

## Competition between Medaka and Mosquitofish under Climate Change

Dept. of Civil and Env. Eng., Waseda University, Student Member ○ Jingjing Wang  
 Dept. of Civil and Env. Eng., Waseda University, Regular Member Yutaka Sakakibara

### 1. Introduction

The medaka, *Oryzias latipes*, is a small, egg-laying, freshwater, bony fish that is native to Asian countries (primarily Japan, China, and Thailand)<sup>1)</sup>; while an introduced fish; Mosquitofish (*Gambusia affinis*) tends to expand and enter into its habitat area, recently. Mosquito fish can eat other insect larvae and fish fry. It is concerned that this invasion by Mosquitofish may be accelerated in many parts of the world<sup>2)</sup>, because population of Mosquitofish has been increasing, but Medaka's has been decreasing quickly in recently years<sup>3)</sup>. Under climate change, the invasion will be further accelerated. According to data from *Saitama Prefecture Environment International center*, the average ground temperature in Saitama was already raised 2-3°C<sup>4)</sup>. In this study, competition and population changes among Medaka and Mosquitofish were investigated experimentally under different temperatures. Besides, we also want to discuss the way to protect native Medaka fish through the study.



Fig. 1 Medaka, Mosquitofish and their Juveniles

### 2. Methods

Medaka and Mosquitofish (Fig.1) were caught in Motokoyama-river, Saitama Prefecture. During the whole experiments, water quality in tanks was kept suitable to grow and feeding rate was kept at 0.003g/fish\*day. In isolated cultures, Medaka and Mosquito fishes (10 fishes each consisting of 5 female and 5 male fish) were put in different fish tanks and temperature was changed every two week step-wisely from 22°C to 36°C and from 20°C to 8°C<sup>5)</sup>. After that, putting 10 each Medaka and Mosquitofish

cultivated independently in the same tanks at 10, 15, 25 and 30 °C, and numbers of surviving fishes were counted. In addition, ratios for spawning, hatching, larval survival were also measured.

### 3. Results and Discussions

Experimental results in isolated cultures were shown in Fig. 2 and Fig. 3, demonstrating that no deaths were observed in the temperature range of 16°C to 30°C. However, above this range, mortality rates for Medaka increased significantly in comparison with Mosquitofish (as shown in Fig.2).

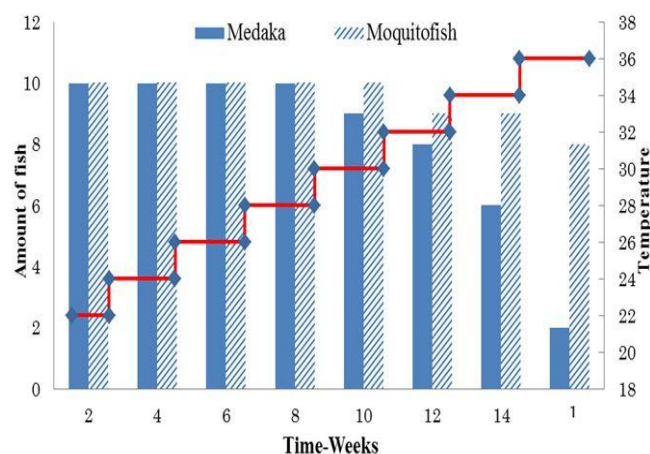


Fig. 2 Results of isolated cultures where temperature was step-wisely increased.

Moreover, Mosquitofish didn't show their advantage at lower temperature around 10 °C. When water temperature was reduced to lower than 14°C, Mosquitofish activity declined and some female fishes lower temperature around 10 °C.

When water temperature was reduced to lower than 14°C, Mosquitofish activity declined and some female fishes died, while Medaka still survived. Medaka could tolerate lower temperatures in comparison with Mosquitofish.

