Study on the release of carbon, nitrogen and phosphorus from the decomposition of aquatic plants

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Abstract. It is important to study the decomposition process and nutrient dynamics of aquatic plants in order to understand the material circulation process of water ecosystem. The decomposition and release of carbon, nitrogen and phosphorus from aquatic plants at different temperatures were studied by indoor plant decomposition simulation test. The results show that temperature has obvious effect on the decomposition process of aquatic weeds. High temperature is obviously beneficial to the release of carbon, nitrogen and phosphorus. With the increase of temperature, the amount of carbon, nitrogen and phosphorus released into the water increased. The decomposition rate decreases with time.

Keywords: Aquatic plants; Temperature; Carbon, nitrogen and phosphorus; decomposition.

1. Introduction
The source and sink of greenhouse gas CO$_2$ is becoming the focus of global research. Aquatic ecosystems are huge sinks of CO$_2$. According to Downing [1] study, it is estimated that the amount of organic carbon stored in lakes is about 0.036Gt (1Gt = 10$^{15}$g). In freshwater lakes, carbon is transferred between nutrient levels in aquatic ecosystems as an active element. In biogeochemical cycles, nitrogen and phosphorus cycles are the limiting factors in most ecosystems. It is important to understand the pathways that link the circulation of these two substances to the carbon cycle. Lake eutrophication greatly increased the primary productivity and capacity of CO$_2$ sink. Submerged plants grow and die on their own every year. Large aquatic plant debris increased the amount of nitrogen and phosphorus nutrients in the lake, greatly accelerating the aging and death of the lake.

There have been many studies on the effects of different aquatic plant decomposition processes on water quality. The decomposition process of different aquatic plants was correlated with biomass density.[2,3] It is also related to dissolved oxygen conditions [4], initial N and P content, cellulose, hemicellulose, lignin content, C/N/C/P, lignin /N and other conditions [5].

The study on the amount of carbon, nitrogen and phosphorus released by the decomposition of dominant species of aquatic plants has important theoretical guiding significance for the quantitative evaluation of the role of large aquatic plants in the biogeochemical cycle of freshwater lakes, the understanding of the evolution process of lake ecosystem and the prevention and control of lake eutrophication. Liangzi lake is rich in aquatic vegetation, with the characteristics of grass lake vegetation,
and the coverage rate reaches 54.27%. Submerged plant community was absolutely dominant, with a biomass ratio of 70.4% [6]. This paper studies the decomposition and release of carbon, nitrogen and phosphorus from dominant species of aquatic grasses in liangzi lake, aiming to provide theoretical guidance for wetland protection in liangzi lake.

2. Materials and methods
Liangzi lake has the characteristics of grass lake vegetation. The submerged plant community was the dominant one with a biomass ratio of 70.4%. In the submerged plant community, c.emersum community was dominant, with a biomass ratio of 19.8%. Therefore, goldfish algae was selected as the test sample in this experiment.

Weigh 200g fresh plant samples. Put it in a small red plastic container with 2L of water in it. Place test samples in incubators. The temperature was adjusted to 4°C, 20°C and 30°C respectively. 4°C simulated the decomposition and release rule of submerged plants in winter. The decomposition and release rules of spring and autumn were simulated at 20°C. The decomposition and release law in summer was simulated at 30°C. Three repetitions per set. The test period is 28 days. The sampling interval was 7 days. The total carbon, nitrogen and phosphorus contents of plant samples were determined before and after the experiment.

3. Results

3.1. The effect of temperature on carbon release from macrophyte decomposition
The decomposition of aquatic weeds was simulated under different temperature conditions, and the results showed that temperature had significant influence on the decomposition process of aquatic weeds (Fig.1). Under the condition of 4°C, the amount of carbon released into the water by water grass decomposition increases slowly with the extension of time. Under the conditions of 20°C and 30°C, the amount of carbon released into the water by water grass decomposition increases rapidly with the extension of time. The amount of carbon released into the water increased slowly after 21 days. As the temperature increases, the amount of carbon released into the water increases. Statistical analysis showed that the difference between treatments reached an extremely significant level. The decomposition and mineralization of organic compounds in water environment must go through the biochemical oxidation process of hydrolysis and in vivo metabolism. The biological oxidation of organics mainly depends on the action of heterotrophic bacteria and other microorganisms. Bacteria use organic matter as food, breaking it down into simple compounds, from which they take the materials and energy needed to make up their own cells. The activity of bacteria and other microorganisms increases with the increase of temperature in a certain temperature range. The decomposition rate of large plants is known to depend on several environmental factors, especially temperature, oxygen concentration and nitrogen concentration.

