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# Effects of dissolved oxygen on the decomposers and decomposition of plant litter in lake ecosystem

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ABSTRACT

Plant litter releases an amount of carbon, nitrogen and phosphorus during decomposition, which potentially has significant impacts on carbon, nitrogen, and phosphorus cycles and lake eutrophication. Dissolved oxygen (DO) plays an important role in changing the decomposition rate of litter and the major decomposers of litter. The decomposition rates of *Phragmites australis*, *Triarrhena lutarioriparia* and *Carex* spp under four DO concentration conditions (anaerobic group (0 mg/L DO), low DO group (6 mg/L DO), medium DO group (7 mg/L DO), high DO group (8 mg/L DO)) were measured in the laboratory for 120 days. The microorganisms community structure under the four DO conditions was tested to explore the major litter decomposer. The results showed that affected by litter quality, the decomposition rates of the three litters followed the order: *Triarrhena lutarioriparia* > *Phragmites australis* > *Carex* spp. A large amount of carbon, nitrogen and phosphorus were stored in water over litter decomposition. DO accelerated carbon and nitrogen release and promoted the decomposition of litter. The litter of high DO group decomposed 25.5%–42.0% more than that of anaerobic group. DO significantly affected the microbial community structure, and the proportion of microorganisms with the ability to decompose litter was higher in high DO group.

## 1. Introduction

As an important part of ecosystem, lake ecosystem can absorb and recycle a large amount of carbon (C), nitrogen (N), phosphorus (P) and other substances, which has been a research hotspot (Sun et al., 2020; Qin et al., 2020). Litter decomposition in lake ecosystem releases a large amount of C, N and P into the water (Zhang et al., 2018a,b). Changes in the rate of litter decomposition play an important role on ecosystem energy flow and material cycling (Seelen et al., 2019; Du et al., 2020). On the global scale, litter decomposition plays an important role in regulating ecosystem C sequestration and atmospheric carbon dioxide ($CO_2$) concentration (Li et al., 2022). $CO_2$ and methane produced during litter decomposition contribute to climate change (Zhang et al., 2022), which is the focus of carbon neutralization and carbon peak (Chen et al., 2022; Li et al., 2022). Lake eutrophication also increases the yield of litter, and excessive litter accumulation will seriously deteriorate water quality and lead to eutrophication (Grasset et al., 2016; Song and Jiang, 2020). Litter decomposition is a fundamental process in the structure and function of lake ecosystem, and understanding the decomposition of plant litter is critical for the assessment of C emissions and the N and P cycles in a lake.

Litter decomposition in lake ecosystem can be divided into three processes: leaching, conditioning, and fragmentation (Chimney and Pietro, 2006). Leaching refers to the process in which a large amount of soluble components in litter are released. The litter loses a lot of mass in this process, usually up to 80% of its initial mass (Atkinson and Cairns, 2001). Conditioning refers to the consumption of unstable organic matter and certain insoluble compounds in plants by microorganisms, where litter mass is lost slower than in leaching. Fragmentation refers to the process in which litter is broken down by weathering, freezing, wetting and soil fauna. Litter decomposition is influenced by physical, chemical and biological processes (Zhang et al., 2018a,b). Litter quality was found to be the most important factor affecting the litter decomposition rate (Cornwell et al., 2010; Zhang et al., 2008). A high C:N ratio usually results in a slow decomposition rate because there are more cellulose and lignin (Atkinson and Cairns, 2001). A low C:P ratio can result in a high decomposition rate by providing enough energy (Wu et al., 2007). Temperature rising within a certain range and a relatively

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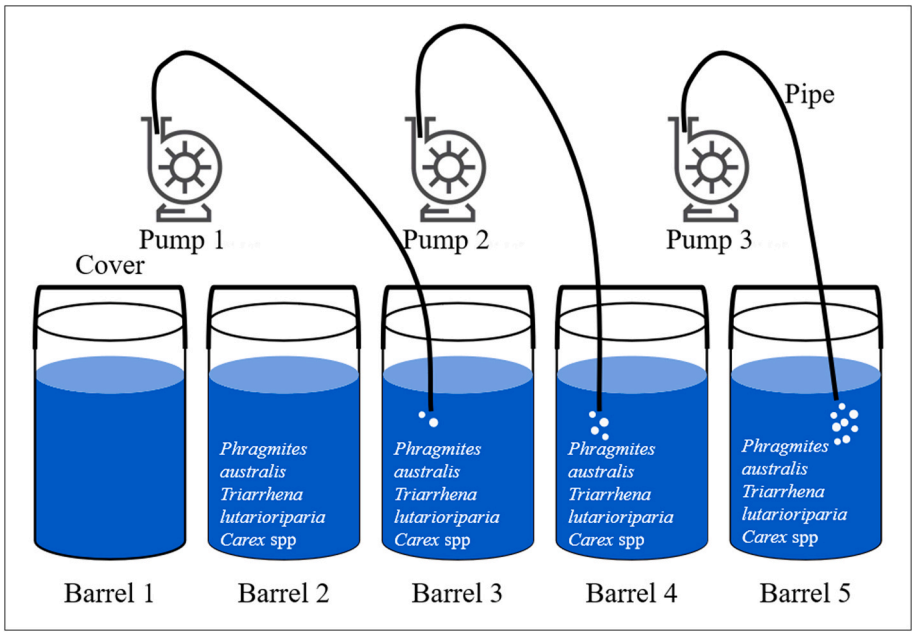


**Fig. 1.** Device connection: the ventilation of Barrel 1 and Barrel 2 both are 0 L/min, the ventilation of Barrel 3 is 1 L/min, the ventilation of Barrel 4 is 2 L/min, the ventilation of Barrel 5 is 4 L/min. The laboratory temperature is 20–23 °C.

