Some aspects of the reproductive biology of *Labiobarbus ocellatus* in Tulang Bawang River, Lampung, Indonesia

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Abstract. This study was conducted in April 2013 to March 2014 at Tulang Bawang River and Bawang Latak Swamp, Lampung, Indonesia. The aims of this study were to asses some reproductive aspects of *L. ocellatus*. The specimens were consisted of 690 males and 651 females. The results showed that sex ratio of *L. ocellatus* was 1:1 during the spawning period in October-January. This species was total spawner and they spawned annually in rainy season. The peak of breeding season was occured in November to December. The total length at first maturity of *L. ocellatus* are 157±1 mm (male) and 160 ±1 mm (female). The fecundity varied between 2.142-24.294 and had corellation with total length in equation as log F = 3,653 log L - 4,546 (Tulang Bawang River) and log F = 3,982 log L - 5,287 (Bawang Latak Swamp).
Key Words: *L. ocellatus*, reproduction, GSI, fecundity, spawning period.

Introduction. *Labiobarbus ocellatus* (Heckel, 1843) is a benthopelagic tropical freshwaters fish belonging to Cyprinidae family (Kottelat et al 1993; Roberts 1993; Froese & Pauly 2014), native to Peninsular Malaysia and the Greater Sunda Islands of Sumatra and Borneo (Weber & de Beaufort 1916; Kottelat et al 1993), also known as Bornean eye-spot silver shark in ornamental fish trading. This species is a pelagic fish primarily occurring in rivers but also some lakes, and is known to move into seasonally inundated floodplains or forested areas during the wet season (Kottelat et al 1993).

There is lack of data and information about *L. ocellatus* (Froese & Pauly 2014). Since described by Haeckel in 1843, some biology aspects of this species has not been studied yet. Some studies that have been done are morphology (Weber & de Beaufort 1916; Roberts 1989, 1993; Kottelat et al 1993), distribution area (Weber & de Beaufort 1916), and food habits (Hartoto et al 1999; Torang & Buchar 2000; Kottelat & Widjanarti 2005). The reproductive aspects of *L. ocellatus* have not been evaluated.

The importance of understanding the reproductive biology of fish has been recognized as key to the development of realistic population models since the earliest studies of fish population dynamics (He et al 2015), to explain the variations in populations level as well as to make efforts to increase fish production (Azadi & Mamun 2004), fishery management (Claramunt et al 2014), biodiversity conservation (Suzuki et al 2004) and also for commercial farming (Freitas et al 2013). The fecundity is an important parameter for aquaculture as well as for management of fish populations. It estimates the reproductive potential of a species allowing for comparisons between populations and making predictions about species (Bagenal 1978). The size of the first maturity of male fish is a criteria that used to control fishing activities aimed to protect juvenile to reach sexual adult level (Suzuki et al 2004). Understanding the size at first sexual maturation is fundamental for achieving good stock management by correctly identifying the minimum size for capture and the mesh size of fishing nets (Hilborn & Walter 1992). Similarly, the determination of the spawning period (beginning, peak, and end) and its duration are critical factors in the fishery management (Claramunt et al 2014). This study aimed to analyze some reproduction aspects of *L. ocellatus*, such as sex ratio, maturity level of gonads, fecundity, egg diameter, type of spawning, the spawning season, and the size of the first maturity.

Material and Method

Study area. The Tulang Bawang River is a floodplain river located in Tulang Bawang, northeastern district of Lampung Province, Sumatera, Indonesia. The floodplain area in Tulang Bawang River is over 86,000 hectares and believed to be an important spawning and feeding ground of many riverine fish species (Noor et al 1994). The study was performed along a segment of the middle Tulang Bawang River and Bawang Latak Swamp (Figure 1). Four observation stations were sited longitudinal from upstream to downstream of Tulang Bawang River, i.e. Pagar Dewa (St. 1: 105^o 10' 04.46" E; 4^o 27' 15.88" S), Rawa Bungur (St. 2: 105^o 12' 17.44" E; 4^o 27' 40.32" S), Ujung Gunung (St. 3: 105^o 14' 24.84" E; 4^o 27' 49.57" S), and Cakat Nyinyik (St. 4: 105^o 16' 01.9" E; 4^o 26' 24.34"S), as well as an observation station in Bawang Latak Swamp (St. 5: 105^o 17' 11.12" E; 4^o 30' 15.66" S), a floodplain area located at the Miring River that interflown to the Tulang Bawang River.

