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Fecundity of Bonylip barb (*Osteochilus vittatus* Cyprinidae) in different waters habitats

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Abstract
Fecundity and egg diameter of *O. vittatus* are part the reproductive aspects of fish and very important to know. This information can be used to predict recruitment and recovery of *O. vittatus* stocks in order to domestication and culture. The study was conducted from February to July 2014 in Singkarak Lake, Antokan River and Koto Panjang Reservoir. The number of observed samples are 50 individuals of female fish with the level of maturity of the gonad III and IV from each habitat. Total fecundity of *O. vittatus* from Singkarak Lake were 11,711±4,576 granules/individuals with egg diameter ranged from 0.80 to 0.99 mm, Antokan River were 6,378±3,344 granules/individuals with egg diameter ranged from 0.78 to 0.93 mm and Koto Panjang Reservoir were 14,824±2,397 granules/individuals with egg diameter ranged from 0.90 sampai 1.15 mm. Conclusion fecundity and eggs diameter was significantly ($p<0.05$) between habitats.

Keywords: *O. vittatus*, fecundity, eggs diameter, habitats

1. Introduction

Fifteen species of *Osteochilus* found in Indonesia inland water namely are *O. borneensis, O. melanopleura, O. kelabau, O. schlegli, O. kahajenensis, O. repang, O. vittatus, O. triporus, O. brachynotopterus, O. hasselti, O. waandersi, O. kappeni, O. brevicauda, O. spilurus and O. harrisoni* [1]. *O. vittatus* lived in Lake Maninjau [2, 3, 4], Singkarak Lake [5, 6], Koto Panjang Reservoir [7], Kampar Kanan River [8]. This fish is an important economic value for non-food sources of cholesterol and traded extensively with prices between IDR 25,000 to 35,000 per kg [9], of the ecology has been successfully used as a biocontrol agent to reduce phytoplankton bloom of Mycrosistys algae in Maninjau Lake [10]. The problem now that there was scarcity *O. vittatus* in Maninjau Lake due to damage spawning habitat by damming the upstream Antokan River for Hydroelectric Power, the capture of were not selective [11], changes in trophic status lakes from oligotrophic become eutrophic weight [2, 9, 12] and the introduction of new species such as *Oreochromis niloticus, Oxyeleotris marmorata, Cherax quadricarinatus* were not intentionally due to fish farming with pond cages so that there is competition food and predation on eggs and larvae of *O. vittatus* [9] . In Singkarak Lake the scarcity due to the damming of the upstream Ombilin River for Hydroelectric Power and the capture of were not selective [5, 13, 14], in Koto Panjang Reservoir due to changes in water flow becomes stagnant for Hydroelectric Power [7, 15].

Fecundity related with total length and body weight of fish [14, 15]. Environmental factors, especially the availability of food in the habitat as an important in the quality of the eggs and the timing of reproduction [16, 17], lack of food can cause a delay in the maturation of the gonad and low fecundity [18, 19]. Food for fish can be a determining factor for population density, growth and fish condition, whereas one species of food fish usually depends on the age, place, time and digestive tract of the fish itself [20].

O. vittatus have not been successful due to domestication and cultivation of unknown reproductive potential and food habits. Therefore the analysis of fecundity, egg diameter and food habits of *O. vittatus* in different habitats is the focus in this study because it can be used as a reference for the selection of qualified candidates for the successful broodstock of domestication and culture.

2. Materials and Methods
2.1 Sampling location
The *O. vittatus* (Fig. 1.) samples were collected from February to July 2014 in Singkarak Lake Solok Regency (00º 31′ 46" - 00º 42′ 20" S Latitude and 100º 26′15"–101º 31′46"E Longitude), Antokan River which is the oulet of Maninjau Lake Agam Regency (100º.24′.20"–100º.25′.20"S Latitude and 00º.16′.60"- 00º.27′.21"E Longitude) and Koto Panjang Reservoir Lima Puluh Kota Regency (101º23’64"–101º.24′.13"S Latitude and 00º.11′.13" – 00º.09′.32" E Longitude) (Fig. 2.) and description of aquatic habitats of *O. vittatus* sampling (Table. 1).