**Table 1**
Initial DO concentration.

| Barrel | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Ventilation ( L/min ) | 0 | 0 | 1 | 2 | 4 |
| DO concentration ( mg/L ) | 5.3 | 5.3 | 6.8 | 7.9 | 8.3 |

high water level can both promote the rate of litter decomposition (Hobbie and Chapin, 1996; Zhang et al., 2018a,b). Some studies have found that the effects of microorganisms on litter decomposition can be equivalent to that of litter quality (Gulis and Suberkropp, 2003; Pen et al., 2022). Bacteria and fungi with the ability to secrete lignin enzyme, cellulase are the major decomposers of plant litter in microorganisms such as Acidobacteriota and Bacilli (Kuehn et al., 2004; Pankratov et al., 2012; Siegert et al., 2011). The community and activity of microorganisms directly affect the rate of litter decomposition (Ayres et al., 2006). The influence of environmental factors on litter decomposition is mainly through the activity of microorganisms (Li et al., 2022).

Microorganisms can be divided into three categories based on their oxygen requirements: anaerobic, aerobic and facultative, and their decomposition abilities vary greatly (Matsuyama et al., 2007). Aquatic hyphomycetes primarily mediated litter decomposition in lake ecosystem (Gulis and Suberkropp, 2003; Pascoal et al., 2005). Dissolved oxygen (DO) plays an important role in determining the microorganisms community and activity (Argyropoulos and Menachem, 1998). Particles and dissolved organic carbon (POC and DOC) dissolved faster in high DO concentration, and the rate of litter decompression increased (Paccagnella et al., 2020; Tonin and Hepp, 2011). However, the increase of DO concentration don't significantly affect microbial-induced litter decomposition due to the poor litter quality or functional redundancy among aquatic hyphomycete community (Gomes et al., 2018). High temperatures, heavy rains, drought and anthropogenic activities have altered the lake ecosystem (Woodward et al., 2012). DO concentration in lake could vary greatly due to eutrophication, the rise or fall of the water surface, and climate change (Li et al., 2013; Dixon et al., 2015). The response of decomposition rate and major decomposers to changes in DO concentration is not well documented. Analyzing the details of the microorganism species that affected the decomposition of litter systematically is of great significance for understanding the function of ecosystem, coping with environmental changes and harmony between human and nature (Berg and McClaugherty, 2014).

As the largest freshwater lake in China, Poyang Lake has a large biomass of emergent plants and hygrophytes, which enter the lake after they die (Liao et al., 2013). Three dominant plants (*Phragmites australis*, *Triarrhena lutarioriparia* and *Carex* spp) in Poyang Lake were selected for lab experiment, which is convenient to control DO concentration (Han et al., 2019). Four experiment conditions were set up: an anaerobic group (0 mg/L), a low DO group (6 mg/L), a medium DO group (7 mg/L) and a high DO group (8 mg/L). The objectives of this study were to assess the difference of decomposition rates of different plant litter, the release process of C, N and P of litter, whether and how DO changes the rate of litter decomposition, and the corresponding change of microorganisms community structure to DO. We found that plant litter with a lower C:P will decompose faster, and the microorganisms community structure in high DO group is more conducive to litter decomposition.

## 2. Materials and methods

### 2.1. Materials and experimental design

Lab experiment was done in the Institute of River and Ecology at Tsinghua University. Plant litter of *Phragmites australis*, *Triarrhena lutarioriparia* and *Carex* spp were transported from Poyang Lake (28°22′–29°45′N, 115°47′–116°45′E) to laboratory. These plant litter were washed, air-dried, separated into stems and leaves, and finally dried until the weight no longer changed in an oven at 70 °C. 60 mesh nylon litterbags were divided into three equal parts for packing different plant litters. Considering the volume of the litterbags, the average distribution of roots, stems and leaves and the integrity of the sample, 3 g of *Phragmites australis*, 1 g of *Triarrhena lutarioriparia* and 2 g of *Carex* spp were packed into respective litterbags.

As shown in Fig. 1, barrel 2–5 were packed same litters, and ventilation is incremental. The concentration of DO was controlled by using Songbao oxygen pump double hole SB-628 (6 W) to change and maintain ventilation. The DO concentration increases with the increase of ventilation (Table 1). Barrels 2–5 were called anaerobic group, a low DO group, a medium DO group and a high DO group. Each barrel with 30 L contained 25 L of water. According to the test results for N and P

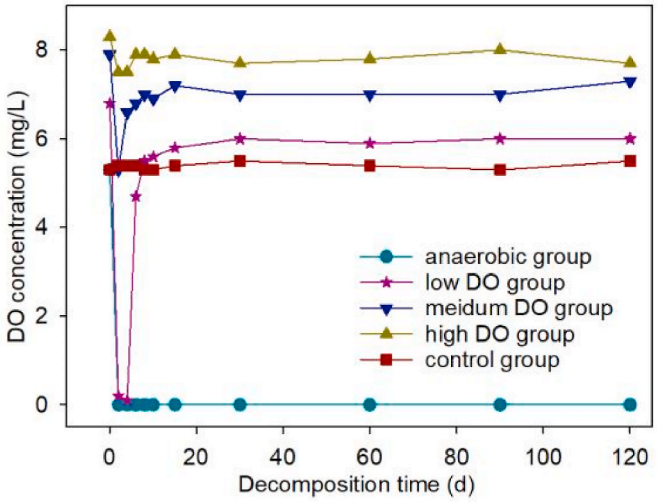


**Fig. 2.** Dynamics of DO concentrations of control group, anaerobic group, low DO group, medium DO group and the high DO group.

concentrations in Poyang Lake, the experimental water was diluted until the N concentration was 3.57 mg/L and the P concentration was 0.021 mg/L. Barrel 1 was set as the control group to explore whether the DO concentration in water changed without litter decomposition.

### 2.2. Collection and analysis of litter

Two litterbags of *Phragmites australis*, *Triarrhena lutarioriparia* and *Carex* spp were taken out from Barrels 2–5 on 2, 4, 6, 8, 10, 15, 30, 45, 60, 90 and 120 d after the initial deployment. The DO concentrations in Barrels 1–5 were measured by a portable DO meter (JPB-607A) when taking samples. The samples were rinsed with deionized water and put into a drying oven at 70 °C until the dry mass no longer changed for electronic balance weighing. The initial litter and samples were ground into powder for chemical analysis after weighing. The concentrations of C, N and P of litters were analyzed by the combustion method in Tsinghua University Analysis Center (Yang et al., 2021). 50 ml of liquid was taken out from Barrels 2–5 at the beginning and the end of this study to measure the concentrations of C, N and P in water for analyzing the effects of litter on carbon cycling and eutrophication.

