Effectiveness of squid atractors made from PVC pipe material for squid egg collection

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Abstract. Squid attractors are used as a place for the squid to lay its eggs which later can be hatched and cultivated to meet the world's demand for cephalophods which currently are exclusively fulfilled from stocks caught in nature. This study aims to determine the effectiveness of squid atractor made by PCV pipe materials, to determine the depth whereas the attractors gave the best results, and to measure the time needed for the eggs to hatch. Two types of squid attractor made by PVC pipe material were used, namely Attractor Type 1 (T1) with cover on the top and both sides of the right and left, and Type 2 (T2) which is given a cover only at the top. Squid attractors were set around a stationary liftnet with a distance of 5 meters. The depth around stationary liftnet are varied with 8 meters depth on the west side, 6-7 meters depth on the north and south side and 5 meters depth on the east side. The results showed that the number of clusters produced was influenced by the type of attractor and the position of setting whereas this positions were reflecting the depth of the water (df = 4, F = 14.74, $p < 0.05$). The number of squid eggs in 1 cluster was amounted to 484 eggs, so the number of eggs produced in this study was 12,584 eggs. Atractor T1 gave the best results compared to T2 atractors (df = 1, F = 21.56, $p < 0.05$). Based on the results of squid eggs found on the attractor, the squid effectively lays its eggs at a depth of 6-8 meters. Squid eggs should be moved from attractor before 23rd day for cultivation purpose.
Key Words: attractor effectivity, stationary liftnet, PVC pipe material, squid attractor, squid eggs.

Introduction. Market demand for cephalopods is currently depending on the stocks caught in nature. However, with the increasing demand in every year, capture fisheries cannot fulfill all of the demand. The increasing of commercial needs for cephalopods and the declining of fish stocks will increase the fishing efford toward cephalopod in recent decades (Pierce & Portela 2014; Rodhouse et al 2014; Vidal et al 2014). The development of cephalopod cultivation may be the only reasonable alternative to meet the commercial demand for cephalopods nowadays (Vidal et al 2014). In order to increase production and maintain the sustainability of cephalopod resources and the environment's carrying capacity, it is necessary to perform restocking and cultivation with appropriate methods. Attractor as tools to collect squid eggs is one of the solutions for collecting squid eggs from nature which can then be cultivated. Squid attractor is functioning as a place for the squid to attach its eggs until the eggs eventually hatch (Baskoro et al 2011). Squid attractor should be designed according to its behavior so that the amount of eggs attached could be optimized. Furthermore, hatching time needed should be evaluated to determine the transport time to the cultivation place.

Squid attractor is also functioning as an artificial reef which becomes a new area for fish, soft corals and macroalgae to become a new ecosystem in a waters (Baskoro et al 2011). Squid attractor which have provided benefits to fisheries sector should be improved with durable skeletal materials, so that the benefits provided can last longer, not to damage the waters and are expected to become artificial coral reefs. Grove et al (1991) states that the basic properties of materials used for artificial reefs must meet special requirements, including durable, safe, well-functioning and economical materials, in which concrete metals can meet these standards and most commonly used as materials for artificial reefs. Hixon & Brostoff (1985) found that PVC plastic substrates support the same fouling assemblage as dead coral substrates for inverse abundance and algae biomass, coverage, diversity and species composition off the coast of Hawaii.

Squid attractor was developed by utilizing the squid behavior, wherein they lays the egg on the substrate with a dim environment. These conditions are fit to the attractor, making it to be very effective as a spawning ground. Research on squid attractors has been carried out for a long time, starting with harmonica wire and used tires (Baskoro & Mustaruddin 2007), bamboo material (Tallo 2006), and made from used steel drums (Oktariza 2016). The main factors supporting the squid to spawn are that the place should be protected and safe from disturbances of natural factors such as waves and currents, as well as threats from predators, other influential factors are the type of substrate, surface substrate and the shape of the substrate as the place to lay the eggs (Nabhitabhata 1996). Squid will avoid the area with many predators (Cabanellas-Reboredo et al 2014; Smale et al 2001). According to Pratasik et al (2016), cuttlefish species in North Sulawesi are found in various habitats around coral reefs wich shows different habitat roles for different species and stages of life.

Attractor designs which are adapted from squid behavior and the depth of deployment in the waters are expected to produce a better amount of squid eggs for further cultivation. The right time for transferring the squid eggs in the attractor will also provide better results during cultivation, so it is necessary to know the hatching time of squid eggs. Therefore, this study aims to determine the effectiveness between the two tipe of squid attractor, the right depth for squid attractor deployment and the time needed for the eggs to hatch.

Material and Method

Research site. The research was performed on a stationary liftnet located on 06.988430S and 106.54240E, in the waters of Sangrawayang Sukabumi, West Java, Indonesia. The research was performed on October 2017 (Figure 1).

