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Effect of Bait use and Underwater LED on Squid (*Loligo* sp.) Catches in Karimunjawa Waters Jepara Central Java

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A B S T R A C T

Karimunjawa is an island located North of Java Island that has good capture fisheries potential One of the fishing gears operated in Karimunjawa is squid rods. Squid fishing rods are the dominant fishing gear used by Karimunjawa fishermen, Jepara. This fishing gear is selective and environmentally friendly. This is due to its simple construction and operation. The aim of the study was to analyze the effect of using natural bait, namely kurisi fish (Nemipterus japonicus) with blue and white light colors on the catches of squid (Loligo sp.) hand line fishing gear. The method used was experimental fishing with 6 treatments, a total of 36 repetitions in 6 fishing trips. Consists of treatment of blue LED kurisi with surface light, blue LED kurisi without surface light, white LED kurisi with surface light, white LED kurisi without surface light, dummy bait without LED with surface light and dummy bait without LED without surface light respectively 6 repetitions. The results of this study indicate that of the 6 treatments, they mutually influence the catch. The results of the Analysis of variance, using blue lights have a value of 0.000 <0.05. Kurisi (Nemipterus japonicus) using white lights has the same value, namely 0.000 <0.05. The combination of the use of bait and lights produces a result of 0.000 > 0.05. The test results showed that natural bait kurisi (Nemipterus japonicus) and blue and white lights had an effect on the squid fishing catches. Squid fishing using natural bait kurisi (Nemipterus japonicus) and lights were good for use in squid fishing gear in Karimunjawa waters.

Keywords: Squid (*Loligo* sp.), squad fishing rod, natural bait, underwater LED

1. Introduction

Squid fishing rod (*Loligo* sp.) is the dominant fishing gear used by Karimunjawa fishermen. Fishing rods are fishing gear that has a simple construction, because it doesn't require a lot of materials to build. Karimunjawa fishermen use fishing rods according to the fishing season, when it is the season for squid (*Loligo* sp.) the fishing line is adjusted to catch squid (*Loligo* sp.), when it is the season for cob (*Euthynnus affinis*) and mackerel (*Scomberomorus* sp.) then the fishing line is adjusted with the fish. Fish resources other than squid (Loligo sp.) are seasonal, so Karimunjawa fishermen use squid fishing rods (*Loligo* sp.) as the main fishing gear, because each catch always produces results, only the quantity of the catch varies. Squid fishing rods (*Loligo* sp.) operated by Karimunjawa fishermen specifically for catching squid (*Loligo* sp.) usually use artificial bait in the form of shrimp. The shape of the hook and bait on the fishing line is also different from the fishing target other than squid (*Loligo* sp.). According to Ramadhan and Apriliani (2016), the target catch in the Karimunjawa area consists of demersal fish and pelagic fish. The fishing tools that are widely used by fishermen are hand lines, arrows, traps and nets. Fishing line is a tool used to catch pelagic fish. The use of fishing gear depends on the season and the availability of fish resources.

Each fishermen in Karimunjawa have their own characteristics based on type of catch. Squid fishermen (*Loligo* sp.) catch using fishing aids in the form of lamps and artificial baits. The lights used are on the rear side of the boat, totaling 6 pieces where 3 are installed on the right side and 3 are installed on the left side of the ship. The lights on the boat serve to invite the squid (*Loligo* sp.) crowds closer to the boat and make it easier for fishing rods to catch squid (*Loligo* sp.). This light can attract squid (*Loligo* sp.) to come closer, because squid (*Loligo* sp.) are positive phototaxis or like light. Apart from lights, the next fishing tool is artificial bait. Artificial bait in the form of shiny colored shrimp or fish. According to Daris et al. (2021), the catches of hand line are different based on the type of lamp. The catch shows that LED lights get more catches than petromax.

