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The Effectiveness of Detritus Balls on Cockle (*Anadara granosa*) Growth

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Abstract

The detritus balls had been found to be effective as food for the survival of the cockles (blood cockle, *Anadara granosa*, Linnaeus 1785) kept in captivity but have not been tested in the field. In this study two plots of farm areas each measuring 20 m X 20 m were selected as testing fields where one served as test plot and the other was the control plot. Initially, there were cockles present in both plots aged about 18 months old measuring between 19 mm to 29 mm and only test plot was treated with 100 detritus balls. After the six months period (from January –June), 4,000 cockles from each plot were collected and measured.

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Generally, 70 % of the cockles fed with detritus had grown to more than 30 mm whereas only 18.6% of cockles not fed with detritus had reached over 30 mm. Some physico-chemical water parameters were also measured to investigate its relationship with the cockle growth. It was found that the main cause of cockle depletion was the high unionized ammonia NH_3 concentration.

Keywords: detritus balls; cockles growth; cockle culture.

1. Introduction

Unlike other mariculture systems, cockles are not fed but left to survive on natural food in the open culture system [1]. In Malaysia, cockle culture started since 1948 in Perak [2] and spread out to other areas and states due to its widespread popularity and economic gain. However, in recent years, the production in Selangor had shown a declining trend. In 2001, there were 654 hectares of farm producing about 6,922 mt of cockles benefitting directly only 25 farmers. By 2012, the farms have increased to 5,262 hectares with an increase of 11,842 mt production benefitting 750 farmers [3]. However, in term of production rate (the ratio of output to farms size), it illustrated a declining trend since 2001 except in two consecutive peaks in 2004 and 2005 (see Fig. 1.0). In 2001, the production rate was 10.6 mt/ha and by 2012, it had reduced to 2.3 mt/ha indicating an alarming situation for marine aquaculture in Selangor.

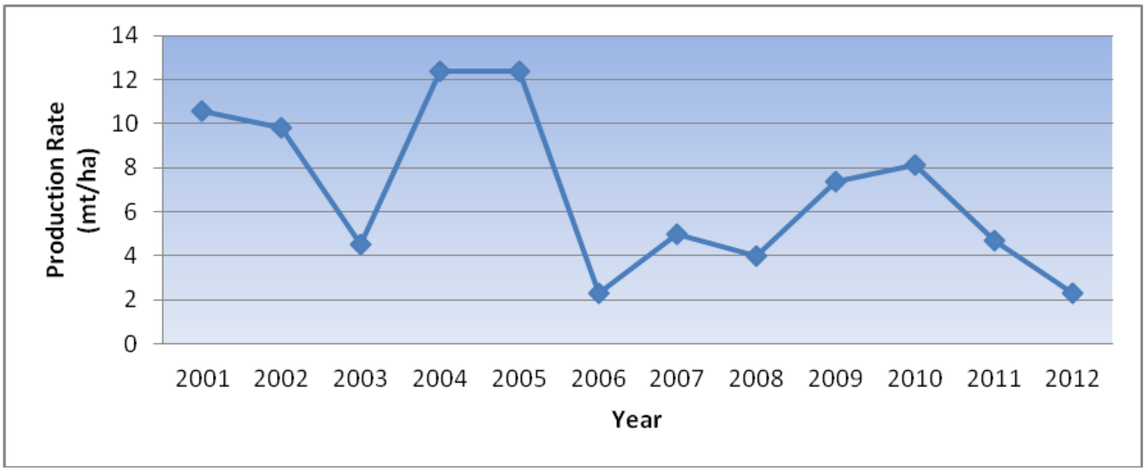

Figure 1.0: Cockle production rate from the year 2001 until year 2012. Source [3].

Cockle productivity does not depend on the availability of food supply alone. The maximum organic content of the Sg Buluh's mud flats was 7.8% as measured by [4] compared to 11% suggested by [5] for optimum growth.