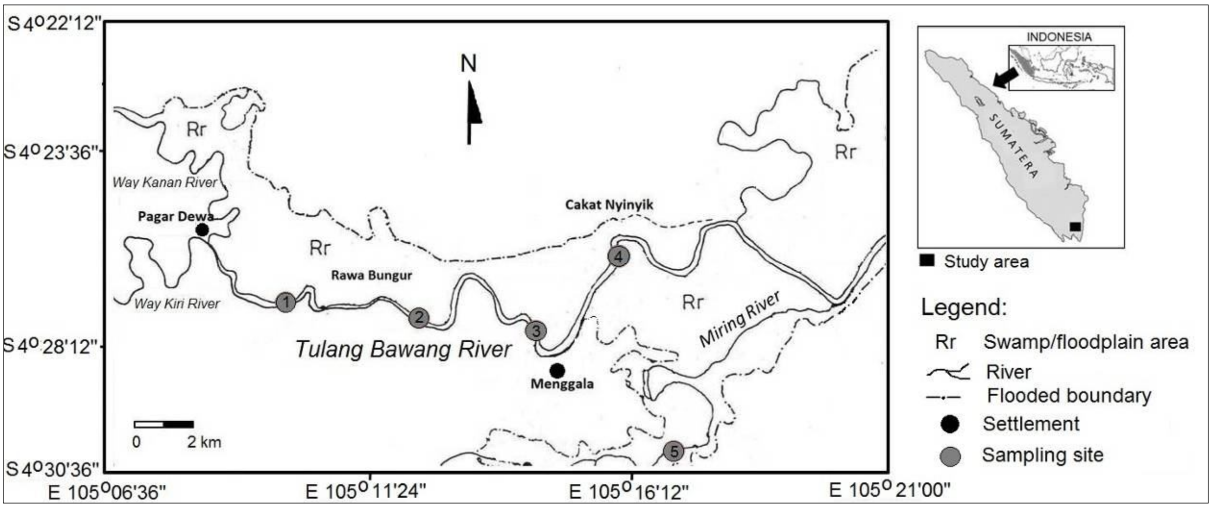

Figure 1. Map of study area.

Sampling methods. The speciemens of *L. ocellatus* were collected by using gillnets with varying mesh size of 1”,1½”, 1¾”, and 2” every month during April 2013 to March 2014. Specimens were preserved in 10% buffered formalin, then stored in cool box for identification to the species level and further analysis in the laboratory. Total specimens were 1314 consisted of 690 males and 651 females. The sex was determined by direct observation on genital pore; male fish have a long bulge on its genital whereas the females only have small holes with no noticeable bulge.

Six physical-chemical variables were measured *in situ*, i.e pH, dissolved oxygen, and temperature (Horiba Model U-10); water transparency (Secchi disk), depth (Hondex Model PS-7), and current velocity (Flowatch Model FL-03). Water samples were also collected for determination of NH_4^+, P-PO_4, TSS, and total organic compounds in the laboratory according Rice et al (2012). All of the water variables were recorded every month at each sampling sites. The monthy rainfall data for the study period were obtained from the Board of Agriculture, Food Crop, and Horticulture (BPTPH), Lampung Province.

Reproductive studies. In laboratory, all individuals sampled were weighed (BW) with an electric balance to the nearest 0.01 g and total length (TL) of each fish was measured with slide calipers to the nearest 0.1 cm. TL, body mass (BM) and gonad mass (GM) were recorded to calculate the gonadosomatic index (GSI = 100 GM/BM). Furthermore GSI informed about spawning period. Sex ratio was determined by comparing the number of male to female fish during spawing period (October-January). A chi-square (χ^2) test was used to detect differences in sex ratios of sampled fish monthly from an expected 1:1 ratio. An α level of 0.05 was used to determine significance. The development of gonad maturity was observed morphologically according to Effendie (1979) as shown in Table 1.

Table 1

Determination of gonad maturity stage

Stage	*Female*	*Male*
I. Immature/ resting	Ovary shaped like a thread up to the body cavity. Gonad looks clear with slippery surface	Testes shaped like a thread, shorter and ends in body cavity. Gonad looks clear
II. Developing	Ovary appear larger. The color turns yellowish dark. Eggs still not visible to naked eyes	Testes appear larger. Color changes to milky white. The shape is clearer than stage I
III. Maturation	Ovary turns yellow. Morphologically, eegs are visible to naked eyes.	Testes surface is serrated. The color whiten, testes appear larger. When preserved is prone to breaking
IV. Ovulation/ spawning	Ovary appears larger, the eggs are yellow and easily separated. Oil drops are not visible, filling ½-$^2/_3$ of the body cavity, intestine pushed away	Similar to stage III, appears clearer. Testes solidify
V. Spent	Ovary crumpled, wall thickens, remaining egg drops are present near the genital pore. Numerous eggs like stage II	The backside of testes flattens and the side near the genital pore are still filled

Source: Effendie (1979).

To estimate fecundity, samples of gonad were obtained from each female and weighed; the oocytes were counted manually under a stereomicroscope. The absolute fecundity (F = N × WO) was determined considering the number of oocytes (N) per gram of gonad samples (g) and the total weight of stripped oocytes (WO). Relationships between fecundity and TL was calculated using a least squares regression of following logarithmic transformation equation $F = aL^b$; where F represents the number of eggs (absolute fecundity), ‘a’ represents a constant, ‘b’ represents the regression co-efficient, while ‘L’ represents the total length (TL) in mm.

