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Exploration of Floristic Composition and Management of Gujar Tal in District Jaunpur

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Abstract**—**Present paper enumerates highlights of seasonal variation in floristic composition and ecological strategies for the management of 'Gujar Tal' at Jaunpur in tropical semi-arid region of eastern U.P. (India). Total composition of macrophytes recorded was 47 from 26 families with maximum 6 plant species of Cyperaceae from April, 2012 to March, 2013 at certain periodic intervals. Maximum number of plants (39) was present during winter followed by (37) rainy and (27) summer seasons. The distribution pattern depicted that maximum number of plants (27) was of marshy and swampy habitats usually transitional between land and water.

Keywords**—**Floristic, life form, management, weeds.

I. Introduction

FLORISTIC inventory of any ecosystem is necessary to understand present diversity status. It deals with the study, which is involving taxonomic identification and listing of plant species present. Majority of plants is most essential for human survival and economic well-being and for ecosystem function and stability.

India has sizeable area under fresh water wetlands (>0.15 million ha), total area of natural wetlands is 14, 64, 806 ha in which the contribution of U.P. is 12,832 ha [1]. There are more than 922 'Tals'(wetlands) in U.P. [2].Wetland, as the name suggests refers to such landscape which is saturated with water or covered by water, either perennially or major part of the year. The wetlands are typically transitional gradient between upland and open water with maximum depth up to six metres [3]. These lands may support both aquatic and terrestrial species, and are the richest site of biodiversity. The flood water shows the prominent effect on the growth and distribution of submerged macrophytes. Wetlands are currently drawing attention of ecologist and environmentalists from nearly all the countries of the world. These are of great economic and aesthetic values. Unfortunately, despite government's several conservation efforts, wetland area is shrinking day by day.

The wetlands, linked with living organisms and biomass produced by aquatic plants are essential for the growth of aquatic fauna like fish for food and O_2 produced by aquatic plants are important for their survival. Varieties of aquatic plants present in water body, animals and environmental forces act together as interrelated components.

The present wetland besides being the repository of floral and faunal diversity plays important role in aquatic farming. Some of the self grown perennial aquatic weeds like *Oryza rufipogon* (wild rice or 'Tinni rice'), *Nelumbo nucifera* and *Ipomea aquatica* are good sources of income, apart from nutrient rich diet supplements by fish, snails and crabs [4].

Human interests are also varied, as for one purpose of plant may be resource and for another a weed [5].Aquatic weeds can be classified according to their habitat and morphological characteristics [6]. Some preliminary studies on aquatic weed problems in India and their management have been conducted [7], [8]. The ecological studies in Indian lakes are confined to limnology [9], [10] and macrophytes in relation to wetland ecology [11].

Unfortunately, at present, the entire 'Gujar Tal' has been covered by a few noxious aquatic weeds and among them *Eichhornia crassipes* is the most luxuriant due to its successful and vigorous vegetative growth. The entire wetland being converted into 'weed bowls' on alarming rate leading to swampfication and causing different kind of nuisance to achieve the target of aqua-farming [12]. A sustainable management of aquatic weeds is required without which wetland fishery can ever take its potential and on the other hand we have to manage resourceful species of biodiversity. It may lead the entire 'Tal' as healthy wetland biotope. Therefore, the present investigation has been carried out to understand ecological attributes of plant diversity composition, life forms, management aspect of weeds and finally the present wetland in relation to aqua-farming.

II. Materials and Methods

A. Study Area and Climate

In district Jaunpur (U.P.) where the present study has been conducted there are number of 'Tals' (wetlands) for example 'Dehesura Tal', 'Mani Tal', 'Arrebarre Tal', 'Rohua Tal', 'Ranimau Tal', 'Raipur Tal', 'Badshai Tal', 'Manichha Tal', 'Manne Tal', 'Pawai Tal', 'Narar Tal', 'Gajadharpur Tal', 'Kunwarpur Tal' and among them the biggest 'Tal' is 'Gujar Tal'. Therefore, the district Jaunpur may be called or referred as 'Tal District' in eastern U.P. This study was carried out in 'Gujar Tal' ($24^0$6'-$25^0$5' N and 80^0-82^0 E longitude) about 200 ha and 4.5 m deep in eastern U.P. (India). The particular 'Tal' (Fig. 1) was dug out in 1904 by joint efforts of landlords and local public nearby lake in order to meet scarcity of water. The present lake is 28 km away from Jaunpur city and 1.5 km away in west from Khetasarai town area.

