Food preference, growth pattern, condition and reproduction factors of kissing gourami, *Helostoma temminckii* in the peat swamps of South Sumatra, Indonesia

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Abstract. The objective of this study is to disclose the preferences and the availability of feed, growth patterns and reproductive biology of the kissing gourami (*Helostoma temminckii*), locally known as "tembakang", in the peat swamps of South Sumatra, Indonesia. The peat swamps of Kayu Agung City, Ogan Komering Ilir (OKI) Regency, South Sumatera province, Indonesia, host various species of swamp fish with economic value, one of which is the kissing gourami. This fish is able to live in conditions of minimal oxygen and low pH. The study was carried out from February to June 2020. The tools used to catch fish were fish traps called "kemilar", made of wires with 10 cm between them and gill nets with mesh sizes of 2.5 and 4.5 cm. The results showed that the main food group of the kissing gourami was detritus with the index of preponderance or index of the largest portion of 69.06%. The ratio of male to female was 3.9:1, the growth pattern was positive and negatively allometric, the gonad maturity index value of male kissing gourami was 12.54%, and that of the female was 15.52%. The egg diameter ranged from 0.0013 to 0.956 mm, fecundity ranged from 1420 to 6680 eggs, and the maturity stages of male and female gonads were from I to IV.

Key Words: gonads, growth, main food, sex ratio.

Introduction. Ogan Komering Ilir Regency (OKI), South Sumatra, Indonesia, has extensive peat swamps scattered in several areas, one of which is Kayu Agung Sub-district. The peat swamps in OKI Regency cover approximately 500000 ha, consisting of very large lowland areas, about 25% of which is land and 75% is swamp waters (Directorate General of Water Resources 2004). The peatland has an important role for nearby human life and for other living organisms. The ecological function of peat swamps is to control floods and influence the global climate, while other benefits include a direct support for life (Policy Synthesis Team 2008).

The Kayu Agung peat swamp is located in the province of South Sumatra, Indonesia, which is an inland water area with a moderate diversity of intraspecies and interspecies of fish (Muslimin et al 2020), some with economic value, including the kissing gourami (*Helostoma temminckii*), a local favorite, with a selling price between 2.47-3.39 USD in 2021 (Ahmadi 2021). According to Nurmayani (2017), some local swamp fish in the peat swamp waters of OKI Regency are the climbing perch (*Anabas testudineus*), snakeskin gourami (*Trichogaster pectoralis*), snakehead (*Channa striata*), kissing gourami (*Helostoma temminckii*), the Malay combtail (*Belontia hasseltii*), *Pristolepis* spp., *Rasbora* spp. and *Cryptopterus* spp.

Kissing gourami plays an important role in OKI Regency in improving the social economy of the fishing community, and it can also meet the protein needs of the community. According to Lisna (2016), the community prefers kissing gourami because its meat has good organoleptic properties. However, until now, the way to obtain kissing gourami still depends on the wild catch. It is presumed that the kissing gourami decreases in number due to overexploitation. The natural rate of fish catchment has decreased due to the fact that the captured fish are sexually mature and do not have the opportunity to spawn again (Lisna 2016). If this situation continues, it will result in a further decline and threat of extinction. The decrease of fish populations in an ecosystem is caused by human activities that damage the ecosystem, including overfishing (Dudgeon 2006; Ross et al 2008).

Kissing gourami is one of the tropical freshwater fish species of Southeast Asia. This fish has a high tolerance to the environment, including being able to survive in conditions of low oxygen and low pH values, especially in peatlands (Fahmi-Ahmad et al 2015; Thornton et al 2018). Kissing gourami is one of the important species in inland aquatic ecosystems, so its sustainability should be maintained. The objective of this study was to obtain accurate data relating to feed preferences and morphological aspects, reproductive aspects, sex ratio, length and weight relationship, gonad maturity level, gonad maturity index, fecundity and egg diameter.

Material and Method

Description of the study sites. Fish samples were collected from February to June 2020 in the peat swamps of Kayu Agung OKI, South Sumatra Province, Indonesia with three sampling periods in 4 locations (Figure 1). GPS was used to determine the sampling points. A fishing gear made of wire with the distance of 10 cm between wires was used for sampling; the front has a gap to extract the catch that extends from top to bottom, and gill nets have 2.5 and 4.5 cm mesh. Plankton net with a mesh size of 200 μm, containers, a boat, pH meter, DO meter, thermometer, sample containers, Secchi disk, fish surgical instruments, microscope, spectrophotometer, cooler box with ice cubes, a ruler with a precision of 1 mm, Ohaous electric scales with an accuracy level of 0.01 g, computer and stationery were used. Tissues, gloves, 4% formalin, 10% alcohol, aluminum foil, rope, distilled water, label paper, duct tape and hand washing soap were also used.

The analysis of kissing gourami samples and plankton identification were carried out in the Biology Laboratory of the Faculty of Agriculture, Muhammadiyah University of Palembang, South Sumatra Province, Indonesia. Water quality analysis was carried out in the field and at the Laboratory of the Environmental and Sanitation Service of Palembang City, South Sumatera, Indonesia.

Sampling procedure. Fish samples were collected from the catch of fishermen using gill nets installed in the water and from the "kemilar". The captured kissing gourami were transported to the Biology Laboratory, Faculty of Agriculture, Muhammadiyah University of Palembang. The fish were placed into a cooler with ice cubes for euthanasia. The length was measured using a ruler and the weight was determined using a balance.

The fish were grouped into 6 groups based on size and sex. The fish were dissected to see the level of gonad maturity, to determine sex, gonad weight, gonad maturity index, fecundity and egg diameter. The plankton samples were collected using a plankton net. Water sampling was carried out 3 times in February, April and June 2020, 30 L, from the surface and from a depth of 50 cm. Water with plankton collected from a depth of 50 cm was placed in a 30 L container. The filtered plankton sample was put into a sample bottle and fixed using 4% formalin. The plankton in the fish stomach was observed by removing the stomach content, which was placed on a petridish; 3 drops of aquades were added. The content was crushed using tweezers and analyzed using a binocular microscope with 4x magnification. Physical and chemical water parameters were measured *in situ* with a pH meter, a thermometer, a DO meter, and a Secchi disk. Ammonia, phosphate were determined in the laboratory. The water samples were placed in 500 mL sample containers without any preservatives and stored in a cool box. The measurement of water physico-chemical parameters was based on APHA (2005).