The spawning type was characterized by analyzing of oocytes diameters frequency distribution of matured gonads (stage IV). This was achieved by measuring diameters of 50 oocytes from anterior, middle, and posterior part in a subsample for each ovary. All present oocytes were measured under a stereomicroscope using a micrometric ruler. Determination of oocytes’ diameter grouping based on their normal distribution was conducted using Bhattacharya method, which could separate the length frequency distribution into some normal distribution (Sparre & Venema 1989). Based on the rhythm that oocytes are ovulated, Tyler & Sumpter (1996) described two types of spawning patterns, synchronous ovulator (total spawners) and asynchronous ovulators (batch spawners). Total spawners refer to species which theirs eggs are released in a single episode in each breeding season; whereas in batch spawners, eggs are released in batches over a period that can last days or event months (Murua & Saborido-Rey 2003).

The spawning period were estimated from the GSI by direct observation of the gonads and monthly variations in egg diameters of samples (Lagler 1966). The spawning periodicity was established by noting that month of the year when GSI was at its peak (Zhang et al 2009; Olele 2010).

The mean size at first maturity was calculated based on Spearman-Karber method using the cumulative percentage frequency curve of mature fish in the sample; the size at first maturity is the size corresponding to 50% maturity (Udupa 1986). The log size at first maturity (m) is given by

$$m = Xk + \frac{X}{2} - (X \sum Pi)$$

where:
Xk = last log size at which 100% of fish are fully mature;
X = log size increment average difference of median logarithmic;
Pi = proportion of fully mature fish in the 1st size group.

Results and Discussion. Most of the freshwater fish that live in the tropical floodplain river tend to spawn during the rainy season with regard to the availability of abundant food and increase the depth and breadth of aquatic habitats (Rainboth 1996; Effendie 2002; Song 2007; Nurdawati & Prasetyo 2007; Bakhris et al 2007; Welcomme 2008; Ernawati et al 2009a). In tropical waters, the rain that occurred at the beginning of the rainy season can trigger spawning migration and breeding and it is closely related to the rise in water level (Lowe-McConnell 1987; Baran 2006). The rising water season has environmental conditions that are more favourable to the survival of offspring, such as an increase in food availability with the arrival of allochthonous material in the aquatic environment, more space to escape from predators, and in some circumstances, greater availability of oxygen dissolved in the waters (Lowe-McConnell 1987).

The monthly changes of various maturity stages of the gonad in the frequency occurrence on male and female have a similar patterns (Figure 2). The development of the female gonad were determined as follows: developing/maturation (August-September), spawning (October-December), and spent (December-January). In males, developing stage started in July and continued till the end of the September reached maturation stage. The spawning stage was observed from October to December coincided with the rainy season. And, the spent stage was determined between December and January. On the whole, more fish spawn in the swamp waters than in the main river. The composition of male and female at stage IV and V were found in Bawang Latak Swamp reached 42.05% (male) and 48.31% (female); whereas in Tulang Bawang River varied between 10% to less than 20% (Figure 3). The monthly change of GSI trend was given as Figure 4. Both males and females reached mean GSI at maximum levels in November and then decreased. Fish that lived in swampt waters has a higher GSI than in the main river.

The reproduction of *L. ocellatus* took place during the rainy season which lasts from October to January characterized by the presence of male and female had reached stage IV and V of gonad maturation. This condition coincided with the beginning of the rainy season and leveling up of water surface. The peak spawning of *L. ocellatus* occured in November and December which GSI had highest value than the other months. Based on the GSI distribution which has a peak, that fish spawn only once a year.

In November, male and female of *L. ocellatus* in stage IV of gonad maturity had reached 90% in Bawang Latak Swamp, whereas in Tulang Bawang River has only reached 30% (male) and 10% (female). This indicated that spawning activity in Bawang Latak Swamp had been going ahead than Tulang Bawang River. *L. ocellatus* in Tulang Bawang River was estimated not spawn in the main river, but around floodplain surrounded the river. Most of sampled fish that caught by gillnet in the main river facing toward swamp or stagnant water located in the riverbank indicated that fish tend to spawn in the swamp water.

More *L. ocellatus* spawned in Bawang Latak Swamp than Tulang Bawang River. Sampled fish caught during the spawning period between October to January largely derived from Bawang Latak. The conditions of Bawang Latak water are relatively calm and varying depths as the floods can create diverse habitats for aquatic organisms. Puddles widespread, shallow, fast-flowing quiet, and the existence of various types of aquatic vegetations in Bawang Latak are a suitable habitat for the young fish to refuge and foraging.

