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Investigation of aquatic vascular flora at Sadullapur Upazila of Gaibandha District, Bangladesh

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Abstract

The present article focused on aquatic vascular plants diversity and their conservation status in natural and manmade wetlands habitats of Sadullapur Gaibandha. The study was conducted in between May 2019 to June 2020. A total of 52 aquatic plant species was recorded from Sadullapur Gaibandha in the present study. These are assigned to 35 genera under 30 families. For each species scientific name, local name, family, division, habit, habitat, use and status are provided. Ecological habitats analysis of aquatics shows variations. Among them, 37% species prefers to grow near the edge of water, 13% submerged, 11% as emergent, 11% as free floating and 28% as rooted floating in the aquatic habitat. In case of submerged species, they produce flowers on surface of the water. After pollination fruits remain under water up to maturation. Among them, 49% species used as fodder, 22% as medicinal, 4% as aquarium purpose, 9% as vegetable, 6% as edible, 10% as fish food in the study area. The population number of different aquatic plant species in habitats is not uniform. Overall analysis showed that 46% aquatic plant species in the study area found to be rare, 44% species found common and 10% species found as abundant. This status of aquatic plant species is very preliminary. Based on field observations and discussion with local people we are able to identify a good number of rare aquatic plants and also pointed some conservation measures for them in future. The investigation recorded a number of rare aquatic plant species from the study area. These are *Trapa bispinosa* (Singara), *Nelumbo nucifera* (Paddo), *Nymphaea pubescens* (Sada shapla), *Oenanthe javanica* (Panidhone), *Nymphaea rubra* (Lal shapla), *Ottelia alismoides* (Panikola), *Enhydra fluctuans* (Titidata) and *Centrostachys aquatica* (Thuash). Populations of such species in the wild are very rare because of local demand for the use. These species need to be cared for conservation.

Keywords: Species diversity; Aquatic vascular plants; Gaibandha district; Bangladesh

1. Introduction

The majority of our terrestrial ecology relies on plant variety. We are all completely reliant on plant diversity, both directly and indirectly, for not only food energy but also for all of our everyday needs. Humans employ tens of thousands of higher plant species and a few hundred lower plant species for a range of reasons, including food, fuel, fiber, oil, herbs, spices, industrial crops, and pasture and fodder for domesticated animals. People in tropical areas have employed between 25000 and 30000 plant species, with up to 25000 species being used in traditional remedies [70]. Thousands of species are also cultivated for decorative purposes in parks, public and private gardens, as avenue trees, and for shade and shelter. Plant variety also plays a vital part in ecosystem services, such as providing a clean environment, protecting watersheds, stabilizing slopes, improving soils, regulating climate, and providing habitat for most of our wild wildlife. Currently, humans are posing a significant danger to plant variety across the planet. Urbanization, commercial agriculture, tree plantations, logging and timber extraction, mining and transportation, pollution, overharvesting, tourism, biological invasion, and alien monoculture plantings are all examples of human-caused concerns. Natural catastrophes and other natural occurrences have an influence on plant diversity in various ecosystems.

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The study of aquatic plant diversity is critical because it offers a baseline for comparison following habitat alteration and for tracking changes in biodiversity over time. The results of the survey can be used to identify uncommon, imperiled, foreign, native, pest, and therapeutic plant species. The survey results are now being utilized to assess the possible impact of proposed projects and to inform management programs in order to make biodiversity protection decisions. Students, researchers, biodiversity management planners, social foresters, NGOs, District gazetteers, and other enthusiastic plant enthusiasts want data on water plant variety.

Plant diversity exploration and documentation in various forests, protected areas, districts, and upazilas has already begun [2], [3], [5-6], [9-16], [19-65], [71-72], [74-91], [93-94] and [96-106]. The South Asian subcontinent has a large number of publications on water plants [66], [67], [68], [69], [92], [95]. In Bangladesh, researches on aquatic plants have been identified for the districts of Kishoregonj and Noakhali, as well as the Rajshahi university campus [48], [67] and [76]. However, for the Gaibandha district, no comparable aquatic plant survey and documentation activity has been discovered. Dams and diversion, modern agriculture, irrigation, pollution, and biological invasion are all contributing to the fragility of aquatic environments. Species are fast becoming extinct due to a lack of scientific record.

