Effects of different operation time and shape of octopus bubu on the total catch of octopus (*Octopus cyanea*)

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Abstract. Traditionally, *Cymbiola nobilis* snail shell was used for trapping octopus, *Octopus cyanea*. However, the abundance of snail had declined and thus the shell used for trapping the *O. cyanea* should imperatively be replaced with other materials. To understand the effects of materials, shape and operation time of the *O. cyanea* bubu on the number of catches, a research has been conducted in Kuala Tanjung Indah Village, Batubara Regency, North Sumatra Province, Indonesia. This research found that there was no significantly different in the number of *O. cyanea* caught for each trap shapes (7-9 specimens day^{-1}). Contrarily, there was a different number of caught during the morning and afternoon periods. These findings showed that the number of *O. cyanea* caught was not affected by the material and the shape of the traps, but probably it was affected by the operational time.

Key Words: concrete trap, Kuala Tanjung Indah village, snail shell, number of catches.

Introduction. Bubu is a traditional fishing gear which is commonly known by fishers, often called as traps and guiding barriers. This traditional fishing gear is made from variety of materials such as rattans, wires, irons, nets, bamboos, woods and woven plastics. The basic principle of bubu to catch fish is to divert fish into traps, commonly known as fishing pots or fishing baskets (von Brandt 1984). The *Octopus cyanea* bubu has a semicircular round shape and is equipped with a buoy, a buoy rope, and the main rope and snail shells. The *O. cyanea* bubu fishing operation in Kuala Indah Village declined due to the decrease of snail shells abundance for the fishing gear's component. Thus, the fishers need a substitute material for constructing the *O. cyanea* bubu.

The current research was intended to identify the effectiveness of cement concrete as suitable substitute materials replacing the snail shells use as *O. cyanea* bubu component. Cement concrete is easy to find since it is available in almost all sources of building materials and relatively easy to shape. Furthermore, the operation time for *O. cyanea* bubu by fishers is normally in the morning and afternoon, but this fishing operation time degree of effectiveness is not yet statistically determined. Based on the description above, this research aimed to compare the total catch of *O. cyanea* bubu from three different cement concrete shapes: snail shell shape, rounded shape and cup shape with a different fishing operation time, in the morning and in the afternoon.

Material and Method

Study site. This research was conducted in August 2016 in the Kuala Tanjung Indah Village, Sei Suka Sub-district, Batubara Regency, North Sumatera Province, Indonesia (Figure 1).

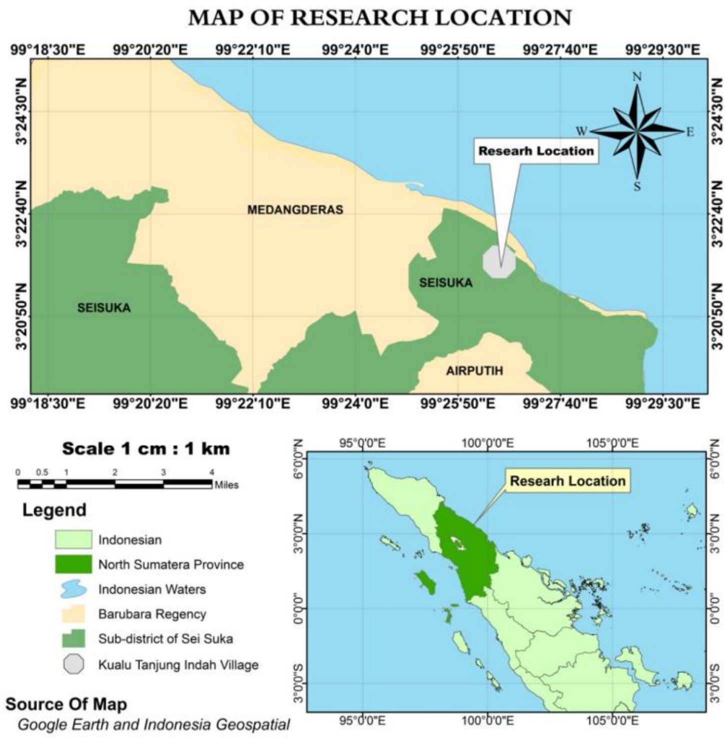


Figure 1. Map of research site.

