Journal of Building Technology, 2024, Volume 6, Issue 2
DOI: 10.32629/jbt.v6i2.2953
ISSN Online: 2717-5103
ISSN Print: 2705-1390

Research on the Ecology of Aquatic Plants

Junle Li

School of Ecology and Environment, Tibet University, 850013, Xizang, China.

Abstract: Aquatic plants are a group of species capable of thriving in water environments, including phytoplankton, submerged plants, emergent plants, and wetland plants. This study systematically explores the ecological characteristics of aquatic plants, analyzing their roles and functions across various ecological environments. By examining the diversity of aquatic plants and assessing their ecological value, this research also investigates their potential applications in sustainable urban development, wetland conservation, and ecological landscape design. The ultimate aim of this study is to provide a scientific basis for the conservation and management of aquatic plants, fostering the development of relevant policies to promote more effective ecological governance and environmental protection.

Key words: aquatic plants; ecological value; urban planning

1. Introduction

Aquatic plants are an essential component of ecosystems, widely distributed in water bodies such as lakes, rivers, wetlands, and oceans, where they create unique aquatic ecological environments. According to the International Society for Aquatic Plants, aquatic plants are primarily defined as species highly dependent on water bodies for survival, with morphological adaptations suited to the changing water environment. This category typically includes floating plants, submerged plants, emergent plants, and wetland plants. These plants not only grow in water but also play a vital role in maintaining water quality, enhancing ecological conditions, and supporting biodiversity.

2. Analysis of Aquatic Plants

Aquatic plants are species that grow in or near water and are widely distributed across various aquatic ecosystems, including lakes, rivers, wetlands, and oceans. Globally, over 12,000 species of aquatic plants have been identified, encompassing mosses, ferns, and various seed plants. According to the Flora of China, around 20% of the world's aquatic plant species are found in China, highlighting the country's importance in aquatic plant diversity. China has a rich variety of aquatic plants, with approximately 300 species of mosses, 200 species of ferns, and more than 1,700 species of seed plants.

The distribution range and ecological functions of aquatic plants also vary significantly. Some species, such as reeds and cattails, play crucial ecological roles in aquatic ecosystems by providing habitats, enhancing water purification, and promoting biodiversity. These plants are found globally across freshwater, saltwater, and tidal regions, where they contribute to the water body's ecological balance and provide irreplaceable ecological services. Ecological studies suggest that the diverse species and ecological functions of aquatic plants interact in a coordinated manner, collectively influencing the stability and productivity of aquatic ecosystems. This underscores the significance of studying the ecology of aquatic plants[1].

3. Ecological Value of Aquatic Plants

Aquatic plants play an essential role in ecological environments, particularly in water purification and carbon storage. Eutrophication is a significant environmental issue today, where excess nitrogen (N) and phosphorus (P) lead to algal blooms that deteriorate water quality. Research shows that aquatic plants can effectively reduce nitrogen and phosphorus levels through natural biological mechanisms, thus slowing down the eutrophication process. According to the *Handbook of Aquatic Plants in Chinese Lakes and Wetlands*, each hectare of reeds can purify around 52 kg of nitrogen and 8.3 kg of phosphorus daily. This finding not only demonstrates the high efficiency of aquatic plants in purifying water but also highlights their vital contribution to maintaining the ecological balance of water bodies. Aquatic plants also play a critical role in the carbon cycle. Thriving aquatic plant communities absorb large amounts of carbon dioxide (CO_2) through photosynthesis, thereby lowering atmospheric greenhouse gas concentrations. A healthy aquatic plant community can absorb approximately 4.5 tons of CO_2 and store about 3.2 tons of carbon annually, which underscores the importance of aquatic plants as a "green carbon sink" in addressing global climate change.

As research progresses, the ecological value of aquatic plants will be more comprehensively recognized and applied, inevitably becoming an essential component of future environmental governance[2]. Furthermore, the ecological value of aquatic plants extends to regulating water temperature, increasing oxygen levels in water, and promoting biodiversity in aquatic habitats. Their leaves and fine roots provide necessary shade, lowering water temperature and creating a more suitable environment for aquatic species.

