GROWTH OF A WINGED PEARL OYSTER, *PTERIA PENGUIN* SUSPENDED AT DIFFERENT DEPTHS

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ABSTRACT

Winged pearl oyster *Pteria penguin* suspended at 1 m (surface), 4 m (mid-depth), and 8 m (bottom) below the sea surface was studied at a site approximately 10m deep, Ko Naga Noi, Phuket. Growth of cleaned oysters (rid of fouling organisms) showed no significant difference at the three depths during a five month period. The water quality and food concentration (chlorophyll *a*) showed no marked variation among the depths. However, infestation of fouling organisms on oyster shells was much more intense at the surface than the greater depths. Mortality rates of uncleaned oysters (with fouling organisms) were 40%, 33.3% and 6.7% respectively at the surface, mid-depth and bottom. Growth rates of the uncleaned bivalves were higher at the bottom. This indicates that fouling organisms in competition for food with the oysters can cause deleterious impact on oyster's survival and fitness, if the bivalves are reared near the surface

INTRODUCTION

The winged pearl oyster, *Pteria penguin* has been used widely in the cultured pearl production for many years in Thailand. Half-pearl is produced by placing half plastic beads onto inner-shell valves of *Pteria penguin*. The oysters are then put in net cages and maintained at 1 m below the sea surface. Undesirable fouling organisms settled on the oysters as well as silt and other outgrowth on the net cages will be occasionally removed. Our study is aimed at investigating the comparison of growths of oysters if they are reared at different depths, *i.e.* the surface, the mid-depth and the bottom. We hypothesize that different growths can be achieved, because at different depths there are different environmental conditions, especially with respect to food. The bottom depths might offer better food source, since tidal currents can scour the bottom and stir up organic detritus from the bottom sediment. Resuspended detritus together with phytoplankton can potentially become food for the bivalves.

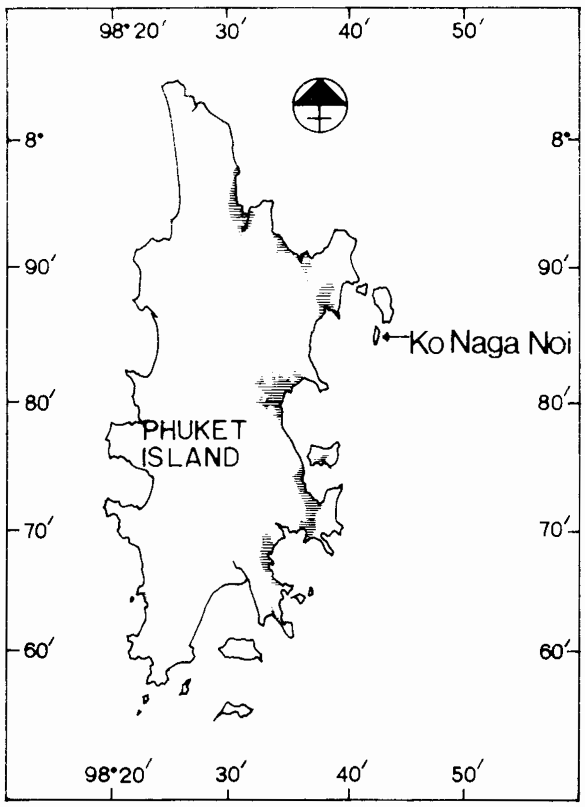

Figure 1. Map of Phuket and study site - Ko Naga Noi

MATERIALS AND METHODS

The study was conducted at Ko Naga Noi, in the northeast of Phuket and approximately 6 km from Phuket (Fig.1). The South Seas Pearl Company has been running the cultured pearl industry at Ko Naga Noi. This project was carried out in the same area where the pearl farming is located. The water is clean and productive, thus it is suitable for the culture. A site of about 10 m depth was chosen. The bottom sediment is mainly composed of fine sand. The experiment started August, 1992 and ended April, 1993.

Pteria penguin was collected by fishermen from Ko Bon and adjacent areas. The oysters of 6-7 cm in shell height were acclimated on a raft at Naga Noi for two weeks prior to the experiment. The oysters were placed in net cages suspended at the three depths, *i.e.* 1 m (surface), 4 m (mid-depth) and 8 m (bottom). At each depth, there were two groups of oysters. Growth in shell height of the first group of 15 individuals was followed throughout the course of the study. Oysters in the first group were cleaned by ridding of fouling organisms every month. The second group consisted of 10 sets with 15 individuals in each set. The oysters in the second groups were left infested with fouling organisms; no removal of any outgrowths was done. A set of 15 individuals were taken out every month to examine the amount of fouling infestation and record the growth. Mortality of oysters in the second group was also recorded. All oysters were reared for five months. Thirty five individuals were sacrificed for studying the length-weight relationship. The relationship is as follows:

