Catch Efficiency of Low-Powered Incandescent Light and LED Light Traps Fishing in Barito River of Indonesia

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ABSTRACT

This study provides scientific evidence on the catch efficiency of low-powered incandescent light and LED light traps in catching crustaceans and fish from highly turbid water in Barito River, South Kalimantan. The experimental conditions encompassed highly turbid water, slow flowing, blocked water, and rarely vegetated habitat with water depths ranging from 2 to 4 m. The traps used were collapsible box shaped trap, wire-square trap, acrylic-square trap, PVC box shaped trap, wire fish trap, bamboo fish trap and minnow nets. The light traps were deployed randomly with an interval distance of 1.5 m using 1-night soaking time. Light traps sampling accounted for 343 shrimps (1 family), 53 fishes (6 families) and 2 crabs (1 family). The shrimp species was dominated by *Macrobrachium* sp. (98.54%) while the fish species was dominated by *Glossogobius giuris* (36.54%). Collapsible trap fishing with incandescent lights was as effective at sampling as wire square trap fishing with LED lights. The minnow nets were excellent in catching shrimp and fish compared with PVC box shaped trap and wire/bamboo fish traps. Colour of light had strong effects on the number of shrimp and fish collected. For future applications in using LED light for trap fishing, a more comprehensive study on its efficiency for catching juveniles of target and non-target species is strongly recommended.

Keywords: Barito River, catch, incandescent light, LED light, *Macrobrachium* sp., trap

INTRODUCTION

In Indonesia, light fishing methods and gears developed well and vary depending on target species. Various examples include the following: "pukat cincin" (purse seine) with electric lamps and petromak lamps is used to catch pelagic fish in North Sumatera (Simbolon, 1995), "Jaring Jiop" or "Payang oras" (danish seine) with petromak lamps are used for squids in North Maluku or Nusa Tenggara Barat (Hamzah and Pramudji, 1997; Hufiadi and Genisa, 2001), "Bagan Rambo" (large lift nets) with electric mercury lamp for pelagic fish in South Sulawesi (Sulaiman *et al*., 2005), Boat bagan with electric generator for pelagic fish in West Sumatera (Baskoro *et al*., 2002), "Bagan Tancap"

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(fixed bamboo-platform lift nets) with petromak lamps for pelagic and demersal fish in South Sumatera (Septifitri *et al*., 2010), "Prayang" trap (bamboo stage trap) equipped with a kerosene lamp for black tiger shrimp (*Penaeus monodon*) in East Java (Kawamura *et al*., 1983), traps with electric coloured lamps or blinking LEDs for ornamental fish/corral fish in Lampung (Linting *et al*., 1993) or various traps with dry-cell battery incandescent and LEDs for freshwater fish and shrimp in South Kalimantan (Ahmadi, 2012).

This study looked at the population of freshwater fish in Barito River which has been reported to be declining over the last few decades, from 350 to 150 species (Hortle, 1995). Important local fishes such as Arowana (*Scleropages formosus*), giant gourami (*Osphronemus goramy*), clown knifefish (*Notopterus chitala*), mad barb (*Leptobarbus hoevenii*) and the greater bony lipped barb (*Osteocheilus melanopleura*) are considered currently extinct and/or endangered. They are extremely vulnerable to non-environmentally friendly fishing gears (e.g. electro-fishing), as well as water pollution. Therefore, the promotion of sustainable and responsible fishing activity should be encouraged.

A number of research endeavored to explore the characteristic habitats and fish species in Barito River (MacKinnon *et al*., 1996; Prasetyo *et al*., 2005; Asyari, 2006), while others studied the abundance and diversity of typical plankton (Rahman, 2008) or fishing activities in the river (Utomo *et al*., 2003; Utomo and Prasetyo, 2005; Prasetyo, 2005; Rupawan, 2006, Utomo and Asyari, 2007). However, there was no scientific information on the use of light traps. This study was conducted to obtain comprehensive information on the catch efficiency of low-powered incandescent light and LED light traps in catching crustaceans and fish from Barito River. The information obtained may be useful for commercial or breeding purposes of extinct and endangered species as well as in fisheries management.

MATERIALS AND METHODS

Study Site

Fieldworks were carried out in April and October 2008, and in March 2009 at Barito River, Banjarmasin, South Kalimantan Province (Figure 1), 03°19'012"S 114°34'098"E and 03°20'665"S 114°36'296"E determined with the GPS 60 (Garmin Co. Ltd., Taiwan). The experimental conditions encompassed highly turbid water (total suspended solids ranged from 182-567 mg L^{-1}), slow flowing, blocked water, and rarely vegetated habitat with water depths from 2-4 m. The transparency of water varied from 45 to 55 cm (Secchi-disk reading at noon). The surface water temperature was recorded daily and ranged from 27 to 29 °C throughout the trials.

