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Diversity and distribution of macrophytes in Nagaram tank of Warangal district, Telangana state

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Abstract
Aquatic plants play an important role in aquatic systems, where they provide food and habitat to fish, wildlife and aquatic organisms. Unfortunately, some aquatic plants often become a problem by stopping uses of water and threaten the structure and function of diverse native aquatic ecosystems. Aquatic weeds are also responsible to reduce the available water resources by way of excess seepage or evapotranspiration process. When seasonal fluctuations occurred, the diversity of aquatic plants is drastically changed and also it blocked the drainage canals of the colonies and irrigations canals badly due to its profuse growth. In the present study, a total of 25 macrophytes were recorded from littoral and sub-littoral zones of the tank at four selected sampling stations. With the floating species like *Hydrilla spp*. and *Lemna spp*. were dominant at all sampling stations. Among the rooted floating species *Nymphea spp*. and *Nelumbo spp.* recorded from all sampling stations. In sub-merged macrophytes, *Ceratophyllum demersum* and *Utricularia spp*. were recorded. An intensive survey of the infestation of the waterways by the aquatic weed populations in the study area documented. This study provides new baseline information on the diversity, distribution and interspecific associations of floating-leafed and submersed aquatic plants in Nagaram tank that will be useful for managing and or controlling the plant species.

Keywords: Aquatic plants, Submerged, Floating species, Diversity and Water resources

1. Introduction
Aquatic weeds are unwanted plants in ponds, lakes, reservoirs and other perennial water bodies, causing economic as well as ecological losses by adversely affecting the aquatic ecosystem, irrigation, navigation, public health and last but not the least, the fisheries development of any nation. Intensive utilization of natural water resources (construction of dams and canals), increased nutrient load and pollution (due to domestic sewage and industrial effluent discharge) and introduction of aggressive exotic plants has made aquatic weeds a menace globally. It is more pronounced in the tropical and subtropical regions where high temperature supports profuse weed growth and multiplication. Aquatic plants are among the prolific ones on earth associated with both positive and negative impact on aquaculture.

Aquatic plants grow profusely in lakes and waterways all over the worlds and have in recent decades their negative effects magnified by man's intensive use of natural water bodies. Eradication of the weeds has proved almost impossible and even reasonable control is difficult. Submersed plants in rivers and irrigation canals increase the bed and bank roughness increasing drag and decreasing flow [38]. As plant biomass increases seasonally this effect is magnified. Plant biomass displaces part of the canals cross sectional area resulting in higher water levels and increased likelihood of flooding. Floating plants increase water loss through evapotranspiration. Brezny *et al.* [6] reported evapotranspiration for water hyacinth was 130 to 150% higher than evaporation from a free water surface under equivalent conditions while Timmer and Weldon [55] reported values 370% higher than a free water surface. In irrigation canals and drainage ditches, they slow or prevent water movement increasing the likelihood of flooding. Floating plants clog waterways, plug water pumps, stop or slow boat traffic, close marinas, prevent access for fishing, prevent water access by waterfowl and wildlife, and causes an increase in mosquitoes [52].

On the other hand over growth of these plants adversely affects aquaculture productivity as they take up the available nutrients from the water body, affect plankton production, interfere with sunlight penetration, create extreme dissolved oxygen variations between day and night, give shelter to harmful insects and fish predators, require large amount of oxygen for

decomposition after death leading to harmful dissolved oxygen levels, lower down water pH (due to liberation of carbon dioxide during respiration and decomposition) and interferes with fish movements and fishing operations. Many aquatic weeds (sea weeds) are known to produce products of industrial importance (agar, alginates, carrageenan) and are cultured commercially world over and developed as an independent enterprise. Many aquatic plants (water hyacinth, water lettuce, duckweeds) possess great potential for phyto-remediation (bio-remediation) of polluted/waste water due to their natural ability to remove toxicants effectively [35]. Hence, the prospects of converting aquatic weeds into much needed food, fertilizers, bio-filters, fuel and raw material for important industries are bright due to their vast availability in India. As different possibilities for utilizing aquatic weeds in some productive manner are discussed, they will be referred as 'aquatic plants' instead of 'aquatic weeds'. The presences of these unwanted and undesirable aquatic plants certainly pose serious threat to the productive potential of the aquatic body. The problem of weeds in fishery waters in more acute in tropical and subtropical countries than the temperature countries. However, aquatic weeds now pose a 'global problem'.