The rate of litter decomposition was analyzed by the single exponential decay mode (Eqn. (1)) (Zhang et al., 2020).

$$y = ae^{-kt} \tag{1}$$

where, y (%) represents the litter mass residue percentage. a (%) represents the fitting parameter. k ($d^{-1}$) represents the decomposition rate. t (d) represents the decomposition time. The time to decompose 95% litter mass is called as $T_{0.95}$, which means the litter has almost completely decomposed (Olson, 1963).

The release and accumulation of elements during plant decomposition is described by a relative regression index (RRI) (Eqn. (2)) (Zhang et al., 2020).

$$RRI_t = \frac{M_0 \times C_0 - M_t \times C_t}{M_0 \times C_0} \times 100\% \tag{2}$$

where, $C_t$ (mg/g) represents the concentration of an element at time t. $C_0$ (mg/g) represents the initial concentration of an element. $M_t$ (g) represents the dry mass of the remaining plant at time t. $M_0$ (g) represents the initial dry mass of the plant. The positive and negative values of RRI represent the net release and absorption of elements respectively. CRRI, NRRI and PRRI represent the accumulation and release of C, N and P respectively. C:N, C:P and N:P ratios of litter can be calculated to analyze the relationship between litter mass and the proportion of elements released over decomposition.

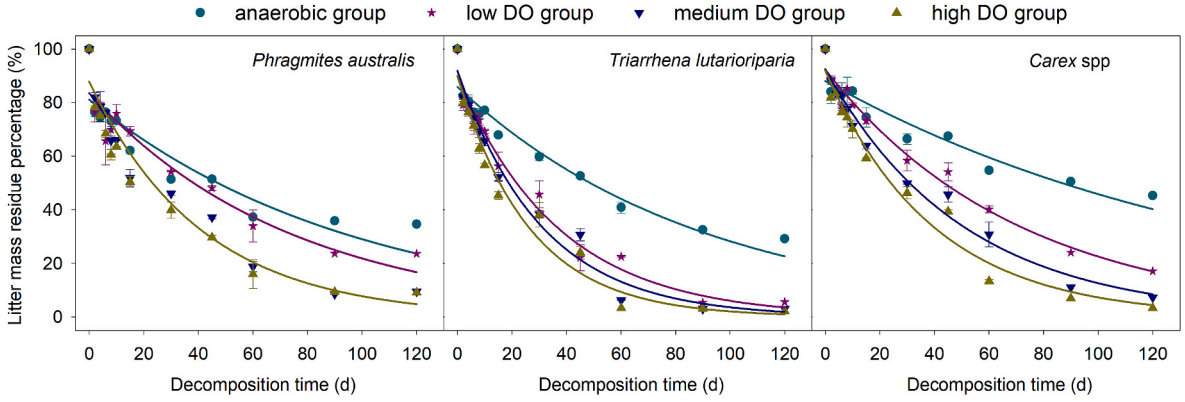


**Fig. 3.** Dynamics of litter mass residue under different DO concentration in 120 d. Dates are shown as mean ± standard error. The curves are fitted using a single exponential decay model:
$y = ae^{-kt}$. Anaerobic group, 0 mg/L DO concentration; low DO group, 6 mg/L DO concentration; medium DO group, 7 mg/L DO concentration; high DO group, 8 mg/L DO concentration.

**Table 2**
Results of repeated measures ANOVAs of the effects of DO, sampling time (T), mass residue percentage (y), C:N ratio, C:P ratio on decomposition rate (k), and the effects of DO, T, y on CRRI, NRRI and PRRI.

| Treatment | f | k | | CRRI | | NRRI | | PRRI | |
|---|---|---|---|---|---|---|---|---|---|
| | | F | P | F | P | F | P | F | P |
| T | 11 | 53.76 | 0.0000 | 135.54 | 0.0000 | 55.96 | 0.0000 | 1.10 | 0.3682 |
| DO | 4 | 8.71 | 0.0001 | 33.05 | 0.0422 | 1.87 | 0.1432 | 12.59 | 0.0000 |
| y | 1 | 20.74 | 0.0000 | 8515.64 | 0.0000 | 300.18 | 0.1432 | 0.36 | 0.5494 |
| C:N | 1 | 3.74 | 0.0558 | – | – | – | – | – | – |
| C:P | 1 | 2.05 | 0.1556 | – | – | – | – | – | – |

**Table 3**
The decomposition rate (k, mean ± standard error) and model-estimated time to 50% ($T_{0.5}$) and 95% ($T_{0.95}$) decomposition.

| plant litter | Group | *a* (%) | P of a | *k* ($d^{-1}$) | P of k | $R^2$ | $T_{0.50}$ (d) | $T_{0.95}$ (d) |
|---|---|---|---|---|---|---|---|---|
| *Phragmites australis* | anaerobic group | 81.13 | <0.0001 | 0.010 ± 0.001 | <0.0001 | 0.850 | 48 | 279 |
| | low DO group | 83.50 | <0.0001 | 0.013 ± 0.002 | <0.0001 | 0.915 | 39 | 217 |
| | medium DO group | 87.83 | <0.0001 | 0.024 ± 0.003 | <0.0001 | 0.961 | 23 | 119 |
| | high DO group | 85.38 | <0.0001 | 0.028 ± 0.003 | <0.0001 | 0.957 | 19 | 101 |
| *Triarrhena lutarioriparia* | anaerobic group | 85.87 | <0.0001 | 0.011 ± 0.001 | <0.0001 | 0.941 | 49 | 258 |
| | low DO group | 89.83 | <0.0001 | 0.027 ± 0.003 | <0.0001 | 0.976 | 22 | 107 |
| | medium DO group | 91.91 | <0.0001 | 0.032 ± 0.003 | <0.0001 | 0.979 | 19 | 91 |
| | high DO group | 89.94 | <0.0001 | 0.038 ± 0.004 | <0.0001 | 0.970 | 15 | 76 |
| *Carex* spp | anaerobic group | 88.06 | <0.0001 | 0.007 ± 0.001 | <0.0001 | 0.908 | 81 | 410 |
| | low DO group | 92.31 | <0.0001 | 0.014 ± 0.001 | <0.0001 | 0.981 | 44 | 208 |
| | medium DO group | 92.53 | <0.0001 | 0.020 ± 0.002 | <0.0001 | 0.981 | 31 | 146 |
| | high DO group | 91.91 | <0.0001 | 0.025 ± 0.002 | <0.0001 | 0.976 | 24 | 116 |

