Journal of Fisheries and Aquaculture
ISSN: 0976-9927 & E-ISSN: 0976-9935, Volume 4, Issue 3, 2013, pp.-115-120.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000265

FECUNDITY, EGG DIAMETER AND FOOD *Channa lucius* CUVIER IN DIFFERENT WATERS HABITATS

AZRITA[1]* AND SYANDRI H.[2]

[1]Department of Biology Education, Faculty of Education, Bung Hatta University, Ulak Karang 25133, Padang Indonesia.
[2]Department Aquaculture, Faculty of Fisheries and Marine Science, Bung Hatta University, Ulak Karang 25133, Padang Indonesia.
*Corresponding Author: Email-azrita31@yahoo.com

Received: September 29, 2013; Accepted: October 25, 2013

Abstract- Fecundity, egg diameter and food habits were part of aspects of the fish reproduction that is very important to know. This information can be used to predict recruitment and fish stock enchancement of *C. lucius* within the of domestication and aquaculture. The research was held in January until November 2012 in Singkarak Lake West Sumatera Province, in foodplain, Pematang Lindung sub district Mendahara Ulu Regency East Tanjung Jabung, Jambi Province, and in foodplain Mentulik Regency Kampar Kiri Hilir Riau Province. The amount of samples that was observed was 30 gonado of female fish Gonado Maturity Level III and IV in each research location. The total of *C. lucius* fecundity from West Sumatera is 1.996±568 eggs in which each egg has 1,35±0,09 mm in diameter, from Jambi is 2.196±866 eggs, each eggs has 1,53±0,11 mm, and Riau is 2.539±716 eggs, each has 1,70±0,14 mm in diameter. The main food of *C. lucius* is fish (70,78-89,01%) and the supplement food are shrimp (5,81-16,13%), frogs (1,77-4,25%) and another additional is water insects (3,98-9,80%). Based on thosekinds of food, then *C. lucius* is considered as the member of pure carnivore fish which has predatore behavior.

Keywords- *C. lucius*, fecundity, egg diameter and food habits

Citation: Azrita and Syandri H. (2013) Fecundity, Egg Diameter and Food *Channa lucius* Cuvier in Different Waters Habitats. Journal of Fisheries and Aquaculture, ISSN: 0976-9927 & E-ISSN: 0976-9935, Volume 4, Issue 3, pp.-115-120.

Introduction

In Indonesia inland waters, there are five types of fish genus Channa, bujuk fish (*Channa lucius*, Cuvier), gabus fish (*Channa striata* Bloch), toman fish (*Channa micropeltes* Cuvier), Jalai fish (*Channa maruliodes* Bleeker) and serandang fish (*Channa pleurothalmus* Bleeker) [1]. This fish species is more popularly known as the snake -headed fish (snakehead) and the local name of the fish in Riau and Jambi were bujuk [2,3] in Singkarak Lake called kiung [4]. These fish include black fish that live in rivers, flood swamps and lakes in Sumatra [5]. Bujuk fish is rarely found due to overfishing and not selective to the size of the population in Batang Hari river floodplain [6], Riau Kampar River floodplain [7], Koto Panjang Reservoir [8] and Singkarak Lake [4]. According to Wilson and Clarke [9] with a reduction in the density of population and shrinking stock of fish may reduce genetic selection, potential fecundity, reduced the average fish spawn, unbalanced sex ratio, and loss of genetic variation. Ruzafa, et al [10] stated that the arrest may increase heterozygosity protection of fish and fish populations to recover from the threat of extinction.

Assessment of fish fecundity *C. lucius* is essential because it will determine the potential seeds for the domestication and cultivation. Fecundity associated with total length and body weight of fish [11]. Environmental variation, particularly the availability of food in their habitat important role on the quality of eggs and fish reproduction time [12] lack of food can lead to delays in gonadal maturation and low fecundity [13,14]. Food for fish can be a decisive factor for population density, growth and condition of fish, while one species of food fish usually depends on the age, place, time and the digestive tract of the fish itself [15]. By knowing the food habits of the species of fish can be seen in the relationship between fish ecology with other organisms that exist in a body of water, such as other forms of predation, competition and food chain.

