PLANTS OF HASHILAN WETLAND, KERMANSHAH, IRAN

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Abstract

Plants of Hashilan, a 260 ha freshwater wetland, located at 35 km northwest of Kermanshah, the provincial capital of Kermanshah Province, western Iran, were studied. Altogether, 116 species of plants (77 terrestrial and 39 aquatic) representing 96 genera and 42 families were identified. **Asteraceae** with 11 genera and 13 species, **Poaceae** 9 genera and 10 species, and **Cyperaceae** with 6 genera and 9 species were the most common plants. Aquatic plants had more biomass and distribution compared to terrestrial plants which were restricted to the islands. Among them **Carex** spp. were found from the edge of the wetland to areas with 40 cm depth. Distribution of all major plant species were recorded and mapped. Names of aquatic and terrestrial plant species are given in appendices 1 and 2, respectively.

Introduction

Wetlands are valuable components of natural landscapes, particularly in dry and semi-dry environments. Wildlife habitat was the first ecological service of wetlands to be recognized [12]. Several other ecological services have also been reported, including flood storage, low flow maintenance, and sediment retention [6,9].

In the Zagros Mountains of western Iran, where the first domestication of plants and animals took place [1,3,13] there has been a long association between man and aquatic environments at least for food (fishes, birds) and water. This association is well depicted in Tagh Bostan near the city of Kermanshah. Persians have had interest in aquatic plants and it is probable that the true sacred lotus, represented on the monuments and tombs of Ancient Egypt, may have been introduced from Persia, where it is native, when King Cambyses and Persians conquered Egypt in 525 B.C [11]. The cultivation of ornamental aquatic plants may also have been as an incidental feature of the very ancient arts of pisciculture and landscape horticulture which can be traced back to at least 2500 BC in Egypt, Assyria and Persia (Op. Cit).

There are only 20 Ramsar Sites in Iran and none in the province of Kermanshah. The province is 236670 ha in size and situated in western Iran, bordering Iraq.

Although there are many wetlands in Kermanshah Province, none of them is as large as Hashilan. This is a freshwater wetland with an area of 260 ha situated at

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46°, 51′ to 46°, 54′ East and 34°, 34′ to 35°, 34′ North, 15 km northwest of Kermanshah, the provincial capital. There are 110 islands in the wetland ranging from 0.1 to 1 ha in size which cover 30% of the wetland's area. Two Karstic springs, Sabz Ali and Man-E-May, originating from the Khorein Mountains located on the northern border of the wetland, provide water to it (95 and 5 percent respectively). Average annual discharge of Sabz Ali Spring has been 323.4 liters per second measured over the period of 13 years (1972-1985); with a range of 208.3 (1977) to 442.5 (1978). The highest discharge is in March and the lowest in September. The total average volume of water in the wetland is estimated to be over 1.02×10^7 cubic meters. The elevation of the wetland is 1310 m above sea level.

With respect to the climate of Iran, a yearly climate cycle for western Iran is as follows. The winter season is ushered in by gradually mounting effect of the very high pressure cell which forms over Siberia as a result of the cooling down of the huge continental land mass. Cold air flows out of the north lowering temperatures to a minimum usually in January. Average annual precipitation during 1961-1984 (23 years) was 451 mm.

The objectives of our studies were: 1) to document plant species richness and diversity in the wetland; 2) elucidate associations among plant species; 3) establish an ecological classification of the wetland plants.

Methods

Specimens of plants were collected from March to June 1995, identified and dried in the field and taken to the laboratory for confirmative identification and weighing. Parallel transects were laid on north to south directions at distances 140 m apart on the wetland. Sampling quadrats (1×1 m) on each transect were chosen at 50 m intervals; the first quadrats were 4 m away from the northern edge of the wetland (close to the Sabz Ali spring). Altogether, 454 plots were studied in July 1995. Presence or absence of plant species in each plot was recorded and percent canopy coverage estimated. Species that covered less than 2% of the plot area were ignored.

All aquatic plant biomass occurring in the water column (aquatic plants) or above soil level (terrestrial plants) in the plots were clipped, put into paper bags and taken to the lab for drying and weighing.

Three soil cores were taken at each community within the wetland and depth of sediment, particle size and chemical analyses were conducted for each horizon. Soil samples (n=21) were collected from different parts of the wetland for texture and chemical analysis. Also, water pH was recorded at the time of plant collections.

