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Research article

REPRODUCTIVE POTENTIAL OF *Glossogobius giuris* (HAMILTON 1882) INHABITING THE PELAGIC WATERS OF LAKE MAINIT, NORTHEASTERN MINDANAO, PHILIPPINES

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ABSTRACT

Aquatic organisms used environmental cues for successful spawning, and that, the organisms themselves should be responsive in case of certain environmental changes. Hence, a study was conducted to describe the reproductive potential of *Glossogobius giuris* inhabiting the waters of Lake Mainit, Northeastern Mindanao. Male and female specimens were collected within the four municipalities, namely: Mainit, Alegria, Kitcharao and Jabonga for a two-year period done quarterly using a locally available modified cast net. Standard methods of preparations and analyses were observed. Results showed that GSI estimates for both male and female followed certain patterns with spawning peaks nearly on the onset of dry season preferably in relatively 'cleaner' areas. Male and female specimens captured had a good proportion of matured and maturing individuals. The histological formations of male and female gonads suggested a year-round spawning pattern. This study suggested that *G. giuris* did vital responses to fluctuations of weather patterns, tolerance to water quality conditions, and wide range of food preference. Therefore, as a proactive means for conservation, it is imperative that catch limit and restrictions be observed to allow adults to spawn, protect the habitat and the entire Lake ecosystem.

Keywords: pijanga, reproductive potential, gonadosomatic index, Lake Mainit

INTRODUCTION

Glossogobius giuris, known locally among the people as *pijanga,* are abundantly found in the four municipalities of Lake Mainit, in Northern Mindanao (Figure 1). They served as important fishery resource and livelihood of the fishing communities. Being abundant and indigenous to that Lake, it is important to know its reproductive biology.

G. giuris belongs to Family Gobiidae, a member of true goby family. It inhabits in almost all aquatic ecosystems including freshwater, estuaries and inshore areas. Its life history is amphidromous and benthopelagic. Phenotypically, it has flattened head, with a lateral profile straight on the middle to convex onwards its head and caudal fin, which is very closely similar to *G. celebius* (UPLB Limnological Research Station 2011). It can complete their life history in freshwater but not restricted to the brackish and marine inshore areas (Maugé, 1986). It inhabits mostly in rock, gravel, or sand bottoms (UPLB Limnological Research Station 2011).

In this study, the reproductive biology of *G. giuris*, is described to account if such information can be translated into proactive means of conservation and management in response to certain environmental changes leading to geographic isolation or habitat restrictions, primarily due to water quality changes.

In some studies, sexual dimorphism is biologically important for determining the morphological traits of species. Sexual dimorphism can be used by fishes as an adaptive mechanism to maximize predator-escape performance and survival capacity. Furthermore, a significant shape variation between populations can be interpreted as due to geographic isolation which serves as physical barrier on the gene pool including predation and biogeographical barriers (Silos et al., 2015).

In case of Etruscan goby *Padogobius nigricans,* sexual dimorphism affect the studied traits, and thus provide useful characters for preservation purposes. Significant intra- and inter-population differences were detected for some meristic traits. In particular most of the studied parameters were affected by ontogeny but not sexual dimorphism except for the caudal fin, for which different values were registered for both sexes in two of the three studied populations. This suggests that the meristic pattern may change from one population to another. Considering the short geographic distance and the similar environmental conditions among the analyzed locations, this differentiation was not expected (Scalici and Gibertini, 2012).

Figure 1. The inhabiting *pijanga* in Lake Mainit showing its phenotypic attributes.

MATERIALS AND METHODS

Study area and specimen collections sites

Lake Mainit watershed covers about 351.40 km^2 extending from the municipalities of Mainit and Tubod in the North; Alegria and Kitcharao in the east; Malimono in the west; and Jabonga in the south, which the water drains at Kalinawan River. Among these municipalities, about 29.11% or 102.30 km^2 of land area is under the jurisdiction of Mainit (Figures 2). This is followed by Jabonga of about 17.84% or 62.70 km^2 and Alegria of about 15.82% or 55.60 km^2. Not far from Alegria is Kitcharao, which covers about 15.37% or 54.01 km^2. The Municipality of Sison covers about 1.2% of watershed which is about 3.39 km^2 (LMDA, 2014 cited in Padilla et al., 2015).

Figure 2. Map of Lake Mainit showing the location of the municipalities of Jabonga and Kitcharao in Agusan del Norte, and Alegria and Mainit in Surigao del Norte.

Collection of *pijanga* specimens

A locally-used cast net fishing gear known as *laya or laja* was used for the collection of *pijanga* specimens and done by the partner fishermen either in whole day or overnight basis depending on wave action and weather conditions. *Pijanga* samples collected in each collection site were subjected to morphometric measurements, extraction of gonad samples. Collection of *pijanga* specimens in four collection sites were done in a quarterly basis for two years.

