Material Circulation of Balanced Aquarium

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1. Abstract

We created Balanced Aquarium, an aquarium which can be stable without the intervention of human. In the aquarium made of plastic bottle, we put shrimp (*Neocaridina denticulate*), water plant (*Egeria densa*), bacteria which contain bacillus subtilis, nitrifying bacteria and distilled water. Then we focus on COD (Chemical Oxygen Demand), ammonium ion, nitrate ion and consider about the survivable condition of shrimp. As a result, COD, ammonium ion, and nitrate ion levels rising were controlled, and we succeeded in keeping the survivable condition of shrimp.

2. Background, Purpose, Hypothesis

Today, raising fish needs a lot of investigation of human such as water quality management, feeding and so on. From small scale raising in our house to large scale raising, its costs are not inexpensive. And then, we thought that studying success condition of Balanced aquarium and creating it leads to a cost cut.

Balanced Aquarium will sustain conditions in them, for instance, COD, ammonium ion, and nitrate ion levels.

3. Pre-experiment

(1) Purpose

We investigate the material in the aquarium which is connected directly with the death of the shrimp by raising it in specific condition that cause of the death is absolutely aggravation of water quality.

(2) Method

We put 500ml distilled water, about 15g Egeria densa and one Neocaridina denticulata in the aquarium. The aquarium is a 2L PET bottle’s lower half part. The aquarium put into the incubator. The condition of the incubator is 25 degrees and bright half of a day, dark other time. We measured Ammonium ion, Nitrate ion and COD once a day by using pack tests until shrimps dies. We experiment 3 times.

Ammonium ion is the urine component of the shrimp and poisonous itself. COD mainly shows the quality of the organic matter about excrement of the shrimp and become an index of pollution of the water. The environmental standard value is less than 8mg/l in case of lake. It is thought that oxygen deficiency occurs because of disassembly by decomposer in case of

higher than this value under natural environment. Ammonium ion is oxidized by Nitrifying bacteria and become Nitrate ion. Nitrate ion is index of lowering the concentration of Ammonium ion.

There are five reasons to use Neocaridina denticulata.

1. Lifespan is more than a year.
2. The length is about 2cm, so it is easy to take care of shrimp.
3. It can survive in still water and dissolved oxygen concentration doesn't have to be high, so this shrimp won't die too easily. This shrimp is durable.
4. It is used aquariums as ornamental.

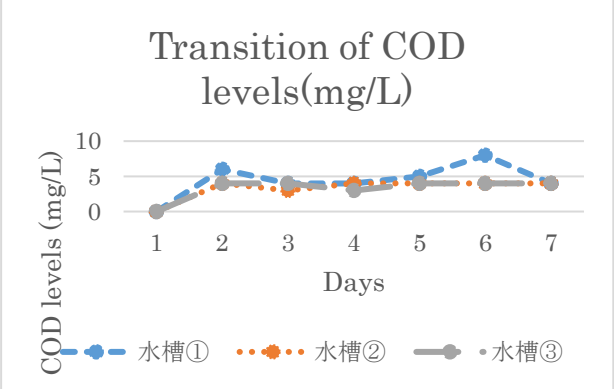
The picture below is the aquarium we used in experiments.

(3) Hypothesis

Ammonia nitrogen is used as the index of environment pollution. So, we thought that the cause of shrimp death is deterioration of water quality by Ammonium ion.

(4) Result

Figure 1 The change of COD concentration in pre-experiment



The shrimp in Aquarium ① died in 7th day. But shrimp in other aquariums had been living for seven days. The concentration of Ammonium ion and Nitrate ion stood at about 4ppm in all three aquariums. We omit two values in this graph so that they're not changing.

However, the concentration of COD increased about 8ppm at the day before shrimp died.

(5) Conclusion

It is thought shrimps died the cause of deterioration of water because of increasing the concentration of COD, that is, increasing excrete of shrimps and decreasing dissolved oxygen by decomposer. We thought increasing the concentration of Ammonium ion has influence on cause of death, but it doesn't true.

4. Main-experiment

(1) Purpose

Judging from pre-experiment, it seemed that rise of COD causes shrimp to die.

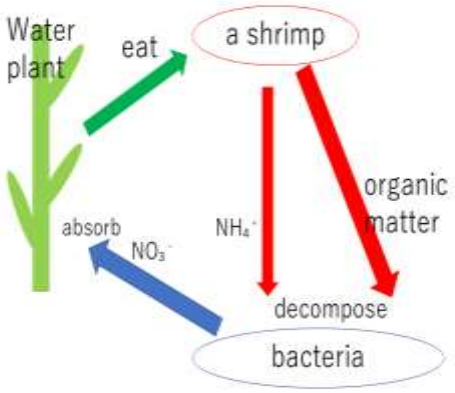
So we used a commercially available bacterial agent (EBPS Sonekemifa : Effective Bacteria Pack Solution) and controlled the circulation of an aquarium. Bacteria agents include bacillus subtilis, nitrifying bacteria and intestinal bacteria. Bacillus subtilis suppress COD by disassembling organic matters, nitrifying bacteria transform ammonia excreted by shrimps into nitrate ion and intestinal bacteria adjust the intestinal environment.