Experimental Design

<u>Experiment 1:</u> Collapsible trap fishing with incandescent light. The objective of this experiment was to evaluate the effect of different light intensities of incandescent light traps on number of catches.

Four collapsible box-shaped traps were constructed with iron rod frame (80 x 60 x 28 cm), covered with polyethylene netting and had two 58 cm slit all-web entrances at the ends (Kagotoku Shiroyama

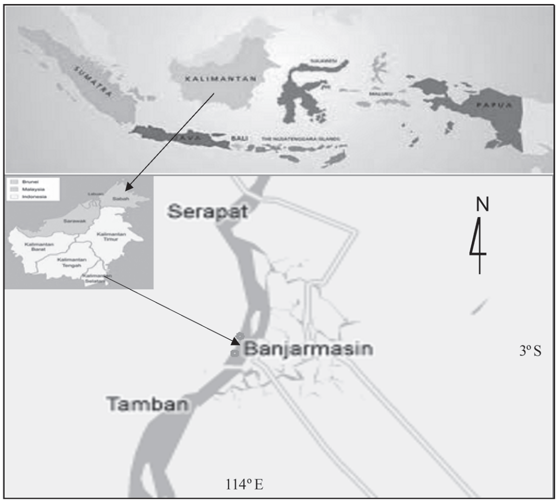

Figure 1. The location of study sites in Banjarmasin, South Kalimantan

Kenmousha, Ise, Japan). Each of the four traps had one incandescent lamp. The lamps used were (i) Japanese squid fishing tackles (Yo-zuri Co. Ltd. Japan) consisting of SIL-1 (10 x 3 cm; 0.45 W) and SIL-2 (16 x 3 cm; 0.9 W) powered by 1.5 and 3.0 V dry-cell batteries respectively, and, (ii) acrylic box-shaped lamps consisting of DIM and LIGHT, of which a 4.5 W lamp was placed inside a waterproof acrylic box (14 x 8 x 15 cm) generated by 6 V dry-cell batteries. For DIM, the walls of the box were lined with white paper. Light intensity of each lamp was 215 lx (SIL-1), 398 lx (SIL-2), 1010 lx (DIM) and 2050 lx (LIGHT) determined in air usingan illuminometer (IM-2D, Topcon, Ltd. Tokyo).

<u>Experiment 2:</u> Wire-square trap fishing with LED light. The objective of this experiment was to examine the effect of different colour LED traps on the number of catches.

Five wire-square traps were made of iron-wire frame (25 x 25 x 22 cm), covered with black 3/5 inch hexagonal mesh wire (16 gauge PVC-coated wire), and had four entry funnels located on each side with a 5 cm inside ring entrance. A trap door on top (23 x 24 cm) was used to release the animals. Each of the five traps was assigned with one colour of LEDs. Each colour (blue, green, yellow, red and extra white) was placed inside the squid lamp case (SIL-2) powered by 3 V dry-cell batteries (0.06 W). Light intensity of LEDs was set at equal quanta intensities by placing a grey fibreglass window screen (Dio Chemicals, Ltd., Tokyo) inside of the lamp.

<u>Experiment 3:</u> Acrylic-square trap fishing with LED light. The objective of this experiment was to examine the effect of different coloured LED traps on the number of juvenile catches. Five acrylic-square traps were constructed with 3-mm acrylic plates and had 8 entrance slits with 1 cm wide opening on each side. The acrylic plates were attached vertically with two sheets of PVC (24 x 24 cm) top-down and reinforced with four iron rods (25 cm long) on each corner. The trap was equipped with two floats at the surface, four wire-stairways (23 x 23 cm) attached to lower part of PVC sheet on each side and a collection wire-jar at the bottom (18 x 18 x 7 cm). A lamp was placed downright in the middle of trap. Each of the five traps was assigned with one colour of LEDs following the same procedure in Experiment 2.

<u>Experiment 4:</u> Traps fishing with white LED and incandescent light. The objective of this experiment was to examine whether size and construction of the light traps have an effect on the number of catches.

Four traps with different sizes and shapes were investigated. These traps were: (1) PVC box-shaped trap: PVC rod frame (67 x 53 x 20 cm) covered with black 150 mm hexagonal mesh wire (16 gauge PVC-coated wires); ten entry funnels are located on each side of the trap with a 5.2 cm inside ring entrance; (2) Wire fish trap: heart-shaped, 45 cm high and 40 cm wide, with 1.2 cm square mesh wire and 2.5 cm wide opening of entrance slit; (3) Bamboo fish trap: heart-shaped, 42 cm high and 30 cm wide with horizontal gap 1.5 cm and 2.5 cm wide opening of entrance slit; and (4) Minnow nets: cylindrical-shaped, 60 cm long by 30 cm wide, covered with 1.3 cm polyethylene netting and 7 cm inside the ring entrance. Each of the four traps was associated with 0.06 W white LED or 1.5 W incandescent squid fishing lamp (SIL-2; Experiment 1).

