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Experimental Fishing with LED Light Traps for Three-spot gourami (*Trichogaster trichopterus*) in Martapura, Indonesia

Siti Aminah and Ahmadi

Abstract
The Three-spot gourami and other aquatic species were sampled from Martapura waters by using LED light traps. The trials consisted of 260-trap hauls with a submersion time of 2 h per night. Light traps sampling accounted for 212 specimens assigned to 12 species of 8 families. *Trichogaster trichopterus* and *Pila scutata* were frequently found in each individual trap throughout the sampling periods. Male and female *T. trichopterus* showed negative allometric growth. Other aquatic species like *Macrobrachium sintangense* and *Enhydris enhydris* were also recorded as additional scientific evidence. The continuous LED light traps seemed to be more effective in collecting specimens than the blinking ones for the most part. The trap fishing with colour LED lights significantly differed from control trap. The yield per unit effort (YPUE) for continuous LED light traps ranged from 4.20-33.10 and from 1.40-13.55 for the blinking ones. It is recognized that low catches in the present study were attributable to technical barriers and other external factors being faced. For future applications, the use of the continuous LED light traps is recommended.

Keywords: continuous light, blinking light, light trap, *Trichogaster trichopterus*, Martapura

1. Introduction

Like many other similar water bodies in other countries [8, 10, 15, 25], Martapura water body plays an important role in meeting fish protein requirements adjacent areas- not only for Banjar district but also for South Kalimantan province. In this area, fishery activities such as fishing, aquaculture and fish processing are complementary. Some fresh fishes like snake-head (*Channa striatus*), climbing perch (*Anabas testudineus*), and Silver Rasbora (*Rasbora* spp) are locally consumed or sold to Martapura, Cempaka and Banjarbaru markets, and some are served as dried fish such as three-spot gourami (*Trichogaster trichopterus*) and snakeskin gourami (*Trichogaster pectoralis*). Several studies have been conducted to introduce the endemic fish species, habitat characteristics, and fishing activities in this area [3, 4, 6, 8]. Like other fishing areas [2, 13, 23], Martapura waters is also open throughout year regardless of seasonal periods that causes some types of fish are becoming harder to find and the sizes of catch are becoming smaller.

As one of the main target species, the three-spot gourami is usually caught by using *Lalangit* (horizontal set gillnet), *Anco* (lift-nets) or *Tempirai* (bamboo-stage trap) with or without a bait. While the use of electro-fishing, which is for targeting snake-head and climbing perk, may potentially kill them since the gear is often operated close to the spawning areas and nursery grounds. Thus, promotion of responsible fishing activity is necessary, and the trapping with underwater lamps would be a promising option. Prior to this study, there was a little information on utilizing lights as a method of fishing. The efforts have been done by university students to collect fish and shrimp from a river using *Anco* or Tempirai with the help of electric lamps and had some success in catching fish, but caught a negligible number of shrimp. During operation, the electric lamps were placed above the gears, without contacting to the water, while the gear body was entire or half sank into the river. Thus, phototactic response of fish was still unclear. For this reason, we carried out a series of field experiments using the LED light traps with continuous and blinking patterns as an alternative sampling tool for collecting species in this river.

2. Materials and Methods

The fieldworks were carried out in Sungai Sipai, Teluk Selong, Tungkaran, and Sungai Batang of Martapura, South Kalimantan Province (Fig. 1); the same fishing grounds as those used by local fishermen (from 03°23'775" S; 114°49'734" E to 03°26'164" S; 114°49'051" E). The research was started from August to October 2017, and our research coincided perfectly with the dry season. The rivers were shallow (<1 m) and rather turbid with the transparency varying from 50 to 75 cm as observed from the surface at noon using sechidisk. The aquatic plants such as *Eichornia crassipes*, *Ipomoea aquatica*, and *Hydrilla verticillata* were abundantly found in these areas. The surface water temperature ranged from 27 to 28.5 °C throughout the trials. Fishing activity was more intense during the dry season than rainy season.

