COMPARATIVE GROWTH AND SURVIVAL OF HATCHERY PRODUCED *CRASSOSTREA BELCHERI* SEEDS AT A MARINE AND AN ESTUARINE SITE IN MALAYSIA

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ABSTRACT

Hatchery produced seeds of the tropical oyster *Crassostrea belcheri* which were either set on marble chips (spats) or free (cultchless) were grown using suspended tray culture for 18 months at Muka Head, Penang (salinity:28-32 ppt) and at Batu Lintang, Kedah (salinity: 15-25 ppt). During the first 12 months growth of cultchless seeds and spats was significantly higher ($p>0.05$) at Muka Head, with mean shell height reaching 6 cm compared to 3.5 cm at Batu Lintang. However, differences in shell height narrowed during subsequent months. By the 18th month the mean shell height of spats and cultchless seeds at both sites had all reached between 7.30-7.63 cm. Overall, *Crassostrea belcheri* survived better at Batu Lintang (13.4%) compared to Muka Head (2.0%). The implications of these results on site selection for mass culture are discussed.

INTRODUCTION

Crassostrea belcheri (Sowerby) is a large tropical oyster that is extensively cultured in Thailand (Saraya, 1982). The same species also occurs in parts of Malaysia where it forms important local artisanal fisheries. Since the late 1960's, studies have been undertaken to culture *C. belcheri* with the objective of increasing production as well as enhancing the income of the fisherfolk. Current production is still mainly based on the harvest of natural stocks although small scale culture operations have been hampered by limited seed supply and is unlikely to take place until sufficient seeds can be supplied from both natural and hatchery sources. Although hatchery seed production has gone through the research to the pilot production phase in Malaysia as well as Thailand, serious concerns remain as to the performance of hatchery produced seeds under different field conditions. This paper reports on the growth and survival of hatchery produced *C. belcheri* seeds at a marine site (Muka Head, Penang) and an estuarine site (Batu Lintang, Kedah) in Malaysia.

MATERIALS AND METHODS

Eyed larvae of *C. belcheri* were set on marble chips or PVC plates. Those set on PVC plates were scraped off with a razor blade 24 hours after setting to produce cultchless seeds. Both types of spats were subsequently held in a nursery for approximately two months before being used for growout studies. For each site, three replicates of each type of seeds (cultchless and set on marble chips) were monitored. For each replicate, 500 cultchless seeds (mean shell height 0.8 cm) or 500 seeds set on marble chips (mean shell height 1.3 cm) were initially kept in 3 mm mesh netlon bags measuring approximately 15 cm x 30 cm. These small bags were held inside a 1.2 cm mesh netlon tray for further protection, and suspended approximately 1 metre below the water surface.

At regular intervals, the nets as well as oysters were cleared of biofouling organisms. Measurements of growth and survival were carried out every 3-4 weeks for 18 months. All oysters in each bag were counted to determine survival rates throughout the study. At each sampling, growth was monitored by measuring the shell height of 100 randomly picked animals.

Two months after the experiment was initiated, when the shell height exceeded 1.5 cm, the oysters were transferred into 1.0 cm mesh netlon trays to prevent overcrowding. At the end of the experiment, all surviving oysters in each bag were counted and measured.

Data was analyzed with a one-way ANOVA to compare the growth and survival of oysters at different culture sites. If significant interactions were present, the data were then subjected to the Duncan's Multiple Range Test to determine which treatments were significantly different.

RESULTS

Fig. 1 summarizes the growth and survival of *C. belcheri* seeds at Muka Head and Batu Lintang. During the first month, no significant difference ($p<0.05$) in growth was noted for seeds set on marble chips between the two sites. However, growth of cultchless seeds was significantly higher ($p>0.05$) at Muka Head. From then onwards until the twelfth month, both cultchless seeds and seeds set on marble