According to [6], growth will also be affected by the stocking density and rate of aerial exposure of the farm. The suggested stocking density for spats is 2,000/m^2 and after three months, thinning will be carried out to reduce the density to about 200-300 pieces/m^2 [7]. As reported by [8], in Juru River, Penang, some heavy metals such as Cu, Cd, Ni and Zn had reduced the growth rate of cockles. Another factor that may have immense impact on cockle productivity is the amount of unionized ammonia NH_3 that according to [9] the LC_{50} at 48-h was 0.08 mg/L and at 96-h was 0.04 mg/L.

This study was the extension of the study by [10] on the survival of the cockles fed with man-made detritus balls in the laboratory. They have demonstrated that 70 % of the cockles placed together with the detritus balls survive while none in the control tanks. The researchers were also testing several compositions of clay and detritus to obtain optimum ratio and concluded that the appropriate content of decomposed leaves found was between 5%-11% in order for the balls to hold intact and submerge in the mud no deeper than 6 cm. However, the previous work did not attempt to study its effect on the growth of the cockles in the open culture system. Thus, the objective of this study is to test the effectiveness of the detritus balls on cockle growth in the farm.

2. Materials and method

2.1 Study site

Cockle farm plot No. 62 situated at the proximity of Sungai Buloh's estuary was selected for the test. It was located approximately at Lat. 3^0 14'51.97 N, Long. 101^0 17'33.65E , at about one kilometer from the estuary. The size of the plot was 50 ha but only 800 m^2 was used for the study and further sub-divided into two plots each measuring 20 m X 20 m (400 m^2). The plots were designated as test plots and control plot. All plots were marked with poles at all angles (see Fig. 2.0).

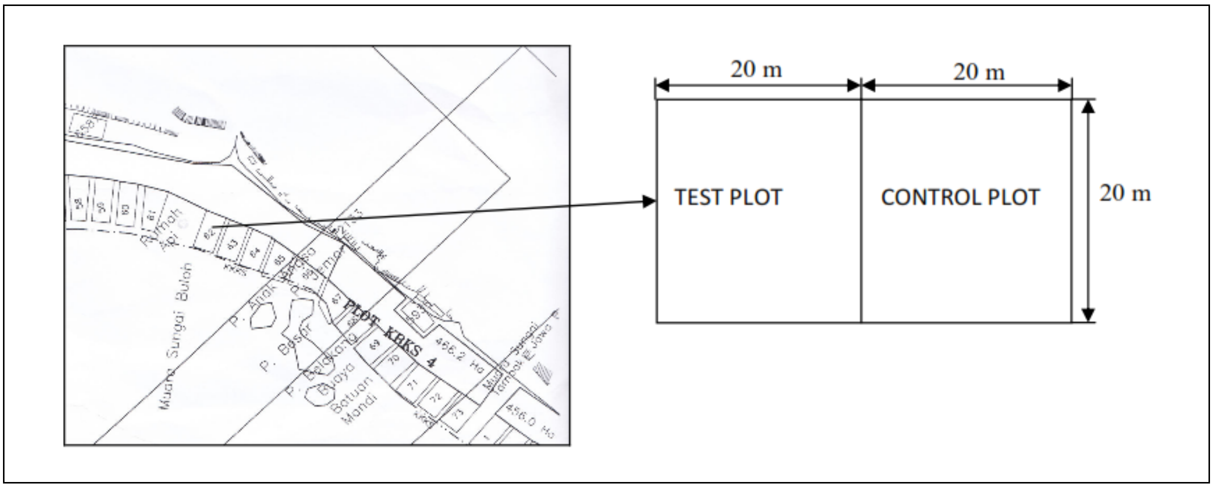

Figure 2.0: Study site at Plot number 62 near Sungai Buloh estuary (muara)