Several studies on fecundity and egg diameter was carried out on fish Channa clan among others fecundity Spotted snakehead fish (*Channa punctata*) in India range from 2.300-29.600 grains [16], egg diameter of 2 mm based reported Khan in [17], fecundity dwarf snakehead (*Channa gachua*) in Berhampur India between 2539-7194 grains, egg diameter from 2.1 to 2.6 mm [18], fecundity chevron snakehead fish (*Channa striata*) in Malaysia ranges from 3,000 - 30 000 grains, egg diameter of 1.25 mm [16], fecundity chevron snakehead fish (*Channa striata*) in floodplain of the River Musi range 1141-16468 grains [19]. Fecundity cobra snakehead fish (*Channa marulius*) range 2000-40000 grains [20] and egg diameter Northern snakehead fish (*Channa argus*) ranged from 1.80 to 1.85 mm based reported Son [17].

Fecundity of some species of fish mentioned above, it turns out research on fish fecundity *C. lucius* have not been reported. It is therefore in line with the management of to *C. lucius* domestication and cultivation, it takes the data aspects of *C. lucius* reproduction and food. Study aspects of fecundity, egg diameter and the focus

on the food habits of this study is to analyze the ability of fish to produce eggs and coaxing the egg size and the main food and supplement each habitat. This information can be used to predict the fecundity, egg diameter and the food that will be used if the *C. lucius* have a chance to cultivated.

Materials and Methods

The research was conducted in Singkarak Lake West Sumatera Province, in foodplain, Pematang Lindung sub district Mendahara Ulu Regency East Tanjung Jabung, Jambi Province, and in foodplain Mentulik Regency Kampar Kiri Hilir Riau Province. Data collected *C. lucius* samples in January, June and November 2012. Sampling fish from each study site respectively by 10 heads each sampling time thus totaling 30 individuals each habitat [Fig-1] by using traps and fishing gear. Sampling points chosen based on the location of fishing grounds *C. lucius* is often done by fishermen. The position of each study site habitat is determined by means of Garmin's GPSMAP 60CSx type Sensors and the habits description [Table-1].

Fig. 1- *Channa lucius* Cuvier

Table 1- Deskription of aquatic habitats of C. lucius sampling

Habitats	Position	Description/Specification
Singkarak Lake West Sumatra Province	100°.26'.15"-101°.31'.46" BT and 00°.31'.46"-00°.42'.20" LS	Elevation waters 360-363 meters above sea level, water temperature 25.66±0.57°C, 1.83±0.20 m brightness, TDS 91.30±0.95 mg/l, TSS 5.93±2.29 mg/l, rocky substrate, littoral depth of 4.36 m±0.32, 7.56±0.40 pH units, dissolved oxygen 5.44±0.25 mg/l, alkalinity 74.06±3.66 mg CaCO3/l, hardness 72.00±3.00 mg/l, conductivity 230.83±15.33 mhos/cm.
Floodplain Pematang Lindung, Jambi Province	108°.24'.20"-108°.25'.20" BT and 00°.16'.60"-00°.27'.21"LS	Elevation waters 10-12 meters above sea level, water temperature 28.66±0.57°C, 0.30±0.05 m brightness, TDS 22.30±2.80 mg/l, TSS 57.00±3.00 mg/l, the basic substrate of mud, water depth of 2.93 m±0.23, 4.50±0.45 pH units, dissolved oxygen 2.61±0.49 mg/l, alkalinity 5.00±1.00 mg CaCO3/l, hardness 3.06±0.11 mg/l, conductivity 5.00±0.78 mhos/cm.
Floodplain Mentulik, Riau Province	101°23'64"-101°.24'.13" BT and 00°.11'.13"-00°.09'.32" LS	Elevation waters 12-15 meters above sea level, water temperature 27.16±1.36°C, 0.44±0.05 m brightness, TDS 16.76±1.12 mg/l, TSS 32.66±5.03 mg/l, the basic substrate of mud, water depth 1.90 m±0.52, 4.40±0.51 pH units, dissolved oxygen 3.92±0.72 mg/l, alkalinity 7.81±0.20 mg CaCO3/l, hardness of 4.05±0.18 mg/l, conductivity 5.50±0.25 mhos/cm.

