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Final report

Small research and development activity

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1 Acknowledgments

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2 Executive summary

To enable improved productivity and expansion of the Vietnamese lobster aquaculture industry, development of land-based production systems as an alternative to sea-cage systems is prudent.

This SRA project enabled the construction of a purpose-built lobster tank production system as a pilot for commercial production.

A 360 day experiment was performed in the tank system to establish baseline production metrics for *P. ornatus* in tanks.

Survival exceeded 75% at densities of up to 7 lobsters per square metre and biomass of up to 5.5 kg/m². Growth rates were equivalent to those achieved in best-practice sea-cage operations.

Survival was not significantly different at the various densities applied suggesting that higher densities could be supported.

The partial water replacement approach to water supply was effective, but recirculation technology would be better to enable temperature control and better water quality management

Typical Vietnamese shrimp hatchery tanks may be too small to grow lobsters beyond 800g, so larger tanks may be necessary to produce the premium Grade 1 lobsters over 1kg.

Economic assessment should be made of the system as used and to extrapolate for higher densities and more intensive production with additional technology. Such economic analysis should be made for Vietnam and Australian environments.

Tank-based culture of tropical spiny lobsters, *P. ornatus* is technically successful, and further development of appropriate technologies should be pursued to stimulate establishment of a tank-based lobster production sector.

3 Introduction

The Vietnam spiny lobster aquaculture industry is a good example of a smallholder based industry which benefits impoverished communities and which has been supported by ACIAR through projects FIS/2001/058 (finalised) and SMAR/2008/021 (current).

Despite the success, there are problems with farmed lobster production in regard to less than optimal productivity which are linked to issues of over-crowding of farms, inadequate nutrition and disease. These issues in turn are related to the sea-cage production systems employed and limited access to optimal sites along the south central coast of Vietnam.

Land-based production systems may provide an alternative that enables more controlled management of water quality, nutrition and disease, and which provides capacity for industry expansion.

Shrimp pond production systems were assessed in 2009 /10 for lobster production and dismissed due to lack of control of water quality. Consideration of tank systems for lobster production was then suggested, and this Small Research Activity project was developed to make the initial assessment.

The aim of the project was to assess the suitability of typical Vietnamese shrimp hatchery system as a production system for spiny lobsters, and if suitable to develop a more comprehensive plan to develop a tank-based lobster production sector in Vietnam and Australia.

There were two specific objectives:

- To design and establish a tank-based lobster production system
- To run a long-term lobster production experiment that established baseline production metrics

4 Background

This SRA project is directly linked to a large on-going project, SMAR/2008/021 which aims to improve the sustainability of the Vietnam lobster farming industry through better understanding of the puerulus resources available, assessment and demonstration of pellet diets for lobsters and examination of alternative lobster production systems. The latter has been necessary because of significant reduction in lobster production because of disease which may be related to coastal pollution generally and more importantly localised pollution due to the practice of feeding lobsters trash fish.

The assessment of pond systems was completed in 2011 and demonstrated that the variability of the water quality in typical shrimp ponds, particularly of salinity, is too great to justify lobster production, which involves high upfront cost to purchase lobster seed. Alternative tank-based production may be a better option than ponds, as they provide greater opportunity for managing the water quality, and therefore decreasing risk of lobster mortality.

This SRA was then developed to assess lobster production in tanks, using under-utilised shrimp hatchery infrastructure. There are potentially hundreds of such under-utilised facilities along the coast of Vietnam that may be turned to lobster production, providing a viable alternative to sea cages. Further, purpose-built tank systems for lobster may also be profitable given the high market value of the lobster.

In Australia, sea-cage production of lobsters is unlikely to be supported in the short to medium term due to its perceived environmental impact on coastal marine ecosystems and consequently difficulty of gaining permits. Land-based systems however may be supported, particularly those with zero net nutrient discharge. On this basis, pond and tank production are also being assessed within SMAR/2008/021 in Australia. This SRA complements this work, for Australian benefit.

