INTERNATIONAL DEVELOPMENT PLANNING REVIEW
ISSN:1474-6743 | E-ISSN:1478-3401

CAGE CULTURE OF SCALLOPED SPINY LOBSTER, *PANULIRUS HOMARUS* (LINNAEUS 1758) IN DIFFERENT COASTAL WATERS CONDITION AT GILIMANUK BAY, BALI, INDONESIA

Bejo Slamet[1*], Apri Imam Supii[2], Fahrudin[1], Widya Astuti[1], Adiasmara Giri[1], Siti Subaidah[1], Suko Ismi[1], Herno Minjoyo[1], Muhamad Marzuqi[1], Zafran[1], Ibnu Rusdi[2], Herno Minjoyo[1], Ketut Mahardika[1], Tridjoko[1] and Ikhsan Khasani[1]

[1]Research Center for Fishery, National Research and Innovation Agency
[2]Research Center for Marine and Land Bioindustry, National Research and Innovation Agency
*Corresponding author: bedjoselamet@yahoo.co.id

Abstract. Scalloped spiny lobster (*Panulirus homarus*) has a high market price in Asia. This research has the aim of obtaining theirs survival, growth and health that is reared at different locations. The study using 6 floating net cage of 3x3x3 m in 2 location at Gilimanuk Bay-Bali. The lobster with initial body weight (BW) 70±2.9 g, carapace length (CL) 5.55±0.8 cm, total length (TL) 13.15±0.16 cm and density of 150 ind./cage. Feeding were 2x/day, with trash fish 5% and dry pellet 1% biomass/day. The sampling was TL, BW, water quality, total haemocyte and brix index. The survival rate during 4 month rearing, higher on B (97.57±1.67%), compared with on A (54.54±14.64%). The grow of BW and TL on B (183.57±57.0 g, and 17.67±0.91 cm) was higher than A (125.33±15.3 g, and 15.85±0.43 cm). The total haemocyte and brix index on B (669.4±55.34 x10^4/ml and 16.9±3.38 %) was higher than A (459.5±35.56 x10^4/ml and 11.3±2.34 %). Water quality especially total Vibrio and plankton density, on location A was higher than B. From that data can be concluded that on location B is very possible and on location A is not possible for Scalloped spiny lobster cage culture.

1. Introduction

The scalloped spiny lobster is a high market price seafood in Asia. The demand for sea lobster needs

in 2014, global lobster production reached 306,000 tonnes valued at over US$2.7 billion [1] and in some places are over-fished [2], [3], [4], [5].

Scalloped spiny lobster has a high opportunity for aquaculture because it has a high market price and is supported by high natural seed sources [6]. The availability of the wild Scalloped spiny lobster fry reached more than 3 million from the Lombok area in 2013 [7], even in 2016 it was estimated that it reached more than 100 million from Lombok, Sumbawa, Java, and Sumatra [8].

The main problem of spiny lobster farming is low survival rate from cannibalism during molting and disease problems by nutritional deficiency and stress from handling [9], [10], [11],

[12]. On the farming, lobster usually are given fresh fish, crustaceans, and mussel as feed, although sometimes the inconsistency in quality of those foods leads to reduced growth and survival rate. At advanced scales, the confined access to the appropriated natural particulars and their storehouse would come a problem. therefore, formulated diet development is one of the crucial issues in successful, [14]. It has been suggested that the differences in spiny lobster growth between fresh and artificial feed are probably due to differences in protein utilization efficiency [13], [15].

The success of scalloped spiny lobster farming in floating net cages cannot be separated from the environmental conditions, especially water quality as a medium that directly affects to scalloped spiny lobster farming activities. The success of lobster reared in research conditions at Fisheries Research Center Gondol is not certain of success in other locations with different environmental conditions. Necessary to test the scalloped spiny lobster culture technology research results at IMRAFE at locations and waters that are different from the environmental conditions of the research location. The purpose of this study was to determine theirs survival, growth and health that is reared at different locations.

2. Material and methods

The location test of lobster culture technology was carried out at 2 locations of floating net cage belong to 2 fish farming group, i.e : Segara Merta (A) and Teluk Asri (B) are show in Figure 1 below .

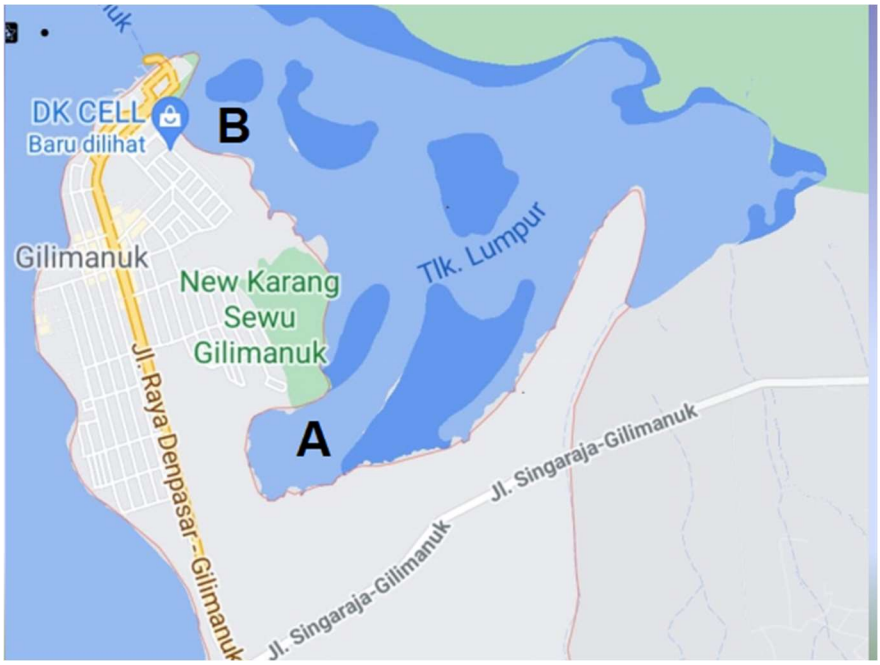

Figure 1. Map of the location test of lobster culture technology at 2 locations of floating net cage belong to 2 fish farming group, i.e : Segara Merta (A) and Teluk Asri (B)

The rearing carried out using 6 rearing net cage with two locations test, each with 3 replicates of floating net cages 3x3x3 m in size. The spiny lobster used for these location test comes from the catch of fishermen in Jembrana, Bali; with mean of initial body weight 70 ± 2.9 g, initial carapace length 5.55 ± 0.8 cm, initial total length 13.15 ± 0.16 cm, and rearing density of 150 ind./cage. Two different location , i.e.: A: Segara Merta and B: Teluk Asri, at Gilimanuk Bay area. The observation of survival rate, total length and body weight were conducted monthly. Feeding was twice daily, with trash fish 5% total body weight/day and dry pellet (Gondol formula) 1% total body weight/day.