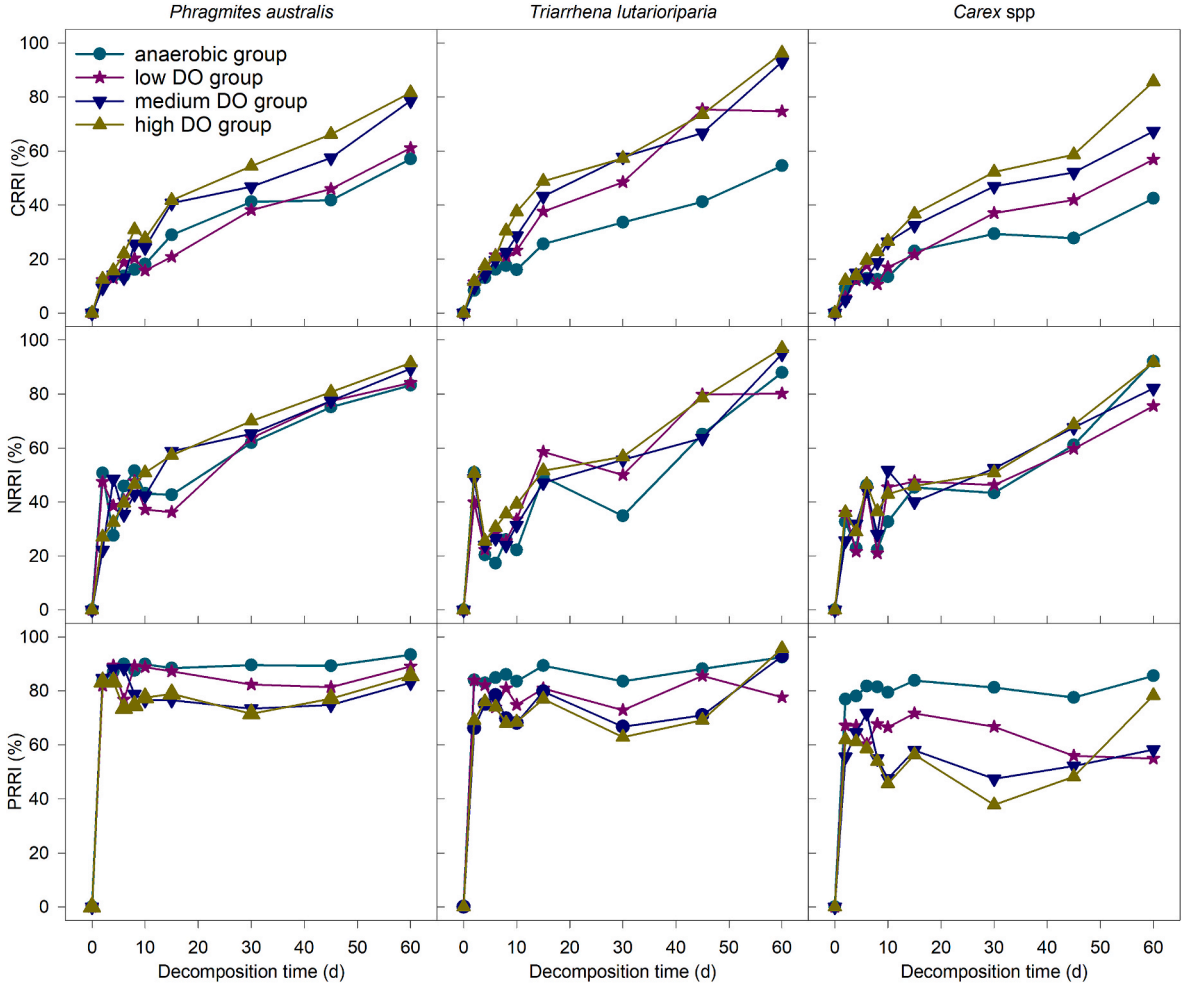


**Fig. 4.** Dynamics of CRRI, NRRI and PRRI of *Phragmites australis*, *Triarrhena lutarioriparia* and *Carex* spp under different DO concentration in 60 d.

**Table 4**
Change of TOC, TN and TP concentration in water under different DO concentration after 60 d.

| | initial element concentration in water (mg/L) | | | element concentration in water after 60 d (mg/L) | | |
|---|---|---|---|---|---|---|
| | TOC | TN | TP | TOC | TN | TP |
| anaerobic group | 7.12 | 3.57 | 0.021 | 67.12 | 49.74 | 12.95 |
| low DO group | 7.12 | 3.57 | 0.021 | 64.99 | 43.16 | 9.92 |
| medium DO group | 7.12 | 3.57 | 0.021 | 65.33 | 38.03 | 6.17 |
| high DO group | 7.12 | 3.57 | 0.021 | 70.22 | 41.09 | 5.63 |

Analysis of variance (ANOVA) was used to evaluate the effects of DO, sampling time (T), mass residue percentage (y), C:N ratio, C:P ratio on decomposition rate (k), and the effects of DO, T, y on CRRI, NRRI and PRRI. Linear regression was used to analyze the relationship between y and CRRI, NRRI, PRRI. Most of the statistical analyze of litter were performed with STATA 15.0 for Windows (StataCorp LLC., College Station, Texas, USA), and the graphs were drawn using SigamPlot 14.0 (Systat Software Inc., Palo Alto, California, USA). Differences were declared significant at $P > 0.05$ unless otherwise stated.

