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Design and Experiment of an Upflow Circulating Water Scallop Hatchery System

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Introduction

- Traditional still water seedling cultivation has significant issues, such as poor breeding density, high mortality rate, and difficulty controlling water quality, when compared to circulating water seedling cultivation. Additionally, creating scallop seedling growing facilities with flowing water can boost breeding effectiveness even more.

Objectives

- The uniformity of D-shaped larvae dispersal in the culture cone under various cone structural designs and operating settings is investigated in this work. In order to give guidance for the design of culture cones in the upflow circulating water scallop incubation system, the optimal culture cone structure is further validated by field tests investigating the influence of inflow structure on the dispersion of D-shaped larvae.

Simulations

- Figure 1 depicts the overall structure of the upwelling scallop larval cultivation system developed in this study. It consists of a filter screen, cultivation cone, flow meter, water tank, water pump, ball valve, etc.
- Applying EDEM-Fluent coupling simulation to simulate the movement of upwelling scallop larvae, conducting single factor experiments and quadratic regression orthogonal rotation combination experiments, and determining structural parameters, Table 1 displays the level coding table. Figure 2 depicts the interaction effects of each structural parameter on the uniformity of the distribution.

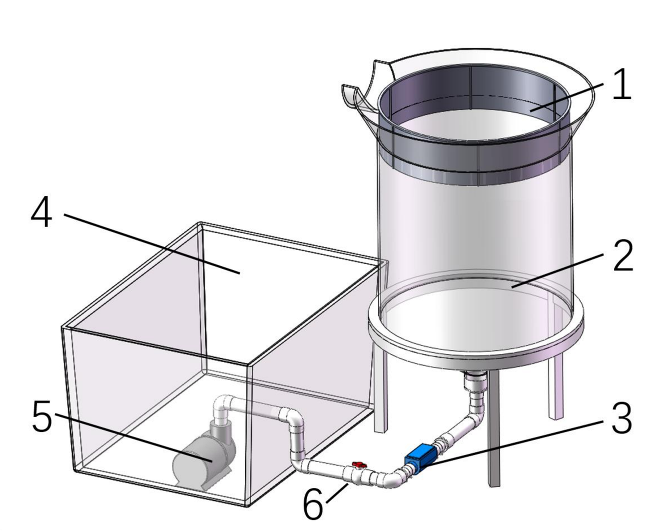

Figure 1. **Upflow Circulating Water Scallop Hatchery System Model**

Table 1. Factor Level Coding Table

Level code	Cone angle ϑ (°)	Inflow velocity v (m/s)	cylinder height/cone height n
-1	80	0.20	1.5
0	100	0.25	2.0
1	120	0.30	2.5

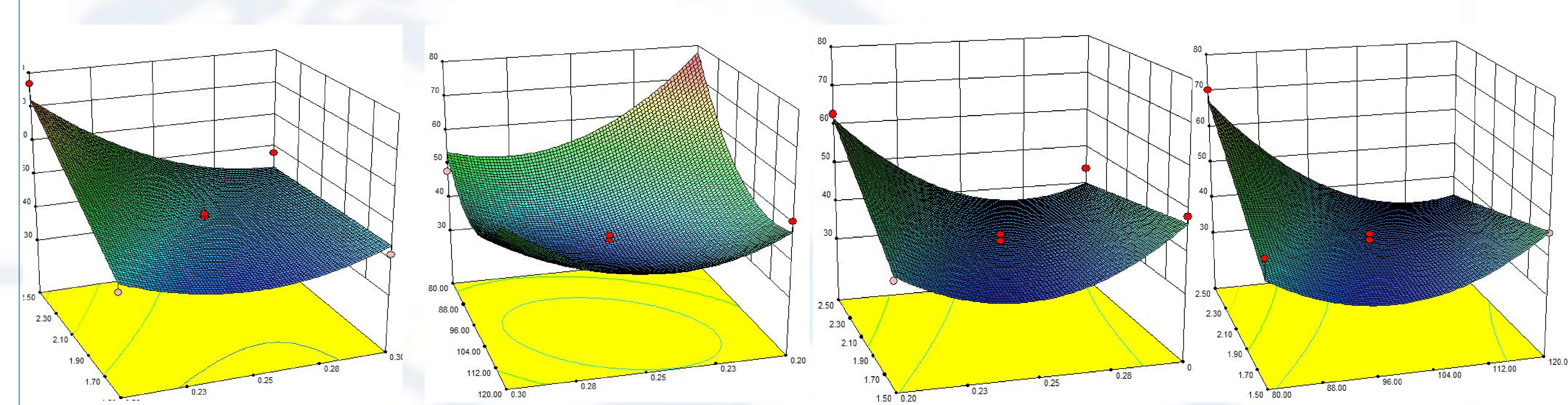

Figure 2. **Response surface analysis**

Prototype test

- A test prototype was constructed to conduct the operational performance test in order to confirm the intended culture cone's operational performance. Figure 3 depicts the test prototype, the inflow deflector angle and cultivation density were adjusted, and prototype validation tests were conducted.
- The three-factor and three-horizontal rotation orthogonal combination experiments were carried out with the deflector angle(c), the inflow velocity (n) and the D-shaped larvae density (τ) as the factors, and the radial distribution coefficient of variation ($Cv1$) and the axial distribution coefficient of variation ($Cv2$) were used as the influencing indexes. The regression equation is as follows
- $Cv1=24.17+0.29c+0.6n+2.79\tau-4.28cn+8.18n^2$
- $Cv2=39.77+1.77c+13.27n+0.15\tau+3.49c^2+25.26n^2$

Figure 3. **Upflow Circulating Water Scallop Hatchery System Prototype**

Conclusions

- The optimal combination of parameters was ϑ=108.97°, n=1.8, v=0.19m/s, c=60.94°, τ=11/ml, under these conditions, the simulated value of the coefficient of variation of the axial distribution of D-shaped insects was 34.40%, the measured value of the larval breeding device was 38.04%, and the relative error between the simulated value and the measured value was 10.58%.
- This study can provide an important reference for the design of larvae cultivation devices for scallop larvae in upwell-flowing circulating water.

Acknowledgement

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