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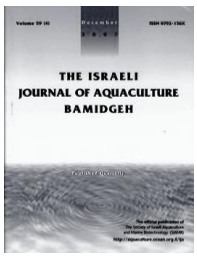

Effect of Color and Mesh Size on Growth Performance and Net Fouling of Suspended Hatchery Trays for *Crassostrea belcheri* (Sowerby 1871) Oysters

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Abstract

The effects of mesh size and color on growth performance and net fouling of suspended plastic mesh trays during nursery culture of spat and juvenile hatchery-reared tropical oysters, *Crassostrea belcheri* (Sowerby 1871), was studied for 60 days. Mesh diameter significantly affected the absolute growth rate in shell width, the specific growth rate, and the final survival of small spat ($p<0.05$). Mesh diameter and color had non-significant effects ($p>0.05$) on the growth performance of large spat. There were no significant interactive effects between mesh size and color on growth performance of small or large spats. Mesh size and color significantly affected ($p<0.05$) the net fouling rate: the rate was high on small mesh (0.35 cm) and low on large mesh (0.72 cm) for small spat, high on black trays and low on green trays for large spat. There were no significant interactive effects of mesh size and color ($p>0.05$) on the fouling rate for either small or large spats.

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Introduction

The development of hatchery production techniques for the tropical oyster *Crassostrea belcheri* (Tan and Wong, 1996; Tanyaros et al., 2000) has allowed oyster culture to be independent of the inherent variability associated with the collection of spat or adults from the wild. To capitalize on these developments, however, appropriate nursery culture protocols are required. The transfer of spat and juvenile oysters from the hatchery to the sea is a critical step, and the methods employed at that time affect subsequent growth and survival.

Spat and juveniles are often reared in mesh during nursery culture. The mesh provides a degree of protection from elements such as excessive wave action and predation, and helps to retain dislodged individuals (Walne and Davies, 1977; Holliday et al., 1991). The size of mesh used for that purpose is important as it influences the growth and survival of spat. Small pores may encourage a film of sediment and other fouling matter that restricts water exchange, removal of metabolic wastes, and availability of food particles (Holliday et al., 1991). Small mesh also requires replacement as bivalves grow and frequent cleaning, which increase labor and equipment costs. However, a mesh that is too large allows predators access to juveniles (Walne and Davies, 1977) and potentially allows spat to escape.

A number of studies report on aspects of the nursery culture of oysters in suspended plastic trays (Holliday et al., 1991; Widman et al., 1991; Taylor et al., 1998; Beer and Southgate, 2008). The aims of this study were to determine the effects of aperture and color of plastic mesh on growth performance and net fouling rates during the nursery culture of hatchery-reared *C. belcheri* spat in suspended plastic mesh trays in southern Thailand.

Materials and Methods

Experimental design. A 2 × 2 factorial design with four replicates per treatment was used to investigate the effects of mesh size and color on the growth performance of hatchery-reared *C. belcheri* spat and the fouling rates of suspended plastic trays during a 60-day trial. The four experimental culture units involved two sizes of mesh aperture (0.35 and 0.72 cm for small spat; 1.22 and 2.00 cm for large), and two colors of plastic tray (green and black).

Experimental procedures. Oyster spat were produced in the hatchery of the Marine Shellfish Breeding Research Unit of the Faculty of Science and Fisheries Technology in Rajamangala University of Technology Srivijaya, Trang Campus, Thailand. The spat were graded by size to prevent growth retardation and assigned to two groups with mean (±SD) shell widths (dorso-ventral) of 1.31±0.19 cm and 1.45±0.19 cm, and shell lengths (antero-posterior) of 2.58±0.34 cm and 3.03±0.47 cm for small and large animals, respectively. The groups were kept for 2 days in a semi-closed recirculation system for acclimatization. Water was totally renewed every day, and food was added twice a day (morning and evening) at a rate of 50 cells/µl of *Chaetoceros calcitran* and *Tetraselmis suecica*. Homogenous groups were distributed randomly into 16 plastic mesh trays (30 × 30 × 5 cm) at densities of 200 and 50 spats per tray for small and large spats, respectively. The plastic trays were tied to rectangular PVC frames (40 × 40 cm) using plastic ropes. The frames were suspended from a raft to a depth of 30 cm in the supply canal of fish ponds (average water depth 3 m) at the Faculty of Science and Fisheries Technology, Rajamangala University of Technology Srivijaya, Trang Campus. An air jet was used to create water movement throughout the nursery culture area. It was controlled by an automatic timer that switched the jet on or off every hour throughout the study period. The tray was cleaned at 5-day intervals by manually scrubbing the outside tray surfaces *in situ* with brushes, and washing them with sea water pumped at low pressure by a submersible pump. Water quality parameters over the study period were dissolved oxygen >6.68 mg/l, total ammonia nitrogen <0.17 mg/l, water temperature 25.9-27.3°C, and pH ≥7.67.