Every month the number of lobsters is counted, and observed of body weight and total length From 10 lobsters per cage. Body weight of lobsters was measured using an electronic balance with accuracy of 1 g, after drying the excess water with an absorbent towel. The total length and carapace length were measured using a caliper with 0.1 mm accuracy, from between frontal spines to end of the tail. To calculate the survival rate (SR) using the method of [16] with formula: Survival rate = (Lobster number on day - t/Lobster number on day 0) x 100%. To calculate weight gain (g), daily weight gain (g per day), daily total length gain (mm per day) use the formula of [16] : Body weight gain (g) = (Final mean lobster weight - initial mean lobster weight); Wt-W0; daily body weight increments (g per day) = (final body weight - initial body weight)/Number of days; (Wt-W0)/t; daily total length increments (mm per day) = (final total length - initial total length)/ Number of days); (TLt - TL0)/t. Body weight gain (g) = (Final mean lobster weight - initial mean lobster weight); $Wt-W_0$. Body weight increments (g per day) = (final body weight - initial body weight)/Number of days; (Wt-W0)/t. Daily total length increments (mm per day) = (final total length - initial total length)/ Number of days); (TLt - TL_0)/t. Calculation of feed conversion ratio (FCR) using the formula [17]: Feed Conversion Ratio = total feed consumption/weight gain.

At the end of the experiment, hemolymph samples were taken to observe the total haemocyte count (THC) and BRIX index from 10 lobsters in each cage. From each lobster, was take 0.2 ml of hemolymph samples from the 3rd walking leg using a 1 ml disposable syringe containing an anticoagulant solution at pH 4.6. and stored at 4^{o}C. THC calculations were carried out under a microscope using a haemocytometer. Calculation of the total number of haemocytes (THC) of hemolymph using the formula [18]. The BRIX index measurement uses a portable digital BRIX meter Atago USA with a scale of 0-32% and an accuracy of 1%. As supporting data, monthly observations were made on water quality parameters : temperature, DO, salinity, pH, ammonia, nitrite, phosphate, total bacteria, total vibrio and plankton density. Business analysis is done by calculating the analysis value, income analysis and BC ratio.

3. Results and discussion

Data of survival rate, total length, and body weight of scalloped spiny lobster reared at 2 locations of floating net cage belong to fish farming group Segara Merta (A) and Teluk Asri (B) for 4 month, showed in Table 1.

Table 1. Survival rate (SR), total length (TL), carapace length (CL), body weight (BW) and feed conversion ratio (FCR) of scalloped spiny lobster (*Panulirus homarus*) reared in 2 floating net cage location for 4 month.

Parameter	Location test	
	Segara Merta (A)	Teluk Asri (B)
SR (%)	54.54 ± 16.76[a]	97.57 ± 1.98[b]
Initial TL (cm)	13.15 ± 0.16	13.15 ± 0.16
Final TL (cm)	15.85 ± 0.43[a]	17.67 ± 0.91[b]
TL gain (cm)	2.7 ± 0.28[a]	4.52 ± 0.59[b]
Daily TL growth (cm/day)	0.0225 ± 0.0021[a]	0.0377 ±0.0043[b]
TL specific growth (%/day)	0.17 ± 0.013[a]	0.29 ± 0.029[b]
Initial CL (cm)	5.55 ± 0.8	5,55 ± 0,8
Final CL (cm)	7.34 ± 0.45[a]	7.65 ± 0.52[b]
CL gain (cm)	1.79 ± 0.11[a]	2.1 ± 0.14[b]
Daily CL growth (cm/day)	0.015 ± 0.0038[a]	0.018 ± 0.0043[b]
CL specific growth (%/day)	0.27 ± 0.068[a]	0.32 ± 0.077[b]
Initial BW (g)	70.2 ± 2.9	70.2 ± 2.9
Final BW (g)	125.33 ± 15.3[a]	183.57 ± 57.0[b]
BW gain(cm)	55.13 ± 6.73[a]	113.37 ± 35.3[b]
Daily BW growth (g/day)	0.46 ± 0.056[a]	0.944 ± 0.294[b]
BW specific growth (%/day)	0.66 ± 0.078[a]	1.345 ± 0.358[b]
FCR	8.37 ± 0.69[a]	6.31 ± 0.57[b]

Data of survival rate of scalloped spiny lobster fry, reared at 2 locations of floating net cage belong to fish farming group Segara Merta (A) and Teluk Asri (B) for 4 month showed in Figure 2. The results of observations on the increase in total length, carapace length and body weight in 2 location of floating net cage in Gilimanuk Bay for 4 months rearing can be seen in Figures 3, 4 and 5.

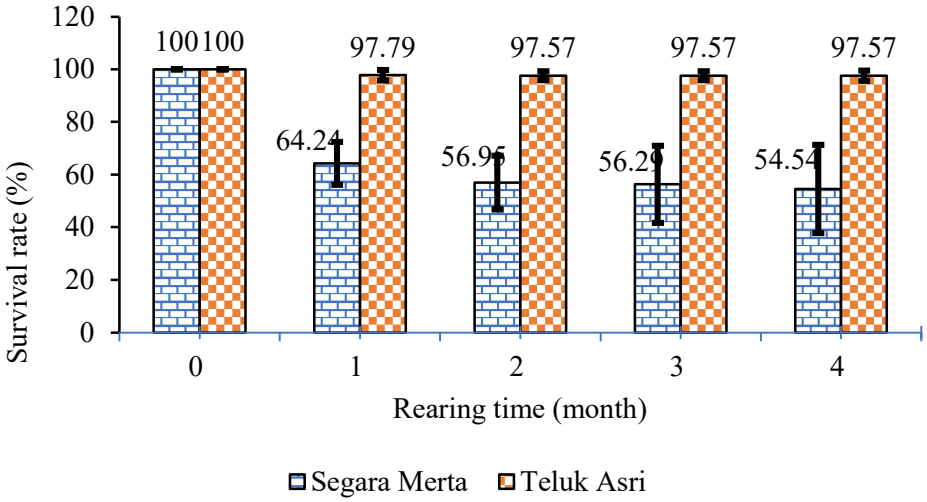

Figure 2. Survival rate of scalloped spiny lobster (*Panulirus homarus*) reared at different location at Gilimanuk Bay, during 4 month.