Examples of *C. lucius* put into a container the size of 120x50x40 cm steroform separately, then transported to the laboratory Integrated Faculty of Fisheries and Marine Sciences Bung Hatta University of Padang. In the laboratory fish samples measured total length (mm) with a ruler measuring accuracy of 1.0 mm and weighed weight (g) with electronic scales brand Shimadzu nearest 0.1 g. Furthermore dissected fish in the abdomen for the observed reproductive organs (gonads) and the determination of the level of maturity of gonads (TKG). TKG morphological observations based on a modified classification of Syandri [21]. Through this stage it can be seen on the female bujuk fish TKG III or IV which is a fish that contain eggs. Calculated fecundity of female fish TKG IV, while the egg diameter was measured from TKG III and IV, the diameter of the eggs in the anterior and posterior only measured at TKG IV.

Fecundity calculation performed two stages, the first stage is to get the eggs that take eggs from parent fish by lifting the entire gonadnya of the stomach and the second stage is to count the eggs using gravimetric methods [22], gonad weight of each fish weighed in units gram and sub gonads weighed as much as 1 gram to determine the number of eggs. Sub section and posterior gonad is anteroir of gonads were then taken and preserved eggs with Gilson solution that aims to harden the eggs and release an egg from the ovary tissue. Gilson solution consisting of 100 ml of 60% alcohol, 880 ml distilled water, 15 ml of nitric acid, 18 ml of glacial acetic acid and 20 g of mercury chloride based Bagenal [22]. The data used for the calculation of egg fecundity of the formula:

F: t = B: b

Where: F = fecundity total

t = number of eggs from the gonad sample (g)

B = Weight of whole gonads (g)

b = weight of sample gonads (g)

To estimate the absolute 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 Ricker (1975) as follows:

$F = a_1 L^{bl}$ atau Log F = log a+b log L.

$F = a_2 Bt^2$ atau Log F =log a+b log W

where:

F = fecundity (item)

L = total length of fish (mm)

Bt = body weight of fish (g)

a and b = constants

To obtain information about the type of fish meal coaxed three size groups, namely the size of 100-200 mm, 201-300 mm size and the size of 301-400 mm, respectively taken as many as 30 fish samples from Singkarak Lake, floodplain Pematang Lindung Jambi and floodplain Mentulik Riau. Fish samples were obtained taken digestive apparatus and stored in labeled containers. Furthermore preserved with 10% formalin and analyzed stomach contents. Identification of food organisms eaten by fish coaxed observed with the naked eye and a microscope.

Analysis of the type of food used index of preponderance is a combination of the two methods is the method of frequency of occurrence and volumetric methods. This method was developed by Natarajan and Jhingran in Effendie [22] with the formula:

Description:

IP = index of preponderance

Vi = volume percentage of food fish species to-i

Oi = percentage frequency of occurrence of food types to-i

n = number of food organisms

Results and Discussion

Fecundity

There are variations in bujuk fish fecundity among study sites [Table-2], total fecundity *C. lucius* in the range of 194-400 mm total length and body weight of 236-227 g of grain per cow ranged from 1152-3746. Demonstrate the potential value of the eggs produced for one-time spawning.

From the data [Table-2] it can be stated that on the average size of which is approximately equal to the total length ranged from 281.70 to 298.03 mm between aquatic habitats of *C. lucius* fecundity differences significantly (p <0,05). Mean fecundity was highest in fish populations coaxed from floodplain Mentulik Riau, while the lowest is Singkarak Lake. The fecundity differences may be caused by genetic differences between populations of *C. lucius* coaxed the fish from floodplain Mentulik Riau has a value higher that the average heterozygosity 0.3668, compared with *C. lucius* populations from floodplain Pematang Lindung Jambi with heterozygosity values of 0.3449 and Singkarak Lake with heterozygosity value of 0.2186 [4]. According to Wilson and Clarke [9] a low heterozygosity values will cause low fecundity of fish. Absolute fecundity relationship with total length and body weight of *C. lucius* of any aquatic habitat by geometric equations are presented in [Table-3] and [Fig-2] and [Fig-3].