<u>Experiment 5:</u> Collapsible trap fishing with LED light. The objective of this experiment was to evaluate the effect of different coloured traps on the number of catches.

Five collapsible box-shaped traps were modified in their funnel entrances by replacing the two slit all-web entrances at the ends with two open slackness nylon monofilaments 23 mm mesh size. Additional net bag was placed at the bottom of the trap to prevent juveniles from dropping. Each of the five traps was assigned with one colour of LED Torpedo flasher (24 x 5 cm, Yuli Co. Ltd. China) or colour incandescent YL/YS-1 (22 x 5 cm, Yuli Co. Ltd. China), consisting of blue, green, yellow, red and extra white. The specifications of traps and lamps used are summarized in Table 1 and shown in Figure 2.

The light traps with constant light pattern were deployed randomly at the bottom of the riverbank and illumination began 1 h before sunset and retrieved the next morning. On each sampling date, each trap was separated from the others approximately 1.5 m to minimize any significant light contamination between traps. Such trap arrangement was considered sufficient at the existing turbidity conditions and illumination intensities. Each experimental group was repeatedly used for 6-night fishing. The trials consisted of 113-trap hauls/lamp type using 1-night soaking time, which varied from 14-16 hours. After retrieval, the catches were counted and identified for species and sex, and measured for total length and weight.

Statistical Analysis

Mann-Whitney test was used to determine which catch differed between incandescent and LED traps. Kruskal-Wallis test was used to investigate if there were significant differences in the total catches of the four or five different trapping treatments. A post-hoc analysis test was performed using the Multiple Comparison to see which catch differed significantly among the traps (Conover, 1980). All tests were evaluated at the 0.05 level of significance.

RESULTS

Light trap sampling accounted for 343 shrimps (1 family), 53 fishes (6 families), and 2 crabs (1 family) as presented in Table 2. There is a large variability in the number of catch between shrimp and fish. The shrimp consisted of 98.54% long arms shrimp (*Macrobrachium* sp.) (24-85 mm TL) and

Table 1. Materials used for traps and lamps for the trapping experiments

Exp.	Type of trap and lamp	#	Material	Size
1.	Collapsible box-shaped trap	4	Iron rod frame covered with polyethylene netting	80 x 60 x 28 cm
	SIL-1	1	Glass	10 x 3 cm
	SIL-2	1	Glass	16 x 3 cm
	DIM	1	Acrylic	14 x 8 x 15 cm
	LIGHT	1	Acrylic	14 x 8 x 15 cm
2.	Wire square trap	5	Iron-wire frame covered with black 150 mm hexagonal mesh wire	25 x 25 x 22 cm
	SIL-2	5	Glass	16 x 3 cm
3.	Acrylic square trap	5	Acrylic	24 x 24 x 23 cm
	SIL-2	5	Glass	16 x 3 cm
4.	PVC box-shaped trap	2	PVC rod frame covered with black 150 mm hexagonal mesh wire	67 x 53 x 20 cm
	Wire fish trap	2	Wire	45 x 40 cm
	Bamboo fish trap	2	Bamboo	42 x 30 cm
	Minnow nets	2	Polyethylene netting	60 x 30 cm
	White LED light (SIL-2)	4	Glass	16 x 3 cm
	Incandescent (SIL-2)	4	Glass	16 x 3 cm
5.	Modified collapsible box-shaped trap	10	Iron rod frame covered with polyethylene netting, and nylon monofilaments 23 mm mesh size	80 x 60 x 28 cm
	LED Torpedo flasher	5	Plastic	24 x 5 cm
	Colour incandescent YL/YS-1	5	Plastic	22 x 5 cm

Table 2. Catch species composition sampled from Barito River using incandescent light and LED light traps

Local name	English name	Family	Species	Catch
Shrimp:				**343**
1. Udang Galah	Giant freshwater shrimp	Palaemonidae	*Macrobrachium rosenbergii*	5
2. Udang Sapit	Longarms shrimp	Palaemonidae	*Macrobrachium* sp	338
Fish:				**53**
1. Blunguran mayang	Tank Goby	Gobiidae	*Glossogobius giuris*	19
2. Belunguran hitam	Sinuous gudgeon	Eleotridae	*Oxyeoleotris urophthalmus*	18
3. Betutu/Bakut	Marbled gudgeon	Eleotridae	*Oxyeoleotris marmorata*	6
4. Sebelah	Flatfish	Pleuronectidae	*Flounder pleuronectes*	3
5. Tilan	Spotted fire eel	Mastacembelidae	*Mastacembelus erythrotaenia*	2
6. Puyau	Bulu barb	Cyprinidae	*Puntioplites bulu*	2
7. Kelabau	Greater bony lipped barb	Cyprinidae	*Osteochilus melanopleura*	1
8. Lundu	Long whiskers catfish	Bagridae	*Mystus gulio*	1
Crab:				**2**
1. Kepiting sawah	Paddyfield's crab	Parathelphusidae	*Parathelphusa convexa*	2