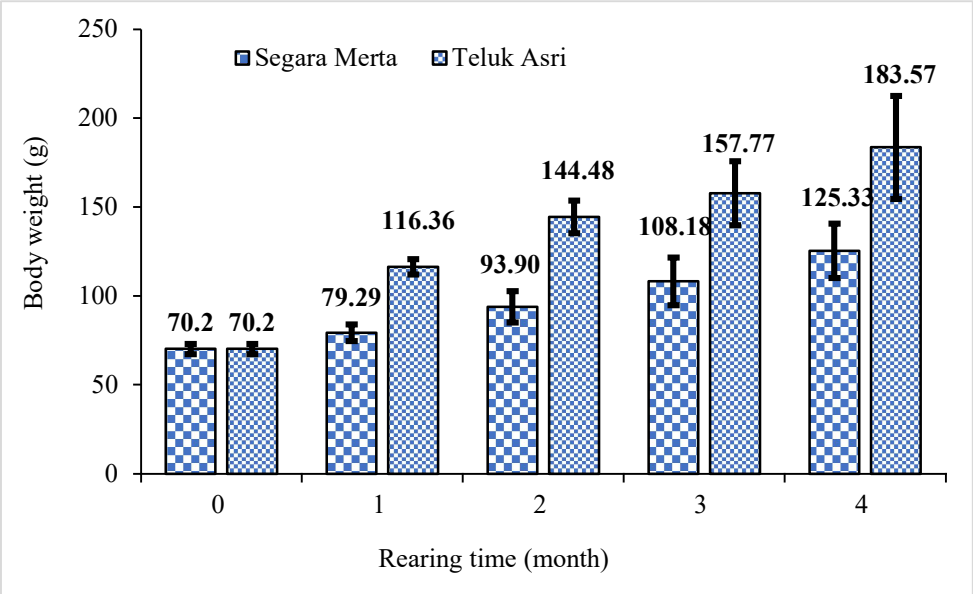

Figure 3. Body weight growth of scalloped spiny lobster (*Panulirus homarus*) reared at different location at Gilimanuk Bay, during 4 month.

From data survival rate on experiment during 4 month rearing in Table 1 and Figure 2, shows that there is a significant different ($P<0.05$) among 2 locations. The better survival rate was on location B (Teluk Asri) with survival rate 97.57 ± 1.98 % compared on location A (Segara Merta) with survival rate 54.54 ± 16.76 %. This result show that from data of Scalloped spiny lobster survival rate reared for 4 month, on location B is more possible and on location A is not possible for Scalloped spiny lobster cage culture on floating net cage test for location test of lobster culture technology for 4 month in location B (Asri Bay).

In Tables 1 and Figures 3, 4 and 5 it can be seen that the growth of body weight, total length, and carapace length of scalloped spiny lobster (*P. homarus*) at 2 location of floating net cage culture in Gilimanuk Bay for 4 months of rearing shows that lobster growth at location B (Pokdakan Teluk Asri) is much better than results were obtained in the floating net cage culture at location A (Pokdakan Segara Merta). From this result shows that lobster culture in floating net cage at location B (Pokdakan Teluk Asri) resulted in much better survival and growth than location A (Pokdakan Segara Merta).

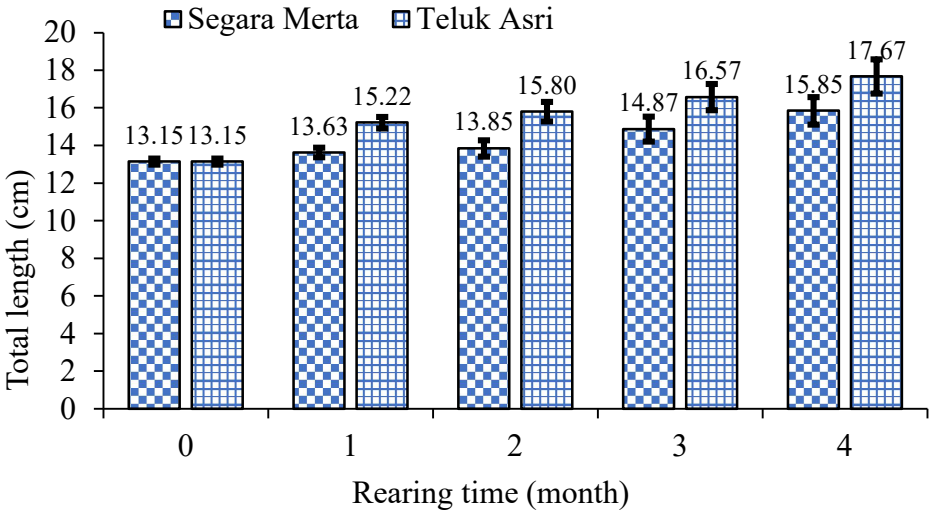

Figure 4. Total length grow of scalloped spiny lobster (*Panulirus homarus*) reared at different location at Gilimanuk Bay, during 4 month.

Spiny lobster growth is also influenced by the location conditions of floating net cage for spiny lobster culture , especially the water flashing rate by ocean currents. Comparison of lobster growth from 3 floating net cage locations in Vietnam with low, medium and high flashing rates, it can be seen that pearl spiny lobster rearing from post puerulus to a weight of more than 150 g in semi-enclosed location A with the lowest flashing rate resulted in a weight gain of per day 0. 43-0.67 g, while at location B, where the flashing rate was higher, it resulted in a higher weight gain per day with an average of 0.82 g, and at location C, with the highest flashing rate, the highest weight gain per day was with average 0.96 g. At the lobster culture locations with a high flashing rate, stocking density can be increased without affecting to the survival and growth. In baby pearl spiny lobster *P. ornatus*, the specific growth rate (SGR) increased with the increase in the size of the lobster cultured. The SGR of pearl spiny lobster 71.0±21.8 g was 0.94±0.33, while the SGR of 165.0±9.6 g was 1.18±0.11 g. In open locations, pearl spiny lobster culture at a density of 21-80 fish/m^2, with survival rate of 72 - 100% [19].