Statistical analysis was carried out by MINITAB (Student Edition, 1989). Test of association for pairs of species were made using 2×2 contingency tables. Where species were dependent, the degree or strength of association between pairs of species were calculated using association indices (Ochiai, Dice and Jaccard) according to Ludwig and Reynolds [5].

The area of the wetland was determined on the latest available aerial photos (1988). This was followed by ground surveys for correction of possible changes at the boundaries.

Results

Plant Species List

Throughout the wetland, 116 species of plants were identified representing 42 families and 96 genera. Among these, 77 species were terrestrial, living only on the islands. The remaining (n=39) were aquatic species including emergent (*Typha*, *Phragmites*), floating leafed (*Nuphar*), submerged (*Myriophyllum*, *Ranunculus*) and free-floating (*Ceratophyllum*). Appendices 1 and 2 give names of aquatic and terrestrial plants of the wetland, respectively.

Plant Biomass

Average plant biomass of the 9 most abundant aquatic species in the wetland was estimated for the plots which contained them. Table 1 summarizes this information. Detailed information on the biomass of the dominant species in the wetland has been reported elsewhere [4].

As is clear in Table 1, *Typha domingensis*, *S. abernaemontani*, *Cladium mariscus* and *Ceratophylum demersum* rank as the 4 species having highest biomass in the plots. *Juncus* spp. show the least biomass (0.5140 Kg/m^2) in measured plots.

Table 1. Descriptive statistics on biomass of dominant aquatic plant species in Hashilan Wetland, Kermanshah, Iran

Plant Species	Sample size	Mean±SE	95% C.I. for the mean
Juncus articulatus	10	0.614±0.086	0.419-0.808
Sparganium erectum	13	1.185±0.167	0.821-1.548
Typha domingensis	51	1.912±0.125	1.661-2.163
Carex distans	127	1.483±0.025	1.437-1.535
Schoenoplectus tabernaemontani	55	1.653±0.114	1.424-1.882
Cladium mariscus	2	1.290±0.650	-0.01-2.59
Cyperus longus	17	0.812±0.116	0.558-1.067
Phragmites australis	52	1.085±0.124	0.836-1.334
Ceratophylum demersum	66	1.270±0.125	1.021-1.519

Species Associations

For the most common aquatic plant species occurring in the plots, there was significant statistical association between the following pairs: *Carex* sp.-*Ceratophyllum demersum* (Chi-square =4.8); *Typha domingensis*-*Schoenoplectus tabernaemontani* (Chi-square =6.0); *Juncus* sp.-*Phragmites australis* (Chi-square =4.3).

Association indices were calculated for these pairs and the results are shown in Table 2.

The overall inter-specific association (multiple species) which was calculated according to Schulter's variance ratio method [10] was 0.20. Since the expected value under the null hypothesis of independence is 1, the calculated value suggests a net negative association among the species, [5, p. 134].

A statistic, W, [W=(N)(VR)=(454)(0.20)=90.8] is computed that may be used to test whether deviation from 1 is significant. Since calculated W is less than 124.34 and more than 77.93; there is a 90% probability that difference from 1 is significant (Op. cit.).*

Table 2. Positive association between pairs of species in Hashilan Wetland, Kermanshah, Western Iran

Name of Species	Ochiai	Dice	Jaccard	Chi-square (Corrected)
Carex sp. & *C. demersum*	0.632	0.624	0.453	4.758
T. domingensis & *S. tabernaemontani*	0.455	0.453	0.293	6.041
Juncus sp. & *P. australis*	0.236	0.182	0.100	4.355

Discussion

The plant species of Hashilan Wetland represent 42 plant families including Asteraceae (11), Poaceae (9), Cyperaceae (6), Apiaceae (7), and Fabaceae (6) among others. The ecosystem provides an excellent place to study plant species in terms of their affinity for wetland habitats. At one extreme are "dryland specialists", which are excluded from wetland habitats' and at the other extreme are anatomically and physiologically specialized strict hydrophytes.

Identifying plant species is an important step towards much needed studies on the life history and/or strategy of aquatic plants in Iranian wetlands. Unfortunately, studies on the ecological nature of aquatic plants have not been carried out in Iran.