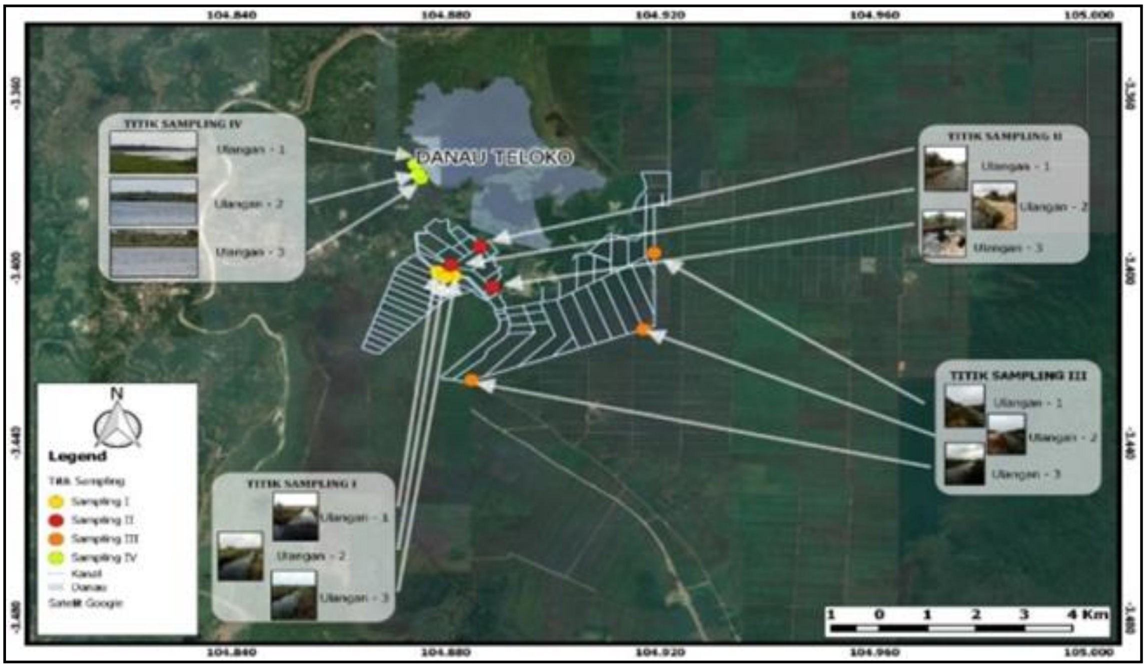

Figure 1. Sampling location.

Plankton diversity index. Fish diversity index was calculated using the Shannon-Wiener diversity index (Nugroho 2006):

$$H' = -\sum_{i=1}^{s} \mathrm{pi.\,In.\,pi}$$

Where: H' - diversity index; pi - number of individuals of each species (pi=ni/N); ni - number of individuals of type i; N - number of individuals of all types. The following criteria were applied to interpret the diversity index values (Khotimah 2013): if H'<1, the diversity is low; if H' is between 1 and 3, the diversity is moderate; if H' is higher than 3, there is a high diversity.

Fish dominance index. The dominance index was calculated using the Simpson formula (Odum 1998):

$$C = \sum_{i}^{n} = 1\left(\frac{ni}{N}\right)^2$$

Where: C - dominance index; ni - number of species to i; N - total number of species. The following criteria was used for interpretation (Nugroho 2006): if C is lower than 0.5, no species dominates the waters; if C approaches the value of 1 (>0.5) then one species dominates the others.

Analysis of fish stomach contents. Gastric analysis was performed to disclose the type of food eaten by fish using the index of preponderance, or the largest part index (Effendie 1979):

$$IP = \frac{Vi \times Oi \times 100}{\sum Vi \times Oi}$$

Where: IP - index of preponderance (the largest part index); Vi - volume percentage of one type of food; Oi - frequency percentage of one type of food; ∑VixOi - number of VixOi of all types of food.

According to Effendie (1979), fish food is classified into 3 parts, namely main food, complementary and additional; if the IP>40%, it is main food, if the IP is between 4-40%, it is supplementary food, and if the IP<4%, it is complementary foods. The analysis was carried out by dissecting the stomach, removing its contents and identifying its constituents, then grouping them according to species.

Length-weight relationship. To determine the growth pattern, the Effendie (1979) formula was used:
W = aLb

Where: W - weight (g); L - total length (mm); a and b - regression constants. There are two types of growth distribution in fish, namely isometric growth (b=3), if the increase in length and weight of the fish is balanced, and allometric growth (b>3, or b<3). A positive allometric growth with a value of b>3 indicates that the weight gain is faster than the length gain. A negative allometric growth with a value of b<3 indicates that the length gain is faster than the weight gain (Effendie 1979). Walpole (1995) states that if the value of the correlation coefficient (r) approaches the value of 1, then there is a linear relationship between length and weight growth. The condition factor was determined using the Fulton formula (Jonsson et al 2012):

$$CF = \frac{W\,x\,100}{L^3}$$

Where: W - weight (g); L - total length (mm).

The data were processed using SPSS with one way ANOVA analysis and tested using the Duncan test. In this study, the dependent variables used were water quality factors (temperature, pH, depth, brightness, turbidity, pH, ammonia, TDS, DO, phosphate and CO2) and morphology (length and weight of fish). According to Anderson & Neumann (1996), if the condition factor value is less than 1, there are problems in the water, the amount of food being insufficient; whereas, if the value of the condition factor is higher than 1, the availability of food in the waters is adequate.

Gender ratio. The sex ratio was determined after dissection. The number of male and female fish caught in each sampling location were compared.

Gonad maturity level (TKG).
TKG was determined based on a formula of Effendie (1997) by observing the morphology of the shape, size and color of the gonads.

Gonad maturity index (IKG). IKG is the ratio of gonad weight to fish body weight at the time of spawning. The IKG value will increase and reach the maximum value when spawning occurs. IKG was measured based on the ratio of the body weight to gonad weight of female fish using a scale with an accuracy level of 0.01 g, with the following formula (Effendie 1979):

$$IKG = \frac{BG}{BT} \times 100$$

Where: IKG - gonad maturity index; BG - weight of gonads (g); BT - body weight (g).