$$Y = -1.6701 + 0.2423X \quad (r^2 = 0.74)$$

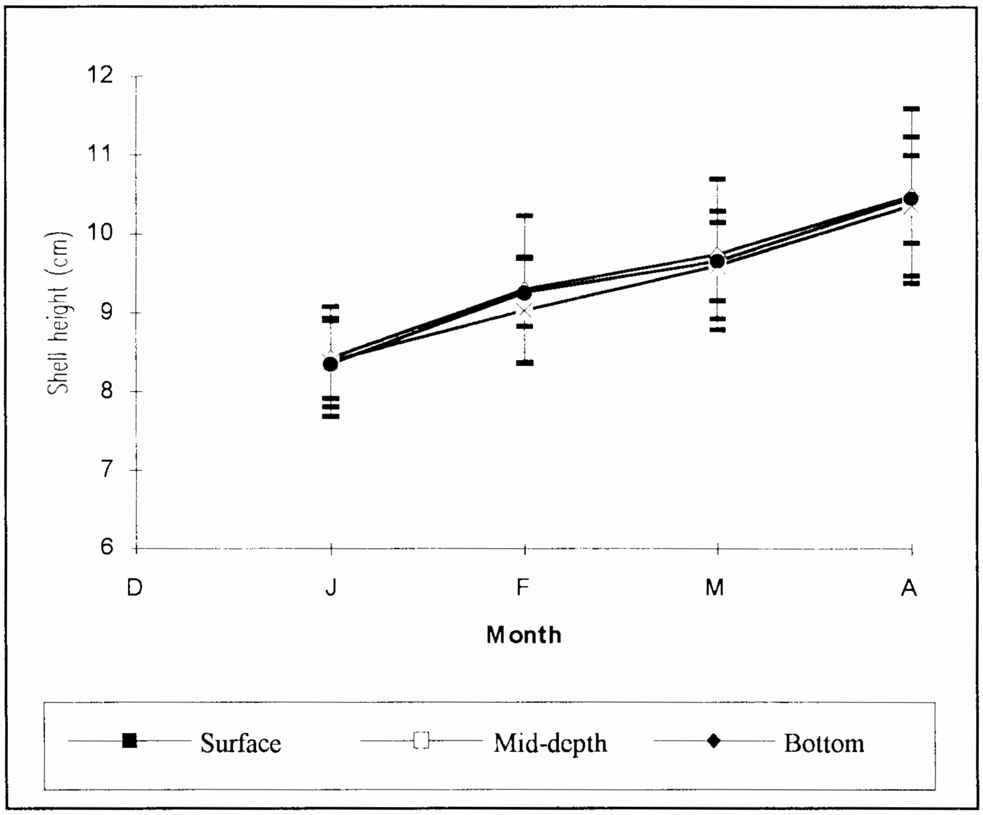

Figure 2. The change in shell heights of cleaned oysters, during the experimental period. Surface 1 m, mid-depth 4 m, and bottom 8 m deep respectively.

where Y is log AFDW
X is log height

Fouling organisms were removed by scraping the shells, dried at 80°C for 24 hrs. and weighed. Ash free dry weight (AFDW) of oysters was obtained by burning at 450°C for 3 hrs. Water samples were collected monthly from the three depths. Three replicates were taken from each depth. Nutrients (nitrates, nitrites, phosphates), dissolved oxygen, total seston, particulate organic matter, chlorophyll *a*, and salinity were measured. Detailed results of water quality, food and biofouling will be presented elsewhere (Tantichodok *et al.*, in prep.).
Instantaneous growth rate was calculated using the following equation:

$$k = \frac{(\ln AFDW_2 - \ln AFDW_1)}{t_2 - t_1} \times 100$$

where k is instantaneous growth rate
$AFDW_2$ is ash free dry weight at t_2
$AFDW_1$ is ash free dry weight at t_1
$t_2 - t_1$ is time interval in days

RESULTS

There were seasonal differences in water parameters (nutrients, chlorophyll *a*, dissolved oxygen, total seston, particulate organic matter) during the study period. However, no marked variation in water parameters among the three depths was observed (Tantichodok *et al.*, in prep.). This was probably due to the well mixed conditions throughout the water column and the shallowness of the study site. Fig.2 shows the growth in shell height of cleaned oysters during the study period. There are no significant differences among the growths of the oysters suspended at three different depths.
Figs. 3 & 4 depict the overall instantaneous growth rates of both cleaned and uncleaned groups. It is clearly shown in Fig. 2 that the growth rates per day of cleaned oysters at the three depths were non-significantly different. Non-significance is also found in the growth rates of the uncleaned group. However, the oysters at the bottom were doing better in terms of growth than at the other two depths.