Twelve light traps plus one trap without lamp as a control were tested simultaneously in different fishing sites. Each of the twelve traps was assigned with 0.9 W LED Torpedo light (215×50 mm, Fishing Net Industry Co. Ltd. China) containing blue (5 lx), yellow (36 lx), orange (129 lx), green (241 lx), red (287 lx) and white (311 lx) powered by 9 V and 3 V dry-cell batteries respectively. The intensity of each lamp was measured with a light-meter LX-100 (Lutron, Taiwan) at FMIPA-ULM's Laboratory. A total of 13 circle-shaped traps were constructed with the same dimensions and materials. The trap made of Polyamide (PA) nylon monofilament (31.75 mm mesh size), which fastened around two wire ring frames (wire dia. 2 mm) ; 1540 mm perimeter was placed on the top and bottom (490 mm diameter). The net height was 270 mm with 0.45 hanging ratio. The trap had four entry holes located on each side of the trap with about 5 cm opening mesh. A sheet of Polyethylene (PE) nylon multifilament was placed on the top allowed for removal of the catches side, and another was placed on the bottom where the lamp was attached (see Fig.2). The objective of this experiment was to evaluate the effect of different colours and light pattern of LED light traps on the number of catches.

The light traps were randomly deployed along the river near vegetated habitats with slow or no current. Illumination began 1 h after sunset, and light traps were retrieved about 2 h afterward. On each sampling date, each trap was separated from the others by approximately 3 m, which was considered sufficient to the river circumstances to avoid light contamination between traps. Each trap was used repeatedly over twenty night operations, and a total of 260-trap hauls was recorded accordingly. After retrieval, the catches were counted, identified for species, and measured for total length and weight. To avoid misplace of the catches, the marked plastic bags were prepared during sampling periods.

The Kruskal-Wallis test, the analysis of variance by ranks, was employed to determine if there were significant differences in the total catches of each group. A post-hoc analysis test was performed using the Multiple Comparison to see which catch differed significantly among the traps. The Mann-Whitney test was used to determine whether or not significant difference occurred between the catches of two different light patterns (continuous and blinking) or that of the tested light trap with the control. All statistical tests were evaluated at the 95% confidence level using SPSS 16.0 software.

The length-weight relationship of *T. trichopterus* calculated using the equation $W = {}_aL^b$, where W is weight in g and L the total length in mm, *a* is the intercept and *b* is the slope. Isometric if $b = 3$, positive allometric if $b > 3$, and negative allometric if $b < 3$. [5]. The coefficient of determination (R^2) was used to determine the degree of linear-correlation of two variables ('goodness of fit') in regression analysis. The condition factor of *T. trichopterus* was calculated using Fulton's formula: $K = 100W/L^3$ [10], where: L = total length (cm) and W = weight (g). The condition factors are used to compare the fatness or well-being of a fish, based on the hypothesis that heavier fish of a given length are in better condition. The *YPUE* (yield per unit effort) was calculated using the following equation: [11]