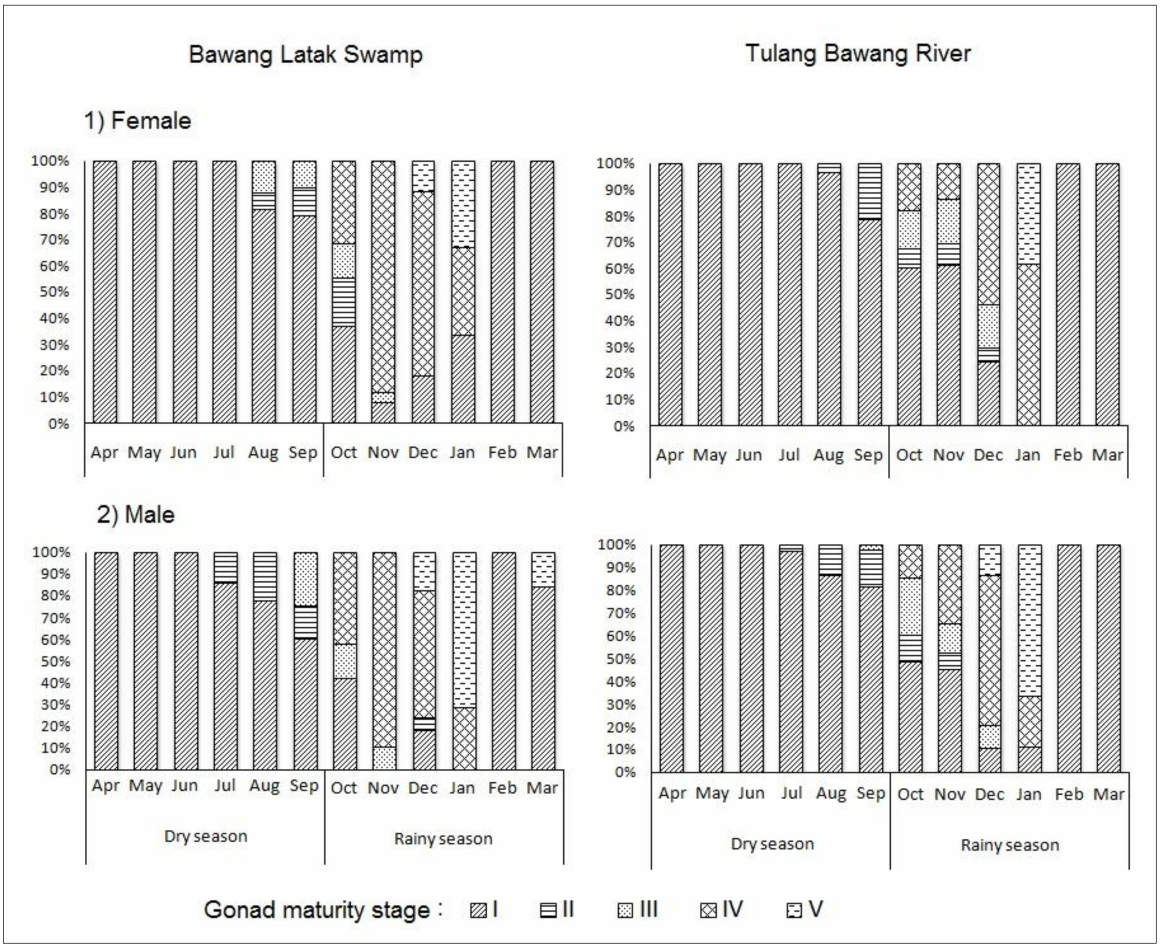

Figure 2. Monthly changes in the frequency occurrence of various maturity stages of the gonad of *L. ocellatus*.

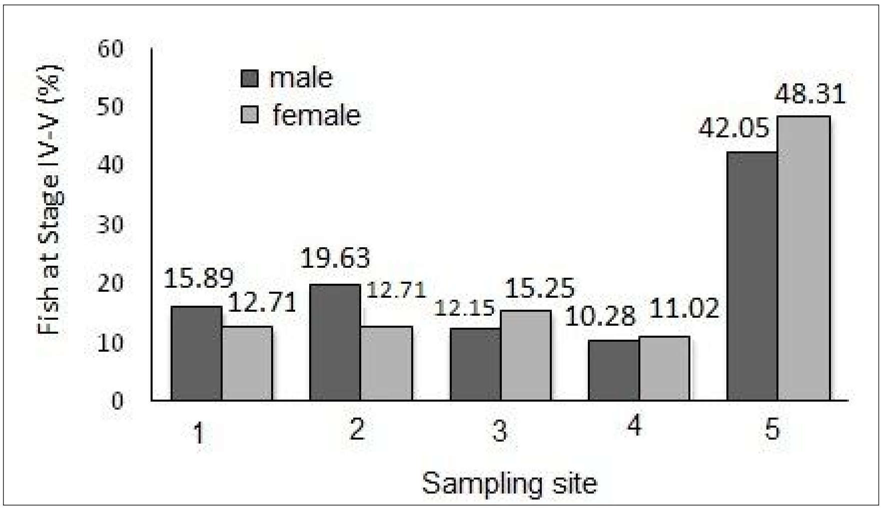

Figure 3. Percentage composition of male and female *L. ocellatus* at stage IV and V during spawning period (1, 2, 3, 4 - in the main river; 5 - in swamp waters).