Table 2- Fecundity variation of C. lucius from different habitats (n=30)

Location	Full Length (mm)		Body Weight (g)		Quantity of Egg (item)/Tail	
	Range	Flats±sd	Range	Flats±sd	Range	Flats±sd
Singkarak Lake	194-299	281,70±28,5	120,6-338,0	236,9±59,4	1152-3002	1996±568[a]
Floodplain P. Lindung Jambi	240-292	297,96±37,2	200,3-489,5	327,4±117,3	1155-3746	2196±866[b]
Floodplain Mentulik Riau	245-400	298,03±37,5	156,0-560,0	276,8±88,5	1293-3710	2539±716[c]

Description: superscrip different numbers behind the numbers mean fekuditas indicate 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 West Sumatera	F= 0,00038 $L^{2,730}$	0,67	30	F= 16,1808.$W^{0,875}$	0,55	30
Floodplain P. Lindung Jambi	F= 0,3258.$L^{1,515}$	0,56	30	F= 147,2312.$W^{0,444}$	0,45	30
Floodplain Mentulik Riau	F= 0,2437. $L^{1,625}$	0,62	30	F= 76,7361.$W^{0,617}$	0,45	30

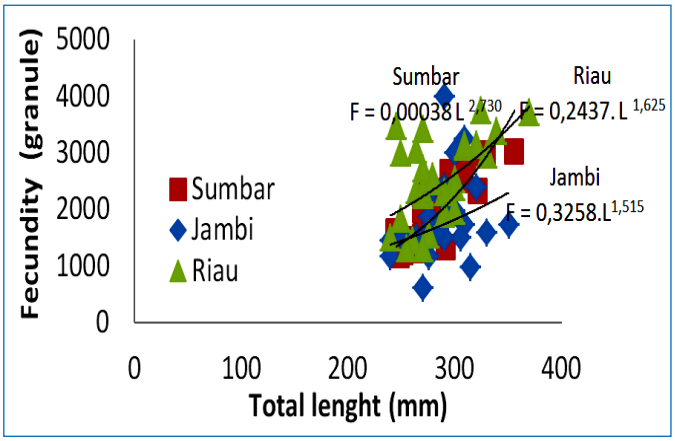

Fig. 2- Correlation between fecundity and total length of *C. Lucius*

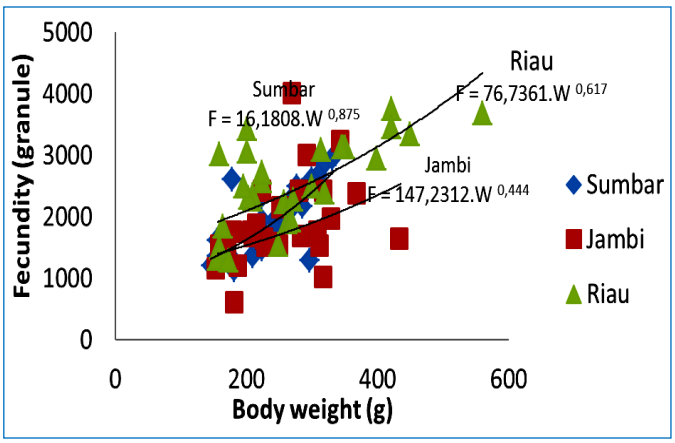

Fig. 3- Correlation between fecundity and body weight of *C. Lucius*

The coefficient of determination (R^2) obtained showed that the value of R^2 fecundity relationship with total length ranged from 0.56 to 0.67 for the third habitat, meaning 56-67% fecundity is determined by the total length, while for the relationship of fecundity with body weight coefficient of determination (R^2) ranged from 0.45 to 0.55, meaning that 45-55% fecundity is determined by body weight. This situation reflects that the length of the body better parameter for estimating *C. lucius* fecundity.

Potential fecundity based on the estimated value of the total long-term relationship with a geometric equation fecundity [Table-3], if the length of each fish habitat 250 mm coaxed the *C. lucius* fecundity alleged Singkarak Lake 1,337 items, from floodplain Pematang Lindung Jambi 1,399 points from floodplain Mentulik Kampar Riau 1,920 grains. Can be stated that the same length then coaxed the fish fecundity of floodplain Mentulik Riau have more fecundity.