RESULTS AND DISCUSSION

Gonadosomatic index for *pijanga*

GSI estimates for male *G. giuris* were observed to be high at Kitcharao and decreases at Jabonga. Although not significantly different (Kitcharao: F values = 1.21 and P values = 0.87; Jabonga: F values = 5.13 and P values = 0.21) (Table 1, Figure 3), it may affect the peaks of spawning capacity as may be related to an early sign of sensitivity to water pollution from improper anthropogenic activities nearby.

GSI estimates for female *G. giuris* were observed to be high at Mainit and a decrease at Jabonga. Although not significantly different (Mainit: F values = 1.17 and P values = 0.89; Jabonga: F values = 1.42 and P values = 0.24) (Table 2, Figure 3), the same with the male, the peaks of spawning capacity might be affected as maybe related to an early sign of sensitivity to water pollution from improper anthropogenic activities nearby.

Table 1. The gonadosomatic index (mean ±SE) for male *G. giuris* inhabiting the Lake Mainit, Northeastern Mindanao from December 2016 to April 2018.

COLLECTION SITES	MEAN/SD values	F VALUE	P VALUE
Mainit	0.79±0.09	3.42	0.33
Alegria	0.78±0.05	1.16	0.97
Jabonga	0.73±0.06	5.13	0.21
Kitcharao	0.81±0.04	1.21	0.87

Table 2. The gonadosomatic index (mean ±SE) for female *G. giuris* inhabiting the Lake Mainit, Northeastern Mindanao from December 2016 to April 2018.

COLLECTION SITES	MEAN/SD values	F VALUE	P VALUE
Mainit	0.94±0.05	1.17	0.89
Alegria	0.93±0.04	1.03	0.97
Jabonga	0.86±0.03	1.42	0.24
Kitcharao	0.89±0.05	1.53	0.73

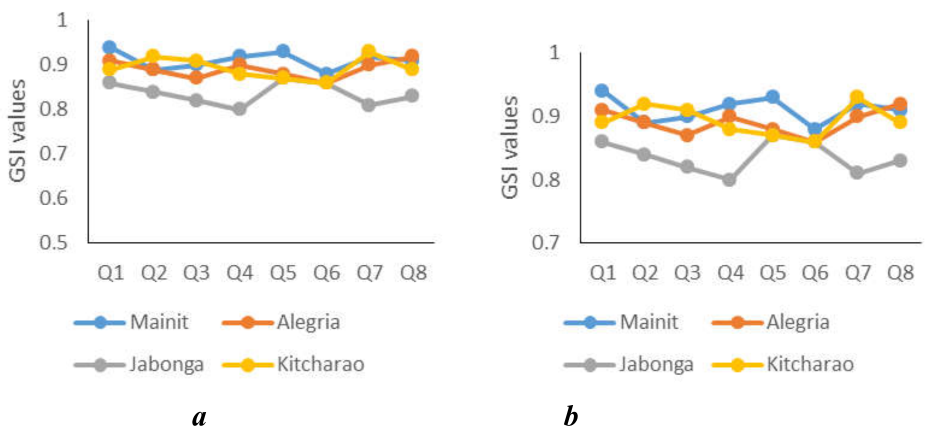

Figure 3. Trend of mean gonadosomatic index values for male (a) and female (b) *G. giuris* inhabiting the Lake Mainit, Northeastern Mindanao from December 2016 to April 2018.

Gonadal stage of *pijanga*

Majority of male *G. giuris* captured were already in matured and maturing stages with a few number at their spawning stage (Figure 4). This implies a relatively favourable reproductive potential in a year round basis.