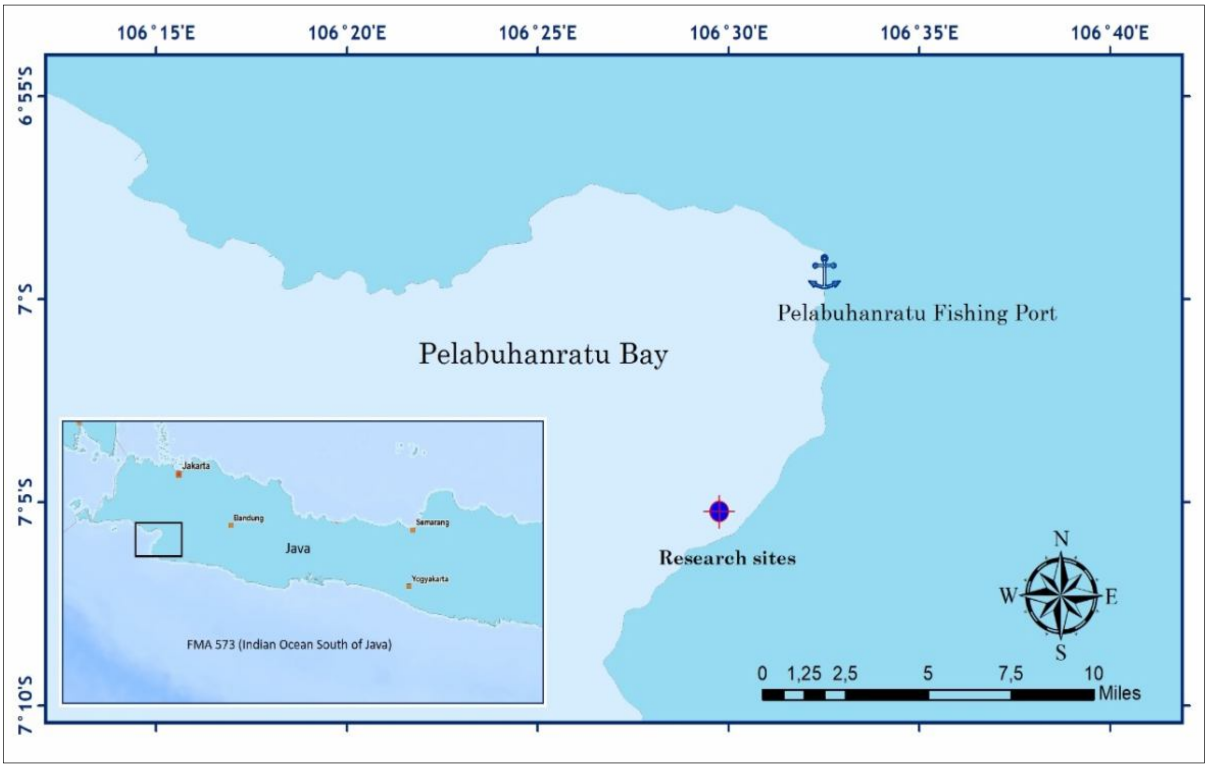


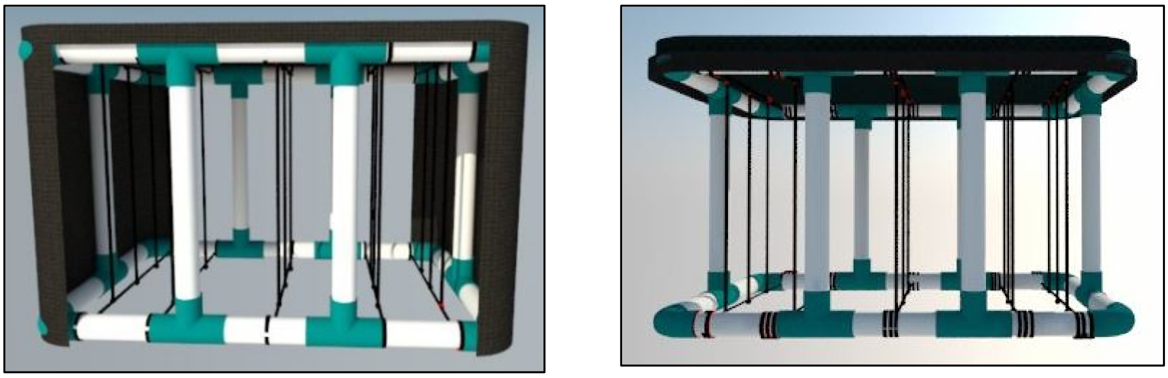
Figure 1. Research site.

Squid attractor. Squid attractor used in this study are rectangular shaped. The frame was made by PVC pipe material filled with cement cast. Cement cast was used to strengthen the frame and also as a sinker. Squid attractor is also attached with attractor line made by sugar palm fibres with diameter (Ø) of 1 cm (Figure 2) and covered by polyethylene net (PE) 40%. Bottom and sides frame were made by PVC pipe with diameter (Ø) of 2 inches, while the upper frame was made by PVC pipe with diameter (Ø) of 1¼ inches. Two types of atractors were used in this study, namely attractor Type 1 (T1) with cover net at the top and the left and right sides made by Polyethilene 40%

(Figure 3a), and attractor Type 2 (T2) with cover net only at the top of the attractor which made by polyethilene 40% material (Figure 3b).

