A Report on the Mass Mortality of the Farmed Japanese Scallop, *Patinopecten yessoensis* on the Korean Coasts of the East Sea

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ABSTRACT

Unexpected mass mortality has been one of the drawbacks in front of the stable production of Japanese scallop (*Patinopecten yessoensis*) on the Gangwon coasts of the East Sea. The preliminary data from our routine observation revealed that the mortality appeared to be related to variation of water temperature in the farming site and the degree of the mortality was dependent on scallop strain. The present study performed to verify the preliminary findings exhibited that the mortality was closely related to daily temperature variation rather than monthly variation. Daily temperature variation was particularly damageable to the scallop during the temperature elevation period. Scallops from hatchery seeds (Chinese strain) were more tolerant against the temperature variation over those from wild seeds. The hatchery scallop gain of the temperature tolerance was probably due to their larval experience to higher temperature in the hatchery as well as their maternal genetic acclimation to upper temperature extreme of the Chinese environment which was recently found.

Key words: mortality, temperature, strain, *patinopecten yessoensis.*

INTRODUCTION

The Japanese scallop (*Patinopecten yessoensis*), a cold-tolerant bivalve, is a key species farmed on the Korean coasts of the East Sea, where daily water temperature is extremely unstable, particularly for 4 months starting July (NFRDI Report, 2006). Since its farming activity from early 1990s unexpected mass mortalities were frequent with more significant mortalities from late 1990s to mid 2000s. Our routine monitoring of the scallop mortalities together with the ambient environmental parameters preliminarily concluded that daily variation of the ambient water temperature to be a main culprit of the mass mortalities (NFRDI Report, 2006).

Several studies have reported damages in physiological status of molluscan species depending on seawater temperature variations for *Mya arenaria* (Abele *et al*., 2002), *Crassostrea virginica* (Hégaret *et al*., 2003), *Ruditapes philippinarum* (Paillard *et al*., 2004), *C. gigas* (Gannaire *et al*., 2006), and *C. gallina* (Monari *et al*., 2007) For scallop, Chen *et al*. (2007) reported that sudden elevation of water temperature can damage the immune system of *Chlamys farreri*. However, study on farmed *P. yessoensis* mortalities by sudden water temperature variation is lacking. Here, we report our observations of the daily water temperature variation in the farming sites and a unique finding about the scallop strain-specific tolerance against the temperature variation.

MATERIALS AND METHODS

Two groups of one-year old *P. yessoensis* (5.9 ± 0.66 g), one from hatchery seeds from Chinese spawners, the other from domestic wild seeds, were separately contained in 12-stored lantern cage (diameter, 45 cm; height, 20 cm). Twenty lantern cages (ten for Chinese strain, ten for domestic wild strain), each being contained 240 scallops evenly through its stories, were deployed in ESFRI scallop

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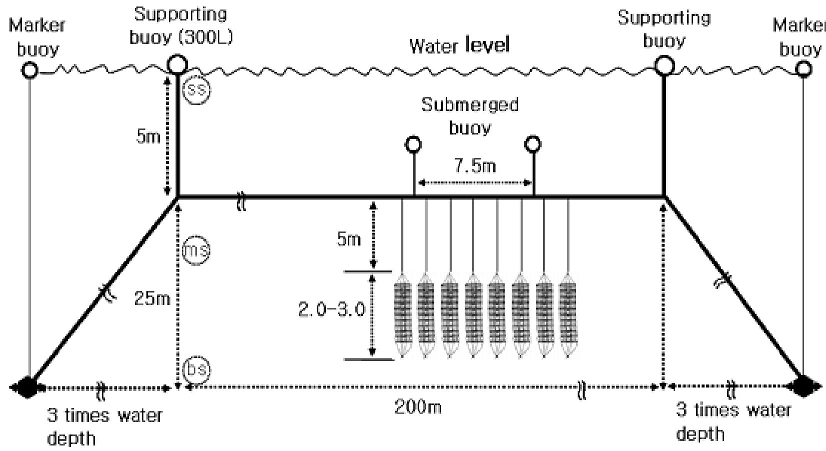

Fig. 1. Deployment of the scallop lantern cages in the experimental longline culture system located on the Gangneung coast, Gangwon, Korea. Water temperatures were measured on every 30-minute basis by three sensors; surface sensor (ss) placed in 1-meter depth, middle sensor (ms) at 15-meter depth, and bottom sensor (bs) at 30-meter depth.

research site, Gangneung, Gangwon, Korea (Fig. 1). Survivals were then monthly measured and analyzed by student's *t*-test of the Sigma Plot Software for statistics. Water temperature variations of the study site (0 m, 15 m, and 30 m) were measured in terms of daily variation (measured on every-30 minute basis) and monthly variation using remote sensing system.