Freshwater ecosystems are an integral part of a geographical region. These systems provide habitats for many plant species, fishes, birds, insects, and others animals. Their interaction with physical factors results in a balanced ecosystem, with plants providing food and shelter for other organisms that live in and close to the water. Thus, the plants in a water body may influence not only the aquatic system but also the surrounding areas. 12% of all animal species live in freshwater ecosystems and many more species are closely associated with these ecosystems [61]. Over 140 species of plants have been reported to act as aquatic weeds both within and around various kinds of aquatic bodies in India. The states comprising west Bengal, Orissa, Bihar, Assam, Tripura and Manipur have the maximum incidence of weed infestation ranging from 40-70%, whereas in other states it many range between 20-5% [37]. In 1951 fisheries in West Bengal had suffered a loss of 45 million kg of fish per year due to excessive water hyacinth in 1.5 lakh hectares of water area. Aquatic macrophytes are classified into Planktonic algae, Filamentous algae, and Surface floating weeds, Emergent Weeds, Submerged Weeds and Marginal Weeds. Because of the major impact of the littoral vegetation on the metabolism of a majority of lake system and a necessary brief resume of the main aspect of macrophytes morphological and physiological adaptation is required in order to appreciate their role in the productivity of fresh water [60]. The macrophytes are well known to antagonize the planktonic population of the lake, there by the shed effect due to the surface area coverage or by high growth rate resulting in nutrient deficiency. Abbasi [1] worked on renewable energy from aquatic biomass. The floating and emergent vegetation in the lake results in to successional changes and relishes a higher nutrient station [48].

Aquatic plants are important as they supply food, shade and shelter for many aquatic organisms. Aquatic plants serve as a substratum to the different micro and macro fauna. These organisms select roots, stems, leaves etc. of floating and submerged macrophytes for attachment. At international level scientists have contributed in the work of phytoplankton diversity. Studies of different aspects related to aquatic invertebrates were done by different scientist like Rosine [42] gave the distribution of invertebrates on submerged aquatic plant surfaces in Muskie lake, Caloroda. Peter [36] observed population changes in aquatic invertebrate living on two water plants in tropical man-made lake. While, Muragesan and Sukumaran [30] gave sustained management of nuisance weeds of freshwater habitats by the utilization as viable resource for multivarious application. Singh *et al.* [51] studied periphyton from pond of Pantnagar and Manmade Lake respectively. The importance of various factors of the surrounding medium on macrophytes growth on productivity has been discussed by many workers [17, 43, 16, 50, 41, 15, 56].

Macrophytes, plants observable by the naked eye, are an important component of aquatic ecosystems. The tolerance limit of aquatic macrophytes is linked with the chemical and physical quality of water [14]. It is therefore, possible to quantify environmental changes of a wetland by the analysis of these plants. Changes in the community composition, or the abundance of individual species, provide valuable information on how and why an ecosystem might be changing [46]. Kumar and Pandit [24] have worked community architecture of macrophytes in Hokasar wetland, Kashmir. Raut *et al.* [40] observed survey of biodiversity of plankton attached to macrophytes from need infested lakes. Anon [4] described about the sea weed cultivation. Uka and Chukwuka [59] studied effect of water hyacinth infestation on the physico-chemical characteristics of AWAB reservoir, Ibadan, Nigeria. Meera *et al.* [27] worked on aquatic weeds as resource of multiple utility. Raju *et al.* [39] proved that Lemna Minor is a suitable aquatic plant for phytoremediation of domestic waste water, which improved the quality of domestic waste water by absorbing organic and inorganic pollutants.