Sample collection and analysis. Every thirty days, the oysters were removed from the plastic trays to be weighed and counted. At the end of the experiment, twenty oysters

from each tray were randomly selected for shell width and length measurement. Growth was expressed as absolute growth rates of width and length (AGRW, AGRL) and individual specific growth rate (ISGR) as follows: AGRW (cm/month) = (mean final shell width - mean initial shell width)/culture period, AGRL (cm/month) = (mean final shell length - mean initial shell length)/culture period, and ISGR (log_g/day) = (ln final individual shell wt - ln initial individual shell wt)/culture period as per Dégremont et al. (2007). Final survival (%) was calculated as 100(final no. of oysters)/(initial no. of oysters).

Net fouling collection and analysis. Plastic mesh was cut to make net fouling collectors with an area of 36 cm^2 (6 × 6 cm). The collectors were dried at 60°C for 24 h in a hot air oven and weighed prior to attachment to the plastic trays. The plastic mesh trays were fitted with collectors made from mesh with a similar size and color as that of the trays. After five days, the collectors were removed, dried at 60°C for 24 h, and weighed. The dry mass of the fouling material was calculated as the difference in initial and final weights as follows: net fouling rate (mg/cm^2/day) = (final wt of collector - initial wt of collector/area of net collector/sampling period.

Statistical analysis. The two-factor experiment was arranged in a completely randomized design. Data from each treatment were subjected to two-way analysis of variance (ANOVA). Duncan's multiple range test was used to detect differences between treatment means due to main effects. Differences were considered significant at the 0.05 probability level (p<0.05).

Results

Growth performance. Growth and survival are presented in Table 1.

Table 1. Growth and survival of small and large hatchery-reared spat of the oyster *Crassostrea belcheri* grown in suspended plastic trays of different mesh sizes and colors.

Mesh diameter (cm)	*Mesh color*	*Final survival (%)*	*Absolute shell growth (cm/month; n = 20)*		*Individual specific growth rate (log_g/day)*	
			Width	*Length*	*First month*	*Second month*
Small spat (1.31±0.19 × 1.45±0.19 cm)						
0.72	Green	57.12±6.23^b	0.44±0.05^b	0.41±0.11	0.12±0.08^{ab}	0.62±0.08^{ab}
0.35	Green	41.62±4.97^a	0.32±0.06^a	0.34±0.06	0.09±0.06^a	0.49±0.06^a
0.72	Black	49.50±4.67^{ab}	0.47±0.05^b	0.53±0.13	0.22±0.05^b	0.83±0.19^b
0.35	Black	43.00±5.61^a	0.42±0.08^{ab}	0.50±0.07	0.07±0.03^a	0.51±0.12^a
Two-way ANOVA for the effects of mesh size and color on small spat						
Mesh diameter		p<0.05	p<0.05	p>0.05	p<0.05	p<0.05
Color		p>0.05	p>0.05	p>0.05	p>0.05	p>0.05
Mesh diameter × color		p>0.05	p>0.05	p>0.05	p>0.05	p>0.05
Large spat (2.58±0.34 × 3.03±0.47 cm)						
2.00	Green	92.00±4.32	0.65±0.37	0.49±0.09	1.67±0.06	1.98±0.10
1.22	Green	94.00±3.26	0.49±0.04	0.48±0.07	1.61±0.15	1.91±0.10
2.00	Black	93.00±5.00	0.55±0.14	0.64±0.08	1.66±0.12	1.94±0.13
1.22	Black	92.00±6.53	0.38±0.12	0.43±0.11	1.53±0.14	1.81±0.13
Two-way ANOVA for the effects of mesh size and color on large spat						
Mesh diameter		p>0.05	p>0.05	p>0.05	p>0.05	p>0.05
Color		p>0.05	p>0.05	p>0.05	p>0.05	p>0.05
Mesh diameter × color		p>0.05	p>0.05	p>0.05	p>0.05	p>0.05