Research methodology. The experimental method of this research was the direct observation at the research site, during 10 days. The completely randomized design considered three factors, namely: the two levels of materials for the bubu, three levels of shape of the bubu and two levels of operation time (morning and afternoon). The form factor with three levels defined the treatments: 1) a snail shell of 11.5 cm height and 7 cm width; 2) a cup shape concrete bubu of 9 cm height and 6 cm width, and 3) a round shape concrete bubu of 7.3 cm height and 6.5 cm width. The composition ratio of the cement concrete for artificial shell was 5:2:3 in sands, cements and water parts, respectively (Figure 2).

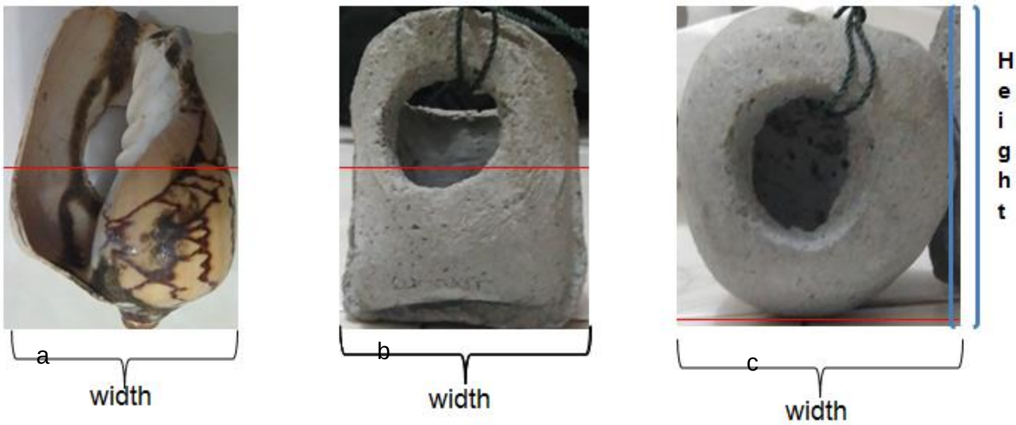


Figure 2. Basic dimension of the trap, a) snail shell; b) cup shape concrete bubu; c) round shape concrete bubu (original).

O. cyanea bubu construction consists of: 1) main line, made from polyethylene (PE) ø 4 mm, 100 m of length; 2) snail shell bubu shape, 30 units; cup shape cement concrete, 30 units and rounded cement concrete shape, 30 units; 3) floating and sign flag, made from plastic with a floating force of 4.8 kg and the flag's pole made from bamboo, measuring 1.50 m in length and 4) sinker with a weight of 4 kg. General arrangement for the traps is using the longline style with 2 meters interval between traps (Figure 3).

