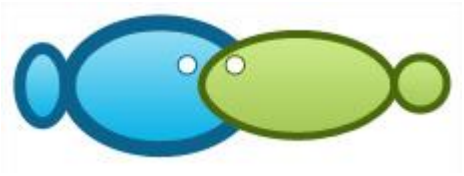

Does the peak spawning activity of *Glossogobius giuris* in Lake Mainit occur in the early months of a year?

Virgilio B. Ratunil Jr., Gregorio Z. Gamboa Jr., Gideon A. Ebarsabal

Faculty of Fisheries, Surigao State College of Technology, Surigao City, Philippines.
Corresponding Author: V. B. Jr. Ratunil, virgiliojrratunil40@gmail.com

Abstract. The white goby (*Glossogobius giuris*) is a dominant fish, mainly caught by many fishermen living in the lakeshore areas of Lake Mainit, Philippines. However, its landed catch has been recently declining, and the present situation requires management intervention so that the fish supply can be sustainable for future generations. This study aims to determine the monthly reproductive performance of *G. giuris* in Lake Mainit. Fish samples were collected monthly from landed catch and each sample was measured to determine the total length (cm), and weighed to determine body weight (g). The gonads of each female were removed and weighed. The gonad maturation degree and egg count were determined. Results showed that the spawning activity of *G. giuris* occurs between January and May. The highest b-values were observed in January and February, with 3.15 and 3.03, respectively, indicating a faster increase in body weight compared to the increase in total length. The highest gonado-somatic index occurred in February, with 9.51±2.69%, while the highest fecundity was found in March, with 164448.83±72959.68 eggs. The number of gravid individuals (stage 4) was determined from January to May, with a peak in March (42.86%). Thus, the peak spawning activity of *G. giuris* occurs in February and March. This finding would help the major stakeholders in the formulation of policies for the conservation and management of fishery resources in Lake Mainit.
Key Words: b-value, fecundity, gonad maturation, gonado-somatic index, spawning.

Introduction. Lake Mainit is the fourth largest lake in the Philippines, with a total area of 17060 ha and a depth of 219.35 m. It is a shared resource of Agusan del Norte and Surigao del Norte provinces, with a shoreline of 62.1 km. The watershed area has 87072 ha, with 28 river tributaries contributing to the water volume of Lake Mainit. The lake is drained by a single outlet, the 29 km Kalinawan River that flows into Butuan Bay (De Guzman et al 2009). The Foundation for Philippine Environment affirms that Lake Mainit is a place of rare and endemic species (Lake Mainit Development Alliance 2009), and its aquatic environment is composed of 41 species of finfish, 10 species of mollusks, and 15 species of aquatic plants (De Guzman et al 2009).

Length-weight relationship (LWR) provides the baseline information regarding the fish that would be beneficial for fishery biologists and conservationists in proposing adequate regulations for sustainable fishery management and biodiversity conservation (Kaur & Rawal 2015). White goby (*Glossogobius giuris*) is a dominant fish catch in Lake Mainit, which affects significantly the economic condition of the people living in lakeshore areas. This fish exhibited a positive allometric pattern (3.25 for combined sexes) indicating a faster increase of body weight than the total length of the fish (De Guzman et al 2009). In the Ganges, Northwestern Bangladesh, white goby is also an important small indigenous fish and has an almost isometric growth pattern for combined sexes (3.068), with slight negative allometric growth for males (2.954) and slight positive allometric growth for females (3.293) (Hossain et al 2009). LWR of *G. giuris* was also determined in Payra River, Patuakhali, Bangladesh, and it showed negative allometric growth in March (2.987), June (2.873), August (2.542), and September (2.524), while positive allometric growth was recorded in April (3.184), May (3.314), July (3.276) and October (3.276) (Roy et al 2014). In Chandigarh, India, LWR of *G. giuris* was

also investigated and the fish exhibited a positive allometric growth pattern, with a significantly high positive correlation (Kaur & Rawal 2015). However, *G. giuris* in the river Singla, Karimganj district, Assam, India, exhibited strong negative allometric growth (1.47), indicating that the river did not present the best conditions for *G. giuris* (Das et al 2017). In Sindh, Pakistan, *G. giuris* is a commercial fish and is considered a delicacy and valuable food fish of Pakistan. However, the fish had negative allometric growth pattern for combined sexes (2.565), males (2.550), and females (2.595) (Achakzai et al 2014), and this result was supported by Mercy et al (2008), with fish presenting b-values less than 3. The growth pattern of the fish is influenced by the availability of food, competition, and predation pressure (Achakzai et al 2014); the reproduction process that can also cause body shape variations among the female population (Ratunil et al 2019).

