

FLORISTIC ACCOUNT OF EMERGENT-AQUATIC AND MARSHLAND ANGIOSPERMS OF D.I. KHAN DISTRICT, KPK, PAKISTAN

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Abstract

In the present study an account is given of an investigation based on the results of the Taxonomic research work conducted in Dera Ismail Khan (D.I. Khan) District, Khyber Pakhtunkhwa (KPK), Pakistan, during 2005-2007. The area was surveyed and collection of semi-aquatic and marshland angiosperms was made at least 2 times from 15 sites of various aquatic habitats. The collected materials were identified with the help of available literature and by comparing with voucher specimens at the herbarium of the Department of Plant Sciences, Quaid-i-Azam University, Islamabad (ISL). In total 40 semi aquatic plant species belonging to 26 genera of 15 families were identified. Cyperaceae was the largest family that contributed 16 species (40%), followed by Poaceae with 6 species (15%), Polygonaceae 4 species (10%), Ranunculaceae and Typhaceae with 2 species (5% each); while 10 families contributed 1 species (2.5% each). Data inventory consists of botanical name, family, class, flowering period, availability, distribution and diagnostic characters. Detailed account of the semi aquatic and marshland angiosperms of Dera Ismail Khan is not available. Therefore, the present study is an attempt to highlight such angiospermic plant species.

Introduction

Dera Ismail Khan is located in northwestern Pakistan (Fig. 1) and has an elevation of 173 m above sea level. It has a total geographical land mass of 0.896 million ha of which 33% is cultivated (Khan, 2003). The climate is continental with marked temperature fluctuations both seasonal and diurnal, with significant aridity. January is the coldest month of the year and July the hottest. The mean maximum and minimum temperatures during winter are 20.3°C and 4.2°C, respectively, compared to 42°C and 27°C during summer. Average annual rainfall is 259 mm (Chaudhry, 1998).

Worldwide there are more than 100 families of vascular aquatic plants. These plants are structurally different from mesophytes or xerophytes by having less developed protective and conductive tissues. They have unique adaptations for buoyancy and aeration, particularly in the ground tissue of the petiole and leaf mesophyll and in the cortex of stem and root (Marwat *et al.*, 2011a). The aquatic plants are of various types, some emergent and rooted on the bottom and others submerged. Still others are free-floating, and some are rooted on the bank of the impoundments, adopting semi-aquatic habitat (Ahmad & Younis, 1979). Such habitats include banks of canals, rivers, periphery of water bodies which are mostly in earthen dams, and partly in masonry dams, drainage ditches and water ponds near villages. These may be called semi-aquatic but more appropriately referred to as emergent aquatic.

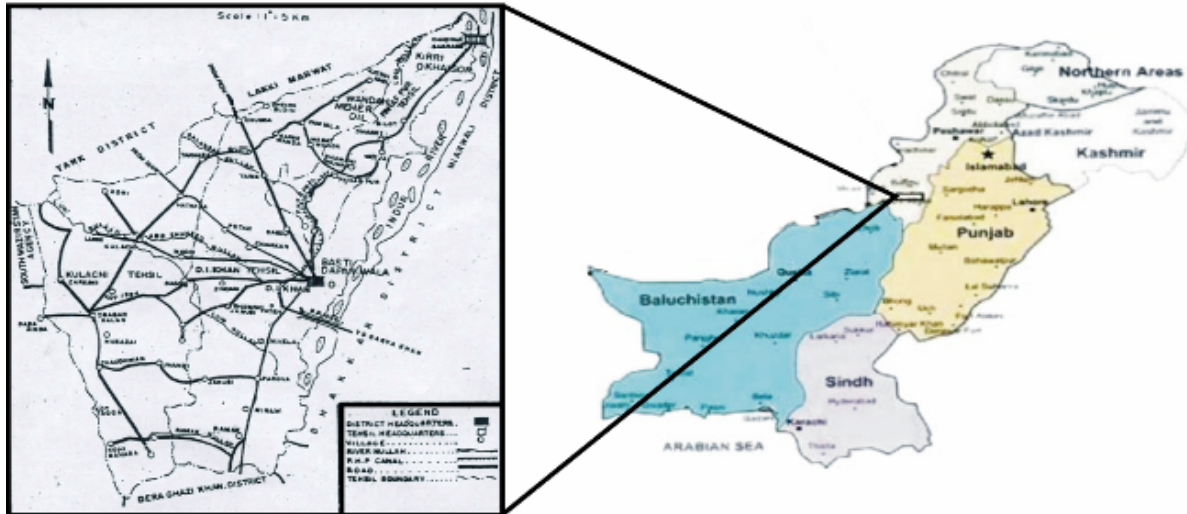
There are situations where vast areas of land remain inundated with water for long periods of time, and may only dry out in severe drought conditions. Such lands are known as marshes or swampy areas. They support a different type of vegetation which may include plants that are capable of growing under both flooded and saturated conditions (Lancar & Krake, 2002).

Some floristic work has been carried out and a number of research papers have appeared in different journals on aquatic plants in the country by Jafri (1966), Stewart (1972), Beg & Samad (1974), Qaiser (2001), Ahmed & Younis (1979), Omer & Hashmi (1987), Leghari *et al.*, (1999), Leghari (2004), Maseeh (2007) & Marwat *et al.*, (2011a, b) but no detailed account of the semi aquatic and marshland angiosperms of Dera Ismail Khan is available. Therefore, the present study was conducted to highlight floristic account of such angiospermic plant species of the research area.