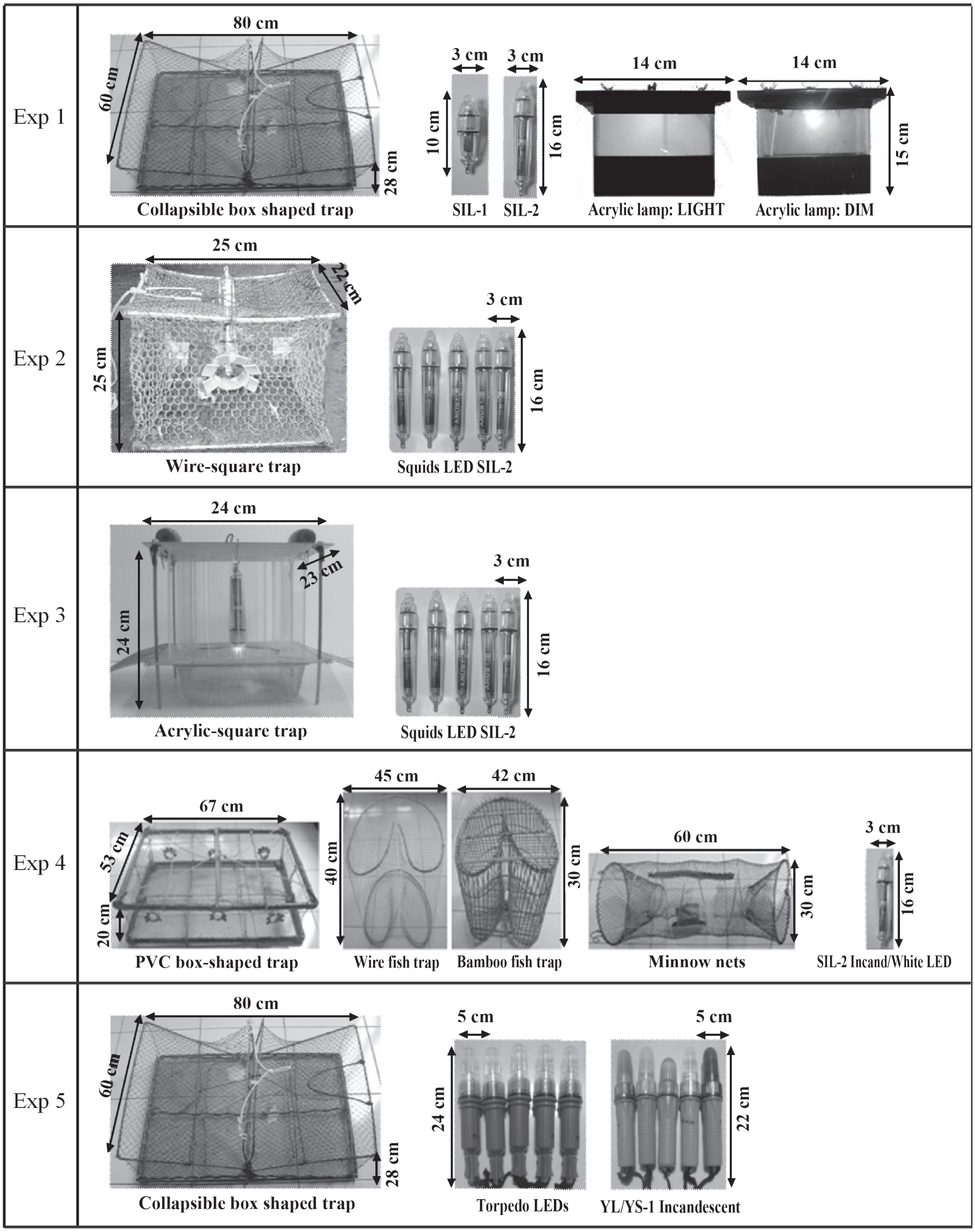

Figure 2. The traps and lamps used during the trapping experiments in Barito River

1.46% giant river prawn (*M. rosenbergii*) (71-75 mm TL) belonging to family Palaemonidae. The fish consisted of 36.54 % tank goby (*Glossogobius giuris*) from family Gobiidae, 34.62% sinuous gudgeon (*Oxyeleotris urophthalmus*) and 11.54% marble gudgeon (*Oxyeleotris marmorata*) from family Eleotridae, 5.77% flatfish (*Flounder pleuronectes*) from family Pleuronectidae, 3.85% spotted fire eel (*Mastacembelus erythrotaenia*) from family Mastacembelidae, 3.85% Bulu barb (*Puntioplites bulu*) and 1.92% greater bony lipped barb (*Osteochilus melanopleura*) from family Cyprinidae, and, 1.92% long whiskers catfish (*Mystus gulio*) from family Bagridae, with sizes ranging from 60-310 mm TL and 4-177 g weight. In addition, we also collected two paddy field's crabs (*Parathelphusa convexa*) belonging to family Parathelphusidae. The relationship between total length and weight of catch species is illustrated in Figure 3.