An attempt was made to classify Hashilan plants according to ecological classifications made by Grime *et al*. [2]. The result of the classification of 23 plant species of Hashilan wetland is shown in Table 3.

Table 3. Classification of Hashilan plant species into life forms, ecological strategies and type of mycorrhizas according to Grime *et al*. (1988)

Name of the plant	Life history	Established strategy	Life form	Mycorrhizas
Alisma plantagoaquatica	P	R/CR	Wet	-
Anagalis arvensis	Asw	R/SR	Th/ch	VA
Berula erecta	P	C/R	Hel	-
Caradaria draba	P	CR	H/G	?
Cirisium vulgare	M	CR	H	+
Galium aparine	Aws	CR	Th	+
Juncus articulatus	P	CSR	Hel/H	VA
Lemna trisulca	(P)	S	Hyd	-
Lycopus europeus	P	CR	Hel/H	+
Lythrum salicaria	P	CR/CSR	Hel/H	AV
Myriophyllum spicatum	P	CSR	Hyd	?
Nuphar lutea	P	C/CSR	Hyd	?
Papaver rhoeas	Asw	R	Th	-
Phragmites australis	P	C	Wet	VA
Plantago lanceolata	P	CSR	H	VA
Polygonum amphibium	P	CR	Wet	-
Potamogeton crispus	P	CR	Hyd	-
Rubus caesius	P	SC	Ph	VA
Rumex conglomeratus	P/M	CR	H/G	-
Scutellaria galericulata	P	CR/CSR	H	VA

* W must be greater than Chi square for 0.05 with N and lower than 0.95 with N with 454 df. (number of sampling units). For degrees of freedom more than 100 we use z which is the square root of 2 Chi square minus square root of 2(df)-1. So, Chi-square for 0.05 and 100 df=77.93 and Chi-square for 0.95=124.34.

Table 3. Continued

Name of the plant	Life history	Established strategy	Life form	Mycorrhizas
Sparganium erectum	P	C/CR	Wet/G	VA
Veronica beccabunga	P	CR	Hel/H	?

The abbreviations are as follows: As, summer annual; Aw, winter annual; Asw, summer or winter annual; P, polycarpic perennial, and species like *Lemna trisulca* which overwinters is denoted as (P). Ecological strategies follow Grime *et al*. [2] and the scheme used is as follows: primary strategies C, Competitor; R, ruderal; SC, Stress tolerant-competitor; SR, Stress-tolerant ruderal; CSR, C-S-R strategist. Strategy types intermediate between these seven are recognized, e.g. CR/CSR. Life forms follow Raunkiaer's [7] classification. The following classes have been identified: Ph, Phanerophytes (woody plant with buds over 250mm above soil surface); Ch, chamaephyte (herbaceous, or woody, plant with buds not in contact with but less than 250mm above soil surface); H, hemicryptophyte (herb with buds at soil level); G, geophyte (herb with buds below the soil surface); Hel, helophyte (plant passing the unfavorable season as seeds); Wet, wide-ranging wetland species (facultatively a helophyte or a hydrophyte). The frequency and nature of mycorrhizal infection have been summarized for each species as follows: -, Non-mycorrhizal (25% or less of records report mycorrhizas); +, Intermediate (26-74% of records report infection with VA mycorrhizas; VA, Normally mycorrhizal (75% or more records report infection with vesicular arbuscular mycorrhizas).

It is not clear how stress and disturbance and consequences of the interaction of these forces have influenced plant species in the wetland. Shortage of water and mineral nutrients are stress factors which reduce the rate of accumulation of biomass. Grazing by cattle, removal of herbage by humans and trampling of vegetation (by humans and domestic animals) are major disturbance factors that destroy plant biomass. Competition and allelopathy could also play a significant role in structuring of aquatic plant communities.

Recommendations

Our studies of Hashilan wetland show a high diversity of plant and animal species living in this unique small ecosystem, and every attempt must be made to conserve it. The wetland provides a superb opportunity for scientific studies of its diverse fauna and flora. Unfortunately, high human population growth rates in villages surrounding the wetland, grazing, extension of agricultural lands, high local demand for irrigation water and poaching are severe problems facing conservation efforts. Conservation sites are usually selected not in the context of the regional development programs in Iran, but as isolated islands that must be preserved against ever increasing pressure from the boundaries. We provide the following recommendations for conservation of the wetland:

1) The conservation of the wetland should be a part of the integrated regional development plans. High unemployment rates (around 30.6%) in the province call for an immediate response from the government.