The spawning period of the fish can be described through its monthly gonad maturation and gonado-somatic index (GSI). The spawning period of white goby (*G. giuris*) in Lake Mainit occurs twice a year (bimodal pattern), from August to September and from December to January, according to Galicia & Lopez (2000). The said information was complemented in 2009, De Guzman et al (2009) revealing that *G. giuris* spawns throughout the year due to the occurrence of ripe males and gravid females in all months, with a single peak of gravid females between January and April. Histological analysis also supports the latter information, because all samples collected from December 2016 to April 2018 from Lake Mainit were at the spawning stage and, thus, male and female individuals were capable of mating all year round (Vedra et al 2019).

GSI is an index of gonad size relative to fish size and is a good indicator of gonad development (Amtyaz et al 2013). In Lake Mainit, no available data states the trend of GSI for *G. giuris* throughout the year, but there were comparisons of GSI among the fish samples in the 4 municipalities of Lake Mainit. Results stated that the GSI estimate for *G. giuris* males was high in Kitcharao, and decreased in Jabonga, but the differences were not significant. Similar results were observed for females *G. giuris*, where the GSI estimate was high in Mainit and decreased in Jabonga, with no significant differences (Vedra et al 2019). In Manchar Lake, Sindh, Pakistan, the reproductive biology of *G. giuris* showed that an increase of GSI was observed in February, but it peaked in March, remaining high from April and June, and declining from July to September (Qambrani et al 2016). In Payra River, Patuakhali, Bangladesh, GSI ranged from 0.064 to 1.697 for males, and from 0.04 to 10.33 for females *G. giuris*. An increase in GSI was observed during the breeding season and had a peak in August (1.23), declining afterward. GSI of females also presented a similar trend, the highest peak being observed in August (8.26) and September (9.34) (Roy et al 2014).

Fecundity is much higher in the wild compared to the one induced in the laboratory for *G. giuris*. The average fecundity of the wild *G. giuris* in Manchar Lake Sindh, Pakistan was 24835.84±10361.74 (Qambrani et al 2016), while the number of eggs was between 8050 and 10070 in induced breeding (Islam et al 2014). No available data about the fecundity of *G. giuris* in Lake Mainit was found, and the fecundity should be determined because the value may vary due to different settings.

This study aims to provide updated information about the status of *G. giuris* in Lake Mainit and can serve as a basis in the formulation of fishery management policies and intervention by major stakeholders aiming for a sustainable catch of *G. giuris*.

Material and Method. 100 *G. giuris* were collected monthly from the fishermen from Brgy, Quezon, Mainit, Surigao del Norte, Philippines, from June 2018 to May 2019. All samples were packed in a 12 kg styrofoam box with ice to maintain freshness and transported to the Surigao State College of Technology laboratory located at Magpayang, Mainit, Surigao del Norte, and each sample was subjected to total length (cm) measurements using a ruler and body weight determination using a digital weighing scale (0.01 g precision). All female samples were selected based on the short fleshy and circular genital papilla (Qambrani et al 2016) and each gonad was extracted to determine gonad maturation, gonad weight, and egg count.

The length-weight equation was used to estimate the relationship between the weight (g) of the fish and its total length (cm) (Le Cren 1951; Jisr et al 2018), using the linear regression of the log-transformed equation:

$W=a\ L^b$

Where: W is the total fresh weight (g) of each fish; L is the total length (cm), and a and b are calculated parameters of linear regression (a is the intercept and b is the slope).

Gonad maturity was determined using the 5-Point Scale used by De Guzman et al (2009): stage 1 – immature; stage 2 - maturing or developing; stage 3 – mature or ripe; stage 4 – spawning; stage 5 – spent.

The GSI is an estimate of the proportion of the gonad mass relative to the total body mass of the fish. It was determined from the ratio of the gonad weight (g) to total body weight (g), where a higher GSI value indicates a higher probability of spawning. The GSI values were calculated following the formula (Qambrani et al 2016):

GSI=Gw x 100)/Bw

Where Gw stands for gonadal weight and Bw for the body weight.