Table 1: Deskription of aquatic habitats of *O. vittatus* sampling

Habitats	Description
Singkarak Lake Solok Regency	Elevation of 360-363 m above sea level, water temperature 25.66±0.57 ºC, brightness 1.83±0.20 m, TDS 91.30±0.95 mg/l, TSS 5.93±2,29 mg/l, bottom substrate is rocky, depth of the littoral 4,36±0,32 m, pH 7,56±0,40 , dissolved oxygen 5.44±0.25 mg/l, alkalinity 74.06±3.66 mg CaCo3/l, hardness 72.00±3.00 mg/l, electrical conductivity 230.83±15.33 mhos/cm.
Antokan River Agam Regency	Elevation 390-400 m above sea level, water temperature 26.0±0,50 ºC, TDS 22.30±2.80 mg/l, TSS 57.00±3.00 mg/l, bottom substrate is gravel and karakal, pH 8.0, hardness 55.40 mg/l, alkalinity 50.44 CaCo3/l, dissolved oxygen 8.10 mg/l, water depths 2.93±0.23 m, alkalinity 75.00±1.00 mg CaCo3/l, hardness 73.56±0.11 mg/l, electrical conductivity 205.00±0.78 mhos/cm.
Koto Panjang Reservoir Lima Puluh Kota Regency	Elevasi 100-107 m above sea level, water temperature 28,16±1,36 ºC, brightness 3.44±0.05 m, TDS 12.05±0.02 mg/l, TSS 22.66±5.03 mg/l, bottom substrate is mud, depth of the littoral 5.50±3.52 m, pH 6.0±0.31unit, dissolved oxygen 3.92±0.72 mg/l, alkalinity 83.14±2.78 mg CaCo3/l, hardness 24.18±0.04 mg/l, electrical conductivity 0.06±0.04 mhos/cm.

2.2 Sample collection
The samples of *O. vittatus* from each location put into a styrofoam container of 120x50x40 cm, then carried to the Terpadu laboratory of The Faculty of Fisheries and Marine Sciences Bung Hatta University Padang. In the laboratory fishes were identified, and total length of each fish was measured to the nearest millimeter and body weight in gram on a digital balance with 001 mg precision. The sexio in fish abdomen done to observe the reproductive organs (gonad) and determination of the level of maturity of the gonads. Observation of the morphology of gonad maturity level based on classification modified by [21]. By that step, the fish of eggs contained can be seen females gonads maturity level III or IV of *O. vittatus*. Fecundity was determined from female with the level of maturity of the gonads IV and egg diameter was measured from the level of maturity of the gonads III and IV using Olympus CX 21 microscope, scale 0.025 mm.

Fecundity calculation of done two stages i.e. the first step is to get the eggs from broodstock by lifting the entire gonads of the stomach and the second step fecundity was determined by gravimetric method [22]. Gonad weight of each fish was weighed (g) and sub gonads weighed as much as 1 g to obtain the number of egos. Sub section is anteroir and posterior gonads of gonads were then taken and preserved with Gilson solution consisting of 100 ml of 60% alcohol, 880 ml of distilled water, 15 ml of nitric acid, 18 ml of glacial acetic acid and 20 g of mercury chloride. The aim is to harden the ego and release of eggs from the gonadal tissue. The data used for the calculation of egg fecundity of the formula: F: t = B: b : where: F = total fecundity; t = number of eggs from the gonad sample (g); B = Weight of whole gonads (g); b = weight of sample gonads (g).

To estimate the total fecundity based on the total length and body weight also sought a relationship between fecundity with total length and body weight of each is expressed by the equation Jhingran (1984)[23] as follows: $F = a_1L^{bl}$ or Log F = log a+b log L and $F = a_2Bt^2$ or Log F =log a+b log W.

where: F = fecundity (granule), L = total length of fish (mm), Bt = body weight of fish (g), a and b = constants.