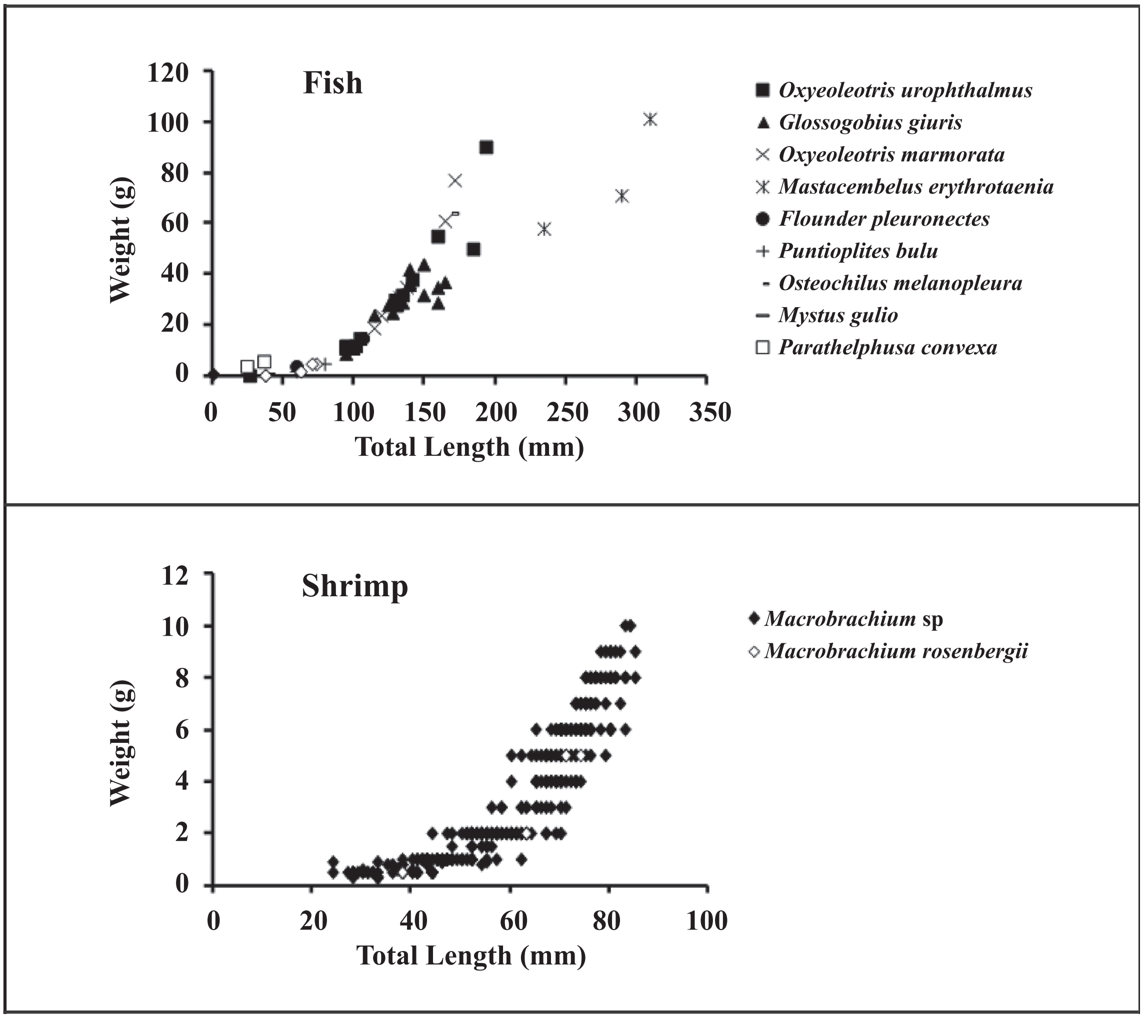

Figure 3. Relationship between total length and weight showing size frequencies of fish (top) and shrimp (bottom).

Effect of light intensity in trap fishing

The four collapsible box-shaped traps with different intensities of incandescent lights were investigated (Experiment 1). There was no significant difference in the total number of catches among the four traps (Kruskal-Wallis test, $H = 2.839$, $p>0.05$). Overall, the traps had some success in catching *Macrobrachium* sp. (total 39), but they also caught negligible numbers of *Glossogobius giuris* (5), *Mystus gulio* (1) and *Mastacembelus erythrotaenia* (1). In this trial, the LIGHT and DIM traps caught the same number of *Macrobrachium* sp. (13) (Table 3A). The average weight of catches was 10.52 ± 17.44 g (mean ± SD).