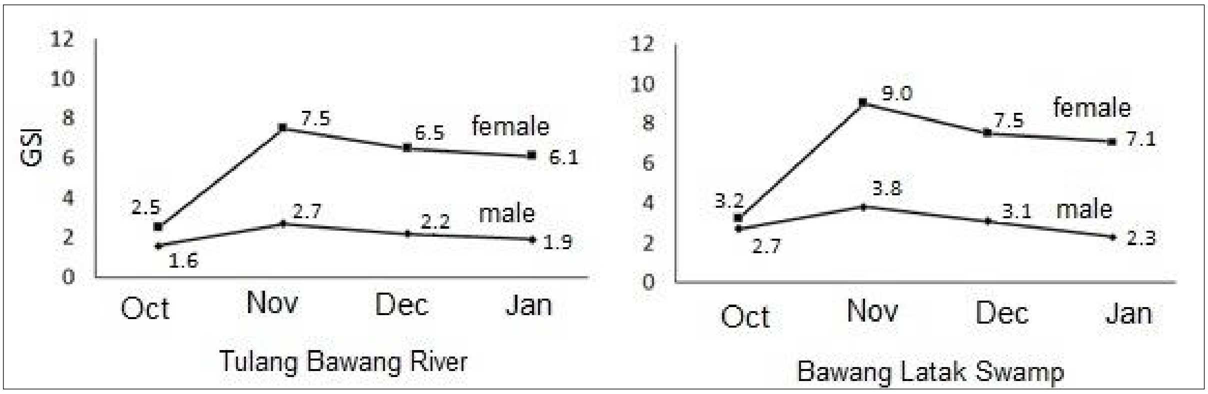

Figure 4. Monthly changes of the average GSI of male and female *L. ocellatus* during spawning period.

Area of Bawang Latak waters which far from Way Miring River had slow stream was similar to the habitat of *L. ocellatus* in Lake Teluk in Jambi (Nurdawati 2010), Lake Cala in South Sumatera (Nurdawati & Prasetyo 2007), as well as Lake Sabuah and Lake Tundai in South Kalimantan (Torang & Buchar 2000), which are entirely oxbow lakes in the floodplain riverine. Characteristics of Lake Teluk with a high population of aquatic plants is a suitable habitat for *L. ocellatus*, so that the fish is one of the dominant species, especially in the rainy season (Nurdawati 2010). Furthermore, Nurdawati & Prasetyo (2007) explained that *L. ocellatus* also lived in the aquatic habitat of Lake Cala, a forest swamp, during the dry season and juvenile utilized these waters as nursery ground during the rainy season.

The reproductive seasonality of *L. ocellatus* is a common reproductive type among tropical species, indicating an adaptation to this type of environment such that they can benefit from various food resources offered during this period and show alignment between the end of gonad maturation and the beginning of the rising water season, as well as many Amazon fish species (Lowe-McConnell 1987) and the other fish in Indonesia, such as *Pristolepis grootii* in Musi River (Ernawati et al 2009a), *Anabas testudineus* in Mahakam River (Ernawati et al 2009b), *Thynnichthys polylepis* in Kampar Kiri River (Bakhris et al 2007), some species in Lake Tonle Sap Cambodia as *Clarias batrachus, Trichogaster fasciata, Helostoma temmincki, Heteropneustes fossilis, Henicorhynchus lobatus, Cirrhinus jullieni* (Song 2007), *Labiobarbus leptocheilus, Labiobarbus lineatus,* and *Labiobarbus siamensis* (Rainboth 1996), some cyprinid fish in Mekong River as *Barbonymus gonionotus, Cyclocheilichthys enoplos, Mekongina erythrospila,* and *Paralaubuca typus* (Baran 2006), as well as *Capoeta umbla* in Karasu River, Turkey (Türkmen et al 2002).

Overall the male fish is nearly equal number to female by a ratio of 1:0.94. For the purpose of reproduction study, only 225 speciments (107 males and 118 females) with matured gonad (stage IV and V) were examined. Based on χ^2 test known that the sex ratio of *L. ocellatus* was closed to 1:1 during the spawning period in October-January, suggesting equal number of males and females on the spawning grounds, except at the main river in November. It's indicated that more fish spawn at the swamp waters than the main river.

Sex ratio can be changed before, during, and after the spawning; when the reproductive migration took place the number of male increase, during spawning the number of male and female were equal, and subsequently dominated by female (Nikolsky 1963; Türkmen et al 2002; Ernawati et al 2009a). This might explained the sex ratio of *L. ocellatus* when spawning period (October-January) was balanced (Table 2), particularly in Bawang Latak Swamp. This condition was similar to *Cichla monoculus* in Campo Grande Dam, Brazil (Chellappa et al 2003). Different cases, the sex ratio was dominated by male fish in *P. grootii* in Musi River (Ernawati et al 2009a), *T. polylepis* in Kampar Kiri River (Bakhris et al 2007), *Rasbora aprotaenia* in some rivers in the National Park of Mt. Halimun (Dewantoro & Rachmatika 2004), or *C. umbla* in Karasu, Turkey (Türkmen et al 2002).

