

# Floristic account of submersed aquatic angiosperms of Dera Ismail Khan District, northwestern Pakistan

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## INTRODUCTION

Pakistan is a developing country of South Asia covering an area of 87.98 million ha (217 million ac), located 23-37°N 61-76°E, with diverse geological and climatic environments. The annual rainfall ranges from 12.5 cm (4.92 in) in the south to 87.5 cm (34.5 in) in the submountainous and the northern plains. About 70% of the rain falls during the monsoon season (Jul-Sep); however, occasional showers also occur during the winter. The summer months are very hot, except in the mountainous areas while the winter months are mild in the plains and severe in the mountains (Ahmad et al. 2007).

Dera Ismail Khan is located in northwestern Pakistan and has an elevation of 173 m. It has a total geographical land mass of 0.896 million ha (2.214 million ac) 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 1999).

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 (Lancar and Krake 2002). 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 semiaquatic habitat (Ahmad and Younis 1979).

In Pakistan, the weediest aquatic species belong to the submerged group that germinates, sprout, grow, and reproduces beneath the water surface. Their roots and reproductive organs remain in the soil at the bottom of the water body. These species cause the most damage because, depending on the degree of their intensity and growth, they are not visible on the surface and they impede the flow of water (Lancar and Krake 2002) causing overflows that lead to loss of irrigation water (Iqbal 1992). Most of these species are found in shallow and medium deep water bodies and in flowing canals and drainage ditches (Lancar and Krake 2002). Some, such as *Hydrilla verticillata*, *Potamogeton crispus* and *P. pectinatus*, increase sedimentation of water reservoirs at accelerated rates (Ashiq et al. 2003). Nevertheless, submerged vegetation is mostly associated with a healthy aquatic system because the plants provide habitat, sediment stabilization, primary production, and sources of food for many birds, mammals, fish, and insects (Ahmad and Younis 1979). They are a source of oxygen for respiration and provide protection through temperature moderation against hot and cold weather.

Lakes and ponds are rich in aquatic flora that constitute an important resource but in Pakistan these natural resources have not been given due attention, and thus their potential remains unexplored. In addition, aquatic plants can be taxonomically difficult, and Pakistan lacks adequate herbarium material to represent the variability in the development of various organs resulting from plasticity in form and structure in relation to aquatic environment. The peak flowering

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time of the aquatic flora in Pakistan is generally during the monsoon, but some flower in other seasons while others flower throughout the year. No detailed account of submerged aquatic angiosperms for Dera Ismail Khan is available. The present study is an attempt to open a new avenue in this field.

## MATERIALS AND METHODS

A floristic study of the submerged plants of Dera Ismail Khan District, northwestern Pakistan, was conducted between 2005 and 2007. Plant specimens were collected at least 2 times from 15 sites (Table 1). The specimens were collected by hand from various aquatic habitats (slow-running water, a lake, sides of stagnant ponds, paddy fields, streams, a sewerage canal). They were carefully washed and preserved in 7% formalin. Data recorded in the field included date of collection, collection number, habitat, flowering season, and frequency of 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 and Samad 1974, Qaiser 1977, Ahmad and Younis 1979, Leghari et al. 1999, and Leghari 2004. After identification, morphological features were compiled for each species, the plants were given voucher numbers, and specimens were deposited at ISL. The family, botanical name, voucher number, occurrence, endemism, and status of each plant were recorded (Table 2), as well as the relative distribution of the species sampled within the district (Table 1). The total number of species of each genus of the research area was compared with their numbers present in the world (Table 3).

## RESULTS AND DISCUSSION

The submerged aquatic vegetation of this district includes 11 angiosperms belonging to 5 families (Table 1). Of these, one family (Ceratophyllaceae) is a eudicot and 4 (Hydrocharitaceae, Najadaceae, Potamogetonaceae and Zannichelliaceae) are monocots. The species *Najas marina*, *Potamogeton lucens*, *P. perfoliatus*, and *Vallisneria spiralis* show restricted distribution and are confined to 1 or 2 sites. Among the widely distributed species are *Ceratophyllum demersum*, *Hydrilla verticillata*, *P. crispus*, and *P. pectinatus*.

