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Abalone *(Haliotis squamata)* enlargement technique using a floating net cage method as a preliminary study of mariculture

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ABSTRACT

The world abalone market demand is increasing in line with the increasing need for various protein sources, and therefore the abalone *(Haliotis squamata)* is enlarged using the floating net cage method. The activity of this study was held at the Center for Mariculture of Lombok Sea located in Village Sekotong Barat, Subdistrict of Sekotong, West Lombok Regency, West Nusa Tenggara Province on January 18 until February 18, 2016. The enlargement of abalone using the floating net cages method needs a series of enlargement activities starting from the selection of location, preparation for nets, spreading seeds, cultivation of seeds, sampling for growth, sorting out, and grading and harvesting abalone in the size of consumption. Seeds that are spread for the enlargement are healthy seeds and responsive with the size of a seed of 2-3 cm. Foods used in the enlargement of abalone (*Haliotis squamata)* are *Gracillaria* sp. by means of giving the foods in ad libitum once in a day. The parameter of water quality includes temperature around 28.7 °C, pH 7.5, the salinity of 29 ppt, and DO 4,8 mg/l. Factors influencing the growth of abalone are foods, water quality, and pests and diseases. As for the obstacles encountered in the process of abalone, enlargement is dirt and pests, and large current surge resulted in low abalone life-span.

Key word : *Molluscs, Abalone, Haliotis squamata, Mariculture, Aquaculture, Indonesia*

Introduction

Molluscs is a group that represents waters organism after fish groups, reaching 1,500 types of snails and 1,000 types of shellfish (Parker *et al.,* 2013). One type of snail that can be found in Indonesian waters is abalone (Setyono, 2004; Tubalawony *et al.,* 2016). Abalone is a group of marine mollusks that are better known as the "seven-eyed shellfish" (Hayati *et al.,* 2017) or "full hungry snails." The type of abalone in nature is estimated to be more than 100 species, but only a few species have been successfully cultivated (Susanto *et al.,* 2019).

Abalone is an important fishery commodity because of its economic value due to its beautiful shell shape and color (Uri and Al-bahrani, 1995). In addition to shells that can be used in the jewelry button industry, abalone meat also contains high enough protein so that it is one of the main foods and prestige, especially among people of Chinese, Japanese,

and American descent. The price of a live abalone is Rp. 150,000 per kg, while for dry abalone the price is Rp. 350,000, - up to Rp. 500,000, - per kg.

Abalone has a high advantage and is an export commodity for Indonesia (Wiradana *et al.,* 2019). So that the enlargement of abalone has a very big role in supporting the production of abalone as an export commodity. Abalone is one of the potential fisheries resources which, if used rationally and properly, can make a large contribution to community income and encourage an increase in regional and state income (Atika and Mulyadi, 2014).

Abalone *(Haliotis squamata)* has an oval shell shape with a ratio between the width and length of the shell of 64.29%. *Haliotis squamata* has a higher percentage of meat weight (44.48%) compared to shell weight (27.33%) and other organs (gonads and digestion) around 28.20%. Various types of *Haliotis squamata* have a larger portion to be consumed than their total body weight (Susanto *et al.,* 2010a)

Abalone *(Haliotis squamata)* cultivation has recently begun to be developed in Indonesia, although there are still many obstacles in the provision of seeds until now its cultivation is still developing. There are two ways to produce abalone before it is harvested and reaches consumers. First (i), abalone seeds (both natural selection and spawning in seed institutions) are released or stocked in protected locations or areas for a certain period of time before being harvested and sold to consumers. Second (ii), abalone seeds are maintained and raised commercially using certain containers and techniques until they reach a size that is suitable for sale to consumers (Eny and Setyono, 2007)

Abalone enlargement activity *(Haliotis squamata)* is an activity to maintain the seeds that are stocked until the abalone is a suitable size for sale or consumption. Abalone *(Haliotis squamata)* enlargement activities can be carried out using the enlargement technique on floating net cages. Based on the description above, preliminary research was carried out on the Abalone *(Haliotis squamata)* enlargement technique using the floating net cage method so that it can provide preliminary information about the development of this technique in the mariculture sector in Indonesia.