Table 2

Sex ratio of *L. ocellatus* at gonad maturity at stage IV and V

Month	*Tulang Bawang River (St. 1, 2, 3, 4)*				*Bawang Latak Swamp (St. 5)*			
	M	*F*	*R*	χ^2*	*M*	*F*	*R*	χ^2*
Oct	9	10	0.90	0.05	8	12	0.67	0.80
Nov	14	5	2.80	4.26	17	23	0.74	0.90
Dec	23	20	1.15	0.21	13	14	0.93	0.04
Jan	16	26	0.62	2.38	7	8	0.88	0.07

M = male; F = female; R = sex ratio (M:F); χ^2* < 3.841 ($\chi^2_{(0,05;\ 1)}$) indicated sex ratio is 1:1.

Average fecundity observed from 102 female samples at stage IV was 1,395 eggs per gram of gonads and ranged between 3,404-21,147 eggs per female (Table 3). The total length (L)-fecundity (F) relationship were calculated as log F = 3,653 log L - 4,546 (R^2 = 0.787) in Tulang Bawang River and log F = 3,982 log L - 5,287 (R^2 = 0.824) in Bawang Latak Swamp (Figure 5).

Table 3

The average fecundity of *L. ocellatus*

Interval of total length (mm)	*Tulang Bawang River*		*Bawang Latak Swamp*	
	n	$F_{average}$	*n*	$F_{average}$
160-169	20	3,645±353	14	3,404±608
170-179	21	4,122±798	9	4,309±841
180-189	6	5,372±591	8	5,734±1,426
190-199	4	7,015±1.268	4	6,777±1,083
200-209	0	---	2	5,769±2,083
210-219	0	---	1	9,700
220-229	0	---	8	14,330±1,588
230-239	0	---	4	12,224±1,693
240-249	0	---	1	21,147
Total	51		51	

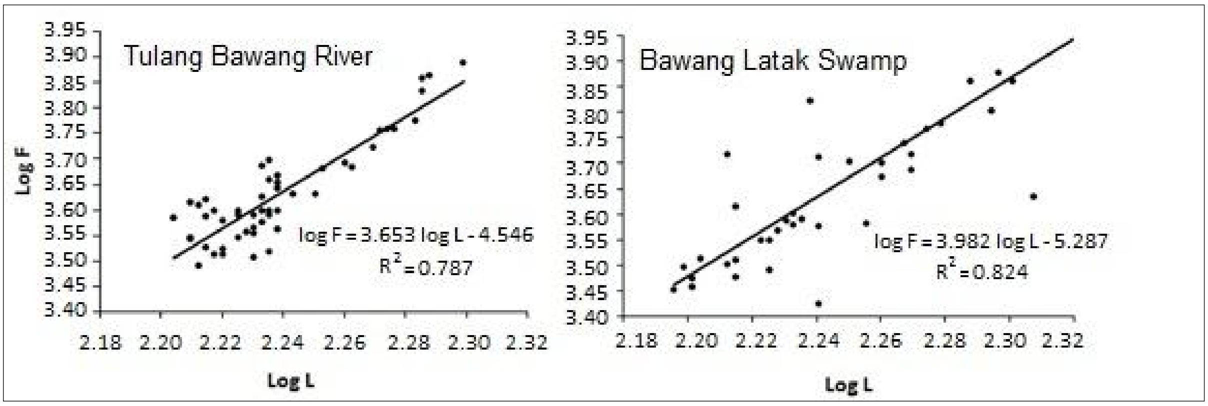

Figure 5. The relationship between log fecundity and log total length of female *L. ocellatus* at stage IV (F = fecundity, L = total length).

Based on the female's equation of fecundity-total length relationship did not differ significantly between sampled fish from Tulang Bawang River and Bawang Latak Swamp, it is predicted that female fish had the same potential for recruitment in both waters. There is a correlation between fecundity with total length, so that the female's total length could be used to estimate fecundity. While reached first maturity at the total length of 160±1 mm, *L. ocellatus* were predicted had fecundity of 3,089 eggs. These conditions approached actual fecundity in sampled fish at size of 160 mm which had 3,262 eggs.

The distribution of oocytes diameter derived from 102 female at stage IV varied between 0.52 to 0.90 mm (average 0.73±0.04 mm). Oocytes diameter is relatively similar between the anterior, middle, and posterior part of the ovary. The distribution of oocytes diameter only form one group (Figure 6) that indicated *L. ocellatus* is total spawner. As a total spawner, *L. ocellatus* has a strategy to maximize the number of juveniles produced by utilizing the arrival of the rainy season. With high fecundity, the whole eggs were released as the fish spawned to produce a lot of juvenille and they had a chance of a better life because of the availability of abundant food, the widespread of nursery ground during floods, or availability a lot of refugee area so that the young fish had a high survival rate due to predation. Other freshwater fish which had the spawning type like *L. ocellatus* included *Osteochilus vittatus* (Uslichah & Syandri 2003), *T. polylepis* (Bakhris et al 2007), *P. grootii* (Ernawati et al 2009a), *Henicorhynchus lobatus* and *C. jullieni* (Song 2007).