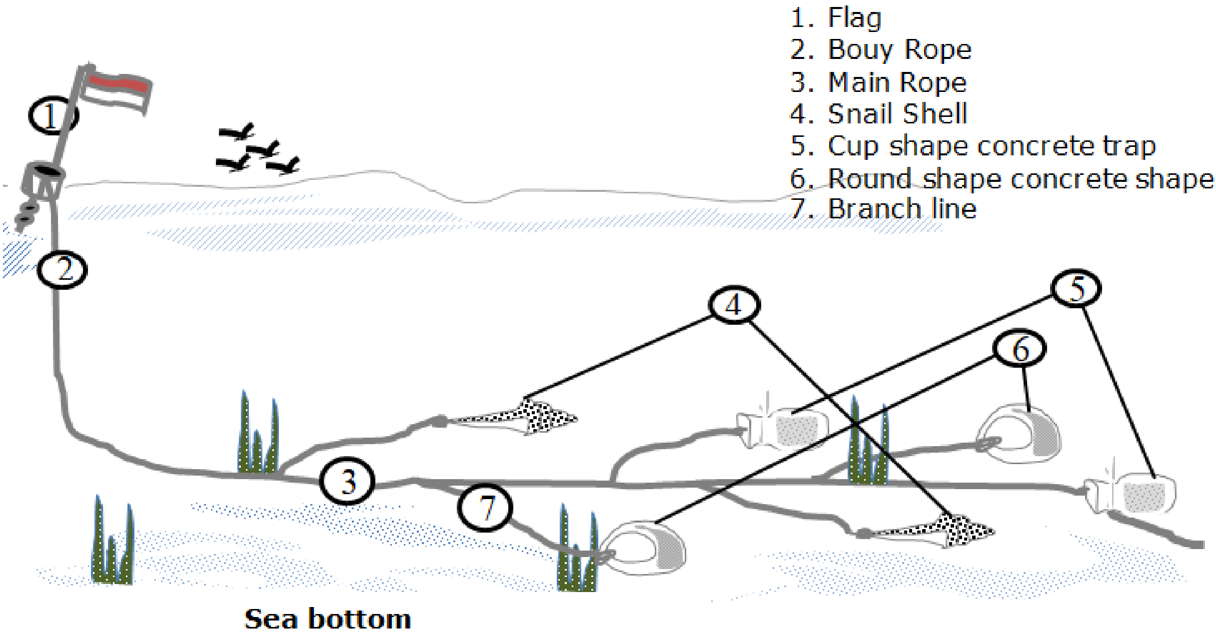


Figure 3. The construction of the bubu (original).

The buoys for *O. cyanea* bubu consist of two pieces of plastic bottles with a length of 10 cm tied to poles, made from 2 meters of bamboo equipped with flag as a sign (Figure 4).

Figure 4. a. Buoy; b. Anchor (original).

The catch data were analysed using ANOVA (SPSS Version 22) analysis. If the ANOVA test results showed that the F value is greater than F table at 95% of confidence intervals, the proposed alternative hypothesis (H1) was accepted and it means there were differences between the treatment levels (Sudjana 1982). The data are considered as normally distributed.

Results. Batubara Regency is one of the regencies in North Sumatera Province. Geographically, Batubara Regency is located between $2^0$46' - $3^0$26' N and $99^0$05' - $99^0$39' E. Kuala Tanjung Indah Village shares their borderline with Medang Deras subdistrict in the north, with Kuala Indah Village in the south, with the Malacca Strait in the east, and with Air Putih Subdistrict in the west. Oceanographic characteristics at the fishing ground are important parameters for the success of the fishing operations. Detailed oceanographic parameters measured during the research were: current speed, temperature, salinity, depth and turbidity. Parameter values varied during the observation: the current speed ranged from 20 to 48 cm sec^{-1}; the depth ranged between 25 and 30 m; temperature ranged from 28 to 35ºC; salinity ranged from 29 to 33 ppt; water turbidity ranged from 0.70 to 0.90 m (Table 1).

Table 1

Aquatic environmental parameters

Date	Current speed (cm sec^{-1})	Depth (m)	Temperature (^oC)	Salinity (ppt)	Turbidity (m)
05.09.2016	22	28	32.30	32	0.80
06.09.2016	27	30	33.00	30	0.79
07.09.2016	33	30	30.46	31	0.70
08.09.2016	20	27	28.00	29	0.90
09.09.2016	24	28	28.70	31	0.80
10.09.2016	22	31	29.00	32	0.70
11.09.2016	21	29	28.50	33	0.80
12.09.2016	45	30	35.00	31	0.90
13.09.2016	48	25	35.00	33	0.90
14.09.2016	40	28	35.00	32	0.70
Range	20-48	25-30	28.00-35.00	29-33	0.70-0.90
Average	30.2	28.6	31.496	31.4	0.799

Catch composition. The octopus species caught during the research were *O. cyanea* (Figure 5). The total *O. cyanea* caught during the 10 days of research observation were presented in Table 2, where the highest capture was recorded from the cup shape concrete bubu and operated both in the morning, with 9.82 kg or 96 individuals and in the afternoon, with 8.5 kg or 83 individuals. At the opposite, the lowest catches were shown from the round shape concrete bubu, where the capture was 8.31 kg or 82 individuals in the morning and 6.55 kg or 64 individuals in the afternoon.

Figure 5. *Octopus cyanea* (original).

