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Alteration of Feeding and Filtering Rates of Two Species of Marine Copepods Exposed to Different pH Levels

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Abstract

Impacts of different pH levels on different species of marine copepods, Calanoida copepod *Schmackeria poplesia* and Cyclopoida copepod *Oithona similis* were evaluated, and the alteration of key physiological processes of feeding and filtering were comparatively studies under controlled lab conditions. The optimal pH for *O.similis* and *S.poplesia* was 9.0 and 8.0

respectively, and they performed differently when exposed to different pH levels. For *S. poplesia*., the feeding and filtering rates increased steadily with the increment of pH at the range of 6.0~8.0, and reached the peak at pH 8.0. However, the rates decreased when pH was above 9.0. *O.similis* seemed more adaptive to the change of pH, and the increment was found in feeding and filtering rates at a range of 6.0~8.0. The maximus appeared at pH 9.0. compared to the other pH levels, the acidifying level of pH 6.0 presented the most obviously inhibition on feeding and filtering. Results in the present study would shed light on establishing the optimum culturing conditions for the cultivation of marine copepod.

Keywords: pH level; feeding, filtering; marine copepod

1. Introduction

Globing warming have led to a decrease in both pH and the availability of ions in seawater, which is known as ocean acidification (Orr et al., 2005). This ongoing process has been proved to exerted negative impacts on different marine biota, and has been mostly devoted to organisms that depend on the availability of carbonate ions in seawater such as bivalves. Despite a growing number of studies published on the negative impacts induced by seawater acidification on key physiological processes including growth and reproduction, metabolism, immune function and calcification on bivalves (Sun et al., 2016; Xu et al., 2016), less information available regarding interference in marine zooplankton exposed to such scenarios because most of them are non-calcifying organisms. Marine copepods are important zooplanktonic biota. They are the key loop between primary producers and higher trophic levels and play essential role in stability and sustainability of the marine ecosystem, and growth, without any doubt, is critical to the population dynamics and biomass fluctuation. Besides, they are small, short life cycle and vulnerable to the environmental changes, which make them desirable organism models in the field of environmental toxicology. We thus performed the present study, aiming at elucidating the impacts of different pH level, especially that leading to acidification, on key physiological processes of feeding and filtering in marine copepod. Results would shed light on establishing the optimum culturing conditions for the cultivation of marine copepod.

2. Materials and Methods

2.1 Organism Collection and Cultivation of Two Species of Marine Copepod

Adult individuals of *Schmackeria poplesia* and Cyclopoida copepod *Oithona similis* were collected from the shrimp pond located in Qingdao, Shandong province using a small plankton net. The copepod samples were stored in 25 L polyvinyl chloride barrels and quickly transferred into lab conditions with 2 h after collection. The active and healthy individuals with good phototaxis were chosen and were kept in 2L beaker containing raw seawater with continuous aeration for acclimation. The cultivating system was kept at 5~10 ℃ with a 12 h light: dark cycle in illuminating incubators with a light intensity of 700 Lux, and the salinity was set at 30. Different bait mixture was applied for the acclimating cultivation: mixture of *Isochrysis galbana*: *Chlorella sp.*: *Phaeodactylum tricornutu* at a ratio of 3:1:1 was used for *S. poplesia,* and that of *I. galbana: Thalassiosira weissflogii:*

Platymonas hellgolandica at the same ratio was for *O. similis*. The biomass of the bait was controlled within 10^4cells/mL. After acclimation, the female individuals with eggs were picked up and were transferred into the 1L beaker, and the temperature was steadily increased to 15 ℃. The larvae were collected every other day to obtain the first-generation offspring and developed them to the adult for further experiment. The other cultivating conditions were the same as above described without other description. The microalgal cultivation was performed according to the method of Zhao et al. (2017), and the raw material was treated and sterilized according to the procedure of Zhang et al. (2015).