In fact, the present of certain aquatic plants are frequently desirable in fish ponds. Any slackness in controlling their excessive growth dimensions productivity of the water by utilizing the nutrients or cheeks the penetration of sunlight by shading, may lead to eight super saturation or depends of Oxygen. Heavy weed infestation restricts the living space for fishes, fishing operations, gradual siltation and also provides shelter for unwanted fauna and parasites, which make their appearance and harm the existing fish population. Moreover, aquatic weeds provide harbouring place to predatory and week fishes which are profuse feeders and prolific breeders and over populate themselves. These factors limit the available foods to the cultivable carp species resulting into less fish production. Gases like H_2S and CH_4 are formed by aquatic weeds, which are harmful to fishes. On the other hand, presence of aquatic weeds in small numbers is desirable because they from natural food for many fishes [25]. Also they are good source for organic slime at pond bottom and help in maintaining good oxygen supply. They form food fertilizers in the pond when decayed. This study provides new baseline information on the diversity, distribution and interspecific associations of floating-leafed and submersed aquatic plants in Nagaram tank that will be useful for managing and or controlling the plant species.

2. Materials and methods

Study area:

Physiography: Warangal district is a part of the Northern Telangana of Telangana State. It lies approximately between the latitude of 17°19′ and 18°13′ North latitude of and 78°49′ and 80°43′ East latitudes. The area around the city is studded with isolated hills, hill streams, rainfed tanks, large tanks and lakes. The soils of the city comprise of sandy loams with patches of shallow black cotton soils and at places even medium and deep cotton soils. In Warangal district there are

4676 tanks, the area covered under tanks in 1, 05, 627 hectares and of which Nagaram tank is the major fish producing tank.

Study Site:

Most of the water bodies in Warangal and around the city such as ponds, lakes, tanks and streams have become polluted as a consequence of increasing industrialization, urbanization and other developmental activities for the last ten years. Today many of the aquatic bodies receive thousands of liters of sewage, domestic waste, industrial and agriculture effluents containing substances varying from simple nutrients to highly toxic substances. At the same time, the water-borne waste derived from the house and animal or food processing plants are diverted into these aquatic bodies. This is causing high pollution loads in these water bodies because of rolling and porus soil. Nagaram tank located a latitude 790-34'-00" West 790-36'-00" East and longitude 180-4'-15" South – 180-5'-45" North. The water capacity of the tank is 97.42 metric cubic meters. It has a catchment area of 209.17 hectors. Four samplings stations were selected for the study.

Methodology:

Macrophytes were collected during three different seasons such as rainy, winter and summer. The survey was conducted seasonally to collect the information regarding littoral and submerged vegetation. The macrophytes were collected by land pricking from the littoral one and exposed marginal areas of the tank near to sampling stations and then brought to laboratory immediately, prepared in 10% formation and observed. The collected specimens were identified and confirmed with regional floras [1, 32, 7, 15] and regional checklist for hydrophytes [58].

3. Results and discussion

Aquatic plants serve as good source of food to mankind and animals thus forming a palatable food for water birds and a best for aquatic wild life conservation practices [20]. Aquatic vesicular plants are important indicators of water pollution [47, 49]. Many workers contributed recent aspects of production studies of macrophytes [2, 26]. But, comparatively, the productivity studies of macrophytes in the ponds situated near the industries are less [53]. The sub merged aquatic macrophytes are important constituents of water body which take up elements by well-developed root or rhizome. Aquatic plants are important as they supply food and shelter for many aquatic organisms. They serve as substratum to different micro and macro organisms [40]. According to Kudryavtsev and Yeshov [23] dead parts of the macrophytes act as excellent substrate for the development of micro-organisms.