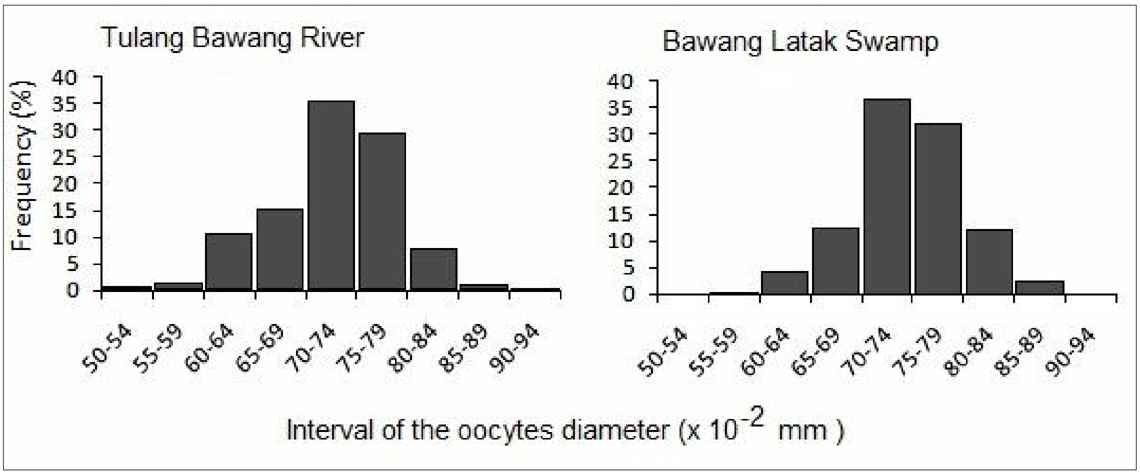

Figure 6. The oocytes diameter's distribution of *L. ocellatus.*

The determination of the size of *L. ocellatus* at first maturity used data from October 2013 to January 2014 while that fish had stage I to IV of gonad maturity. Based on the Spearman-Karber analysis (Udupa 1986), male had reached first maturity at 157-159 mm and female was 160-162 mm (Table 4). The size of the first maturity of *L. ocellatus* approached actual conditions in the waters for both male and female. The smallest size of female in stage IV of gonad maturity is 158 mm, while the smallest male is 155 mm. The size of the first maturity of female are larger than males associated with female's growth rate faster than male. According to Suzuki et al (2004), generally the size of a female fish when first maturity is bigger than the male fish.

Table 4

The size (TL) of *L. ocellatus* at first maturity (mm)

	Male	*Female*
Tulang Bawang River	159±1	162±1
Bawang Latak Swamp	157±1	160±1

Some of the water variables didn't show pronounced temporal variations related to dry and rainy season, except water transparency, TSS, ammonium, and TOM (Table 5). The onset of water inflow from the upstream during the rainy season increased TSS, the depth and extent of waters, and drastically decreases transparency. In general, all of the water variables in all observing site stayed within the adequate range to support the aquatic organisms in the area (Boyd 1990; Effendi 2014).

The average of monthly rainfall in the study area varied from 118 to 485 mm (Figure 7). In dry season (April-September), the monthly rainfall didn't assess 230 mm and reached a peak in December coincided with the flooding at the study area.

Table 5

Water variables in Tulang Bawang River and Bawang Latak Swamp

Variables	*Tulang Bawang River*		*Bawang Latak Swamp*	
	Dry season	*Rainy season*	*Dry season*	*Rainy season*
Water transparency (cm)	10-35	6.0-9.5	20.0-35.0	10.0-25.0
Temperature (^oC)	28.0-30.2	28.6-30.1	29.0-31.0	28.9-31.2
Depht (m)	2.43-6.24	2.97-6.74	2.25-3.75	2.70-4.91
Current velocity (m s^{-1})	0.10-0.80	0.30-0.80	0.05-0.20	0.10-0.40
TSS (mg L^{-1})	36-220	120-222	98-230	49-220
pH	6.05-7.79	6.75-7.45	6.02-6.78	6.67-7.05
DO (mg L^{-1})	4.52-6.73	5.22-6.15	4.50-6.50	4.26-6.00
Ammonium (mg L^{-1})	0.018-0.822	0.120-0.360	0.320-0.845	0.120-2.025
Ortophosphate (mg L^{-1})	0.025-0.600	0.054-0.120	0.098-0.160	0.06-0.11
TOM (mg L^{-1})	14.54-114.39	25.55-49.93	34.52-120.24	11.38-54.20

Dry season: April-September; rainy season: October-March.