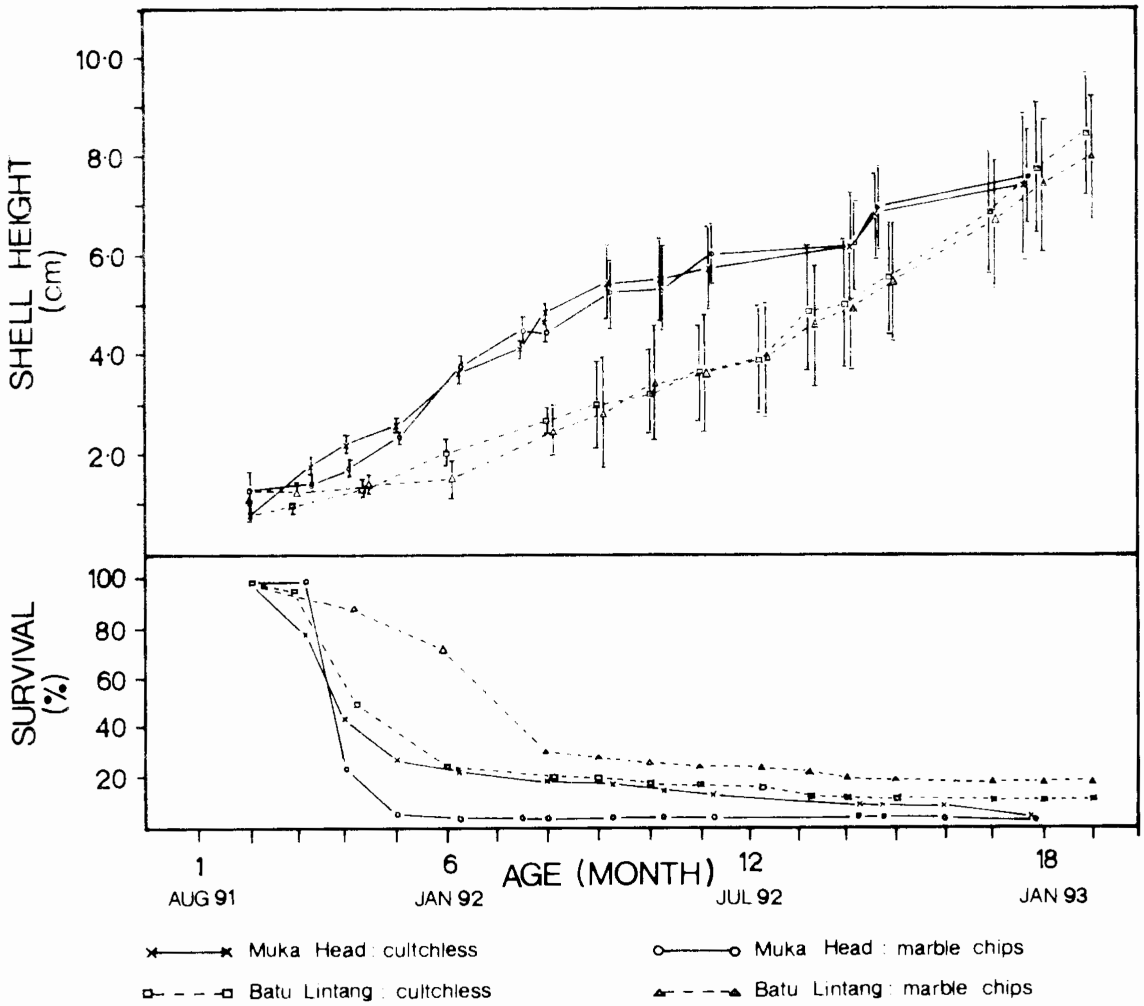

Figure 1. Growth and survival of hatchery produced cultchless seeds and spats set on marble chips, of *Crassostrea belcheri* at Muka Head and Batu Lintang.

chips showed significantly better growth ($p>0.05$) at Muka Head than at Batu Lintang.
The mean shell height of the oysters was not significantly different ($p<0.05$) between sites after 12 months. After 18 months, the mean shell heights for cultchless seeds were 7.30 ± 1.51 cm at Muka Head and 7.63 ± 1.32 cm at Batu Lintang, whereas the mean shell heights for seeds set on marble chips were 7.49 ± 0.97 cm at Muka Head and 7.32 ± 1.36 cm at Batu Lintang. At each site, there were no significant differences in growth between cultchless seeds and seeds set on marble chips.