*Ceratophyllum* is composed of 10 (or 1 polymorphic) species and is cosmopolitan in distribution (Table 3). In Pakistan it is represented by only one species, *Ceratophyllum demersum* (Aziz 1974), which is found in Dera Ismail Khan District (Table 1). *Hydrilla*, a monotypic genus, naturally distributed in parts of Asia, Africa and Australia, was introduced in the New World (Ghafoor 1985). It is represented in Dera Ismail Khan District by the single species *H. verticillata*. The plant is eaten by some freshwater fish and may be used as manure where it occurs in large quantities. It becomes a serious menace to navigation in large lakes and in irrigation canals as it reduces the flow rate of water (Ghafoor 1985).

*Najas* has about 50 species that are cosmopolitan in a large variety of habitats (Cook et al. 1974). *Najas* is represented in Pakistan by 4 species, *Najas graminea*, *N. marina*, *N. minor*, and *N. oguraensis*, which occur from the plains to mountains up to 3100 m and in brackish and fresh waters (Hashmi and Omer 1987) (Table 3). After an extensive survey of the area, 3 species, all annual in habit, were found in Dera Ismail Khan *Najas graminea*, *Najas marina*, and *Najas minor* (Table 1). In general *Najas* is not considered to be of great economic importance although it may be a nuisance in irrigation ditches.

TABLE 1. DISTRIBUTION OF SUBMERGED AQUATIC PLANTS IN DERA ISMAIL KHAN.

Scientific name	Flowering Season	Localities														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<i>Ceratophyllum demersum</i>	Mar-Jun	+	—	—	—	—	+	—	—	+	+	+	+	—	—	+
<i>Hydrilla verticillata</i>	Sep-Mar	+	—	+	—	++	++	+	+	+	—	—	+	+	+	+
<i>Najas graminea</i>	Jul-Sep	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>N. marina</i>	Jul-Nov	—	—	—	—	—	+	—	—	—	—	—	+	—	—	—
<i>N. minor</i>	Mar-Sep	+	—	—	—	+	—	—	—	—	+	—	+	—	—	—
<i>Potamogeton crispus</i>	Mar-Apr	+	+	—	—	—	—	+	+	+	+	+	++	++	—	+
<i>P. lucens</i>	Jul-Aug	—	+	—	—	—	+	—	—	—	—	—	—	—	—	—
<i>P. pectinatus</i>	Feb-May	+	—	+	+	—	+	++	++	+	+	+	—	+	+	—
<i>P. perfoliatus</i>	Nov-Mar	—	—	—	—	+	—	—	—	—	—	—	—	—	—	+
<i>Vallisneria spiralis</i>	Oct-Mar	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Zannichellia palustris</i>	Feb-Mar	+	—	+	—	+	+	—	+	—	—	—	+	+	—	—

### Key:

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|-------------------------------------|----------------------------------|
| 1. Chashma lake                     | 2. Khisore range Badari Dam      |
| 3. Khisore range Ghuraba Stream     | 4. Dara Zinda Stream             |
| 5. Paharpur Sewerage Cana           | 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 |

TABLE 2. SUBMERGED AQUATIC PLANTS OF DERA ISMAIL KHAN, NORTHWESTERN PAKISTAN.

Family	Scientific name	Vouch. No.	Occurrence	Endemism	Status
Ceratophyllaceae	<i>Ceratophyllum demersum</i>	232	Common	Native	Invasive
Hydrocharitaceae	<i>Hydrilla verticillata</i>	130	Abundant	Native	Invasive
Hydrocharitaceae	<i>Vallisneria spiralis</i>	274	Rare	Native	Non-invasive
Najadaceae	<i>Najas graminea</i>	245	Rare	Native	Non-invasive
Najadaceae	<i>N. marina</i>	417	Rare	Native	Non-invasive
Najadaceae	<i>N. minor</i>	273	Common	Native	Non-invasive
Potamogetonaceae	<i>Potamogeton crispus</i>	193	Abundant	Native	Invasive
Potamogetonaceae	<i>P. lucens</i>	412	Rare	Native	Non-invasive
Potamogetonaceae	<i>P. pectinatus</i>	244	Abundant	Native	Invasive
Potamogetonaceae	<i>P. perfoliatus</i>	413	Rare	Native	Non-invasive
Zannichelliaceae	<i>Zannichellia palustris</i>	280	Common	Native	Non-invasive