Materials and Methods

Research period and location

This research was conducted at the Lombok Marine Cultivation Center (BPBL), West Sekotong, Sekotong Sub-District, West Lombok Regency, West Nusa Tenggara, Indonesia (coordinates 115º46 '- 116º28' East Longitude and 8º12 '- 8º55'LS) from January to February 2016.

Abalone enlargement technique in floating net cages

Enlargement of abalone using the floating net cage method requires a series of optimal enlargement activities in order to reach the desired size. The technique of growing abalone in floating net cages includes i) site selection, ii) net preparation, iii) seed distribution, iv) seed maintenance, v) growth sampling, vi) sorting and grading and vii) harvesting consumption size abalone (Figure 1).

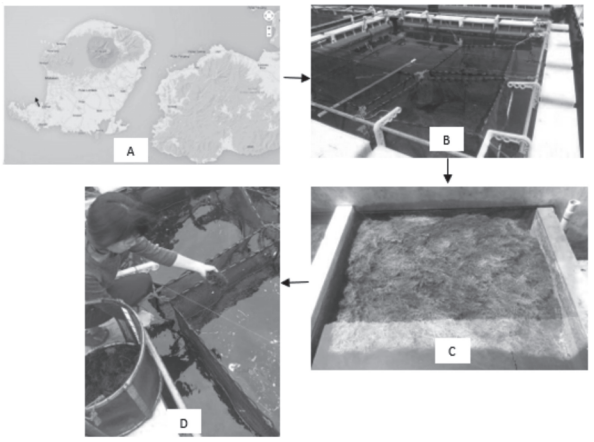

Fig. 1. A) Research location; B) floating net cages used for the maintenance of Abalone (*H. squamata*); C) Fresh feed in the form of Macroalgae *(Gracilaria sp.)*; D) Feeding

Site selection

The location for the enlargement of the abalone should be chosen according to its natural habitat, namely sandy, rocky, and rocky water basins. Abalone prefers this location because it is suitable for its natural habitat to be attached to rock and coral substrates. Calm waters protected from currents and big waves and strong winds. If the location experiences large currents and waves, it is certain that the abalone will experience death overtime.

The level of water transparency in the cultivation area should be above 10 meters with an optimal salinity of 32-35 ppt. It is recommended that the cultivation location has clear and clean waters and should avoid areas with fresh water runoff such as river estuaries.

Preparation of nets and seeds

The nets used for enlarging cages on cages are made of HDPE *(High-density Polyethylene)* with a mesh size of 6 inches. The size of the nets in each 3 x 3 x 3 m^3 cage plot, while the enlargement net basket is 1 x 1 x 1 m^3. The bottom of the net for maintenance is weighed with a square pipe following the size of the net so that the net can sink to the bottom of the water. The maximum distance between the bottom surface of the net and the bottom of the water is 10 meters and a minimum of 5 meters at the lowest tide.

The selected abalone seeds have 2-3 cm shell length for enlargement. Sowing of seeds is carried out in the morning or evening by moving the PVC *(Poly Vinyl Chloride)* pipe together with the seeds attached to the pipe to a basket that has been fed in the form of fresh seaweed in wet conditions. This PVC pipe functions as a substrate and a place for shelter for abalone seeds. The baskets are immediately taken to the sea to be spread on the cultivation containers that have been prepared in the floating net cages. Abalone seeds are stocked at a density of 250 individuals for each basket.

Maintenance of seeds

Abalone seed maintenance includes feeding and maintenance of floating baskets. Feeding is done every 2 to 3 days on an ad libitum basis. Before the feed is given, the feed is washed first with running water by shaking the basket containing *Gracillaria* sp.. The purpose of washing feed with running water aims to remove dirt such as mud and predators, namely snails, crabs, and seaworms.