2.2 Test design

The age of the existing cockles in the study plot was obtained from the farm's owner Mr Kahar bin Buntal (identification number: 520711105749) who estimated to be about 15 months old at the beginning of the test. It was assumed that all cockles contained in the plots were of the same cohort. The selected 800 m^2 plot was surveyed to determine individual size of the cockles before the start of the test using a dredger locally known as 'kor' (see Fig. 3.0). It was done firstly by evenly distributing the cockle population, with a method known as 'dredging the cockles' using a dredge that was run through the sea-bed several times. It was a practice adopted by farmers to evenly distribute the cockle population to avoid clumping of the cockles that may result increased mortality rate or reduced growth [11]. The density of the plots was then thinned down to 300 pieces/m^2 as to achieve optimum growth as suggested by [6]. About 4,000 cockles were collected randomly [12] and measured using vernier caliper for total length [13] at the beginning of the test from each plot. Hundred (100) detritus balls were thrown into the test plot in Jan 2013. The control plots were without the detritus balls.

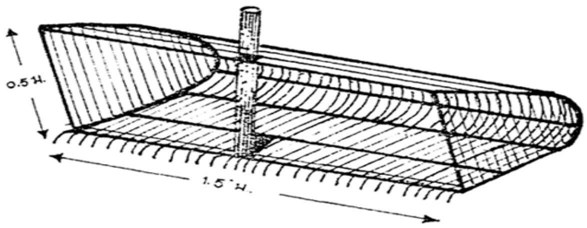

Figure 3.0: The 'kor' pole normally about 1.5 m long.

2.3 Detritus balls

The preparation of the detritus balls as described by [10]. The detritus ball contained approximately 11% of decomposed leaves enclosed by clay and weighed approximately 500 gm (see Fig.4 and 5). As tested by [10], the detritus balls will crack open between 90-105 minutes after being submerged in the water (see Fig. 6).

Figure 4: Detritus balls

Figure 5: : Cross-section of a detritus ball showing decomposed leaves

Figure 6: Broken detritus balls in the water

2.4 Physico-chemical parameters

The selected parameters such as total ammonia, temperature, pH, dissolved oxygen (DO), salinity, were taken twice per month and heavy metals (Cu, Fe, Mn and Zn) three times during the 6-month period. The heavy metals were analyzed using the Atomic Absorption Spectroscopy (AAS) method at the laboratory of Centre of Tropical Soil Studies, Universiti Putra Malaysia while total ammonia using calorimeter HACH DR/890. The rest of the parameters were taken using YSI Multi-probes Professional.

3. Results and discussion

At the end of June 2013, 4,000 cockles were randomly collected from each plot and individual lengths were measured. Although 141 cockles measured 37 mm each from the test plot were visibly outliers, the Grubb's test [14] performed showed that they are not significant outlier thus accepted as valid data (mean=30.7, sd= 3.4, $p > 0.05$). Table 1 shows the length-frequency of the individual cockles. Statistical test of ANOVA revealed that there was significant different of means among the groups ($p< 0.05$) implying the effect of the detritus balls had taken place. Although the mean difference between test plot and control plot was only 2.0 mm or 0.07% increase, the number of large cockles was more in the test plot than in the control plot. In general, it can be deduced that 70.3 % of the cockles fed with detritus had grown to more than 30 mm whereas only 18.6% of cockles not fed with detritus had reached over 30 mm (see Figure 7). The cockle density had also reduced to about 230 pieces/m^2 indicating the occurrence of mortality. It was confirmed with the existence of empty shells during the harvesting.