Fecundity. Fecundity was calculated using the gravimetric method (Effendie 1979). The fish gonads were taken and weighed with an electronic scale with 0.001 g accuracy). The number of eggs was counted under a microscope at 10×4 magnification, and entered into the formula:

$$F = \frac{G}{Q} \times N$$

Where: F - fecundity (number of eggs); G - weight of the gonads (g); Q - weight of the sample gonads (g); N - number of eggs per sample gonad.

Egg diameter. Egg diameter was measured using a micrometer scale, then the egg diameter was analyzed in the form of a histogram.

Results

Water physico-chemical parameters. The OKI peat swamp water quality condition is influenced by human activities such as agriculture, plantations, settlements, and fishing. All of the above activities have directly or indirectly affected water quality. Changes in water quality will directly affect the condition of the fish resources in the OKI peat swamp. The value of water quality in the OKI peat swamp (Table 1) was suitable to support fish life.

Table 1

The values of physico-chemical parameters of the peat swamps of Kayu Agung

Parameter	*Month*			*Reference*	
	February	*April*	*June*		
Temperature (ºC)	27-33.2	29.1-33	26.3–27.7	28.7-31.2[a]	30[b]
Depth (cm)	40-310	60-300	70-90	100-220[a]	130[b]
Clarity (cm)	22-75	14.8–60.5	14.2-35	10-34[a]	0.85[b]
Turbidity (NTU)	3.14–32.5	0.44–28.2	5.28–15.2	-	
pH	3.3–3.6	3.5–4	3–4.5	5.7-7.3[a]	4.5[b]
DO (mg L^{-1})	3.7–5	4.4–5.5	4.4–5.6	4.2–5.9[a]	4.3[b]
Ammonia (mg L^{-1})	0.14–3.32	0.96–2.6	0.9–3.15	-	-
TDS (mg L^{-1})	19-91	17-75	20-72	-	-
Phosphate (mg L^{-1})	0.19–3.16	0.24–2.14	0.07-119	0.10-0.49[a]	0.06-0.11[b]
CO_2 (mg L^{-1})	0.3–0.6	0.4–0.6	0.3–0.6	-	

Note: a) Ubamnata et al (2015); b) Prianto et al (2016); DO - dissolved oxygen; TDS - total dissolved solids.

Table 1 shows that the water quality in the peat swamps of OKI is in good condition. Each measured parameter changes in value every month, but the change is minor and the values remain within the threshold of quality standards for fisheries.

Gastric analysis. 173 kissing gourami were caught during the study in the waters of the Peat Swamp of Kayu Agung. The food composition of the kissing gourami identified in the stomach was included in 7 groups: detritus, palm oil, insects, clam shell pieces, caterpillars, fish scales and plankton (Table 2; Figure 2).

The plankton species found enter 10 classes (Table 2): 3 classes of phytoplankton and 7 classes of zooplankton. The most common phytoplanton found is the Bacillariophyceae class. The results of the plankton observations in the peat swamp waters of Kayu Agung, OKI, show that the percentage of the Bacillariophyceae class is the highest, with 118.48 individuals (37.42%) (Table 3), and the species with the highest number was *Hemiaulus haucki*, with 28.31 individuals (23.89%). Bacillariophyceae is the most present both in the waters and in the stomach of kissing gourami.

Table 2
The composition of plankton types found in the stomach of kissing gourami (*Helostoma temminckii*)

Plankton class	*Plankton genera*
Chlorophyceae	*Navicula, Chlorella, Closterium, Mougeotia, Striatella, Spyrogyra, Asterionella, Cosmarium, Hyalotheca, Spondylosium*
Cyanophyceae	*Oscillatoria, Aphanizomenon, Melosira, Aphanocapsa, Trichodesmium, Nodularia.*
Bacillariophyceae	*Hamialus, Cyclotella, Cerataulina, Synedra, Nitzschia, Rhizosolema, Thallasiothrix, Tabellaria, Coscinodiscus, Coscinosira, Diatoma, Fragillaria*
Magnoliopsida	*Eurytemora, Nauplius*
Branchiopoda	*Daphnia, Bosmina,*
Maxillopoda	*Diaptomus, Cyclops*
Rotifera	*Branchionus*
Malacostraca	*Brachyscelus, Lanceola*
Tintinidaeae	*Tintinnopsis*
Monogononta	*Notholca*
Chlorophyceae	*Navicula, Chlorella, Closterium, Mougeotia, Striatella, Spyrogyra, Asterionella, Cosmarium, Hyalotheca, Spondylosium*
Cyanophyceae	*Oscillatoria, Aphanizomenon, Melosira, Aphanocapsa, Trichodesmium, Nodularia.*
Bacillariophyceae	*Hamialus, Cyclotella, Cerataulina, Synedra, Nitzschia, Rhizosolema, Thallasiothrix, Tabellaria, Coscinodiscus, Coscinosira, Diatoma, Fragillaria*

Figure 2. Stomach contents of the kissing gourami (*Helostoma temminckii*).

Index of preponderance (IP) of the food of kissing gourami. The results of the analysis of the kissing gourami stomach showed that detritus was most abundant (69%) and fish scales had the lowest value (1%) (Figure 3).

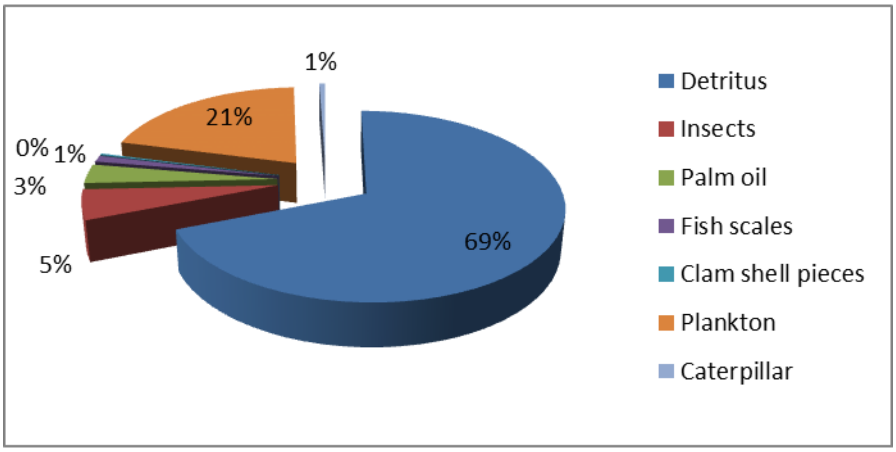

Figure 3. Food in the stomach of kissing gourami (*Helostoma temminckii*).