Furthermore, ammonium ion and nitrate ion are fixed and used for a water plant to glow up.

We presented in Figure2 how material circulation happens in the aquarium.

Thus, we investigated the amount of bacteria we need to keep water clean enough for shrimps to live.

Figure2　material circulation in the aquarium



(2) Method

We used four 2 litter plastic bottles as aquariums and put 500ml distilled water, 5 water plant grams and one shrimp, we also put in bacteria agent respective 8ml, 10ml, 15ml and

50ml. Then, we measured COD and concentration of nitrate ion and ammonium ion by using a pack test until it died. We determined the amount from this data.

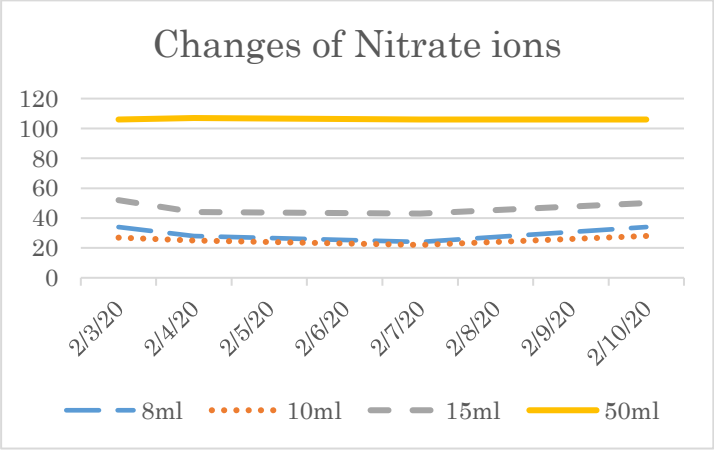
(3) Hypothesis

The value of COD and the concentration of nitrate ion and ammonium ion will become stable and low when the amount of bacteria increases. As a result, the shrimp will not die of diseases caused by water pollution.

Besides, they converge to a low value when we put bacteria agent in the aquarium sufficiently.

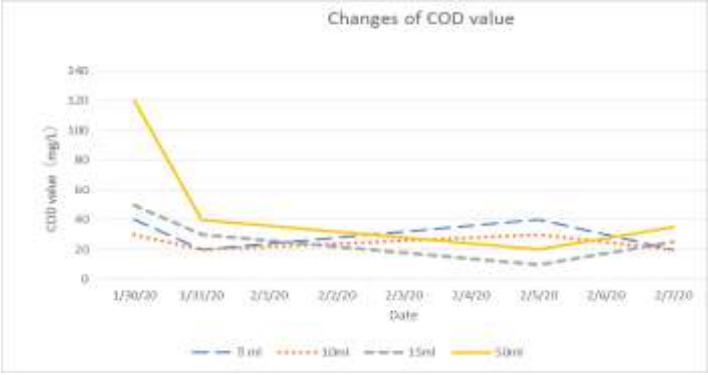
(4) Result

Figure3　Changes in concentration of nitrate ion



There was a difference in concentration of nitrate ion in each aquarium. However, the value of all aquariums was stable at a constant level.

Figure 4 The changes of COD concentration



All shrimps in each aquarium survived for over a month.

The value of COD varied between 10ppm and 30ppm, but all shrimps lived longer than in the pre-experiments.

The concentration of ammonium ion was no changes from 0.2 ppm from the first day to the end of measurement for all aquariums.

(5) Consideration

There was a difference in concentration of nitrate ion, but all shrimps were alive for about a month, and the concentration was stable, so we can say that the balanced aquarium has been established.

In addition, the value of COD in all aquariums was constant, despite the variation in the value of COD.

Therefore, it was found that 8 ml of the bacterial agent is sufficient for 500 ml of water in the aquarium.

5. Conclusions

It can be said that balanced aquarium was established because the concentrations of COD and nitrate ions converged. In addition, under the conditions of 500ml of pure water, about 15g of giant canada-a water plant, and 1 shrimp, a balanced aquarium is established when at least 8ml of the bacteria we used is administered.

6. Future Outlook

Since our aquarium is open type, we always need water supply. We would like to aim at an aquarium that does not require additional supply of water in a sealed environment by capping a plastic bottle. In addition, oxygen deficiency may be considered in the closed space. We would like to aim at an aquarium in which the oxygen consumption due to respiration of shrimp, giant canada, and bacteria and the oxygen supply due to photosynthesis of giant canada are balanced. In this case, it is necessary to take into consideration the growth of giant canada, shrimp, and bacteria in the aquarium, which greatly increases completely. In this experiment, we used one shrimp as a consumer, but we would like to examine the conditions for establishment when more than two fish are propagated and the conditions for using other aquatic organisms. In addition, in this experiment, the space with the aquarium was always set at 25℃ and 12 hours of sunshine, so it is hard to say that nature was exactly reproduced. In the future, we would like to carry out experiments to obtain more practical results by making the situation closer to the natural situation.

7. Acknowledgements

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8. References

The influence of water injection and aeration on the water quality and the growth of European eels
https://www.jstage.jst.go.jp/article/aquaculturesci1953/28/1/28_1_26/_article/-char/ja/