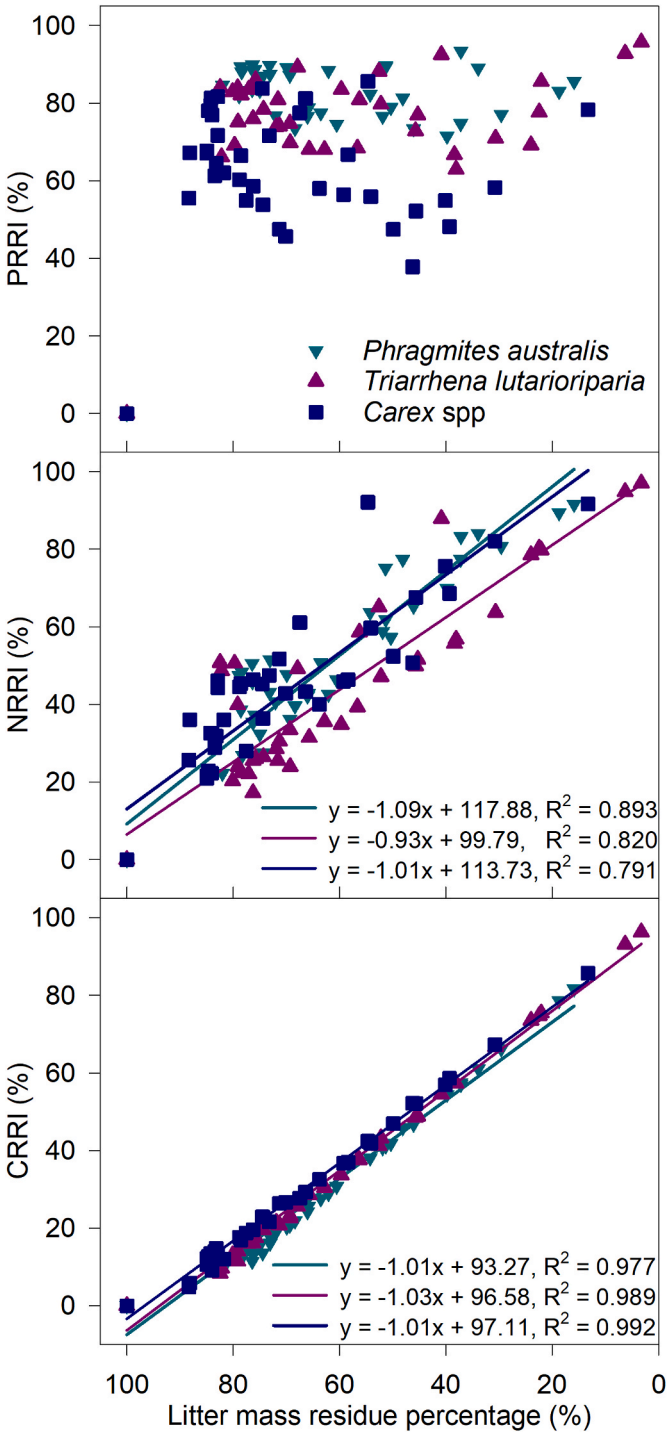


**Fig. 5.** Correlations of litter mass residue percentage with CRRI, NRRI and PRRI.

### 2.3. Collection and analysis of microorganisms

100 ml of liquid was collected from Barrels 2–5 on the 90 d after the initial deployment. Liquid was filtered by a 0.22 μm microorganism filtration membrane for keeping microorganisms on the filtration membrane. The filtration membrane was cryogenically preserved and sent to Majorbio Bio-Pharm Technology Co., Ltd. (Shanghai, China) for DNA sequencing analysis. The genomic DNA of microorganism was examined using gel electrophoresis with 1% agarose, amplified by a polymerase chain reaction (PCR) and purified. Illumina sequencing was performed by constructing a paired-end reads (PE reads), which was spliced according to the overlap relationship. The quality of the sequences was controlled and filtered. After the samples were distinguished, Operational Taxonomic Unit (OTU) cluster analysis and species taxonomy analysis were carried out. Based on the OTU cluster analysis results, OTU diversity index analysis was conducted, and sequencing depths were calculated. Based on the taxonomic information, statistical analysis of community structure was done at each classification level.

Venn diagram showing number of OTU and community heatmap of Phylum level were combined to analyze the differences in the number and species of microorganisms in different groups. The differences of microorganisms community was considered to be the main reason for the change of rate of litter decomposition. The data were analyzed on the online platform of Majorbio Cloud Platform (www.majorbio.com).

## 3. Results

### 3.1. Dynamics of dissolved oxygen concentration of all groups

The DO concentration of the control group was stable at 5.3–5.5 mg/L, indicating the DO concentration in water will remain stable without the influence of litter decomposition (Fig. 2). Litter decomposition consumed a lot of oxygen in the early stage, and the demand for oxygen gradually decreased over decomposition. The DO supply of anaerobic group was less than the demand for litter decomposition, resulting in the whole environment being in anaerobic (Fig. 2). The DO concentration of low DO group, medium DO group and high DO group increased progressively and remained stable after the 20th day, which was in line with the experimental expectation.

### 3.2. Dynamic of litter mass under different dissolved oxygen concentration

The litter mass continuously lost, ranging from 54.8% to 94.7% over the total experiment (Fig. 3). The litter mass rapidly lost in the early stage with the consumption of a large amount of DO, especially in the first two days (Fig. 2; Fig. 3). The rate of litter decomposition was affected significantly by decomposition time, and decreased gradually over decomposition (Table 2). The increase of DO concentration significantly affected and promoted the decomposition of litter: the litter mass loss percentages of *Phragmites australis* in high DO group and anaerobic group were 97.9% and 70.9% respectively at 120 d; the litter mass loss percentages of *Triarrhena lutarioriparia* in high DO group and anaerobic group were 90.9% and 65.4% respectively at 120 d; the litter mass loss percentages of *Carex* spp in high DO group and anaerobic group were 96.7% and 54.8% respectively at 120 d (Table 2; Fig. 3).