$$YPUE = \frac{\sum weight}{\sum number\ of\ nets * \sum fishing\ trials}$$

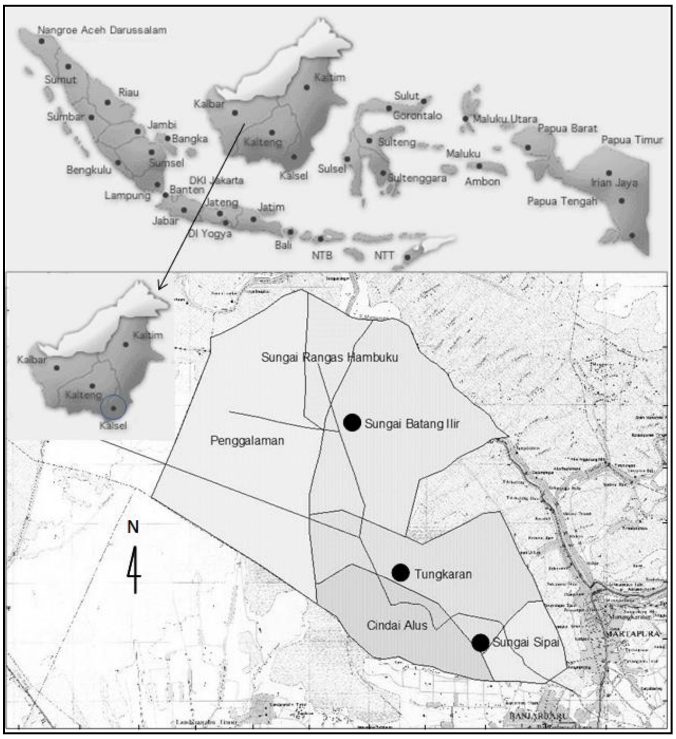

Fig 1: Map showing the study sites for trapping experiments in Martapura, South Kalimantan

Fig 2: The traps and lamps used during the trapping experiments in Martapura

3. Results

A total of 212 specimens assigned to 12 species of 8 families were collected throughout the study periods as shown in Table 1. There was a large variability in number of catch between mollusc and other aquatic species collected. The mollusc was dominated by *Pila scutata* (Moussan, 1848) 61.2%, while the shrimp was represented by *Macrobrachium sintangense* (De Man, 1898) with size ranged of 40-55 mm total length and 0.8-1 g weight. The fish catch composed of *Trichogaster trichopterus* (Pallas, 1770) 17.0%, *Oreochromis niloticus* (Linnaeus, 1758) 8.3%, *Anabas testudineus* (Bloch, 1792) 3.3%, *Puntioplites bulu* (Bleeker, 1851) 2.8%, *Mystus nigriceps* (Valenciennes, 1840) 1.4%, *Trichogaster pectoralis* (Regan, 1910) 1.4%, *Rasbora* spp (Bleeker, 1849) 0.5%, *Hypostomus Plecostomus* (Linnaeus, 1758) 0.5%, *Osphronemus goramy* (Lacepède, 1801) 0.5%, with sizes ranged from 30-153 mm TL and from 1-35 g weight. In addition, three rainbow swamp snakes *Enhydris enhydris* (Schneider, 1799) were also recorded, with the sizes ranged from 490-775 mm TL and from 127-201 g weight.

The most important family in regard to number of catches was Ampullariidae, which most of *Pila scutata* caught by the blue (n=14), green (32) and red (36) light traps. *T. trichopterus* (36) were found in all traps except the blinking green, orange and red lights. *Oreochromis niloticus* (17) also responded to all traps except the continuous red and white lights. *Anabas testudineus* were more responsive to yellow, white and red lights. Other important species like *Rasbora* spp (1) and *Osphronemus gourami* (1) only reacted to the white and orange light traps. While *Macrobrachium sintangese* (7) were more attracted to the green and white blinking lights. Lastly *Enhydris enhydris* were interested in the continuous blue light trap (3) and blinking red (1).

When the six continuous LED light traps plus a control were investigated, Kruskal-Wallis test showed that there were no significant differences in both the number of catches and weight among the seven traps tested (χ^2=2.464 and χ^2=3.694, df=6, P>0.05); and the similar results were observed in the blinking ones plus a control (χ^2=1.160 and χ^2=7.527, df=6, P>0.05). Table 2 shows that the continuous LED light traps collected about three time more specimens (153) compared to the blinking ones (52) during the whole sampling periods (P<0.05). No significant difference was observed in the weight of catches between continuous and blinking light traps (P>0.05). The YPUE for continuous LED light traps ranged from 4.20-33.10, and for the blinking ones ranged from 1.40-13.55 (Table 3). Further analysis also pointed out that there were no statistically significant differences in both the total length and weight between males and females across the traps (t=0.272 and t=0.160, df=34, P>0.05).

