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Effect of Water Ammonia Nitrogen Concentration on Survival of Mosquitofish *Gambusia affinis*

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Abstract

In this study, the relationship of the growth of invasion fish with water eutrophication processes was explored in Yangtze estuary, China. High water ammonia nitrogen concentration produced high effects on the growth and survival of mosquitofish *Gambusia affinis*. When the ammonia nitrogen was higher than 51.75 mg/l, the fish death rate obviously increased with days, and at the 4th day fish presented the highest mortality, while 23.72 mg/l ammonia nitrogen conditions have been able to ensure fish survival for two days in experiment treatment. Therefore, ammonia nitrogen of Grade V polluted water (national water quality criteria) is just 3 mg/l, and the water can be enough to support fish normal survival. Our results suggest mosquitofish was a suitable pioneer species for restoring polluted water ecology and purify water.

Keywords

Water Pollution, Ammonia Nitrogen, Mosquitofish, *Gambusia affinis*, Eutrophication

1. Introduction

Eutrophication has become a worldwide environmental problem and has drawn many researchers' attention all over the world. In China, anthropogenic nitrogen contamination and eutrophication in some lakes and rivers have significantly increased due to the rapid development of industry and agriculture over the past several decades. An important characteristic of eutrophication is the breakout of water bloom, followed by dissolved oxygen

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declining and ammonia increasing. Mosquitofish *Gambusia affinis* is native to North America and introduced in China in 1927 to control mosquito number. The fish tremendously increased in temperate and tropical regions, and become a serious invasive species today. As a larvivorous fish and prolific breeder, mosquitofish has an negative effect on the ecological function of the lake [1] [2], and their predator behavior could profoundly decrease local biodiversity [3]. When in food shortage, these fish show especially strong cannibalism and predatory behavior on small organisms [4].

Little attention has been paid to the interaction between aquatic biological invasion and water eutrophication. By field investigation, we found that *G. affinis* was widely distributed in most of the rivers in Fengxian, Shanghai, China. Native species *Oryzias latipes* in the niche had been completely replaced by mosquitofish, and *O. latipes* is hardly been found in rivers of Fengxian district today. The objective of this study was to determine the effect of water ammonia nitrogen concentration on survival of mosquitofish *G. affinis*, analyze the relationship between aquatic invasive species and the key index of eutrophication ammonia nitrogen and clarify the tolerance of *G. affinis* on ammonia toxicity.

2. Materials and Methods

We used a dip net to capture the test fish from field river (30˚53'26" - 30˚53'33"N, 121˚21'48" - 121˚23'20"E). Experiments were conducted in laboratory of Shanghai Academy of Agricultural Sciences. Three 1000 ml tanks were deployed for each of control group and four treatments with six fish per tank. *G. affinis* collected were cultured indoor for one week for their acclimatization to the experimental conditions prior to the formal experiment. In order to reduce water evaporation, tiny airing was used as the mean of water oxygen aeration. Individuals chosen for the experiment were 10 mm in mean length (±2 mm). Fish were placed into the tank and fed everyday until the beginning of experiment. During the course of the experiment, we continued observing fish behavior but not feeding them. The numbers of death individuals per tank were recorded at 24, 48, and 96 h after experiment beginning respectively and then removed dead individuals in time.

3. Results

The results show that the mortality rate of mosquitofish increased with the increasing of ammonia nitrogen concentration, and at the 96 h after experiment beginning, mortality reached the maximum (**Table 1**). *G. affinis* could live in the high-ammonia environment compared to the Chinese perch *Siniperca chuatsi*, and their tolerances on ammonia were different in different growth stages. Yet, excess ammonia nitrogen content also could imperil the survival of *G. affinis.* At the 24 h of experiment, the fish appeared in the symptoms of the color white. At the 48 h, the fish showed the loss of body balance and the shortness of breath, then their activity slowed down, side tours, roll over, side floating on the water surface. At this time use glass rod to stimulate fish, the fish also can avoid the rod. The death began to appear at the 24 h and high mortality was found at the 96 h. This result proved that although the *G. affinis* has high tolerance on ammonia, but excess ammonia concentration still has lethal effect on the fish.

Water pollution and eutrophication have threatened mosquitofish population severely. Excess nutrient concentrations could affect feeding habits and behavior [5], and change mosquitofish body and viability [6], while the volatile ammonia from algae decomposition is especially harmful to fish reproduction, survival and growth [5].

Table 1. Average mortality rates to different ammonia concentrations.

Ammonia concentration (mg/L)	Average mortality rates (%)		
	24 h	48 h	96 h
0	0	0	0
23.72	0	0	55.56
51.75	11.1	16.67	77.78
71.42	16.67	27.78	83.33
99.63	27.78	38.67	94.44

In short, although *G. affinis* has considerably high tolerance on ammonia [5] [7], but excess ammonia concentration still has lethal effect on the fish, and mass death of *G. affinis* appeared after 96 h for exposure to high ammonia. As a widespread invasive species, *G. affinis* has occupied some ecological niches of native species. The excessive increasing of ammonia produced by water pollution and eutrophication probably inhibits invasion process of mosquitofish.

4. Conclusion

At the 4th day of experiment treatment fish showed high mortality rate, and the mortality of experimental fish increased with the increase of ammonia nitrogen concentrations. At the ammonia nitrogen concentration of 23.72 mg/l mosquitofish can survive two days. Water pollution degree of ammonia nitrogen concentrations has been far inferior to that of national water quality criteria (Grade V, 3 mg/l). This result suggested that mosquitofish had high tolerance on water pollution, especially high ammonia, this species can be used as pioneer species, improve the ecology condition of polluted water and purify water quality, conduct ecological restoration on water pollution.

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