Survivorship and Growth Performance of Red Spiny Lobster *Panulirus longipes longipes* Reared in Floating Netcages Fed with *Sardinella* spp at Different Feeding Rates

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ABSTRACT

This study was conducted to determine the survivorship and growth performance of *Panulirus longipes longipes* fed with *Sardinella* spp. in floating netcages at different feeding rates and to determine which feeding rate provides the best feed conversion ratio.

Results showed that a feeding rate of 20% gave the highest growth (final average weight) followed by 15% and 10% feeding rates, respectively. In terms of length increment, 20% feeding rate likewise promoted the highest increment.

Differences in feed conversion ratio among treatments was significant ($P<0.05$). Among the different treatments however, stocks fed at 15% body weight attained better growth increment and trend in feed conversion ratio.

Keywords: feeding rates, *Panulirus longiceps longiceps*, cage culture, *Sardinella* spp.

INTRODUCTION

Panulirus longipes, a long-legged spiny lobster (Ravago-Gotanco et al. 2003) had pointed spines on their carapace and antenna (Shokita 1991). The body of P. *longipes longipes* is red, walking legs are red with many white spots; each abdominal somite has many small white spots (Gonzales and Taniguchi 1995).

Lobsters are favored food in many countries because of their fine flavor. Even in this age of abundant food supply, demand for luxury food like this exceeds their supply (Shokita et al. 1991). Lobsters have excellent market demand and price. Live lobsters commands an even higher price compared to frozen lobsters (James and Marian 2003) as they are important export items and expensive delicacies (PCARRD 1981). Lobster business today is a lucrative fishing enterprise because of its unlimited demand (Campomanes 1992).

According to Bardach *et al.* (1972), lobster P. *japonicus* can be cultured in ponds and shallow bays. In Guimaras, Philippines, *P. ornatus, P. versicolor* and *P. longipes longipes* were cultured in pens (Tambuli 1988). In Palawan, lobsters were temporarily stocked in submerged cages to keep the animals' alive (Gonzales and Taniguchi 1995) before marketing.

According to Gonzales and Taniguchi (1995), lobster > 100g should not be sold to any fishery market to properly benefit man. They should be released in its

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natural habitat to grow further or grown in cages or in pens until they reach a marketable size (150 grams or more). However, knowledge on the biology of many crustacean species is still inadequate and it needs to be extended through further information dissemination and experimentation (Gonzales and Taniguchi 1995). Since this species of lobster is a high value and their population is relatively low compared with the other species of lobster (Ravago-Gotanco et al. 2003), they are vulnerable to overexploitation. To lessen population pressure in the wild, this study was conducted to determine the feasibility of culturing *Panulirus longipes longipes*. Specifically, this study was conducted to determine the growth performance of red spiny lobster *(Panulirus longipes longipes)* reared in floating netcages fed with chopped *Sardinella* spp. at different feeding rates, and to determine which feeding rate can provide the best feed conversion ratio.

METHODOLOGY

The lobster culture was conducted near the Western Philippines University - Puerto Princesa Campus Fish Cage Project in Tiniguiban Cove, Puerto Princesa City (Figure 1) located 09°46.464 N and 118° 43.898 E.

Red spiny lobsters were collected from the offshore of Sabang, Puerto Princesa City. Forty five (45) individuals were collected and soaked in iced seawater for 3 to 5 seconds until they stopped moving. The animals were then wrapped individually by a piece of newspaper, and systematically arranged inside the styrofoam box. The lobsters were transported early in the morning to the study area. Upon arrival, the box was opened and the experimental animals were unwrapped individually inside the cage. Lobster was held at surface of water, until they swam freely in the prepared cages. The floating netcages made up of bamboo poles (3.5 m. in length) were divided into 9 (1m x 1m) cage frames. A polyethylene B-net 1m x 1m x 1.5m with a mesh size of 0.25 cm was used as netcages. These netcages were firmly attached to the cage frame. Reinforcement bar measuring 1 x 1 meter was placed inside the cage as sinker (Plate 1). For protection of cage net, perimeter net (2.50cm mesh size) was installed.

Figure 1. Map of Puerto Princesa Bay showing the experimental site.

Plate 1. Installation of sinker in the floating net cages used in the study.