2. Material and methods

2.1. Study area

Sadullapur is an upazila of Gaibandha District in the Division of Rangpur, Bangladesh. Sadullapur is located at 25.3833°N 89.4667°E. It has 47,102 homes and a total area of 227.97 km². As of the 1991 Bangladesh census, Sadullapur has a population of 243,012. Males constitute 50.4% of the population, and females 49.6%. The upazila's adult population, over 18 years, is 117,347. Sadullapur has an average literacy rate of 25.1% (7+ years), below the national average of 32.4%. The literacy rate of this upazila is 89.3. Sadullapur Upazila is divided into 11 union parishads: Bongram, Damodorpur, Dhaperhat, Faridpur, Idilpur, Jamalpur, Kamarpara, Khodkomor, Noldanga, Rasulpur, and Vatgram. The union parishads are subdivided into 166 mauzas and 169 villages [4].

2.2. Methodology

The work is based on fresh materials collected during twenty six visits to Sadullapur upazila of Gaibandha district, Bangladesh from May 2019 to June 2020 to cover the seasonal variations. The visits covered aquatic habitats in the study area. Plant parts with either flowers or fruits were collected using traditional herbarium techniques to make voucher specimens for documentation [73].

2.3. Identification

Collected aquatic species were authentically identified with the help of various books [1], [7] and [18]. For the current name and up-to-date nomenclature [8] and [17] were also consulted.

3. Results

A total of 52 aquatic plant species were discovered during the current investigation of Sadullapur Gaibandha's aquatic habitats. These species are divided into 35 genera, which are divided into 30 families (Table 1). Aside from these, the research region also had other water-tolerant tree species. Hijal [*Barringtonia acutangula* (L.) Gaertn.], Koranja [*Pongamia pinnata* (L.) Pierre], Pidali [*Trewia nudiflora* L.], Dumur [*Ficus hispida* L. f.], Jalibet [*Calamus guruba* Buch.-Ham.], Shitalpati [*Schumannianthus dichotomus* (Roxb.)]. During the monsoon, they can withstand water logging.

Table 1 Total number of Monocotyledons and Dicotyledons and Pteridophytes in case of wetlands in Sadullapur Gaibandha

Categories	Dicotyledons	Monocotyledons	Pteridophytes	Total
Number of families	17	12	01	30
Number of genera	16	18	01	35
Number of species	29	21	02	52

The scientific name, local name, family, division, habit, habitat, usage, and status of each species are listed (Table 2). The findings are preliminary, and future research might lead to an increase in the number of aquatic plant species in the

district. Variations in aquatic plant species' ecological environments have been discovered. In the aquatic habitat, 37 percent like to grow along the water's edge, 13 percent as submerged, 11 percent as emergent, 11 percent as free floating, and 28 percent as rooted floating (Figure 3). Flowers are produced on the water's surface by submerged species. Fruits are kept under water until they reach maturity after pollination. Aquatic plant species have a wide range of life forms. Herbs account for 94% of all species, while shrubs account for the remaining 6% (Figure 2).

In my research, I documented the utilization of a variety of aquatic plant species. In the research region, 49 percent of the species were utilized as fodder, 22 percent as medicinal, 4% as aquarium plants, 9% as vegetables, 6% as edible, and 10% as fish food (Figure 4). Monocots make up 41 percent of the species, Dicots make up 55 percent, and Pteridophytes make up 4% (Figure 1). Poaceae and Cyperaceae (monocot) have the most species (3 and 4), followed by Hydrocharitaceae, Pontederiaceae (three species), Araceae (one species), and the rest (one species) (Figure 6).