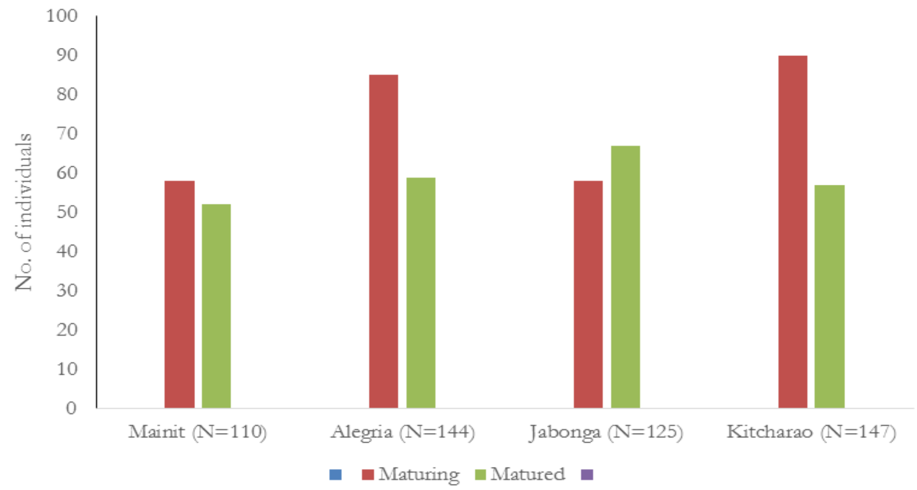

Figure 4. Gonadal maturity values for male *G. giuris* inhabiting the Lake Mainit, Northeastern Mindanao from December 2016 to April 2018.

Female *G. giuris* captured were high in numbers at spawning stages, followed by maturing and matured stages (Figure 5). This result shows that recruitment of each new fingerlings is possible in a whole year round.

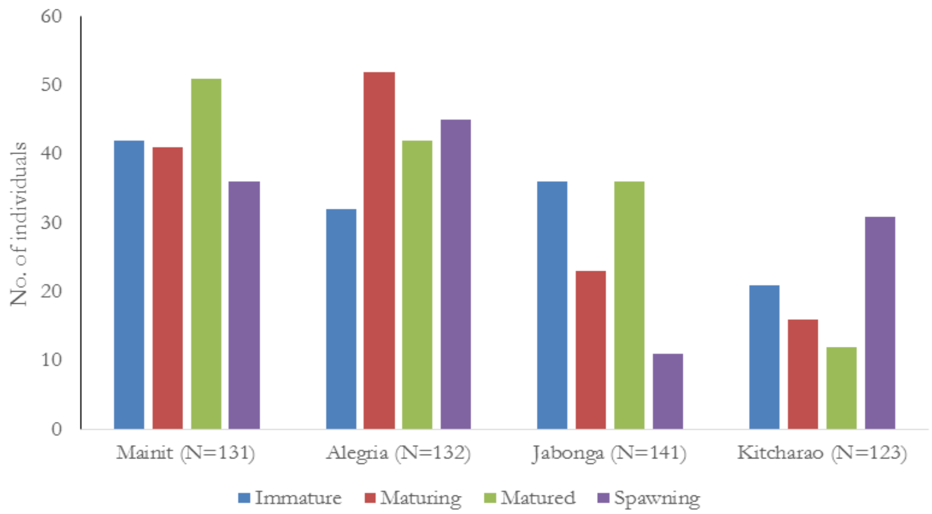

Figure 5. Gonadal maturity values for female *G. giuris* inhabiting the Lake Mainit, Northeastern Mindanao from December 2016 to April 2018.

Histological analysis of gonads of *G. giuris*

The male gonads based on histolological analysis showed that they are capable of mating because they are at spawning stage. Similar findings were observed from Q1 to Q8 December 2016 to April 2018. The histological formations of male gonads are very similar within the sampling periods such that presence of matured spermatocytes are observed, and being followed by the developing primary and secondary spermatocytes (Figure 6). Thus, males are spawners all throughout the year.

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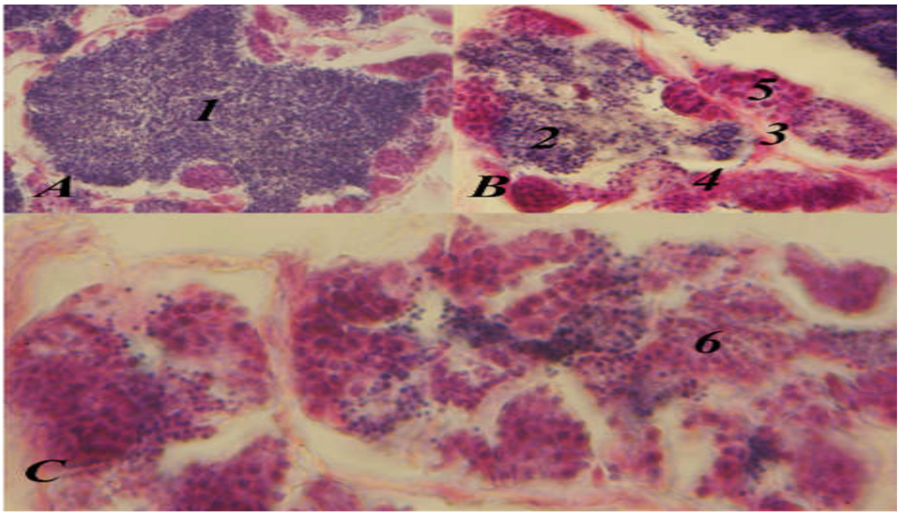

Figure 6. Male *G. giuris* A: a lump of matured spermatocytes (1) ready for spawning, surrounded by developing spermatocytes B: testis section in a spawning condition (2) showing lobules with developing spermatozoa (3) primary and secondary spermatocytes (4) spermatids and (5) spermatozoa. C: the interstitial duct tissues (6) with lobules filled with different stages of spermatogonia and spermatocytes (x100).