In Vietnam, seacage culture of lobsters based on a wild fishery supply of naturally settling juveniles (puerulus), started in the province of Khanh Hoa in 1992 and has expanded significantly around south-central Vietnam since 2000. *Panulirus ornatus* (ornate spiny lobster) is the most important cultured species, because of strong demand and high price in the Chinese market, and because pueruli of this species are the most abundant. In recent years, farming of *P. homarus* has developed into a strong secondary production sector, as significant numbers of pueruli of this species are also caught, and it similarly attracts good price and strong demand.

In 2006, there were more than 49,000 cages producing approximately 1,900 t of product, valued at about US$90 million. However, disease caused a decline in productivity and production in the Vietnam lobster farming industry, particularly from 2008. Coastal pollution in Vietnam from numerous sources is likely to be a significant causative agent as is the traditional practice of using low value fish, molluscs and crustaceans, so called ‘trashfish’ as the food for farmed lobsters. Although use of manufactured diets for lobster farming will improve water quality at farm sites, the medium term outlook for sea-cage based lobster farming is for continued problems and sub-optimal production.

While it is apparent that improvements in environmental management, particularly in feeding practices, are alleviating the disease issues, it is prudent to assess alternative production systems that are not subjected to the same environmental problems.

5 Lobster Tank Production System

A fundamental aspect of this project was the design and establishment of a simple tank production system that might be replicated by others either by building similar systems or retro-fitting shrimp hatchery tank systems.

The system illustrated below was designed and constructed with collaboration of a small-holder hatchery operator.