In Magnoliopsida (dicot) the largest families are Onagraceae and Nymphaeaceae contains 4 and 2 species, Lentibulariaceae, Amaranthaceae contains 3 and 2 species, Lythraceae, Polygonaceae, Menyanthaceae, Acanthaceae and Convolvulaceae contains 2 species and rest families contains 1 species (Figure 7) and Pteridophytes contains 1 family Azollaceae contains 2 species. The population number of different aquatic plant species in habitats is not uniform. My overall analysis showed that 46% aquatic plant species in the study area found to be rare, 44% species found as common and 10% species found as abundant (Figure 5). The present inventory of aquatic plant species is very preliminary. Further long term survey is necessary to make complete list of aquatic plant species of Sadullapur Gaibandha.

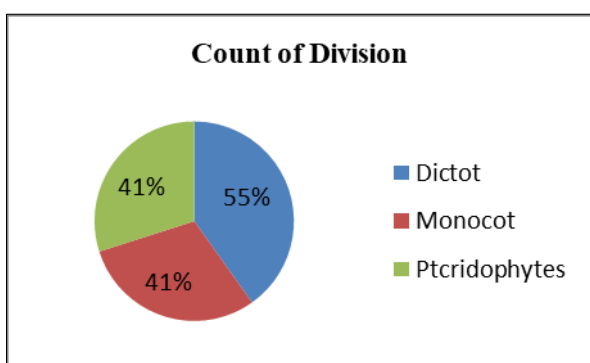


Figure 1 Percentage of plant species in Monocot, Dicot and Pteridophytes

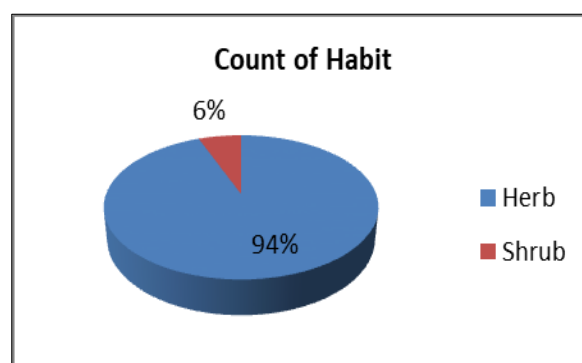


Figure 2 Vegetation analysis of the species based on habit

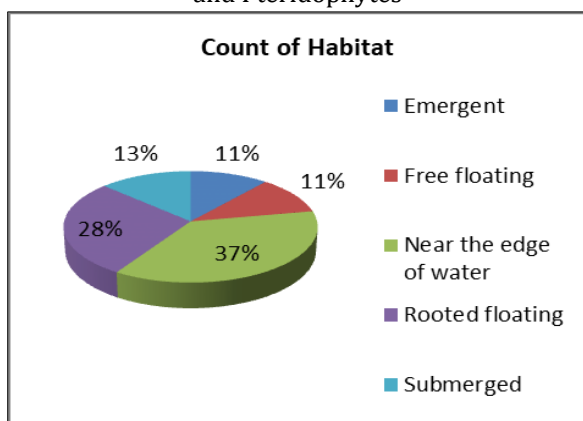


Figure 3 Pie chart showing the percentage of plant species in different habitats

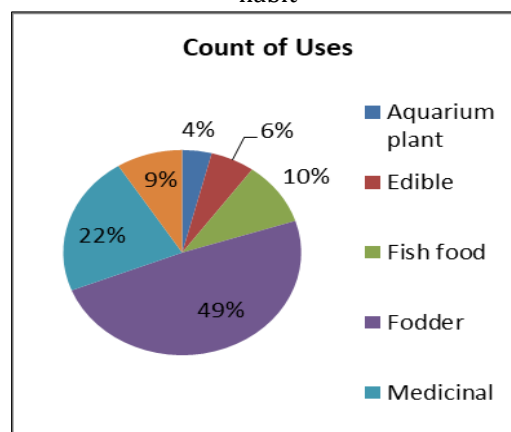


Figure 4 Pie chart showing the uses of the species

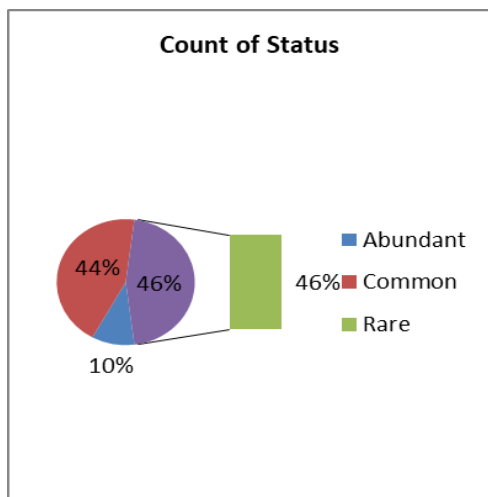


Figure 5 Pie chart showing the status of the aquatic plant species

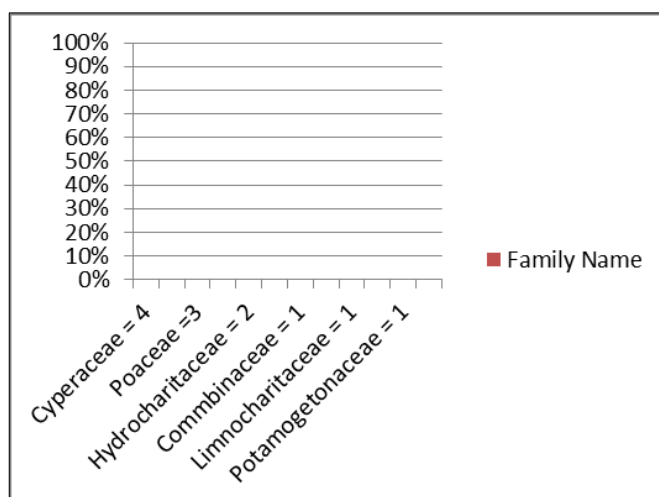


Figure 6 An analytical data showing dominant monocot families along with genera and species

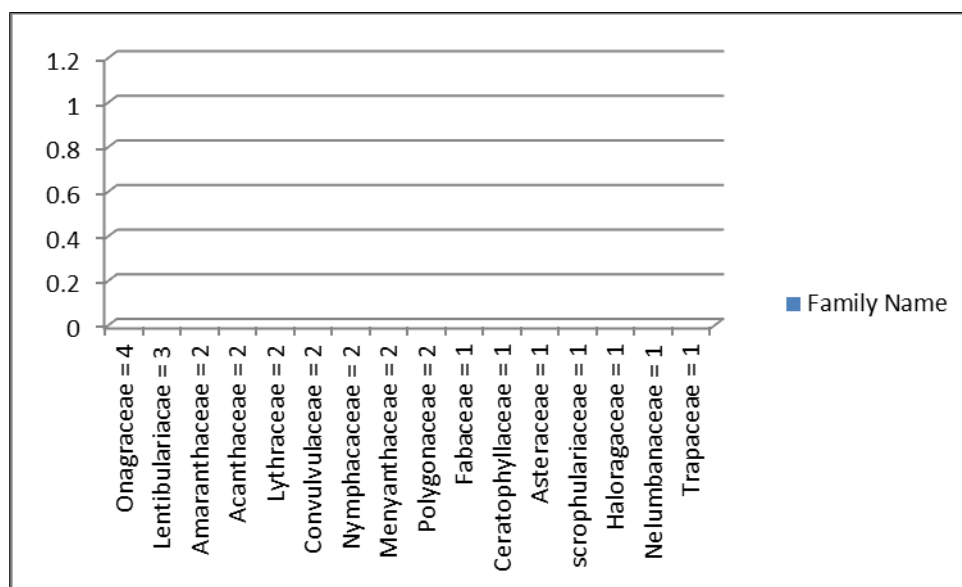


Figure 7 An analytical data showing dominant dicot families along with genera and species