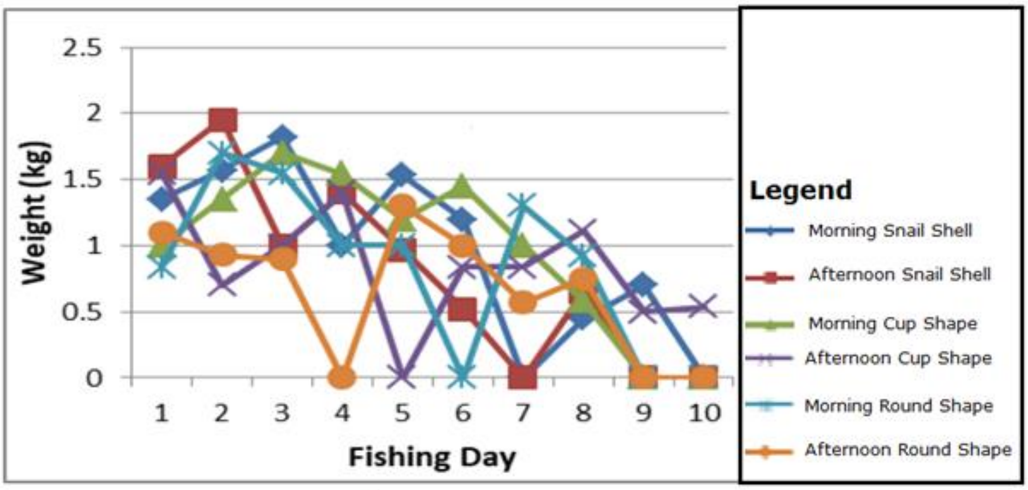
Table 2

The catches of all three forms of bubu operated in the morning and afternoon fishing operation time (day/month/year)

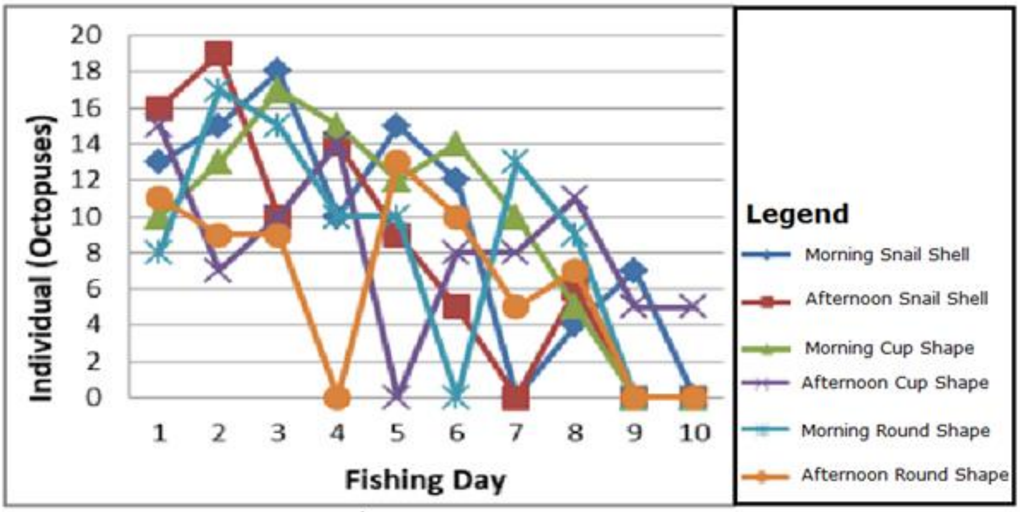
Date	Snail shell (SSt)				Cup shape (CSCt)				Round shape (RSCt)			
	Morning		Afternoon		Morning		Afternoon		Morning		Afternoon	
	kg	ind	kg	ind	kg	ind	kg	ind	kg	ind	kg	ind
05.09.2016	1.35	13	1.6	16	1	10	1.55	15	0.84	8	1.1	11
06.09.2016	1.57	15	1.95	19	1.35	13	0.7	7	1.7	17	0.93	9
07.09.2016	1.82	18	1	10	1.7	17	1	10	1.55	15	0.9	9
08.09.2016	1	10	1.4	14	1.54	15	1.4	14	1	10	-	-
09.09.2016	1.53	15	0.97	9	1.2	12	-	-	1	10	1.3	13
10.09.2016	1.2	12	0.52	5	1.45	14	0.84	8	-	-	1	10
11.09.2016	-	-	-	-	1	10	0.84	8	1.3	13	0.57	5
12.09.2016	0.45	4	0.65	6	0.58	5	1.11	11	0.92	9	0.75	7
13.09.2016	0.7	7	-	-	-	-	0.5	5	-	-	-	-
14.09.2016	-	-	-	-	-	-	0.54	5	-	-	-	-
Sum	9.62	94	8.09	79	9.82	96	8.48	83	8.31	82	6.55	64
Average	0.96	9.4	0.81	7.9	0.98	9.6	0.85	8.3	0.83	8.2	0.66	6.4

Ind-individual.