Feeding for the enlarged abalone in floating net cages is done in the morning at around 08.30 A.M, this is done so that the remaining feed can be cleaned and replaced with new and fresh feed. Abalone feed, namely macroalgae are stored in a concrete tub measuring 1 x 0.5 x 0.75 m^3 with a 24-hour water circulation with the aim that the macroalgae will not rot easily and their quality and nutrition are maintained.

Sampling length and weight of abalone

Abalone growth sampling was carried out to determine the growth of abalone every month. Abalone growth is very slow when compared to other fishery commodities. To get abalone with a size of more than 5 cm only takes 12 to 14 months of maintenance with optimal feeding. Sampling for the growth of shell length and bodyweight of the abalone was carried out once a week in a month, this sampling aimed to monitor the growth of the abalone that was kept.

Water quality

Water quality measurements are carried out once a week for a period of one month.

Results and Discussion

Based on the results of the sampling, it is known that at the beginning of the distribution, the average length of the abalone shell was 4.02±0.15 cm with an average body weight of 11.365±1.55 g and the measurement of abalone growth 28 days after stocking, it was known that the average length of the abalone shell was 4.37±0.21 cm (Figure 2). The average bodyweight of the abalone is 11.936±1.53 g.

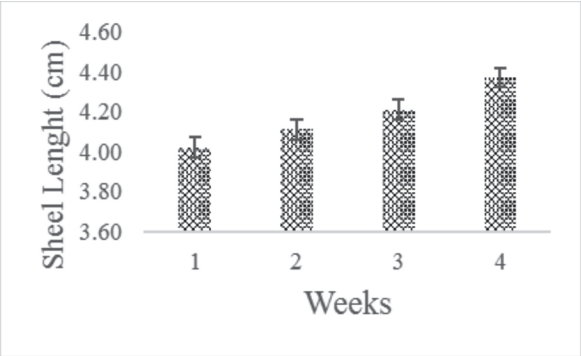

Fig. 2. Rata-rata±SD panjang (cm) cangkang abalone *(H. squamata)* yang dipelihara di Keramba Jaring Apung selama 30 hari.

This agrees with Susanto *et al.* (2010b) that abalone seeds with a maintenance time of 70 days obtained relatively faster shell length and width growth reaching 5.81 mm and 4.01 mm with average growth per month reaching 2.0 - 2.37 mm.

The quality of water available in the floating net cages is used as a container for rearing abalone. Based on the data obtained, the average water quality parameters in the floating net cages are temperature 28.7ºC, pH 7.5, salinity 29 ppt, and DO 4.8 mg / l, the water quality measurement table is presented in table 2. The appropriate temperature is 27.5-28.5ºC, salinity 30-33 ppt, water pH ranges between 7.5-8.5 and DO> 5 mg / l (Susanto *et al.*,

2010b). According to Farliani *et al.* (2020) states that water conditions with temperatures above 30 ºC and last a long time will affect abalone conditions, the degree of acidity (pH) affects the productivity of water which has an impact on the growth of aquatic organisms. Neutral waters tend to be more productive than acidic water so that the life of aquatic animals will be disturbed if the pH of the water is far from the normal point (pH 7) (Leduc *et al.,* 2013). Based on water quality measurements, it shows that the water quality in the floating net cages is suitable for abalone life and for abalone enlargement activities.

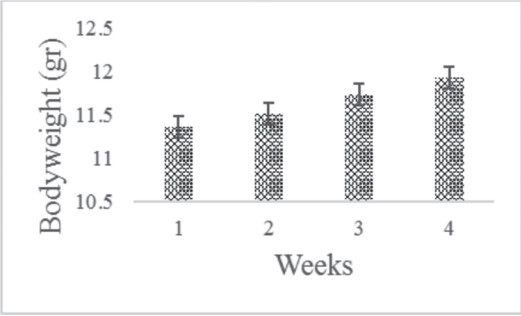

Fig. 3. Mean ± SD weight (g) of abalone *(H. squamata)* kept in floating net cages for 30 days.