The analysis of the stomach contents revealed that the most dominant food group as the main food was detritus, with an IP of 69.06%, while the lowest IP value was for complementary food, namely scales, insects, shellfish and palm oil. Plankton was as an additional food with an IP of 21% (Figure 3).

Length-weight relationship of kissing gourami. There were 138 males and 35 females. The total length values of kissing gourami ranged between 71 and 148 mm. The largest number of fish was in the 110-122 mm size interval, 59 fish, while the lowest number was in the range of 136-148 mm, 5 fish (Table 3).

Table 3

Male and female kissing gourami (*Helostoma temminckii*) grouped by length range

Parameter	*Total Length (mm)*
February	71 - 83
	84 -96
	97 - 109
	110 -122
	123 -135
	136 - 148
April	71 - 83
	84 -96
	97 - 109
	110 -122
	123 -135
	136 - 148
June	71 - 83
	84 -96
	97 - 109
	110 -122
	123 -135
	136 - 148
	Total

The length-weight relationship of male kissing gourami had the formula W=0.000006L3.2492; the value of b=3.2492 was obtained. The female kissing gourami had the formula W=0.000001L3.0811; the value of b=3.0811 was obtained. The correlation coefficient (r) for male fish was 0.892836, and that of females was 0.832365; the correlation coefficient values are very strong, indicating a close relationship between length growth and weight growth. This result is supported by Walpole (1995), who states that if the value of r approaches the value of 1, there is a linear relationship between length and weight growth.

The value of the coefficient of determination (R^2) represents the distribution of weight and length data that follow the regression line. The R^2 value for males was 0.7854 and for the female it was 0.6527, meaning that 65% to 78% of the total length and weight gain variance is shown in the weight-length relationship (Figure 4). The length-weight relationship of males is presented in Figure 4 and Table 4. The growth of the males in February and June is negatively allometric (b<3), while in April it is positively allometric (b>3), indicating that the weight gain is faster than the length increase.

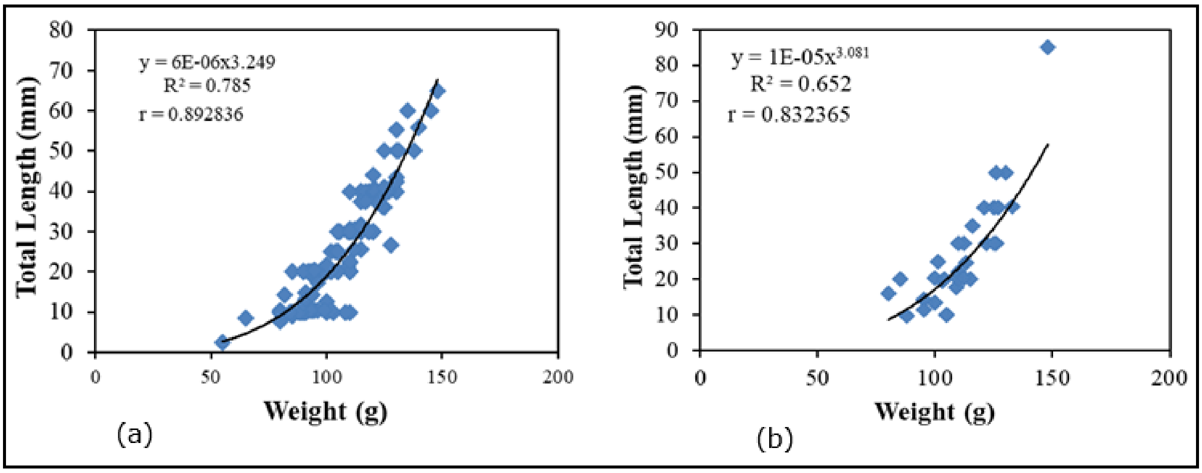

Figure 4. Length-weight relationship of male (a) and female (b) kissing gourami (*Helostoma temminckii*); R^2 - coefficient of determination; r - correlation coefficient.

Table 4

The correlation between length and weight of male kissing gourami (*Helostoma temminckii*)

Month	*Parameter*					Growth pattern
	W	*a*	*b*	*R^2*	*r*	
February	$y=5E-0.5x^{2.7499}$	5E-05	2.7499	0.70	0.73	Negatively allometric
April	$y=5E-06x^{3.3031}$	5E-06	3.3031	0.71	0.87	Positively allometric
June	$y=5E-05x^{2.8309}$	5E-05	2.8309	0.85	0.93	Negatively allometric

Note: W - weight; a - coefficient of determination i; b - exponent showing isometry; R^2 - coefficient of determination; r - correlation coefficient.

The length-weight relationship of females (Figure 4; Table 5) is negatively allometric in February and April, and positively allometric in June.

Table 5

The correlation between length and weight of female kissing gourami (*Helostoma temminckii*)

Month	*Parameter*					*Growth patterns*
	W	*a*	*b*	*R^2*	*r*	
February	$y=0.0906x^{1.1194}$	0.0906	1.1194	0.15	0.460945	Negative Allometric
April	$y=0.0007x^{2.2368}$	0.0007	2.2368	0.65	0.804271	Negative Allometric
June	$y=1E-06x^{3.5853}$	1.00E-06	3.5853	0.98	0.987484	Positive Allometric

Note: W - weight; a - coefficient of determination i; b - exponent showing isometry; R^2 - coefficient of determination; r - correlation coefficient.

Condition factor. The condition factor shows the fitness of a fish from a population in various stages of its life cycle; it is also used as an indicator of the energy condition of the fish (Mutmainah 2013). The condition factors for males and females are presented in Table 6.