Materials and Methods

A floristic study of the semi aquatic and marshland Angiosperms of Dera Ismail Khan District, KPK, Pakistan, was conducted during 2005-2007. The specimens were collected by hand from various aquatic habitats such as slow-running water, sides of stagnant ponds, paddy fields, streams, sewerage canals and marshy places of the study area (Table 1). Data included date of collection, collection number, habitat, flowering season, and occurrence. The collected material was identified by comparing with voucher specimens at the herbarium of the Department of Plant Sciences, Quaid-i-Azam University, Islamabad (ISL) with the aid of a dissecting light microscope (Zeis, 2000). Literature used for identification included Jafri (1966), Beg & Samad (1974), Bhopal & Chaudhri (1977a, b), Qaiser (2001), Ahmad & Younis (1979), Cope (1982), Marwat *et al.*, (1996), Leghari *et al.*, (1999) & Leghari (2004). After identification, the plants were deposited in the herbarium of the said university. Plants with botanical names, common names, family, class, habit, flowering and fruiting period, availability, relative distribution, total number of species of each genus, major diagnostic characters and % age share of families were listed in Tables 1-4. Photographs of some plants were also made and were included in the paper (Plates A-J).

Map of Pakistan indicating the study area (D.I.Khan district)



Source : D.I.Khan division Map 1st Ed :1988
Published by Survey of Pakistan.

Fig. 1. Map of Dera Ismail Khan, KPK, Pakistan.

Table 1. Semi-aquatic and marshland angiosperms of D.I.Khan district.

S.#	Botanical name	Vern. name	Common name	Habit	Class	Availability
1.	<i>Alternanthera sessilis</i>	-----	Sessile joyweed	Perennial herb	Dicot	Common
2.	<i>Bacopa monnieri</i>	Jal birahmi	Waterhyssop	Perennial herb	Dicot	Not common
3.	<i>Bolboschoenus affinis</i>	-----	-----	Perennial herb	Monocot	Common
4.	<i>B. glaucus</i>	-----	-----	Perennial herb	Monocot	Common
5.	<i>Brachiaria ramosa</i>	Gandheri, Kori	Browntop millet	Annual herb	Monocot	Common
6.	<i>Centella asiatica</i>	Brahmi Booti	Pennywort	Perennial herb	Dicot	Not common
7.	<i>Coronopus didymus</i>	Jangli Halon	Swine cress	Annual herb	Dicot	Common
8.	<i>Cyperus alopecuroides</i>	-----	-----	Perennial herb	Monocot	Common
9.	<i>C. difformis</i>	Bari Ghoin	Variable flat sedge	Annual herb	Monocot	Common
10.	<i>C. iria</i>	Bhoi	Flat sedge	Annual herb	Monocot	Common
11.	<i>C. pymaeus</i>	-----	-----	Perennial herb	Monocot	Not common
12.	<i>C. rotundus</i>	Deela	Nut-sedge	Perennial herb	Monocot	Common
13.	<i>Cynodon dactylon</i>	Kabbal	Bermuda grass	Perennial herb	Monocot	Common
14.	<i>Echinochloa crus-galli</i>	Swank, Dhiddan	Barnyard grass	Annual herb	Monocot	Common
15.	<i>Eclipta prostrata</i>	Bhangra, bhringraja	False daisy	Annual herb	Dicot	Common
16.	<i>Eleocharis geniculata</i>	-----	Spike-rush	Annual herb	Monocot	Not common
17.	<i>E. palustris</i>	-----	Common spikerush	Perennial herb	Monocot	Common
18.	<i>Fimbristylis bisumbellata</i>	-----	-----	Annual herb	Monocot	Not common
19.	<i>F. dichotoma</i>	Choti bhoi	Forked fringerush	Annual herb	Monocot	Not common
20.	<i>F. ferruginea</i>	-----	-----	Annual herb	Monocot	Not common
21.	<i>F. quinqueangularis</i>	-----	Five angle fimbry	Annual herb	Monocot	Not common
22.	<i>Mentha logifolia</i>	Jangli poodina	Horse mint	Perennial herb	Dicot	Common
23.	<i>Oxalis corniculata</i>	Khatti booti	Wood-sorrel	Annual herb	Monocot	Common
24.	<i>Paspalum papalioides</i>	Naru ghas	Water grass	Perennial herb	Monocot	Common
25.	<i>Phalaris minor</i>	Dumbi sittee	Bird's seed grass	Annual herb	Monocot	Common
26.	<i>Phragmites karka</i>	Drumbi, Nar, Nalu.	Common reed	Perennial herb	Monocot	Common
27.	<i>Phyla nodiflora</i>	Bukan	Frogfruit, capeweed	Perennial herb	Dicot	Common
28.	<i>Polygonum barbata</i>	-----	Joint Weed	Perennial herb	Dicot	Common
29.	<i>P. flaccidum</i>	-----	Smart weed	Annual or perennial	Dicot	Not common
30.	<i>P. glabrum</i>	-----	Marsh buckwheat	Annual	Dicot	Not common
31.	<i>Portulaca oleracea</i>	Kulf, salunaka	Purslane	Annual	Dicot	Not common
32.	<i>Pycreus flavidus</i>	-----	-----	perennial	Monocot	Not common
33.	<i>Ranunculus muricatus</i>	-----	Butter-cup	Annual	Dicot	Not Common
34.	<i>R. scleratus</i>	Jal dhania	Blister butter-cup	Annual	Dicot	Common
35.	<i>Rumex detatus</i>	Jangli palak	Toothed dock	Annual	Dicot	Common
36.	<i>Schoenoplectus litoralis</i>	-----	-----	Perennial herb	Monocot	Common
37.	<i>S. triquetra</i>	-----	Streambank bulrush	Perennial herb	Monocot	Not common
38.	<i>Suaeda fruticosa</i>	Laani, Laana	Sea Blite	Annual	Dicot	Common
39.	<i>Typha domingensis</i>	Kundar, Lukha	Southern cat-tail	Perennial herb	Monocot	Common
40.	<i>Typha elephantina</i>	Kudar, Lukha	Elephant grass	Perennial herb	Monocot	Common