Descriptions :
(1) PVC pipes strengthened by cement cast with Ø of 1¼ inches and 270 mm length;
(2) Cover net with polyethylene (PE) 40% material;
(3) Attractor line made by sugar palm fibers with Ø of 1 cm;
(4) PVC pipes strengthened by cement cast with Ø of 2 inches and 450 mm length;
(5) PVC pipes strengthened by cement cast with Ø of 2 inches and 250 mm length.

Figure 2. Design of squid attractor with PVC pipes material strengthened by cement cast.



(a) (b)

Figure 3. Squid attractor; (a) Type 1 (T1) with cover net (Polyethylene 40%) on the upper and both sides and (b) Type 2 (T2) with cover net (Polyethylene 40%) only on the upper side.

Research design. Sixteen (16) pieces of squid attractor were used in this research which consists of 8 pieces of attractor Type 1 (T1) and 8 pieces of attractor Type 2 (T2). These attractor were deployed around stationary liftnet with a distance of 5 meters. Four (4) pieces of attractor were set on each side of stationary liftnet with a distance of 1 meter between the attractors and placed side by side between types. Attractor were deployed on 4 direction of stationary liftnet so that the current received by all attractor should be the same from various sides. However, current velocity was not taken into account. Other factors were also not taken into account since attractor only deployed around stationary liftnet. Stationary liftnet sides were divided based on wind directions, namely the northern side, western side, southern side, and eastern side. The side which is close to the shore is the eastern side. In this study, the northern, western, southern and eastern side of stationary liftnet also reflect the depth of the waters due to different depths in each side. Stationary liftnet were located 100 m from the shoreline (at lowest tide) with uneven water depth around. Research design can be seen in Figures 4 and 5.

According to Von Brandt (1984), stationary liftnet is classified into lifnet which utilize lamps while operating as fish attractor. Stationary liftnet is generally rectangular and made of bamboo which is plugged in the bottom of water to make it stands firmly above the water, where in the middle of the building a net is installed. Permanent lifnet only helps researchers to place the monitor part along with the power Underwater camera "SENU" to monitor the development of hatching time of squid eggs. This study only focusing on the performance of the attractor as a place to lay the squid eggs and also monitoring the development of hatching time of squid eggs.

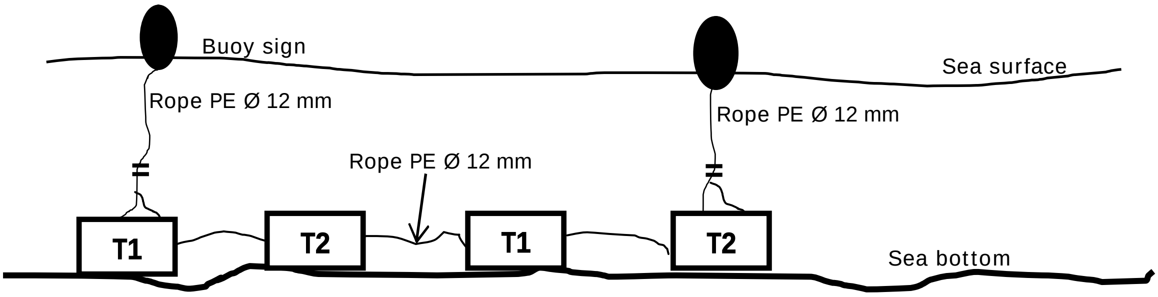


Figure 4. Design of 1 series of attractor setting in the waters.

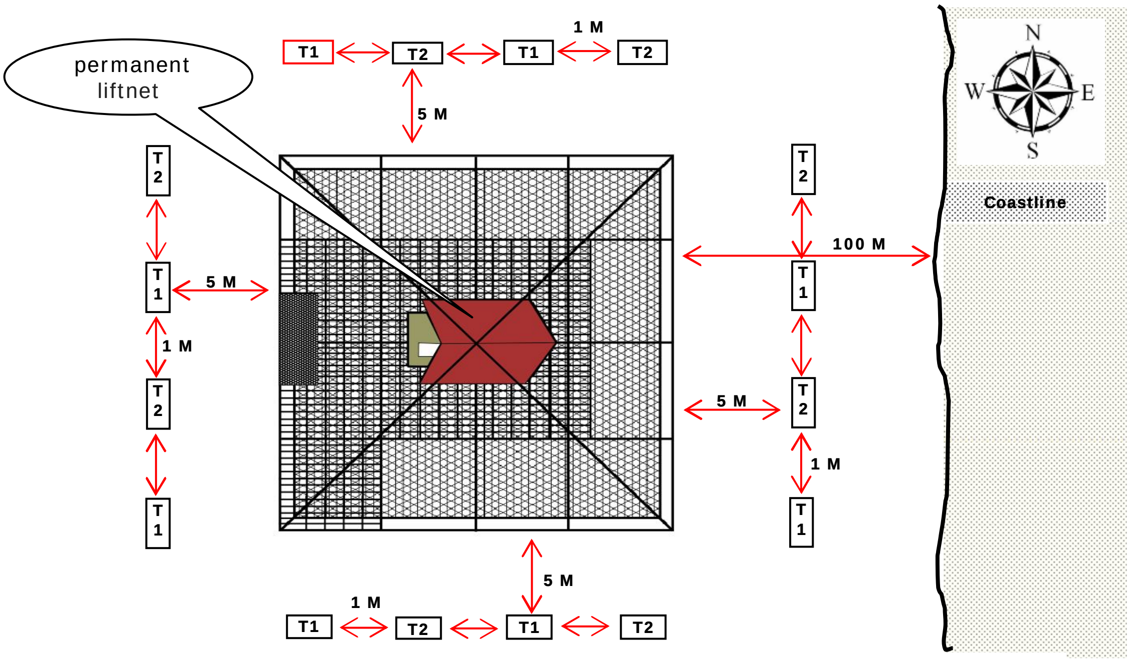


Figure 5. Design of squid attractor setting around liftnet.