The analysis of length-weight relationship of *T. trichopterus* confirmed that both males (n=26) and females (n=10) showed negative allometric growth, with the *b* values were 1.6086 and 2.4036 respectively, as shown in the following parabolic equations: $W = 0.006*TL^{1.6086}$ (R^2 = 0.9366) and $W = 0.0002*TL^{2.436}$ (R^2 = 0.7027) (Fig. 3). The condition factor (*K* value) of males was 1.88 (0.93-5.56) and 1.79 (1.13-3.13) for females, indicating fish are in good condition. The *K* values of nine fish species sampled in this study ranged of 1.40-3.71 (Table 4).

Table 1: The catches composition sampled from Martapura waters using various lighted traps over 20-night sampling periods

Local Name	English Name	Scientific Name	Family	Total catch	Total length (mm)	Weight (g)
Sepat Rawa	Three spot gourami	*Trichogaster trichopterus*	Osphronemidae	36	30-111	1-16
Sepat siam	Snakeskin gourami	*Trichogaster pectoralis*	Osphronemidae	3	105-110	17-21
Puyau	Bulu barb	*Puntioplites bulu*	Cyprinidae	6	102-153	18-24
Lundu	Twospot catfish	*Mystus nigriceps*	Bagridae	3	45-120	7-17
Seluang	Silver Rasbora	*Rasbora* spp	Cyprinidae	1	45	1
Sapu-sapu	Plecostomus	*Hypostomus plecostomus*	Loricariidae	1	96	8
Papuyu	Climbing perk	*Anabas testudineus*	Anabantidae	7	57-100	9-17
Nila	Nile Tilapia	*Oreochromis niloticus*	Cyprinidae	17	48-127	2-35
Gurame	Giant gourami	*Osphronemus goramy*	Osphronemidae	1	52	6
Udang ragang	Swamp shrimp	*Macrobrachium sintangese*	Palaemonidae	7	40-55	0.8-1
Siput gondang	Gondang snail	*Pila scutata*	Ampullariidae	126	11-45	1-22
Ular rawa	Rainbow swamp snake	*Enhydris enhydris*	Homalopsidae	4	490-775	127-201
Total				212		

Table 2: Number of catches by species and typical light traps used in the experiments

Catch Species	Continuous LED light traps						Blinking LED light traps						Control trap	Total catch
	B	G	Y	O	R	W	B	G	Y	O	R	W		
Trichogaster trichopterus	1	2	9	1	1	13	1		1			7		36
Trichogaster pectoralis	1		2											3
Puntioplites bulu	1				2		1	1		1				6
Mystus nigriceps						2						1		3
Rasbora spp						1								1
H. plecostomus			1											1
Anabas testudineus			1			2	1		1		2			7
Oreochromis niloticus	1	2	2	2			2	2	2	1	1	1	1	17
Osphronemus goramy										1				1
Macrobrachium sintangese								1				4	2	7
Pila scutata	14	32	4	8	36	9	6	5		7		1	4	126
Enhydris enhydris	3										1			4
Total	21	36	19	11	39	27	11	9	4	10	4	14	7	212

B=blue, G=green, Y=yellow, O=orange, R=red, and W=white

Table 3. The weight of catches by species and typical light traps used in the experiments

Catch Species	Continuous LED light traps						Blinking LED light traps						Control trap	Total weight
	B	G	Y	O	R	W	B	G	Y	O	R	W		
Trichogaster trichopterus	7	16	38	2	3	95	9		3			65		238
Trichogaster pectoralis	19		38											57
Puntioplites bulu	18				43		24	33		33				151
Mystus nigriceps						24						17		41
Rasbora spp						1								1
H. plecostomus			8											8
Anabas testudineus			8			19	6		16		35			84
Oreochromis niloticus	17	13	10	18			13	27	18	2	35	2	2	157
Osphronemus goramy										6				6
Macrobrachium sintangese								1				4	2	7
Pila scutata	186	193	16	64	124	133	31	15		47		7	24	840
Enhydris enhydris	415										201			616
Total	662	222	118	84	170	272	83	76	37	88	271	95	28	2206
YPUE (g)	33.10	11.10	5.90	4.20	8.50	13.60	4.15	3.80	1.85	4.40	13.55	4.75	1.40	110.30

B=blue, G=green, Y=yellow, O=orange, R=red, and W=white

Table 4. The statistical description obtained for nine fish species sampled in Martapura using continuous and blinking LED light traps where K value is the condition factor.