The decomposition rate (k), the time to decompose 50% litter mass ($T_{0.5}$) and the time to decompose 95% litter mass ($T_{0.95}$) estimated by the model were shown in Table 3. The decomposition rate of *Triarrhena lutarioriparia* was the highest, followed by the decomposition rates for *Phragmites australis* and *Carex* spp. Affected by DO, the $T_{0.95}$ of the high DO group was reduced by 168–294 d, compared with the anaerobic group.

### 3.3. Response of C, N and P in litter under different dissolved oxygen concentration

C, N and P were released over decomposition, and a large amount of C and nutrients were stored in the water (Fig. 4; Table 4). Increasing DO concentration stimulates the release of C of litter, from 57.1% to 81.7% for *Phragmites australis*, from 54.5% to 96.3% for *Triarrhena lutarioriparia*, and from 42.4% to 85.7% for *Carex* spp at 120 d. Increasing DO concentration was conducive for the release of N of litter, from 83.3% to 91.6% for *Phragmites australis* and from 87.9% to 97.0% for *Triarrhena lutarioriparia* at 120 d. Increasing DO concentration was not conducive for the release of P of litter, from 93.4% to 85.6% for *Phragmites australis*

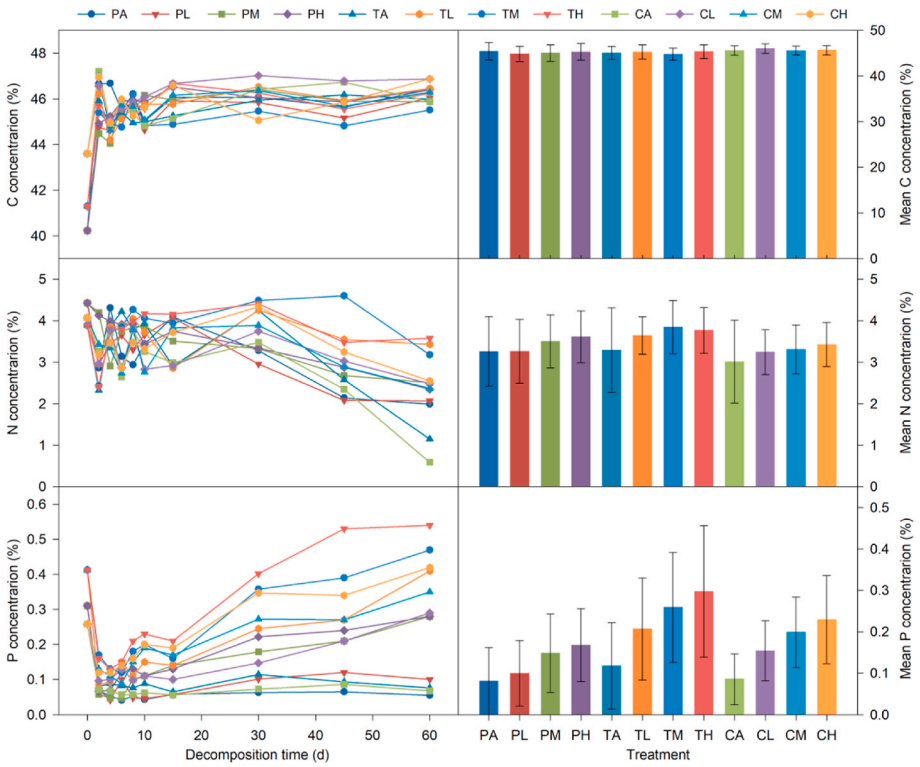


**Fig. 6.** Dynamics of the C, N and P concentration of *Phragmites australis*, *Triarrhena lutarioriparia* and *Carex* spp under different DO concentration in 60 d. Date were shown as mean ± standard error. PA, *Phragmites australis* in anaerobic group; PL, *Phragmites australis* in low DO group; PM, *Phragmites australis* in medium DO group; PH, *Phragmites australis* in high DO group; TA, *Triarrhena lutarioriparia* in anaerobic group; TL, *Triarrhena lutarioriparia* in low DO group; TM, *Triarrhena lutarioriparia* in medium DO group; TH, *Triarrhena lutarioriparia* in high DO group; CA, *Carex* spp in anaerobic group; CL, *Carex* spp in low DO group; CM, *Carex* spp in medium DO group; CH, *Carex* spp in high DO group.

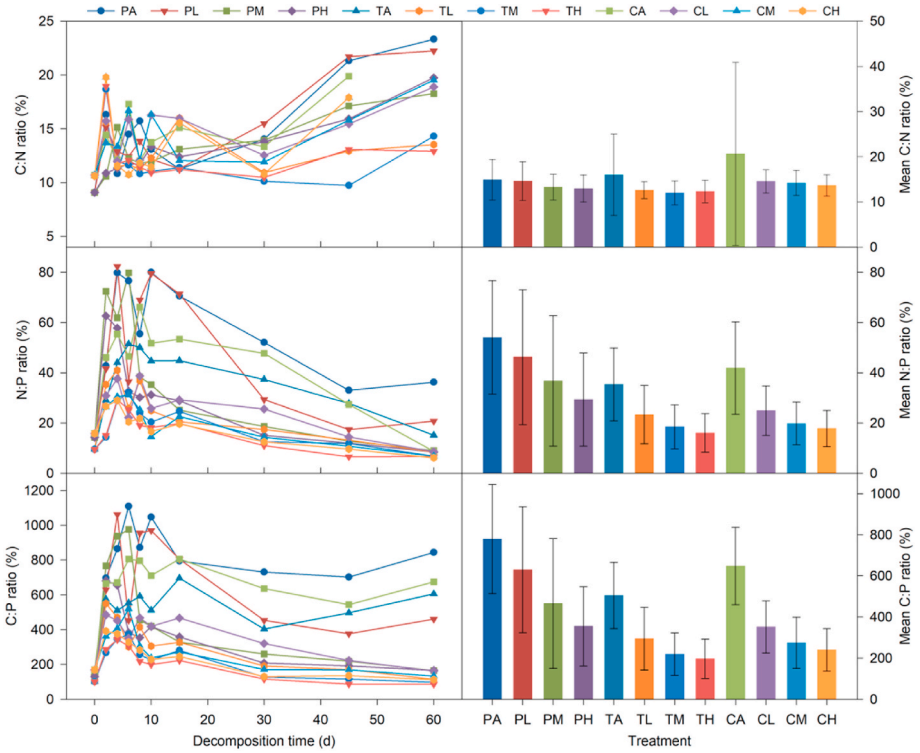


**Fig. 7.** Dynamics of the C:N, N:P and C:P ratios of *Phragmites australis*, *Triarrhena lutarioriparia* and *Carex* spp under different DO concentration in 60 d. Date were shown as mean ± standard error. Treatment are described in Fig. 6.

from 92.5% to 95.7% for *Triarrhena lutarioriparia* and from 85.6% to 78.3% for *Carex* spp at 120 d.

