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Short Communication

Nursery Culture of Oyster *Crassostrea belcheri* (G.B. Sowerby II 1871) Spat in Plastic Mesh Nets Suspended Vertically and Horizontally

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Abstract

A comparative study on the nursery culture of tropical oyster spat *Crassostrea belcheri* (G.B. Sowerby II 1871) in plastic mesh nets suspended vertically and horizontally was conducted for 45 days. The results revealed no difference in absolute growth rate of shell width between both hanging methods. Spat suspended vertically showed higher absolute growth rate of shell length and instantaneous growth rate than those suspended horizontally. No significant difference was found between the mean survival rate of vertically (78.8±3.4%) and horizontally suspended (76.0±8.2%) spat. The vertically suspended net showed a higher fraction of spat larger than 1.22 cm than those in the horizontally suspended nets.

Introduction

Oyster culture in Thailand has been practiced for several decades along the coasts and *Crassostrea belcheri* (G.B. Sowerby II 1871) is one of the most commercially important bivalves (Department of Fisheries 1994). The majority of spat for grow-out farms are collected from natural sources, but the amount of oyster seed produced from those sources is limited and insufficient. The development of hatchery production techniques for *C. belcheri* (e.g. Tan and Wong 1996; Tanyaros et al. 2008; Tanyaros and Kitt 2011, 2012; Tanyaros et al. 2012) has made oyster culture operations independent of the inherent variability associated with the collection of spat or adults from the wild. To capitalise on these developments however, appropriate nursery culture protocols are required for the species. The transfer of oyster spat from the hatchery to the sea is a critical step, and the methods employed at that time affect subsequent growth and survival. Spat are often reared in mesh culture units during nursery culture. The mesh provides a degree of protection from the elements, such as excessive wave action and predation, and helps to retain dislodged individuals (Walne and Davies 1977; Holliday et al. 1991).

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Although a number of previous studies have reported on aspects of the nursery culture of oysters in suspended plastic mesh nets (Holliday et al. 1991; Tanyaros et al.2008; Tanyaros and Kitt 2012), the effects of different suspensions of the culture units containing spat have not been determined. The aims of this study were to determine the effects of the vertical and horizontal suspension of plastic mesh nets on growth performance of hatchery-reared *C. belcheri* spat. These research findings will benefit the nursery culture of oyster spat produced in hatcheries and support more effective oyster farming practices.

Materials and Methods

Experimental oysters

The oyster *C. belcheri* spat used in this experiment were produced in the hatchery at the Marine Shellfish Breeding Research Unit, Faculty of Science and Fisheries Technology, Rajamangala University of Technology Srivijaya, Trang campus, Trang, Thailand. To prevent possible growth retardation, spat were graded for minimum size variation, and had a mean (±SD) shell width (dorso-ventral measurement) and shell length (antero-posterior measurement) of 1.04±0.11 cm and 1.17±0.08 cm, respectively. Spat were kept for 2 days in a semi-closed 105 L recirculation system for acclimation before the start of the experiment. The water was totally renewed every day, and food was added twice a day (morning and evening) at a rate of 50 $cells \cdot \mu L^{-1}$ of *Chaetoceros calcitrans* (Paulsen) Takano 1968 and *Tetraselmis suecica* (Kylin) Butcher 1959 in equal proportion.

Experimental design

Two types of suspension methods (vertical and horizontal) were designed to investigate the effects on the growth performance of hatchery-reared *C. belcheri* spat in plastic mesh nets during a 45-day growth trial. Each plastic mesh net (dimension 90 cm × 30 cm × 5 cm) was divided into six sections by inserting a plastic rope at 15-cm interval for the vertical suspended plastic mesh net but the horizontal suspended plastic mesh net was not sectioned. (Fig. 1). Each homogeneous group of spat from grading was randomly allocated into plastic mesh nets for horizontal suspension, while the spat for the vertical suspension were separated into six equal portions before being placed into the divided plastic mesh nets. The density of spat in each plastic mesh net was 900 spat per tray which is equivalent to 3 $spat \cdot cm^{-2}$. Each type of suspension comprised of 16 replicates. Four plastic mesh nets containing spat were secured in a rectangular PVC frame (dimension 100 cm × 40 cm) by using plastic ropes. Each frame was suspended vertically from a raft at a depth of 30 cm from the surface of the water in a seabass *Lates calcarifer* (Bloch 1790) culture pond (average water depth 2 m) at the Faculty of Science and Fisheries Technology, Rajamangala University of Technology Srivijaya, Trang campus. A paddle wheel was used to create water movement through the nursery culture area throughout the study period. The suspended plastic mesh nets were cleaned at 5-day intervals. Cleaning of nets involved manual scrubbing of the outside surfaces of the nets *in situ* with brushes and washing with low-pressure seawater that was pumped with a submersible pump to remove fouling.