Differences in fecundity of each *C. lucius* habitat can also be caused by the availability of food waters. Diversity in Singkarak Lake only 19 fish species [23] in the Batang Hari river and it floodplain are 162 species [23], in the Kampar River and it floodplain are 86 species [7]. More species of fish in a body of water, supposedly the more species of fish that can be eaten by *C. lucius* so as to increase the number of fecundity. The extent of the effect of fish species are eaten by bujuk fish fecundity to in this study can not be disclosed.

Egg Diameter

Diameter of fish eggs coaxed gonad maturity level (TKG) III and IV of Singkarak Lake West Sumatra, marshes floodplain Pematang Lindung Jambi and floodplain Mentulik Kampar Riau [Table-4].

Description: The number superscrip different behind the average number per TKG shows significantly different (p <0.05)

Diameter of *C. lucius* eggs TKG TKG III and IV were significantly different between study sites. Mean diameter of fish eggs coaxed TKG IV derived from floodplain Mentulik Riau greater (1.70±0.14 mm) than the diameter of fish eggs coaxed TKG IV of floodplain Pematang Lindung Jambi (1.53±0.11 mm) and Singkarak Lake West Sumatra (1.35±0.09 mm). Such differences may be caused by genetic differences between populations. Bujuk fish populations based on genetic heterozygosity values of floodplain Mentulik Riau highest from population floodplain Pematang Lindung Jambi and Singkarak Lake [4].

Table 4- Egg diameter of C. lucius based on the gonada development and research location

Lokasi	Egg diameter (mm) TKG III		n	Egg diameter (mm) TKG IV		n
	Range	Flats		Range	Flats	
Singkarak Lake West Sumatera	1,00-1,30	1,12±0,09[a]	50	125-155	1,35±0,09[a]	50
Floodplain Pematang Lindung Jambi	1,15-1,36	1,28±0,25[b]	50	1,32-170	1,53±0,11[b]	50
Floodplain Mentulik Riau	1,17-1,42	1,32±0,06[c]	50	1,40-1,90	1,70±0,14[c]	50

Food available may also cause differences in egg diameter between aquatic habitats. Bujuk fish are carnivorous that has the ability to take a fish species that live in the habitat. In floodplain Pematang Lindung Jambi and floodplain Mentulik Riau have greater species diversity [24,7]. Supposedly the more diversity of fish species that eat will affect the bujuk fish egg diameter. Syandri [21] suggests differences in diameter bilih fish eggs can be caused by the availability of food in the wild. Diameter of bujuk fish eggs almost the same size as the diameter of the eggs fish *Channa argus* diameter ranging from 1.8 to 1.85 mm (Soin, 1960 in [17], egg diameter ranged from 0.9-1.1 mm to *Channa blehari* [17], and *Channa gachua* egg diameter ranging from 2.1 - 2.6 mm [18].

The next diameter size group IV TKG eggs differ between the anterior and posterior in the ovary, suggesting that oocyte development is synchronism coaxing fish group (par groups) found that at least two different populations of oocytes at a rate of gonad development. Based on the type of oocyte development is the type of spawning *C. lucius* that is a partial spawner fish species that do not secrete mature eggs at once on a single spawning, spawning in the river associated with high surface water from rain or flooding. In *C. striata* also found that egg diameters markedly different between the anterior and posterior TKG IV and based on these differences, the nature of *C. striata* is a partial spawning [19]. According to Lowe-Mc Coonell [24] is an adaptation of partial spawning types are favorable for reproduction of fish that spawn in the river associated with fluctuations in water level due to high rainfall or flooding, and at the time the food is plentiful. Among the fish species are partial types of fish species protect egg spawning and fecundity of the fish are usually smaller than the fish spawning the same type but not the eggs.