Fig 1: Elongated body of *Osteochilus vittatus*

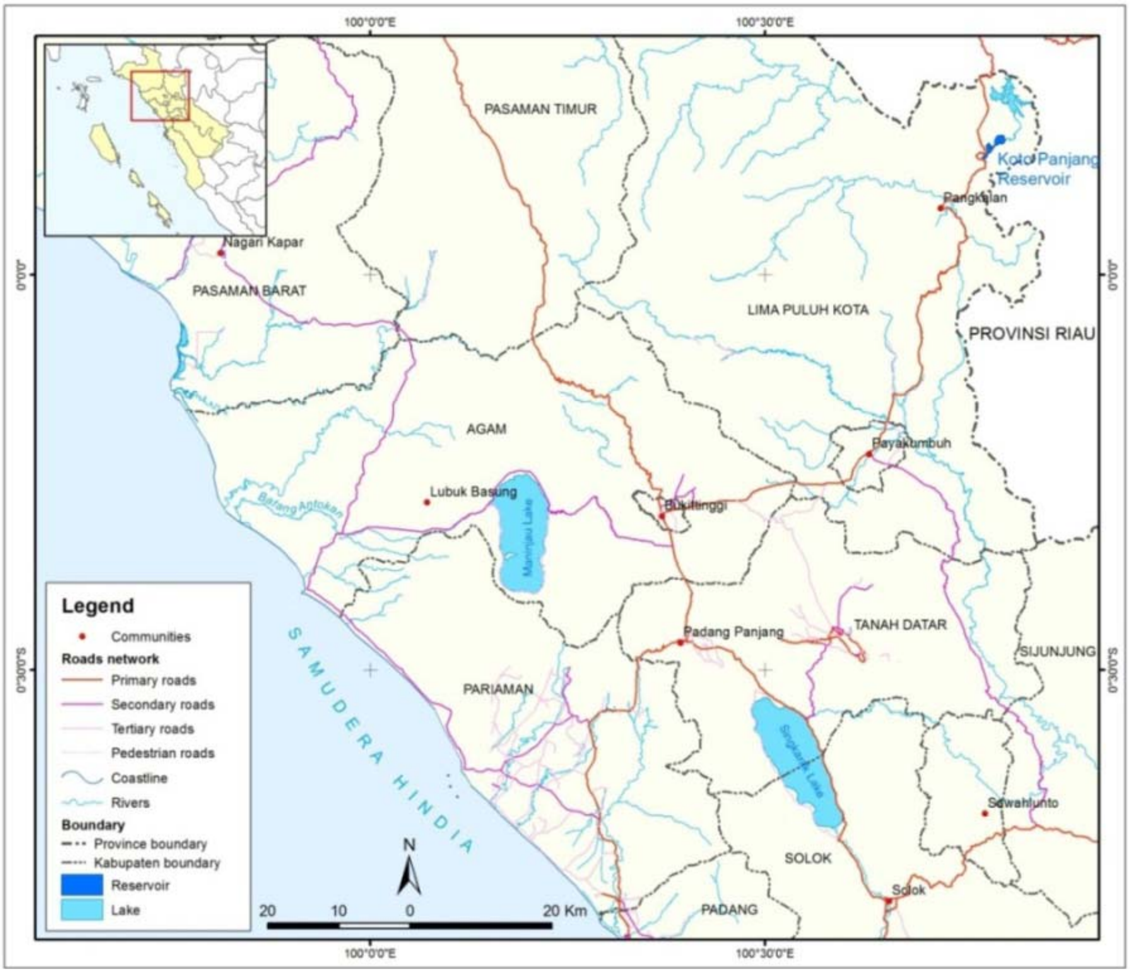

Fig 2: Map of West Sumatra Province and locations of *O. vittatus* sampling

3. Results

3.1 Fecundity

The results of the study proved that the fecundity of *O. vittatus* between different habitat, the average fecundity of *O. vittatus* from Singkarak Lake are 11,711±4,576 granules/individual, Antokan River 6,378±3,344 granules/individual and Koto Panjang Reservoir are 14,824±2,397 granules/individual (Table 2), it shows the potential fecundity of eggs produced for one-time spawning. The relation between total fecundity with total length and body weight of each habitats of *O. vittatus* based on the geometric equations are presented in Table 3, Fig 3, 4, 5, 6, 7, 8.