High mortality was observed at Muka Head for all the replicates from the second to the fourth month which coincided with the wet season. The same trend was seen at Batu Lintang for cultchless seeds. Survival remained constant thereafter. At Batu Lintang, *C. belcheri* seeds set on marble chips showed high mortality from the fourth to the sixth month which coincided with the dry season. Overall, survival of both types of seeds was better at Batu Lintang.

Fig. 2 summarizes the daily salinity fluctuations from January until December. It can be seen that

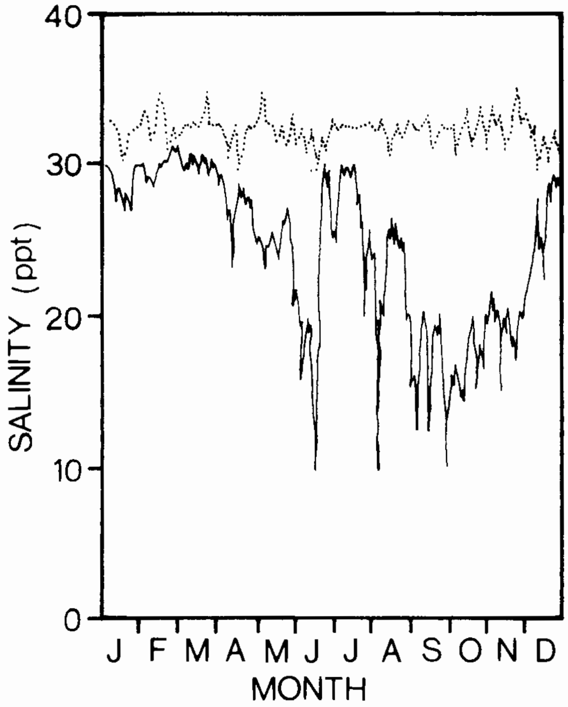

Figure 2. Annual salinity fluctuations.

salinity fluctuation were higher at Batu Lintang (10-30 ppt) compared to Muka Head (28-35 ppt). Salinities at Muka Head rarely dip below 30 ppt

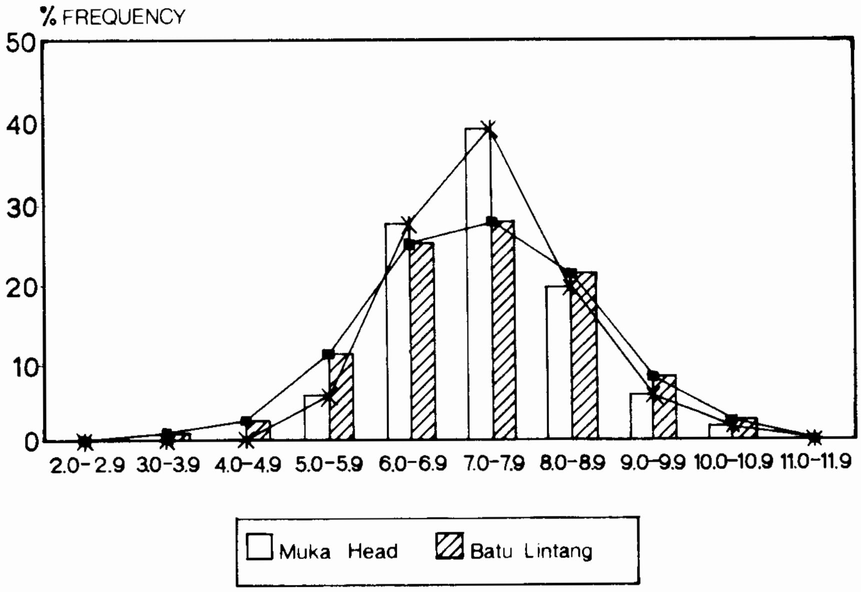

Figure 3. Frequency of size distribution of *Crassostrea belcheri* at Muka Head and Batu Lintang.

while Batu Lintang experienced a period of sustained high salinity (25-30 ppt) from December till March corresponding to the dry season on the west coast of Peninsular Malaysia. Batu Lintang experienced large salinity fluctuations during the end of October through early November during the intermonsoonal rain.

Though direct measurements were not made, it was observed that biofouling (mainly barnacles) at Muka Head site was more severe. In the case of Batu Lintang, biofouling (bryozoans, sponges and barnacles) was moderate to severe only during the dry season (December - April). During the rainy season, biofouling was insignificant.