Data collection. The number of clusters in each squid attractor was measured with SCUBA (Self Contain Underwater Breathing Apparatus). Photos were taken by using Sportcam "SBOx". Data collection with SCUBA was performed until 14th day since there is no addition on the number of squid eggs on the day 12 and so on and it was feared that the activity will disturb the hatching of eggs since it was almost reach the hatching time. The number of egg capsules were calculated on the surface by taking several clusters and take some egg capsules to find out the number of eggs in each capsules. Furthermore, squid hatching time was measured by using Underwater cam "SENU", which directed to attractor. Observations began after the squid eggs were found attached on attractor. Underwater camera was installed right after the squid eggs were found in the attractor until it hatched.

Data analysis. The experimental design used was a Randomize Complete Block Design with Attractor type as treatments (attractor T1 and T2) (Figure 3), and depth which represented by the deployment position of attractor in four side of stationary liftnet (Figure 5). Furthermore, this research also see the result of interaction between treatment (attractor type) and group (depth) toward the number of squid egg clusters. Statistical analysis was performed by using Statistical Analysis System (SAS), with the significance of the difference defined in $p < 0{,}05$. Furthermore, treatment (attractor type), group (depth) and interaction between treatment and group were analyzed using analysis of variance (ANOVA) to find out the average number of squid egg cluster and see if there is any significance difference for each category.

Squid eggs calculation was performed by counting the number of squid egg capsules on each cluster and the number of squid eggs in each capsule, therefore, the calculation was be performed by using the formula below :

$$\sum SE_{CLS} = \frac{(\sum CPSE_{CLS1}\ X\ \overline{SECP}) + \cdots + (\sum CPSE_{CLSn}\ X\ \overline{SECP})}{n}$$

where:

$\sum SE_{CLS}$: the number of squid eggs in a cluster;

$\overline{SECP}$: the average number of squid eggs in one squid egg capsule;

$\sum CPSE_{CLSn}$: the number of squid egg capsules on cluster-n;

n : the number of sample taken.

Results and Discussion. The number of egg clusters that can be acquired in this study were 26 clusters, attractor T1 acquired 20 egg cluster and atractors T2 acquired 6 egg cluster. Furthermore, each position was described based on the deployed place around stationary liftnet. Attractor on the western side got the most egg cluster with the total of 13 egg cluster, attractor on the southern side got 7 egg clusters in total, attractor on the northern side got 6 egg clusters in total and no egg cluster found on attractor set in the eastern side of stationary liftnet. The amount of egg clusters and the depth characteristics of each side of stationary liftnet are shown in Table 1.

Table 1

Number of egg clusters in each attractor type and deployed position

Placement position of the attractor	*Water depth (meter)*	*Number of egg clusters*		
		T_1	T_2	Σ
West side	8	9	4	13
North side	6-7	5	1	6
East side	5	0	0	0
South side	6-7	6	1	7
Total		20	6	26

The effect of attractor type and deployed place of attractor toward the amount of egg clusters produced were analyzed using the General Linear Model. The results of statistical analysis as presented in Table 2 showed the interaction between attractor type and the deployed position of attractor (deployed position reflects the depth of the waters) resulted in a significant result toward the number of squid egg clusters (df = 4, F = 14.74, p-value = 0.0002). Separately, attractor type also gave a significant difference toward the number of squid egg clusters (df = 1, F = 21.56, p-value = 0.0007). In addition, deployed position of the attractor also significantly affecting the number of squid egg clusters (df = 3, F = 12.47, p- value = 0.0007). Therefore, attractor type, deployed position and the interaction between attractor type and deployed position significantly affecting the number of squid clusters.

Table 2

Results of statistical analysis toward the relationship between the number of squid egg clusters and the type of attractor, the deployed position of attractor and the interaction between the type and position of the attractor

No	*Item analysis*	*DF*	*Mean Square*	*F Value*	*Pr > F*
1	The relationship between treatment (the type of attractor) and the number of squid egg clusters.	1	12.25000000	21.56	0.0007
2	The relationship between group (the position of deployed position of attractor) and the number of squid clusters.	3	7.08333333	12.47	0.0007
3	The relationship between the interaction between treatment (attractor type) and group (the deployed position of attractor) with the number of squid egg clusters.	4	8.37500000	14.47	0.0002

R. Squared = 0.842767.

Anova's analysis results with $\alpha = 5\%$ toward the average number of squid egg clusters for 2 types of attractors were significantly different (F = 6.24, p-value = 0.0256), and the average number of squid clusters in 4 deployed positions of attractor was also significantly different (F = 4.56, p-value = 0.0231). The result of interaction between treatment (attractor type) and group (deployed position of attractor) toward the average number of squid egg clusters also showed a significant different result (F = 21.57, p-value = 0.001). The detail of ANOVA results are presented on Table 3.

