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Estimation of flow in a rearing tank of marine fish larvae by simplified numerical computation—a case of two-dimensional flow

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Abstract

Marine fish larvae are fragile against physical stress. However, few studies have been conducted to evaluate the flow field in a rearing tank, which is assumed to provide a high degree of physical stress to marine fish larvae. The flow field in a rearing tank (volume of 1 m^3) is generated by aerators, which are commonly used to provide oxygen.

This paper is a report on the estimation of stationary flow in the rearing tank of marine fish larvae. The larvae are seven band grouper larvae of *Epinephelus septemfasciatus*, which have a very low survival rate immediately after the hatching of eggs. The experiments of rearing of seven band grouper larvae were carried out using rearing tanks with four aeration rates (1000, 200, 50 ml/min,

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and no aeration). The effects of aeration on the survival and floating death of seven band grouper larvae were examined. The experiments confirmed that the mass mortality of seven band grouper larvae depends on the flow rate in the rearing tank. Aeration at 200 ml/min resulted in the highest survival and growth rates of grouper larvae.

Larvae-rearing experiments provided evidence that the flow rates of the rearing tanks are very important design aspects of rearing tanks. The estimation of flow in a rearing tank for an aerating rate of 200 ml/min was carried out by numerical calculation. The computation was simplified by a two-dimensional flow based on experimental results. The calculated flow in the rearing tank was compared with the experimental one. The calculation of the stationary flow in the rearing tank showed good qualitative and quantitative agreement with the experimental results. The numerical estimation of the flow in a rearing tank of marine fish larvae was confirmed to be effective and satisfactory for the design of a tank that would provide optimum performance.

Keywords: *Epinephelus septemfasciatus*; Larval rearing tank; Flow field; Numerical computation

1. Introduction

The culturing of marine fish larvae is in an era of rapid progress and significant improvement. However, marine fish larvae are fragile against physical stress, such as unfavorable flow, light, and temperature conditions, which may result in the mass mortality of larvae. Among fish species, grouper larvae are highly sensitive to physical stress, and mass mortality is caused by flotation in the rearing tank after the hatching of eggs (Masuda et al., 2001). The flow in a rearing tank was assumed to have the greatest impact of any condition on small grouper larvae. The flow in a rearing tank is usually generated by aerators that commonly provide oxygen and evenly distribute live food. However, few studies have been conducted on the flow field in the rearing tank (Backhurst and Harker, 1988). Yamaoka et al. (2000) reported that air bubbles produced during aeration caused mass mortality as a result of flotation. In addition, the idea that death can be caused by floating needs to be explained here and elsewhere. Shiotani et al. (2003) attempted a series of systematic experiments in which stationary flow was measured in 1 m^3 polyethylene rearing tanks for seven band grouper *Epinephelus septemfasciatus*.

The experiments of rearing seven band grouper larvae were carried out using rearing tanks (1 m^3 polyethylene tank) with four aeration rates (1000, 200, 50 ml/min, and no aeration). A spherical aerator was set at the bottom center of the tank to generate the flow in the tank. The effects of aeration on the survival and floating death of seven band grouper larvae were examined by counting the number of dead larvae floating in the tank. Rearing experiments were used to confirm that the flow depended on the mass mortality of seven band grouper larvae. Aeration at 200 ml/min produced the highest survival and growth of grouper larvae.

Measurements of stationary flow in a rearing tank identical to those used in rearing experiments were made using an aeration rate of 200 ml/min. The results of the study indicated that the stationary flow in the rearing tank was vertical and the horizontal circulation was unremarkable. However, a considerable amount of time was required to measure the flow in the rearing tank. In addition, since the optimum stationary flow varies