Effect of different colours of LED light in trap fishing

The five wire-square traps with different colours of LED lights were examined in Experiment 2. There was no significant difference in the total number of catches among the five traps (Kruskal-Wallis test, $H = 3.095$, $p>0.05$). The shrimp was dominated by *Macrobrachium* sp. (total 66), while the fish was represented by *Oxyeleotris urophthalmus* (10). The least number of catch was *Glossogobius giuris* (1) caught by red trap (Table 3B). The average weight of the catches was 7.84 ± 9.11 g.

The five acrylic-square traps containing the selected colours of LED lights were tested in Experiment 3. In general, the traps had no success in catching both shrimp and fish; the three *Macrobrachium* sp. juveniles caught by blue and yellow light traps occurred due to the considerable breakage on the entrance slits of the traps which allowed the animals to escape from the traps (Table 3C). The average weight of the catches was 2.27 ± 2.37 g.

Relationship between size and shape of trap with its catch efficiency

The performance of PVC box-shaped trap, wire fish trap, bamboo fish trap, and minnow nets associated with incandescent lamp (SIL-2) or white LED was examined in Experiment 4. There were no significant differences in the total catch among the four traps (Kruskal-Wallis test, $H_{LED} = 6.889$, $H_{INC} = 4.286$, $p>0.05$). Overall, the minnow nets were most effective among the traps (total 20 for incandescent light trap and 14 for LED light trap) where the catch was dominated by *Macrobrachium* sp. The other traps showed less number of catch for all trials (Table 3D). This indicates that there is a relationship between stability and catch efficiency of traps. The average weights of catches for incandescent light traps and LED light traps were 7.15 ± 8.63 g and 7.33 ± 8.02 g, respectively.

Effect of different colours of incandescent and LED lights in trap fishing

The five modified collapsible traps containing coloured incandescent lights or coloured LED lights were investigated in Experiment 5. The results showed that the colour of lights had strong effect on the number of shrimp and fish collected, with both traps catching *Macrobrachium* sp. and *Glossogobius giuris* (Table 3E) frequently. Quantitatively, LED light traps were more effective in catching *Macrobrachium* sp. (total 138) than colour incandescent light traps (total 51) (Mann-Whitney test, $T = 1.412$, $p<0.05$). The average weights of catches for incandescent light traps and LED light traps were 5.22 ± 11.64 g and

Table 3. The number of catches based on species and typical light traps used. A = collapsible box-shaped trap; B = Wire-square trap; C = Acrylic-square trap; D = traps with different sizes and shapes; E = modified collapsible box-shaped trap.

A. Exp. 1	Species	Incandescent light Trap					
		SIL-1	SIL-2	DIM	LIGHT	Total	
	Macrobrachium sp.	10	3	13	13	39	
	Glossogobius giuris	1	2	1	1	5	
	Mystus gulio	0	0	0	1	1	
	Mastacembelus erythrotaenia	0	0	0	1	1	
	Total	**11**	**5**	**14**	**16**	**46**	
B. Exp. 2	Species	LED light Trap					
		Blue	Green	Yellow	Red	White	Total
	Macrobrachium rosenbergii	0	0	2	2	0	4
	Macrobrachium sp.	10	16	15	14	10	65
	Glossogobius giuris	0	0	0	1	0	1
	Oxyeoleotris urophthalmus	1	1	0	0	8	10
	Parathelphusa convexa	0	0	1	1	0	2
	Total	**11**	**17**	**18**	**18**	**18**	**82**
C. Exp. 3	Species	LED light Trap					
		Blue	Green	Yellow	Red	White	Total
	Macrobrachium sp.	1	0	2	0	0	3
	Total	**1**	**0**	**2**	**0**	**0**	**3**
D. Exp. 4	Species	White LED light Trap					
		Box-shaped trap	Wire fish trap	Bamboo fish stage	Minnow nets	Total	
	Macrobrachium sp.	1	5	0	11	17	
	Oxyeoleotris urophthalmus	0	0	0	3	3	
	Oxyeoleotris marmorata	1	0	1	0	2	
	Total	**2**	**5**	**1**	**14**	**22**	
	Species	Incandescent light Trap					
		Box-shaped trap	Wire fish trap	Bamboo fish stage	Minnow nets	Total	
	Macrobrachium sp.	6	6	0	14	26	
	Oxyeoleotris urophthalmus	0	1	0	3	4	
	Oxyeoleotris marmorata	0	1	0	0	1	
	Flounder pleuronectes	0	0	0	2	2	
	Puntioplites bulu	0	0	0	1	1	
	Total	**6**	**8**	**0**	**20**	**34**	
E. Exp. 5	Species	LED light Trap					
		Blue	Green	Yellow	Red	White	Total
	Macrobrachium sp.	31	31	22	26	28	138
	Glossogobius giuris	2	0	4	2	1	9
	Oxyeoleotris marmorata	0	0	1	1	0	2
	Mastacembelus erythrotaenia	0	0	0	1	0	1
	Puntioplites bulu	0	0	0	1	0	1
	Total	**33**	**31**	**27**	**31**	**29**	**151**
	Species	Incandescent light Trap					
		Blue	Green	Yellow	Red	White	Total
	Macrobrachium rosenbergii	0	0	1	0	0	1
	Macrobrachium sp.	5	13	23	6	4	51
	Glossogobius giuris	1	1	1	0	1	4
	Oxyeoleotris marmorata	0	0	0	0	1	1
	Flounder pleuronectes	0	0	0	0	1	1
	Mastacembelus erythrotaenia	0	0	0	1	0	1
	Osteochilus melanopleura	1	0	1	0	0	1
	Total	**7**	**14**	**25**	**7**	**7**	**60**