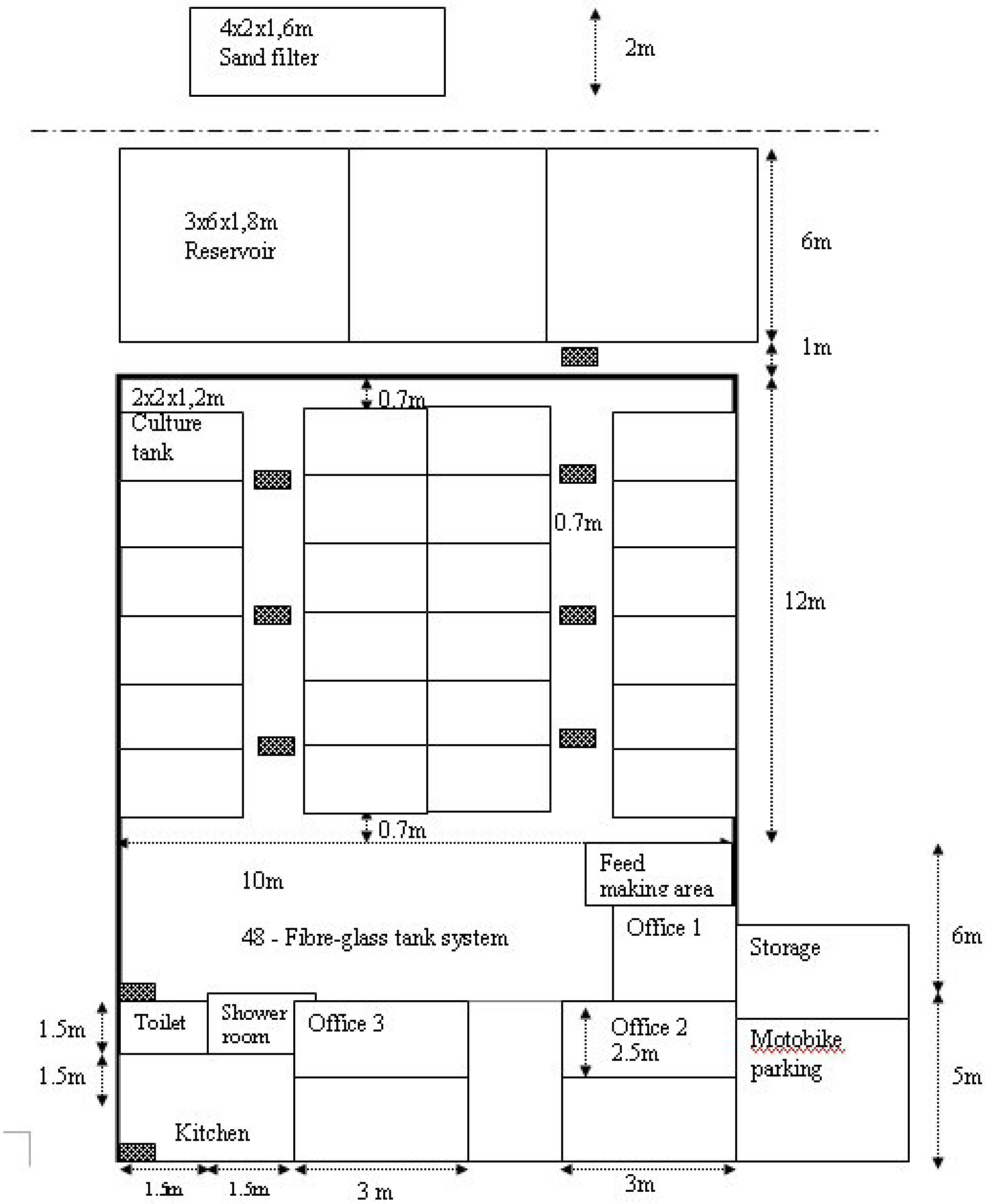

Figure 1. Diagrammatic illustration of lobster production tank system established.

Table 1. Fixed costs for lobster production tank system in Vietnam.

Item	Quantity	Units	Price	Life time	Setup cost	
	(number)		(VND/unit)	(years)	(VND)	(US$)
Purchase and installation of filters						
Sand filter tanks	2	number	16,000,000	10	32,000,000	1,600
Filter bags	4	number	150,000	1	600,000	30
Pump	2	number	3,000,000	2	6,000,000	300
Pipes	350	m	30,000	2	10,500,000	525
Connectors	50	number	16,000	2	800,000	40
Steel	10	kg	30,000	1	300,000	15
Sea-well	1	number	3,000,000	2	3,000,000	150
					0	0
Purchase and installation of reservoir						
Concrete reservoirs	3	number	36,000,000	10	108,000,000	5,400
Pumps	2	number	3,000,000	2	6,000,000	300
Pipes	20	m	25,000	2	500,000	25
UV unit to purify water from bacteria	2	number	35,000,000	1	70,000,000	3,500
					0	0
Purchase and installation of the tanks						
Tanks	24	number	8,000,000	10	192,000,000	9,600
Aerators	2	number	11,000,000	5	22,000,000	1,100
Hoses (Ø = 20 mm) for aeration	100	m	10,000	2	1,000,000	50
Hoses (Ø = 2 mm) for aeration	4	roll	20,000	2	80,000	4
Air valve+airstone+ceramic sinker	120	set	10,000	2	1,200,000	60
Pipes (Ø = 90 mm) for water flow	40	m	54,000	2	2,160,000	108
Pipes (Ø = 60 mm) for water flow	120	m	25,000	2	3,000,000	150
Connectors/water valves	100	number	16,000	2	1,600,000	80
Climbing mesh + ceramic sinker + rope	48	set	60,000	2	2,880,000	144
Pipes for on-bottom shelter	24	tank	25,000	2	600,000	30
Pipes for off-bottom shelter (+small pipe & rope)	24	tank	30,000	2	720,000	36
Siphoning pipe	24	number	150,000	1	3,600,000	180
					0	0
Purchase and installation of equipment for feeding						
Freezer	2		9,000,000	5	18,000,000	900
Fridge	1		7,000,000	5	7,000,000	350
Mixer	1		4,900,000	5	4,900,000	245
Mincer	1		5,000,000	5	5,000,000	250
Microwaver	1		2,000,000	5	2,000,000	100
Gase stove	1		1,700,000	4	1,700,000	85
Sieve	2		106,000	4	212,000	11
Steamer	1		5,000,000	5	5,000,000	250
Scales	3		1,000,000	2	3,000,000	150
Bucket	40		50,000	1	2,000,000	100
Oven	1		10,000,000	5	10,000,000	500
General setup costs						
Generator (back up for electricity)	1	number	13,000,000	5	13,000,000	650
Shed and buildings	300	m	500,000	10	150,000,000	7,500
Cost of leasing land	5	year	15,000,000		75,000,000	3,750
Labour for initial set-up (person day)	60	PD	300,000		18,000,000	900
Miscellaneous consumables	1		50,000,000		50,000,000	2,500
					0	0
Total					833,352,000	41,668