Result and Discussion

This qualitative floristic survey was conducted for the first time in D.I. Khan District, KPK, Pakistan. During the study 40 species and 26 genera belonging to 15 families were recorded from the research area (Table 1). Of these monocots are represented by 24 species belonging to 13 genera and 3 families, while eudicots contributed by 16 species belonging to 13 genera and 12 families. Cyperaceae was the largest family that contributed 16 species (40%), followed by Poaceae with 6 species (15%), Polygonaceae 4 species (10%), Ranunculaceae and Typhaceae with 2 species (5% each); while 10 families contributed 1 species (2.5% each) (Table 2).

Table 2. Percentage of families of weed plant species in wheat crop in D. I. Khan District.

S.#	Family	No. of species	% Age
1.	Cyperaceae	16	40.00
2.	Poaceae	06	15.00
4.	Polygonaceae	04	10.00
3.	Ranunculaceae	02	05.00
5.	Typhaceae	02	05.00
6.	Amaranthaceae	01	02.50
7.	Apiaceae	01	02.50
8.	Asteraceae	01	02.50
9.	Brassicaceae	01	02.50
10.	Chenopodiaceae	01	02.50
11.	Lamiaceae	01	02.50
12.	Oxalidaceae	01	02.50
13.	Portulacaceae	01	02.50
14.	Scrophulariaceae	01	02.50
15.	Verbenaceae	01	02.50
Total		40	100.00

Grasses are widespread than any other family of flowering plants of the world and represented by 10,000 species and 610 genera (Cope, 1982). Clayton & Renvoize (1986) reported the total number of grasses in the world as about 10,000 sp. and 651 genera (Ahmad *et al.*, 2009).

As in the case of any aquatic ecosystem, monocots dominate the vegetation having more species diversity in contrast to terrestrial habitats. Cyperaceae (sedges), Poaceae (Grasses), Polygonaceae, Ranunculaceae and Typhaceae with 16, 6, 5, 2 and 2 species respectively dominate the wetland vegetation of the presently studied area (D.I. Khan).

Data inventory, consisting of botanical names, common names, family, class, habit, flowering and fruiting period, availability, relative distribution, total number of species of each genus, major diagnostic characters and % age share of families, was presented in Tables 1-4.

In D.I. Khan district some of the important genera to which most of the semi-aquatic plant species belong are *Alternanthera*, *Bacopa*, *Bolboschoenus*, *Brachiaria*, *Centella*, *Coronopus*, *Cynodon*, *Cyperus*, *Echinochloa*, *Eleocharis*, *Eclipta*, *Fimbristylis*, *Mentha*, *Oxalis*, *Paspalum*, *Phalaris*, *Phragmites*, *Phyla*, *Polygonum*, *Portulaca*, *Pycraeus*, *Ranunculus*, *Rumex*, *Suaeda*, *Schoenoplectus* and *Typha*.

Alternanthera (Amaranthaceae), is a large and rather difficult genus with 150-170 species found in the warmer regions of the world (Townsend, 1974; Cook *et al.*, 1974). A few species are aquatic or subaquatic (Cook *et al.*, 1974). In Pakistan it is represented by 3 species

(Townsend, 1974). In D.I. Khan District two species, *A. sessilis* (L.) DC. and *A. pungens*, are found.

A. sessilis (Fig. 4E) is a common species, very widespread in waste and cultivated ground, especially in damp or wet conditions (Townsend, 1974). It is an "agricultural weed that invades disturbed wet areas in tropical and subtropical areas of the U.S." Overall, *A. sessilis* has a "low significant ecological impact" (Tomaino, 2006).

Bacopa (Scrophulariaceae) is composed of about 100 species which are distributed in the warmer regions of the world. Many species are found in wet and swamped regions and may be found submerged in water for several months each year (Cook *et al.*, 1974). In D.I. Khan District it is represented by single species, *Bacopa moneiri* (L.) Pennell. It is an amphibious plant of the tropics and normally found growing on the banks of rivers and lakes (Binita *et al.*, 2005). It is also frequently found as a weed in rice fields and irrigation ditches (Cook *et al.*, 1974).

Bolboschoenus (Cyperaceae) has about 16 species, distributed in all continents except S. America; represented in Pakistan by two species, *B. affinis* (Roth) Drobov and *B. glaucus* (Lam.) S.G. Smith (Kukkonen, 2001). These species are also found in D.I. Khan District. *B. affinis* (Fig. 3A) is found in shallow water, irrigation channels, waste land pools, rice fields. *B. glaucus* is found in 'Scirpus-community' of shallow water in brooks and also artificial depressions of the research area.

The genus *Brachiaria* (Poaceae) comprises 80 to 90 species distributed in the tropics and subtropics, mainly in Africa (Cook *et al.*, 1974; Cope, 1982); six species occur in Pakistan (Cope, 1982) and two species in D.I. Khan. One species, *B. ramosa* is common and abundant in rice fields, along ditches and canals and in marshes.