Squid fishing line (*Loligo* sp.) used in Karimunjawa has the same shape as squid jigger in general. Each fishing line is usually given a hook of 2 pieces. The fishing line is tied in stages from the bottom up and each fishing line connection is given a swivel. This aims to make it easy to connect two or more fishing lines that have different sizes. Apart from that, it also make it easier for fishermen to change hooks and new threads when the threads break either due to the pull of the squid (*Loligo* sp.) or due to snagging. Kemujan fishermen only use artificial bait in the form of shrimp or in the form of bait from the fishing line brand torpedo and only use the help of light attractors on the surface. So this study aims to determine the effect of natural bait and underwater lights on squid (*Loligo* sp.) catches. The operation of the squid fishing gear (*Loligo* sp.) in Karimunjawa is the same as the operation in other areas, which consists of 3 stages of setting, jigging and hauling. First, the fishing line is lowered to the middle or close to the bottom of the water or fishermen usually use instinct for fishing depth. Once in the water column, the fishing line is jerked to invite the squid (*Loligo* sp.) to come closer and

get snagged on the fishing line. According to Mulyawan (2015), the operation of squid (*Loligo* sp.) fishing rods consists of setting, jigging and hauling. The operation is by lowering the fishing line into the water column and then jerking it and pulling it out when it feels like a squid (*Loligo* sp.) is stuck.

2. Materials and Method

2.1 Description of the Study Sites

This research was conducted in March 2023 in the Kemujan waters of Karimunjawa Island, Jepara, about 3.1 nautical miles from the mainland (figure 1). Karimunjawa has 27 islands, of the 27 islands only five are inhabited, including Kemujan, Parang, Mosquitoes and Genting. The population of Karimunjawa Regency in 2019 measured as much as 9,784 people consisting of 4,931 men and 4,853 women. This number was spread across the villages of Karimunjawa, Kemujan, Mosquito, Parang (Cahyanto et al., 2016). This island could be easily accessed by sea from Semarang using Indonesian National Shipping (PELNI) ships and ships from Jepara. This island was affected by water seasons, east monsoons, transitional seasons and west monsoons (Hendrayana and Samudra, 2021).
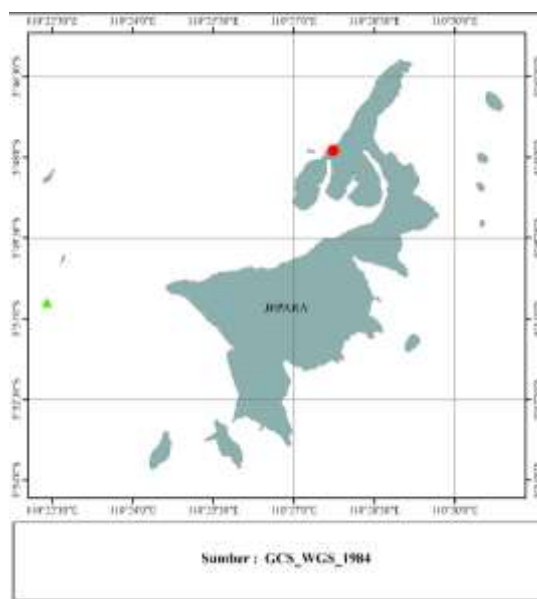

Figure 1. Fishing Locations in Karimunjawa Waters, Indonesia

2.2 Tools and Materials

The fleet used was included in the ship with a length of 11.43m, width of 2m, draft of 0.7m and 1.84 GT. Consisting of 2 main engines of inboard type each 16 pk. On the stern of the ship there are 6 lights located on the right and left of the ship, 3 each. The types of wood used on ships are blangiran wood (hatch), teak wood (boat houses) and ironwood (keel).

The fishing gear used as research material was squid rod (Loligo sp.) (Figure 1). One unit of fishing gear for squid (*Loligo* sp.) consists of: A reel using dark brown bamboo cut into a tube shape with a diameter of 10 cm and a length of 15 cm. The fishing line (line) used is PA Monofilament no. 2.0 0.23 mm in diameter with a length of 20 meters. Fishing line for bait including type PA Monofilament no. 1.2 diameter 0.18mm. The swivel used was 2 cm for each fishing unit consisting of one swivel and 1 unit to connect the main line (PA Mono No. 2.0) with a fishing line (PA Mono No. 2.0). The ballast used was building iron with a length of 10 cm, a diameter of 1.5 cm and a weight of 271 grams. Underwater LEDs used in squid fishing gear are Blue and White LED lights. This LED light would be installed on the main line of the squid fishing gear that will be treated. The power of the LED lamp is 3 v, 8 cm long.
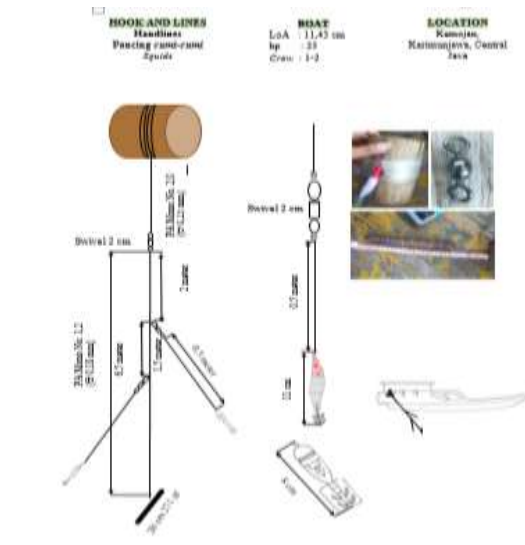
Figure 2. Design and Construction of Squid Fishing Gear