Continuous light trap	Total catch	Total Length (mm)		Weight (g)			*K*
		min - max	Mean±SD	min - max	Mean±SD	Total	Mean±SD
Blue	4	75 - 110	95±15.0	7 - 19	15 ± 5.6	61	1.69±0.2
Green	4	57 - 92	70±15.3	4 - 12	7 ± 3.4	29	2.24±1.1
Yellow	15	40 - 110	72±22.3	1 - 21	7 ± 5.7	105	1.40±0.2
Orange	3	50 - 73	61±11.5	2 - 16	7 ± 8.1	20	2.21±1.7
Red	3	50 - 153	107±52.4	3 - 24	15 ± 11.0	46	1.41±0.9
White	18	30 - 120	70±27.5	1 - 17	8 ± 5.2	139	2.60±2.1
Blinking light trap							
Blue	5	51 - 116	80±23.3	2-24	10 ± 8.3	52	1.68±0.3
Green	3	85 - 145	107±32.8	12-33	20 ± 11.4	60	1.65±0.5
Yellow	4	52 - 78	63±11.0	3-16	9 ± 5.6	37	3.71±1.7
Orange	3	52 - 145	86±51.5	2-33	14 ± 16.9	41	2.09±1.9
Red	3	99 - 127	109±15.9	17-35	23 ± 10.1	70	1.75±0.1
White	9	30 - 115	79±31.0	2-17	9 ± 6.2	84	2.26±2.0
Control	1	48	48±0.0	2	2 ± 0.0	2	1.81±0.0

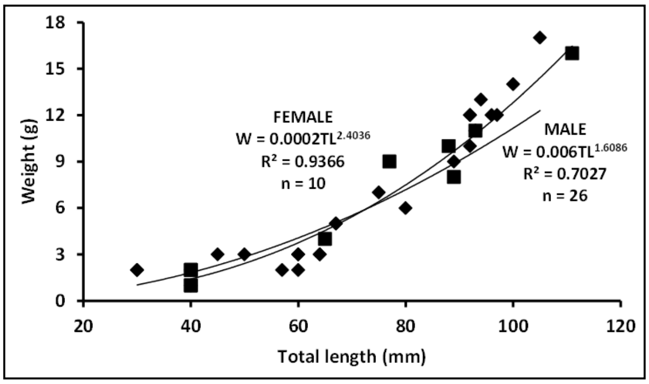

Fig 3: The length-weight relationships of males and females *Trichogaster trichopterus* sampled from Martapura waters. Both males (n=26) and females (n=10) demonstrated negative allometric growth, with the *b* values 1.6086 and 2.4036 respectively. ◆ male and ■ female

4. Discussion

Like many other similar fishing activities in South Kalimantan, various types of fishing gears are being used either for commercial or research purposes [6, 21, 24, 28]. Unfortunately, none of these studies provided any information on the use of light traps for sampling aquatic species in the rivers or swampy areas. Based on our previous studies [2, 3], the trap fishing with underwater lamps had some success for collecting fish, shrimp and other aquatic species from those areas. In the present study, we enlarged our fieldworks and improved the experimental design. The fishing sites covered shallow rivers and swampy areas including irrigation canal. The fact that the use of both continuous and blinking LED light traps provided more of option for the sampling method of fishing.