CRRI and NRRI were affected significantly by decomposition time, DO and litter mass residue percentage (Table 2; Fig. 4; Fig. 5). The loss of litter mass mainly depended on the release of C and N. P was released mainly at the early stage of decomposition, and PRRI was not affected significantly by decomposition time and litter mass residue percentage (Table 2; Fig. 5). PRRI was affected significantly by DO, and was negatively correlated with DO (Table 2; Fig. 4). The concentration of C in litter remained stable, and the concentration of N in litter decreased to

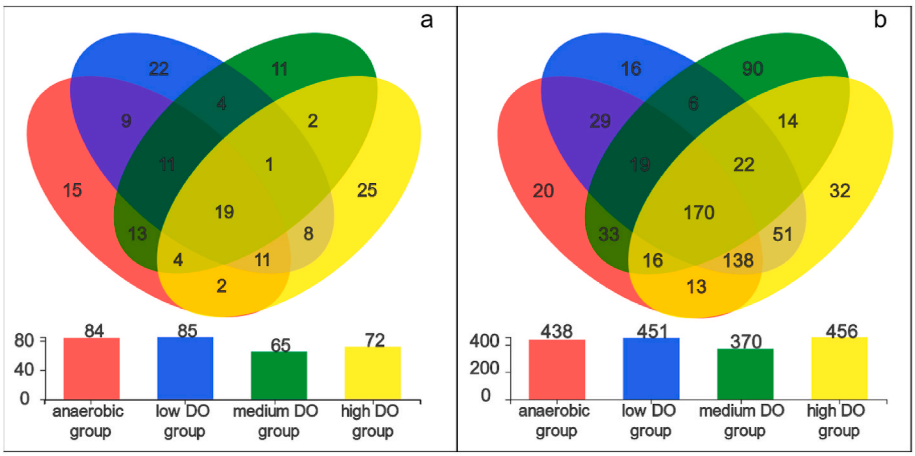


**Fig. 8.** Venn diagram on OTU level in different DO concentration: (a) bacteria and (b) fungal.

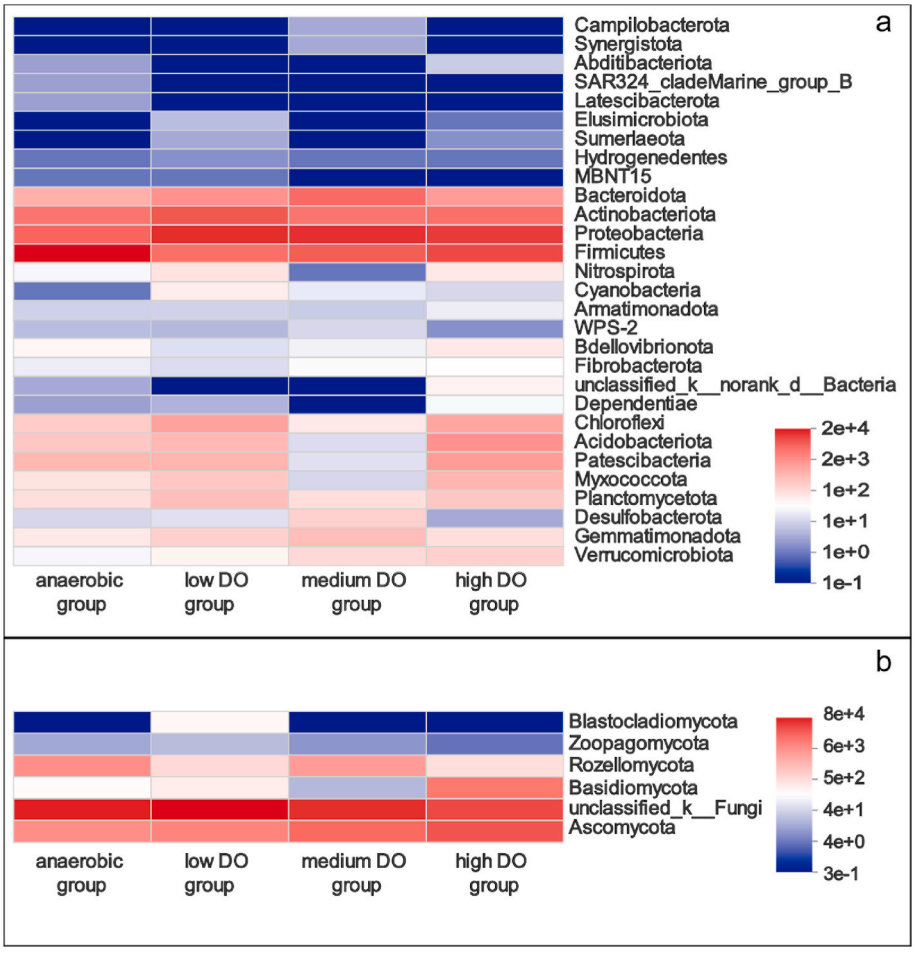


**Fig. 9.** Community heatmap analysis on phylum level in different DO groups: (a) bacteria and (b) fungal.

varying degrees, and the concentration of P in litter increased or decreased differently (Fig. 6). DO concentration promoted significantly the release of C, and the C:N ratio and C:P ratio increased (Table 2; Fig. 7).