Table 1: Length-frequency of cockles

Total length (cm)	Frequency of cockles in Plot no.62 (before)	Frequency of cockles in Control Plot (after)	Frequency of cockles in Test Plot (after)
19	98		
20	88		
21	85		
22	512		
23	523		
24	1123		
25	524	597	
26	123	612	108
27	311	312	213
28	213	616	311
29	400	1121	516
30		410	912
31		121	522
32		211	832
33			324
34			121
35			
36			
37			141
Total	4000	4000	4000

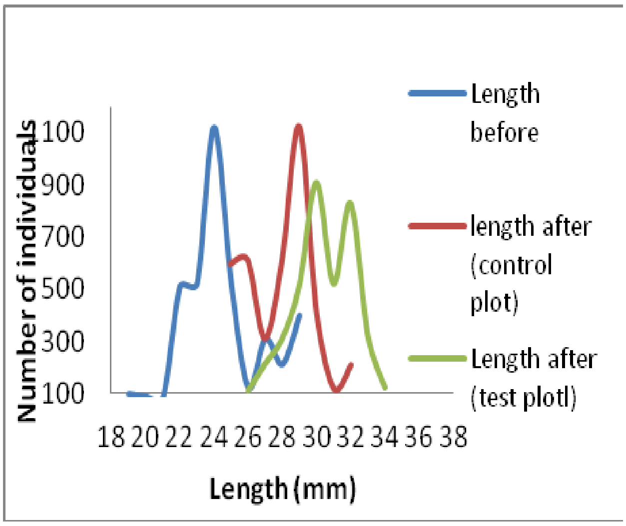

Figure 7: Number of cockles and length after the test.

Information on the study of cockle growth in Malaysia is mostly out-dated. Only two studies were frequently cited, for example by [15,16,17,18,19,20]. The two studies were carried out between 1978 to 1979 by Broom [21], and between 1984 to 1985 by Oon [29]. However the growth parameters obtained by both studies may have changed tremendously as reported by [10] that the aging of the cockle beds over many years of farming may lessen the nutrients and organic matter needed for growth. Food for cockles such as planktons, detritus and small animals must have depleted due to nutrient deficiency. Apparently the growth rate will be in the descending trend. The study by [21] fitting the Von Bertalanffy Growth Function (VBGF) [23] obtained the best estimates of the growth constant (k) and asymptotic length (L_∞) as 1.01 yr-' and 44.4 mm respectively for populations under optimum conditions and by[22] in Kuala Selangor, Selangor obtained the growth constant (k) = 0.78 yr^{-1}, L_∞ = 41.4 mm and the value of t_0 = 0.118 (the age at which the organisms would have had zero size). Comparing the values of k obtained by [21,22], it suggests the lower growth rate by the latter [23]. Fig. 8 is plotted by using growth parameters obtained by both studies (k, L_∞ and t_o) and with known age of the cockles (the test and control plots), the six months growth of the plots were also plotted and compared to growth curves of [21], and [22] The test plot curve indicates an improved growth after being treated with the detritus balls [see Fig. 9]. Apparently it will take more than two years to reach L_∞ indicating slow growth rate in present cockles.

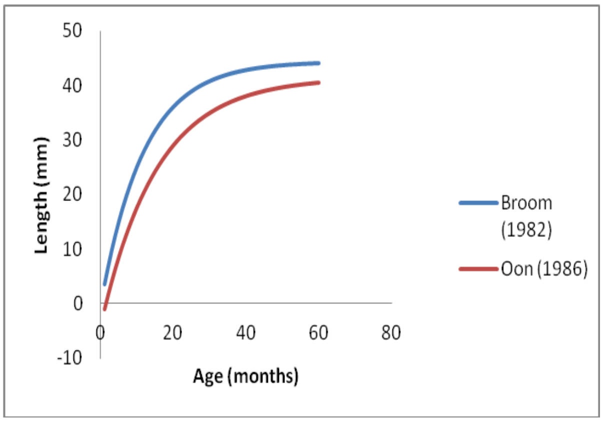

Figure 8: Growth curves of Broom. Source [21,29].