It is a great challenge to apply light traps in the same fishing grounds as those used by local fishermen who are using different type of gears. Selective placement of gears is one of the important factors to success in fishing operation; at least, it will minimize a conflict with other people around since the lights may disturb their routine works. Low catches in the present study was attributable to some technical barriers and other external factors beyond means i.e.: (a) The intensity of fishing activities in the rivers and swamps was so high in cases where local fishermen and outsiders go fishing everyday (from morning to evening) using cast net, lift-net, fish trap, stage trap, hand-line, by hands, and even by the electricity. As a result of these activities, fish become stress and the catches become less. (b) Most of fishing spots during research were the areas that have been frequently visited by fishermen, while seeking the new location by walking is quite far and desolate. Moreover, an extra work is needed to open the vegetated habitats such as *Eichornia crassipes* and *Hydrilla verticillata* that abundantly found in that new location. (c) A submersion time of 2 h per night for application of light traps is considered unlucky enough to entice fish into the light traps. This time limit is more hammered at sense of security since the location is a remote place. Conversely it is unsafe to leave the gears in a remote place without an immediate control. (d) Fishing activities were coincided perfectly with the moon night which had an effect on the number of catches as many literatures also confirmed such condition [16, 18, 19, 22].

2 In practical, catching *T. trichopterus* with lift net, cast net or scoop net in the densely vegetated habitat is not considered useful, but light traps did. In Martapura, the fish production in particular *T. trichopterus* depends on natural harvest without any measures of fish farming. Thus, light traps could be a possible solution in harvesting *T. trichopterus* for breeding purposes. In the present study, males were more responsive to the lights than females at the most, and males were 2.7 times heavier than females. The body shape of males and female *T. trichopterus* displays a negative allometric growth pattern. The similar observation was also documented for *T. fasciata* (Bloch and Schneider, 1801) (b = 2.58) in Nitai Beel, India [14]. The weight of fish increased when they utilize the food items that are available for growth and energy [15]. We could not sample more other important species during this study. It is very likely the fish beyond our sampling radius since the light traps deployed near riverbank at the most. From family Ampullariidae, *Pila scutata* were excessively found in the light traps, which the local people usually collect them from shallow water by hand either for bait or duck food because of having high protein. It meant that light trap provided another option of harvesting method.

The K values of 1.40-3.71 for nine fish species (see Table 4) 5 are also commonly found in some fish species from other habitats. These values showed that most of the species in this river were in good condition. Variation in the value of the mean K may be attributed to biological interaction involving intraspecific competition for food and space [7] between 5 species. On the other hand, the factors affecting the variation values of K may include sex, stages of maturity, state of stomach contents and availability of food [1, 10, 12].

For internal evaluation, the use of continuous LED light traps seemed to be more effective compared to the blinking ones, in which case fish are to be comfortable with light stimulations. In another case, the use of blinking LED light trap was more effective than that of incandescent light trap for sampling fish in the swampy area [3]. Trap with nylon multifilament resulted in fish often caught by the gilled and may potentially kill them if the trap left for a longer time. Thus, the selection of netting materials other than nylon multifilament including theirs entranceways is also necessary to allow fish still life inside the trap. In terms of cost, the present light trap is cheaper (~US$ 10 per unit) than other light traps, which are using relatively expensive materials either for the lighting system or the main body (mostly Plexiglass), for example Stobutzski trap US$ 300 [26], Bucket trap US$ 120 [27] and Bottle trap US$ 70 [20]. For future research, the use of different light intensities of single LED is recommended and the result is open for discussion.

5. Conclusion

Trap fishing with the continuous LED light traps was more effective in collecting specimens than the blinking ones. The YPUE of continuous LED light traps was higher than that of the blinking ones for the most part. All colours tested in this study were differed significantly from control. Males and females *T. trichopterus* showed negative allometric growth, which meant that the length increases more than weight. Low catches in the present study was attributable to technical obstacles and other external factors that have yet to be completely resolved to support of future research.

6. Acknowledgments

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