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Fig. 1 A view of 'Gujar Tal' wetland

The water regime of the lake varies seasonally depending on the rainfall of the catchment, scorching heat during summer season and by occasional natural and manmade cracks in nearby Sarda Canal embankments. Therefore, the lake is not having definite banks due to fluctuation in water level. The climate is typically monsoonal with three different seasons viz. summer, rainy and winter. The total rainfall during study period (April, 2012 to March, 2013) was 882 mm out of which about 809.8 mm was during rainy season.

TABLE I
VARIATION IN FLORISTIC COMPOSITION OF 'GUJAR TAL'

S.N.	Plant Species	Family	Life form	Season		
				S	R	W
1	*Aeschynomene aspera* Linn.	Fabaceae	M	-	+	+
2	*Aeschynomene indica* Linn.	Fabaceae	M	-	+	-
3	*Alternanthera sessilis* (L.) Dc.	Amaranthaceae	M	+	+	+
4	*Amaranthus spinosus* Linn.	Amaranthaceae	M	+	+	+
5	*Amaranthus viridis* Linn.	Amaranthaceae	M	+	+	+
6	*Ammannia baccifera* Linn.	Lythraceae	M	+	+	+
7	*Ammannia multiflora* Roxb.	Lythraceae	M	+	+	+
8	*Anagallis arvensis* Linn.	Primulaceae	M	+	-	+
9	*Aponogeton natans* (L.)Engl. & K.Krause	Aponogetonaceae	Fl, Su	-	+	-
10	*Azolla pinnata* R.Br.	Azollaceae	Ff	-	+	-
11	*Ceratophyllum demersum* Linn.	Ceratophyllaceae	Su	+	+	+
12	*Cyperus kyllingia* Endl.	Cyperaceae	M	+	+	+
13	*Cyperus platystylis* R.Br.	Cyperaceae	M	-	+	+
14	*Cyperus pygmaeus* Descr.	Cyperaceae	M	-	+	+
15	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Ff	+	+	+
16	*Eleocharis plantaginea* (Retz.)R &S	Cyperaceae	E	+	+	+
17	*Eragrostis atrovirens* (Desf.) Trin. ex Steud	Poaceae	M	-	+	+
18	*Fimbristylis dichotoma* Vahl.	Cyperaceae	M	-	+	+
19	*Gnaphalium indicum* Linn.	Asteraceae	M	+	-	+
20	*Gnaphalium luteo-album* var *multiceps* Hk.f.	Asteraceae	M	+	-	+
21	*Hydrilla verticillata*(L.F.)Royle	Hydrocharitaceae	Su	-	+	+
22	*Hygroryza aristata* (Retz.) Nees	Poaceae	Fl	-	-	+
23	*Ipomoea aquatica* Forsk.	Convolvulaceae	Fl	-	+	+
24	*Jussiaea repens* Linn.	Onagraceae	Fl	+	-	-
25	*Lippia nodiflora* A. Rich.	Verbenaceae	M	+	+	+
26	*Ludwigia parviflora* Roxb.	Onagraceae	E	-	+	+
27	*Marsilea minuta* Linn.	Marsileaceae	Ff	-	+	+
28	*Najas graminea* Del.	Hydrocharitaceae	Su	-	+	-
29	*Nelumbo nucifera* Geertn.	Nymphaeaceae	Fl, E	+	+	+
30	*Neptunia prostrata or oleracea*(Lamk.)Baill.	Mimosaceae	M	-	+	+
31	*Nymphaea nouchali* Burm.F.	Nymphaeaceae	Fl	+	-	+
32	*Oryza rufipogon* Griff.	Poaceae	E	+	+	+
33	*Paspalidium punctatum* (Burm.) A. Camus	Poaceae	M	+	+	+
34	*Polycarpaea corymbosa* (L.) Lamk.	Caryophyllaceae	M	-	+	-
35	*Polygonum barbatum* Linn.	Polygonaceae	M	-	+	+
36	*Polygonum hydropiper* Linn.	Polygonaceae	M	+	+	-
37	*Polygonum plebeium* R.Br.	Polygonaceae	M	+	+	+
38	*Potamogeton crispus* Linn.	Potamogetonaceae	Su	+	+	+
39	*Potentilla supina* Linn.	Rosaceae	M	+	-	+
40	*Rumex dentatus* Linn.	Polygonaceae	M	+	-	+
41	*Sagittaria guayanensis* Kunth	Alismataceae	E, M	-	+	+
42	*Salvia plebeia* R. Br. Linn.	Lamiaceae	M	-	+	+
43	*Sciripus articulatus* Linn.	Cyperaceae	M	+	+	+
44	*Typha angustata* Bory & Chaub.	Typhaceae	E	+	+	+
45	*Utricularia flexuosa* Vahal	Lentibulariaceae	Ff	+	+	+
46	*Vallisneria spiralis* Linn.	Hydrocharitaceae	Su	-	-	+
47	*Veronica anagallis-aquatica* Linn.	Scrophulariaceae	M	+	-	+

