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## Research on the Selection and Application of Aquatic Plants in Constructed Wetlands -- Taking Qinyuan Artificial Lake of Guangxi Polytechnic of Construction as an Example

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# Research on the Selection and Application of Aquatic Plants in Constructed Wetlands -- Taking Qinyuan Artificial Lake of Guangxi Polytechnic of Construction as an Example

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**Abstract.** The direct absorption of aquatic plants in artificial lake, adsorption of pollutants, indirect improvement of artificial lake environment and promote microbial water purification and other environmental protection effects are increasingly obvious. Taking Qinyuan artificial lake of Guangxi Polytechnic of Construction as an example, this paper selects aquatic plants suitable for local environment with strong decontamination ability, good landscape effect and high economic value in the constructed artificial lake wetland system, which plays an important role in purifying sewage in the campus and the overall environment and achieves the expected purpose. Through this case study, the role of aquatic plants in artificial lake in sewage purification and wetland landscape construction was studied, so as to provide theoretical basis for the application of aquatic plants in artificial wetland in water purification.

**Keywords:** constructed wetland; Aquatic plants; The water quality purification.

## 1. Introduction

Aquatic plants are an important part of the constructed wetland system, especially large aquatic plants, which play a role in purifying water quality, creating wetland landscape and improving ecological environment in artificial lakes and wetlands such as schools, parks and communities. Guangxi Polytechnic of Construction Qinyuan lake wetland is located in the Guangxi Polytechnic of Construction campus, with a total area of about 100 square meters, belongs to shallow water type small lakes, Qinyuan lake mainly aquatic plants such as lotus, scirpus taber naemontani, Jiao grass, calamus, water purification, creating beautiful landscape of campus is of great importance. This paper discusses the significance of aquatic plants in sewage purification and landscape construction of Qinyuan artificial lake, in order to provide theoretical basis for the selection of aquatic plants in the ecological construction of artificial wetland.

## 2. Distribution of aquatic plants in Qinyuan artificial lake

### 2.1 overview of aquatic plants

Generally speaking, aquatic plants can be roughly divided into four types according to the relative position of leaf surface and water surface and living habits, that is, emergent plants, floating leaves,



floating plants and submerged plants. The classification is mainly based on the different growth environments and production forms of aquatic plants.

*2.1.1. emergent water plants.* Emergent plants refer to the aquatic plants whose roots grow in the bottom mud or soil and whose *stems* and leaves protrude out of the water. Common water plants are mainly cattails, water Onions, reeds, lotus and other common plants.

*2.1.2. floating leaf plants.* A floating-leaf plant is one in which the leaves float on water and the roots grow in mud. Because the floating leaf plant has a large amount of gas in its body, its leaves or the whole plant can float on the water surface.

*2.1.3. floating plants.* The root of the floating plant does not grow in the mud under the water, but the leaves float on the water, and the whole plant can drift with the current. Common floating plants are duckweed, manjianghong, etc.

*2.1.4. submerged plants.* A submerged plant is one that is completely submerged, with only a few stems and leaves above water. Submerged plants have slender leaves but highly developed aerenchyma. Common submerged plants include antirrhinum, sargassum, etc. [2].