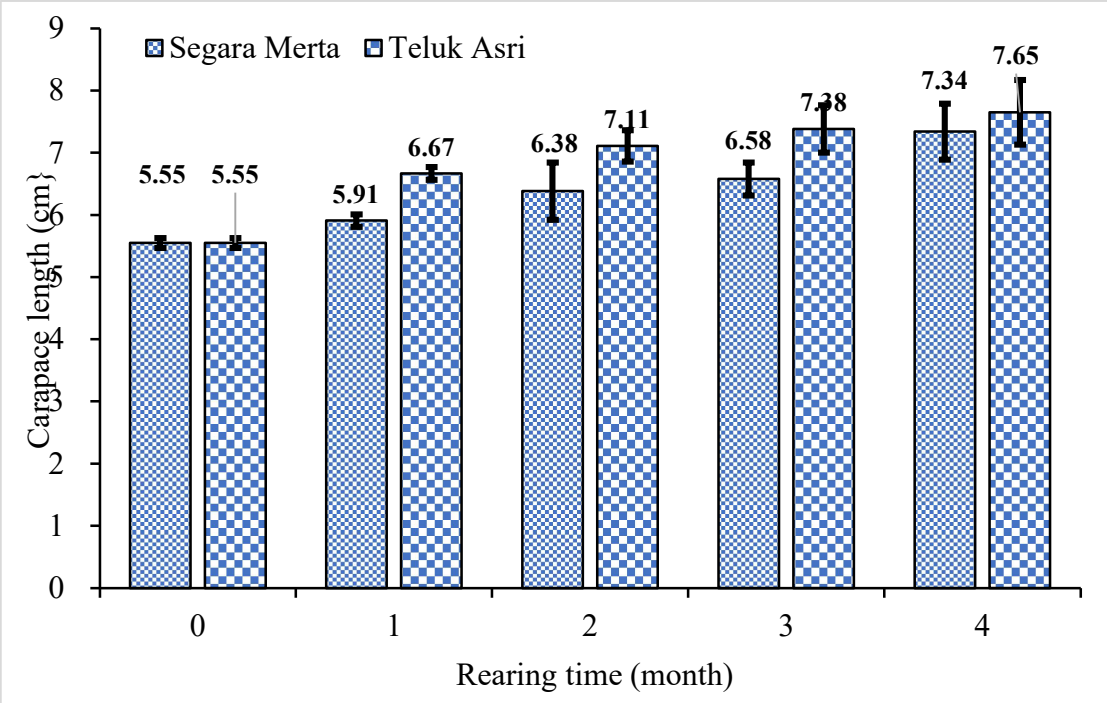

Figure 5. Carapace length grow of scalloped spiny lobster (*Panulirus homarus*) reared at different location at Gilimanuk Bay, during 4 month.

The result of scalloped spiny culture in net floating cages, from juveniles for 266 days at a density of 21 to 80 individuals per m^2, did not show a significant difference, with an average survival rate of 70% [20]. In farmers in Vietnam, the survival rate of *P. ornatus* is 70-95% at a density of 15 fish/m^2 [19]. Suggested for the maintenance of *P. cygnus* from puerulus with an initial density of 50 fish/m2 then gradually reduced to 25 fish/m2 after the first year and 20 fish/m2 in the following year [21]. [22] also reported on the maintenance of P. ornatus where the difference in density of 20-50 fish/m2, did not affect growth with 52% survival and high specific growth of 1.56% per day. [22] assumed that the pearl spiny lobster *P. ornatus* could grow from 3 g to 1 kg in size in 18 months. Observations of [20] on the rearing of the scalloped spiny lobster *P. homarus* in floating net cage from 1.58 g in size with a density of 60 fish/m2 to 123 g in size during 266 days. In rearing pearl spiny lobster *P. ornatus* and scalloped spiny lobster *P. homarus* in floating net cages with high density, it is not recommended to use shelter, because it does not get the result more optimal growth and survival [23], [6], [24]. [25] observed that the growth of scalloped spiny lobster in Vietnam from post-pueruli to 123.10±0.62 g within 266 days, and from a size of 123.61±29.26 g, reaching a weight of 341.25±46.2 g in 225 days. In scalloped spiny lobster culture in India from post puerulus to 200 g in size abouth 365 days and up to a weight of 350 g in 490-520 days [26]. In spiny lobster culture, *P. polyphagus* in India from post pueruli reaches 73 g in 310 days, for *P. ornatus* up to 80 g within 250 days and for *P. cygnus* up to 80 g in 455 days [26]. Spiny lobster immunity can be increased by adding a mixture of probiotics to the feed. [27]. Pearl spiny lobster culture in marine floating net cages in Vietnam

has a faster growth rate from post pueruli to 300 g in 365 days and up to about 1,000 g in 540-600 days [28], [29].

From the total hemocyte count (THC) data in Table 2, it can be seen that the average THC value at the pokdakan Segara Merta (location A) (inner edge of the bay) (459.5±35.56 x 10^4/ml) is lower than the B pokdakan location in Teluk Asri (outer lip). bay) (669.4±55.34 x 10^4/ml); and statistically significantly different ($p<0.05$).

The hemolymph brix index value in Table 2 can be seen that the highest at the pokdakan Segara Merta (location A) (inner edge of the bay) (11.3±2.34%) is lower than the location in B (pokdakan Teluk Asri) (outer lip of the bay) (16.9±3.38%); and statistically significantly different ($p<0.05$).