From the results of this study revealed that the size of *C. lucius* eggs including large eggs will most likely have a large larval mouth opening making it easier to accept natural food such as *Artemia salina* nauplii as food changes of endogenous feeding to exogenous feeding. This opinion is based on research results Syandri [25] for *Tor douronensis* were hatched larvae measure 1.1 mm at the age of four days can take *Artemia salina* nauplii as food for larval survival is natural so it can reach 80%. In contrast to the bilih fish larvae have hatched a new size 0.2-0.3 mm, very difficult to provide natural food and at the age of 13 can take a new day *Artemia salina* nauplii, due to the survival of *Mystacoluecus padangensis* larvae until age 14 days only 30% [21]. In this study the size of the larvae and larval mouth opening coaxing newly hatched fish can not be disclosed. Therefore research is needed coaxing fish hatchery domestication and thus the size and larval mouth opening can be seen to facilitate the maintenance of seed as a potential aquaculture.

Based on field observations of *C. lucius* live in the water calm in the swamps along the river and the flood waters of the lake, hiding under the water plant during the day, evening found actively foraging. Based on these *C. lucius* spawn to make a nest in shallow waters with weak currents as spawning habitat. Author with fishermen find fish larvae pleaded under water plants and shrubs under water. *C. striata* of the clan pleaded with fish-shaped nest made of foam around water plants in swamps, in the form of some sort of foam circle that serves as a protective egg [26].

Food Habits

Based on the analysis of food habits with the largest share index method against three groups of *C. lucius* total length that the first group of size 100-200 mm, 201-300 mm in the second group and third group of 301-400 mm, respectively 30 fish samples of any size group proved the longer the fish size coaxed the percentage of fish food in the form of the higher primary, followed by shrimp, frogs and aquatic insects [Fig-4].

Major food *C. lucius* on three different group sizes and habitat is fish with the largest share index values range from 70.78 to 89.01%, supplementary food is shrimp with index of preponderance ranges from 5.81 to 16.3% and children frog 1, 77 to 3.28%. Based on the stretcher can be grouped coaxing fish to fish purely carnivorous predator [Fig-5]. Species of fish are eaten by fish coaxed from stomach content analysis is *Rasbora* sp, *Anabas testudinae*, *Helostema temmincki*, *Trichogaster trichopterus*. Similarly, the main food *C. striata* is a fish with an average index of 87.79% compared to the bulk with other foods. Fish species mentioned above is that many species are in the flood waters swamp which is also the main habitat of *C. striata* [19].

The percentage of fish as a major food *C. lucius* can not be separated from the nature of the fish as a purely carnivorous predator fish that live in the waters of the river to the swamp flood and freshwater such as Singkarak Lake. On the river and it floodplain habitats have a high level of species diversity [7,23], while in the waters of Singkarak Lake is relatively low [28]. Food habits and food network is determined by the diversity of fish species, species interactions, ecosystem structure and productivity species [27]. According to Lagler, et al [30] fish food habits are influenced by several factors such as season, age of fish habitat and availability of food in his life. It is the fish *Johnius belangeri* is the main meal of shrimp and can not be separated from the main habitat that live in estuarine waters. As we know that in estuarine waters is an excellent habitat for the growth and development of the shrimp [15]. Order of fish food habits differentiated into four categories based on the percentage of the bulk index is the main food, food supplements, food additives and food substitutes [29].