Table 2: Fecundity variation of *O. vittatus* from different habitats (n=50)

Location	Total length (mm)		body weight (g)		Fecundity (granule/individual)	
	Range	Average ± SD	Range	Average ±SD	Range	Average ±SD
Singkarak Lake	125-246	173.23±29.60	74.0-214.0	137.66±35.64	4,624-20,307	11,711±4,576[a]
Antokan River	122-212	161.0±23.84	55.6-124.4	84.85±18.17	1,850-13,350	6,378±3,344[b]
Koto Panjang reservoir	160-262	192.41±27.28	112.9-277.3	153.37±153.57	11,875-21,350	14,824±2,397[c]

Note: superscript different numbers behind the numbers mean fecundity was significantly different (p<0,05)

Table 3: Geometric equation of the correlation between body length and body weight with fecundity

Lokasi	$F = a L^b$	R^2	n	$F = a W^b$	R^2	n
Singkarak Lake	$7.340 \times 10^{-3} L^{2.701}$	0,91	50	$F= 2.925 W^{1.6173}$	0,84	50
Antokan River	$6.032 \times 10^{-5} L^{3.619}$	0,77	50	$F= 1.397 W^{1,723}$	0,90	50
Koto Panjang Reservoir	$F= 63.381 L^{1.036}$	0,79	50	$F= 410.241 W^{0.702}$	0,66	50

The coefficient of determination (R^2) shows that fecundity with total length correlation for all three habitats ranging from 0.77% to 0.91%, meaning that 77% to 91% fecundity is determined by the total length, whereas correlation fecundity with body weights obtained the coefficient of determination (R^2) ranged from 0.66% to 0.90%, meaning that 82% to 93% fecundity is determined by body weight, this number states that the total length is better for estimating fecundity.

Potential fecundity based on the total length of the geometric equation (Table 3), if the length of each habitat *O. vittatus* average of 180 mm/individual, the fecundity alleged of *O. vittatus* from Singkarak Lake is 9,061 grains/individual, Antokan River is 8,760 grains/individual and Koto Panjang Reservoir 13,753 grains/individual. Furthermore, if the body weight of *O. vittatus* average of 200 g/individual each habitat, the fecundity alleged of *O. vittatus* from Singkarak Lake is 15,402 grains / individual, Antokan River is 12,896 grains / individual and Koto Panjang Reservoir 16,918 grains individual.

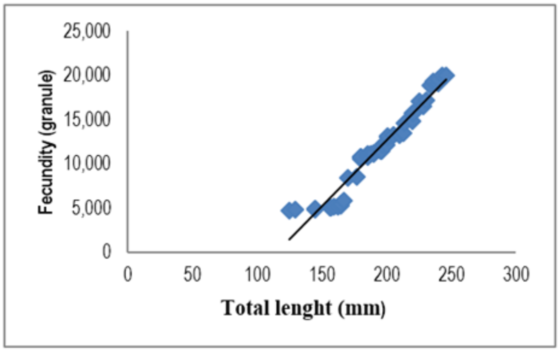

Fig 3: Correlation between fecundity and total length of *O. vittatus* from Singkarak Lake

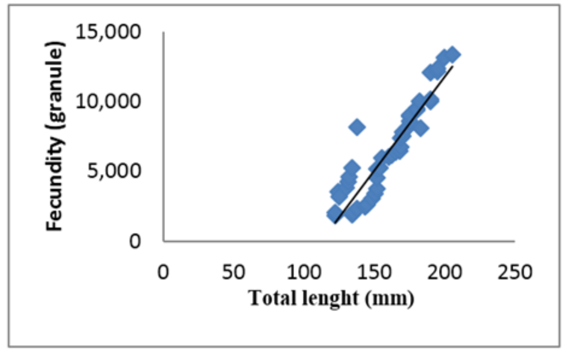

Fig 4: correlation between fecundity and total length of *O. vittatus* from Antokan River