Table 2. Total haemocyte count (THC) and brix index of scalloped spiny lobster *P. homarus* hemolymp on 2 location of floating net cage

Location	THC (x 10^4/ml)	Brix index (%)
A (Segara Merta)	459.5±35.56^a	11.3±2.34^a
B (teluk Asri)	669.4±55.34^b	16.9±3.38^b

From the THC and brix index values (Table 2), it can be seen that location B has a higher value which indicates a better spiny lobster health condition. From the observations, it was found that at location A, many spiny lobsters were in weaker condition and were attacked by milky hemolymph disease (MHD). THC values and brix index can be used to assess the overall health of lobsters [30, 31]. Total Hemocycte Count (THC) and brix index can be used to determine stress levels in crustaceans [32]. Hemocytes are important in the immune system of crustaceans, where the total number of hemocytes can be used to determine the level of health and immune condition [33]. Stress conditions in crustaceans can be indicated by elevated of glucose levels, as in *P. homarus*, when stressed can reach to 20.80 mg/dL [32], in *Helix pomatia* can reach to 14.41 mg/dL, and [34], and in *Astacus leptodactylus* can reach to 13.20 mg/dL [35]. The increasing value of THC indicates that spiny lobster is under stress condition.Increased THC values indicate an increase in cardiovascular activity which is generally caused by stress from mishandling and extreme changes in environmental conditions of the rearing water media [35]. The stress incidence in lobsters can be caused by environmental conditions of maintenance, poor handling and the occurrence of bacterial infections [36]. The THC value in *P. cygnus* under normal conditions whad a range of 5.6 ± 0.7 x 106 cells/mL, if the THC value was outside this range, it indicated that the lobster was in abnormal condition [37]. The stress treatment of lobster on *Homarus americanu*s, for 24 hours, responded to a drastic decrease in hemolymph glucose levels from 0.85 mmol/l in 24 hours which fell to 0.4 mmol/l [38]. The BRIX index value in spiny lobster can be interpreted as the amount of sugar contained in hemolymph, which value is highly correlated with hemolymph protein levels; which in the business world the BRIX index is the basis for determining the health condition of lobsters and determining the treatment to be carried

out and post-harvest [39]. A high BRIX index value in lobsters indicates a high protein content value in hemolymph. The BRIX index value is also related to the molting phase. Generally, high BRIX index values are found in healthy lobsters that have a normal molting cycle. The BRIX index value is related to the molting phase where the highest value is obtained a few minutes before molting, and then decreases after molting occurs [39].

Business analysis

The results of the business analysis, in 2 locations of floating net cages in the Pokdakan Segara Merta lobster cultivating group in Gilimanuk Bay in Table 3. it can be seen that by producing lobster with survival of 54.54% and the average final weight of 125 g, and the selling price of lobster Rp. 320,000/kg; for 1 cycle (4 months) with an operational cost of Rp. 1,797,500 can generate total sales of Rp. 14,355,000; or generate a net profit of IDR 2,537,500 per cycle for 4 months. From the results of the calculation of the B/C ratio of production per cycle, the value is 1.22; which is a value that is categorized as still profitable.

From the results of the business analysis at the lobster culture location in the Pokdakan Teluk Asri lobster aquaculture group in Gilimanuk Bay, Bali in Table 4, it can be seen that by producing lobster with survival rate of 97.57% and the average final weight of lobster 183.5 g, and the selling price of lobster IDR 320,000/kg; for 1 cycle with operating costs of Rp. 14,290,500 can generate total sales of Rp. 26,080,000; or generate a net profit of IDR 11,789,500 per cycle (for 4 months). From the calculation of the B/C ratio of production per cycle, the value is 1.82; which is a value that is categorized as very profitable. The results of research by [40] on lobster cultivation with a mass system, the B/C ratio value is 1.37.

Table 3. The business analysis, scalloped spiny lobster culture in floating net cages of the Pokdakan Segara Merta lobster culture group in Gilimanuk Bay

No	Description	Volume	Unit	Price	Total
A.	Floating net cage (4 cages)				
	a. Bamboo petung	8	sticks	150,000	1,200,000
	b. Styrofoam cage buoy	16	pcs	500,000	8,000,000
	c. Trawl net 3x3x3m	6	Unit	1,000,000	6,000,000
	d. Rope PE diameter 4 mm	7	Kg	50,000	350,000
	e. Rope PE diameter 12 mm	20	Kg	50,000	1,000,000
	f. Anchor 100 kg	4	pcs	200,000	800,000
	g. Floating cage Setting fee	1	Unit	1,000,000	1,000,000
		Total			18,350,000
	Work equipment for 1				

No	Description	Volume	Unit	Price	Total
	cycle maintenance				
	a. Box Styrofoam	1	pcs	50,000	50,000
	b. Scope net	1	pcs	50,000	50,000
	c. Portable Bucket	1	pcs	40,000	40,000
	d. Carry bucked	1	pcs	25,000	25,000
	e. Scissors/knife	2	pcs	10,000	20,000
		Total			185,000
B.	Operational fee				
1	Baby lobster	450	ind	12,000	5,400,000
2	Depreciation fee				
	a. Floating net cage	4	month	305,000	1,220,000
	b. Work equipment	4	month	46,250	185,000
3	Feed				
	a. Trash fish	215	kg	5,500	1,182,500
	b. Pellet	35	kg	30,000	1,050,000
4	Salary (1 worker)	4	month	500,000	2,000,000
5	Gasoline	95	Liter	8,000	760,000
		Total			11,797,500
C.	Income	247	ind	58,000	14,355,000
D.	Profit				2,537,500
E.	B/C Ratio percyclus				1.22

Description :
Floating net cage depreciation fee 20%/year
Survival rate = 54.54%
The average size of lobster at harvest is 125.3 g/ind
Lobster price per kg IDR 320.00/kg

Table 4. The business analysis, scalloped spiny lobster culture in floating net cages of the Pokdakan Teluk Asri lobster culture group in Gilimanuk Bay

No	Description	Volume	Unit	Price	Total
A.	Floating net cage (4 cages)				
	a. Bamboo petung	8	sticks	150.000	1.200.000
	b. Styrofoam cage buoy	16	pcs	500,000	8,000,000
	c. Trawl net 3x3x3m	6	unit	1,000,000	6,000,000
	d. Rope PE diameter 4 mm	7	kg	50,000	350,000
	e. Rope PE diameter 12	20	kg	50,000	1,000,000