Table 2 Aquatic plant species with scientific name, local name, family name, division, habit, habitat, use and status

Scientific Name	Local Name	Family Name	Division	Habit	Habitat	Use	Status
<i>Actinoscirpus grossus</i> (L. f.) Goetgh. & D.A Simpson	Kasura	Cyperaceae	Monocot	Herb	Near edge of water	Fodder	Common
<i>Aeschynomene indica</i> L.	Bhathsola	Fabaceae	Dicot	Shrub	Near edge of water	Fodder	Rare
<i>Alloteropsis cimicina</i> (L.) Stapf	Unknown	Poaceae	Monocot	Herb	Emergent	Fodder	Common

<i>Alpinia nigra</i> (Gaertn.) Burt.	Tara	Zingiberaceae	Monocot	Shrub	Near the edge of water	Medicinal	Rare
<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Helencha	Amaranthaceae	Dicot	Herb	Emergent	Medicinal	Common
<i>Alternanthera sessilis</i> (L.) R. Br. ex Roem. & Schult.	Hainsashak	Amaranthaceae	Dicot	Herb	Emergent	Medicinal	Common
<i>Ammannia alternifolia</i> H.Perrier.	Red Ammannia	Lythraceae	Dicot	Herb	Submerged	Aquarium plant	Rare
<i>Ammannia gracilis</i> Guill. & Perr.	Red Ammannia	Lythraceae	Dicot	Herb	Submerged	Aquarium plant	Rare
<i>Azolla filiculoides</i> Lamarck	Lal Khudipana	Azollaceae	Pteridophytes	Herb	Free floating	Fish food	Abundant
<i>Azolla pinnata</i> R. Br.	Lal Khudipana	Azollaceae	Pteridophytes	Herb	Free floating	Fish food	Abundant
<i>Brachiaria distachya</i> (L.) Stapf	Cori ghas	Poaceae	Monocot	Herb	Near the edge of water	Fodder	Common
<i>Brachiaria mutica</i> (Forssk.) Stapf	Nardul	Poaceae	Monocot	Herb	Near the edge of water	Fodder	Common
<i>Ceratophyllum demersum</i> L.	Kanta jhangi	Ceratophyllaceae	Dicot	Herb	Submerged	Fodder	Rare
<i>Colocasia esculenta</i> (L.) Schoott	Kachu	Araceae	Monocot	Herb	Near the edge of water	Vegetable	Common
<i>Commelina benghalensis</i> L.	Dholpata	Commelinaceae	Monocot	Herb	Emergent	Fodder	Rare
<i>Cyperus alopecuroides</i> Rottb.	Chancha	Cyperaceae	Monocot	Herb	Near the edge of water	Fodder	Common
<i>Cyperus laxus</i> Lamk.	Unknown	Cyperaceae	Monocot	Herb	Near the edge of water	Fodder	Common
<i>Eichhornia crassipes</i> (Mart.) Solms	Kachoripana	Pontederiaceae	Monocot	Herb	Free floating	Fodder	Abundant
<i>Enhydra fluctuans</i> Lour.	Titidata	Asteraceae	Dicot	Herb	Near the edge of water	Vegetable	Rare
<i>Hydrilla verticillata</i> (L. f.) Royle	Kanjil	Hydrocharitaceae	Monocot	Herb	Submerged	Fodder	Rare