3.2. The effect of temperature on nitrogen release from macrophyte decomposition
The release of nitrogen decomposed by water weeds was simulated at different temperatures, and the results showed that temperature had a significant effect on nitrogen release (Fig. 2). The release amount of nitrogen at 30°C and 20°C was significantly higher than that at 4°C. And the higher the temperature, the greater the release. The peak value of nitrogen release curve at 30°C was nearly 2 times higher than that at 4°C. The peak value of nitrogen release curve at 20°C was 1 times higher than that at 4°C. Statistical analysis shows that the difference between treatments is extremely significant. Because microorganisms play a very important role in the release of nitrogen. temperature affects the activity and activity degree of microorganisms, and temperature promotes the decomposition of organic nitrogen, thereby increasing the release of nitrogen into water.
3.3. The effect of temperature on phosphorus release from macrophyte decomposition

Simulation results (Fig. 3) showed that high temperature was significantly beneficial to phosphorus release. Phosphorus release increased rapidly in the first two weeks at 30°C and 20°C. From the third week, the release was slightly reduced. Under the condition of 4°C, the release amount increases stably with the extension of time. Pan [7] found that it took about half a year for large aquatic plants to decompose completely, and the decomposition rate in the later stage was lower than that in the early stage. There was a good logarithmic relationship between the decomposition products of aquatic plants and the time and temperature at the time of decomposition.

4. Discuss

Many products are released during the decomposition of aquatic plants. In addition to organic carbon, there are nitrogen, phosphorus and other minerals. The results showed that temperature had significant effects on the release of carbon, nitrogen and phosphorus during the decomposition of aquatic weeds. With the increase of temperature, the amount of carbon, nitrogen and phosphorus released into water...
increases. After 21 days, the amount of carbon, nitrogen and phosphorus released into the water increases slowly. This is mainly at the early stage of the decomposition of aquatic plants. In addition to decomposition and mineralization release, soluble carbon, nitrogen and phosphorus from plants enter water bodies due to dissolution. With the progress of decomposition, the proportion of refractory substances is increasing, the decomposition rate decreases, and the release amount of carbon, nitrogen and phosphorus decreases. Tang [2] found that different decomposition processes of aquatic plants had different influences on water quality, which were correlated with plant biomass density. Zhou [3] found that the larger the biomass of aquatic plants is, the more nutrients they release when they rot. Cao [5] found that in the whole decomposition cycle, the larger the initial N and P content, the faster the decomposition will be, and the larger the initial cellulose, hemicellulose, lignin content, C/N, C/P, lignin/N content, the slower the decomposition will be. In the early stage of decomposition, the higher the content of N in the residue, the faster the decomposition, and the higher the content of hemicellulose, C/N and lignin/N, the slower the decomposition, while the higher the content of lignin in the later stage, the slower the decomposition, and other factors have little influence. Zhang [8] found that the decomposition rate of C and N of submerged plants bitter grass and Malay seed vegetable was consistent and not affected by the environment. The decomposition of duckweed C and N is greatly affected by the environment. The release rate of bitter grass at the beginning N was higher than C. The decomposition rate of P in all three plants exceeded that of C and N within one week, and was greatly affected by the environment. Wang [9] found that during the decomposition process of submerged plants, the release of plant biomass and the release of nitrogen and phosphorus were not synchronized. The release of nitrogen is slightly faster than that of biomass, but the two are closer. Phosphorus is released most rapidly, with 30 per cent released within the first 20 days of decay and 50 per cent lost within 60 days. This is basically consistent with the results of this study.

Acknowledgments
This work was financially supported by Hubei science and technology support project (2015BBA151)

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