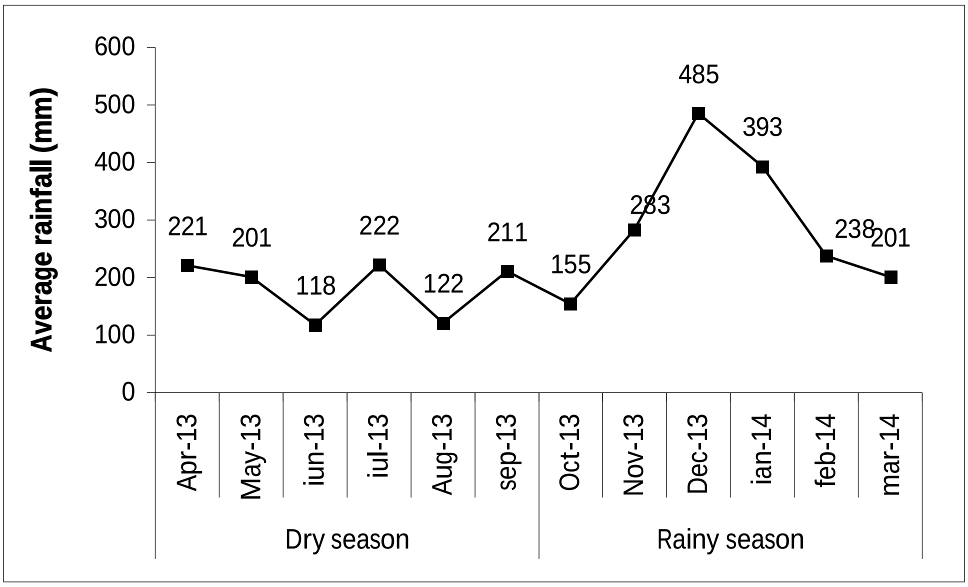

Figure 7. The average of monthy rainfall (Source: BPTPH, Lampung Province).

Some important water variables, i.e. pH, water temperature and dissolved oxygen, were within normal condition to support aquatic organisms life. Measured pH values ranged from 6.02 to 7.79. Most of aquatic biota are sensitive to changes in pH and they like pH value of about 7 to 8.5 (Novotny & Olem 1994). Water temperature at the study site ranged from 28.0-31.2^oC still within the optimum for the growth of fish. Boyd (1990) stated that the aquatic species in the tropics and subtropics will not grow well when the water temperature dropped below 26^oC and caused of death while below 10^oC. Dissolved oxygen measured at the study site ranged from 4.26 to 6.73 mg L^{-1}. The minimum requirement of dissolved oxygen for fish to grow and develop is 3 mg L^{-1} and it would be better above 5 mg L^{-1} (Rahardjo et al 2011). Ammonium (NH_4^+) in the study sites ranged from 0.018 to 2.025 mg L^{-1}. Basically, ammonium in water is ionized form of ammonia that is affected by pH; mostly ionized ammonia will become ammonium when the pH is less than or equal to 7 (Effendi 2014). Ammonium is not toxic to aquatic biota.

All observation site in Tulang Bawang River was characterized by high values of phosphate, especially during the dry season. Orthophosphate was measured ranged from 0.025 to 0.600 mg L^{-1}. According to Boyd (1990) levels of phosphorus in orthophosphate rarely exceed 0.1 mg L^{-1} although in the eutrophic waters. Orthophosphate was high in station 3 (0.600 mg L^{-1}) and station 4 (0.410 mg L^{-1}) could be derived from agriculture activity, domestic waste, or detergent from the headwaters of Tulang Bawang River. Total suspended solids (TSS) in the study site ranged from 36 to 230 mg L^{-1}. Suspended solids consisted of mud, silt and microorganisms that are not toxic, but it can increase turbidity. The condition of Tulang Bawang River and Bawang Latak Swamp were turbid due to material erosion did not affect the growth of *L. ocellatus*. This condition is similar to Lake Teluk in Jambi with brown turbid due to the high eroded soil particles, but *L. ocellatus* more dominant than the other fish (Nurdawati 2010).

When associated with body shape, *L. ocellatus* have the ability to swim in fast-flowing waters in Tulang Bawang River and Bawang Latak Swamp, therefore the water flow in main river did not restrict their movement toward spawning ground. In accordance with the opinion of Beamish et al (2006), species with long based dorsal fins, capable of independent motion along their length and moderately rounded bodies, such as *L. siamensis* and *L. leptocheilus,* can be expected to be strong swimmers with good maneuverability.

Conclusions. *L. ocellatus* is a total spawner species which spawned during the rainy season in Bawang Latak Swamp and other floodplain surrounded the main river with the peak of spawning occured in November-December coincided with the rising waters. During spawning period, sex ratio of *L. ocellatus* was 1:1. The size of first gonad maturity of *L. ocellatus* is 157±1 mm (male) and 160±1 mm (female). The average fecundity varies between 3,404-21,147 eggs and it had correlated with the total length in equations as log F = 3,653 log L - 4,546 (in Tulang Bawang River) and log F = 3,982 log L - 5,287 (in Bawang Latak Swamp).

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