During the period of investigation the macrophytes of the tank were observed and recorded. Total 25 macrophyte species were recorded from littoral and sub littoral zones of the tank nearby sampling stations. In the free floating macrophytes, 6 species were recorded of which *Hydrilla spp*. and *Lemna spp*. were dominant on all the sampling stations. Among rooted floating, *Nymphaea spp*. and *Nelumbo spp*. recoded from all the sampling stations. In free submerged, two species were recorded *Ceratophyllum* and *Utricularia* species showed its appearance on all the four stations. Sharma and Singhal [48] recorded 11 species of macrophytes of which 4 were floating, 5 submerged and 2 emerged from a tropical lake and recorded fluctuations in macrophytic biomass value, higher during summer (March to May) and lower during monsoon and post monsoon period (July to October). Mathew [26] recorded the biomass increase from December to the maximum in April and June showed a decline in domestically polluted tropical pond. Meshram [28] recorded dominant macrophytes as Hydrilla varticillata, Ceratophyllum spp. and Chara spp. in Wadali Lake. Das [9] reported Potamogetan pectinatus, P. natans, Polygonum, Iocharis, Ceratophyllum, Vallisnaria, Hydrilla and Lemna in the descending order of abundance from lake Nainital Kumaun. Ambasht [3] also recorded 25 species of macrophytes from Gujar Tal, Jaunpur Township North India. Kiran *et al.* [20] recorded 15 species belonging to 13 families and grouped under submerged (2 species), rooted floating (2 species), free floating (2 species), emergent (7 species), and marshy amphibious (2 species) from fish culture ponds, Karnataka. Giri *et al.*, [12] also recorded total of 84 macrophytic species belonging to 73 genera and 34 families were observed during the study period. Among these, 55 terrestrial plants (66%), 11 aquatic plant species (13%) and 18 semi aquatic plant species (21%) have been found. Murphy [29] found that the highest macrophytes diversity was observed in mesotrophic to slightly entrophic lakes. In the present investigation, Azolla spp. and Vallisnaria spp. were recorded only from Station-4 and Station-3. Narayana and Somashekar [33] considered Vallisnaria spiralis and Azolla spp. that prefer unpolluted sites and domestic wastes. The presence of mostly pollution free macrophytic species from sites Station-1 and Station-3 showed their mild or pollution free status.

The Nagaram tank is surrounded by agricultural plains with scanty tree growth. The entire vegetation of' this area can be classified as Terrestrial vegetation and Aquatic vegetation (Table No. 1). Aquatic vegetation can be studied with emergent, submerged and free floating.

Hydrophytes

Emergent Plants: These plants grow on the exposed or semi-submerged soils. Plants produce serial reproductive and vegetative organs, which are *Typha augustatus, Vallisneria spiralis.*

Submerged plants: These plants grow in below the surface of water and the plants identified in Nagaram Tank, *Hydrilla verticillata.*

Free Submerged plants: Ceratophyllum demersum and *Utricularia spp.*

Free floating hydrophytes: These occur on standing and slow flowing waters. *Pistia stratiotes* and *Azolla pinnata.*

Terrestrial vegetation

Nagaram tank is covered by dominant trees of Neem, Acacia arabica. In this tank *Eichhornia crassipura, Ipomea spp.* and *Vallisneria spiralis* forming thick mats in the stagnant water. The shallow water is getting enriched with high bottom sediments which are the ideal habitat for luxuriant growth of aquatic plants.

Table 1: The Diversity of Macrophytes in Nagaram tank During June, 2012 to May, 2015

Sl. No.	Name of the Macrophytes	Rainy				Winter				Summer			
		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
1	*Ipomea pisulosa*	+	+	+	+	+	+	+	+	+	+	+	+
2	*Ipomea aquatica*	+	+	+	+	+	+	+	+	+	+	+	+
3	*Eichhornia crassipura*	+	+	+	+	+	+	+	+	+	+	+	+
4	*Hydrilla verticillata*	+	-	-	-	-	-	+	+	+	+	+	+
5	*Chara zeylanica*	+	+	-	-	-	-	-	+	+	+	+	+
6	*Ceratophyllum demersum*	+	+	-	-	+	+	+	+	+	+	+	+
7	*Spherodela polyrhiza*	+	+	-	-	+	+	+	+	+	+	+	+
8	*Nymphoides hydrophylla*	+	+	-	+	+	+	+	+	+	+	+	+
9	*Vallisneria spiralis*	-	-	-	-	-	-	+	+	+	+	+	+
10	*Potamogeton orispus*	+	+	-	-	+	+	-	+	+	+	+	+
11	*P.pestinata*	-	-	-	-	+	+	-	+	+	+	+	-
12	*P.perfoliatus*	+	+	-	-	+	+	-	+	+	+	+	+
13	*Sagitaria sgittiphotia*	-	-	+	+	-	-	-	+	+	+	-	-
14	*Utricularia spp.*	-	+	-	-	+	+	+	-	-	-	-	-
15	*Lymnophyton*	+	+	-	-	+	+	+	-	-	+	+	+
16	*Mucoria vaginalis*	-	-	-	-	+	+	+	-	-	-	-	-
17	*Nymphaea pubescens*	+	+	+	-	-	+	+	+	+	+	+	+
18	*Alternam thera philoxiroides*	+	+	-	-	+	+	+	+	+	+	+	+
19	*Typha angustata*	+	+	+	+	+	+	+	+	+	+	+	+
20	*Ottilia elismoides*	-	-	-	-	-	-	-	-	+	+	+	+
21	*Marcelia spp.*	+	-	-	+	+	+	+	+	+	+	+	+
22	*Pistia stratiotes*	+	+	+	+	+	+	+	+	+	+	+	+
23	*Cyperus spp.*	-	-	+	+	+	+	+	+	+	+	+	+
24	*Cynodon dactylon*	-	-	-	-	-	+	+	+	+	+	+	+