5.1 SWOT analysis of lobster production tank system

Strengths

- Small-scale – easy for local farmers to manage
- Reasonable costs – potential small-holder farmers can invest
- Advantageous for nursing and farming of lobsters less than 1000g.
- Easy for monitoring feeding and water quality
- Higher survival compared with sea-cages nearby

Weaknesses

- Small tanks may be too small for bigger lobsters
- Lower growth rate compared with sea-cages nearby

Opportunities

- Avoidance of disease outbreaks that affect lobsters in sea-cages
- Good alternative to sea-cages which have limited new areas
- Suitable for accepting hatchery produced pueruli

Threats

- Culture sites restricted because of tourism demands
- Market fluctuations in price and demand, particularly for China
- Higher production cost because of higher capital and operating costs.

Figure 2. Concrete tanks used for lobster production.

6 Lobster Production Experiment

To establish baseline production metrics of lobsters grown in tank systems, an experiment was designed using two treatment factors (density and shelter) and a production period sufficient to generate marketable product.

The experiment entailed a 3 × 2 factorial which examined three stocking densities and two shelter treatments. There were four replicates per treatment, using a total of 24 tanks.

The tanks were made of concrete with dimensions of 2.0m x 2.0m x 1.2m deep. Filtered sea water was supplied to the tanks with an exchange rate of 50% per day. Each tank had five air-stones for aeration and sufficient shelters for the number and size of the lobsters.

Under commercial conditions in sea-cages, as lobster grow, their densities are periodically reduced to maintain an acceptable biomass. To examine different densities while accommodating the industry-based convention of size grading, the experiment was divided into 3 stages. The densities at each successive stage were 6, 8, 9.5; 5, 6.5, 8; and 4, 5.5, 7 animals per square metre. The initial weight (mean ± standard deviation) for each stage was 24.8 ± 9.5 g, 34.1 ± 12.6 g, and 83.9 ± 38.1 g. The duration of the successive stages was 60, 120 and 180 days.

The shelter treatments consisted of i) on-bottom pipe shelters using PVC pipes and ii) off-bottom table shelters consisting of acrylic sheet supported on legs. The on-bottom pipes had a diameter of 40, 60 and 90 mm for the stages 1, 2 and 3, respectively. The off-bottom table shelters were held above the tank bottom a distance of 40, 60 and 90 mm for stages 1, 2 and 3, respectively (Figure 3).

Figure 3. Photos of the two shelter types employed. PVC pipe shelters on the left and acrylic table shelter on the right.

Lobsters were fed twice daily to satiety using a laboratory-made formulated moist pellet (Figure 4), based on the known nutritional requirements (Williams 2007). The diet formulation is shown in Table 2. For manufacturing the diet, fish flesh was frozen and minced twice through a 3 mm die plate fitted to a meat mincer attachment of a 200 L planetary dough mixer (Chufoods, Taiwan). Dry ingredients were thoroughly mixed together in the dough mixer before the minced fish was added along with trans-glutaminase binder (Ajinomoto Food Ingredients, Japan). The ingredients were thoroughly mixed together and deionised water was added if necessary to produce consistent dough of about 55–60% dry matter (DM). The dough was cold-extruded through the mincer and the spaghetti-like noodles set overnight in a refrigerator. The noodles were reduced in length and held at -20ºC until required.

Figure 4. Moist pellet manufactured in the laboratory for the tank experiment.

Table 2. Formulation and composition of the lobster moist pellet.

Attribute	%
Formulation (% as used)	
Fresh fish	40.0
Fish meal	50.0
Shrimp powder	5.0
Fish oil	1.0
Others	4.0
Chemical composition (% dry matter)	
Dry matter	59.3
Ash	19.8
Crude protein	67.1
Total lipid	10.0
NFE	3.2

Samples of the finely ground diet were analysed in duplicate by standard laboratory methods, essentially in accordance with AOAC International (1999). DM was determined by drying at 105°C to constant weight and ash by ignition at 600°C for 2 hours. Total nitrogen was determined by a macro Kjeldahl technique using mercury as the catalyst in the digestion and titration to an end point pH of 4.6. Crude protein (CP) was calculated using a conversion factor of 6.25 irrespective of the nature of the nitrogen. Total lipid was determined gravimetrically following chloroform–methanol (2:1) extraction using the method of Folch et al. (1957). Nitrogen-free extract was measured as the difference between the total and the sum of moisture, ash, protein and lipid content. The determined chemical composition of the diets is shown in Table 2.