2.2 Experimental Design

The experiment was conducted in clean beakers containing raw seawater with pH values of 6.0、7.0、8.0 (control group) and 9.0, respectively. HCl and NaOH at a concentration of 1M was used to adjust the pH values. 10 adult copepods without eggs were randomly picked out and were placed into cultivating system above mentioned for 3 days. Thereafter, examination on feeing and filtering was performed according to the method of description of Castellani et al. (2005), and no feeding was performed during the experiment. The feeding and filtering rates were calculated according to the following equations (Frost, 1972):

$$\mathrm{F} = V/N \cdot log_e(Ct/Ctf)$$

$$\mathrm{G} = F(Ctf - C0)/log_e(Ctf/Co)$$

where '*V*' is the total experimental volume (mL); '*N*' is the number of the copepod in each beaker (ind); '*t*' is the duration (h) of the experiment; 'c_0' and 'c_t' denote the cell densities in each flask at the beginning and at time '*t*' after exposure in the control group, respectively; 'c_{tf}' is the final density in the treated groups.

2.3 Statistic Analysis

SPSS Statistics 17.0 was used to analyze the data. The difference between the test and control results were analysed statistically with one-way analysis of variance (one-way ANOVA).

3. Results

3.1 Effects of Different pH Levels on Feeding and Filtering Rates of S. Poplesia

The feeding and filtering rates of *S. poplesia presented the similar changing tendency* at the range of pH 6.0~9.0, which increased firstly and then decreased. Their lowest rates appeared at pH 6.0, which was the typical condition of seawater acidification. A relative increment was found thereafter and reached the peak at pH 8.0, which was set as the control in the present study. The further elevation of pH would significantly decrease the rates, inferring the occurrence of inhibition on metabolism.

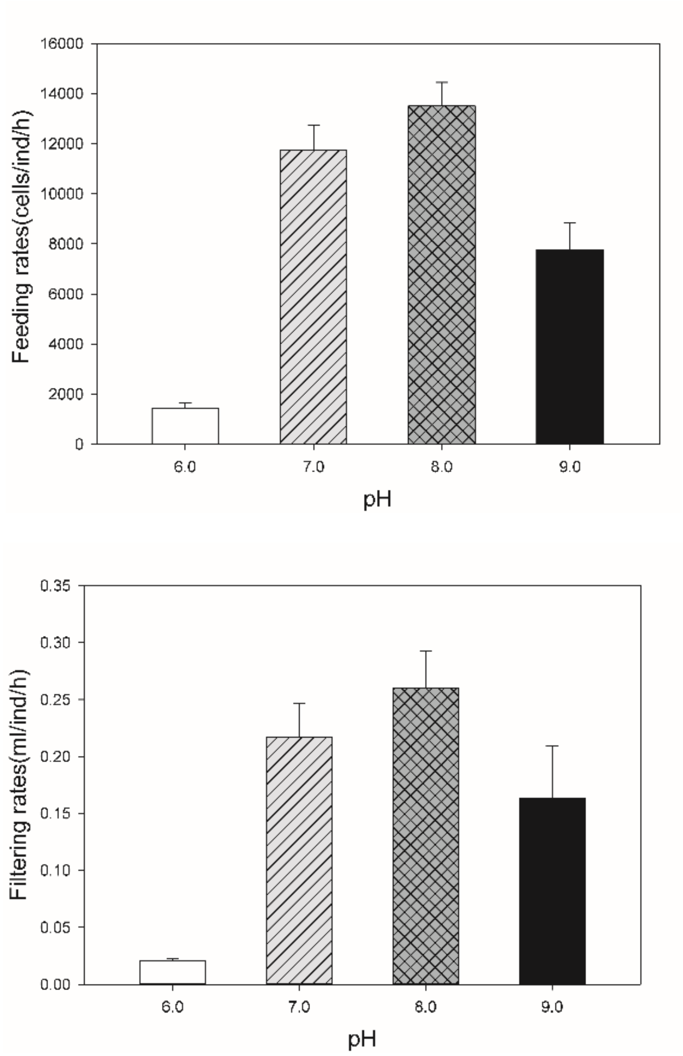

Figure 1. Effect of different pH levels on feeding and filtering rates of *S. poplesia*

3.2 Effects of Different pH Levels on Feeding and Filtering Rates of O.Similis

Different to those in *S. poplesia*, the feeding and filtering rates in *O.similis* increased steadily during the whole treatment, and the peak appeared at pH 9.0. Significance was observed between the treated group of pH 9.0 and pH 6.0. it seemed that *O.similis* was more adaptive to the alteration of pH levels compared to *S. poplesia*.