No	Description	Volume	Unit	Price	Total
	mm				
	f. Anchor 100 kg	4	pcs	200,000	800,000
	g. Floating cage Setting fee	1	unit	1,000,000	1,000,000
		Total			18,350,000
	Work equipment for 1 cycle maintenance				
	a. Box Styrofoam	1	pcs	50,000	50,000
	b. Scope net	1	pcs	50,000	50,000
	c. Portable Bucket	1	pcs	40,000	40,000
	d. Carry bucket	1	pcs	25,000	25,000
	e. Scissors/knife	2	pcs	10,000	20,000
		Total			185,000
B.		Operational fee			
1	Baby lobster	450	indr	12,000	5,400,000
2	Depreciation fee				
	a. Floating net cage	4	month	305,000	1,220,000
	b. Work equipment	4	month	46,250	185,000
3	Feed				
	a. Trash fish	375	kg	5,500	2,625,500
	b. Pellet	70	kg	30,000	2,100,000
4	Salary (1 worker)	4	month	500,000	2,000,000
5	Gasoline	95	Liter	8,000	760,000
		Total			14,290,500
C.	Income	81,5 kg (444 ind)		Rp 320.000/ kg	26,080,000
D.	Profit				11,789,500
E.	B/C Ratio percyclus				1.82

Description :
Floating net cage depreciation fee 20%/year
Survival rate = 97.57%
The average size of lobster at harvest is 183,5 g/ind
Lobster price per kg IDR 320.00/kg

From the results of observations on water quality of sea water around floating net cages for 4 months reared in 2 locations, namely temperature, DO, salinity,ammonia, phosphate and nitrite; still in the range of good values for lobster growth, exceptively on very high density of plankton at the location of the Segara Merta floating net cages. Spiny lobsters can still grow well in water quality conditions at DO 2.7-5.4 mg/L [41], Nitrite < 5 mg/L [42], Ammonia < 0.1 mg/L [41].

and at a salinity of 30-35 ppt [43]. From the water quality parameter data during the study, it showed the optimal value for supporting lobster rearing in both locations. The results of observations of water pH during the study in table 5 show a relatively stable value in the range of 8.1-8.2. *P homarus* can still grow well at water pH conditions of 7.07-7.86 [36]. The results of the observation of water temperature conditions during the study in Table 5, can be seen in a relatively stable value in the range of 28.4-29.6°C. *P. homarus* growth conditions can be produced fastest at an average water temperature of 28°C, this is the best water temperature condition [41]. The results of observations of water salinity conditions during the study in Table 5 were obtained ranging from 34-35 which showed salinity values were still appropriate and supported the life of lobsters. *P. homarus* has a fairly wide salinity tolerance of 30-40 ppt [44].

The condition of the waters at location A (pokdakan immediately) that caused the poor survival and growth of sand lobster at location A was the smaller flashing rate and high fertility of the waters, which was indicated by a very high abundance of plankton. At the beginning of the lobster stocking, the abundance of plankton in location A reached 10,640 ind/L, in the following month it was higher and in the 4th month it increased sharply to 35,027 ind/L show in Table 5 and 6 which was much higher than normal. According to [45], that the abundance of plankton is high if the abundance value is greater than 2,000 ind/L.

Table 5 and 6 shows that fluctuations in the abundance of plankton are quite high and there is a tendency to have something to do with the lunar/tidal phase. The results of research by [46], in P Bonerate and P Kalalo have an abundance of phytoplankton 14,259-303,106 individuals per m3 and are dominated by diatom groups (64.77%) and Cyanophyta (23.85%). The results of research by [47], in Pemaron waters, Bali, have an abundance of 1,125-1,323 ind/L., while the results of research by [48], in Teluk Klabat, Bangka-Belitung, have an average abundance of phytoplankton 1,267 ind/L. and dominated by the Diatom group.

Table 5. Water quality (temperature, DO, salinity, pH and plankton abudance) on 2 location of floating net cage culture

Rearing Time (month)	Temperature (C)		DO (mg/L)		Salinity (ppt)		pH		Plankton abudance (ind/L)	
	Segara Merta	Teluk Asri	Segara Merta	Teluk Asri	Segara Merta	Teluk Asri	Segara Merta	Teluk Asri	Segara Merta	Teluk Asri
0	27.4	26.7	5.75	5.49	33	33	8.11	8,18	10,640	108
1	27.5	27.5	5.02	5.11	33	33	8.21	8.24	12,151	156
2	28.6	27.6	5.07	5.11	34	34	8.13	8.22	20,624	252
3	27.5	27.3	5.44	5.08	34	34	8.12	8.22	22,523	276
4	27.8	27.7	5.56	5.45	34	34	8.24	8.23	35,027	430

Table 6. water quality (ammonia, nitrite, phosphate, total bacteria and total vibrio) on 2 location of floating net cage culture

Rearing Time	Ammonia (ppm)		Nitrite (ppm)		Phosphate (ppm)		Total Bakteri (CFU/ml)		Total Vibrio (CFU/ml)	
(month)	Segara Merta	Teluk Asri	Segara Merta	Teluk Asri	Segara Merta	Teluk Asri	Segara Merta	Teluk Asri	Segara Merta	Teluk Asri
0	< 0,01	<0,01	<0,003	< 0,003	0.0122	0.007	1700	510	400	ttd
1	< 0,01	<0,01	<0,003	< 0,003	0.0135	0.0088	1.9	2	ttd	ttd
2	0,026	<0,01	<0,003	< 0,003	0.1673	0.0309	16	2.6	10	ttd
3	<0,01	<0,01	<0,003	< 0,003	0.012	0.0084	19	16	10	ttd
4	<0,01	<0,01	<0,003	< 0,003	0.018	0.018	85	13	60	10

5. Conclusion

Differences in survival rates, weight and length growth, health and B/C ratio of scalloped spiny lobster culture at 2 locations of floating net cages are highly dependent on the water quality of the media. Parameters of water quality especially phosphate, total vibrio and plankton density, in location A was higher than location B. Location B is very possible for scalloped spiny lobster cage culture. Location A is not possible for or scalloped spiny lobster cage culture.

References

[1] FAO 2016 FAO Yearbook.Fishery and Aquaculture Statistics. Food and Agriculture Organization of the United Nations, Rome, p. 105.

[2] Hargiyatno I T, Prasetyo A P, Fauzi M, Satria F 2013 Relationship length-weght and condition factor of spiny lobster (*Panulirus homarus*) in south beach of Java *BAWAL* **5** 41-48.

[3] Fauzi M, Prasetyo A P, Hargiyatno I T, Satria F, Utama A A 2013 Relationship length-weght and condition factor of rock lobster (*Panulirus penicillatus*) in south beach of Gunungkidul and Pacitan *BAWAL Vol.* **5** 97-10.