Table 6

The average values of length, weight, and condition factor of kissing gourami (*Helostoma temminckii*)

Month	*Male*				*Female*			
	N	*PT (mm)*	*BT (g)*	*CF*	*N*	*PT (mm)*	*BT (g)*	*CF*
Feb	21	98.2 ± 17^{a}	107.9 ± 107.7^{a}	1.55 ± 0.51^{a}	18	101.55±10.1a	87.3 ± 79.5^{a}	1.62 ± 0.62^{a}
Apr	65	100.3 ± 11.2^{a}	52.4 ± 74^{a}	1.99 ± 0.47^{b}	13	116.7 ± 10.8^{b}	86.9 ± 115.5^{a}	1.9 ± 0.32^{a}
Jun	52	115.5 ± 14.9^{b}	776 ± 1435^{b}	2.14 ± 0.34^{b}	4	130 ± 13.3^{c}	55 ± 21.2^{a}	2.41 ± 0.18^{b}

Note: N - number of fish; PT - total length; BT - weight; CF - condition factor; different superscripts show a significant difference ($p<0.05$).

The condition factor of males had the highest value in June, 2.14±0.34, which is significantly different when compared to February and April. The highest value for females was in June, 2.41±0.18, significantly different from February and April.

Sex ratio of kissing gourami. The sex ratio varied based sampling period (Table 7), and gonadal development (Table 8).

Table 7

Sex ratio of kissing gourami (*Helostoma temminckii*) by size ranges

Range of sizes (mm)	*Number of fish*		*Rex ratio*	
	Male	*Female*	*Male*	*Female*
71 - 83	8	0	8	1
84 -96	35	7	5	1
97 - 109	27	10	2,7	1
110 -122	50	12	4,2	1
123 -135	14	5	2,8	1
136 - 148	4	1	4	1

Table 8

Sex ratio of kissing gourami (*Helostoma temminckii*) by sampling period

Month	*Sex*		*Sex ratio*	
	Male	*Female*	*Male*	*Female*
February	21	18	2.6	1
April	65	13	5	1
June	52	4	13	1
Total	138	35	3.9	1

Table 9

Sex ratio of kissing gourami (*Helostoma temminckii*) by gonad maturity level

Level gonad maturity	*Sex*		*Sex ratio*	
	Male	*Female*		
I	25	3	8.3	1
II	79	13	6.1	1
III	32	13	2.4	1
IV	2	6	0.3	1

Gonad maturity level (TKG). The TKG of kissing gourami varied from February to June, for both males and females, from TKG I to IV (Figure 5). Figure 6 presents the stages determined.

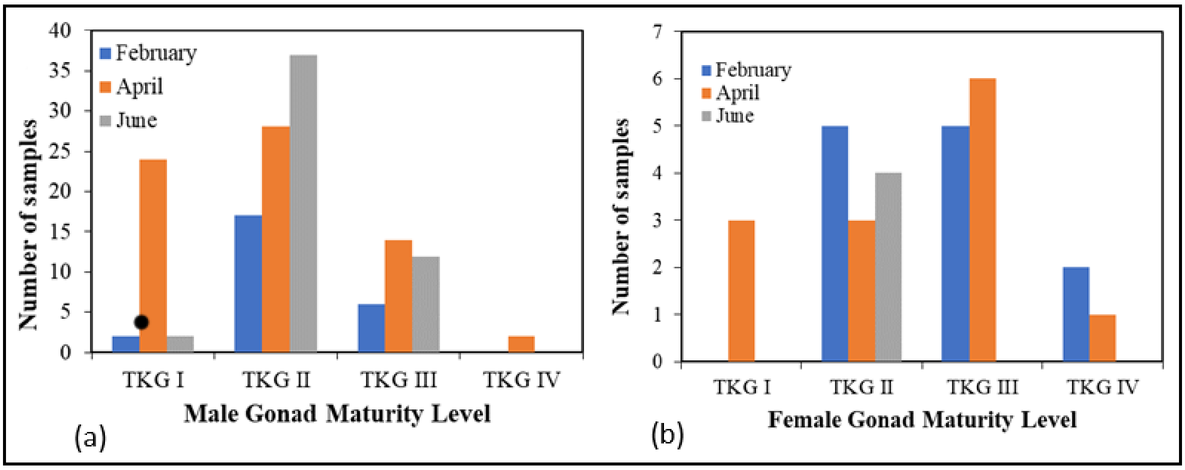

Figure 5. Gonad maturity level (TKG) of kissing gourami (*Helostoma temminckii*).

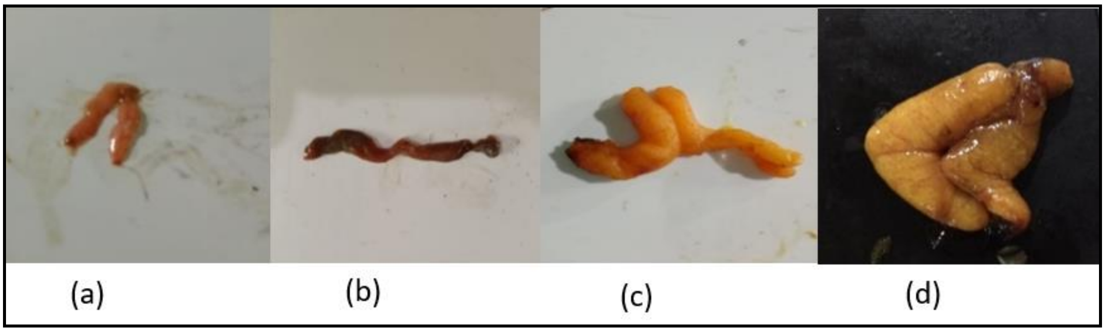

Figure 6. Gonad maturity level (TKG) of female kissing gourami (*Helostoma temminckii*): (a) I; (b) II; (c) III; and (d) IV.

In February, the most frequent TKG in males was II, whereas in females it was II and III. In April, most male had TKG II, while females had TKG III. In June, the most males had TKG II, while all females had TKG II. Overall, both males and females had generally TKG II and III.

Gonad Maturity Index (IKG). The gonad maturity index of the kissing gourami was between 3.78-12.54% for males and between 2.03-15.52% for females (Figure 7).