Symbol: E=Emergent, Fl=Floating leaved, Ff=Free floating, Su=Submerged, M=Marshy, S= Summer, R=Rainy, W=Winter, +=Present, -=Absent

B. Floristic Composition of 'Gujar Tal'

The present work is based on collection of macrophytes mostly belonging to angiosperms of study area from April, 2012 to March, 2013 at monthly intervals but depicted in the Table I on seasonal basis for the purpose of study. The collected plants were identified with the help of floras and designated into different life forms.

III. Results and Discussion

A. Floristic Composition and Life Forms

During the course of the study spanning a year total 47 species of macrophytes from 26 families were identified. Seasonal variation in macrophytes present was also recorded. In the present investigation five types of life forms have been identified in 'Gujar Tal' (Table I).

1. Emergent: Emergent aquatic macrophytes are plants that are rooted in shallow water with vegetative plants and emerging photosynthetic parts above the water surface. These weeds may be called semi-aquatic but more appropriately referred to as emergent aquatic weeds e.g. *Eleocharis plantaginea*, *Ludwigia parviflora*, *Oryza rufipogon* and *Typha angustata*.
2. Floating leaved: Plants characterized by attached root system to the bottom or substratum and leaves are floating on the water surface e.g. *Hygroryza aristata*, *Ipomea aquatica*, *Jussiaea repens* and *Nymphaea nouchali*.
3. Free floating: Plants not rooted to the bottom and float freely on the surface of water e.g. *Azolla pinnata*, *Eichhornia crassipes*, *Mirsilea minuta*, *Utricularia flexuosa*. However, *Eichhornia crassipes* adapted to free floating condition but as the water recedes it anchored to the soil with its well developed roots.
4. Submerged: It is characterized by macrophytes growing under water in submerged state. Their roots and reproductive organs remain in the soil at the bottom of the water body e.g. *Ceratophyllum demersum*, *Hydrilla verticillata*, *Najas graminea*, *Potamogeton crispus* and *Vallisneria spiralis*.
5. Marshy: A semiaquatic plant that grows in soft wetland or on saturated soil mud e.g. *Aeschynomene aspera*, *Aeschynomene indica*, *Alternanthera sessilis*, *Amaranthus spinosus*, *Amaranthus viridis*, *Ammannia bacciferea*, *Ammania multiflora*, *Anagallis arvensis*, *Cyperus kyllinga* ,*Cyperus platystylis*, *Cyperus pygmaeus*, *Eragrostis atrovirens*, *Fimbristylis dichotoma*, *Gnaphalium indicum*, *Gnaphalium luteo-album* var *multiceps*, *Lippia nodiflora*, *Neptunia prostrata* or *oleracea*, *Paspalidium punctatum*, *Polycarpea corymbosa*,*Polygonum barbatum*, *Polygonum hydropiper*, *Polygonum plebeium*, *Potentilla supina*, *Rumex dentatus*, *Salvia plebeia*, *Scirpus articulatus*, *Veronica anagallis-aquatica* and are recorded at margins of the littoral zone of the lake.