2) The boundaries of the wetland should be monitored consistently and any effort by local land owners to claim land from the wetland should be prevented. We have prepared a map of the wetland.

3) Any attempt to remove water from Sabz Ali Spring for irrigation purposes should be avoided. This would have severe impact the wetland particularly in dry years (as in 1999 and 2001).

4) Agricultural practices in the lands surrounding the wetland should be directed to crops that are more water efficient.

5) Recreation facilities could be established in the area. We have observed local people and inhabitants of Kermanshah fishing in the area.

6) Attitudes of local people should change towards the wetland. This could be achieved by local and National T.V. programs.

7) More research should be carried out on the wetlands.

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Appendix 1. Aquatic plant species of Hashilan Wetland, Kermanshah Province, Western Iran

Plant Species	Family	Common Name
1) Alisma plantagoaquatica	Alismataceae	American waterplantain
2) Althaea officinalis	Malvaceae	Common marshmallow
3) Berula erecta	Apiaceae	Cutleaf water-parsnip
4) Butomus umbellatus	Butomaceae	Flowering rush
5) Carex distance	Cyperaceae	
6) Carex divisa	Cyperaceae	Separated sedge
7) Carex hispida	Cyperaceae	
8) Catabrosa aquatica	Poaceae	Water whorlgrass
9) Ceratophyllum demersum	Ceratophyllaceae	Coon's tail
10) Chara sp.	Characeae	
11) Cladium mariscoides	Cyperaceae	Smooth sawgrass
12) Cyperus fuscus	Cyperaceae	Brown flatsedge
13) Cyperus longus	Cyperaceae	
14) Epilobium mospelinesis	Onagraceae	
15) Juncus acutus	Juncaceae	Spring rush
16) Juncus articulatus	Juncaceae	Jointed rush
17) Lemna trisulca	Lemnaceae	Star duckweed
18) Lycopus europeus	Lamiaceae	Gypsywort
19) Lythrum salicaria	Lythraceae	Purple loosestrife
20) Myriophyllum spicatum	Haloragaceae	Spike watermilfoil
21) Nuphar lutea	Numphaeceae	Yellow pondlily
22) Oenanthe silaifolia	Apiaceae	
23) Paspalidium geminatum	Poaceae	Egyptian panicum
24) Phragmites australis	Poaceae	Common reed
25) Polygonum amphibium	Polygonaceae	Water knotweed
26) Polypogon monspeliensis	Poaceae	Annual rabbitsfoot grass
27) Potamogeton crispus	Potamogetonaceae	Curley pondweed
28) Potamogeton nodosus	Potamogetonaceae	Longleaf pondweed
39) Potamogeton pectinatus	Potamogetonaceae	Clasping leaf pondweed
30) Pulicaria dysantrica	Asteraceae	
31) Schoenoplectus tabernaemontani	Cyperaceae	
32) Scirpus maritimus	Cyperaceae	Saltmarsh bulrush
33) Scripoides holoschoenus	Cyperaceae	
34) Scrophularia macrophyllum	Scrophulariaceae	Figwort
35) Sium sisaroides	Apiaceae	Parsnip
36) Sparganium erectum neglectum	Sparganiaceae	Simple stem burreed
37) Typha domingensis	Typhaceae	Southern cattail
38) Utricularia australis	Lentibulariaceae	Bladderwort
39) Veronica beccabungea	Scrophulariaceae	European speedwell

Appendix 2. Terrestrial plants of Hashilan Wetland, Kermanshah Province, Western Iran

