the dominant life form of the identified species. The geophytes were found buried in the mud and soil in the form of rhizomes and tubers.

The leaf size spectrum of the flora was composed of nanophyll (23 species), microphyll (20 species) and mesophyll (18 species) as shown in figure 5. Haq and Badshah (2021), reported microphyll and nanophyll as dominant leaf size spectra which are in the line with results of the present finding. Amjad et al. (2017), also recorded nanophyll as the dominant leaf size class of the flora of Kotli, Azad Kashmir, Pakistan.

3.3 Phenology

Phenologically most of the plants bloom in the spring season (41 species, 63.07%) followed by summer (19 species, 29.23%) and winter (3 species, 4.61%) and autumn (2 species, 3.07%) as shown in figure 6. The blooming of more species in the spring and summer may be due to moist and warm climatic conditions (Haq and Badshah, 2021). It was observed that the South American native Eichhornia crassipes, a perennial free-floating aquatic plant, blooms with blue to purple coloured flowers in both still bodies of water and slowly moving water. These flowers attracted a variety of beneficial insects that helped in pollination as well as offering them a suitable habitat.

The region has a dry, temperate climate with heavy monsoon rains in the months of July and August, which can cause flooding. These floods uprooted the riparian vegetation and tend to damage its structure. The eroded soil that is brought by river floods tends to bury the

herbaceous vegetation and destroyed them. Thus climatic conditions have a significant impact on the ecological characteristics of flora.

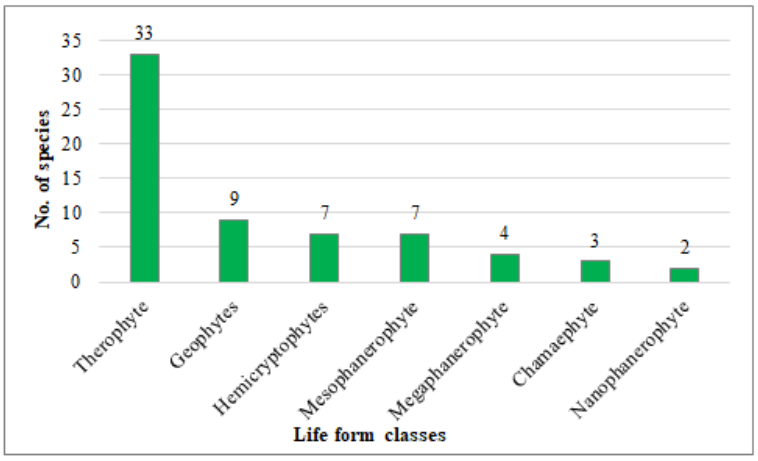

Figure 4. Life form of the flora

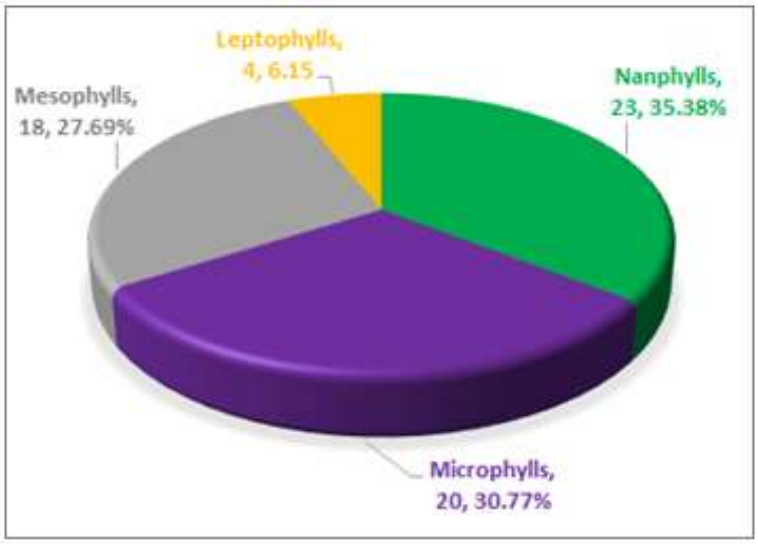

Figure 5. Leaf size spectrum of the flora

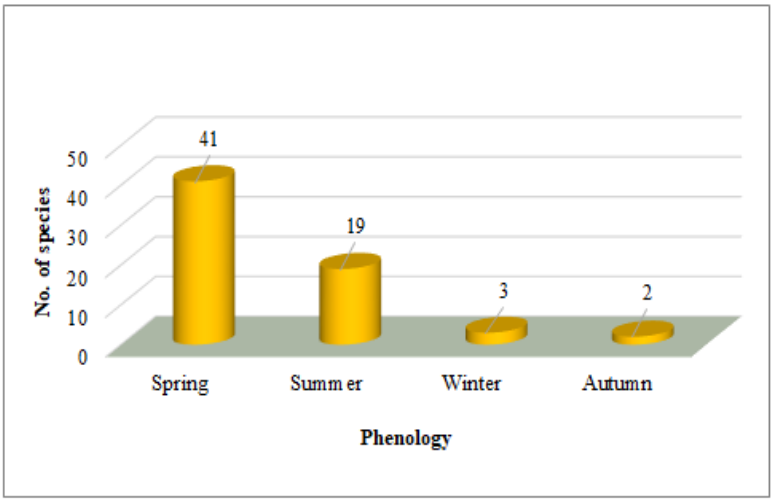

Figure 6. Phenology of the flora

4. Conclusion

The health of the aquatic flora along riparian corridors is thought to be indicated by the riparian vegetation. We have documented 65 plant species belonging to 34 families distributed in 55 genera from riparian areas of Bajaur, Pakistan. The most abundant families were Asteraceae, Poaceae and Salicaceae. Therophytes followed by geophytes and hemicryptophytes were the dominant life forms, and nanophyll and microphyll were the characteristic leaf size classes in the area. Phenologically most of the plants bloom in the spring season. This is the first report on the riparian flora in district Bajaur, and it may be useful for future comprehensive and in-depth investigations of the plant resources in the area.

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