Fecundity represents the reproductive potential of a female fish. 3 sub-samples were collected from gonad samples from the anterior, middle, and posterior portions and weighted. Egg count in every subsample was carried out under the dissecting microscope.

Results and Discussion. Only 955 specimens could be examined due to severe weather in some periods of the study. The total length of *G. giuris* ranged from 6.5 to 19.9 cm for females, and from 7 to 23.6 cm for males. The percentage of males and females in the population was 59.9% and 40.1%, respectively (Table 1). In the LWR, the monthly b-values were considered in describing the growth pattern of male and female *G. giuris* (Figure 1). Positive allometric growth was observed in males (October, November, January, February, and April) and females (September, October, January, and February), indicating a faster increase of body weight compared with the increase in total length. Male and female individuals with b-values less than 3 presented negative allometric growth, in which fish becomes more slender as it becomes longer. In male *G. giuris*, 2 peaks were observed, in October (3.50) and January (3.24). An almost similar trend was also seen in female *G. giuris* in October (3.40) and January (3.15), but the first peak started earlier in September (3.40).

Table 1

Descriptive statistics of *Glossogobius giuris* in Lake Mainit, Philippines

Sex	*No*	*%*	*Minimum length (cm)*	*Maximum length (cm)*	*Mean±SD*
Female	383	40.1	6.5	19.9	12.95±1.73
Male	572	59.9	7	23.6	13.24±2.01

The gonado-somatic index describes the size (weight) of the gonad of the fish projecting the spawning event to occur. *G. giuris* spawn throughout the year in Lake Mainit, but the peak occurs once or twice a year (De Guzman et al 2009; Galicia & Lopez 2000). The monthly values of the GSI are presented in Figure 2. The highest GSI values were 10.43% in November, followed by 9.51% in February, 8.98% in May, and 6.39% and below for the rest of the months showing a trimodal peak.

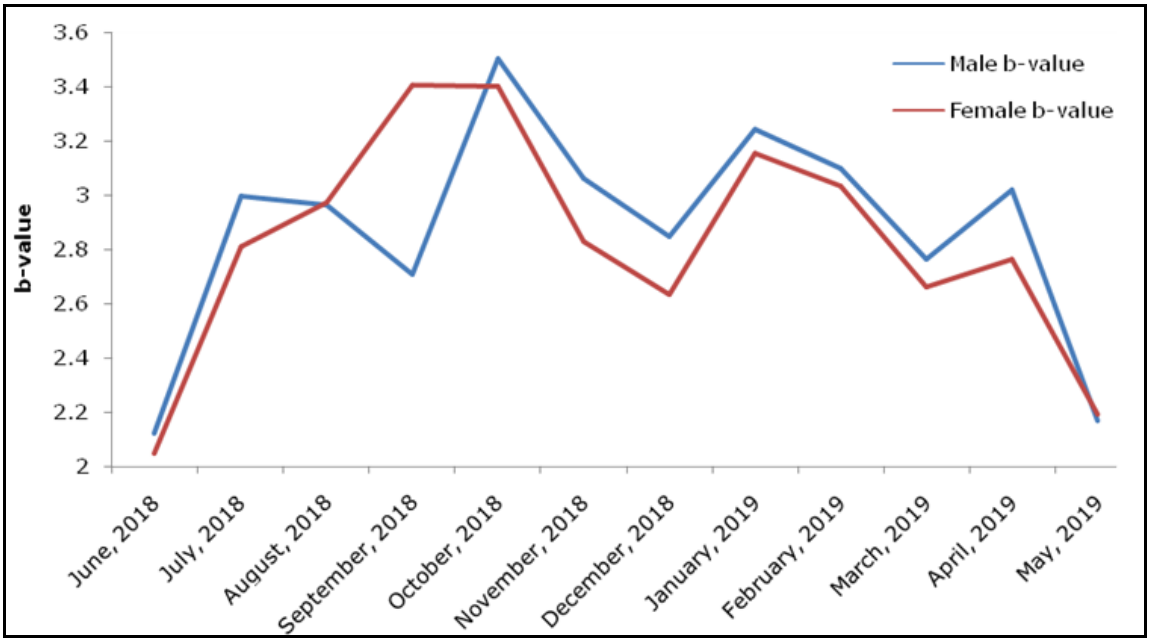

Figure 1. Monthly b-values of male and female *Glossogobius giuris* from June 2018 to May 2019.