**Keyword:** Biological Invasions, climate change, Medaka, Mosquitofish, Temperature

**Address:** 3-4-1 Okubo, Shinjuku, Tokyo, Japan. **E-mail:** sakaki@waseda.jp

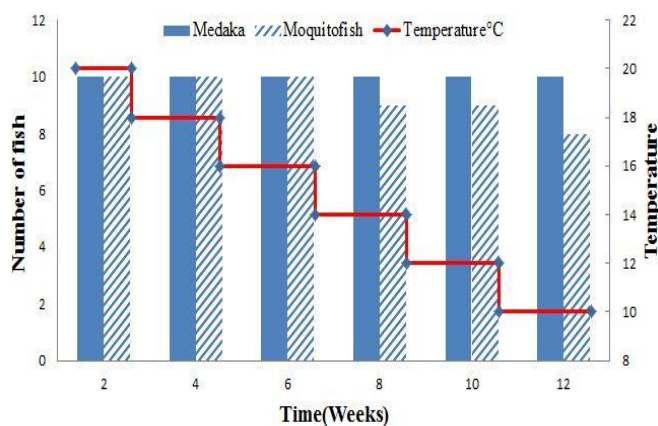


Fig. 3 Results of isolated cultures where temperature was step-wisely decreased.

In addition, it was found that the highest spawning success rate of Medaka (i.e. 70%) was observed at 25°C, which were larger than 15% at 20°C or 25% at 30°C. Mosquitofish can still multiply above 30°C, while Medaka never spawns.

Temperature effect is also significantly for both larvae (and juvenile) fishes in a water temperature range of 20-26°C, where both juvenile fishes had relatively higher survival rates.

Results in co-cultures of both fishes were shown in Fig.4 and Fig.5. Mosquitofish attacked Medaka directly, so that every Medaka died within one or two weeks. This period was shorter in higher temperature. But, Mosquitofish was not aggressive at lower temperatures, e.g. only one Medaka died at 14°C and no fish died at 10°C.

#### 4. Conclusions

From experimental results, it was found that Mosquitofish expelled Medaka through direct attacks and lower mortality rate at higher temperature above 25 °C. At lower temperature around 10 °C, both fishes can survive. From these results, it is considered that global warming will give more competitive advantage to Mosquitofish.

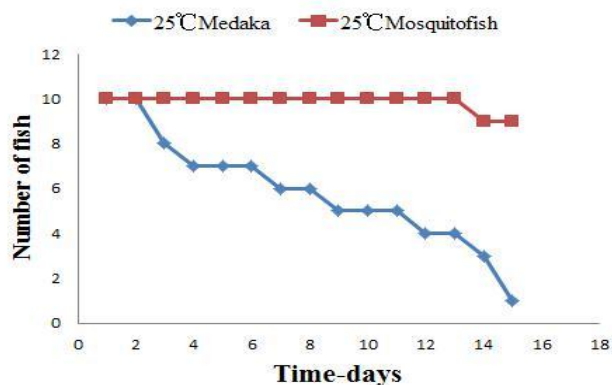


Fig. 4 Competition between Medaka and Mosquitofish at 25°C.

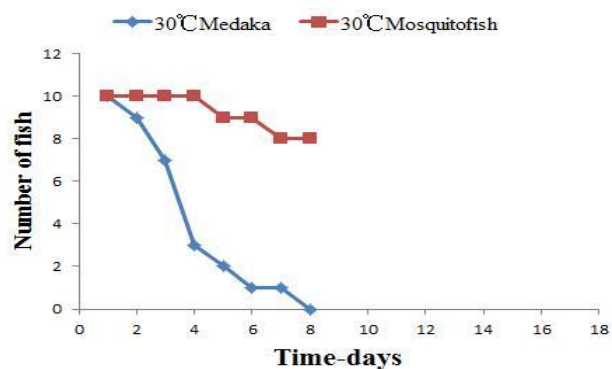


Fig. 5 Competition between Medaka and Mosquitofish at 30 °C.

#### References

- 1] 岩松 鷹司, メダカと日本人, 青弓社 2002 ISBN:4787232010.
- 2] G. Chandra, I. Bhattacharjee, S.N. Chatterjee & A. Ghosh (2008) Mosquito control by larvivorous fish, *Indian J Med Res* 127, January pp 13-27.
- 3] Akihiro Shima, Hiroshi Mitani. *Medaka as a research organism: past, present and future. The University of Tokyo, 2004.*
- 4] 日本気象庁, 埼玉の気温年平均気温の経年推移, 1946-2010.
- 5] Jingjing Wang, Yutaka Sakakibara. *Competition between Medaka and Mosquitofish under Different Temperature* 仙台 第48回日本水環境学会年会. 257, 201.