[4] Erlania I, Radiarta N, Sugama K 2014 Dynamics of lobster (*Panulirus spp*.) seeds abundance in Gerupuk Bay, West Nusa Tenggara. A challenge for lobster aquaculture technology development *J. Ris. Akuakultur* **9** 475-486.

[5] Musbir, Sudirman, Palo M 2014 The Use of an Environmental Friendly Artificial Atractor to Collect Spiny Lobster Seed (*Panulirus* spp) *J. Ipteks PSP* **1** 95-102.

[6] Jones C M 2010 Tropical spiny lobster aquaculture development in Vietnam, Indonesia and Australia *J. Mar. Biol.Ass. India* **52** 304-315.

[7] Bahrawi S, Priyambodo B, Jones C 2015 Census of the lobster seed fishery of Lombok (pp.12-19).*In* Jones C.M. (Ed.), Spiny Lobster Aquaculture Development in Indonesia, Vietnam and Australia.*Proceedings of the International Lobster Aquaculture Symposium held in Lombok, Indonesia*, 22–25 April **2014**. ACIAR Proceedings No. 145. Australian Centre for International Agricultural Research: Canberra.

[8] Jones C M, Anh T L, Priyambodo B 2019 Lobster aquaculture development in Vietnam and Indonesia. *In* Radhakrishnan, E.V., Phillips, B.F. & Achamveetil, G. (Eds.),

Lobsters: Biology, Fisheries and Aquaculture. Springer Nature Singapore **2019** 542-570.

[9] Slamet B, Rusdi I, Giri A, Haryanti 2020 Post puerulus of scalloped spiny lobster, *Panulirus homarus* (Linnaeus 1758) rearing in floating net cage with different artificial diet IOP Conf. Series: Earth and Environmental Science **521** 012005.

[10] Sumbing M V, Al-Azad S, Estim A, Mustafa S 2016 Growth performance of spiny lobster *Panulirus ornatus* in land-based Integrated Multi-Trophic Aquaculture (IMTA) system. *Trans. Sci. Technol* **3** 143–149.

[11] Slamet B 2016 Grow out of scalloped spiny lobster (*Panulirus homarus*) in bottom cage with different rearing cage Prosiding seminar tahunan XIV hasil penelitian perikanan dan kelautan **2019** 549-556.

[12] Mashaii M, Rajabipour F, Shakour A 2011 Feeding Habits of the Scalloped Spiny Lobster, *Panulirus homarus* (Linnaeus, 1758) (Decapoda: Palinuridae) from the South East Coast of Iran, *Turkish Journal of Fisheries and Aquatic Sciences* **11** 45-54.

[13] Crear B J, Thomas C W, Hart P R, Carter C G 2000 Growth of juvenile Southern rockCrear B J, Thomas C W, Hart P R and Carter C G 2000 Growth of juvenile Southern rock lobsters, *Jasus edwardsii*, is influenced by diet and temperature, whilst survival is influenced by diet and tank environment *Aquaculture* **190** 169-182.

[14] Crear B J, Thomas C W, Hart P R, Carter C G 2000 Growth of juvenile Southern rockThomas C, Carter C and Crear B 2003 Feed availability and its relationship to survival, growth, dominance and agonistic behaviour of the Southern rock lobster (*Jasus edwardsii*) in captivity *Aquaculture* **215** 45-65.

[15] Tolomei A, Crear B, Johnston D 2003 Diet immersion time: effects on growth, survival and feeding behaviour of juvenile Southern rock lobster, *Jasus edwardsii Aquaculture* **219** 303- 316.

[16] Crear B J, Thomas C W, Hart P R; Carter C G 2000 Growth of juvenile Southern rockLe Moullac G and Van Wormhoudt A 1994 Adaptation of digestive enzymes to dietary protein, carbohydrates and fiber levels and the influence of protein and carbohydrates quality in *Penaeus vannamei* larvae (Crustacea: Decapoda). *Aquat. Living Resour*. **7** 203-210.

[17] Crear B J, Thomas C W, Hart P R, Carter C G 2000 Growth of juvenile Southern rockLorenzon S, Martinis M, Borme D and Ferrero E A 2013 Hemolymph parameters asphysiological biomarkers for monitoring the effects of fishing and commercial maintenance methods in *Squilla mantis* (Crustacea, Stomatopoda) *Fish. Res.* **137** 9-17.

[18] Crear B J, Thomas C W, Hart P R, Carter C G 2000 Growth of juvenile Southern rock Jusilla J, Jago J, Tsvetnenko E, Dunstan B and Evans L H 1997 Total and differential haemocyte counts in Western rock lobster (*Panulirus cygnus* George) under postharvest stress *Mar. Freshwater Res.* **48** 863-868.

[19] Priyambodo B, Jone C 2015 Building Indonesia's lobster farming industry.*In* Jones C.M.

(Ed.), Spiny Lobster Aquaculture Development in Indonesia, Vietnam and Australia.*Proceedings of the International Lobster Aquaculture Symposium held in Lombok, Indonesia*, 22–25 April 2014. ACIAR Proceedings No. 145. Australian Centre for International Agricultural Research: Canberra **20**15 22-25.

[20] Vijayakumaran M, Venkatesan R, Murugan T S, Kumar T S, Jha D K, Remany M C, Mary Leema T, Syed J S, Dharani G, Selvan K, Kathiroli S 2009 Farming of spiny lobsters in sea cages in India. *New Zealand Journal of Marine and Freshwater Research* **43** 623–634.

[21] Johnston D J, Melville-Smith R., Hendriks B, Maguire G B, Phillips B F 2006 Stocking density and shelter type for the optimal growth and survival of western rock lobster *Panulirus cygnus* (George). *Aquaculture* **260** 114–127.

[22] Jones C M, Linton L, Horton D, Bowman W 2001 Effect of density on growth and survival of ornate rock lobster, *Panulirus ornatus* (Fabricius, 1798), in a flow-through raceway system. *Marine and Freshwater Research,* **52** 1425–1329.

[23] Williams K C 2009 Nutritional requirements of juvenile *Panulirus ornatus* lobsters. *In* K.C. Williams (ed.): Spiny lobster aquaculture in the Asia–Pacific region. Proceedings of an international symposium held at Nha Trang, Vietnam, 9–10 December 2008. ACIAR Proceedings **132** 131-146.