Centella (Apiaceae) has 20 to 40 species (Cook *et al.*, 1974; Nasir, 1972) that are found in the Southern hemisphere (Nasir, 1972). *C. asiatica* (L) Urban is frequently found in water. It is distributed in the warmer regions of the world and grows in a variety of habitats including shallow water streams, ditches, rice fields and pools (Cook *et al.*, 1974) This species is also reported from Pakistan (Nasir, 1972), and D.I. Khan district.

Cynodon (Poaceae) is a genus of 8 species in tropical and warm temperate regions; represented by 2 species in Pakistan (Cope, 1982). One species, *C. dactylon* is found as weed in cultivated fields and moist and marshy grounds *Cynodon* in D.I. Khan district.

Cyperus (Cyperaceae) is a large genus of about 600 species, distributed throughout the tropical and temperate regions. The plants are mostly aquatic and growing in still or slow-moving water (Wikipedia, 2012a), represented in Pakistan by about 40 species (Kukkonen, 2001). While in D.I. Khan district 7 species. *Cyperus alopecuroides* Rottb. (Fig. 3B), *C. difformis* L., *C. iria* L., *C. pygmaeus* Rottb. and *C. rotundus* L. were found in ditches, ponds and rivers shores, and rice fields.

Coronopus (Brassicaceae) is composed of about 10 species, mostly Eurasian; only 1 occurs in Pakistan (Jafri, 1973). This species, *Coronopus didymus* (Linn.) Smith is also reported from D.I. Khan district.

Table 3. Distribution of semi-aquatic and marshland angiosperms of D.I.Khan District.

Botanical name	Localities														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<i>Alternanthera sessilis</i>	+	-	-	+	-	+	-	-	+	+	+	+	-	-	+
<i>Bacopa moneiri</i>	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-
<i>Bolboschoenus affinis</i>	+	-	+	-	++	++	+	+	+	-	-	+	+	+	+
<i>B. glaucus</i>	+	-	-	+	-	-	-	+	-	-	+	-	-	+	+
<i>Brachiaria ramosa</i>	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
<i>Centella asiatica</i>	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+
<i>Coronopus didymus</i>	+	-	+	-	-	-	+	+	-	-	-	+	-	-	-
<i>Cyperus alopecuroides</i>	-	-	-	-	+	+	-	-	-	-	+	-	-	-	-
<i>C. difformis</i>	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
<i>C. iria</i>	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-
<i>C. pygmaeus</i>	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
<i>C. rotundus</i>	+	-	-	-	+	+	+	-	+	-	+	+	+	+	+
<i>Cynodon dactylon</i>	+	+	+	-	-	+	+	+	-	+	+	+	+	-	+
<i>Echinochloa crus-galli</i>	+	-	-	-	-	-	+	-	-	-	+	-	-	-	-
<i>Eclipta prostrata</i>	+	-	-	-	-	+	+	+	-	-	+	-	-	-	-
<i>Eleocharis geniculata</i>	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
<i>E. palustris</i>	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Fimbristylis bisumbellata</i>	-	-	-	-	-	-	-	-	-	-	+	-	+	-	+
<i>F. dichotoma</i>	-	-	-	-	-	-	-	-	-	-	+	-	+	-	+
<i>F. ferruginea</i>	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+
<i>F. quinquangularis</i>	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+
<i>Mentha longifolia</i>	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-
<i>Oxalis corniculata</i>	+	-	-	-	-	-	+	-	-	+	-	+	-	-	+
<i>Paspalum paspaloides</i>	+	-	-	-	-	-	-	+	-	-	+	-	-	-	-
<i>Phalaris minor</i>	+	-	-	-	+	+	-	-	-	-	-	-	+	-	+
<i>Phragmites karka</i>	+	-	-	-	+	-	-	-	-	+	-	+	-	-	-
<i>Phyla nodiflora</i>	-	-	-	-	+	+	-	-	-	-	+	+	-	-	-
<i>Polygonum barbata</i>	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-
<i>P. flaccidum</i>	+	+	-	-	-	-	+	+	+	+	+	++	++	-	+
<i>P. glabrum</i>	-	-	-	-	-	-	-	-	-	-	+	-	++	-	-
<i>Portulaca oleracea</i>	+	-	-	-	+	-	+	+	-	-	-	-	-	-	-
<i>Pycnus flavidus</i>	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-
<i>Ranunculus muricatus</i>	+	-	-	-	+	-	+	-	-	-	-	+	-	-	-
<i>R. scleratus</i>	-	+	-	-	-	+	-	-	-	-	-	+	+	-	+
<i>Rumex dentatus</i>	+	-	-	-	+	-	-	-	+	-	+	-	-	-	-
<i>Schoenoplectus litoralis</i>	-	-	-	-	-	+	++	++	+	+	+	-	+	+	-
<i>S. triqueter</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Suaeda fruticosa</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Typha domingensis</i>	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+
<i>T. elephantina</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Key: 1. Paroa circle, 2. Chashma lake, 3. Khisore range Badari Dam, 4. Dara Zinda Stream, 5. Paharpur Sewerage Canal, 6. Awaran Sewerage canal, 7. Rangpur Adda Irrigation Channels, 8. Paharpur Irrigation channels, 9. Bilot Sharif Pond, 10. Dhakki Mor Pond, 11. Basti Dapanwala Pond, 12. Darya Khan Bridge Ponds, 13. Indus River, 14. Ara Irrigation channels, 15. Darya Khan Bridge Spurs
++ = Abundant, + = Present, - = Absent