Table 1. k or instantaneous growth rate (% day) of the cleaned oysters suspended at the three depths (standard deviation is given in parenthesis)

	Nov-Dec	Dec-Jan	Feb-Mar	Nov-Mar
Surface	0.342	0.169	0.261	0.193
	(0.132)	(0.062)	(0.126)	(0.065)
Mid-depth	0.275	0.217	0.268	0.190
	(0.106)	(0.133)	(0.112)	(0.056)
Bottom	0.374	0.148	0.284	0.202
	(0.128)	(0.060)	(0.106)	(0.062)

Table 2. k or instantaneous growth rate (% day) of the uncleaned oysters suspended at the three depths (standard deviation is given in parenthesis)

	Nov-Dec	Dec-Jan	Feb-Mar	Nov-Mar
Surface	0.254	0.184	0.182	0.158
	(0.107)	(0.106)	(0.052)	(0.037)
Mid-depth	0.244	0.196	0.172	0.163
	(0.107)	(0.068)	(0.052)	(0.081)
Bottom	0.354	0.208	0.225	0.211
	(0.143)	(0.062)	(0.045)	(0.047)

Table 1 summarizes the instantaneous growth rate (%/day) of the cleaned oysters. The growth rates were higher during the first month and the rates declined. The k values did not show any differences among the depths. Table 2 shows the k values for the uncleaned group. Again the growth rates were higher during the first month at all depth and then they decreased greatly due to the problem of fouling organisms, especially at the surface.

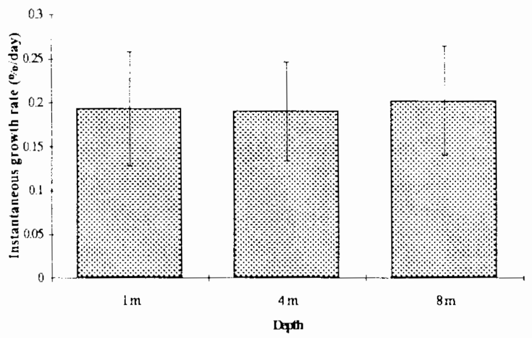

Figure 3. Instantaneous growth rate (%/day) for cleaned oyster, as a function of depth.

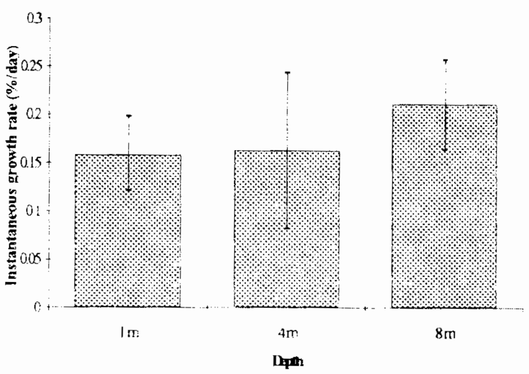

Figure 4. Instantaneous growth rate (%/day) for uncleaned oyster, as a function of depth.

The intensity of fouling organisms on shells of individuals during the study period is shown in Table 3. At the surface, the fouling problem was much greater than that at the greater depths. The biofoulers grown on the shells were bryozoans, barnacles, tunicates, hydroids, stony corals, sponges, and algae. The detailed results will be presented by Tantichodok *et al.* (in prep.).

Table 3. The dry weight biomass of biofoulers on the shells of five individuals suspended at different depths

Month	Surface	Mid-depth	Bottom
Nov-Dec	53.24	2.87	2.71
Nov-Jan	88.19	21.19	10.91
Nov-Feb	97.87	23.99	14.25
Nov-Mar	298.40	66.84	21.76

No mortality was found among the cleaned oysters at any depth. The mortality of uncleaned oysters at the three depths were: surface (40%), mid-depth group (33.3%) and the bottom group (6.7%). The cause of death was probably due to biofouling.

DISCUSSION

Enhanced growth of oysters when suspended near the bottom was not observed in this study. Rhodes *et al.* (1984) has suggested that faster growth could be achieved if suspension-feeding molluscs were suspended near the bottom, which he called "benthic turbidity zone". The benthic turbidity zone can potentially support better growth due to the combined food sources of phytoplankton and organic detritus. At the shallow study site (approximately 10 m) the water column was probably well-mixed throughout. Consequently, the suspended oysters of all depths were in contact with the same food sources. The growth of cleaned oysters were not statistically different. The growth of cleaned oysters was then not controlled by the physical or density-independent environment.

The growth of uncleaned oysters which were left infested by the fouling organisms were not significantly different (ANOVA tests). However, there is an evident trend that the uncleaned oysters did better at the bottom. The infestation of fouling organisms was much less at the bottom than at the surface and mid-depth. Many of the biofoulers are suspension-feeders which compete for food with the oysters. The mortality at the surface was much higher than at the bottom. This was attributed to the fouling problems. The biofoulers must have competed for food and reduced the fitness of the oysters. Kuriyan (1951) pointed out that the outgrowths of biofoulers on oysters' shells affected the growth of the oysters. Cleaning or scrubbing shells is a common practice among the pearl oyster farmers.

This study has pointed out that culture of *P. penguin* at a depth of 10 m can support good growth, and less problems of biofouling and mortality. Longer periods of growth studies at different depths should be carried out to shed more light on the suitability of depths for growing pearl oysters. The growth of oysters at such a system is controlled by density-dependent or biotic factors, rather than physical factors.

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