Means (±SD) in the same column with different superscripts significantly differ (p<0.05)

Net fouling rate. Net fouling rates are presented in Fig. 1. Two-way ANOVA showed non-significant interactive effects between mesh size and color for both small and large spat. Fouling rates were high on the small mesh (0.55±0.07 mg/cm^2/day for green; 0.54±0.08 mg/cm^2/day for black) and low on the large mesh (0.39±0.05 mg/cm^2/day for green; 0.34±0.07 mg/cm^2/day for black). Fouling rates were high on black plastic trays

(0.37±0.02 mg/cm^2/day for 2.00 cm mesh; 0.34±0.04 mg/cm^2/day for 1.22 cm mesh) and low on green trays (0.24±0.02 mg/cm^2/day for 2.00 cm mesh; 0.24±0.03 mg/cm^2/day for 1.22 cm mesh).

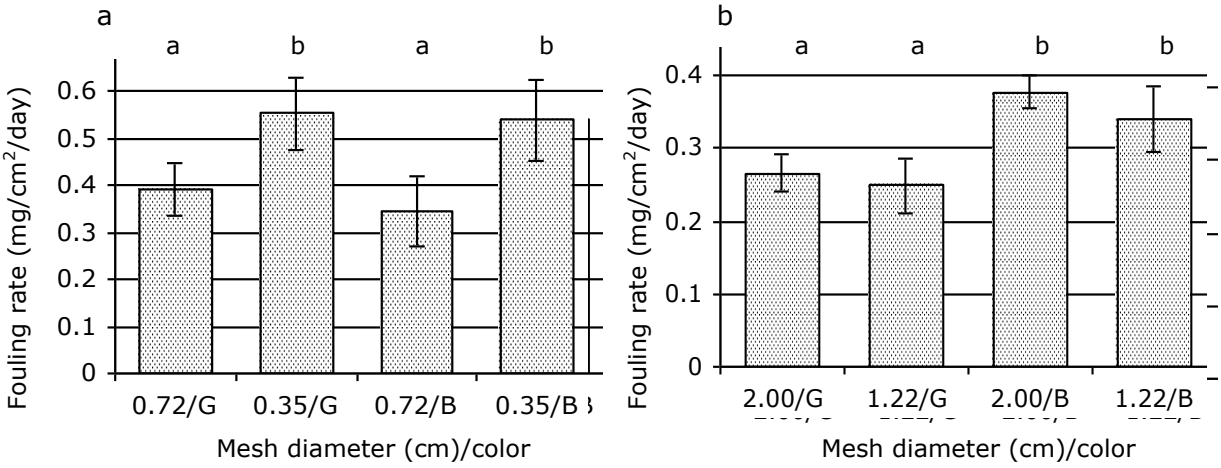

Fig. 1. Fouling rate of (a) small and (b) large tropical oysters (*Crassostrea belcheri*) nursed in suspended plastic trays of different mesh sizes and colors. G = Green; B = Black.

Discussion

The use of plastic mesh trays is a simple technique for nursery culture of *Crassostrea belcheri* spat in oyster hatcheries in Thailand, as the material is readily available in local markets. A suitable plastic mesh can protect spat, greatly improve survival, and reduce labor costs for cleaning (Holliday et al., 1991). In this experiment, the mesh size of plastic trays affected the growth performance of small nursery-cultured spat, with a large mesh producing better growth performance than a small mesh. The small mesh greatly encouraged the deposition of sediment and fouling matter, while clogging by fouling matter on the plastic trays affected the growth performance of small 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 in the growth and survival of bivalves in suspended culture (Vélez et al., 1995; Lodeiros and Himmelman, 1996, 2000). Reductions in the weight and size of cultivated bivalves have been reported by Dittiman and Robles (1991), Enright (1993), Claereboudt et al. (1994), Lodeiros and Himmelman (1996), Taylor et al. (1997), Cigarría et al. (1998), and Pit and Southgate (2003).