4. Application of Aquatic Plant Ecology

4.1 Application in urban planning

The Olympic Forest Park in Beijing serves as an example of the use of aquatic plants in urban planning. This park incorporates approximately 15 hectares of artificial wetlands, planted with various aquatic plants such as irises, cattails, and bulrushes, forming a multi-layered biological community. These plants play a crucial role in treating urban runoff pollution. Statistics show that the wetland system can treat around 73,000 cubic meters of runoff pollution annually, significantly reducing the pollution load entering the city's drainage system. Further analysis reveals that the artificial wetland in the Olympic Forest Park demonstrates varying water quality improvement effects across different seasons. During spring and autumn, with moderate temperatures, the photosynthetic activity and growth rates of aquatic plants are at their peak, maximizing the removal efficiency of nitrogen and phosphorus. Below are data on the seasonal water quality improvement effects of the artificial wetland in the Olympic Forest Park:

Table 1. Water quality improvement effects of the Olympic Forest Park Artificial Wetland (Unit: mg/L)

Season	Chemical oxygen demand (COD)	Total nitrogen (TN)	Total phosphorus (TP)
Spring	30 → 10	2.5 → 0.5	0.25 → 0.05
Summer	28 → 12	2.0 → 0.8	0.20 → 0.07
Autumn	32 → 8	3.0 → 0.7	0.30 → 0.08
Winter	35 → 20	4.5 → 2.5	0.40 → 0.20

The data above demonstrates that the inclusion of aquatic plants enables the wetland system to perform exceptionally well in water quality management. Notably, the removal efficiency of COD, total nitrogen, and total phosphorus exhibits some seasonal fluctuations, closely linked to temperature, the growth cycle of aquatic plants, and precipitation levels.

In aquatic plant-based urban planning, the government has also constructed ecological corridors to connect different wetland systems, forming an ecological network that further enhances urban ecological service capacity. In future urban planning, the construction of aquatic plant ecosystems should be incorporated into the overall blueprint to achieve sustainable development and the goals of ecological civilization. The application of aquatic plants in urban planning continues to make new progress, offering an eco-friendly approach that not only improves water quality and promotes biodiversity but also provides a better living environment for urban residents, exemplifying the harmonious integration of ecology and urban development[3].

4.2 Application in Wetland Plant Construction

In the Xianghai National Nature Reserve in Jilin Province, the extensive planting of wetland plants has effectively promoted water purification and improved water quality. A series of wetland construction and restoration projects have been implemented in the area, with primary plantings of cattails and bulrushes, creating a diverse community of wetland plants. These plants not only provide habitats but also significantly enhance the water's self-purification capacity through the interaction of their roots, stems, leaves, and associated microorganisms. The water purification cycle in the Xianghai Wetland has been reduced to six months, with significant improvements in water quality. Past surveys indicate an average reduction of 35% in total nitrogen concentration and 33% in total phosphorus concentration. Below is the detailed data on water quality changes in the Xianghai Wetland Reserve for analysis and comparison:

Table 2. Water quality changes in Xianghai Wetland Reserve (Unit: mg/L)

Parameter	Before experiment	After experiment	Change rate
Total nitrogen	3.5	2.3	35%
Total phosphorus	0.15	0.10	33%
Suspended solid	50.0	20.0	60%
pH Value	7.8	7.5	-3.85%

The data indicates that the removal rate of suspended solids reaches 60%, which is significant for reducing water turbidity and improving conditions for photosynthesis. The slight decrease in pH also suggests that the planting of aquatic plants may play a role in balancing the water environment. Wetland plants can efficiently absorb nutrients from the water, thereby inhibiting eutrophication.

Therefore, in the context of national wetland conservation and ecological restoration, promoting the use of aquatic plants' ecological characteristics in wetland construction has become especially important. By applying similar experiences from various regions nationwide, the overall level of ecological civilization can be effectively elevated, contributing to the goal of sustainable development.