The bait used was natural bait and artificial bait. Natural bait in the form of Kurisi fish (*Nemipterus japonicus*). Artificial bait made of rubber mixture shaped like a torpedo has a weight of 8 grams and a length of 10 cm. The bait is attached to the hook when operating. The natural bait used was kurisi fish (*Nemipterus japonicus*) which was obtained by catching it using a hand line in the afternoon or asking it from other fishermen according to Sarapil et al. (2021) The fishing equipment used for kurisi fishing activities is hand line. The size of the fish used was 13 cm according to Oktaviani et al. (2016), The size at first maturity or (LM) obtained in this study was 196 mm, while the LM of kurisi fish in Blanakan and Tegal was at 90-125 mm. Natural bait was placed on both fishing lines that have been colored blue and white.

2.3 Research Methods

The research method used was experimental fishing, namely carrying out operations to catch squid (*Loligo* sp.) using treated handline fishing gear. The research was carried out simultaneously with fishing activities, carried out by conducting treatment of the research object and the existence of controls. This research differs from ordinary fishermen's fishing rods, in that this study applied squid (*Loligo* sp.) fishing, involving sight and smell of squid (*Loligo* sp.). Lights using LED types with blue and white colors are in accordance with previous research on these two colors having a significant effect on squid (*Loligo* sp.) catches. Kurisi bait (*Nemipterus japonicus*) was chosen because it has a fairly high protein content, namely 16.86%. This has fulfilled the elements to invite squid (*Loligo* sp.) to approach, where squid (*Loligo* sp.) and other fish are sensitive to the content of protein, fat and amino acids.

2.4 Application of Bait and Light Treatment

The study applied treatment with 1 type of bait and 2 types of underwater lights and 2 controls. Fishing line is operated at night from 6 PM 11 PM (GMT +7), where there were 6 repetitions with 1 trip representing 1 repetition. Then the fishing line was applied to kurisi bait (*Nemipterus japonicus*) with blue and white LED lights. The placement of the kurisifish (*Nemipterus japonicus*) bait was attached to the fishing line by adjusting the shape of the fishing line so that the kurisifish (*Nemipterus japonicus*) cannot be separated from the fishing line. In this study, the fishing line was inserted into the gill cavity to the mouth with the fish facing the fishing line or facing upwards. The size of the fish is adjusted to the size of the fishing rod which uses LEDs to anticipate the release of the bait from the fishing rod.

The mechanism for applying the treatment consists of 2 parts carried out at one time so that 1 trip contains 6 treatments. The front of the ship was applied without surface light consisting of treatment of kurisi bait (*Nemipterus japonicus*) with blue underwater LED, treatment of kurisi bait (*Nemipterus japonicus*) with white underwater LED and treatment of artificial bait control and without underwater LED. The rear of the ship is applied with 6 surface lights each 3 lights on the right and on the left side of the ship which consists of treatment of kurisi bait (*Nemipterus japonicus)* with blue underwater LED, treatment of kurisi bait (*Nemipterus japonicus*) with white underwater LED and control treatment dummy bait and without underwater LED.