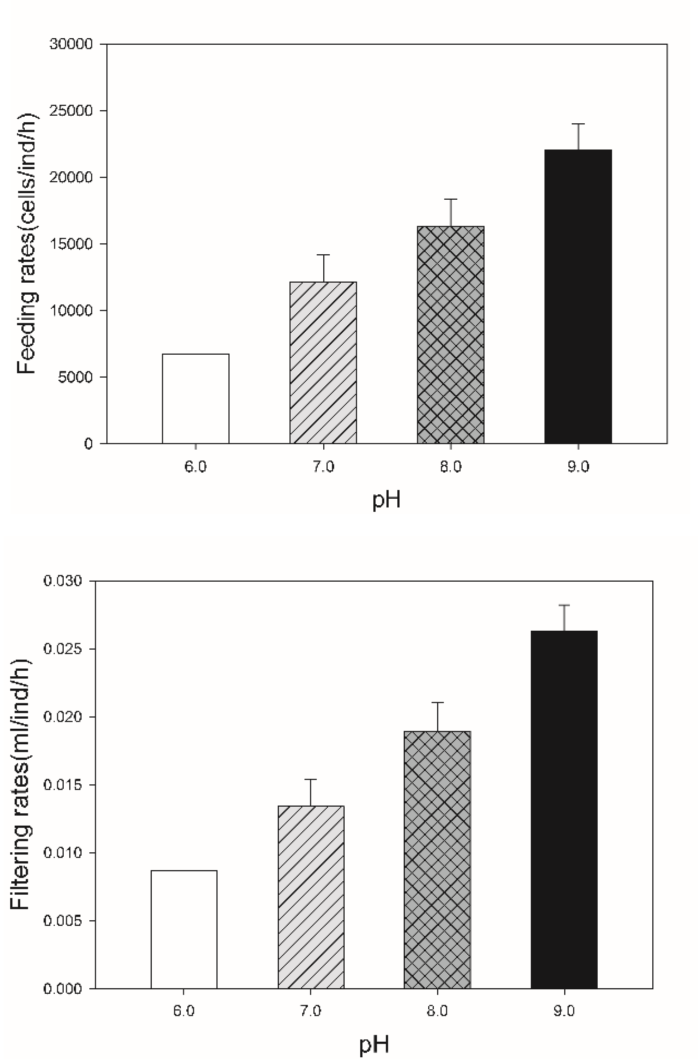

Figure 2. Effect of different pH levels on feeding and filtering rates of *O.similis*

4. Discussion

We found in the present study that the alteration of pH level significantly affected the feeding and filtering rates of two species of marine copepod, and pH at seawater acidification level seemed to exert negative impacts on them. This results were similar to the previous studies, which reported that seawater acidification interfered with feeding, metabolism and reproductive development of many zooplanktonic biota (Kurihara et al, 2008; Maar et al., 2012). Moreover, *O.similis* present more tolerance to the decreased pH as compared to *S. poplesia*. The obtained documents on 7 species of marine copepods had showed that the 24 h LC_{50} for seawater acidification induced by HCl addition was about 5. 02~ 5. 69, and a great difference was found among the species with different growth habit. For instance, the benthic copepod was the most tolerant one, and the phytophagous species was more tolerant than carnivorous ones. Moreover, the swimming ability of copepods also helps them avoid acidified environment (Thistle, 2007). When combined considered the results in the present study, we presumed that seawater acidification would interfere with the growth and metabolism of marine copepod, and different species exhibited various performance to the pH alteration. Results in the present study would be helpful for establishing an optimal system for copepod cultivation.

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