Evaluation of Bivalve (Anodonta Cygnea) in Filtration of Nitrogen and Phosphorus Compounds

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Received: June 2009 Accepted: June 2010

Introduction

Population ecology of commercial marine bivalves is the subject of many studies; conversely, information on the fresh water bivalves is very scarce because the exploitation of these mollusks has never been important, except in limited areas and at certain periods. For example, in Northern America, pre-Columbian societies used freshwater mussels mainly for food. In the Tennessee Valley the shell of ten species are used in the button industry and exported to Japan for cultured pearl industry. In Rumania, the shells of freshwater bivalves, nominally those of the genus *Unio*, are exploited for button industry and their soft tissues are used as fodder in poultry farming. According to Negus, her studies on *Unio* and *Anodonta* were the first on the growth rate and production of freshwater bivalves. Magnin & Stanczykowska compared the results of their research on the production of fresh water bivalves in Canadian lakes with those done by European authors due to lack of American studies on this subject. Most researches started from the 1960's, when these mollusks were used as indicators of radioactive and stable pollutants. Even if the commercial value of the freshwater bivalves is negligible, their role in the trophic ecology of certain environments is important. Freshwater bivalves of south Caspian Sea lands are dispersed in major parts of this area. The swan mussel (Anodonta cygnea) is one of the most famous fresh water suspension feeders in comparison with other few fresh water mussels in Caspian Sea lands. It seems to be an active agent in natural water cleaning from suspended particles down to bacteria.

However the sampled region is one of the most populated areas of north of Iran and many of the rivers coming to the sea, support high quantities of urban and agricultural sewages. The generation of sewage by agricultural and industrial activities causes a poor quality for waters. Dissolved Phosphate & Nitrate in wastewater create environmental inconveniences. Reduction of this dissolved party by a biological means was the main objective of the present research. In order to demonstrate utilization of A. cygnea, in reduction of Nitrate & Phosphorus in wastewater, they were placed in closed systems at 19 – 20 ºC.

Materials and methods

Specimens were collected in the early spring of 2006 from Tajan river mouth, one of the main effluent rivers of south Caspian Sea basin. Bivalve specimens were acclimatized in the same tank before the experiments started. The end of acclimation was distinguished by observing normalization in their filter feeding behavior according to works already done by Javanshir.

Our experiment system media (bivalves transferred to this media) consisted of a 100 liters connected to four 2.5 L recipients. Connections were realized with 2 cm Ø polyethylene pipes. One of recipients was used as control with no bivalve specimen supply. One recipient of 30 liters was used to collect the outflow of four experimental recipients. The water current in recipients design, flowed from big tank (100 L) to four little recipients (2.5 L) by gravity.

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Here, bivalves have enough time to filter the suspended materials in the water. Then, outflow was collected (by gravity) from 30 L recipient. Waste water content of the lather, was pumped to the main tank of 100 L. Before and after all recipients, water current was controlled utilizing polyethylene valves. Specific valve was installed just after the main tank in order to sub sampling of the initial concentrations of nitrogen and phosphate. Temperature and saturated oxygen remained constant using an aquarium electric heater and an air pump.

In this study, three different treatments of Nitrogen (80, 100 and 200 ppm) and Phosphorus (20, 40 and 60 ppm) were separately examined. Sampling was done three times at all treatments. $CO(NH_2)_2$ and K_2HPO_4 were used for achieving different concentrations of nitrogen and phosphorus.

At the beginning of experiment, the outlet from four little recipients were closed but the valve of main tank allowing water current to these four recipients was opened, permitting the current to fill the system. As soon as the system was filled, the valves were closed. The valves remained closed for 30 minutes to allow the bivalves in 2.5 L recipients to do the filtering. After this time outlets were opened and the secondary concentrations (C30) were sub sampled from outlet current in a 50 ml laboratory tube. At the end of sub sampling, the current from the main tank was re-opened and system water circulation was maintained for 120 minutes, which allowed the current to be recycled in the system. After this time the same periods of 30 and 120 minutes were repeated for two times, each one sub sampled in three replicates.