RESULTS AND DISCUSSION

Gangwon coasts of the East Sea are less influenced by anthropogenic activities, thereby, being best candidate for *P. yessoensis* aquaculture. The scallops on the coasts, however, have experienced frequent mass mortalities since they were introduced for aquaculture (NFRDI Report, 2006). Preliminary data of our routine measurements showed two unique tendencies about the mortality. One tendency was temperature-related, the other was strain-specific. To verify our preliminary data, we measured water temperature variation of the farming site and survival of strain-different scallops in the study site (Figs. 2 and 3).

Fig. 2 shows survival of the scallop for 4 months starting May under the standard aquaculture system. In our 4-month study, significant mortalities from the previous measurement happened in August both in domestic and Chinese strains. However, mortality of domestic strain ($p < 0.01$) was much more significant than Chinese strain ($p < 0.05$). Even though August mortality of the Chinese was significant, its survival rate by the end of the experiment was still competitive with or even higher than normal culture without statistic difference (NFRDI Report, 2006). This finding suggests that the mortality is strongly strain-specific.

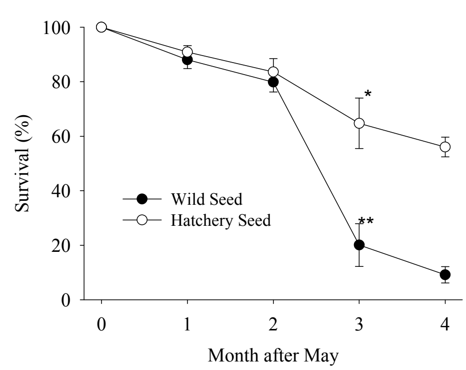

Fig. 2. Survival of the on-growing *P. yessoensis* originated from wild and hatchery seeds in the experimental site. Significant difference from the previous value during mass mortality was expressed with a single asterisk for $P < 0.05$ and double for $p < 0.01$.

Farmed population often faces with erosion of genetic diversity by the limited use of spawners, occasionally differentiating it from wild population (Alarcon *et al*., 2004). Chinese population of *P. yessoensis* was first introduced into China from Japan for aquaculture purpose in 1982. The continued domestication of the scallop in the temperature-variable Chinese waters made it differentiated in genetic diversity from its original wild population (Li *et al*., 2007). The temperature tolerance of our hatchery scallop was probably attributed to larval experience to higher temperature in the hatchery as well as maternal genetic difference from wild population.

We also measured changes in water temperature of the study site to give a comparison with the scallop mortality. Fig. 3 details water temperature profiles of the study site. The study site was very much unstable in daily water temperature. Interestingly, biggest daily temperature variation was about 14°C and this was found in bottom waters (30 m deep). The time the biggest daily temperature variation was measured was August, coinciding with the time of mass mortality.

It is well known that acute changes of water temperature can damage bivalve physiology (Gannaire *et al*., 2006 Monari *et al*., 2007). In our findings, daily temperature variation of October was comparable with that of August. However, none of the two scallop strains showed a significant mortality in October. One possible explanation of this discrepancy is that October daily temperature variation was in the temperature deceasing while August daily temperature variation was in the temperature elevating (compare two daily temperature variations with monthly variations in Fig. 3). Chen *et al*. (2007) supports our explanation in part, who found that immune system of Jikong scallops is more vulnerable by higher temperature exposure than by lower one even in a given variation regime.

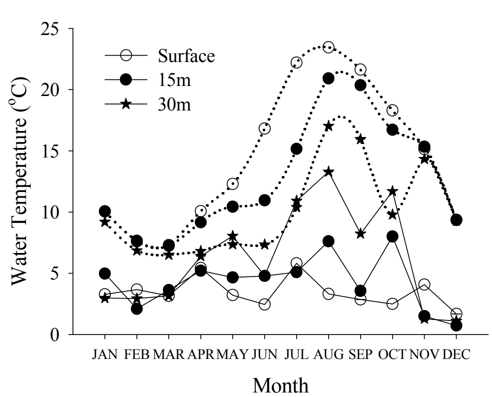

Fig. 3. Water temperature variation of the experimental sites. The smoothed dotted lines are for monthly variation on average, while solid lines are for maximum daily variation.

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