Juvenile *Panulirus ornatus* lobsters were purchased from local fishers in Khanh Hoa and transported to the Nha Trang University's seawater laboratory. After an initial acclimation period of 1 week during which lobsters were fed a common diet of fresh food items (lizard fish), lobsters of a similar size were randomly and equally distributed to the experimental tanks. All lobsters were fed five times daily (nominally 9.30, 12.30, 15.30, 18.30 and 21.30) with the allocation adjusted to minimise food wastage. Tanks were siphoned clean of uneaten food and faecal matter once daily; tanks were cleaned as necessary to maintain tank hygiene. Moults were recorded and removed when first noticed and water temperature was measured daily in the morning.

A variety of growth statistics was used, including specific growth rate (SGR) based on weight.

$SGR = (\ln We - \ln Ws)/D \times 100$

where: $\ln We$ = natural log of final weight,

$\ln Ws$ = natural log of initial weight,

D = duration of the growth period in days.

The feed conversion ratio (FCR) was calculated on a dry matter basis.

Lobster productivity response data were analysed as a two-way factorial using the SPSS (Chicago, Illinois, United States of America) package's General Linear Model (Univariate, Full Factorial). In the absence of a significant interaction between main effects (stocking density × shelter setting), differences between treatments for the stocking density effect were examined using Duncan's multiple range test ($P = 0.05$), while differences between the shelter setting effect were examined using Student's t-test at $P = 0.05$.

7 Results and Discussion

Water quality remained within acceptable limits throughout the experiment (nitrite, NO_2 <0.3 mg/L; ammonia, NH_3 <0.03 mg/L; pH, 7.3 to 8.5, salinity, 28-34‰). Although water temperature averaged 26ºC (standard deviation (SD) ± 2.1, Figure 5), sub-optimal temperatures as low as 23 to 24ºC occurred in December and January.

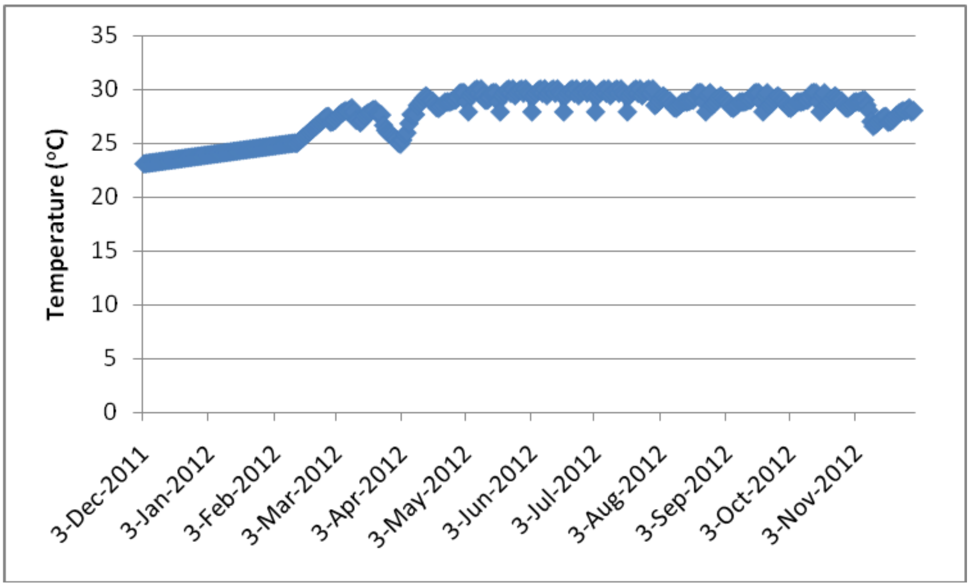

Figure 5. Average daily water temperature in tank system.