Table 1. Results of measurement of water quality in floating net cages

Weeks	Water quality			
	Temperature (ºC)	pH	Salinity (ppt)	DO (mg/L)
I	28.6	7.4	30	5.1
II	30.2	7.0	26	5.0
III	27	7.9	30	4.6
IV	29	7.8	30	4.8
Mean±SD	28.7±1.32	7.5±0.41	29±2	4.8±0.22

Note: DO: *Dissolved Oxygen*, SD: Standar Deviation.

Sort and grading

Sorting is carried out on abalone seeds measuring 3-5 cm using a plastic spatula then separated by type and size and kept in different baskets for abalone enlargement activities (Figure 4).

Grading is carried out to separate defective or diseased seeds and then transferred to a different container to be given recovery action, while the dead abalone seeds are transferred in a different container and then discarded to prevent the spread of disease.

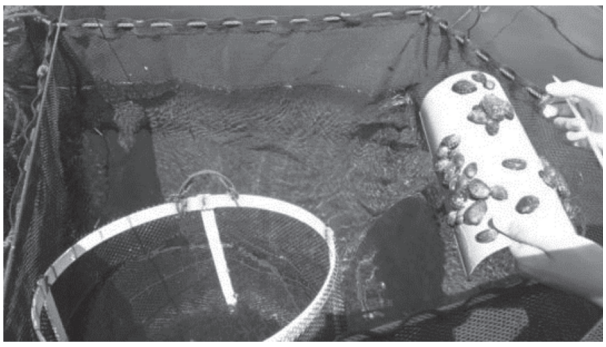

Fig. 4. Sorting activities

Harvesting

The abalone which is ready for harvest will be moved ashore with the prepared basket. The abalone to be packaged is released from the substrate pipe or basket using a plastic spatula and placed in a net which is designed like a bag with a size of 10 x 10 cm^2 so that the abalone can stick to the substrate. Each bag contains 50-100 abalones. The net bag is inserted into a transparent plastic bag with a size of 120 x 50 cm^2 with a thickness of 0.6 mm. Each plastic bag filled with 25% water and 75% oxygen, tied with rubber, and placed in a Styrofoam box with 2 to 3 ice cubes tucked in to maintain temperature stability during transportation.

Pest and disease

Pests are living organisms that interfere with abalone life in the cultivation container during the enlargement process. Pests can cause death to abalone if not handled properly. Pests can also act as predators for abalone and as competitors in food. Pests found in abalone cultivation containers such as crabs, barnacles, and snails. These pests can be removed when cleaning the net by regularly removing crabs, barnacles, and snails (Figure 5).

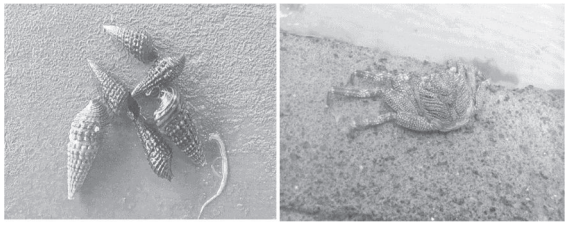

Fig. 5. Pests in the form of snails and crabs.

Abalone disease rarely occurs during the enlargement process. Abalone disease occurs when the condition of the abalone is decreasing due to very drastic weather changes, which causes the water to fluc-

tuate rapidly so that the abalone becomes stressful and can cause death. In these circumstances, abalone is very risky for disease attacks (Wiradana *et al.*, 2019).

Conclusion

The technique of enlarging abalone using the floating net cage method includes several stages, namely site preparation, net preparation, seed distribution, seed maintenance, growth sampling, sorting and grading, as well as pest and abalone disease control.

The factors that affect the growth of abalone are the quality and type of feed, water quality, as well as pests and diseases. Obstacles in the form of dirt, organic matter, polluting materials, and large waves should also be considered when maintaining abalone in the floating net cages.

Further research

Research is still needed on the best types of microalgae that can be used as natural food for abalone in floating net cages. Monitoring studies of bacteria and pollutants such as heavy metals are also needed to support abalone cultivation using the floating net cages method.

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