Echinochloa (Poaceae) is a difficult genus to separate from *Brachiaria*. The reflexed tip of the upper palea, though requiring careful dissection, seems to be the most reliable distinguishing character (Cope, 1982). It consists of 20-30 species which are cosmopolitan in warmer parts of the world (Cook *et al.*, 1974; Cope, 1982). About half the species are aquatic or semi aquatic. Some species are troublesome weeds in rice fields and irrigation channels (Cook *et al.*, 1974), represented by 5 species in Pakistan (Cope, 1982) while 2 species are found in D.I. Khan. *E. crus-galli* is economically the important member of the genus *Echinochloa* (Cope, 1982). *Echinochloa crus-galli* is said to be a good fodder grass and is readily eaten by cattle (Marwat *et al.*, 2012). It is a polymorphic weed of warm temperate and subtropical regions. It is common in marshy places and rice fields of Pakistan (Cope, 1982) and D.I. Khan District as well.

The ecological requirements of *E. crus-galli* and rice are similar (Anon., 2009). *Eclipta* (Asteraceae) genus consists of 3-4 (Cook *et al.*, 1974) or 5 species. They are mostly warm-temperate to tropical New World, introduced in Old World (Chen, 2011). A single species, *E. prostrata* (L.) L., was recorded in D.I. Khan district. Although not strictly aquatic yet it is commonly found in standing water, in rice fields and irrigation ditches (Cook *et al.*, 1974).

Eleocharis genus consists of about 150-200 species which are cosmopolitan in distribution (Cook *et al.*, 1974; Kukkonen, 2001). Most species occur in marshes and shallow water and several have been reported as weeds in rice fields (Cook *et al.*, 1974). Represented in Pakistan by c.10 species (Kukkonen, 2001). In D.I. Khan 2 species are found. These two species, *E. geniculata* and *E. prostrata* (L.) L. (Fig. 3C) are densely tufted herb found in shallow water pond, marshland, wet meadows or rice fields, (Kukkonen, 2001; Marwat & Khan, 2008). In D.I. Khan it was recorded from marshy area.

Table 4. Major diagnostic characters of semi-aquatic and marshland angiosperms of D.I.Khan District.

Scientific name	Fl. & Fr.	Major diagnostic characters
<i>Alternanthera sessilis</i>	Aug-Nov	Usually perennial; stem more or less fistular; leaves opposite, linear-oblong; flowers white, small in dense globose heads.
<i>Bacopa moneiri</i>	May-Oct	Perennial or annual herb; stem creeping; leaves decussate, Succulent; flowers, white to pink or bluish. fruit capsule.
<i>Bolboschoenus affinis</i>	Jan-Apr	Perennial herb, trigonous above; inflor. compact, formed by 1- 6 spikes; perianth bristles usually 4; stigmas 2, often 3; nut trigonous and plano convex.
<i>Bolboschoenus glaucus</i>	Sept.-Oct.	A tufted, erect herb; spikelets usually 3-rarely 2- or 4-flowered; lemma back has long, stiff hairs and geniculate and twisted dorsal awn; fruit straw coloured; seeds hairy or tufted.
<i>Brachiaria ramosa</i>	Jul-Oct	Loosely tufted annual; leaf-blades broadly linear; inflor. of 3 racemes borne on an axis; racemes 1-8 cm long; spikelets elliptic to broadly elliptic.
<i>Centella asiatica</i>	Apr-Sept	Perennial prostrate aromatic herb; stem rooting at the nodes; leaves reniform, long petioled; inflorescence single and axillary umbel of 2-4 flowered; flowers white; fruit ovate to orbicular.
<i>Coronopus didymus</i>	Mar-Jun	Diffuse or procumbent; basal and lower leaves rosulate, pinnatisect, stalked, 6-10 jugate, upper leaves similar or pinnatifid and only 3-5 jugate; racemes 30-60-flowered, flowers minute.
<i>Cynodon dactylon</i>	All the year	Perennial widely creeping by runners and forming tufts; leaf blades linear to lanceolate; infl. racemes usually 4-6; spikelets 1-flowered.
<i>Cyperus alopecuroides</i>	Apr-Sep	Perennial, about 140 cm long; stem trigonous; leaf blade about 60 x10 cm; involucre bracts 5-7, leaf-like; inflor. each cluster with about 70 spirally arranged spikes; stigmas 2 or 3; nut biconvex.
<i>C. difformis</i>	Sep-Dec	Annual; stem sharply triquetrous; leaves sheathed; inflo. umbellate; rays 5-8, each bearing a head of small sessile spikelets; involucre bracts 3-4; spikelets distichous; style 3-branched; nut trigonous.
<i>C. iria</i>	Jul - Oct	Stems triquetrous; leaves 3-ranked, longer than the stems; inflor. compound; spikelets yellowish; involucre bracts 3-5, longer than the inflor.; style 3-branched; nut trigonous.
<i>C. pygmaeus</i>	Jun-Nov	Perennial, tufted herb; stem trigonous; leaves as long as stem; inflor. a regular globose head; bracts 4-7 foliose; spike narrowly obovoid, compressed; stigma 2; nut lenticular or plano-convex.
<i>C. rotundus</i>	May-Oct.	Perennial, stoloniferous; stems triquetrous; leaves few basal; inflor. simple or compound, spikelets compressed; spikelets linear-oblong, distichous; style 3-branched; nut trigonous.
<i>Echinochloa crus-galli</i>	Jun-Oct	Annual; culms 25-100 cm high; inflor. linear to ovate, 6-22 cm long, the racemes untidily 2-several-rowed, spikelets ovate-elliptic, lower lemma acuminate or with an awn up to 5 cm long.
<i>Eclipta prostrata</i>	All the year	Usually annual, an erect or prostrate, with rooting at nodes, stem and branches; leaves are opposite; stem and leaves sparsely strigose; flowers head white; the disc flowers are tubular.
<i>Eleocharis geniculata</i>	All the year	Annual herb; stems clumps, terete, with 5-6 deep grooves; leaves reduced to sheaths; spikes somewhat globose; perianth bristles 6-8; stigmas 2; nut biconvex, stylopodium much wider than long.
<i>E. palustris</i>	Apr-Jun	Perennial, gregarious, with creeping rhizome; stem terete; leaves reduced to sheaths; inflor. with a single spikelet; perianth bristles 4; stamens 3; style 2-branched, villous; nut compressed
<i>Fimbristylis bisumbellata</i>	Mar-Jul	Annual, stems tufted; leaves linear; Inflor. compound umbel, bracts 2-3; spikelets smaller, ovoid-oblong; style 2-branched, upper half villous; nut plano-convex, with 5-7 ridges on each face.
<i>F. dichotoma</i>	Feb-Mar	Perennial herb of marshy places; stems tufted; Inflor. umbellate; involucre bracts 2-3, leaf-like; spikelets ovoid; glumes 4-nerved; style 2-branched; nut biconvex with 8-10 ridges on each face.
<i>F. quinquangularis</i>	Mar-Aug	Annual herb, found on wet ground; stem tufted, quadrangular; leaves reduced to sheath. Inflor. decomposed umbel; bracts 3-4, leaf-like; spikelets numerous, ovoid, brownish; style 3-branched, nut ovoid, trigonous, tuberculate.