Increasing the frequency of cleaning of plastic trays (every 2-3 days) is labor intensive and requires additional equipment. For large spat, neither mesh size nor color affected the growth performance. However, the dry mass of fouling material was influenced by the color. Black trays had higher fouling rates than green trays. From observation, fouling organisms attached to both colors of plastic were dominated by filamentous algae. Black trays had higher fouling rates than green as a result of the difference in heat absorption from sunlight. In general, black materials absorb more heat from sunlight than other colors, and so may stimulate growth of filamentous algae. The use of black plastic mesh for oyster nursery culture may thus increase labor and the frequency of cleaning. While attempts have been made to exploit natural antifouling chemicals from marine plants (Armstrong et al., 1999), these are expensive solutions. There yet remains considerable impetus for the development of environmentally sustainable biological control methods.

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References

Armstrong E., McKenzie J.D. and G.T. Goldsworthy, 1999. Aquaculture of sponges on scallops for natural products research and antifouling. *J. Biotechnol*., 70:163-174.

Beer A.C. and P.C. Southgate, 2008. Effect of mesh coverings on retention and growth of blacklip pearl oyster (*Pinctada margaritifera*) spat during early nursery culture. *Aquat. Living Resour*., 21:441-445.

Cigarría J., Fernández J. and L.P. Magadán, 1998. Feasibility of biological control of algal fouling in intertidal oyster culture using periwinkles. *J. Shellfish Res*., 17:1167-1169.

Claereboudt M.R., Bureau D., Côté J. and J.H. Himmelman, 1994. Fouling development and its effect on the growth of juvenile giant scallops (*Placopecten magellanicus*) in suspended culture. *Aquaculture*, 121:327-342.

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

Dégremont L., Ernarde B., Bédier E. and P. Boudry, 2007. Summer mortality of hatchery-produced Pacific oyster spat (*Crassostrea gigas*). I. Estimation of genetic parameters for survival and growth. *Aquaculture*, 262:41-53.

Dittiman D. and C. Robles, 1991. Effect of algal epiphytes on the mussel *Mytilus californianus*. *Ecology*, 72:286-296.

Enright C., 1993. Control of fouling in bivalve aquaculture. *World Aquacult*., 24:44-46.

Holliday J.E., Maguire G.B. 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. *Aquacult. Res*., 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.

Pit J.H. and P.C. Southgate, 2003. Fouling and predation; how do they affect growth and survival of the blacklip pearl oyster, *Pinctada margaritifera*, during nursery culture? *Aquacult. Int*., 11:545-555.

Ross K.A., Thope J.P., Norton T.A. and A.R. Bran, 2002. Fouling in scallop cultivation: help or hindrance? *J. Shellfish Res*., 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., Anan K., To-on N., Choopunth P. and L.M. Kitt, 2000. Settlement and growth of hatchery oyster seed (*Crassostrea belcheri*). In*: 17th Rajamangala Institute of Technology Symp.* January 14-16, 2000, Queen Sirikit Convention Center, Bangkok, Thailand.

Taylor J.J., Southgate P.C. and R.A. Rose, 1997. Fouling animals and their effect on the growth of silverlip pearl oysters, *Pinctada maxima* (Jameson) in suspended culture. *Aquaculture*, 153:31-40.

Vélez A., Freites L., Himmelman J.H., Senior W. and N. Marín, 1995. Growth of the tropical scallop, *Euvola* (*Pecten*) *ziczac*, in bottom and suspended culture in the Golfo 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.

Widman J.C. and E.W. Rhodes, 1991. Nursery culture of the bay scallop, *Argopecten irradians irradians*, in suspended mesh nets. *Aquaculture*, 99:257-267.