4.3 Application in landscape construction

In landscape construction, aquatic plants serve not only as essential elements for aesthetic enhancement but also as crucial components for ecological functions. By introducing aquatic plants, water quality is effectively improved, biodiversity is increased, and habitats are provided for various flora and fauna.

In addition to lotus and water lilies, other aquatic plants like bulrush and cattail are also incorporated in Suzhou Humble Administrator's Garden, enhancing the overall water quality improvement. Bulrush covers about 1,500 square meters, with an average nitrogen absorption of 2.5 grams per square meter annually, resulting in a total nitrogen absorption of 3,750 grams within the garden. Cattail, covering approximately 2,000 square meters, absorbs around 1,200 grams of nitrogen annually, with a total absorption of 2,400 grams. The combined absorption capacity of these aquatic plants significantly improves the garden's water management. Environmental monitoring data show that, before the introduction of these aquatic plants, the total nitrogen content in the water was as high as 4.5 mg/L. Through ecological purification by aquatic plants, the total nitrogen content in the water was gradually reduced over a year to 1.2 mg/L, a decrease of 73%. Similarly, the total phosphorus content in the water dropped from 0.35 mg/L to 0.1 mg/L, a reduction of 71%.

With this diverse configuration of aquatic plants, the Humble Administrator's Garden not only achieves water purification but also significantly enhances the ecological environment of the garden. Biodiversity within the garden has also improved, with species that rely on aquatic plants as habitats, such as frogs and dragonflies, increasing yearly, becoming a highlight for visitors interested in observing nature. Below is a summary table of the nutrient removal effects of various aquatic plants in Suzhou Humble Administrator's Garden:

Table 3. Nutrient removal effect of aquatic plants in Suzhou Humble Administrator's Garden (Unit: kg/ha/year)

Plant species	Nitrogen absorption (N)	Phosphorus absorption (P)	Ammonium chloride absorption
Lotus	1,500	300	800
Water Lily	2,000	400	1,200
Bulrush	2,500	600	1,500
Cattail	1,200	250	900

The substantial amount of ammonium chloride removed by aquatic plants significantly improves the water quality of the garden, particularly after the rainy season, when runoff increases the risk of eutrophication. At this time, aquatic plants can effectively utilize their root systems and overall ecological functions to absorb and digest excess nutrients in the water. In addition to lotus and water lilies, the Humble Administrator's Garden has introduced various other aquatic plants, such as bulrush and cattail, which also play crucial roles in nutrient absorption. One hectare of bulrush can absorb approximately 2.5 tons of total nitrogen annually, while cattail absorbs around 1.2 tons, helping to lower nutrient levels in the water to safe limits.

5. Conclusion

In summary, aquatic plants play a vital role in maintaining ecological balance and have significant potential applications in urban construction, wetland conservation, and landscape beautification. As global environmental issues intensify, the research and application of aquatic plant ecology are undoubtedly becoming increasingly important. In the future, it will be essential to focus on strategic promotion and standardized management practices to fully realize the ecological and social benefits of aquatic plants.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Wang Mingchao. 2023. Landscape Planning and Design of Baoshan Park Based on Environmental Ecology Theory. *Journal of Shandong Jianzhu University,* 38(2):127-134.

[2] Chen Xin, Du Qingping, Lin Yu, et al. 2024. Analysis of Ecological Ditch Improvement Technology and Combined Process Purification Effects. *Environmental Ecology*, 6(8):49-52.

[3] Liu Yixuan, Hu Dou, Du Yueying, et al. 2024. Restoration of Urban Landscape Water Bodies and Disposal of Polluted Aquatic Plants. *World Ecology,* 13(2):238-242.

[4] Huang Faming, Sun Ning, Xie Pei, et al. 2023. Research Progress on the Decomposition Process of Aquatic Plants and Its Influencing Factors. *Journal of Ecology*, 42(2):471-480.

The Author Introduction: Li Junle (2000-), male, Han nationality, from Xiantao, Hubei Province, Master candidate, School of Ecology and Environment, Tibet University, majoring in ecology.