Table 4. (Cont'd.).

Scientific name	Fl. & Fr.	Major diagnostic characters
<i>F. ferruginea</i>	Jun-Nov	Perennial herb, stem tufted, trigonous; leaves linear, margins incurved and scabrous, ligule a fringe of short hairs; inflor. terminal, simple or rarely compound umbel; involucre bracts 2-3 in number; spikelets style 2-branched, villous; nut biconvex.
<i>Mentha logifolia</i>	May-Nov	With aromatic smell; stems much branched, leafy, hairy; leaves variable; inflor. congested verticillasters, terminal spikes; corolla light purple, violet, white; nutlets slightly mucilaginous on wetting.
<i>Oxalis corniculata</i>	Mar-Dec	Creeping, rooting at the nodes; leaves palmately trifoliate; flowers solitary or in 2-5 flowered axillary umbels; sepals; petals 5, yellow; carpels 5, pubescent; capsule subcylindric many seeded
<i>Paspalum paspaloides</i>	Mar-May	Creeping stoloniferous; culms 6-50 cm high; leaf-blades 5-20 cm long; inflor. composed of 2(-4) conjugate racemes; spikelets ovate, plano-convex, pale-green.
<i>Phalaris minor</i>	Mar-May.	Culms 20-100 cm high, profusely branched tillers at the base; leaves linear, sheathing; inflorescence terminal spike, ovate-oblong
<i>Phragmites karka</i>	Apr-Nov	Perennial reed; culms erect, upto 10 meter tall; leaf-blades 30-80 x 1.2-4.0 cm; panicle 30-50 cm long, the lowest node often many branched in a whorl; spikelets with lower glume just over half as long as the upper.
<i>Phyla nodiflora</i>	All the year	Perennial, prostrate, rooting at nodes; leaf blade spatulate, serrate above; inflor. a very dense, cylindrical to ovate spike; flowers pinkish purple or white; fruit capsule, 1-seeded.
<i>Polygonum barbatum</i>	Aug-Oct	Annual herb, stem erect or creeping below, ochreas membranous; inflor. flowers in terminal and axillary, long spike like racemes and perianth white; tepals 5; stamens 5-8; styles three; nuts trigonous.
<i>P. glabrum</i>	Apr-Nov	Annual herb, erect; ochreas membranous, glabrous; inflor. terminal and axillary spike like racemes, perianth white or pinkish, 5-parted nuts dark brown and shiny.
<i>P. flaccidum</i>	Mar-Apr	Annual, stem erect or prostrate; leaves lanceolate or oblong-lanceolate; flowers in terminal or axillary, lax spike like racemes; perianth rose to white; stamens 6; nuts circular and flattened in 2-styled flowers, and 3-angled in 3-styled flowers.
<i>Portulaca oleracea</i>	All the year	Annual herb, mostly prostrate stems; leaves succulent, clustered at stem joints and ends; flowers yellow have five regular parts; seeds are formed in a tiny pod, which opens when the seeds are mature.
<i>Pycreus flavidus</i>	Mar-May	Annual herb; stem tufted, triquetrous; inflor. umbellate; bracts 2-3; spikelets narrowly oblong; style 2-branched; nut laterally compressed with one angle facing the rachilla.
<i>Ranunculus muricatus</i>	Mar-Apr	Annual, stem fistulose, sometimes absent; leaves similar, blade roundish reniform; flowers, yellow; ovary apocarpous; achenes arranged in a large globose head, compressed, beak sides spiny.
<i>R. scleratus</i>	Mar- Jul	Annual or biennial; stem hollow; basal leaves 3-lobed, upper ones sessile, 3-lobed; flowers numerous, yellow; achenes dorsally keeled, attached to elongated, spindle-shaped receptacle.
<i>Rumex dentatus</i>	Feb-Sep	Annual herb, stem fistulose with large basal leaves and oblong to linear upper leaves similar, blade Inflorescence racemose; flowers in distinct whorls which are usually leafy, minute, green; achenes acutely trigonous, almost winged.
<i>Schoenoplectus litoralis</i>	Jul-Sep	Perennial, rhizomatous; stem trigonous above and terete below; leaves usually reduced to sheaths, inflor. umbellate; involucre bract 1-2, triquetrous; spikelets ovoid-oblong, perianth bristles 4; style 2-branched; nut compressed.
<i>S. triquetra</i>	May - Jul	Perennial, rhizomatous; stem distal parts sharply, proximal parts obtusely trigonous; leaves reduced to sheaths; blades mostly reduced to mucro; inflor. 3-7 sessile spikes; perianth bristles 4-6; stigmas 2; nut biconvex or almost plano-convex.
<i>Suaeda fruticosa</i>	Mar-Sep	Perennial, suberect or decumbent herb; leaves fleshy, linear, semi-terete, saltish in taste; flowers axillary, solitary or 2-3; perianth segments incurved; style 3; utricle membranous.
<i>Typha domingensis</i>	All the year	Perennial, partly submerged; stem rhizomatous; leaves radical, linear, upto 3 meter or more long, 2-2.5 cm. broad, semi-cylindrical above, spongy; male and female spikes are separated; male spike covered with linear hairs; female spikes pale-brown.
<i>T. elephantia</i>	Mar-Aug	Perennial, 1.4- 4.0 m. tall; leaves linear, trigonous above the sheath, angularly keeled dorsally; male and female are separated; axis of the male flower covered with hairs; female spike cylindrical, blackish brown or brown..