(+)=Present.
(-)=Absent.

Kiran [21] recorded a total of 13 species belonging to 11 families. Species among plant, indicative of organic enrichment as Pistia stratiotes, Alternanthera philoxeroides and Commelina sp. were found in large population. Pistia stratiotes and Alternanthera philoxeroides were regarded as pollution tolerant aquatic macrophytes and be used as a biological indicator for eutrophication. It indicates that, aquatic macrophyte species are specific to the environmental quality. Dana Ahmed Mohammed Barznji [8] stated that the Aquatic plants have a remarkable capability to remove excessive nutrients load form the water otherwise cause eutrophication of the water body. They have also been used to mitigate heavy metals, toxic organics, suspended solids and bacteria from agricultural outcome, landfill, acid-mine drainage and urban storm water runoff. In addition, the aquatic plants, indirectly helping some materials to sediment and suspend them through slowing the water current and thus affecting metal retention in water bodies. Saravana Kumar and Prabhakaran [45] reported an intensive survey of the infestation of the water ways by the aquatic weed populations, provides new baseline information on the diversity, distribution, and interspecific associations of floating-leafed and submersed aquatic plants in Veeranam command area that will be useful for managing and or controlling the plant species. Additionally the similar observations were reported by Muthulingam *et al.* [31] and Udayakumar and Ajithadoss [58] in five ephemeral lakes of Thiruvallur District, Tamil Nadu. They noticed that *Marsilea quadrifolia*, *Cyperus rotundus*, *Cyperus iria* mostly grow during summer in low depth areas in the channels. The pollution indicator species such as Eichhornia crassipes, Pistia stratiotes also recorded which indicate eutrophication [57]. Raju *et al.* [39] proved that Lemna minor is a suitable aquatic plant for phytoremediation of domestic waste water, which improved the quality of domestic waste water by absorbing organic and inorganic pollutants.

The studies on Ichthyofaunal diversity from different fresh water bodies of India have been carried out during the last few decades [5, 10, 18, 19, 22, 54]. The main source of pollution is due to runoff water from agriculture fields in the rainy season carrying inorganic fertilizers, toxic pesticides and other chemicals enter in the channels. Narayana and Somashekar [33] noticed that the physico-chemical characters influenced the growth of species, distribution, indicator group and pollution tolerant species. Nichols *et al.* [34] found that the vegetation responses to environmental factors are not always linear. Sangeeta [44] evaluated that the usefulness of different macrophytic species (Bio-filters) in reducing the nutrient content of the water i.e. to reduce the pollution level of water. Meera *et al.* [27] stated that aquatic weeds as "Resources of Multiple utility" i.e., Aquatic plants as fish feed, total fish feed, fish feed ingredients, as feed for other animal, human food and fertilizers for fuel production, and also a bio- control agent. Controlled growth of vegetation in fish ponds is usually beneficial to fishes. It helps in maintenance of healthy pond life and the eco physiography of the pond. Some of the submerged weeds are good oxygen generators. Moreover, they provide shelter to fish food organisms particularly the insect larvae. They also absorb inorganic components from the soil, water or atmosphere and bring them in to the food chain of the pond ecosystem. The marginal weeds are also beneficial in checking the erosion in pond exposed to wind and wind action, thus reducing the turbidity. In the view of the above facts, the aquatic macrophytes in Nagaram tank were estimated during the study period.

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