Upon arrival in the experimental site, the box was opened and the experimental animals were unwrapped individually inside the cage. Lobsters were held at surface of water until they swam freely at a stocking density of 5 pieces per cage. Initial weight and carapace length of lobsters to be experimented ranged from 43.13 to 45.80g and 3.45 to 3.56cm, respectively.

Three feeding rates (20%, 15% and 10%: n=5) with three replicates were used in the study. Replicates for each feeding rate were assigned in the netcages using Completely Randomized Design. The Red spiny lobster was fed with fresh or frozen chopped *Sardinella* spp. Feed was given once a day at 5 to 6 pm.

Individual weight and carapace length (Pascual et al. 1980) of experimented red spiny lobsters were

measured using Tanita™weighing scale (500g capacity) and a vernier caliper, respectively at the start of the rearing period and every 25 days thereafter for 75 days. Sampling was done early in the morning. Water temperature and salinity were determined daily.

The mean average body weight and carapace length among feeding rate were analyzed using Analysis of Variance (Gomez and Gomez 1984). Feed conversion ratio (FCR) in each treatment was computed by dividing the total feed consumed with the weight gain (Pascual 1989) after 75 days culture period, growth increment (weight and carapace length) and survival rate in every 25 days culture period were also computed.

RESULTS AND DISCUSSION

Survivorship

One hundred percent survival were obtained from 15% and 10% feeding rates while 20% feeding rate had a survival rate of only 86.67% as an effect of a mortality of two lobsters in its two replicates, although differences among survival rates in the different feeding rates was not significant ($P>0.05$). In spite of it, the average survival rate in this study (95.56%) was higher compared to the 90% expected survival rate of lobsters grown in netcages (Tambuli 1998).

Though survival and growth of lobsters are affected by temperature, salinity and pollutants, temperature is the most important environmental factor that affects the growth rate of lobsters (Phillips *et al.* 1980). The water temperature in experimental site ranged from 28.17 to 31.07°C. Water salinity within the cages ranged from 29.43 to 30.83ppt while dissolved oxygen ranged from 4.77 to 5.5mg/L. The values obtained in the experimental site for temperature and salinity was almost similar to the criteria established by Phillips et al. (1980), Aiken (1980) and Van Olst et al. (1980) in which water temperature in the culture cage must range from 29 to 32°C and the salinity should be 30 to 34ppt for better production. Temperature higher than 32°C is detrimental for lobster's growth and survival (Aiken 1980); however, Van Olst et al. (1980) and Phillips et al. (1980) stated that lobsters can tolerate temperature as high as 32°C and as low as 18°C provided salinity must ranged from 30-35ppt (Lee and Wickins 1992). Although lobster could adjust to a wide range of salinity (Stewart 1980), salinity fluctuations are naturally occurring and causing environmental stress in cultured lobster, even lobster is a euryhaline and osmoconformer species. In relation to this, Phillips et al. (1980) further stated that seven percent salinity differential from 30 and 34ppt would cause high mortality. Mortality in cultured lobsters is also caused by the amount of dissolved oxygen (Radhakrishan and Vijayakirmaran 1984). Juinio-Menez and Ruinta (1996) as cited by Salvacion, (2000) stated that mortality occurred when dissolved oxygen is less than 4.0 mg/li which is conforming to the statement of Booth and Kittaka (1994), that lethal level of dissolved oxygen for lobster culture ranging from 0.5 to 3.0 mg/li though this was not observed in the study area. Thus, the high survival rate of cultured red spiny lobsters in Tinguiban Cove will probably due to the favored conditions in the experimental site though cannibalism of molted lobster was observed in one of the replicates lobster at 20% feeding rate.

Growth Performance

Weight and length

The lobster fed with chopped *Sardinella* spp. at 20% feeding rate obtained the highest average weight gain (Table 1). A final average body weight of 66.13g, 65.87g, and 63.73g were obtained from 20%, 15% and 10%, respectively.