TABLE 3: SUBMERGED AQUATIC WEED SPECIES OF DERA ISMAIL KHAN.

Name of genus	Distribution		World	Number of species of each genus			
	World	Pakistan		Total*	SS**	Total*	SS**
<i>Ceratophyllum</i>	Cosmopolitan	Peshawar, Keenjhar Lake (Thatta), Phoosna Lake, Bakar Lake (Sanghar), Wah Garden (Taxilla), Lahore	10 or 1 polymorphic	1	1	1	1
<i>Hydrilla</i>	Eurasia and Africa to Australia; introduced in the New World	Swat, Keenjhar Lake, Bakar Lake, Wah Garden, Lahore, Rawal Dam (Rawalpindi and Islamabad), Baluchistan, Kashmir lakes	1	1	1	1	
<i>Najas</i>	Cosmopolitan in fresh and brackish water habitats.	From plains to mountains up to $\pm$ 3100 m in brackish and fresh waters; Keenjhar Lake, Bakar Lake, Wah Garden, Lahore, Rawal Dam.	~40	4	4	3	3
<i>Potamogeton</i>	Temperate regions of the world	Karachi district, Keenjhar Lake, Phoosna Lake (Badin), Bakar Lake, Wah Garden, Lahore, Rawal Dam.	~100	11	9	5	4
<i>Vallisneria</i>	Tropics, subtropics and warm temperate regions in the Old and New World.	Rawal Dam, Wah Garden, Lahore, Bakar Lake, Keenjhar Lake.	2-3	1	1	1	1
<i>Zannichellia</i>	Cosmopolitan	Balochistan, Wah Garden, Sind, Scardu, Ladak, plains to 15000'	4-5 or (1poly morphi)	1	1	1	1

\*Total number of species of each genus.

\*\*Total number of submerged species of each genus.

*Potamogeton* has about 100 species that are cosmopolitan in distribution and occurs in large variety of habitats (Cook et al. 1974). About 12 species are reported from Pakistan (Aziz and Jaferi 1975). Five species were recorded from Dera Ismail Khan (Table 1). Four of the species, *Potamogeton crispus*, *P. lucens*, *P. pectinatus* and *P. perfoliatus* are submerged and one species, *Potamogeton nodosus* Poiret is rooted with both floating and underwater leaves (Aziz and Jaferi 1975).

The genus *Vallisneria* comprises 6 to 10 species that are almost cosmopolitan but are absent from cold regions (Cook et al. 1974). It is represented in Pakistan by *Vallisneria spiralis* L. (Ghafoor 1985), which is also found in Dera Ismail Khan District (Table 1). Most species of *Vallisneria* build up large populations that may seriously hinder the flow of water in irrigation canals.

The genus *Zannichellia* is comprised of 5 (or 1 polymorphic) species, *Zannichellia palustris*, which is cosmopolitan in distribution and found in a wide variety of aquatic habitats

(Cook et al. 1974). It occurs in Pakistan (Aziz and Ali 1972) and is also found in Dera Ismail Khan (Table 1).

Submerged aquatic plants constitute an essential component of ponds, streams, lakes and riverbanks of northwestern Pakistan. This aquatic flora provides nourishment and protection for aquatic animal life. The habitats of such plants are threatened by the scarcity of water and human population pressure that consumes water resources; consequently, the existence of such submerged flora is thought to be vulnerable to future pressures. Measures should be taken to conserve the population of this flora in northwestern Pakistan as a part of the strategy aquatic systems conservation.

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