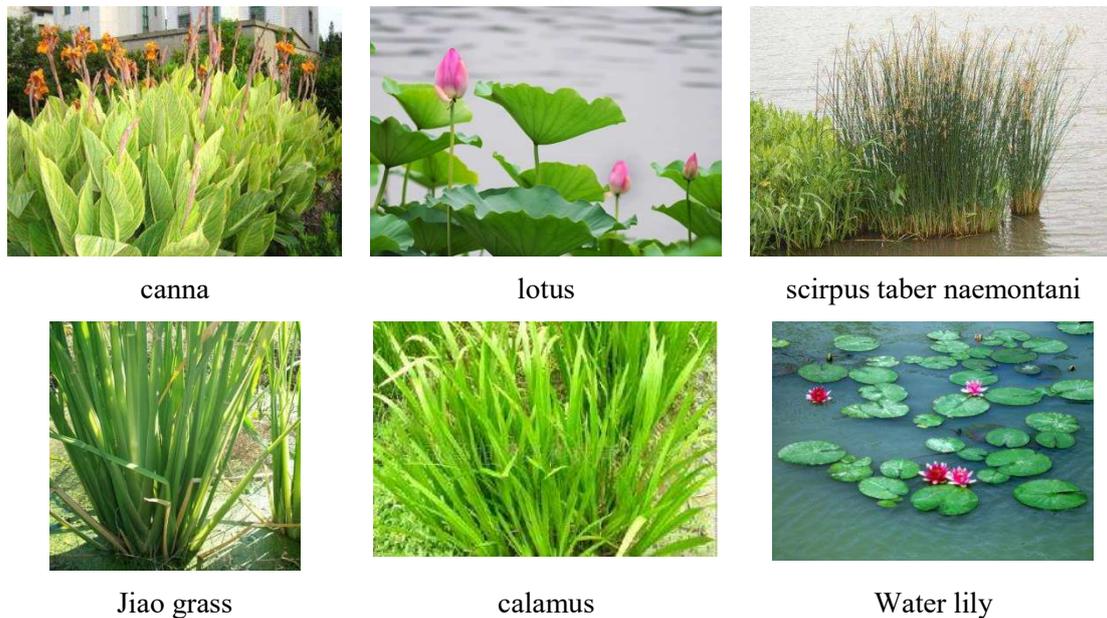
The aquatic plants in Qinyuan artificial lake are relatively simple. Most of the plants in the lake are developed through artificial cultivation. The aquatic communities in the lake can be divided into three layers, from high to low, which are emergent plants, floating leaves or floating plants, and then submerged plants. The distribution rule of aquatic plants in the lake is generally concentric circle from the shore to the deep-water area of the lake, that is, the distribution order from the shore to the deep-water area is: emergent water, floating leaf or floating and submerged plants. It is worth mentioning that the depth of the lake and the ecological environment largely determine the distribution of aquatic plants.

## *2.2 Main aquatic plants in Qinyuan artificial lake*

Qinyuan lake wetland from the early stages of construction, according to local perennial subtropical climate is given priority to, the abundant rain, all the year round constant temperature climate characteristics, combining the college campus landscape layout, and factors such as biodiversity, after four years of ecological construction, the undercurrent in Qinyuan artificial main body and watch flow area are mainly distributed Jiao grass, scirpus taber naemontani, calamus, canna, lotus and other large wetland plant communities; In the deep wet areas, it is mainly aquatic plants such as water bamboo, cattle-rush and duckweed [4], and the biological diversity has been effectively developed, which complements and complements the campus landscape, creating a unique ecological landscape of Qinyuan. The main aquatic plants in Qinyuan artificial lake are as follows.

*2.2.1 canna.* Canna is the most planted and best ornamental plant in Qinyuan artificial lake. Cannas grow well in warm and sunny areas and can be grown in any soil but are best grown in loose, fertile soil with good drainage. Canna plants up to 1.5 m tall are typical emergent plants.

*2.2.2 lotus.* Lotus flower is the most famous landscape plant in Qinyuan artificial lake, it is single dominant species population, it may have water bamboo, duckweed, full river red and so on. Lotus flowers in Qinyuan artificial lake are all cultivated artificially, with high vegetation coverage and good population development. Therefore, this population is suitable for growing in water with water depth generally not more than 2m and water height generally between 0 and 0.15m. It is mainly distributed in shallow swamp areas. Lotus cultivated in Qinyuan artificial lake includes lotus and Hualien, which are both aquatic ornamental plants and water purification plants.