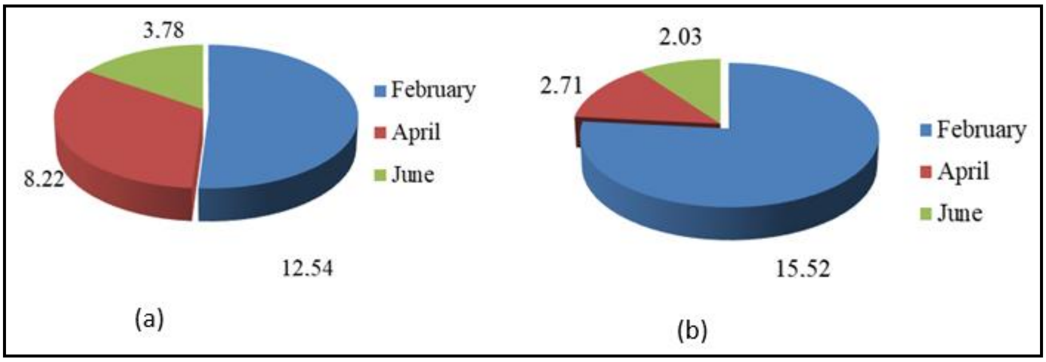

Figure 7. Gonad maturity index of kissing gourami (*Helostoma temminckii*).

Fecundity. The fecundity of kissing gourami in the Peat Swamp of Kayu Agung ranged between 1420 and 6680 eggs (Figure 8).

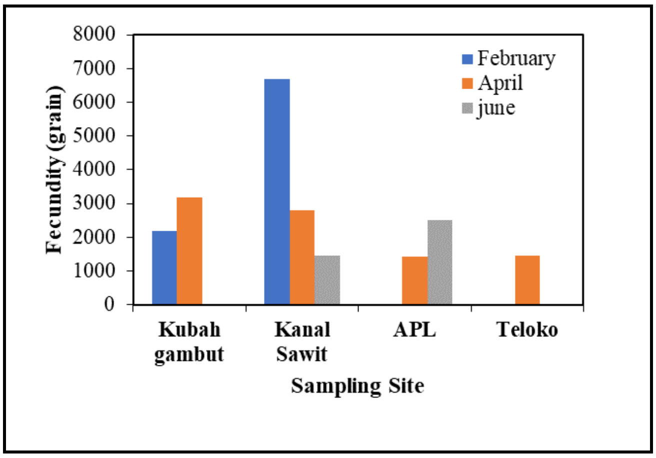

Figure 8. Fecundity of kissing gourami (*Helostoma temminckii*) in the peat swamp of Kayu Agung.

Egg diameter. During the study, the diameter of the kissing gourami's eggs ranged from 0.0013 to 0.956 mm (Figure 9). This size was different every month; in February, it ranged from 0.192 to 0.493 mm, in April it was between 0.0013-0.956 mm and in June it ranged from 0.848 to 0.955 mm. The relationship between egg diameter and body length is presented in Figure 10.

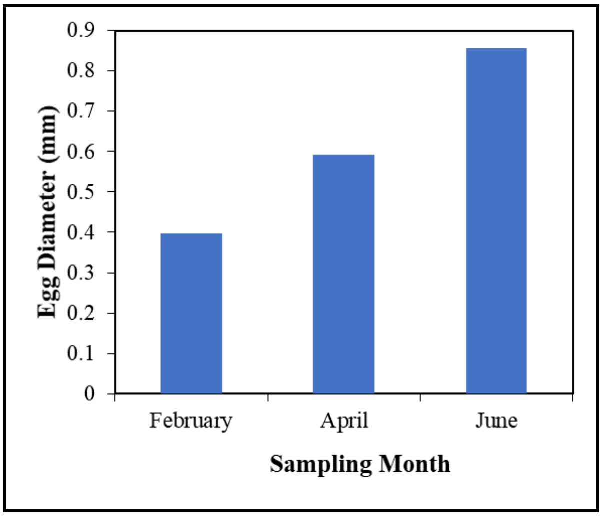

Figure 9. Diameter size of kissing gourami (*Helostoma temminckii*) eggs.

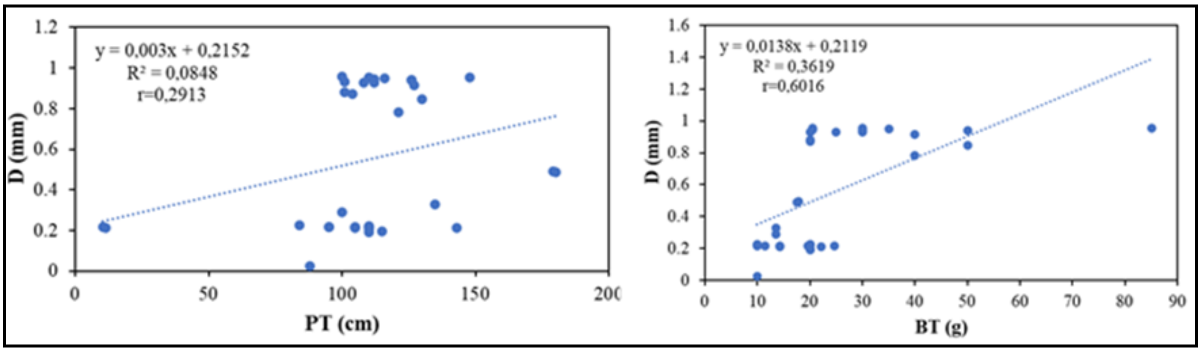

Figure 10. The relationship between egg diameter and body length (a) and body weight (b) of kissing gourami (*Helostoma temminckii*); D - diameter; PT - total length; BT - weight.

Discussion

Water physico-chemical parameters. The pH, DO and temperature are important for the growth and reproduction of fish and can be limiting factors. The pH in the location of the study ranges from 3 to 4.5, being acidic. This value is similar to that obtained by Haryono & Tjakrawdjaya (2000), where the pH in peat swamps ranged from 3.5 to 4.8. The values are also similar to those obtained by Prianto et al (2016) (4.5) and Ubamnata et al (2015) (5.7-7.3). Low pH is caused by the large amount of organic matter derived from decaying vegetation in the swamps.