The overall catch both in terms of weight and number of individuals during the research showed a declining trend over time. The catch in the afternoon for all forms of bubu was higher than the catch in the morning (Figure 6a and 6b), over the whole observation period. In general, the amount of *O. cyanea* caught using the snail shells and the artificial cement concrete shells were not significantly different. Between 64 and 96 individuals were caught for the 10 days of research observation, averaging approximately between 0.21 to 0.32 *O. cyanea* individuals (shell day)$^{-1}$ or 0.022 to 0.033 kg (shell day)$^{-1}$ (Figure 6). The differences were significant in terms of fishing time: a, where morning catches were larger than afternoon catches. Morning catches ranged between 0.250 and 0.300 individuals (trap day)$^{-1}$ (0.025–0.032 kg (trap day)$^{-1}$), while afternoon catches ranged from 0.200–0.280 individuals (trap day)$^{-1}$ (0.021–0.028 kg (trap day)$^{-1}$).



a



b

Figure 6. Fluctuations of *Octopus cyanea* catches (a) in weight and (b) individual for the three different shapes of *Octopus cyanea* bubu, according to the fishing time (morning and afternoon).

From the ANOVA analysis, the result showed that there were significant differences between morning and afternoon operation time for the total catch weight F_{cal} (1.005) > F_{tab} (0.321) and in number of individuals F_{cal} (1.014) > F_{tab} (0.318) at 95% confidence intervals, while no significant statistical difference were found for the effect of the bubu's shapes.

Discussion. This research found that the current speed is medium, ranging from 25 to 50 cm sec^{-1}, as also stated by Nybakken (1992). Water temperature was influenced by the intensity of sunlight into the waters and during the research it varied from 28 to 35ºC, a typical range for tropical water, as stated by Nybakken (1992). Water temperature is one of the most important factors for regulating the ecosystem and the organisms' distribution. Nybakken (1992) found a tropical water temperature range between 28 and 30ºC. Water depth at Kuala Tanjung Indah Village varied from 25 to 30 m of deep. According to Sinaga & Riwayati (2009), the sea floor discriminated three different zones, namely: a) litoral zone, where sunlight still can reach the ocean's floor, at depths ranging between 0 and 200 m, b) neritic zone, where the floor is dimly lit, at depths ranging between 200 and 2,000 m and c) abyssal zone, where light can no longer reach the floor, at depths larger than 2,000 meters. Based on this research, salinity level was found between 29 and 33 ppt, while the water turbidity varied between 0.70 and 0.90 m. The water brightness level is highly related with its turbidity: the higher the turbidity, the lower the penetration of light (Mujito et al 1997). Budiyanto & Sugiarto (1997) stated that *O. cyanea* is benthic, usually seeking for a shelter in the cracks of rocks, under rocks or in the seaweed of the coastal waters. Their preferred place is the hollow rocks. The use of the snail shell is based on Harisman (2012), Safari (2012) and Zamharir (2013), whose research revealed that some local fishermen operate longline fishing gear with the fish hook replaced with empty shells of punangan (*Volutacorona nobilis*), empty papaya snails (*Nilo aethiopicus*) or ceramic and coconut shells, due to the behaviour of *O. cyanea* seeking to hide in the empty snail shell.

The catches difference between morning and afternoon fishing time are related to the sheltering behaviour of the *O. cyanea*: more active in the morning and seeking to hide from the daylight in the afternoon. *O. cyanea*'s ability to differentiate between morning and afternoon might be supported by its eyes, being able to distinguish light polarization, but seeming insensitive to the colours. *O. cyanea*'s eye orientation is maintained by autonomic motion (reflexes) so that the pupillary opening is always horizontal (Hanke et al 2020). By analogy with a focusing camera, cephalopod eyes are referred to as "camera eyes." *O. cyanea* retina is very different from the mammalian retina in terms of cellular organization (Young 1971).