2.5 Data Collection

The data collection method used in this research was:

a. Observation Method

This method was carried out to find out directly about the construction of squid fishing gear (*Loligo* sp.), fishing areas, catches in Karimunjawa waters. The observation method was carried out by making direct observations in the Kemujan area, Karimunjawa. Observations include measuring fishing vessels, measuring fishing gear, experimental fishing to fishing ground areas and measuring catches.

b. Interviw Method

Interviews were conducted directly with squid fishing fishermen (*Loligo* sp.) using a question-and-answer technique. The interviews included the main dimensions of the vessel, the price of the vessel, the price of fishing gear, the fishing gear purchase location, the economic life of the vessel and fishing gear, the location of the fishing base and fishing ground. Data collection was carried out at the respondent's house with the assistance of the respondent's children in answering interview questions.

c. Literature Study Method

This literature study method was carried out by studying theories that support research so that it is hoped that with a strong theoretical basis a good understanding will be obtained. Literature study was carried out by looking at relevant references regarding Karimunjawa Waters and everything related to the title of this research to be compared with the results of observations or direct observations. According to Tryasmara (2017), literature study is a data collection method that is directed at finding data and information through written documents, photos, images, and electronic documents that support the writing process.

d. Documentation Method

The method used were categorized as a primary and secondary data collection, primary collection was carried out by researchers by documenting several processes or conditions during research activities. Documentation was done by taking pictures during research activities. The pictures taken include pictures of fishing vessels, fishing gear, fishing base and fishing ground as well as catches. In addition to taking pictures, this method also records everything that is related and if it is included in the research data. Secondary data was obtained by taking photos related to squid fishing rods (*Loligo* sp.)

Statistical Analysis

All data were tested for normality and homogeneity assumptions. The effect of using natural baits and underwater LEDs was tested using a two-way Anova followed by Tukey's Post doc test, to determine the respective effects of natural baits and underwater LEDs and to determine the interaction between the two. The significance of the difference was defined at $p < 0.05$. Statistical analysis was performed using SPSS software.

3. Result

Based on data from the Analysis of Variance, it was found that the results of research using light bait and control treatments showed different results. The treatment is said to be significant if the significance is <0.05. The test results from the research data show that the use of natural bait with Underwater LED, surface light and the interaction of the two has a very significant effect, which has a value of 0.000. This shows that the significance is <0.05 (Table 1).

Table 1. Analysis of Variance Result

	df	F	Sig.
Naturalbait_LED	2	15.592	,000
Surfacelight	1	236.842	,000
Naturalbait_LED*Surfacelight	1	12.039	,000

R Squared = ,972 (Adjusted R Squared = ,967)

3.1 Estimation of the Effect of Natural Baits and Underwater LEDs

On average, the most catches are kurisis with white underwater LEDs with a value of 3,583. The next average order of catch data was kurisi with underwater blue LEDs with an average value of 3,250. The last order of average catch data is without bait and without underwater LED value of 2.167 (Table 2).

Table 2. Estimation of the effect of natural baits and Underwater LEDs

LED bait	Mean	Std. Error	Lower Bound	Upper Bound
Blue LED kurisi	3.250	.188	2.867	3.633
White LED kurisi	3.583	.188	3.200	3.966
Without bait and light	2.167	.188	1.784	2.550

3.2 Estimation of the Effect of Surface Light

The use of surface light has an influence on the catch. The use of lights on squid lines has a greater effect than without surface lights. This can be seen from the average value of using surface lights of 4.667 with only 1.333 without lights. This shows that the use of surface lights is better than without surface lights (Table 3).

Table 3. Estimation of the effect of Surface Light

Light	Mean	Std. Error	Lower Bound	Upper Bound
Surface light	4.667	.153	4.354	4.979
Without light	1.333	.153	1.021	1.646

3.3 Estimation Natural Bait Interaction with LEDs and Surface Lights

The use of LED bait combined with surface lighting has a significant interaction on squid fishing catches. The combination of LED bait with surface lighting with the best results was a kurisi with white underwater LED with an average value of 6.000. The next combination is a kurisi with underwater LED blue with an average value of 4,500. The lowest combination is without bait and without underwater LED value of 3.500 (Table 4).