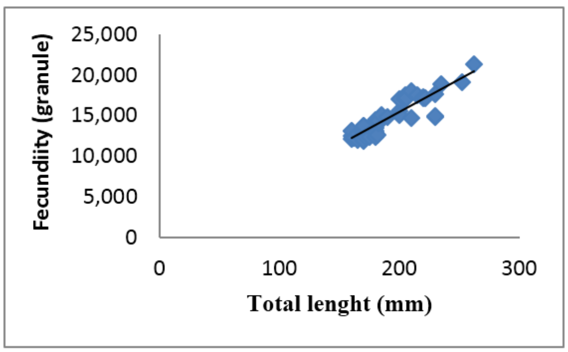

Fig 5: Correlation between fecundity and total length of *O. vittatus* from Koto Panjang Reservoir

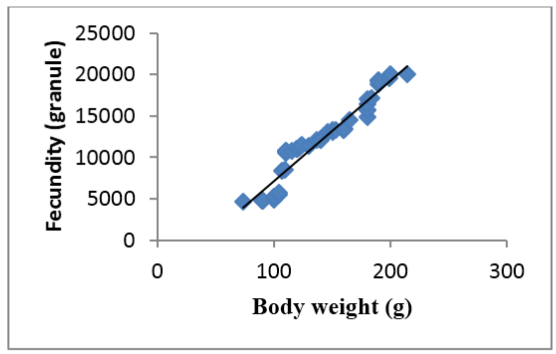

Fig 6: Correlation between fecundity and body weight of *O. vittatus* from Singkarak Lake

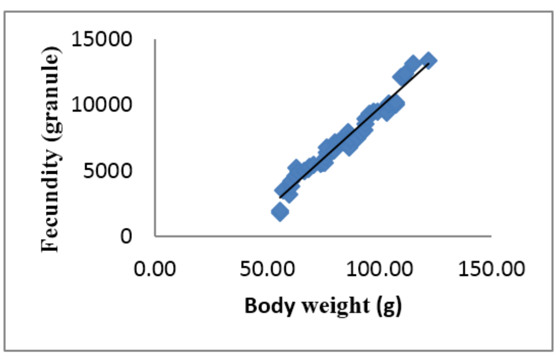

Fig 7: Correlation between fecundity and body weight of *O. vittatus* from Antokan River

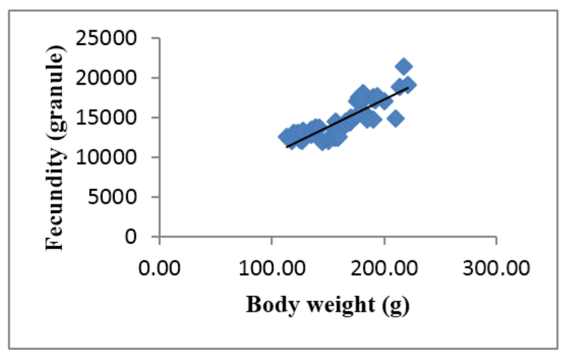

Fig 8: Correlation between fecundity and body weight of *O. ittatus* from Koto Panjang Reservior

3.2 Eggs Diameter

The diameter of the eggs of *O. vittatus* on gonad maturity level III and IV from Singkarak Lake, Antokan River and Koto Panjang Reservoir.