<i>Hygrophila erecta</i> (Burm. f.) Hochr	Unknown	Acanthaceae	Dicot	Herb	Near the edge of water	Fodder	Common
<i>Hygrophila phlomoides</i> Nees	Unknown	Acanthaceae	Dicot	Herb	rooted floating	Fodder	Common
<i>Ipomoea aquatica</i> Forssk.	Kalmi Shak	Convolvulaceae	Dicot	Herb	Near the edge of water	Vegetable	Common
<i>Ipomoea fistulosa</i> Mart. ex Choisy	Dhol kolmi	Convolvulaceae	Dicot	Shrub	Near the edge of water	Medicinal	Common
<i>Kyllinga microcephala</i> Steud.	Nirbishi	Cyperaceae	Monocot	Herb	Emergent	Fodder	Common
<i>Lemna perpusilla</i> Torrey	Khudipana	Lemnaceae	Monocot	Herb	Free floating	Fish food	Common
<i>Limnocharis flava</i> (L.) Buchen.	pani kala	Limnocharitaceae	Monocot	Herb	Near the edge of water	Fodder	Abundant
<i>Limnophila heterophylla</i> (Roxb.) Benth.	Unknown	Scrophulariaceae	Dicot	Herb	Near the edge of water	Fodder	Rare
<i>Ludwigia adscendens</i> (L.) Hara	Kesara-dum	Onagraceae	Dicot	Herb	Emergent	Medicinal	Common
<i>Ludwigia hyssopifolia</i> (G. Don) Exell	Molsishak	Onagraceae	Dicot	Herb	Rooted floating	Medicinal	Common
<i>Ludwigia perennis</i> L.	Unknown	Onagraceae	Dicot	Herb	Rooted Floating	Medicinal	Rare
<i>Ludwigia prostrata</i> Roxb.	Unknown	Onagraceae	Dicot	Herb	Rooted Floating	Medicinal	Rare
<i>Monochoria hastata</i> (L.) Solms	Baranukha	Pontederiaceae	Monocot	Herb	Rooted Floating	Fodder	Common
<i>Monochoria vaginalis</i> (Burm. f.) C.Presl	Sarkachu	Pontederiaceae	Monocot	Herb	Rooted floating	Fodder	Common
<i>Myriophyllum tetrandrum</i> Roxb.	Unknown	Haloragaceae	Dicot	Herb	Free floating	Fodder	Common
<i>Najas gracillima</i> (A. Br. ex Engelm.) Magnus	Unknown	Najadaceae	Monocot	Herb	Submerged	Fish food	Rare
<i>Nechamandra alternifolia</i> (Roxb. ex Wight) Thw.	Rasnajhangi	Hydrocharitaceae	Monocot	Herb	Submerged	Fish food	Rare
<i>Nelumbo nucifera</i> Gaertn.	Padma	Nelumbonaceae	Dicot	Herb	Rooted Floating	Medicinal	Rare

<i>Nymphaea nouchali</i> Burm. f.	Nilpaddo	Nymphaeaceae	Dicot	Herb	Rooted Floating	Edible	Rare
<i>Nymphaea rubra</i> Roxb. ex Andr.	Lal shapla	Nymphaeaceae	Dicot	Herb	Rooted floating	Edible	Rare
<i>Nymphoides hydrophylla</i> (Lour.) Kuntze	Panchuli	Menyanthaceae	Dicot	Herb	Footed floating	Fodder	Common
<i>Nymphoides indicum</i> (L.) Kuntze	Chandmalla	Menyanthaceae	Dicot	Herb	Rooted floating	Fodder	Common
<i>Oenanthe javanica</i> (Blume) DC.	Panidhone	Apiaceae	Dicot	Herb	Near the edge of water	Vegetable	Rare
<i>Persicaria glabra</i> (Willd.) M. Gomez	Lal-kukri	Polygonaceae	Dicot	Herb	Near the edge of water	Medicinal	Rare
<i>Persicaria hydropiper</i> (L.) Delarbre	Bishkaatali	Polygonaceae	Dicot	Herb	Near the edge of water	Medicinal	Rare
<i>Pistia stratiotes</i> L.	Topapana	Araceae	Monocot	Herb	Near the edge of water	Fish food	Abundant
<i>Potamogeton crispus</i> L.	Unknown	Potamogetonaceae	Monocot	Herb	Near the edge of water	Fodder	Common
<i>Sagittaria guayanensis</i> Kunth	Kaowathukri	Alismataceae	Monocot	Herb	Rooted floating	Fodder	Rare
<i>Trapa bispinosa</i> Roxb.	Singara	Trapaceae	Dicot	Herb	Free floating	Edible	Rare
<i>Utricularia aurea</i> Lour.	Jhangi	Lentibulariaceae	Dicot	Herb	Rooted floating	Fodder	Rare
<i>Utricularia inflexa</i> Forssk.	Panijhangi	Lentibulariaceae	Dicot	Herb	Rooted floating	Fodder	Rare
<i>Utricularia scandens</i> Benj.	panijhangi	Lentibulariaceae	Dicot	Herb	Rooted floating	Fodder	Rare