The interaction between the main effects of stocking density and shelter was not significant (P>0.05) for each of the measured response traits but there were significant treatment differences within main effects (Table 3).

Generally, there were no significant differences between stocking densities for growth (We, DGR, SGR), DM FCR and survival except for the stage 3. In the third stage, at the low and medium stocking densities (4 and 5.5 animals per square metre, respectively) the survival rates were not significantly different (P>0.05) and higher than that of the higher stocking density treatment (P<0.05). Regarding the shelter type, there were no significant differences for growth (We, DGR, SGR), DM or FCR for all stages. Survival was higher (P<0.05) with table shelters than it was with pipe shelters for all experiment stages.

Jones et al. (2001) reported on a density experiment for juvenile *P. ornatus*, in which small lobsters (3.24 ±0.09 g) were stocked at three densities (14, 29 and 43 lobsters/m²) within each of four 4,000 L fibreglass raceway tanks with flow-through seawater supply. The lobsters were fed continually through the night with a commercial penaeid shrimp (*P. japonicus*) diet, supplemented with prawn flesh once per day. Growth and survival were monitored by monthly sampling of 20 lobsters from each experimental unit. After 272 days, survival was not significantly different between densities, and averaged 52.5%. Lobster size was also unaffected by density, and mean size for all lobsters was 225.3 g at harvest.

To some extent, our results are similar to those from Jones' experiment, especially lobster growth parameters. The only difference is the survival rate which was unaffected by density in Jones' work. Jones applied the flow-through seawater supply and continual feeding using auto feeders which ensured high water quality including the water temperature and feed availability in culture tanks during the experiment. While, in our experiment, the sea water was exchanged at the rate of 50% a day and manual feeding was applied. A further significant difference was the sub-optimal water temperature from December to February (Figure 4), when temperatures as low as 23-24ºC were experienced and which Jones et al. (2009) reports are out of the optimal range. Additionally, with a fixed water exchange regime, water quality progressively detiorated as lobsters grew and generated more waste.

Cannibalism occurred to some extent throughout the experiment and was observed to be higher when the lobsters were not fed sufficiently and as biomass per square metre increased.

Table 3. Main productivity responses of lobsters stocked at different densities and two different shelters.

Trait	Treatment responses[a]					
	Stocking density			***Shelter***		±*SEM*
	Low	Medium	High	Pipes	Table	
Stage 1	***(6)***	***(8)***	***(9.5)***			
W_e (g)	33.9	33.9	31.4	30.2	35.9	*2.56*
DGR (g/d)	0.14	0.13	0.14	0.12	0.15	*0.011*
SGR (%/d)	0.47	0.45	0.50	0.47	0.48	*0.016*
FCR (DM basis)	4.4	4.5	4.2	4.4	4.3	*0.36*
Survival (%)	76.6	81.3	86.5	76.7^{X}	86.2^{Y}	*2.09*
Stage 2	***(5)***	***(6.5)***	***(8)***			
W_e (g)	81.2	81.3	85.5	72.5	92.8	*7.81*
DGR (g/d)	0.39	0.39	0.44	0.35	0.47	*0.046*
SGR (%/d)	0.72	0.70	0.74	0.70	0.74	*0.018*
FCR (DM basis)	4.0	4.4	4.3	4.2	4.2	*0.14*
Survival (%)	84.4	82.7	77.0	78.5^{X}	84.2^{Y}	*1.37*
Stage 3	***(4)***	***(5.5)***	***(7)***			
W_e (g)	343.7	308.8	294.4	277.6	353.6	*30.57*
DGR (g/d)	1.45	1.26	1.15	1.13	1.44	*0.151*
SGR (%/d)	0.78	0.69	0.68	0.72	0.71	*0.060*
FCR (DM basis)	3.4	3.5	3.3	3.4	3.4	*0.14*
Survival (%)	86.0^{B}	82.4^{B}	75.0^{A}	78.3^{X}	83.9^{Y}	*1.40*

[a] As the interaction between main effects was not significant (P > 0.05), only the mean data for each of the main effects are shown;
[A,B; X,Y] Within treatment effects and rows, means with a common superscript letter do not differ significantly (P > 0.05); SEM = standard error of the mean.