Table 4: Egg diameter of *O. vittatus* based on the gonadal development and research location

Site	Egg diameter (mm) Maturity level III		n	Egg diameter (mm) Maturity level IV		n
	Range	Average±SD		Range	Average±SD	
Singkarak Lake	0.70-0.82	0.74 ± 0.03^{a}	50	0.80-0.99	0.89 ± 0.04^{a}	50
Antokan River	0.68-0.76	0.73 ± 0.02^{a}	50	0.78-0.93	0.87 ± 0.03^{b}	50
Koto Panjang Reservoir	0,70-0,90	$0.75\pm0.04c^{a}$	50	0.90-1.15	0.96 ± 0.17^{c}	50

Note: superscript different numbers behind the numbers mean gonads maturity level was significantly different (p<0,05)

The diameter of the eggs of *O. vittatus* on gonad maturity level IV were significantly different ($p < 0.05$) between habitat. The mean diameter of the eggs of *O. vittatus* gonad maturity level IV from Koto Panjang Reservoir (0,96±0,17 mm) larger than the diameter of the eggs *O. vittatus* from Singkarak Lake (0.89±0.04 mm) and Antokan River (0.87±0.03 mm). Furthermore, from the results of histological analysis of gonads, known that oocyte development of *O. vittatus* is *par groups* i.e. found at least two different populations of oocytes at a rate of gonadal development (Fig. 9).

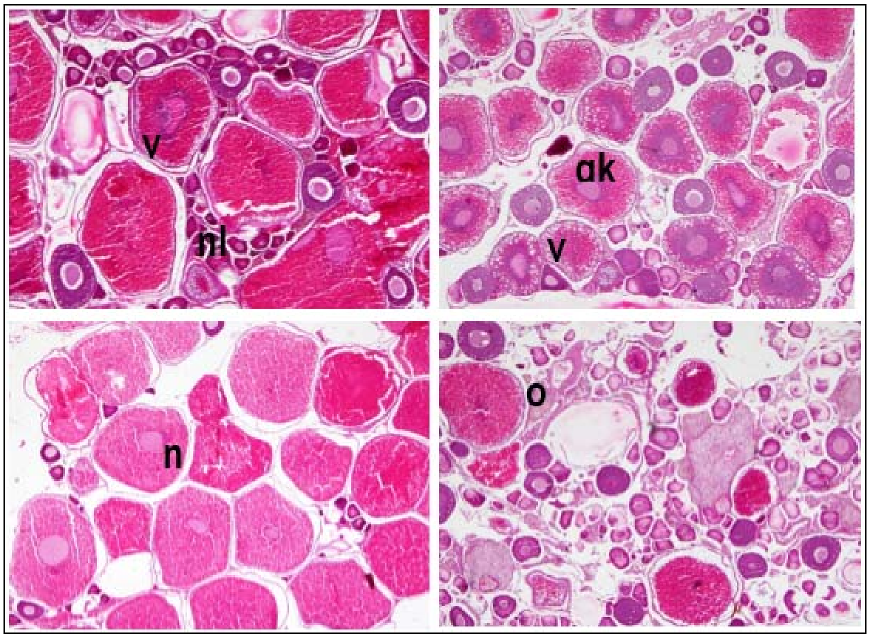

Fig 9: Gonad maturity level I (A) of histology ovarian has the nucleolus (nl) was clear. Gonad maturity level II (B) with a row of vacuoles (v) in the peripheral. Gonad maturity level III (C) with vacuoles (v) and yolk granules (gk). Gonad maturity level IV (D) with nucleus (n) near the boundary edge. Gonad Maturity level V (E) with the follicle wall (o) squiggly

4. Discussion

The different numbers total fecundity of *O. vittatus* on Singkarak Lake, Antokan River and Koto Panjang Reservoir, may be caused by the size of the total length and body weight, the length and weight of the body, the higher fecundity. Highest fecundity in Koto Panjang Reservoir population avarage 96,880 grains / kg body weight, Singkarak Lake population avarage 84,860 grains / kg body weight and Antokan River population avarage 75,030 grains / kg body weight. Fecundity of *O. vittatus* is similar to the fecundity of *O. hasselti* ranged between 80,000 to 110,000 grains / kg body weight [24] and smaller than fecundity of *O. kelabau* ranged between 130,000 to 140,000 grains / kg body weight [25]. The high fecundity of *O. vittatus* from Koto Panjang Reservoir can be caused by differences in total length and body weight. Fecundity *of Bathygobius soporator* ranged between 5,462 eggs for fish of total length 12.4 cm, total weight 25.0 g, gonad weight 0.5 g, and mean egg diameter 0.45 mm to 63,250 eggs for fish of total length 12.9 cm, total weight 45.0 g, gonad weight 3.0 g, and mean egg diameter 0.44 mm [26].