The difference in temperature (27-33.2°C) in this study is probably caused by the change of seasons, from the rainy season to the dry season. In the rainy season, the water temperature is lower, while in the dry season the water temperature increases. The optimal temperature for kissing gourami growth is 28-32°C (Effendie 2003). DO values tended to be low, due to the decomposition and oxidation of organic and inorganic materials (Ma'ruf et al 2018). Ma'ruf et al (2018) state that fish in swamp waters can adapt to low oxygen values because they have an additional breathing apparatus, the labyrinth. This organ is in the form of gill chambers with small folded pockets, equipped with blood vessels to absorb oxygen (Asyari 2007). Kordi & Andi (2009) stated that ammonia content exceeding 1 ppm is harmful to fish. Ammonia levels in the study location ranged from 0.14 to 3.32 mg L^{-1}. This value is high, but can still be tolerated by fish. The ammonia in peat swamps comes from plant debris in the swamps. According to Yuliana et al (2012), the main source of ammonia is organic materials, metabolic activities and the process of decomposition of organic materials, especially those that contain high levels of protein. The level of turbidity in the peat swamps of Kayu Agung ranges from 0.44 to 32.5 cm. The high turbidity is caused by the large number of suspended particles that come from the decomposition of water plants and detritus. Ubamnata et al (2015) state that the low penetration of light entering water is caused by the large number of dissolved particles and organic materials that have accumulated from the water plants remains. The highest turbidity occurs in February, because it is a transition season from the rainy season to the hot season, causing a mixture of water masses by currents and an increase in particles carried by currents. Water transparency and total dissolved solids (TDS) are interrelated water parameters; a higher value of TDS decreases transparency. The highest transparency was in February.

The phosphate value in waters should not exceed 1 mg L^{-1} (Effendie 2003). If there is excess phosphate, eutrophication will occur. The phosphate level determined in the study far exceeds 1 mg L^{-1}, reaching 11.9 mg L^{-1}, due to high input of phosphate from agricultural activities, plantations, rice fields that use fertilizers and residual fertilizers, which enter the study location through washing of the land by rainwater. The phosphate value is lower than the results of a study in the Bawang Latak swamp, which ranged from 0.07 to 0.60 mg L^{-1}, due to fish and agricultural feed waste (Ubamnata et al 2015).

Gastric analysis. A large number of Bacillariophyceae was found in the stomach of kissing gourami because they are abundant in the waters of the peat swamps of Kayu Agung, OKI. According to Rosita (2007), the Bacillariophyceae class is mostly found in water. Zahid (2011) states that phytoplankton of the class Bacillariophycaea are small, easy to digest and capable of carrying out photosynthesis. The results of the study showed that the largest plankton class was Bacillariophyceae.

Index of preponderance (IP) of the food of kissing gourami. Our results are similar to the results of Tafrani (2012), who determined that the most dominant food in Lubuk Lampam waters was detritus for climbing perch (*Anabas testudineus*). The dominant value of detritus is due to the availability of abundant food sources in the waters, in the form of organic waste originating from vegetation. According to Effendie (2002) and Simanjuntak et al (2006), fish appetite is influenced by several factors, including the availability of food in the water, and the texture and the color of the food. The results of the calculation of the IP of the captured kissing gourami show that they eat various food, so they are classified as omnivorous. The dominant type of food eaten by kissing gourami is detritus with organic waste from water plants. Prianto et al (2016) stated that the food of kissing gourami mainly consists of phytoplankton, with a small portion of zooplankton. The most common types of food found in OKI's peat swamps are aquatic plant groups (vegetation). The study was conducted in the dry season, which caused changes in the amount of food availability, temperature, fish foraging and spawning activities (Wellcomme 1979).

Length-weight relationship of kissing gourami. The results showed that the relationship between the length and weight of male and female aquaculture fish was close, but varied, with a negative allometric growth pattern. These results are similar to the results of Ahmadi (2021), where kissing gourami from the Batang River grew negatively allometric. This was due to unfavorable water conditions, which caused a reduced food availability. According to Ubamnata et al (2015), negative allometric patterns in fish are caused by unfavorable aquatic environmental conditions, such as reduced total organic matter content and low food availability, resulting in stunted growth. According to Nikolsky (1963), the variation in growth patterns in an aquatic environment depends on its conditions and on the food availability that can support the growth of organisms. Furthermore, according to Effendie (1979), apart from food factors, the growth pattern of fish is also influenced by differences in the level of maturity of the gonads and their gender.

Condition factor. The values of the condition factors of males and females are relatively the same. This situation occurs because the amount of food available in the peat swamp waters of Kayu Agung is in stable conditions; this can be seen from the value of the condition factor, which is more than 1. The condition factor is also influenced by the management of fisheries, biotic and abiotic factors (Murphy et al 1991; Blackwell et al 2000).

Sex ratio of kissing gourami. The kissing gourami is a heterosexual fish, eggs and sperm being found in different individuals, so the development of testes and ovaries is separated from the larvae phase, and fish that are male or female remain the same throughout their lives (Lisna 2016). According to Sjafei (2012), there are two stages of fish gonad development: the sexual maturity stage, namely the development of the gonads to sexual maturity and the maturation stage of sexual products (gametes) that occurs when the fish is an adult. The sex of male and female kissing gourami is difficult to distinguish, but when it starts to reach maturation, the gonads are already visible. According to Lisna (2016), the dimorphism of kissing gourami can be seen in the color, males being brighter than females, with a coarser head surface; females are smoother, and the stomach surface of males is slightly more slender.

The data obtained during the study showed that male fish were predominant in the peat swamps of Kayu Agung. Table 8 shows that almost all size ranges (mm) have a high male to female sex ratio. Thus, it is difficult to determine when the kissing gourami has the potential to produce eggs. However, it is suspected that it spawns at sizes between 97 and 148 mm.

The larger number of males was probably found due to the uneven distribution, different types of spawning and growth patterns. According to Lisna (2016), if there is a difference in size and sex, it will cause a difference in the gonad maturity level of each fish. Furthermore, Nikolsky (1963) states that the sex ratio of a species in one population is not the same and varies every year. Ernawati et al (2009) states that the distribution of fish in the waters is not the same because fish migrate.