During 50 days of culture, *P. longipes longipe*s fed at 20% and 10% body weight were almost similar in weight (59.22g. and 59.33g.). However, it was then observed that body weight of stocks fed at 15% body weight rapidly increased towards the end of the 75 days culture period (Table 1), although it had the lowest initial average body weight (43.13 g) while stocks at 20% feeding rate constantly gain weight (22.87g) until it reached 75 days of culture period. An apparent increase in average weight was observed in 15% feeding rate until 75 days reaching 65.87 grams. On the other hand, the 10% feeding rate had the highest body weight in the first 25 days and slows down its growth thereafter while the lobsters fed at 20% feeding rate obtained the highest final average weight (66.13g)

Days of Culture	Feeding Rate 20%		15%		10%	
	Weight (g)	Carapace length (cm)	Weight (g)	Carapace length (cm)	Weight (g)	Carapace length (cm)
	43.27	3.45	43.13	3.51	45.8	3.56
0	±1.15	±0.11	±2.37	±0.11	±2.31	±0.02
	47.35	3.62	45.53	3.54	49.07	3.71
25	±2.48	±0.09	±2.80	±0.13	±2.76	±0.05
	59.22	3.85	51.93	3.73	59.33	3.91
50	±3.20	±0.08	±5.49	±0.12	±3.41	±0.06
	66.13	4.03	65.87	4.06	63.73	3.95
75	±2.68	±0.06	±3.41	±0.00	±5.84	±0.17
Gain	**22.87**	**0.58**	**22.73**	**0.55**	**17.93**	**0.39**

Table 1. Average body weight and carapace length of Panulirus after 75 days culture period.

in 75 days culture period. Differences in gain and final weights among feeding rates were not significant (P>0.5), which is consistent with the condition at the starts of study.

Initial carapace length of lobsters being cultured ranged from 3.45cm to 3.56cm (Table 1). Lobster fed at 15% feeding rate obtained the highest final average carapace length of 4.06cm followed by 20% (4.03cm) and 10% (3.95cm), respectively. These results in carapace length (0.052-0.054cm/day carapace length increment) were comparable and even higher with the findings of Smale (1978) regarding the growth of the juveniles of *P. homarus* in South Africa which had a carapace length increment of 0.01cm/day.

The total weight gained of animals in the cages which were fed equivalent to 20% of total biomass was 22.87g; followed by 15%, 22.73g. Feeding rate of 10% only attained a gained in weight of 17.93g which could be reflected to the highest metabolic rate of organisms at the early age where feeds given were not enough to sustain lobsters' physiological processes.

The total carapace length gained in experimental lobster was almost similar in 20% (0.58cm) and 15% (0.55cm). The lowest carapace length gain was with 10% feeding rate (0.39cm). The differences in lobsters' carapace length gains were not significant at 5% level of significance.

Weight and Carapace Length Increment

Feeding rate of 20% body weight had the highest average weight increment (0.1016g/day). It was followed by the lobster fed at 15% (0.1011g/day). Lobster fed at 10% had the lowest average weight increment with only 0.0797g/day (Table 2). Lobster fed at 20% feeding rate got the highest weight increment (0.0544 and 0.1582g/day) for the first 25 and 50 days culture period. It was followed by the lobsters given 10% feeding rate (0.0436 and 0.1368g/day). However, after 75 days culture period, lobsters fed at 15% feeding rate showed a consistent increase in weight (Table 2) unlike with the lobsters which fed at 20% and 10% feeding rate, respectively.

Lobster fed at 20% feeding rate had the highest average carapace length increment (0.0077cm/day), followed by 15% (0.0073cm/day) and 10% (0.0017cm/day). During the initial 50 days culture period, highest growth increment in carapace length was observed in 20% (0.0092cm/day). Lobsters fed at 10% feeding rate obtained a low carapace length increment towards the end of the culture period probably due to molting (Two lobsters molted when the study ended). Likewise, consistent increase was observed at 15% feeding rate and continuously increases towards the end of 75 days culture period resulting to the highest increase in carapace length which was probably attributed to the amount of feeds intake (Table 2).

Days of Culture	Feeding Rate 20%		15%		10%	
	Weight increment (g/day)	Carapace Length increment (cm/day)	Weight increment (g/day)	Carapace Length increment (cm/day)	Weight increment (g/day)	Carapace Length increment (cm/day)
0	-	-	-	-	-	-
25	0.0544	0.0068	0.0320	0.0012	0.0436	0.0020
50	0.1583	0.0092	0.0853	0.0076	0.1368	0.0027
75	0.0921	0.0072	0.1859	0.0132	0.0587	0.0005
Total	0.3048	0.0232	0.3032	0.0220	0.2391	0.0052
Average	0.1016	0.0077	0.1011	0.0073	0.0797	0.0017

Table 2. Growth increment of Panulirus longipes longipes at Tiniguiban Cove, Puerto Princesa Bay.