In addition to the total length and body weight parameter, the morphometric characters and gene diversity also led to the difference fecundity. Morphometric character of *O. vittatus* population of Koto Panjang Reservoir is best to the population of Singkarak Lake and the Antokan River [3]. The best gene diversity of *O. vittatus* from Koto Panjang Reservoir population with a value of 0.1512, then Singkarak Lake population with a value of 0.1250 and Antokan River population with a value of 0.0431 [27]. The same condition is also found in *Channa lucius* from Kampar River floodplain Riau Province with gene diversity 0.3668 and fecundity 2,539±716 grains/individual, Lake Singkarak West Sumatra Province gene diversity with value 0.2186 and fecundity 1,996±568, Tanjung Jabung Timur floodplain Jambi Province gene diversity with value 0.3449 and fecundity 2,196±866 [28]. Based on [29] the low gene diversity can cause low fecundity of fish. Differences fecundity of *O. vittatus* between habitats may be caused by the availability of food such waters. In Koto Panjang Reservoir plankton density 37,785 cells / liter [30], Singkarak Lake 31.150 ind/liter [31] and Antokan River based on the results of the analysis of 2,066 cells / liter.

Eggs diameter of *O. vittatus* between habitat is differences, differences in egg size can be caused due to the availability of natural foods in the nature and related to water conditions. Singkarak Lake and Koto Panjang Reservoir are inland water that are stagnant with high plankton density, whereas Antokan River is flowing inland water containing low plankton density. Allegedly the more diversity of species of plankton are eaten by *O. vittatus* so it will affect the diameter of the egg. According [21] that the eggs diameter of *Mystacoleucus padangensis* in Singkarak Lake influenced by the availability of natural food in the nature, more and more types and density of natural food, the greater the diameter of the egg.

Furthermore group of egg diameter gonad maturity level IV differ between the anterior and posterior in the gonads, this suggests that the development of oocytes *O. vittatus* are of synchronism par groups i.e. found at least two different populations of oocytes in the gonadal development level. Based on oocyte development is the type of *O. vittatus* spawning is a partial spawner ie the species of fish that do not remove mature eggs at once at the time of spawning, spawning in the river been linked to high water levels due to rain or flood. According [32] partial spawning type is favorable for reproductive adaptations fish spawning in the river linked with the high water level fluctuations due to rain or flood and at the time the food is so abundant. Among the fish species, partial type found in fish species that do not protect the eggs after spawning and fecundity of these fish are usually more when compared to the same spawning fish type but protects the eggs after spawning.

From the research it can be stated that the *O. vittatus* egg size ranges from 0.87 mm to 0.96 mm, almost close to the diameter of the eggs of *Tor douronensis* i.e. 0.9 to 1.1 mm [33]. The diameter of the larger eggs tend to have mouth openings larger larvae so making it easier to accept the natural food such as *Artemia salina nauplii and Daphnia* when the change of food from endogenous feeding to exogenous feeding. This opinion is based on research results Syandri [33] on larvae newly hatched of *Tor douronensis* measuring between 0.9 to 1.1 mm, after the age of four straight days it can take *Artemia salina* nauplii so during the maintenance fourteen days that larval survival rate can reach 80%. In contrast to the fish larvae newly hatched of *Mystacoleucus padangensis* has the size 0.2-0.3 mm, very difficult to provide natural food and at the age of thirteen days can take *Artemia salina* nauplii, consequently the survival of fish larvae up to fourteen days only 30% [21].

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