4. Discussion

The wetlands in Gaibandha district yielded a total of 52 aquatic plant species, divided into 35 genera and 30 families. Magnoliopsida (Dicots) has 17 families, 17 genera, and 29 species, while Liliopsida (Monocots) has 12 families, 18 genera, and 21 species, and Pteridophytes has 1 family, 1 genus, and 2 species, which is higher than Magnoliopsida (Dicots). [76] Discovered 22 species in Bangladesh's Noakhali Sadar, divided into 16 families and 21 genera. The greatest families in Magnoliopsida are Nymphaeaceae and Onagraceae, which have 2 and 4 species each, whereas the largest families in Liliopsida are Cyperaceae and Poaceae, which contain 4 and 3 species each, comparable to [90]. Asteraceae (7 species) in Magnoliopsida and Poaceae (7 species) in Liliopsida are the two biggest families, according to [90]. In Magnoliopsida, [94] identified the biggest Fabaceae family (23 species) and Poaceae (16 species) in Liliopsida.

Emergent (Emergent plants grow in shallow waters and situations near water bodies where water recedes), free floating (Floating plants are found on the surface of large, deep, and shallow depths of water bodies), and aquatic (Aquatic plants are found in the surface of large, deep, and shallow depths of water bodies. Some plants in this environment float freely and travel large distances, while others float on the water's surface but attach to soil beneath the water's surface), submerged (species germinate, sprout, develop, and reproduce beneath the water's surface).

Their reproductive organs and roots stay in the soil at the bottom of the water body), rooted floating (species that float on the top but are rooted on the bottom), and certain species that grow along the water's edge. During the study period, 6 species were emergent, accounting for 11% of all plant species, 6 species were free floating, accounting for 11% of all plant species, 7 species were submerged, accounting for 13% of all plant species, 15 species were rooted floating, accounting for 28% of all plant species, and 19 species were found near the edge of water bodies, accounting for 37% of all plant species, which is higher than Basak et al [67] Four species are floating, four are emergent, and two are submerged, according to the data. Some species are economically significant and have a positive impact on the local community.

Ipomoea aquatica (Kalmi shak) is one of them, and it is utilized as a vegetable. Locals grow it in a swamp and sell it near the market. It was given the name *Schumannianthus dichotomus* in the area. Patipata, a water-tolerant plant, can be seen growing around the edges of ponds and other bodies of water. The plant is worth a lot of money. It was first planted by the Bangladesh Forest Department on a commercial plot of wet forest lands. The peel of the plant's stem is used to make a fine mat. Mats are used as a bed cover, a wall mat, and a material for handicrafts. The plant is flourishing despite its lack of attention. It has the ability to regenerate through sprouting. It will continue to grow from generation to generation after you have planted it. The juice of the leaves is used by the locals to treat ear ache. Sheetolpati is well-known in the broader Sylhet region, as you are all aware. *Nelumbo nucifera* (padma) is a plant that is used to treat hair problems and is known as takpata by the locals. The species' blossom is particularly huge and spectacular. Diabetic patients love the seeds of such plants. Helencha *Alternanthera philoxeroides* is a vegetable that is also used as cow feeding. *Oenanthe javanica* (Panidhone) is a plant that is used as a vegetable and is commercially significant.