Table 4. Estimation Natural Bait Interaction with LEDs and Surface Lights

Light	LED bait	Mean	Std. Error	Lower Bound	Upper Bound
Surface light	Blue kurisi	4.500	.265	3.958	5.042
	White kurisi	6.000	.265	5.458	6.542
	Without bait and light	3.500	.265	2.958	4.042

3.4 Estimation of Natural Bait Interactions with Underwater LEDs and without Surface Lights

The use of LED bait combined with no surface light has a significant interaction on squid fishing catches. The combination of LED bait with surface lighting with the best results is a kurisi with underwater LED in blue with an average value of 2,000. The next combination is a kurisi with a white underwater LED with an average value of 1.167. The lowest combination is no bait and no underwater LED with a value of 0.833 (Table 5).

Table 5 Estimation of Natural Bait Effect with Underwater LED and without Surface Lights

Light	LED bait	Mean	Std. Error	Lower Bound	Upper Bound
Without light	Blue kurisi	2.000	.265	1.458	2.542
	White kurisi	1.167	.265	.625	1.708
	Without bait and light	.833	.265	.292	1.375

4. Discussion

Data collection in March obtained quite a lot of catches. The catches obtained were used to analyze the effect of the treatment which can be explained in more detail in this study. According to Rivai et al. (2017), the season for good fishing for squid occurs in the western monsoon (December-February). According to Prasetyo et al. (2014), the catch of squid (*Loligo* sp.) in 2011-2012 was mostly caught in the transition season II to the west season. The distribution of squid (Loligo sp.) fishing mostly occurs in the western part of Java to the Karimata Strait. The temperature distribution of the upper sea in the west monsoon is higher (24.8-32.10C) compared to the east monsoon (24.2 -29.40C). The distribution of Chlorophyll-a in the east season was higher (0.282 -0.459 mg/L) than in the west season (0.304 -0.452 mg/L). According to Kurniawan et al. (2020), squid live in waters with a temperature of 8 to 33°C and a salinity of 8.5 to 30 ppm.

4.1 Natural Bait and Underwater LED

The results showed that there was an effect of using bait with blue and white underwater LEDs on squid fishing catches. The best results are kurisi baits with white LEDs. According to Palatangara et al. (2019), the use of lights is absolutely necessary to catch squid (Loligo sp.) with fishing gear. Because the squid (Loligo sp.) is a type of water animal that is attracted to light (positive phototaxis). The lights used in catching squid (Loligo sp.) are lights (blits). The lamp is tied to the main rope and lowered with the hook. According to Palawe et al. (2019), the color of the flashing LED light for squid fishing rods has a significant effect on squid catches. According to Mulyawan et al. (2015), white lights have a higher catching power than other colored lights, where the catch of squid is 64% compared to other lights.

Natural bait in the study has a significant effect compared to fishing without natural bait. Kurisi bait (*Nemipterus japonicus*) can attract squid (*Loligo* sp.) because of the content in the fish. Kurisi fish (*Nemipterus japonicus)* in Karimunjawa also fulfills the requirements to be bait, namely the price is cheap and easy to get. This is in accordance with the research of Reza et al. (2019), squid (*Loligo* sp.) catches during the study were influenced by fishing season or hydrochemical physical factors. The performance of natural bait is higher than artificial bait because 90% of squid (*Loligo* sp.) eat fish. According to Adjiatma et al. (2020), Trash fish are small fish caught while fishing. This fish has a small size, so trash fish is considered a fish with low economic value or cannot be marketed. Trash fish can be used as bait because it contains protein and amino acids. Riyanto et al. (2010) the main chemical components that affect the olfactory response of fish are protein, fat, and amino acids. Trash fish contains ingredients such as alanine, arginine, methionine, leucine and proline, so that trash fish can stimulate the fish's olfactory organs. According to Fajar et al. (2016), Kurisi (*Nemipterus japonicus*) is a bottom fish

whose nutritional value is as important as pelagic fish. Kurisi fish (*Nemipterus* sp.) is a by-catch of demersal fish. Kurisi fish (*Nemipterus japonicus*) has a fairly high protein content of around 16.85% and a low fat content of around 2.2%. This is in accordance with Jumiati et al. (2021), Based on the results of the proximate analysis, the protein content and fat content are; 16.85% protein and 2.2% fat.