Culture experiments with *P. ornatus* in land-based systems to date have confirmed the importance of shelter within the culture environment (Jones et al. 2009, Tuan, L.A. 2012). Our observations showed that the primary value of shelter to lobsters was to maximise survival through meeting an intrinsic behavioural requirement and thus mediating stress, and by diminishing agonistic interactions and cannibalism. A further issue regarding shelter is size-specific requirement. As farming of *P. ornatus* involves growth from the small puerulus stage of less than 1 g to in excess of 1 kg, shelter requirements may need to be modified for each of several size ranges. According to Dennis et al. (1997), shelter specifications and lobster size are strongly correlated. The presence of shelter not only offers a darker environment but can be a refuge from predators. During juvenile *P. ornatus* rearing, cannibalism usually occurs post moult and a satisfactory shelter type can provide a haven during this episode. Cannibalistic behaviour has been significantly reduced in temperate *Jasus edwardsii* fed a nutritionally adequate diet and provided with shelter (Crear et al. 2000). Requirements and preference for type of shelter in juvenile lobster rearing may be different from those in the wild and may also vary with age (Kittaka and Booth 1994).

According to Jones (2007), in his first attempt to specifically assess shelter requirements for *P. ornatus*, an experiment was carried out using a small pool of available lobsters to examine two fixed-structure shelters with different hole diameters to test the hypothesis that hole diameter is an important shelter characteristic. There were not enough lobsters to allow sufficient replication. The two shelter types included a stack of plastic (polyethylene) pipes with 60 mm diameter holes, and clay house bricks with holes of 27 mm diameter. Lobsters stocked were 7.1 g (mean ± 0.9 g SE), and their maximum width was considerably less than 27 mm, so they were easily able to inhabit either shelter type. Although there were no differences in either survival or growth between the two shelter types, survival overall was high (67–83%) and growth was also high (DGC > 2.0%/day). Observation suggested that the brick shelter with the smaller hole was preferred. Subsequently, for a more stringent test of the value of shelters, an experiment was carried out (Jones and Shanks 2008) to examine the effect of presence or absence of shelter and of shelter type (mesh bundles versus concrete blocks with holes) for small juvenile lobsters in the range of 1–2 g. This experiment applied a stocking density of 38 lobsters/m² with four replicates. Shelter significantly affected survival, with the mesh bundle style shelter enabling survival of 92% (over 48 days) compared to 67% with the concrete block shelter and 59% with no shelter at all. There was no shelter effect on growth.

Other studies of the effects of shelter provision on cultured crustaceans have also shown a significant impact on survival, and generally little or no effect on intrinsic growth (Crear et al. 2000; James et al. 2001; Jones et al. 2001). The improved survival is likely to be related to a reduction in cannibalism, since the shelter offers opportunity to avoid or at least minimise interaction during moulting, when lobsters are more likely to be attacked. On the basis of results to date, use of mesh bundle shelters is recommended, particularly for the smallest lobsters from postpuerulus through to 10 g (Jones et al. 2009). For larger lobsters, the effect of shelter provision may be less significant, although still justified (Jones et al. 2009, Tuan, L.A. 2012).

The results from our study showed that the survival in three stages of the experiment was high (>76%), even over the more protracted 180 day stage 3, irrespective of shelter type. This confirms the importance of providing shelter in lobster culture. However, the application of the off-bottom table shelter supported higher survival compared with that of the pipes ($P<0.05$) for all stages. This may be due to the shape and structure of the shelters: pipe with a curved surface compared with the table with a flat surface on which the lobster can moult with minimal interaction with others. Additionally, table shelters appeared to facilitate better cleanliness of the tank bottom relative to pipes, which in turn may mediate stress for lobsters.