### 3.4. Response of microorganisms community under different dissolved oxygen concentration

As shown in Fig. 8, the number of OTU of bacteria in different DO concentration varied greatly, ranging from 370 to 456, and the number of OTU of fungi did not change significantly. More bacteria on OTU level survived in high DO concentration, and more fungi on OTU level survived in low DO concentration, and the species of microorganisms in medium DO concentration were least (Fig. 8). The phylum of anaerobic bacteria were few, mainly *Firmicutes* and unclassified fungi (Fig. 9). Some microorganisms can survive in aerobic environment and anaerobic environment, such as *Alphaproteobacteria* and *Actinobacteria* (Fig. 9).

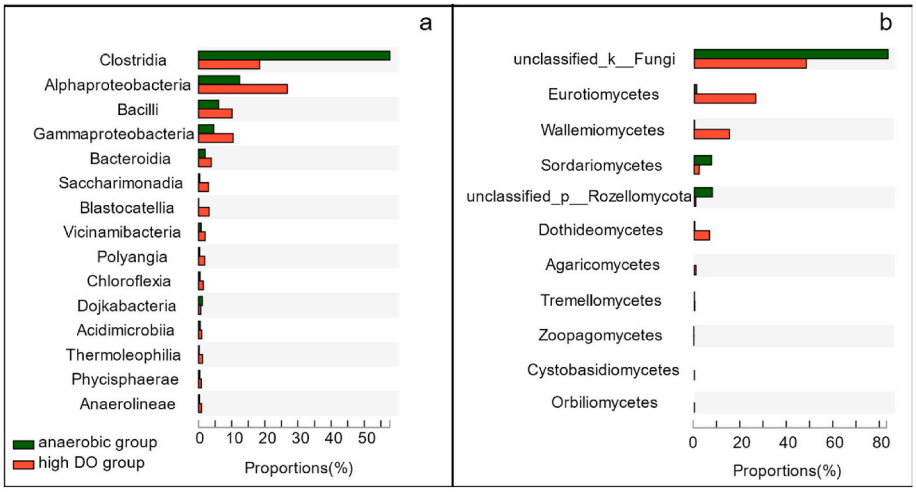


**Fig. 10.** The sample difference between anaerobic group and high DO group on class level: (a) bacteria and (b) fungal.

### 3.5. Analysis of major litter decomposers

The rate of litter decomposition and microorganisms community were different significantly between anaerobic group and high DO group (Fig. 3; Fig. 9). As shown in Fig. 10, *Alphaproteobacteria*, *Gammaproteobacteria*, *Bacilli, Blastocatellia*, *Eurotiomycetes*, *Wallemiomycetes*, and *Dothideomycetes* accounted for more proportion in high DO group. *Clostridia* is the largest class the anaerobic group, accounting for 89.7% of *Firmicutes* and 57.7% of total bacteria. Increasing DO concentration reduced the proportion of *Clostridia*, and the proportion of *Bacilli* increased in *Clostridia* and total bacteria. *Bacilli* can break down proteins and complex polysaccharides (Lu et al., 2007). *Proteobacteria* is mainly composed of *Alphaproteobacteria* and *Gammaproteobacteria*. *Alphaproteobacteria* is an endosymbioticbacteria that settles in cells (Martijn et al., 2018), and *Gammaproteinbacteria* is a nitrogen fixing *Rhizobium* (Shiraishi et al., 2010). *Alphaproteobacteria* and *Gammaproteobacteria* had little role in decomposing litter (Mastný et al., 2020). *Blastocatellia* belonged to *Acidobacteriota*, which played an important role in the decomposition of litter (Pankratov et al., 2012). *Ascomycota* in the anaerobic group was mainly composed of *Sordariomycetes* (85%). The concentration of *Sordariomycetes* in the high DO group was smaller, only 6.3% of *Ascomycota. Eurotiomycetes* accounted 75% for the majority *Ascomycota* in high DO group. Many microorganisms in *Eurotiomycetes* such as *Aspergillus* can produce cellulase and ligninase (Srivastava et al., 2014). *Wallemiomycetes* and *Dothideomycetes* were also the most efficient lignin degrading microorganism (Sánchez, 2009; Koukol, 2010). The effects of unclassified fungi on litter decomposition can't be evaluated. In conclusion, the increase of *Bacilli, Blastocatellia*, *Eurotiomycetes*, *Wallemiomycetes*, and *Dothideomycetes* is the reason for the accelerated decomposition rate of litter in high DO group.

## 4. Conclusions

This study focused on the effect of DO concentrations on litter decomposition rates and microorganism community. We measured the dry mass, C, N and P concentrations of litter over a 120 d experimental period. The experiment results show that decomposition rates of *Triarrhena lutarioriparia* are the highest, followed by *Phragmites australis* and *Carex* spp. DO promoted the decomposition of litter. The litter mass loss percentages of litter in anaerobic group was the lowest, ranging from 54.8% to 70.9%. The litter mass loss percentages in high DO group was the highest, ranging from 84.1% to 96.7%. The decomposition rate of litter was the highest in the first two days, and then gradually slowed down, which was significantly affected by mass residue percentage and sampling time. C and N were released continuously in the process of litter decomposition, and P was released mainly in the early stage. Litter decomposition significantly changed the concentrations of C, N and P in water, and had an impact on carbon cycle and eutrophication. DO accelerated the release of C and N, decelerated the released of P. DO significantly affected the microorganism community structure. More species of microorganisms existed in aerobic environment in this study. *Bacilli*, *Blastocatellia*, *Eurotiomycetes*, *Wallemiomycetes*, and *Dothideomycetes* accounted for more proportion in high DO group, and accelerated litter decomposition. Altogether, this study shows systematically how DO improves the decomposition rate of litter by changing the structure of microorganism community. These insights improved the understanding of litter decomposition and provide scientific support to the studies of C, N, P cycles in lake environment.

## CRediT authorship contribution statement

**Siwen Liu:** Methodology, Experimentation, Software, Writing – original draft. **Guojian He:** Conceptualization, Data curation, Software. **Hongwei Fang:** Supervision. **Song Xu:** Experimentation. **Sen Bai:** Software, Writing – review & editing.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

No data was used for the research described in the article.

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