FEASIBILITY OF AKOYA PEARL OYSTER CULTURE IN QUEENSLAND

Thesis submitted by

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Statement on the Contribution of Others

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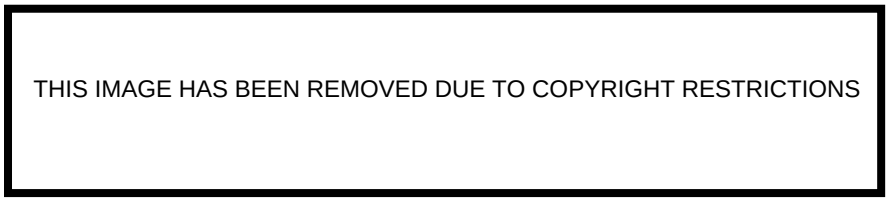

(Photo: Andrew Beer)

Frontispiece: Pearls and pearl jewellery date back to the Roman Empire where it has been noted by historians that an entire military campaign was financed through the selling of one single pearl (Anon 1998).

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Abstract

Pearl culture is the second largest aquaculture industry in terms of value in Australia. It is currently worth an estimated Aus$300 million annually and it is anticipated that the industry will be worth Aus$500 million by 2010. The Australian pearl industry is currently based on South Sea pearl production from the silver-lip pearl oyster, *Pinctada maxima*, for which it is world renowned. However, there has been recent interest in pearl production from two other major marine pearl oyster species, the blacklip pearl oyster, *P. margaritifera*, and the Akoya pearl oyster, *P. fucata*, which are both abundant in Australian waters.

Production of Akoya pearls, until recently was dominated by the Japanese. However, recent down-scaling of the Japanese pearl oyster industry due to factors that resulted in the death of millions of oysters, has presented an opportunity for other countries to enter the Akoya pearl market. Australia is one such country which has received a lot of interest in Akoya pearl production over the last 5-10 years because of:

(1) its reputation as a quality pearl producing nation;
(2) the clean non-polluted waters around Australia; and
(3) the wide distribution of Akoya oysters along the Australian coastline.

Consequently, there was a need for biological information on which the feasibility of Akoya pearl oyster culture in Australia could be assessed. The major objective of the current project was to develop techniques to determine whether Akoya pearl oyster culture is feasible in tropical north Queensland. The results of this study will compliment the results of research with similar goals conducted in temperate Australia

(New South Wales). The focus of this study was to produce Akoya pearl oysters in tropical Australia for the first time, before optimizing protocols for hatchery and nursery culture. This information was then utilized to suggest possible sites within Queensland which would be suitable for Akoya pearl oyster production, based on 'biological performance'.

The first successful culture of Akoya pearl oysters in Australia under tropical conditions produced 213 000 larvae which were transferred to settlement tanks. A total of 58 000 spat were subsequently transferred from settlement tank and resulted in 48 000 spat ranging in size from 2-30 mm at 3.5 months of age. These spat were produced using established protocols for other pearl oyster species. After 12 months, Akoya pearl oysters had a mean dorso-ventral shell height (DVH) of 56.2 ± 0.2 mm and showed superior growth rate to those reported for this species in more traditional culture regions (i.e. SE Asia).

This project investigated aspects of hatchery production including embryonic and larval development to identify optimal protocols for hatchery culture of Akoya pearl oysters (Chapters 4 and 5). Full orthogonal designs were established to investigate; (1) the effects of water temperature and salinity; and (2) the effects of density and addition of antibiotics on the development of *P. fucata* embryos into D-stage veligers. Maximum development of *P. fucata* embryos into D-stage veligers occurs within a water temperature range of 26-28°C and a salinity range of 28-32‰. Further results suggested that antibiotics are not required during embryonic development of *P. fucata* as development of larvae was not improved in the presence antibiotics. Results have also shown that maximum development of embryos into D-stage veliger occurred when larval stocking densities were low. Suggesting an ideal stocking density is strongly dependant on the individual hatchery and the production

goals. These results have obvious implications for the selection of sites for an Akoya oyster hatchery in Queensland. Ideally, a site should be selected in which water parameters are within the above-mentioned ranges.

A number of pearl oyster culture techniques were investigated during this project to optimise nursery culture of Akoya pearl oysters under Queensland (tropical) conditions. These included the effects of depth, stocking density, culture apparatus and fouling on the growth and survival of pearl oysters.