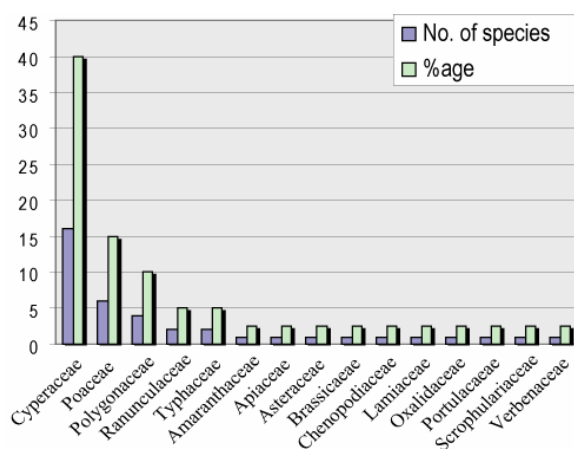


Fig. 2. Showing the % age share of families in semi-aquatic and marshland angiosperms of D.I. Khan District.

Fimbristylis (Cyperaceae) is a genus of about 200-300 species (Cook *et al.*, 1974; Kukkonen, 2001) found in tropical and subtropical regions of the world. Several species are aquatic, mostly occur in wet places (Cook *et al.*, 1974), represented in Pakistan by 14 species (Kukkonen, 2001). Five species occur in D.I. Khan District. Out of these four species, *Fimbristylis bisumbellata* (Forssk.) Bubani, *F. dichotoma*, *F. ferruginea*, *F. quinquangularis* are found in moist, marshy places along rivers, ditches, irrigation channels and rice fields of study area.

The genus *Mentha* (Lamiaceae) comprises 25 to 30 species distributed mainly in the temperate areas of Eurasia; also in Australia and southern Africa; introduced elsewhere. Represented in Pakistan by 6 species but this account of species is inevitably provisional; many specimens can only be named tentatively (Hedge, 1990). In D.I. Khan district 2 species, *Mentha longifolia* and *M. spicata* were investigated.

M. longifolia is a polymorphic aromatic herb (Hedge, 1990). The correct nomenclatural citation of this species is, to some extent, a matter of opinion. In this paper following (Hedge, 1990) *M. longifolia* has been favoured. Oxalis (Oxalidaceae) is a large genus with about 800 species (Cook, 1974; Nasir, 1971). Mostly found in North and South America, South Africa and fairly well represented in Europe and Asia. Six species are found in Pakistan (Nasir, 1971). One species, *O. carniculata* is recorded from D.I. Khan district.

Paspalum (Poaceae) has 200-250 species (Cook, 1974; Cope, 1982) distributed in the warmer regions of the world, with most species in America. A few species are aquatic or semi aquatic (Cook, 1974). Three species are reported from Pakistan, one of them has been introduced (Cope, 1982). One species, *P. paspalodes* (Michx.) Scribner was found in D.I. Khan district. It provides good pasturage, especially on alluvial flats. It occurs as a garden weed, along ditches and irrigation channels, as a weed in rice-fields and is gregarious in swampy places (Cope, 1982). It may become weedy in our research area.

Phalaris (Poaceae) is a genus of 15-20 species distributed throughout the world (Cook, 1974; Cope, 1982). Only 2 species are native to Pakistan, but several have been introduced, mainly in bird-seed (Cope, 1982). It is represented by one species, *Phalaris minor* in D.I. Khan district. It is a weed of cultivated fields and moist places in D.I. Khan.