Table 3

The result of ANOVA analysis

Average difference model	*F value*	*Pr > F*
Attractor type	6.24	0.0256
Deployed position of attractor	4.59	0.0231
Interaction between attractor type and deployed position of attractor	21.57	0.001

$\alpha = 5\%$

The result showed that Attractor T1 has the highest average number of squid egg clusters compared to Attractor T2, with an average of 2.5 squid egg custer produced. While the result of deployed position of attractor showed that attractor on the western side of stationary liftnet collected more squid egg cluster compared to Attractor in other positions with an average of 3.25 squid egg clusters. The result of interaction between attractor type and deployed position of attractor showed that Attractor T1 deployed on the western position of stationary liftnet collected more squid egg cluster than other attractor type in other position by 4.5 squid egg clusters. Interactions between squid egg cluster with the type of attractor and the deployed position of attractor can be seen in Figure 6.

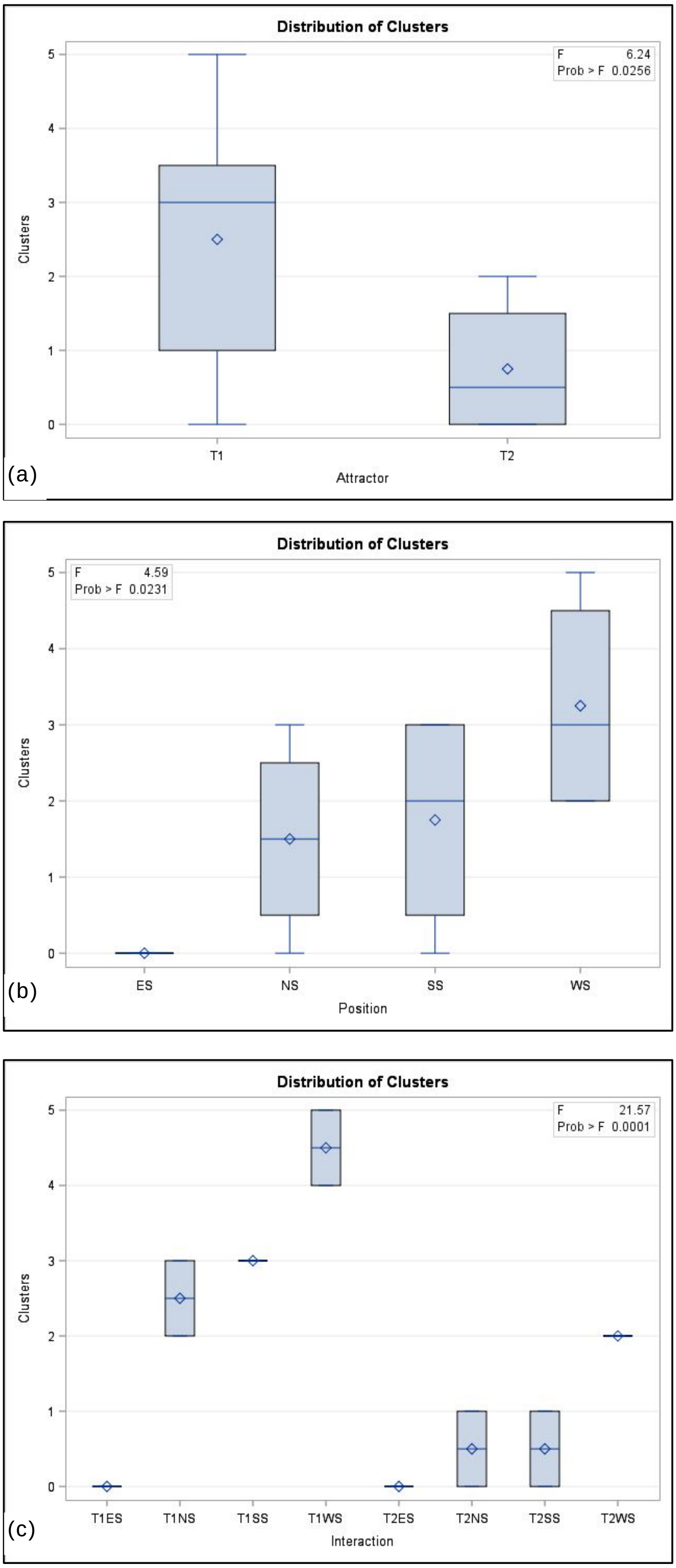


Figure 6. Distribution of squid clusters based on the type (a), the position of the attractor (b), and interaction between attractor type and deployed position of attractor (c) (ES - east side; NS - north side; SS - south side; WS - west side).