Mean water quality parameters over the study period were as follows: dissolved oxygen 4.65-5.47 (5.11±0.32) $mg \cdot L^{-1}$, total ammonia nitrogen 0.16-0.45 (0.25±0.11) $mg \cdot L^{-1}$, water temperature 28.0-30.5 (29.0±0.98) ^{o}C, pH 7.56-8.02 (7.81±0.14) and salinity 25.0-30.5 (6.4±2.2) ‰.

Sample collection and analysis

Every 15 days during the experiment, 20 randomly selected spat were removed from the plastic mesh nets to be measured and weighed. Growth was expressed as absolute growth rates for shell width and length (AGRW, AGRL) as well as instantaneous growth rate (IGR). The calculation formulae for each were:

– AGRW ($cm \cdot day^{-1}$) = (mean final shell width - mean initial shell width)/culture period.

– AGRL ($cm \cdot day^{-1}$) = (mean final shell length - mean initial shell length)/culture period.

– IGR (day^{-1}) = [ln (final shell weight (g) / initial shell weight (g))/culture period.

At the end of the experiment (45 days), all spat from each experimental unit were graded using sieves with mesh sizes of 1.22 cm in diameter, and then counted. Survival and size fractions were calculated and expressed as percentages.

Vertical **Horizontal**

Fig. 1. Vertical and horizontal suspended plastic mesh trays used for nursing hatchery-reared oyster spat in this study.

Statistical analysis

A t-test was performed using SPSS (version 17.0) to test for differences in growth variables between the vertical and horizontal hanging methods**.** A difference was considered significant at the 0.05 probability level ($P<0.05$).

Results

The growth performance for hatchery-reared spat *C. belcheri* grown in plastic mesh nets suspended vertically and horizontally for 45 days in a fishpond is presented in Table 1.

Mean final shell width was 1.97±0.07 and 1.81±0.07 cm, and final shell length was 1.92±0.14 and 1.60±0.18 cm in the nursery culture by vertical and horizontal suspension respectively. No significant effects (P > 0.05) on AGRW were found between the vertical and horizontal suspension. However, the vertical suspension of the plastic mesh nets supported a significantly higher AGRL and IGR of spat than that of the horizontal suspension over the study period (P < 0.05). A high proportion of the spat were retained in the vertically suspended plastic nets with mesh size larger than 1.22 cm in diameter (59.4±4.4%) and low proportion for the horizontal suspended nets (40.0±4.5%), while the fraction of spat smaller than 1.22 cm in diameter was higher in the horizontally suspended nets (57.8±6.1%) and lower for the vertically suspended (42.26±6.1%), (P<0.05). Mean survival for the vertical and horizontal suspension were 78.9±3.4% and 76.0±8.3%, respectively. No significant difference was found for the final survival rate between the two hanging methods.

Table 1. The growth performance for hatchery-reared oyster spat *Crassostrea belcheri* grown in plastic mesh nets suspended vertically and horizontally for 45 days in a fish pond.

Growth performances	Suspension Method		*P*-value
	Vertical	Horizontal	
AGRW ($cm^{.}day^{-1}$)	0.041±0.006	0.040±0.005	> 0.05
AGRL ($cm^{.}day^{-1}$)	0.038±0.001	0.029±0.002	**< 0.05**
IGR (% day^{-1})	0.022±0.001	0.011±0.001	**< 0.05**
Size fraction >1.22 (%)	59.4±4.4	40.0±4.5	**< 0.05**
Size fraction <1.22 (%)	42.2±6.1	57.8±6.1	**< 0.05**
Survival (%)	78.8±3.4	76.0±8.2	> 0.05

Discussion

The use of plastic mesh nets is a simple technique for the nursery culture of *C. belcheri* spat in oyster hatcheries in Thailand, as the material used is cheap and readily available in local markets. A suitable plastic mesh can protect spat, greatly improve survival, and reduce labour costs for cleaning (Holliday et al. 1991). In this experiment, vertically suspended nets produced better growth performance than horizontal suspension. The spat often accumulated in the centre of the plastic net and a greater density was found in the horizontally suspended nets. Growth was reduced at high densities because of the reduction of space, which leads to increased physical contact between individuals, with more frequent irritation and retraction of the mantle, or valve closure, resulting in less feeding (Côté et al. 1994).

From observations, horizontal suspension greatly encouraged the deposition of sediment and fouling matter clogging the plastic nets which probably affected the growth performance of the spat. The negative effects of fouling are related to the reduction of water flow through the culture enclosure.

Reduced flow can decrease the availability of food particles, reduce oxygen levels, and limit the dispersal of waste products (Côté et al. 1994; Ross et al. 2002). The growth of fouling organisms often leads to decreases and affect the growth and survival of bivalves in suspended culture (Vélez et al. 1995; Lodeiros and Himmelman 1996, 2000). According to Eckman et al. (1989) growth of passive suspension feeders is also related to local fluid dynamics.