5.32 ± 13.17g, respectively. Furthermore, sex ratio of *Macrobrachium* sp. was 1:2.3 (male:female). We also collected 48 egg-bearing females during the whole sampling period. From the length measurement, the male chelae was 1.5 times as long as its total length and 1.3 times as long as the females of the same body size.

DISCUSSION

According to Utomo *et al*. (2003) there were 25 fishing gear types that operated along Barito River. Among the fishing methods, trapping with baits are commonly found in South Kalimantan, but trapping with lamps is still rarely known. Some researchers from the Faculty of Fishery, Lambung Mangkurat University explored collecting fish and shrimp from shallow rivers using "Tempirai" (bamboo fish traps) or "Anco" (lift nets) with the help of electric lamps and had some success in catching fish, but caught a negligible number of shrimp (Aswadirani, 2003; Mukhlasin, 2004; unpubl. data). In its operation, the electric lamps were placed above the gears while the gear bodies were submerged partially or totally into the rivers. Ansyari (2003; unpubl. data) reported that the addition of electric lamps above the "Tempirai" resulted in a higher number of catch than without lamp. Thus, the animals had positive photo response but indirect contact with light sources. So, we performed a series of trapping with underwater lamps to provide better results, more energy efficiency and save the situation (e.g. at rain).

The optical characteristic of a lamp is one of the important components in designing a light trap, and critical to success in fishing operation. A simple form of acrylic box-shaped lamp with all directional luminous (see Experiment 1) was manually made and successfully used to capture American crayfish (*Procambarus clarkii*) from a pond in Japan (Ahmadi *et al*., 2008). Another light source, incandescent squid fishing tackle (e.g. SIL-1, 0.45 W) with diamond shape in its surface, was able to increase the distribution of the amount of lights and showed equally effective to the acrylic box-shaped lamps (DIM/LIGHT, 4.5 W). The SIL-1 or SIL-2 seemed to be more effective when operated in clear water than turbid water. Whenever they are applied in turbid water the use of higher intensities is recommended and the results are still open for discussion.

Acrylic-square light traps were only used for one day fishing due to impracticability during its operation (Experiment 3). As a result, the traps caught a negligible number of juvenile shrimp and no fish was caught. The acrylic entrance slits apart from the trap body because of loss of adhesiveness when soaked and from water pressure. Acrylic-square light trap was initially tested in indoor tanks belonging to the Faculty of Fishery, Kagoshima University Japan and had some success in catching the juvenile of *P. clarkii* during recapture experiment. A redesign of the current acrylic-square light trap may increase the function of catch efficiency in Barito River.

The results also clearly demonstrated that traps with different sizes and shapes but containing the same amount of attractant had an effect on the numbers caught as shown in Experiment 4. Comparative trapping with incandescent lamps or LED lights revealed that minnow nets were excellent in catching shrimp and fish as compared to that of PVC box-shaped trap, wire-fish trap, and bamboo fish trap. This is because the minnow nets had a cylindrical shape and are easily rolled on to the riverbed, allowing the animals to easily find the funnel entrances. Whereas for square or oval type traps, their positions could easily change due to the bottom current resulting in animals not being able to find the funnel entrance. For bamboo fish traps, a critical issue was found on the bamboo-aperture itself, which had approx. 15 mm width which made it possible for animals inside the trap to escape. Thus, to be able to catch more, the construction and size of bamboo fish trap should be modified and stabilized with weights when in operation.

A total of 398 specimens originated from 11 species belonging to 8 families were sampled from Barito River. Prior to this study, some researchers carried out surveys to inventory fish species living in this river. For example, MacKinnon *et al*. (1996) documented 47 fish species belonging to 8 families, while Prasetyo *et al*. (2005) reported that there were 104 fish species from 23 families. Most of them were collected from Sembujur River, a tributary of Barito River. The present study is a good starting point in view of commercial purposes where yellow and red LED light traps are likely effective in catching *M. rosenbergii*, whereas white LED light traps are more effective in catching *Oxyeleotris marmorata*. This provides an alternative for fishers to use light traps since baited traps or hook and lines are not considered useful. Since the catch sizes of both species were smaller than marketable size, this could mean that in order to capture more large sized species, the construction and size of light traps should be improved, performance of underwater lamps should be refined, the fishing area should be extended, and experimental designs should be developed with different methods. Other fish species like the rare *Osteochilus melanopleura* could be targeted for breeding purposes. This study tried to collect information on the catch efficiency of the tested light traps with no specific species to be targeted, so the issues on by-catch were not discussed in this study.