The results of the comparative analysis of the sex ratio of the kissing gourami in the peat swamps of Kayu Agung based on the level of gonad maturity (TKG IV) is 0.3:1 (Table 9), which means that the fish spawning requires more male fish. Spawning should occur with a 1:1 ratio (Makmur 2003). While the sex ratio of kissing gourami during the study ranged from 3.9:1 (Table 8), this result is greater than the results of Lisna (2016), of 1.25:1. Statistically, this shows a significant difference, which means that there is an imbalance and instability of the ratio between males and females in the peat swamp of Kayu Agung, OKI. The possible cause was that sampling took place during the transitional period from the dry to the rainy season. This situation is supported by the opinion of Rahardjo et al (2011), where in tropical areas such as Indonesia, the sex ratio of fish varies greatly, or there is an imbalance between males and females. There are many factors that contribute to this imbalance, like different locations, seasons and fishing times. According to Aswady et al (2000), the imbalance of the sex ratio in a water is suspected to occur because the captured fish are not in one spawning area. According to Nikolsky (1963), towards the end of the season and during the spawning season, there will be differences in the sex ratio of fish.

Gonad maturity level (TKG). The great number of fish with TKG II and III found is probably because during the previous months, the fish in the peat swamp of Kayu Agung were spawning, and, at that time, there was also a rainy season. This is reinforced by the results of Zworykin (2012), who states that, generally, fish spawn during the rainy season. This is also confirmed by Prianto et al (2014) for a different species, the climbing perch, which has gonad maturity levels of I and II in February, March and June, and III and IV from June to October. Fish gonads will experience development at the end of the rainy season, while in the rainy season the fish spread out for food. This is supported by Kordi & Andi (2009), who note that *Channa striata* spawn at the end of the rainy season and throughout the dry season. Muslim (2017) notes that environmental conditions will affect the growth and development of fish gonads.

The levels of gonad maturity of males and females (III and IV) show that there is a spawning process of kissing gourami in the waters of the peat swamp of Kayu Agung. Based on the TKG, it is suspected that the kissing gourami spawns at its peak between the end of June and early August. In this study, TKG V was not found in males or females. It is assumed that the fish have spawned before reaching TKG V. According to Sulistono et al (2006), kissing gourami found in the Kumpeh Ulu Jambi swamp did not have TKG V, because at TKG IV the sperm had already been released. Brojo et al (2001) note that fish with gonads at TKG IV enter the spawning stage.

Gonad Maturity Index (IKG). The IKG value will increase and reach the maximum value when spawning occurs. According to Effendie (2002), the TKG value will increase if the gonad weight and fish weight will also increase. The IKG peaks just before spawning and decreases afterwards (Effendie 1997). From Figure 7, it can be seen that the highest IKG of kissing gourami males was 12.54% in February. The highest IKG of females was also in February, 15.52%. Based on these values, it can be said that kissing gourami spawned in February (when it rained). According to Lisna (2016), during the rainy season, the amount of food available in the waters is higher, so that the gonad weight of the kissing gourami will be greater and will affect the IKG value. Overall, the IKG value of kissing gourami in the peat swamp of Kayu Agung ranges from 2.03 to 15.52%. According to Amornsakun et al (2004), freshwater fish have an IKG value of 8-10%. Ernawati et al (2009) stated that the IKG value of climbing perch ranges from 0.14-17.77%, which means that the IKG value of kissing gourami in the peat swamp of OKI is similar to that of other freshwater fish.

Fecundity. The fecundity value of the kissing gourami observed during the study varied from 1420 to 6680 eggs. According to Tafrani (2012), the number of eggs or fecundity of the kissing gourami ranges from 19000 to 144104 eggs. Samuel et al (2002) stated that the fish caught in the Arang-Arang Jambi lake, kissing gourami, climbing perch and cork (*Channa striata*) had a fecundity of 2193-13600 eggs. Makmur (2006) found that the climbing perch with body weights between 15-110 g and gonad weights of 2.42-15.96 g had fecundities ranging from 4882 to 19248 eggs. The fecundity value obtained in the current study is lower than the results of Tafrani (2012). This situation is caused by environmental factors of the peat swamp of Kayu Agung, OKI, which are not supportive, including food availability and other environmental factors. Food from the plankton group is dominated by 1 class, namely Bacyllariophyceae, both in the stomach and in water.

This is supported by Prianto et al (2014), who notes that low fecundity can be caused by spawning behavior and less supporting environmental factors. Furthermore, a low fecundity is caused by the presence of fish groups that have already spawned and will cause different egg production and uneven distribution.

Egg diameter. According to Effendie (1997), the egg diameter will determine the quality of the yolk. If the fish eggs are large, the resulting larvae will also be large. Overall, egg diameter during the study was similar to that found by Jacob (2005), ranging from 0.61 to 1.2 mm, by Prianto et al (2014), ranging from 0.35 to 2.215 mm, and by Patowary & Dutta (2012), which ranged from 0.56 to 0.8 mm. The difference in fish egg diameter is probably caused by genetic factors from the fish population. According to Sumpter (1990), the egg diameter is caused by genetic factors and fish population. The results of the analysis of the relationship between length and body weight with egg diameter show correlation coefficients (r) of 0.2913 and 0.6016, respectively. The value close to 1 means that the correlation coefficient is very strong. It means that there is a close relationship between growth in length and weight and egg diameter. The R^2 values of 0.0840 and 0.3619 show that the egg diameter is influenced by body weight and body length, respectively. A greater body weight and length will increase the egg diameter.

The correlation coefficient value indicates that there is a close relationship between growth in length and weight. The egg diameter can be influenced by the quality and quantity of feed (Helmizuryani et al 2020).

Conclusions. The main food of the kissing gourami in the peat swamp of Kayu Agung, OKI, Indonesia, is detritus with an IP of 69.06%; complementary foods are in the form of fish, insects, shellfish and palm oil, while plankton is an additional food. The fish have a high reproductive potential value, with fecundity ranging from 1420 to 6680 eggs, and gonad maturity levels from I to IV. Male gonad maturity index values were greater than those of females. Further studies need to be carried out at a cultivation scale to optimize the production of kissing gourami in the future.

Acknowledgements. The authors would like to thank the Chancellor, Dean of the Faculty of Agriculture, UM Palembang and Chair of the Environmental Science Study Program of Sriwijaya University who have facilitated this study.

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Received: 01 February 2021. Accepted: 23 April 2021. Published online: 30 August 2021.
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How to cite this article:
Helmizuryani, Suwignyo R. A., Hanafiah Z., Faizal M., 2021 Food preference, growth pattern, condition and reproduction factors of kissing gourami, *Helostoma temminckii* in the peat swamps of South Sumatra, Indonesia. AACL Bioflux 14(4):2583-2600.