[24] Williams K C, Smith D M, Irvin S J, Barclay M C, Tabrett S J 2005 Water immersion time reduces the preference of juvenile tropical spiny lobster *Panulirus ornatus* for pelleted dry feeds and fresh mussel. Aquac. Nutr. **11** 415–426.

[25] Tuan L A, Mao N D 2004 Present status of lobster cage culture in Vietnam. In: K. C. Williams (Ed.). *Spiny lobster ecology and exploitation in the South China Sea Region. ACIAR Proceedings*. Canberra: Australian Centre for International Agriculture Research **120** 21-25.

[26] Radhakrishnan E V, Vijayakumaran M 1990 An assessment of the potential of spiny lobster culture in India. In: *CMFRI Bulletin-National symposium on research and development in marine fisheries*, CMFRI, Kochi **44** 416–426.

[27] Haryanti, Sembiring, S B M, Sudewi, Widiastuti Z, Giri N A, Sugama K 2017 Immunity response of juvenile spiny lobster, *Panulirus homarus* with probiotic supplementation on moist diets. *Jurnal Riset Akuakultur* **12** 85-97.

[28] Wang J T, Han T, Li X Y, Hu S X, Jiang Y D, Wang C L 2016 Effects of dietary phosphatidylcholine (PC) levels on the growth, molt performance and fatty acid composition of juvenile swimming crab, *Portunus trituberculatus*. Anim. Feed Sci. Technol. 225–233.

[29] Williams K C 2007 Nutritional requirements and feeds development for post-larval spiny lobster: A review. *Aquaculture* **263** 1–14.

[30] Retzlaff A, Claytor R, Petrie B, Frail C, Tremblay J, Pezzack D, Lavallée J 2007 Variation in moult timing and market quality in the American lobster (*Homarus americanus*). In:

Bedford Institute of Oceanography: in Review. Fisheries and Oceans Canada, Dartmouth, NS, Canada **2006** 22-26.

[31] Simon C J, Fitzgibbon Q P, Battison A, Carter C, Battaglene S C 2015 Bioenergetics of nutrient reserves and metabolism in spiny lobster juveniles *Sagmariasus verreauxi*: predicting nutritional condition from haemolymph biochemistry. *Physiological and Biochemical Zoology* **88** 1–19.

[32] Oniam V, Arkronrat W, Mohamed N B 2015 Effect of feeding frequency and various shelter of blue swimming crab larvae, *Portunus pelagicus* (Linnaeus, 1758). *Songklanakarin J. Sci. Technol.* **37** 129–134.

[33] Chakraborty S, Ghosh U 2014 In vivo immunological changes occurring at different time intervals in white spot syndrome virus infected shrimp, treated with anti-WSSV drug derived from marine plants. *Int. J. of Basic and Applied Virology* **3** 1-15.

[34] Bislimi K, Behluli A, Halili J, Mazreku I, Osmanil F, Halili F 2013 Comparative analysis of some biochemical parameters in hemolymph of garden snail *Helix pomatia* of the Kastriot and Ferizaj Regions, Kosovo *Int. J. of Engineering and Applied Sciences* **4** 11-18.

[35] Leland J C, Butchera P A, Broadhursta M K, Patersonc B D, Mayer D G 2013 Damage and physiological stress to juvenile eastern rock lobster *(Sagmariasus verreauxi)* discarded after trapping and hand collection. *Journal of Fisheries Research* **137** 63-70.

[36] Adiyana K, Supriyono E, Junior M Z, Thesiana L 2014 Application of various shelters on stress response and survival rate of lobster *Panulirus homarus* nursery *J. Kelautan Nasional* **9** 1-9.

[37] Jussila J, Jago J, Tsvetnenko E, Dunstan B, Evans L H 1997 Total and differential haemocyte counts in western rock lobsters (*Panulirus cygnus* George) under post-harvest stress. *Marine and Freshwater Research* **48** 863–867.

[38] Lorenzon S, Giulianini P G, Martinis M, Ferrero E A 2007 Stress effect of different temperatures and air exposure during transport on physiological profiles in the American Lobster *Homarus americanus*. *Journal of Comparative Biochemistry and Physiology, Part A* K 34 **147** 94-102.

[39] Wang G, McGaw I J 2014 Use of Serum Protein Concentration as an indicator of Quality and Physiological Condition in the Lobster *Homarus americanus* (Milne-Edwards, 1837).Journal of Shellfish Research **33** 805-813.

[40] Slamet B, Giri N A, Haryanti, Rusdi I, Andrianto W, Permana I G N 2016 Grow out of the spiny lobster *Panulirus homarus* in concrete tank with mass system and battery system in Sepanjang Beach Gunungkidul Regency Yogyakarta Prosiding Forum Inovasi Teknologi Akuakultur **2016** 479-586.

[41] Phillips B F, Kittaka J 2000 Spinny lobster: fisheries and culture. Blackwell Science, Osney Mead-GB **2000** 508-532.

[42] Drengstig A, Bergheim A 2013 Commercial land-based farming of European lobster (*Homarusgammarus* L.) in recirculating aquaculture system (RAS) using a single cage

approach. *Aquacultural Engineering* **53** 14–18.

[43] Vidya K, Joseph S 2012 Effect of salinity on growth and survival of juvenile Indian spiny lobster, *Panulirus homarus* (Linnaeus*). Indian. J. Fish*. **59** 113-118.

[44] Verghese B, Radhakrishnan E V, Padhi A 2007 Effect of environmental parameters on immune response of the Indian spiny lobster, *Panulirus homarus* (Linnaeus, 1758). *Fish & Shellfish Immunology* **23** 928–936.

[45] Sulistyowati E 2001 Effect of fish culture activities in floating net cages and floating stalls on fish and plankton diversity index (thesis). Universitas Sebelas Maret **2001** 1-298.

[46] Aty R N, Kepel A T 2006 The Relationship of Phytoplankton Community Structure with Water Quality Parameters in the Eastern Coastal Waters of Bonerate island and Kalalo island . J. Segara **2** 196-204.

[47] Suarna I W, Restu I W, Wijana M S 2007 Study of Marine Biota in Pemaron Waters, Bali. J. Bumi Lestari **7** 24-30.

[48] Adnan Q, Sugestiningsih 2006 Ecological Condition of Phytoplankton in Klabat Bay Waters, Bangka-Belitung, June 2003. J. Teknik Lingkungan Special Edition **1** 215-222.