In the present investigation (Table I) five major types of life forms (marshy=27, submerged=5, floating & free floating =4 each and emergent=4) were identified. In contrast, some of the plants have shown two different life forms, i.e. floating, submerged (*Aponogeton natans*); floating, emergent (*Nelumbo nucifera*) and emergent, marshy (*Sagittaria guayanensis*). Based on above observations maximum 27 species reported on saturated muddy soil of littoral zone, i.e. lake-land transition zone. They enjoy some of the best ecological conditions found in terrestrial and aquatic habitats, therefore richer in plant diversity [13]. Maximum number of plant species (39) reported in winter followed by rainy (37) and summer (27) seasons, respectively. It is mainly due to fluctuations of climatic and biotic factors.

On perusal of Table I, it is clear that *Cyperaceae* was the largest family contributing 6 species followed by *Poaceae* and *Polygonaceae* each with 4 species. In contrast, *Amaranthaceae*, *Hydrocharitaceae* were represented by 3 species each whereas *Asteraceae*, *Fabaceae, Lythraceae*, *Onagraceae* and *Nymphaeaceae* by 2 species each. The remaining families have contributed 1 species. Slightly higher number of plants in *Cyperaceae* and *Poaceae* might be due to the rhizomatous underground parts, which are well adopted to survive under poor O_2 content and propagate vegetatively and rapidly.

B. Management of 'GujarTal'

Macrophytes are common features of 'Gujar Tal' wetland ecosystem. This kind of vegetation is prerequisite to understand the structure of the lake ecosystem and plays important role in balancing it. The macrophytic vegetation plays essential role in function of ecosystem of such shallow lake. On the basis of present study and observations noted during field trips there are various steps of strategies and measures of eco reforms recommended. It all in the respect to conservation of economically important repository of the plant diversity for human use and in fish culture, enhance the production and productivity. Human being gets benefits from floral and faunal diversity. The wetland is lucrative for fishery, snails, crabs, and plant diversity is source of food, fodder, thatch and medicine etc. In lake, macrophytes provide cover for fish, substrate, and shelter for young fish and aquatic invertebrates. Macrophytes also produce oxygen and act as a food for fish and wild life. It was also observed that these abated aquatic weeds of wetland also cause harm to aquatic environment directly. Therefore, quite a few aquatic plants with their abundant growth adversely affect the human interest and create nuisance in fish culture etc. It all may be discussed under strategies of eco reforms for implementation:

(i) The aquatic weeds create a variety of problems. The presence of luxuriant excessive growth of aquatic weeds influences the management of 'Gujar Tal'. Floating and deep rooted submerged weeds produce dense mats and prevent the movement of boats. *Eichhornia crassipes* and *Eleocharis plantaginea* etc. take most of the available light and nutrients. These plants choke the water body and reduce the light intensity in subsurface layers resulting death of some of plants and fishes. The efforts of cultivation of rice and self-grown wild rice (*O. rufipogon*) during rainy season in nearby lake land transition zone are also affected by spreading of *E. crassipes* through

inundated water. It seems that native species remain less harmless in comparison to adventive species, which become dominant and weedy. Therefore, there is need of manual or physical removal of such aquatic weeds for eradication or utilization as compost manure, as *E. crassipes* has reasonably good potential for raw material manufacture. Thus harvesting may be used as a tool of ecological implication for control measures. This method causes least disturbances and has negligible side effects in comparison to use of weedicide.