Attractor T1 was more occupied by squid to attach their eggs than attractor T2. The number of squid egg attached on attractor T1 was significantly different than attractor T2. This was presumabely due to the the design of attractor T1 which has a wider area covered by cover net than attractor T2, making it more protected from water currents and from predators. The attractor wich is covered by cover net has created a protected area for the squid to attach their eggs. According to Field (1965), the most important factor for squid nesting is that the place should be protected and safe from natural factors disturbance such as waves and flows, as well as threats from predators (Nabhitabhata 1996; Smale et al 2001; Cabanellas-Reboredo et al 2014). Furthermore, sugar palm fiber was selected as a perfect substate to attach squid eggs due to the rough characteristic of its surface. Nabhitabhata (1996) states that other factors influencing the squid to choose their nesting place are the type of substrate, the surface of the substrate and the shape of the substrate.

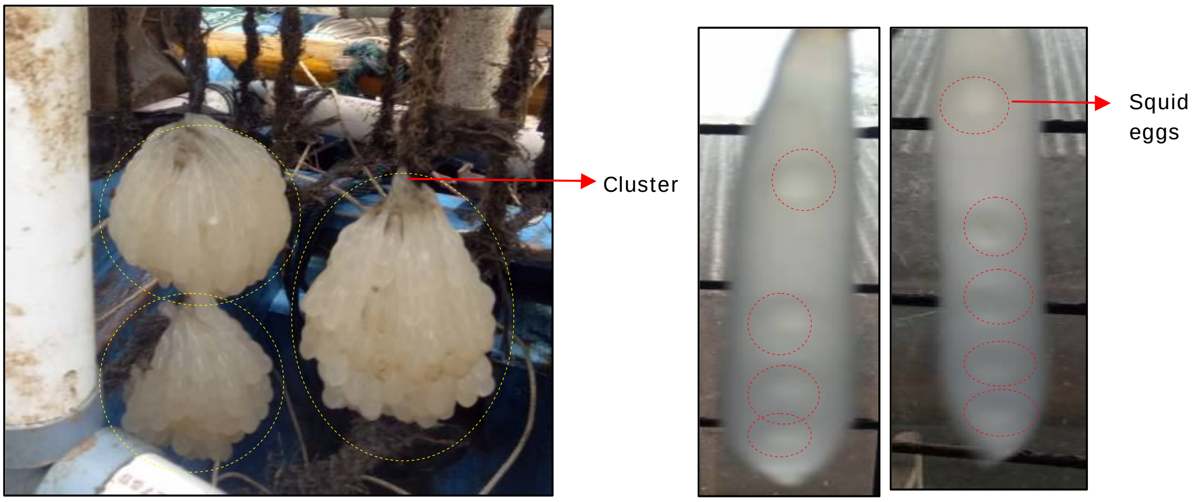
The different position of attractor deployment (which representing the depth of the water) was significantly influencing the number of egg clusters. Based on Table 1, it can be seen that more squid eggs were obtained on the western side of stationary liftnet, folowed by the attractor in the southern and northern sides. However, no squid egg was found on the eastern side with shallowest dept. This was presumabely happened because squid prefer to lay their eggs at a depth of 6-8 meter on a substrates with the gap between egg capsules and sea floor less than 20 cm. Hasaruddin et al (2015) states that squid egg can be found at the depth of 6-12 meters near the bottom of the waters and they will lay their eggs on the inner substrate located at the sea floor with sandy substrates (Cabanellas-Reboredo et al 2014). Moreover, Nabhitabhata (1996) states that shape, location of substrate and position are important factors for spawning media for bigfin reef squid (*Sepioteuthis lessoniana*). Attractor effectiveness in collecting squid eggs is also influenced by the location of setting, as in the Eastern side of stationary liftnet which is too close to the shore.

Squid egg clusters are consisted of several egg capsules. Each capsule contains several squid eggs inside. Bigfin reef squid (*Sepioteuthis lessoniana*) has white, opaque or cloudy, slender, and cylindrical shape of egg capsules. The length varies depending on the number of eggs in each bag and several egg capsules are attached together in one cluster (Nabhitabhata 1996). The number of squid egg capsules based on the sample taken in this study was amounted by 100-115 bags. Furthermore, each egg capsule contains of 4-5 eggs which resulted to 484 squid eggs in one cluster. The number of squid eggs collected from attractor T1 was amounted of 9,680 eggs, while attractor T2 only contained of 2,904 eggs. Furthermore, the number of eggs obtained in four direction of stationary liftnet were amounted of 6.292 eggs on the western side, 3.388 eggs on the southern side, 2.904 eggs on the northern side and no eggs found in the attractor depoyed on the eastern side. The number of squid eggs found in this study was amounted of 12.584 eggs in total. This result showed that squid attractor can be used as an alternative tool to collect squid eggs. Squid eggs in each cluster and squid eggs in one egg capsule can be seen as Figure 7.

Squid eggs were observed by using Underwater camera on attractor T1 deployed on the western side of stationary liftnet (Figure 5). Observation through underwater camera was performed since the first time squid egg found on attractor until it hatched. Squid eggs started to hatch on the 23rd day to the 25th day with the total length of the planktonic larvae of 5 mm (Figure 8). The shape of squid planktonic larvae has resembled to an adult squid. Thus, the transport of squid eggs from atractors to cultivation site should be done before squid eggs reach 23 days of hatching time.