Aquatic *Centrostachys* Thuash, as it is known locally, is also commercially significant and is grown as a vegetable by men in marshes. Stems are offered as a vegetable at the local market. It was utilized by the locals to boost appetizers. It contains therapeutic characteristics that can help with coughs, cold, and stomach problems. The stem paste is highly useful in cases of constipation. I also hypothesized that the stem of such a plant may help to lower blood sugar levels in humans. To prove the local claim of therapeutic capabilities, phytochemical and pharmacognosy studies are required. Ducks consume *Azolla pinnata* and *Azolla filiculoides* (Lal khudipana). Cows consume a variety of plants from the Cyperaceae and Poaceae families, including *Hygroryza aristata* (Jangli dhan), *Actinoscirpus grossus* (Kasura), and others.

In this location, uncommon species such as *Trapa bispinosa* (Singara), *Nymphaea rubra* (Lal shapla), *Nelumba nucifera* (paddo), *Oenanthe javanica* (panidhone) and *Ottelia alismoides* may be found. Only one location in the area has *Nymphaea rubra* (Lal shapla) and *Nelumba mucifera* (Padma). This species grows in an undisturbed environment; if any disturbances, such as fishing or farming, occur in the marsh, they will go extinct in the near future.

Only this location grows *Ammannia alternifolia*, *Ammannia gracilis*, *Centrostachys aquatica* (Thuash), *Oenanthe javanica* (Panidhone), and *Ottelia alismoides* (Shamakola). These species have a very limited range; throughout my field investigation, I only discovered them in one site. These factories are vital to the economy. *Centrostachys aquatica*, often known as Thuash, is a plant whose stems are marketed as vegetables in the local market. *Oenanthe javanica*, also known as Panidhane, is an aquatic herb that grows near water's edge. The plant's shoot is sold as a vegetable in the local market. The juice of the leaves is used to treat jaundice. In the research region, the species is quite uncommon. I discovered it in nature and also saw it at the market. The fruits of *Ottelia alismoides*, also known as Shamakola, are consumed as vegetables. Because of local demand for their use, these species' populations are extremely scarce. These animals require special attention to ensure their survival. Otherwise, the species will be extinct in the near future.

5. Conclusion

Aquatic plants are the major components of wetland ecosystems. All aquatic life other than plants directly and indirectly depends on green products. Any change in the species and population composition of aquatic ecosystem may fail to maintain ecological balance in which many organisms interact with each other for their survival. The preliminary survey in Sadullapur Gaibandha resulted in recording of total 52 aquatic plant species. They are belonging to 35 genera under 30 families. Among them, Dicotyledons is represented by 17 families whereas Monocotyledons are represented by 12 families and Pteridophytes represented by 1 family. In Magnoliopsida, Nymphaeaceae and Onagraceae are the largest family each of them contain 2 and 4 species, whereas in Liliopsida the largest families are Cyperaceae and Poaceae

contains 4 and 3 species. The investigation recorded a number of rare aquatic plant, species from the study area. These are *Trapa bispinosa* (Singara), *Nelumbo nucifera* (Padma), *Nymphaea pubescens* (Sada shapla), *Oenanthe javanica* (Panidhone), *Nymphaea rubra* (Lal shapla), *Ottelia alismoides* (Shamakola), *Enhydra fluctuans* (Helencha) and *Centrostachys aquatica* (Thuash). Population of such species in the wild is very rare because of local demand for the use. These species need to be cared for conservation. Otherwise, the species will be eliminated from the wild very soon. Based on the preliminary survey in Sadullapur Gaibandha, it is very difficult to make sound conclusion on the status of aquatic flora. The results of present study showed that aquatic habitats of Gaibandha district is floristically rich in terms of area and the district is also the home for many rare aquatic plant species of Bangladesh. To make a complete inventory of the aquatic flora of Sadullapur Gaibandha further long term survey is necessary.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that there are no conflicts of interests.

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