Phragmites (Poaceae) is a cosmopolitan genus of 3-4 species (Cook, 1974) but less common in the tropics. It is usually found in dense stands fringing streams, rivers, ponds and lakes, in marshes and in estuaries (Cook, 1974), 2 species of which occur in Pakistan (Cope, 1982). In D.I. Khan it is represented by one species, *P. karka* (Retz.) Trin. ex Steud., which occurs in swamps and beside streams of the area.

Phyla (Verbenaceae) is a small genus of c. 10 species, mainly distributed in North and Central America, with 1-2 species in warmer parts of Asia and Africa; only one species, *Phyla nodiflora* (Linn.) Greene is found in Pakistan (Jafri & Ghafoor, 1974) and D.I. Khan district as well. *P. nodiflora* (Fig. 3D) is distributed in wet places, often in gregarious patches of the presently research area. It is common on the irrigation ditches and ponds.

Polygonum (Polygonaceae) is composed about 60 species that are distributed in both the hemispheres (Qaisar, 2001). Many species grow in wet places but relatively few (10-20) are truly aquatic. Most aquatic or nearly aquatic species are tropical (Cook *et al.*, 1974). Represented by c. 20 species (Qaisar, 2001) and according to Bhopal & Chaudri (1977b) by 62 species in Pakistan. In D.I. Khan 4 species are found. Out of these *P. barbatum* L., *P. flaccidum* and *P. glabrum* (Fig. 4F) are gregarious near rivers and streams, in marshes, in shallow water in pools and ditches.

Portulaca (Portulacaceae) is composed of About 200 species, chiefly American but also distributed in other tropical and subtropical regions of the world (Ghafoor, 1973), represented by 5 species in Pakistan and 3 species in D.I. Khan District. One species, *P. oleracea* L. (Fig. 4G) is found as a weed in cultivated fields and waste moist marshy places of the district. It is used as vegetable and medicinal herb (Sher *et al.*, 2011; Marwat *et al.*, 2011c).

Pycnus (Cyperaceae) genus consists of c.70 species, distributed in tropical and warm areas; represented in Pakistan by 6 species (Kukkonen, 2001). In D.I. Khan it is represented by two species, *P. flavidus* (Retz.) T. Koyama and *P. laevigatus*. *P. flavidus* is found in marshy places, along river banks and rice fields.

Ranunculus (Ranunculaceae) is a large genus. The species indicated varies greatly (from 400-600) from author to author (Cook, 1974; Chen, 2011) of which 35 are aquatic which are cosmopolitan (Cook, 1974), represented in Pakistan by 23-25 species (Riedle & Nasir, 1991). According to Qureshi & Chaudhri, 1988, 36 species occur in Pakistan. While in D.I. Khan it is represented by two species, *R. muricatus* L. and *R. scleratus* L. (Fig. 4I). Both the species are commonly found in marshy places in D.I. Khan.



Fig. 3. A. *Bolboschoenus affinis*, B. *Cyperus alopecuroides*, C. *Eleocharis palustris*, D. *Phyla nodiflora*

Rumex (Polygonaceae) is a genus of more than 200 species, distributed in temperate regions especially in the Northern areas of both parts of the world; represented in Pakistan by 15 species (Bhopal & Chaudri, 1977b) and 2 hybrids (Qaisar, 2001). One species, *Rumex dentatus* L., was recorded from D.I. Khan District. It grows in disturbed habitat, often in moist areas, such as lakeshores and the edges of cultivated fields. This plant has allelopathic activity, producing substances that inhibit the growth of other plants near it (Wikipedia, 2012b).

Schoenoplectus (Cyperaceae), a genus with c. 60 species, distributed on all continents; represented in Pakistan by 11 species (Kukkonen, 2001). In D.I. Khan district 2 species, *S. litoralis* (Schrad.) Palla and *S. triqueter* (L.) Palla were recorded.

S. litoralis (Fig. 4H) is a perennial, partially submerged aquatic herb, while *S. triqueter* is perennial herb found in marshy grounds (Marwat *et al.*, 2008), alluvial meadows, by rivers and lakes, rice fields (Kukkonen, 2001).

Suaeda (Chenopodiaceae) genus is composed of about 80-90 halophytic species, distributed throughout the world, but primarily extra-tropical, growing on wet, moist or dry saline, alkaline and gypsiferous soils in semi-deserts, deserts and along sea-shores. It is represented in Pakistan by 7 species. (Freitag *et al.*, 2001) or 9 species (Bhopal & Chaudhri, 1977a) and D.I. Khan district by 3 species. In Pakistan, *S. fruticosa* is the most common and ecologically most adaptable species of the genus (Freitag *et al.*, 2001).

Typha (Typhaceae) is a genus of about 10-11 species. The genus has a largely Northern Hemisphere distribution, but is also found in a variety of wetland habitats (Omer & Hashmi, 1987; Thomas, 2008). In Pakistan, represented by 5 species (Omer & Hashmi, 1987). Two species, *T. domingensis* Pers. (Fig. 4J) and *T. elephantina* Roxb. were reported from D.I. Khan. Both the species are dominant in fresh and brackish marshes, back waters, lagoons pools and along water courses (Swapna *et al.*, 2011). *T. elephantina* can easily be distinguished from the other by the angular keeled leaf sheath (Omer & Hashmi, 1987).



Fig. 4. E. *Alternanthera sessilis*, F. *Polygonum glabrum*, G. *Portulaca oleracea*, H. *Schoenoplectus litoralis*, I. *Ranunculus scleratus*, J. *Typha domingensis*; Source: All the photos by author.

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