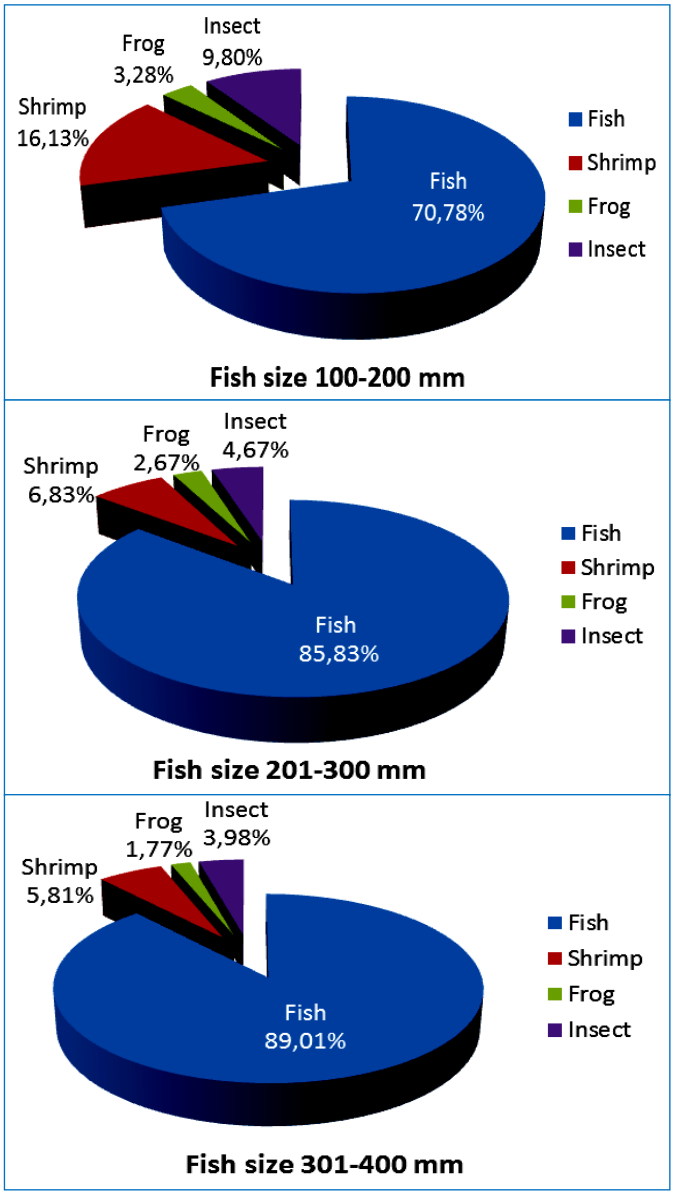

Fig. 4- Histogram of avarage value of *Index Preponderance* (%) for *C. lucius* based on the fish size

Fig. 5- Kind foods of bujuk fish

Based on the results of measurements of intestinal length to 30 *C. lucius* with a total length ranged 270-350 mm with a mean of 310±30.33 mm and 235-310 mm standard length with a mean of 274±27.45 mm, length of intestine obtained coaxing fish ranged from 180 -240 mm with a mean of 206±24.94 mm, coaxing the fish intestine length was 75.18% of the standard length. According Effendie [22] carnivorous fish have short bowel due to carnivorous fish food is meat, so that the digestive process does not require a long process such as fish-eating plants.

Conclusion

1. There are differences in *C. lucius* fecundity at each study site, coaxing the fish fecundity in Singkarak Lake 1152-3002 ranged grains with an average 1996±568 grains/tail, floodplain Pematang Lindung Jambi range 1155-3715 with the average 2196±866 grains/head and floodplain Mentulik Riau range 1293 -3710 with the average 2539±716 grains/tail.
2. There are differences in egg size between habitats, fish eggs coaxed diameter size of Singkarak Lake range 125-155 mm with a mean of 1.35±0.09 mm, floodplain Pematang Lindung Jambi 1.32 to 1.70 mm with a mean of 1.53±0.11 mm and floodplain Mentulik Riau 1.40 to 1.90 mm with a mean of 1.70±0.14 mm.
3. There are differences in the size of the anterior part of the egg with an average of 1.40 mm and 1.70 mm posterior to the flats, so stated the type of *C. lucius* is partial spawning. Size to be breeded egg diameter ranged from 1.35 to 1.70 mm, which spawn in the calm waters overgrown with water plants, nature float eggs on the water surface and is maintained by the parent.
4. *C. lucius* is a major food fish with the largest share index value from 70.78 to 89.01%, from 5.81 to 16.3% supplement shrimp and frog child from 1.77 to 3.28% and food additives aquatic insects. Based on these foods classified coaxing fish to fish purely carnivorous predator with an average length of intestine 75.18% of standard length.

Acknowledgements

We are indebted to Department Aquaculture, Faculty of Fisheries and Marine Science Bung Hatta University for providing full laboratory facilities during the study periods. There is no conflict of interest among the authors for the publication of this research article.

Conflicts of Interest: None declared.