Macrobrachium sp. was found abundantly in this river and showed a more positive response to lights than *M. rosenbergii*. Size frequency of *Macrobrachium* sp. collected (24-85 mm) indicated that the light traps caught juveniles and adults exclusively. More females than males were collected during the whole sampling period. This includes the egg-bearing females which could be useful for biological research and fisheries management. *Macrobrachium* sp. could be considered a multichromatic species because it was photopositive for all colours tested. This species morphologically resembles the Australian river prawns (*M. australiense*) from Australia River (Dimmock *et al*. 2004). To differentiate between species, cheliped traits are considered as they show a high level of developmental variation (Short, 2000). For comparative morphology, it was clear from our findings that the male chelae of *Macrobrachium* sp. (112 mm) was two times as long as that of *M. australiense* (51 mm) as described by Short (2000), at the same body size (72 mm) (see Fig. 4). It is a great challenge to provide correct identification of *Macrobrachium* sp. wherever possible since it has not been recently reported.

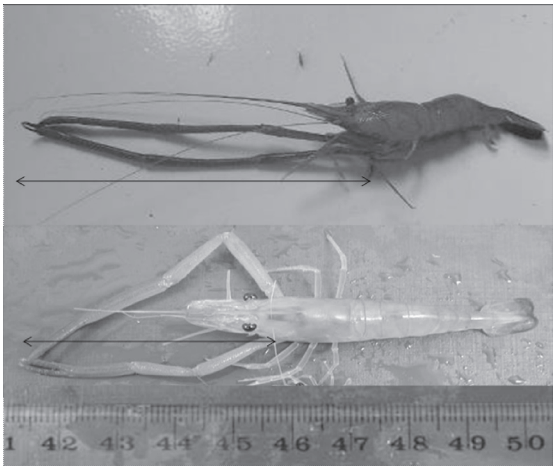

Figure 4. *Macrobracium* sp. from Barito River (top) and *M. australience* from Australia River (bottom) with the same body size. The lines with arrow show the length of the chelae.

Experimental observations and comparison of the shape of light traps showed that the form of entrance slits had an effect on the capture process and survival of the animals. In Experiments 1-4, the shrimp or fishentered the traps through the entrance slits with elastic-webbing, and are cylindrical shaped, heart-shaped or rectangular-shaped. An unexpected exception was found in Experiment 5, which showed another way for the animals to be caught. Modified entrance slits of collapsible traps from the slit all-web entrances to the open slackness nylon monofilaments at both ends resulted in several capture statuses, namely, gilled for *Glossogobius giuris*, *Oxyeleotris urophthalmus*, *Oxyeleotris marmorata* and *Mystus gulio*; entangled for *Mastacembelus erythrotaenia* and *Flounder pleuronectes*; entrapped inside the nets for *M. rosenbergii* and *Macrobrachium* sp. or a combination of wedged and entangled for *Puntioplites bulu* and *Osteochilus melanopleura*, where those animals were still alive when taken out of the river.

This study produces meaningful information on responses of aquatic species to light traps from highly turbid water with 0.06 W LED powered by 3 V dry-cell batteries. We intend to expand our future research for specific target species at different characteristic habitats, for instance to capture climbing perch (*Anabas testudineus*) and snakehead (*Channa striata*) in swampy areas; *Oxyeleotris marmorata* in lake of Riam Kanan or *M. rosenbergii* in estuary of Barito River by using the light traps with specific designs associated with various colours or light intensities. By determining target species, the issues on by-catch could be pointed out.

We could not standardize catches to the catch per unit of effort (CPUE) for all treatments because soaking period of the lights during operation was variable and dependent on the type of light devices and variance in battery life. For example, a 0.45 W lamp SIL-1 (1.5 V) in Experiment 1 would frequently turn off in the four lamps. Under such condition, the calculated CPUE for SIL-1 at approximately 10 h of immersion was 0.65 and for LIGHT (4.5 W, 6 V) at 16 h of immersion was 1.41.

CONCLUSION

This study provides scientific information on the catch efficiency of low-powered incandescent light and LED light traps in catching crustacean and fish fromhighly turbid water in Barito River.

Collapsible fish traps with incandescent lights were as effective at sampling as wire square traps with LED lights. The use of minnow nets was an excellent way of catching shrimp/fish compared to PVC box shaped trap and wire/bamboo fish traps. Colour of light had strong effects on the number of shrimp/fish collected. For future applications of using LED light for trap fishing, a more comprehensive study on its efficiency for catching juveniles of target and non-target species is strongly recommended.

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