Plant Species	Family	Common Name
1) Achillea wilhelmsii	Asteraceae	Yarrow
2) Adonis aestivalis	Ranunculaceae	Summer pheasant's eye
3) Adonis annua	Ranunculaceae	Blood drops
4) Alcea kurdica=Althaea kurdica	Malvaceae	Alcea
5) Allium sp.	Liliaceae	Wild onion
6) Anagallis arvensis	Primulaceae	Scarlet pimpernel
7) Anagallis sp.	Primulaceae	
8) Anthemis haussknechtii	Asteraceae	
9) Astragalus spp.	Fabaceae	
10) Bromus danthoniae	Poaceae	Oat brome
11) Bromus tectorum	Poaceae	
12) Bidens tripartita	Apiaceae	Threelobe beggarticks
13) Bupleurum lancifolium	Apiaceae	Lanceleaf throw wax
14) Calamagrostis pseudophragmites	Poaceae	Reedgrass
15) Calistegia sepium	Convolvulaceae	Hedge false bindweed
16) Callipeltis cucularia	Rubiaceae	
17) Capparis spinosa	Capparaceae	Caper
18) Cardaria draba	Brassicaceae	Pepperweed whitetop
19) Carduus arbicus	Asteraceae	Plumeless thistle
20) Castridium phleoides	Poaceae	
21) Centaurea behen	Asteraceae	
22) Centaurea depressa	Asteraceae	Centaurea
23) Centaurium minus	Gentianaceae	Centaurium
24) Centaurium tenuiflorum	Gentianaceae	
25) Cerpis sp.	Asteraceae	
26) Cirsium canum	Asteraceae	Queen Anne's Thistle
27) Cirsium vulgare	Asteraceae	Bull thistle
28) Consolida soleroclada	Ranunculaceae	Consolida
29) Convolvulus contabrical	Convolvulaceae	Bindweed
30) Cynodon dactylon	Poaceae	Bermudagrass
31) Daucus sp.	Apiaceae	Wild carrot
32) Dianthus polycladus	Caryophyllaceae	
33) Dipsacus laciniatus	Dipsacaceae	Cutleaf teasel
34) Echinops sp.	Asteraceae	Globethistle
35) Echium glomerata	Boraginaceae	Echium
36) Euphorbia aellenii	Euphorbiaceae	
37) Euphorbia strictior	Euphorbiaceae	Panhandle Spurge
38) Ferula sp.	Apiaceae	Ferula
39) Galium aparine	Rubiaceae	Sticky willy
40) Galium incanum	Rubiaceae	Bedstraw
41) Gentiana olivieri	Gentianaceae	Gentian
42) Glyocorrhiza glabra	Fabaceae	Cultivated bicorice

Appendix 2. Continued

Plant Species	Family	Common Name
43) Heliotropium rotundifolium	Boraginaceae	Heliotrope
44) Leontodon sp.	Asteraceae	Leontodon
45) Lepidium latifolium	Brassicaceae	Broadleavedpeperweed
46) Linum bienne	Linaceae	Pale flax
47) Linum corymbolosum	Linaceae	
48) Mentha longifolia	Lamiaceae	Mint
49) Muscari acaucasica	Liliaceae	Grape hyacinth
50) Muscaria laeta(longipes) ??	liaceae	
51) Myagrum perfoliatum	Brassicaceae	Birds eye cress
52) Nasturtium microphyllum	Brassicaceae	
53) Ononis spinosa	Fabaceae	Ononis
54) Plantago lanceolata	Plantaginaceae	Narrow leaf plantain
55) Plantago media	Plantaginaceae	Hoary plantain
56) Papaver rhoeas	Papaveraceae	Corn poppy
57) Pentanema divaricatum	Asteraceae	
58) Pyrus syriaca	Rosaceae	Pear
59) Ranunculus constantinopliatanus	Ranunculaceae	Buttercup
60) Ranunculus macrorhynchus	Ranunculaceae	Water Buttercup
61) Rubus caesius	Rubiaceae	European dewberry
62) Rumex conglomeratus	Polygonaceae	Clustered dock
63) Rumex dentatus	Polygonaceae	Toothed dock
64) Salix alba	Salicaceae	Willow
65) Salvia syriaca	Lamiaceae	Sage
66) Scutellaria galericulata	Lamiaceae	Marsh skullcap
67) Senecio sp.	Asteraceae	Groundsel
68) Silene sp.	Capparacea	Silene
69) Sideritis montana	lamiaceae	Mountain ironwort
70) Spergularia diandra	Capparaceae	Diandra sandspurry
71) Thymelaea passerina	Thymelaceae	Mezereon
72) Trifolium fragiferum	Fabaceae	Strawberry clover
73) Trigonella caerulea	Poaceae	Blue fenugreek
74) Valerianella coronata	Valerianaceae	European cornsalad
75) Verbascum sp.	Scrophulariaceae	Mullein
76) Vicia cuspidata	Fabaceae	Vetch
77) Vicia hybrida	Fabaceae	Hairy yellow vetch