Manual cleaning of aquatic weeds could be applied mostly to floating and emergent weeds. The harvested weeds removed physically from localized area of wetland may be utilized as feed, fuel and manure etc. During the course of study it was observed that the considerable infestation of nuisance floating weeds e.g. *E. crassipes,* removed by farmers some localized pockets of the lake and left to decompose on dry land of crop fields nearby lake to use as manure.

Typha angustata one of the most important emergent weeds growing on margins of lake on shallow submerged area and cutting of areal shoots of *T. angustata* at flowering stage for different traditional uses by local people is common practice. This practice must be encouraged for creating 'Gujar Tal' as a healthy wetland for fisheries. Herbivore fish species like C*tenopharyngodon idella* (Grass carp), *Puntius pulchellus* and *P.dobsonii* are voracious feeder of submerged aquatic weeds may be used as a tool of biological control.

(ii) Peripheral emergent zone of 'Gujar Tal' is mostly occupied by self-grown wild rice '*O. rufipogon'* commonly known as 'Tinni rice'. Its yield was observed 85 kg per hectare. The rice sold in the market at Rs 100 to 150 per kg. It is a good source of income of local inhabitants and also provide habitat for rearing of duck and large flocks of migratory water birds like ducks, cranes, flamingoes, ergets, lapwings etc. during winter season.

(iii) It was observed that some local people have started rearing of duck birds near the lake margin in an improvised bamboo boundary 'Barra' with polythenes which usually feed on grains of wild rice (*O. rufipogon*), insects, worms, frogs and tiny fishes in the lake. These birds are source of income to them by shelling eggs and birds. Popularization of integrated farming system of duck, poultry and pig farming with rearing of fish can be profitable venture. The efforts of local people for rearing of duck birds nearby lake must be appreciated and should get financial support by local government.

(iv) The entire 'Gujar Tal' is facing illegal theft of fishing, hunting and catching of migratory birds by their traditional methods during night (published in Danik Jagaran News Paper-Hindi Edition 31.11.2010) in spite of their legal restrictions on hunting of migratory birds. This practice must be discouraged.

(v) Flowers, leaves, and rhizomes of *Nelumbo nucifera* are good sources of income. The flower is sold at Rs 25 to 30 per hundred. It is also exported (Hindustan News Paper-Hindi Edition 25.08.2013) apart from other traditionally used plants [4]. This practice should be restricted and minimized, as there is ruthless utilization of plant resources.

(vi) There is need to create education and awareness among people about lake and its margin. There is serious threat to present 'Tal' as the area is shrinking due to anthropogenic pressure and swampification caused by massive infestation of weeds and thus water depth is reducing. Local inhabitants also do encroachment for the cultivation of crops and removal of vegetational cover for crops at lake margins. It leads to erosion and must be checked.

(vii) The raw domestic sewage should be collected and purified in 'oxidation pond' with the help of algae, fungi and bacteria near the lake margin then may be passed in mid stream of lake through pipes. This treated water will be least harmful to lake water. It is recommended that indiscriminate use of biocides and fertilizers in the surrounding crop fields should be regulated as to reduce the chances of run-off in the lake through lake margins. Thus, this large wetland should be prevented from deterioration and degradation of water quality.

(viii) Experimental farms may be established in proximity of the lake margin. Large areas of the lake may also be used for seed multiplication to collect appropriate and waterlogged varieties of rice (*Oryza sativa* Linn.) crop and good forage grasses, as there is acute shortage of fodder for cattle. During the course of study it was observed that farmers are not aware of improved varieties of deep water rice crop which are recommended by National and International Rice Research Institutes, which could be worthwhile to raise their agricultural economy. These farms may also serve as demonstration block for education of villagers.

(ix) If 'Gujar Tal' is subjected to bird's sanctuary by resolutions passed by U.P. Government of India, it may be developed as a good picnic spot for boating etc. apart from fish culture by minimizing the macrophytes of lake.

This kind of study will undoubtedly encourage the development of healthy wetland of Gujar Tal. These biotopes if managed properly may lead to material benefit of mankind and help in increasing the GDP of the nation.

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