The results in growth of *P. longipes longipes* showed that a feeding rate of 10% and 20% respectively obtained an almost similar faster growth at the start while 15% feeding rate slowly improved during the 50 days culture period. As cultured lobster became older the feeding rate of 15% obtained a higher growth in carapace length and body weight followed by 20% and slow growth rate was observed in 10% which could be reflected to the amount of food being intake. For lobster fed at 20% feeding rate, more leftovers had been collected. Amount of leftovers were enough to affect the water quality and probably the cause of mortality in two replicates of 20% feeding rate. On the other hand, lobsters fed at 10% were very much active during the first culture period. Since the feeding rate is low, the amount of feeds given to the stocks when they become older probably may be not enough, resulting in the reduction of growth increment on both weight and carapace length.

Feed Conversion Ratio

Cultured lobsters fed at 20% feeding rate consumed the highest amount of feeds after 75 days of culture (Table 3). It was followed by the lobsters fed at 15% and 10% with 22.73kg and 17.93kg, respectively. As a result, lobster fed at 20% body weight obtained the poor feed conversion ratio (Table 3). Although, Pascual (1989) stated that the lower the FCR, the better it is because less feed is required per unit weight gain as shown in 10% feeding rate (Table 3), the feeding rate of 15% showed the best trend in feed conversion ratio (Figure 2) which also showed better weight and carapace length increment (Table 2).

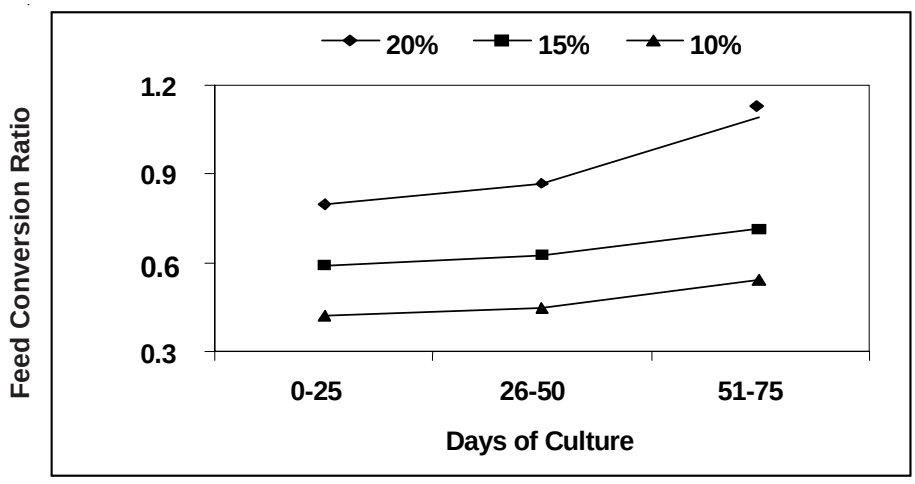

Figure 2. Trend of feed conversion ratio among three feeding rates.

Differences in feed conversion ratio (FCR) between and among feeding rates were significant ($P<0.05$), and significant difference ($P<0.01$) was also observed between 20% and 10% feeding rates.

Days of Culture	Feeding Rate		
	20%	15%	10%
0 - 25	3.24525	2.42606	1.71750
26 - 50	3.55125	2.56106	1.84013
51 - 75	4.44150	2.92106	2.22488
TOTAL	11.238	7.908	5.78251
Total weight gain (g)	22.87	22.73	17.93
FCR	0.491	0.348	0.322

Table 3. Total feeds consumed in kg after 75-day culture

CONCLUSION AND RECOMMENDATIONS

Based on this study, the differences in weight among feeding rates were not significant though significant difference was found on their feed conservation ratio. Weight and carapace length increment is useful in determining the feasibility of designed feeding rates.

To get better results, this study should be conducted for a minimum of 6 months to determine how efficient the feeds be converted into flesh of lobster taking different feeding rates.

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