References

[1] Said A. (2007) *Pomfret*, 1(4), 121-126.

[2] Alawi H.P. and Rengi Tang U.M. (2008) *Directory of Commercial Fish in Public Waters Bengkalis, Riau*, Unri Press, 53.

[3] Samuel., Adjie S. and Nasution Z. (2002) *Jurnal penelitian perikanan Indonesia*, 1(8), 1-13.

[4] Azrita (2011) *National Seminar on Water Forum General Mainland Indonesia*, Palembang, 325.

[5] Utomo A.D., Asyari and Nurdawati S. (2001) *Indonesian Fisheries Research Journal*, 1 (7), 1-9.

[6] Nurdawati S., Muflikhah N. and Sunarno T.D. (2006) *Pomfret*, 1 (1), 1-9.

[7] Simanjuntak C.P.H., Rahardjo M.F., Sukimin S (2006) *Indonesian Journal of Ichthyology*, 6(2), 73-80.

[8] Warsa A., Nastiti U.S., Krismono and Nurfiarini A. (2008) *Pomfret*, 2(3), 93-97.

[9] Wilson D.S., Clarke A.B. (1996) *Natural History*, 9(96), 26-28.

[10] Ruzafa A.P., Wanguemert M.G., Lenfant P., Marcos C., Charton J.A.G. (2006) *Biological Conservation*, 129, 244-255.

[11] Syandri H. (1998) *Iptekni Journal*, 2(6), 28-38.

[12]Reidel A., Boscolo W.R., Feiden A., Romagosa E. (2010) *Aquaculture*, 298, 354-359.

[13]Schreck C.B., Contreras-Sanchez W., Fitzpatrick M.S. (2001) *Aquaculture*, 197, 3-24.

[14]Johnston A.T., Wiegand M.D., Pronyk R.J., Dyal S.D., Watchorn K.E., Kollar S., Casselman J.M. (2007) *Ecology of Freshwater*, 16, 295-306.

[15]Prianto E. and Suryanti N.K. (2009) *Pomfret*, 2(6), 257-263.

[16]Jhingran A.G. (1984) *The Fish Genetic Resources of India: Bureau of Fish Genetic Resources*, Allahabad and Maya Press Pvt. Ltd., Allahabad, 82.

[17]Courtenay W.R.Jr. and Williams J.D. (2004) *Snakeheads (Pisces, Channidae) A Biological Synopsis and Risk Assessment*, U.S. Geological Survey Circular, 1251.

[18]Mishra S.K. (1991) *National Symposium on New Horizons in Freswater Aquaculture*, 55-56.

[19]Makmur S., Rahardjo M.F., Sukimin S. (2003) *Indonesian Journal of Ichthyology*, 3(2), 57-62.

[20]Lee P.G and Ng P.K.L. (1991) *Nature Malaysiana*, 16(4), 113-129.

[21]Syandri H. (1997) *Fisheries Journal Crisp*, 2(6), 28-38.

[22]Effendie M.I. (1979) *Fisheries Biology Methods*, Foundation Dewi Sri, Bogor.

[23]Nurdawati S. (1995) *Agricultural Research and Development News*, XVI(4), 4-6.

[24]Lowe-McConnell K.H. (1975) *Fish communities in tropical freshwater their distribution, ecology and evolution*, Longman, London.

[25]Syandri H. (2004) *Journal of Agricultural Dynamics*, XIX(1), 141 -151.

[26]Muflikhah N. (2007) *Pomfret*, 1(5),169-175.

[27]Khan M.F., Panikkar P. (2009) *Ecological Modelling,* 220, 2281-2290.

[28]Syandri H. (2008) *Threats to germplasm Bilih fish (Mystacoleucus padangensis Blkr) and conservation efforts in Singkarak Lake*. Scientific Oration at the inaugural ceremony of the Professors of the Faculty of Fisheries and Marine Science Bung Hatta University.

[29]Nikolsky G.V. (1963) *The Ecology of Fishes*, Academic Press, New York, 563.

[30]Lagler K.F., Bardach J.E., Miller R.R. and Passino D.R.M. (1977) *Ichthyology*, 2nd ed., John Wiley and Sons, New York 505.