**Figure 1.** The main aquatic plants in Qinyuan artificial lake

*2.2.3 scirpus taber naemontani.* Green Onions generally grow in Qinyuan lake and shallow water area, can adapt to a certain depth. The height of water onion is not high, generally between 0.1 and 0.3m. The appearance is gray-green, the vegetation coverage is high, the population is well developed, and a stable population has been formed in Qinyuan artificial lake. As a typical marsh herb, leeks have strict requirements on soil fertility. Therefore, leeks can effectively remove organic matters such as ammonia nitrogen, phosphate and heavy metals from soil, and meanwhile, leeks can beautify artificial wetlands.[5]

*2.2.4 Jiao grass.* The bamboo population is one of the marsh plants cultivated in Qinyuan artificial lake, it is often mixed with pureed, reed and other emergent plants, and grow together with duckweed, manjianghong and other plants. It may grow in lakes with water depth of 0.1-0.15m and the population height of 0.2-0.3m. From spring to summer every year, the population may be light green in appearance, but dark green in summer, and may turn yellow soon after autumn. Water bamboo mainly distributed in Qinyuan artificial lake around the lakeside waterfront zone, used for solid slope protection, wetland ornamental.

*2.2.5 calamus.* *Acorus gramineus* population is a shallow marsh wetland plant, often mixed with reed, pungent grass and other emergent plants. Wild calamus mainly in the mountain streams, Qinyuan artificial wet calamus for artificial cultivation, calamus populations in the wild usually less than 0.1 m, but artificial cultivation of calamus height can reach more than 0.15 m, communication during the spring and summer when the leaves are more obvious, showing a yellow-green appearance, calamus leaf began to wither gradually after the summer and fall, at the same time as the lower associated plants grow taller, are often flooded cover and not significant, is commonly used in artificial lake aquatic plants, have a high ornamental value [6].

### 3. Application of aquatic plants to water purification

#### 3.1 removal of nitrogen and phosphorus

Aquatic plants can absorb and utilize organic or inorganic substances in soil or water according to their developed roots and stems, such as nitrogen and phosphorus in eutrophic water. At the same time, aquatic plants can also enrich heavy metals in water or some toxic and harmful substances in plants.

Aquatic plants in the process of growth, the need to absorb large amount of nutrients such as nitrogen and phosphorus, and these nutrients would be obtained from the slime water or the water, aquatic plants such as nitrogen and phosphorus nutrients into its components to promote plant growth, among them, the inorganic nitrogen plant can be direct synthesis of protein and organic nitrogen, inorganic phosphorus compounds absorbed by plants and assimilation may be turned into the plant's own ATP, DNA, RNA and other organic compounds. Benefit from the life cycle of aquatic plants are generally longer features, such as nitrogen and phosphorus nutrients can be in the plant body exist for a long time, then in the aquatic plants die or be harvested, plant nitrogen and phosphorus in the body will be as the plants to remove water, and then leave it to a certain extent, can achieve the effect of purifying water body [2]. In Qinyuan artificial lake, canna, lotus, calamus, water onion, water bamboo, water lily and so on can remove nitrogen and phosphorus.

### *3.2 removal of heavy metals and pesticides*

In addition to absorbing and utilizing nutrients such as nitrogen and phosphorus in water, aquatic plants can also absorb and enrich heavy metal ions and pesticides through their developed root systems. Thanks to the highly developed root system of aquatic plants, aquatic plants can utilize the root system to enrich heavy metal ions, pesticides and other pollutants such as synthetic organic compounds in the body, thus reducing the content of heavy metals and pesticides in the water to some extent. The accumulation of heavy metals in aquatic plants can only change heavy metals from one form to another, that is, from toxic to non-toxic. Or through diffusion and migration, the concentration of heavy metals and pesticides in water or bottom sediment is gradually reduced. Aquatic plants can absorb and enrich the heavy metals in water for innocuous treatment or use aquatic plants to fix up the heavy metals to prevent their further diffusion. Aquatic plants have a strong ability to accumulate heavy metals such as zinc, lead and copper. The ability of aquatic plants to accumulate heavy metals is successively submerged plants, floating plants and emergent plants. Aquatic plants with developed roots are larger than those with underdeveloped roots [2]. In Qinyuan artificial lake, aquatic plants which can absorb heavy metals and other toxic and harmful substances are also planted, such as water plants with water bamboo, cattails, lotus flowers, calamus, etc. The growth of these aquatic plants which can absorb heavy metal ions plays a role in reducing the total amount of heavy metals in Qinyuan artificial lake to some extent.