Rates of flow past an organism affect the particulate flux and the food intercepted per unit time (Muschenheim 1987). The removal of suspended matter by oysters held in water is dependent on the velocity of flow. An appropriate flow of water through the nursing system can be utilised to achieve rapid growth. This may be the main cause of improved growth, seen in the present study, in oyster spat suspended vertically. An increase in water flow past a filtering bivalve leads to an increase in the absolute uptake of particulate matter because the depleted water is more rapidly replaced (Hildreth and Crisp 1976; Mohlenberg and Riigard 1979; Claereboudt et al. 1994). Some studies indicate that growth is enhanced by increased flow because of the increased food fluxes (Malouf and Breeze 1977; Manzi et al. 1986). The current study indicate that the vertical suspension is suitable for the spat nursery culture in hatcheries, but the design of plastic mesh for nursing spat by this technique needs to be improved by increasing the gaps in the plastic mesh in order to reduce physical contact.

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References

Claereboudt, M.R., J.H. Himmelman, and J. Côté. 1994. Field evaluation of the effect of current velocity and direction on the growth of the giant scallop, *Placopecten magellanicus,* in suspended culture. Journal of Experimental Marine Biology and Ecology 183:27-39.

Côté, J., J.H. Himmelman and M.R. Claereboudt. 1994. Separating effects of limited food and space on the growth of the giant scallop *Placopecten magellanicus* in suspended culture. Marine Ecology Progress Series 106:85-91.

Department of Fisheries. 1994. Oyster culture. Ministry of Agriculture and Cooperative. Bangkok, Thailand. 23 pp (In Thai).

Eckman, J.E., C.H. Peterson and J.A. Cahalan. 1989. Effects of flow speed, turbulence, and orientation on growth of juvenile bay scallops *Argopecten irradians concentricus* (Say). Journal of Experimental Marine Biology and Ecology 132:123-14.

Hildreth, D.I. and D.J. Crisp. 1976. A corrected formula for calculating of filtration rate of bivalve mollusks in an experimental flowing system. Journal of the Marine Biological Association of the United Kingdom 56:111-120.

Holliday, J.E., G.B. Maguire and J.A. Nell. 1991. Optimum stocking density for nursery culture of Sydney rock oysters *Saccostrea commercialis*. Aquaculture 96:7-16.

Lodeiros, C.J.M. and J.H. Himmelman. 1996. Influence of fouling on the growth and survival of the tropical scallop, *Euvola* (*Pecten*) *ziczac* (L. 1758) in suspended culture. Aquaculture Research 27:749-756.

Lodeiros, C.J.M. and J.H. Himmelman. 2000. Identification of environmental factors affecting growth and survival of the tropical scallop *Euvola* (*Pecten*) *ziczac* in suspended culture in the Golfo de Cariaco, Venezuela. Aquaculture 182:91-114.

Manzi, J.J., N.H. Hadley and M.B. Maddox. 1986. Seed clam, *Mercenaria mercennria,* culture in an experimental-scale upflow nursery system. Aquaculture 54:301-311.

Mohlenberg, F. and H.U. Riisgard. 1979. Filtration rate, using a new indirect technique, in 13 species of suspension-feeding bivalves. Marine Biology 54:143-148.

Muschenheim, D.K. 1987. The dynamics of near-bed seston flux and suspension-feeding benthos. Journal of Marine Research 45:473-496.

Ross, K.A., J.P. Thope, T.A. Norton and A.R. Bran. 2002. Fouling in scallop cultivation: help or hindrance? Journal of the Shellfish Research 21:529-547.

Tan, S.H. and T.M. Wong. 1996. Effect of salinity on hatching, larval growth, survival and settling in the tropical oyster *Crassostrea belcheri* (Sowerby). Aquaculture 145:129-139.

Tanyaros, S., K. Anan and L.D. Kitt. 2008. Nursing and grow-out of hatchery-reared big oyster (*Crassostrea belcheri* Sowerby 1871) in the intertidal mangrove area. Kasetsart Journal (Natural Science) 42:495-502.

Tanyaros, S. and L.D. Kitt. 2011. Larval settlement and spat growth of the tropical oyster, *Crassostrea belcheri* (Sowerby 1871), in response to substrate preparations. Asian Fisheries Science 24:443-452.

Tanyaros, S. and L.D. Kitt. 2012. Nursery culture of the hatchery-reared tropical oysters, *Crassostrea belcheri* (Sowerby 1871), in suspended plastic mesh tray: effect of mesh size and colour on growth performance and net fouling rate. The Israeli journal of Aquaculture-Bamidgeh 64:1-5.

Tanyaros, S., T. Pattanatong and W. Tarangkoon. 2012. Effect of water flow rate and stocking density on nursing hatchery-reared juvenile oysters, *Crassostrea belcheri* in a semi-closed recirculation system. Journal of Applied Aquaculture 24:356-365.

Vélez, A., L. Freites, J.H. Himmelman, W. Senior and N. Marín. 1995. Growth of the tropical scallop, *Euvola* (*Pecten*) *ziczac*, in bottom and suspended culture in the Golf de Cariaco, Venezuela. Aquaculture 136:257-276.

Walne, P.R. and G. Davies. 1977. The effect of mesh covers on the survival and growth of *Crassostrea gigas* Thunberg grown on the sea bed. Aquaculture 11:313-321.

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