The findings related to the different shape of traps showed that the *O. cyanea* is sensitive to the texture variation, but not to shape variation. Consequently, the *O. cyanea* does not differentiate between the three forms of bubu, which is in line with Fox et al (2013), who stated that *O. cyanea* tends to stick around and forms a shelter for hiding in crevices of rocks, corals, and seaweed found in coastal waters, with the most preferable place being crevices of rocks, without making distinction of the shape of the holes, but only prioritizing the perception of safety. Wells (1964) experiments showed that *O. cyanea* can be trained to distinguish by touch between a cube and a sphere, opposing previous work has always theories suggesting that octopuses cannot integrate proprioceptive information while learning. However, this ability to discriminate cube and sphere seems to be due to the distortions sensitivity of the rims in contact with the corners of the cube: (1) a cube with the corners even slightly rounded is less readily distinguishable from a sphere than a cube with sharp corners and (2) a narrow rod is readily accepted in place of the cube, by trained animals.

Furthermore, according to Roper et al (1984), *O. cyanea* has the habit to hide in the gaps of empty shell of mollusk and seagrass beds. According to Gunarso (1984), the success rate of a catch depends on the fishers' skills and knowledge on fishing gear, on the environmental conditions, and on the fish's behaviour. In general, body-patterning behaviours in cephalopods depend on three major components: the eyes, the central nervous system (CNS) and the pigmented organs called chromatophores embedded in the skin (Messenger 2001).

Water temperature was in accordance with the findings of Katsanevakis et al (2005), who stated that *O. cyanea* is a poikilothermic, eurythermic ectotherm animal, meaning that its body temperature changes according to the ambient temperature. Their body will absorb the surrounding heat. Contrarily, when swimming towards cooler locations, their body releases heat by the same process. *O. cyanea* will show different adaptive behaviours face to a wide range of ambient temperature variation.

Respiration rate of an *O. cyanea* is a temperature sensitive process: it changes according to the temperature. The oxygen consumption of an *O. cyanea* will increase when the ambient temperature ranges from 16 to 28°C, reaching the maximum level at 28°C. Furthermore, it will decrease if the temperature reaches 32°C. The optimum temperature for the metabolism and for the oxygen consumption is between 18 and 24°C. This *O. cyanea* was catched at 29 to 33‰ salinity, in highly salty waters. This matches with the study of Zhang et al (2010), reporting that the survival salinity of *Octopus variabilis* ranged from 7.0 to 30.3‰, with the appropriate salinity ranging from 16.3 to 27.3‰ and the optimum salinity ranging from 18.0 to 24.3‰. The adaption to a broad range of salinities favoured the large-scale aquaculture of *O. variabilis*. The density and proportion of various blood cells changed significantly under salinity stress.

Besides, *O. cyanea* have good eyesight, their eyes are shaped like a slot and therefore vulnerable to refractive disorders in the form of astigmatism, but apparently doesn't prevent *O. cyanea* to hunt in low light conditions, due to two specific organs called statocyst, connected to their brain and functioning as horizontal orientation detector (Boycott 1960).

A research by Martasuganda (2003) revealed that the area for catching *O. cyanea* is at the water's floor, from muddy to sandy waters, with slow water streams of a depth between 5 and 40 m. Simbolon (2006) stated that the optimization of economic and profitable *O. cyanea* catchment determination needs to consider three main aspects, namely: 1) *O. cyanea*'s available resources, 2) environment where the *O. cyanea* can be gathered and 3) fishing technology.

Conclusions. On a total catch of 25.44 kg (248 individuals), during the current research, the highest values were recorded from the cement concrete trap of a cup shape (9.15 kg, 89 individuals) and the lowest values were recorded from the cement concrete trap of a rounded shape (7.43 kg, 73 individuals). Regarding the fishing time, best captures occurred in the morning as compared to afternoon. There was no sensitivity of the catches to the shape of the traps observed, for the tested designs. This research suggests replacing the use of snail shell by cement concrete traps in catching *O. cyanea*.

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