### *3.3 role of microorganisms*

The metabolism of aquatic plants not only benefits their own existence, but also has an indirect effect on improving the environment for the growth of microorganisms in water. Microorganisms and metazoans that sink mud in water and grow in water are the main force for absorbing and degrading pollutants. Generally speaking, the oxygen generated by the metabolic activities of aquatic plants is transmitted to the plant root system. In addition, the photosynthesis diffuses oxygen in the water, and an oxygen-rich area can be formed around the plant, so as to improve the growth environment of microorganisms and stabilize the aquatic ecosystem. Aquatic plants developed root system and sediment substrate surface is microbial provides good adhesion interface, greatly increased the number of microorganisms, increased the activity of microorganism area, aquatic plants to provide oxygen and secretion of some organic material, can some be absorbed by microorganisms, promoted the microbial metabolism, provide a good environment for aerobic microorganisms. Away from the roots of aquatic plants, an environment suitable for the growth of anaerobic microorganisms is created. Microorganisms can be called the major decomposers of pollutants in constructed wetlands because they can degrade pollutants through nitrification and denitrification. Therefore, the absorption and degradation of pollutants by microorganisms and metazoans are directly or indirectly related to aquatic plants to a certain extent [7]. In addition, aquatic plants can release enzymes and secretions that promote biochemical reactions in sewage and accelerate organic chemical reactions of pollutants, thus promoting the function of wetland sewage purification [8].

#### **4. Summary of the selection and application of aquatic plants in Qinyuan**

Artificial wetland is a kind of artificial wetland ecosystem generated by artificial simulation of natural wetland. Therefore, it has the characteristics and functions of controlling pollution, purifying water quality and maintaining ecological balance with natural wetland in essence, and it is also one of the ecological landscapes of biodiversity. Therefore, we in the choice of artificial wetland planting aquatic plants, besides should give full consideration to internal factors such as different types of aquatic plants, growth characteristics, many combined with local climate conditions, wetland environment and other external factors, and the balance of aquatic plant purification function of constructed wetland water quality and the overall landscape design principle such as the need for a certain choice.

##### *4.1 ecological adaptability and ecological security*

Choose the first condition of artificial wetland aquatic plants are plants to adapt to the local soil and climate conditions, and also can change as the environment changes, such as changes in morphology, structure, physiological characteristics, etc., to have a good ability of ecological adaptability and ecological construction, secondly also accord with the requirement of ecological security, namely the selected plants in artificial wetland maximum, with no adverse impact on the local ecological environment and threats.

##### *4.2 anti-fouling and decontamination ability*

Characteristics of artificial wetland sewage determine when choosing aquatic plants, plant to have stronger resistance to fouling and decontamination capability, it is need to consider when choosing artificial wetland aquatic plant one of the important factors, so we should according to the different nature of the wastewater of artificial wetland to choose different aquatic plants, other ways the choice of artificial wetland, he can't follow them mechanically. Choose different aquatic plants and composition of artificial wetland can produce a certain differences of water quality of the constructed wetland purification effect, the plant decontamination ability mainly depends on plant growth, root developed, such as the rush, has a very developed root system of plants will have good decontamination ability, is one of better water purification plants in wetlands, and the root system developed lower plants, sewage treatment effect is produced by it will be relatively poor.

Through practice, we found that the root system of deep-rooted and tufted emergent water plants is deep in distribution but not wide in distribution area. If planted in subsurface flow wetland, it can better show their good treatment and purification performance. Some deep-rooted plants, such as cattail, calamus, pungent grass, water onion, etc. The root system of plantain, lotus root and other shallow-rooted plants is relatively shallow, so this type of plant is more suitable for planting in the surface flow wetland. The characteristics of floating-leaf root plants are more suitable to be planted in the surface flow wetland, because the growth process of these plants requires a large amount of phosphorus, potassium and other elements. As the dominant plants for phosphorus removal, these plants can be planted in the surface flow wetland to give full play to their phosphorus removal, so as to improve the removal rate of phosphorus by plants in the water. Floating plants have strong adaptability to the environment, so they are usually used as local dominant species in the configuration of aquatic plants [9].