In summary, the experiment confirmed the great potential of *P. ornatus* for commercial aquaculture in concrete tanks. *P. ornatus* is clearly tolerant of high density conditions, and grew well at all the densities applied (maximum 7 individuals/m² at the size of 100-600g) and the biomass levels that those densities represented (average 5.5 kg/ m² at the size of 100-600g). Given the lack of any significant differences in either survival or weight at harvest among densities, there may be opportunities to increase density to higher levels than applied in this experiment. From a commercial point of view, higher densities would be more economic, which may offset any concomitant decrease in survival. Additionally, the local market accepts three grades of commercial-size lobsters comprising Grades 1 (>1,000g), 2 (700g to 1,000g) and 3 (500g to 700g). The farm-gate price currently is

VND1,600,000; 1,500,000 and 1,400,000 per kg for the three grades. This raises a question of which grade is most profitable, and an economic assessment of different culture options should be performed to make this determination. A factor in this will be tank size, as it was apparent in our experiment that a typical shrimp hatchery tank of around 2m x 2m x 1m is not suitable for culturing grade 1 lobsters over 1kg. In addition, optimal temeprature should be maintained at all times, so heating may be necessary during the period December through January.

8 Conclusion

This research was carried out to assess the suitability of typical Vietnamese shrimp hatchery tanks as a production system for spiny lobsters, and if suitable to develop a more comprehensive plan to develop this sector in Vietnam and Australia. In tank systems, spiny lobsters should be stocked at higher densities compared with those in sea-cages (2-3 individuals per square meter) to compensate for the higher capital investment.

There was no significant interaction between treatment main effects ($P>0.05$) and no significant difference relating to growth or feed conversion ratio of lobsters between shelter types or between stocking densities ($P>0.05$). For survival however there was a marked improvement using the table shelter compared with the pipe shelter ($P<0.05$). For stocking densities, there was no significant difference in survival in the first two stages ($P>0.05$), but a significant difference in the third stage, whereby survival was less at the highest density. The results suggest that the table shelter should be used and that *P. ornatus* is tolerant of high density conditions, growing well at all the densities applied.

The experiment confirmed the good potential of *P. ornatus* for commercial aquaculture in concrete tanks. *P. ornatus* is clearly tolerant of high density conditions, and grew well even at the maximum density of 7 individuals/m² at the size of 100-600g. The biomass at that density exceeded 5.5 kg/ m². Given the lack of any significant differences in either survival or weight at harvest among densities, it is likely that higher densities can be supported. From a commercial perspective, higher densities would be more economic, which may offset any concomitant decrease in survival.

There is a need for more tank-based production development, especially with the lobsters at the early stage (post puerulus to less than 20g) and the sub-adult to commercial size stage (less than 500 g to grade 3 or 2 or 1). Although there is currently information about the nutritional requirements of lobsters, there is still a need for a cost-effective and practical diet using local feed ingredients that works in both tank and sea-cage systems, especially the inclusion of some ingredients to improve lobster health and growth.

8.1 Conclusions

P. ornatus grow and survive well in tank systems.

P. ornatus is tolerant of high density conditions (>4 individuals/m²), and grew well at all the densities applied.

The shelter provision improves lobster survival in culture conditions with off-bottom table shelters more effective than on-bottom pipes.

8.2 Recommendations

There is a need for more tank-based production development, especially with the lobsters at the early stage (post puerulus to less than 20g) and the sub-adult to commercial size stage (less than 500 g to grade 3 or 2 or 1).

Although there is currently information about the nutritional requirements of lobsters, there is still a need for a cost-effective and practical diet using local feed ingredients that work in both tank and sea-cage systems, especially the inclusion of some ingredients to improve lobster health and growth.

Economic assessments of tank production of lobsters are required to determine the relative profitability compared with sea-cage production and to determine suitability for Australia.

8.3 Considerations for Australia

The assessment of tank systems for lobster production in Vietnam was encouraging, although a full economic analysis will be necessary to determine the relative profitability in comparison with traditional sea-cage systems.

In Australia where tank-based production of lobsters is more likely to gain approval than sea-cage production, further economic assessment will be necessary as the costs of production are likely to be higher.

A preliminary desktop economic assessment using modified spreadsheet-based models developed for sea cages (Petersen) suggests tank production of lobster in Australia would need to support densities an order of magnitude greater than those applied in the reported experiment. This is clearly possible, but will require recirculation technology and much bigger tanks that can support lobsters throughout the water column. Further research of such intensive production is warranted.

9 References

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