Roper et al (1984) states that squid has no larva stage whereas after the eggs hatched, the larvae already has adult like form. Squid larvae, after they hatch, will swarm around egg cluster to hide from predators due to the large number of fish around the attractor. Baskoro et al (2011) states that squid attractor, in addition to squid nesting sites, also functioning as artificial reefs which become new areas for fish, soft corals and macroalgae to form a new ecosystem in a waters. Darmaillacq et al (2008) states that cuttlefish larvae have to find their own food right after they hatched and the ability to learn visual characteristics of prey will provide important adaptive benefits.

Squid food is related to the size of the squid itself: small squid eats plankton organisms and larger ones will eat crustaceans and small fish (Mulyono et al 2017). In Figure 9, it can be seen that squid larvae took shelter around their egg cluster and they also eat their cluster as their source of food.



(a) (b)

Figure 7. Squid egg cluster (a) attached on attractor line; (b) squid eggs in one capsule.

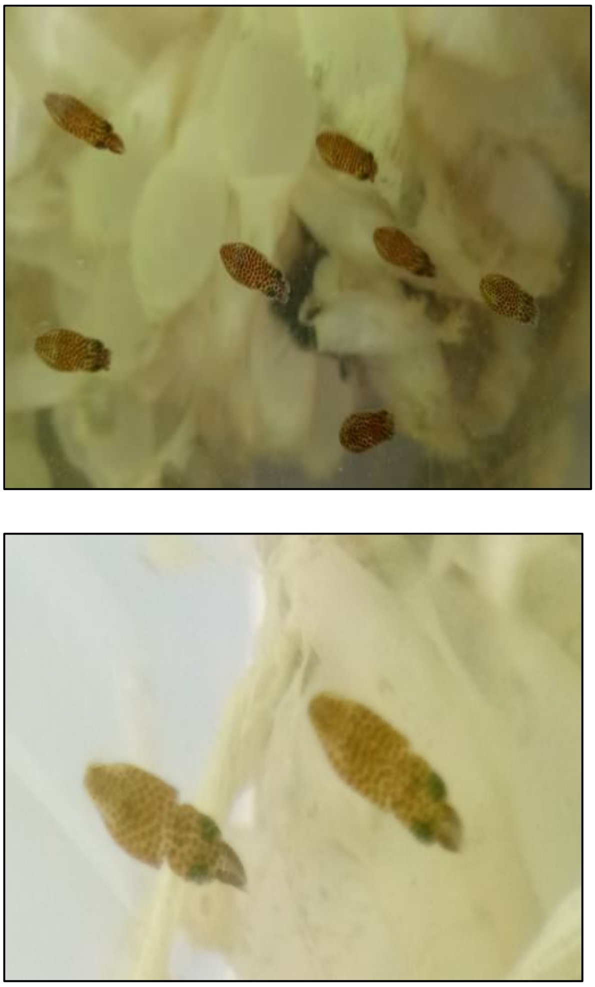


Figure 8. The offspring after 1 day hatching.

Figure 9. The offspring eating egg capsules shortly after they hatched.

The results of this study in comparison with the results of research on bigfin reef squid (*Sepioteuthis lessoniana*), as presented by nabhihabitha 1996, are presented in Table 4.

Table 4

Reference about big fin squid (*Sepioteuthis lessoniana*)

Aspect	*Data*	*Reference*
No.of eggs/capsule	3.0-5.8	Tsuchiya(1981)
	3.8-5.5	SEAFDEC (1975)
	4.8-6.3	Segawa(1987)
	2-11	Nabhitabhata (1996)
	4-5	This study
No.of capsules/Cluster	10-275	Segawa(1987)
	18-131	Tsuchiya(1981)
	73-207	SEAFDEC (1975)
	2-400	Nabhitabhata (1996)
	100-115	This study
No. of eggs/cluster	38-1734	Segawa(1987)
	86-728	Tsuchiya(1981)
	About 1000	Nabhitabhata (1996)
	± 484	This study
Incubation period (day (^{o}C))	14-21	SEAFDEC (1975)
	21-25 (24)	Tsuchiya(1981)
	24-27 (25)	Segawa(1987)
	20.3 (28)	Nabhitabhata (1996)
	23-25	This study

Conclusions. The interaction between treatment (attractor type) and group (deployed position which reflects the depth of the waters) affects the number of squid egg clusters (df = 4, F = 14.74, p-value = 0.0002). Therefore, attractor type 1 deployed in the depth of 6-8 meters are considered to be the most suitable for squid egg collection. As for cultivation purpose, squid eggs should be transferred to hatchery before it reach the age of 23 days

References

Baskoro M. S., Mustaruddin, 2007 [Squids attractors: potential and appropriate technology for integrated coastal development]. Proceedings of Capture Fisheries, IPB-IRC, Bogor. [in Indonesian]

Baskoro M. S., Purwangka F., Suherman A., 2011 [Squids attractors]. Agency Publisher Universitas Diponegoro, Semarang. [in Indonesian]

Cabanellas-Reboredo M., Alós J., March D., Palmer M., Jordà G., Palmer M., 2014 Where and when will they go fishing? Understanding fishing site and time choice in a recreational squid fishery. ICES Journal of Marine Science 71(7):1760-1773.