##### *4.3 landscape benefits*

Aquatic plants not only have the functions of sewage treatment, also in a certain ecological and landscape environment has both economic value and function of landscape reconstruction, the construction of modern artificial wetland, not only considering the economic benefits of aquatic plants, cultural value, landscape effect, also should be more purification function of aquatic plants and the economic benefit, such as landscape effect efficiently together, in order to achieve the effect of the "best". Therefore, when selecting suitable aquatic plants for constructed wetlands, the primary function of plants should be considered first, that is, water quality purification function. Plants with strong decontamination, good purification effect and developed root system should be selected to satisfy the

water quality purification function of constructed wetlands in the first place. Second, combine many subjects such as ecology, environment and landscape aesthetics principles, adjust measures to local conditions, scientific and reasonable configuration of different ecological types of aquatic plants, the artificial wetland landscape are harmoniously integrated into the overall situation of landscape ecological environment around, so let it be as part of the ecological environment and landscape environment, in fully demonstrate the plant individual and group attitude of beauty at the same time, also can cause each other in the surrounding landscape environment response of artistic aesthetic feeling, build give a kind of the four seasons landscape of artificial wetland landscape unique, coordinate the relations between and among plants, landscape, environment, Only in this way can the development of constructed wetlands achieve real sustainable development.

## 5. Conclusion

Guangxi Polytechnic of Construction Qinyuan artificial lake in after years of practice, give full consideration to the environment such as climate, artificial lake landscape construction, the construction of campus environment factors, to create a water quality purification, landscape construction, environmental improvement of artificial lake aquatic plant application system, at the same time, in the process of practice, we recognize that aquatic plants is not only important components of wetlands, but also the main participants in the function of artificial wetland in many aspects, in this sense, constantly pay more attention to the effect of aquatic plants in artificial wetland, also let we found some of the deficiencies and improve points out, Such as how to adjust the growth in aquatic plants introduction and natural, let its formed relatively stable populations of aquatic plants, etc.,Qinyuan man-made construction still remains to further study, this article only to the artificial lake wetland construction according to local actual choice of aquatic plants in practice has made the research and application, the late thought should also be in physiology, species of aquatic plants handsome choose, the decontamination mechanism and so on various aspects are studied, for the artificial wetland to play better ecological environment construction to provide more comprehensive and reliable theoretical basis for the application basis.

## References

- [1] wang shinong. Research progress on biodiversity of lianhua lake wetland in tieling [J]. Journal of liaoning normal college: natural science, 2014, 16 (4) : 21-24.
- [2] wang weijuan. Research on the application of large-scale aquatic phytoremediation technology in water pollution control [J]. Journal of fujian radio and television university, 2012, (3) : 88-89.
- [3] zuo li, shang baixiao, li tieqing, et al. Biodiversity status and restoration of lianhua lake wetland in tieling [J]. Modern agriculture, 2012, (8) : 62-64.
- [4] wang hao, li tieqing. Analysis on the removal effect of nitrogen and phosphorus from urban sewage by lianhua lake wetland ecosystem in tieling city [J]. Environmental science and management, 2013, (2) : 60-62.
- [5] li Yang, bu jun, ma chunyan, et al. Study on wetland plant community of lianhua lake, tieling, liaoning [J]. Journal of shenyang normal university: natural science, 2012, (4) : 548-549.
- [6] zuo li, shang baixiao, wang li, et al. Discussion on the construction of the central island of lianhua lake wetland in tieling [J]. Wetland science and management, 2012, (4) : 9-11.
- [7] li yan, wang liqing. Ecological function and application of large aquatic plants [J]. Environmental pollution and prevention (web version), 2007, (5) : 1-9.
- [8] ma Anna, zhang honggang, hong jianming. The role and mechanism of wetland plants in sewage treatment [J]. Journal of capital normal university: natural science, 2006, (6) : 57-63.
- [9] wang lei, Chen xiaodong, liu zhi, et al. Research on plant selection and allocation technology of constructed wetland in north China [J]. Journal of heilongjiang vocational college of ecological engineering, 2007, (2) : 15-16.