4.2 Surface Light

The use of surface light has a significantly different effect than without using surface light. This was due to the phototactic nature of the squid causing the squid to gather on the boat due to the stimulation of the squid's vision of light. The absence of surface light drastically reduces the lured squid to the bait. According to Daris et al. (2021), The use of lights in water produces strong light penetration and minimal refraction. It's different when using surface lights, the position of the lights above the surface of the water can interfere with the penetration of light entering the waters caused by the reflection of sea water. Palawe et al.'s research. (2021), catching squid (*Loligo* sp.) with the first order of blue LED lights and the second order of white LED lights can attract the attention of squid (*Loligo* sp.), so they can catch more squid than without lights. Blue light can be considered as an excellent source of attraction because the retina of the cuttlefish (*Loligo* sp.) is very sensitive to it. According to research by Turnip et al. (2022), blue LEDs have a short wavelength and a longer light spectrum, so the intensity is higher and the blue color is preferred by many fish species.

4.3 Interaction of the LED feed with the Surface Light

Based on the research results, it was found that the use of LED baits and surface lights had a significant effect on the catch of squid fishing rods. The best catch when using surface light is white LED kurisi bait (*Nemipterus japonicus*). Meanwhile, when not using surface lights the best catch results are found in blue LED kurisi bait (*Nemipterus japonicus*). According to Jeong et al. (2013), the degree of adaptation of squid to blue light was similar between the light-adapted conditions and the dark-adapted conditions, indicating that the retina of the squid is very sensitive to blue light. The wavelength of the white LED light indicates a tendency to decrease light in dark adaptation. This shows that blue light has an advantage in attracting squid (*Loligo* sp.) in dark adaptation, whereas in light adaptation, white light is better than blue light. Blue LEDs are useful when collecting squid and white LEDs are useful when fishing for squid (*Loligo* sp.). The use of blue LEDs mixed with white LEDs has advantages in collecting and fishing. According to Gaol et al. (2019), during the east monsoon, towards the transitional season, the proportion of squid (*Loligo* sp.) caught by the Bouke-Ami tool tends to increase, and the largest production occurs in July-October. The number of fish caught is higher in the dark months than in the light months. According to Nico et al. (2014), kurisi fish includes fish with high protein and low fat, fish that are classified as low fat and high protein have a protein content of 15-20% and a fat content of less than 5%. According to Falah et al. (2014), bait needs to be considered, this concerns the type of bait that the target fish prefers to catch in addition to other requirements such as durability, price and continuous supply of bait. Bait containing fat makes for a better catch because the smell stimulates the fish.

Treatment with LED bait and surface light effect on the catch. Considering that other studies mention the effect of using natural baits and lights. According to Surachmat (2018), the bait used by researchers in hand line fishing gear in Sarang, Rembang is Juwi fish (*Clupea* sp.). Baiting is used to stimulate and attract predators, cannibals and carnivores from squid (*Loligo* sp.) which are the target of fishing. It is important to use bait on fishing rods because the nature of fishing rods is passive. The existence of the bait will be the attention of the fish, so that the fish will approach the bait and then eat it. The combination of bait and light has an influence on the catch. This is also in accordance with the research of Palatangara et al. (2019), the use of natural baits and LEDs has a significant effect on the catch of squid (*Loligo* sp.).

5. Conclusions

This research succeeded in documenting experimental fishing results related to the use of natural baits, underwater LEDs and surface lights in Karimunjawa waters, Jepara, Central Java, Indonesia. The use of natural baits for kurisifish (*Nemipterus* sp.) and blue and white LED lights simultaneously has a very significant effect on catches with a value of 0.000 <0.05. The combination of kurisi bait (*Nemipterus japonicus*) and white LED lights with surface lights is the best combination to get squid (*Loligo* sp.) catches with a value of 0.000 <0.05. Treatment with LED baits and surface lights has an effect on catches. Considering that other studies mention the effect of using natural baits and lights. According to Surachmat (2018), the bait used by researchers in hand line fishing gear in Sarang, Rembang is Juwi fish (*Clupea* sp.). Baiting is used to stimulate and attract predators, cannibals and carnivores from squid (*Loligo* sp.) which are the target of fishing. It is important to use bait on fishing rods because the nature of fishing rods is passive. The existence of the bait will be the attention of the fish, so that the fish will approach the bait and then eat it. The combination of bait and light has an influence on the catch. This is also in accordance with the research of Palatangara et al. (2019), the use of natural baits and LEDs has a significant effect on the catch of squid (*Loligo* sp.)

Acknowledgements

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