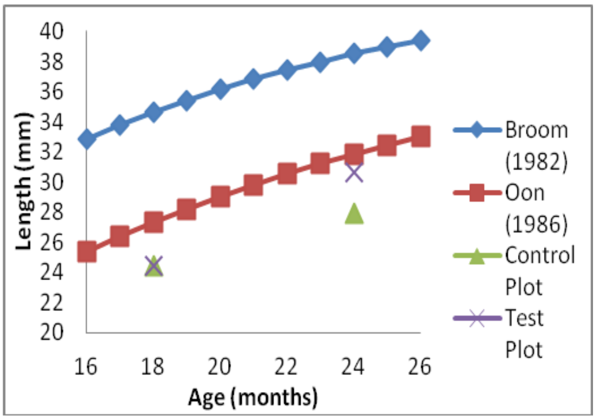

Figure 9: The 6-month growth of Test Plot and Control Plot

During the test period, water parameters were also measured to investigate its effect on the cockle survivability. Particular attention was given to un-ionised NH_3 and some selected heavy metals such as Cu, Fe, Mn and Zn. With known temperature and pH, and using the % NH_3 Table as in [24], the values of un-ionised NH_3 were obtained (as in parenthesis, see Table 2). The un-ionised NH_3 values for the first four months were found below 0.04 mg/L of LC_{50} at 96-h as given by [9]. However, during the months of May and June the values of un-ionised NH_3 were slightly higher than the 0.04 mg/L (0.046 mg/L in May and 0.047 mg/L in June) indicating a substantial cockle death may have occurred. During these months, cockle production indicates a declining trend as shown by [25]. With respect to heavy metals, although their presence was detected, the values were considered insignificant to have caused severe mortality. For instance, Copper concentrations between 5 to 27 µg/L were very much lower than 290 µg/L value of NH_3 of LC_{50} at 48-h as given by [26] or 170 µg/L by [27] The11 µg/L of Zn, detected only in May was low compared to value of LC_{50} at 48-h as obtained by [27], that is 1940 µ/L. Mn and Fe concentrations were negligible. This confirms with [28] that heavy metals contained in Sg Buluh river (that discharged into Sg Buluh farm areas) was not detrimental to cockles. It is then concluded that only the concentration of NH_3 was having some effects on the cockle production. Other parameters were within the range suitable for cockle farming [5,6,29,30].

Table 2 :Physico-chemical parameters

Parameters	Jan	Feb	Mar	Apr	May	Jun
Temperature (^{0}C)	28	30	31	28.6	32	29.8
pH	7.6	7.1	7.8	7.5	7.6	7.2
DO (mg/L)	7.67	7.58	7.42	8.33	8	4.5
Salinity (ppt)	27	27	28	29	29	30
Ammonia (mg/L)	1.4 (0.038)	1.4 (0.014)	0.3 (0.015)	1.4 (0.032)	1.3 (0.046)	4 (0.047)
Cu (µg/L)	-	-	27	18	5	-
Fe (µg/L)	-	-	Traces	186	Traces	-
Mn (µg/L)	-	-	Traces	328	12	-
Zn (µg/L)	-	-	Traces	11	Traces	-

4. Conclusion

Food demand is normally associated with the number of individuals present and farming practices suggest the stocking rate of between 200 -300 pieces of cockles per m^2.The cockle culture method proposed by [2,6,22] has remained unchanged [7] but obviously the stocking rate as practised by the Sungai Buluh farmers had surpassed the optimum stocking rate that may have affected the growth rate of the cockles. Currently, the main concern is whether the farmers are adhering to good farm practices as proposed by previous researchers. The occurrence of unionized ammonia and to some extent the heavy metals are detrimental to cockles and are almost unavoidable due to lack of control over the pollution. However, cockle farming is still a profitable business and farmers are enduring to survive. This allows space for improvement if farmers are taught proper farming practices. With appropriate method of estimating the stocking rate, evenly distributing the population and adding detritus balls occasionally, the cockle production is optimistically increased.

The growth improvement as demonstrated in the presence of detritus in the test plot proved that the cockles need additional food to grow to size similar to cockles cultured some 27 years ago. However, the extensive study on cockle growth using the VBGF should be carried out to provide better understanding of the status of cockle production in the country.

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