P. fucata spat were transferred from the hatchery to the long-line and placed in plastic mesh trays at three different depths, 2 m, 4 m, and 6 m. After 8 weeks on the long-line, spat cultured at 2 m were significantly ($p<0.05$) larger in DVH than spat at either 4 m or 6 m, which were not significantly different from each other. Additionally, greater numbers of 'large' spat were recorded when spat cultured at 2 m compared to spat cultured at either 4 m or 6 m.

Hatchery-produced *P. fucata* spat at 3.5 months of age were graded into three size classes, 'small', 'medium' and 'large', which for the purpose of the study were treated as 'slow', 'normal' and 'fast' growers, respectively. This study aimed to determine whether growth rates differed between oysters from the above-mentioned size classes. Results from this study suggest that when oysters are first graded at 3.5 months of age (8 weeks after transfer to the ocean) slow growing oysters should not be discarded (common practice by some pearl farmers within the industry). This is because slow growers, when compared to 'normal' growers, only require an additional 2-4 months before reaching pearl production size. The implications of retaining slow growers is discussed.

Hatchery-produced spat were cultured at different stocking densities to determine optimal growth and survival of *P. fucata*. Stocking densities were

determined on the basis of percentage of total available net area. In Experiment 1 during early nursery culture, spat were stocked at either 25%, 50% or 75% of total available net area. Maximum growth was recorded for spat cultured at the lowest stocking density (25% of total available net area), which were significantly larger that spat cultured at either 50% or 75% of total available net area. Furthermore, spat cultured at 25% of total available net area had significantly greater numbers of spat in the medium and large size classes than spat cultured at 50% or 75% total available net area. In Experiment 2 during late nursery culture, and based on the results from Experiment 1, spat were cultured at four stocking densities (20, 25, 30 and 40% of total available net area). Similar trends to those in Experiment 1 were recorded in Experiment 2 where spat cultured at the lower stocking densities were significantly larger than spat cultured at the other stocking densities. However, the overall growth performance (Φ') was greatest in spat cultured at the highest stocking density (40% of total available net area). Survival was not significantly different between treatments.

Two experiments were conducted with hatchery-produced *P. fucata* spat using four different culture units to determine which culture unit supported maximum growth and survival. In Experiment 1, the four treatments used were 'box', 'tray', 'pearl net' and 'pearl net with noodles'. While maximum growth, was recorded by oysters cultured in pearl nets, there was no significant difference in growth rate to oysters cultured in pearl nets with noodles; however, oysters cultured in the box treatment were significantly smaller than oysters in all other treatments. Survival of oysters in the box treatment was 47%, whereas, survival of spat cultured in the other three treatments was greater than 90%. In Experiment 2, the four treatments included 'pearl net with small mesh', 'pearl net with large mesh', 'panel net with small mesh', and 'panel net with large mesh'. Maximum growth in terms of DVH was recorded for oysters cultured in

panel nets with large mesh, followed by pearl nets with large mesh, pearl nets with small mesh and panel nets with small mesh. Survival was not significantly different between treatments, and all treatments recorded 85% or greater survival.

Site did not affect growth and survival in the present study when *P. fucata* were cultured at Orpheus Island and Magnetic Island for 12 months. Although slight variations in water temperature, salinity and chlorophyll 'a' were recorded between the two sites, no significant differences were recorded in overall oyster growth performance (Φ') of 3.81 and 3.82 for Orpheus Island and Magnetic Island, respectively. Site selection for pearl oyster culture is important if growth and survival are to be maximised during nursery culture. Akoya pearl oysters showed positive growth at all water temperatures experienced throughout this study; however, the range at which optimal growth occurred was between 25.1-28.1°C. Meanwhile, maximum growth occurred within salinity and chlorophyll 'a' ranges of 29-33‰ and 3.5-5.3 μg L^{-1}, respectively.

This project has produced biological information, which will provide a basis for the development of an Akoya pearl oyster industry in Queensland. Establishment of such an industry would compliment the current valuable pearl industry in Australia. While information generated during this study has answered a number of questions in terms of 'biological performance' there is, however, a requirement for further research to appraise pearl production from Akoya oysters in Queensland and factors influencing pearl quality.

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