Fig. 3 shows the size distribution of 18 months old *C. belcheri* cultured at Muka Head and Batu Lintang. Measurements from all replicates were lumped together for compiling the size distribution since there were no significant differences between the different kinds of seeds at each site. *C. belcheri* cultured at Batu Lintang showed a wider range of sizes, from 3.0 to 10.9 cm with high frequency at the 6.0-6.9 cm, 7.0-7.9 cm and 8.0-8.9 cm class (24.83%, 27.93% and 21.38%, respectively).

Oysters from Muka Head showed a narrower size range from 5.0 to 10.9 cm with high frequency at the 6.0-6.9 cm and 7.0-7.9 cm class (27.45% and 39.22% respectively).

DISCUSSION

The results showed that during the first twelve months, single *C. belcheri* seeds (cultchless or set on marble chips) grew faster at Muka Head compared to Batu Lintang but after 12 months, the differences disappeared. Survival was poorer at Muka Head (2.0% vs. 13.4%)

The growth rate was low at Batu Lintang during the intermonsoonal rain (the first two months after transplantation). Reduction in assimilated ration due to shell closures and additional metabolic costs associated with maintenance of osmotic balance under a stressful salinity regime may explain lack of growth in oysters at Batu Lintang during the first two months after being transplanted from a marine environment. However, rapid growth rate of *C. belcheri* seeds was recorded after 12 months during the intermonsoonal rain with large salinity fluctuations (10-30 ppt). According to Bernard (1983), somatic growth of oysters occurs between 16 and 31 ppt. There is also, probably, a more abundant supply of suitable food organisms in the estuary during the short spells of low salinity occurring during a tidal cycle (Rao & Nayar, 1956), though the rate of growth is dependent not only upon the availability of food in the environment but also upon the ability of the organism to secure it. There was a great variation in the size of individuals at both sites reflecting possible genetic variation between individuals.

The mean shell height of 5 cm in 12 months was lower than the approximately 8-9 cm reported for *C. belcheri* in Sabah, Malaysia (Chin & Lim, 1975), *S. lugubris* in Southern Thailand (Bromanonda, 1978), and *C. madrasensis* in India (Joseph & Joseph, 1983, 1985), but higher than 4 cm of *C. rhizophorae* in Brazil (Ramos *et al.*, 1986). However, it is difficult to compare the results from data obtained from different areas. Rate of growth of oysters is known to be affected by a variety of ecological and environmental factors such as nutrition, temperature, salinity and water quality (Kinne, 1971). Moreover, the difference in quality of suspended matter, and in quality and quantity of available food was not recorded in this experiment.

The poorer survival of *C. belcheri* in marine coastal waters (Muka Head) may suggest that *C. belcheri*, though euryhaline is essentially an estuarine species. This is supported by the studies on the performance of embryo to the setting stage of *C. belcheri* (Tan, 1993) wherein it was shown, that as the larvae develop from the embryo to the setting stage, there is a progressive increase in tolerance to lower salinities, demonstrating how well adapted *C. belcheri* is in exploiting the estuarine habitat where competition from the fully marine species is much reduced. Though direct measurements were not made, it was observed that biofouling (mainly barnacles) at the Muka Head site was more severe between sampling. The amount of biofouling organisms on the trays were beginning to clog up the holes in the trays, restricting water circulation and eventually caused the mortality, or could slow the growth of oysters. The high mortality recorded at Muka Head may also be caused by strong waves which tossed the oysters around inside the trays, often piling them in one corner, and leaving less room for water circulation between the oyster.

Cultivation of *C. belcheri* at estuarine sites is generally favoured over marine sites. The evidence presented here suggests that cultivation of *C. belcheri* at estuarine sites might produce greater survival of oysters than cultivation at marine sites. Careful consideration should be given to the advantages of culturing *C. belcheri* at an estuarine site, particularly in relation to fouling problems and the availability of food in the environment.

ACKNOWLEDGEMENTS

This study was carried out with funding support from IDRC (International Development Research Centre) Canada and the Government of Malaysia. We are grateful to the project staff for their assistance.

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