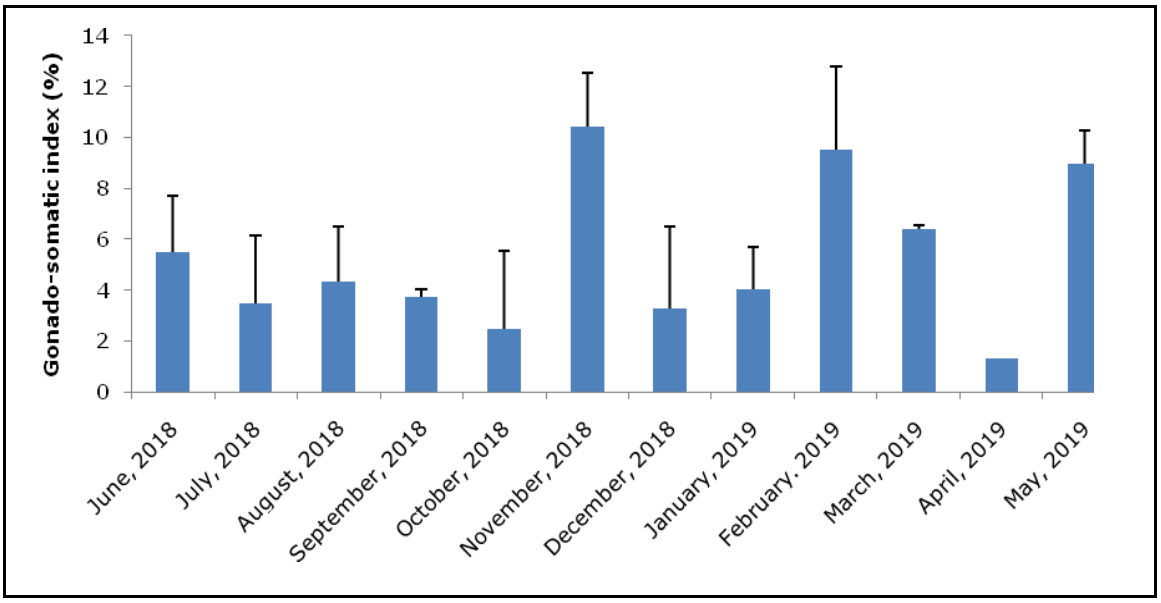

Figure 2. Monthly gonado-somatic index of *Glossogobius giuris* from June 2018 to May 2019.

Monthly gonad maturation is presented in Table 2. The monthly occurrence of developing (stage 3) individuals is prevalent in the study with a peak of 88% in May followed by 68.18% in February and 66.67% in September. In immature (stage 1) individuals, higher percentages were 62.5% in July and October followed by 60% in June and April, while 53.58% and below occurred in the rest of the months, except February and March, in which this stage did not occur. The presence of maturing virgin (stage 2) and spent (stage 5) individuals did not appear monthly and its frequency was very low in the population. Unlike with gravid (stage 4) individuals, it occurred in 5 successive months, from January to May, with a peak in March (42.86%), suggesting that more *G. giuris* are most likely to spawn within these above-mentioned periods.

Table 2

Gonad maturation of *Glossogobius giuris* from June 2018 to May 2019

Months	*Stage 1 (Immature)*	*Stage 2 (Maturing virgin)*	*Stage 3 (Developing)*	*Stage 4 (Gravid)*	*Stage 5 (Spent)*	*(%)*
June 2018	60.00	20.00	10.00		10.00	100
July 2018	62.50	12.50	25.00			100
August 2018	50.00		50.00			100
September 2018	33.33		66.67			100
October 2018	62.50	6.25	25.00		6.25	100
November 2018	53.85	7.69	38.46			100
December 2018	40.00		20.00		40.00	100
January 2019	36.36	9.09	18.18	27.27	9.09	100
February 2019			68.18	31.82		100
March 2019		14.29	42.86	42.86		100
April 2019	60.00		20.00	20.00		100
May 2019	4.00		88.00	8.00		100

The fecundity of *G. giuris* is presented in Figure 3. A single peak was observed in March, with 164448±72959 eggs per female. It was followed by May, with 125245±51036 eggs per female, October with 105198±22872 eggs per female, November with 106770 eggs per female, and the rest of the months with 98000 eggs per female and below.