Darmaillacq A. S., Lesimple C., Dickel L., 2008 Embryonic visual learning in the cuttlefish, *Sepia officinalis.* Animal Behavior 76(1):131-134.

Hasaruddin H., Ibrahim S., Hussin W. M. R. W., Ahmad W. M. A. W., Muchlisin Z. A., 2015 Artificial aggregating device for fish and squid eggs. AACL Bioflux 8(5):832-837.

Hixon M. A., Brostoff W. N., 1985 Substrate characterstics, fish grazing and epibenthic assemblages off Hawaii. Bulletin of Marine Science 37:200-213

Field W. G., 1965 The structure, development, food relations, reproduction and life history of squid *Loligo opalescens* Bery. Fisheries Bulletin 131:1-108.

Grove R. S., Sonu C. J., Nakamura M., 1991 Design and engineering of manufactured habitats for fisheries enchancement (109-152). In: Artificial habitats for marine and freshwater fisheries. Seaman Jr. W., Spreque L. M. (eds), Academic Press, San Diego (US).

Mulyono M., Nuraini A., Dewi I. J. P., Kritiani M. G. E., Syamsudin S., 2017 Biology aspects and length-weight relationship of squid *Loligo chinensis* in the waters of Lamongan Regency, East Java Province, Indonesia. AACL Bioflux 10(5):1221-1225.

Nabhitabhata J., 1996 Life cycle of cultured big fin squid, *Sepioteuthis lessoniana* Lesson. Phuket Marine Biological Center Special Publication no. 16, pp. 83-95.

Oktariza W., 2016 [Model of increased stock of squid (*Photololigo chinensis*) in Bangka Regency, Bangka Belitung Islands Province]. Dissertation, Institut Pertanian Bogor, Bogor. [in Indonesian]

Pierce G. J., Portela J., 2014 Fisheries production and market demand. In: Cephalopod culture. Iglesias J., Fuentes L., Villanueva R. (eds), Springer Netherlands, London, pp. 41-58.

Pratasik S. B., Marsoedi, Arfiati D., Setyohadi D., 2016 Mitochondrial CO1 genetic marker-based species diversity of cuttlefish (Cephalopod; Mollusk) in Manado Bay and Lembeh Strait, North Sulawesi, Indonesia. AACL Bioflux 9(6):1345-1354.

Rodhouse P. G. K., Pierce G. J., Nichols O. C., Sauer W. H. H., Arkhipkin A. I., Laptikhovsky V. V., Lipinski M. L., Ramos J., Gras M., Kidokoro H., Sadayasu K., Pereira J., Lefkaditou E., Pita C., Gasalla M., Haimovici M., Sakai M., Downey N., 2014 Environmental effects on cephalopod population dynamics: implications for management of fisheries. Advances in Marine Biology 67:99-233.

Roper C. F. E., Sweeney M. J., Nauen C. E., 1984 FAO species catalogue. Vol. 3. Cephalopods of the world. An annotated and illustrated catalogue of species of interest to fisheries. FAO Fish. Synop. 125(3):277 pp. Rome: FAO.

SEAFDEC, 1975 Observation on the culture and life history of the broad finned squid *Sepioteuthis lessoniana* Fer. And Orb. SEAFDEC-MSU-Institute of Fisheries Reasearch and Development Annual Report 1975:115-119.

Segawa S., 1987 Life history of the oval squid, *Sepioteuthis lessoniana* in Kominoto and adjacent waters Central Honshu, Japan. Journal of the Tokyo University of Fisheries 74(2):67-105.

Smale M., Sauer W., Roberts M., 2001 Behavioural interactions of predators and spawning Chokka squid off South Africa: towards quantification. Marine Biology 139:1095-1105.

Tallo I., 2006 [The effect of water depth deployment and type of fish actractor on thesquid eggs attachment]. Master Thesis, Institut Pertanian Bogor, Bogor, 64 pp. [in Indonesian]

Tsuchiya M., 1981 On the spawning of the squid, *Sepioteuthis lessoniana* Lesson at Amitori Bay, Iriomote Island, Okinawa. Institute of Oceanic Research and Development, Tokai University Notes 3:53-75.

Vidal E. A., Villanueva R., Andrade J. P., Gleadall I. G., Iglesias J., Koueta N., Rosas C., Segawa S., Grasse B., Franco-Santos R. M., Albertin C. B., Caamal-Monsreal C., Chimal M. E., Edsinger-Gonzales E., Gallardo P., Le Pabic C., Pascual C., Roumbedakis K., Wood J., 2014 Cephalopod culture: current status of main biological models and research priorities. Advances in Marine Biology 67:1-98.

Von Brandt A., 1984 Fish catching methods of the World. Fishing News Book, London, 432 pp.

Received: 14 March 2018. Accepted: 21 August 2018. Published online: 30 September 2018.
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How to cite this article:
Danu S., Baskoro M. S., Zulkarnain, Yusfiandayani R., 2018 Effectiveness of squid atractors made from PVC pipe material for squid egg collection. Ecoterra 15(3):8-19.