The concentration of nitrogen in each sub sample was determined by makro kejeldahl method. As well, the concentration of phosphorus was determined by Spectrophotometer method. At the end of the experiments, bivalves were dried (48h at 48°C in order to obtain dry weight) then the whole body of each one was burned separately (700 °C, in order to achieve ash weight). Dry weight of organic matter (AFDW) was then calculated, using differences between these two measurement values.

Measurements were based on the estimation of the decrease in nitrogen and phosphorus concentration during a fix period of time. We have utilized the JØrgensen formula (JØrgensen, 1990) to estimate the filtration rate (Vw):

$$Vw = V \times \frac{Ln(Ct0) - Ln(Ctn)}{t \times W}$$

Where: Vw: filtration rate (ml. g –1. min –1)

V: recipient volume (ml)

Ct0: N&P concentration at time zero (cell number per ml)

Ctn: final N&P concentration

t: experiment period (minutes)

W: animal weight, AFDW g, (Ash Free Dry Weight)

We have measured the filtration rates as a function of Animal Flesh Dry Weight (AFDW)

Results

The results showed that the filtration rate of A. cygnea decreased parallel to the decrease of nitrogen & phosphorus concentration .Also in low concentration of nitrogen, specific filtration rates were 6.71 ml. g –1. min –1 during the 1st 30 min, 6.44 ml . g –1. min –1 for the 2nd 30 min, and reached to 6.44 ml . g –1. min –1 for the 3rd 30 min. In medium concentration, specific filtration rates were 7.4 ml. g –1. min –1 during the 1st 30 min, 7.09 ml. g –1. min –1 for the 2nd 30 min, and 6.95 ml. g –1. min –1 for the 3rd 30 min. In the 3rd treatment, specific filtration rates were 8.27 ml . g –1. min –1 during 1st 30 min, 8.03 ml. g –1. min –1 for he 2nd 30 min, 7.91 ml. g –1. min –1 for the 3rd 30 min respectively. Differences showed a slight but not significant decrease.

We also faced similar situations for phosphorus, as in low concentration of phosphorus, specific filtration rates were 6.44 ml. g –1. min –1 during the 1st 30 min, 5.85 ml. g –1. min –1 for the 2nd 30 min and reached to 4.54 ml. g –1. min –1 for the 3rd 30 min.

In medium concentration, specific filtration rates were 7.06 ml. g –1. min –1 during the 1st 30 min, 6.52 ml. g –1. min –1 for the 2nd 30 min and 5.92 ml. g –1. min –1 for the 3rd 30 min. In the 3rd treatment, specific filtration rates were 7.94 ml. g –1. min –1 during the 1st 30 min,

7.52 ml. g –1. min –1 for the 2nd 30 min, 7.29 ml. g –1. min –1 for the 3rd 30 min respectively.

Discussion

Today, the use of biological filters is a quite effective and common method for removal of soluble compounds. The idea of using fresh water mollusks for filtration of food from waste water was introduced by Ryther and guillard in 1962.

According to the results of nitrogen refinement by A.cygnea, the filtration rate in all three treatments decreased with time. This can occur because of two reasons, first a reduction in the demand for mussels in comparison with the existing materials over time, and second a reduction in the concentration of other raw materials.

Nitrogen filtration rate was significantly variant during the experiments. This shows that by increasing nitrogen concentration in a media, their filtration rate will increase. Our results are consistent with the results from Crassostrea, Virginia in 2003.

Results of reduced phosphorus concentration confirm that in all of the three treatments, filtration rate will decrease over time.

A comparison between the filtration rate of nitrogen and phosphorus indicates that the filtration rate of nitrogen is more than that of phosphorus.

A research done on Dreissena Polymorpha in Polish lake shows that, this shell affects on the cycle and concentration of nitrogen and phosphorus in the column of water, and filtrates 50 t0 80 percent of nitrogen and 40 percent of phosphorus.

According to the results obtained in this study, this type of mussel has relatively good ability of refinement, and can be used to control and reduce biological pollution (nitrogen and phosphate compounds) in eutrophic lakes, ponds and sewage systems.

Key words

Filtration rate, Phosphorus absorption, *Anodonta cygnea*, Waste water, Biologic purification.