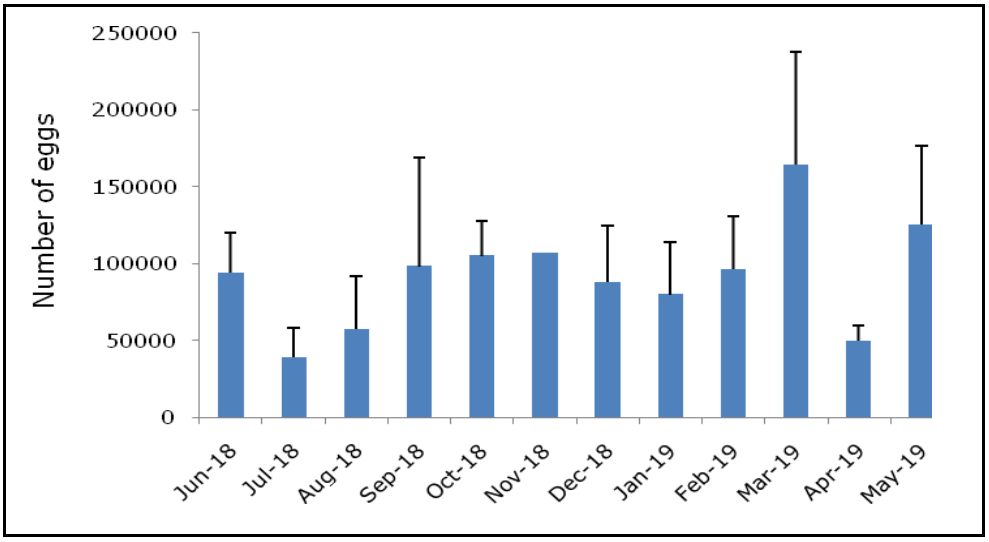

Figure 3. Monthly fecundity of *Glossogobius giuris* from June 2018 to May 2019.

The growth pattern of *G. giuris* was described best in January because the b-values of both male and female individuals rose from December to January and fell from January to March, indicating that breeding activity seemed to occur within the aforementioned period. This is strongly supported by the GSI values, February being one of the peaks with 9.51%. Roy et al (2014) considered August and September, with 8.26% and 9.34%, respectively, as a single peak in GSI for *G. giuris* in the Payra River, Patuakhali, Bangladesh. Based on this study, 1 or 2 spawning peaks for *G. giuris* are eventually occurring in Lake Mainit.

Conclusions. This study has validated the previous findings of the spawning period of *G. giuris* in Lake Mainit. The spawning started in January (80048 eggs per female) and continued to May (125246 eggs per female), with a peak in March (164448 eggs per female). Any fishery management intervention by the local managers must consider the

aforementioned spawning time to protect gravid *G. giuris* from capturing and allow them to spawn in the natural environment so that the optimum yield of marketable sized *G. giuris* will be sustained for future generations.

Acknowledgements. The authors express thanks to the Commission on Higher Education (CHED) of the Philippines for granting the fund to Surigao State College of Technology (SSCT) with the project entitled "Investing Biodiversity Training Center: A Sustainable Community-Based Ecosystem Approach for the Conservation of Lake Mainit".

References

Achakzai W. M., Achakzai S. W. M., Baloch W. A., Qambrani G. R., Soomro A. N., 2014 Length-Weight relationship and condition factor of Tank goby *Glossogobuis giuris* (Hamilton and Buchannan, 1822) from Manchar Lake District Jamshoro, Sindh, Pakistan. Sindh University Research Journal (Science Series) 46(2):213-216.

Amtyaz K. M., Khan M. Z., Hashmi M. U. A., 2013 Studies on gonado-somatic index & stages of gonadal development of striped piggy fish, *Pomadasys stridens* (Forsskal, 1775) (Family; Pomadasyidae) of Karachi Coast, Pakistan. Journal of Entomology and Zoology Studies 1(5):28-31.

Das S., Barbhuiya M. A., Barbhuiya R. I., Kar D., 2017 A study on the length-weight relationship and relative condition factor in *Glossogobius giuris* found in River Singla in the Karimganj district of Assam, India. ISOR Journal of Agriculture and Veterinary Science 10(4):67-69.

De Guzman A. B., Uy W. H., Gorospe J. G., Openiano A. E., Acuña R. E., Roa R. L., Garcia J. P., Ologuin M. M., Santamina J. R., 2009 Sustainable fisheries management program for Lake Mainit. Phase II: comprehensive resource assessment. Final Report. Northern Mindanao Community Initiatives in Resource Management (IFAD-NMCIREMP), Department of Agrarian Reform 13, Lake Mainit Development Alliance (LMDA), PCAMRD-DOST, 73 p.

Galicia A. M., Lopez N. A., 2000 The biology and fishery of indigenous gobies of Mainit Lake, Philippines. ACIAR Proceedings, 98, pp. 375.

Hossain M. Y., Ohtomi J., Ahmed Z. F., 2009 Morphometric, meristic characteristics and conservation of the threatened fish, *Puntius sarana* (Hamilton, 1822) (Cyprinidae) in the Ganges River, northwestern Bangladesh. Turkish Journal of Fisheries and Aquatic Sciences 9(2):223-225.

Islam M. S., Tuly M. D., Hasnahena M., Bahadur P., Hasan M. R., 2014 Induced breeding of freshwater gobi, *Glossogobius giuris* (Hamilton, 1822) in the captivity: a preliminary study. Journal of Fisheries and Aquatic Science 9(1):24-32.

Jisr N., Younes G., Sukhn C., El-Dakdouki M. H., 2018 Length-weight relationships and relative condition factor of fish inhabiting the marine area of the Eastern Mediterranean city, Tripoli-Lebanon. Egyptian Journal of Aquatic Research 44:299-305.

Kaur V., Rawal Y. K. 2015 Length-weight relationship in *Glossogobius giuris* (Ham.) from Sukhna Lake, Chandigarh. International Journal of Science and Research 4:2007-2009.

Le Cren E. D., 1951 The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology 20(2):201-219.

Mercy T. A., Jacob E., Bhaskar R. K., 2008 Length-weight relationship of sixteen species of indigenous ornamental fishes of the Western Ghats of India. Indian Journal of Fisheries 55(4):337-339.

Qambrani G. R., Soomro A. N., Palh Z. A., Baloch W. A., Tabasum S., Lashari K. H., Qureshi M. A., 2016 Reproductive biology of *Glossogobius giuris* (Hamilton), in Manchar Lake Sindh, Pakistan. Journal of Aquaculture Research & Development 7:392-394.

Ratunil V. B., Libay C. P., Borja E. A., Ebarsabal G. A., Gamboa G. Z., Mahomoc D. Q., Manongas J. B., Cabuga C. C., 2019 Analysis of body shape variation in

Glossogobius giuris (Hamilton 1882) sampled from Lake Mainit, Philippines, using geometric morphometrics. International Journal of Fisheries and Aquatic Studies 7(2):287-294.
Roy A., Hossain M. S., Rahman M. L., Salam M. A., Ali M. M., 2014 Fecundity and gonadosomatic index of *Glossogobius giuris* (Hamilton, 1822) from the Payra River, Patuakhali, Bangladesh 2(2):141-147.
Vedra S. A., Roa E. C., Salarda M. Y., Gaid R. D., Roa R. L., Samson J. J., Eballe R. C., dela Peña G. D., Baclayon M. J. O., Rigor M. R., 2019 Reproductive potential of *Glossogobius giuris* (Hamilton 1882) inhabiting the pelagic waters of Lake Mainit, Northeastern Mindanao, Philippines. World Journal of Agricultural Economics and Rural Development 4(1):1-9.
***Lake Mainit Development Alliance, 2009 The Lake Mainit Chronicle. Available at: https://www.slideshare.net/lakemainit/the-lake-mainit-chroniclejanuary-june-2009.

Received: 25 April 2020. Accepted: 21 July 2020. Published online: 30 September 2020.
Authors:
Virgilio Balaba Ratunil Junior, Surigao State College of Technology, Mainit Campus, 8407 Magpayang, Mainit, Surigao del Norte, Philippines, e-mail: virgiliojrratunil40@gmail.com
Gregorio Zurbito Gamboa Junior, Surigao State College of Technology, Narciso St., 8400 Surigao City, Philippines, e-mail: greggy3659@yahoo.com
Gideon Abrenica Ebarsabal, Surigao State College of Technology, Mainit Campus, 8407 Magpayang, Mainit, Surigao del Norte, Philippines, e-mail: gideonabrenicaebarsabal@gmail.com

How to cite this article:
Ratunil V. B. Jr., Gamboa G. Z. Jr., Ebarsabal G. A., 2020 Does the peak spawning activity of *Glossogobius giuris* in Lake Mainit occur in the early months of a year? AACL Bioflux 13(5):2657-2663.