Among the females, similar patterns with the males are also observed throughout a quarterly sampling period from December 2016 to April 2018. Female gonads, based on histological analysis responds similarly to male gonads such that they are also at their spawning stage. This is supported by the presence of matured oocytes (which are ready for spawning), and the developing vitellogenic and pre-vitellogenic oocytes, and fully-differentiated oocytes (Figure 7). Therefore, it is assumed that females are also spawners all throughout the year. The availability of fry in various sizes in a year round basis may testify this observation.

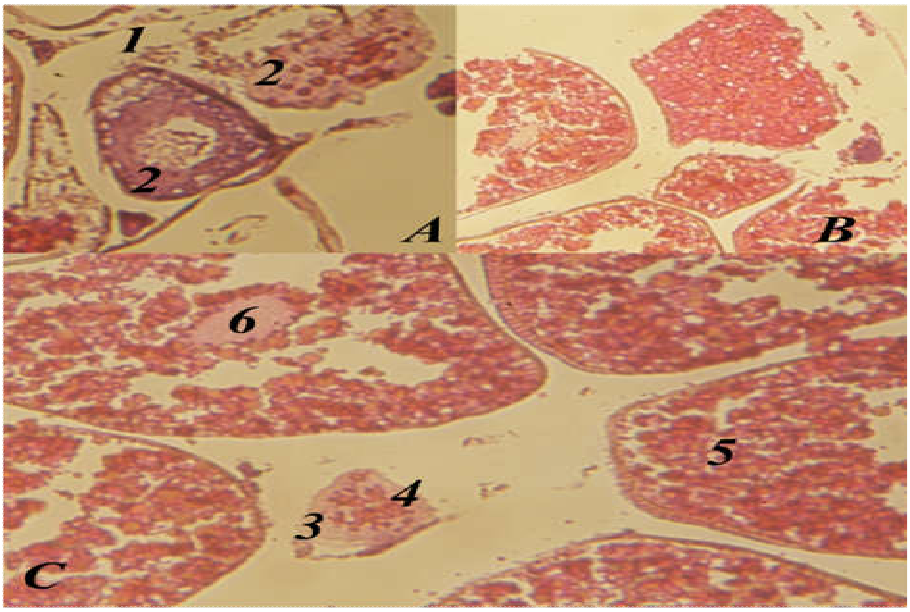

Figure 7. Ovary of *G. giuris* A: a pre-spawning ovary showing pre-vitellogenic developing oocytes (1) and postovulatory follicles (2). B: matured ready-to-spawn oocytes showing fully differentiated egg envelopes. C: the primary (3), secondary (4) and matured (5) oocytes found together in the ovary. Note the wrinkled nuclear envelope with the developing oocytes in a very early stage (6) (x100).

Based on the level of gonadal maturity and the histological profiles of *pijanga* goby, it is observed that it will spawn year-round. However, in their natural habitat, the onset and further process of vitellogenesis and spermatogenesis could not be synchronous among the individual *pijanga*. This could be due to a combined effect of high temperature and long-day regime that elicited the onset of vitellogenesis (Hikada and Takahashi, 1987). In the case of testes, for instance, these factors did not trigger meosis but act only as accelerator (Hikada and Takahashi, 1987). The gonad profiles of *pijanga* might suggest that both male and female can spawn more than once during a breeding season.

In some studies, gonadosomatic index and fecundity of *Glossogobius giuris* was investigated. Variation in fecundity, GSI, total length, body weight and gonad weight
Suggested that it spawned for several months with two spawning peaks: in March and other one extended from June to October (Hossain 2014). This coincided with the observation of the fishers and the present study that peaks of the spawning pattern of *pijanga* is between September to February. Likewise, similar pattern was observed in other species of fish (Kong and Chen 2013; Macinnis and Corkum, 2000; Roy et al., 2014; Kovacˇic´ 2007).

Pijanga is one of the amphidromous species in Lake Mainit, hence its life-history traits especially the pelagic larvae would show high variability between and within species and populations. This could be due to the spatial and temporal variability of the Lake environment. Temperature, food availability and seasonal conditions affect survival and larval growth. Among species with an extensive reproduction period, the pelagic conditions encountered by larvae vary according to the hatching date and induce variability in the postlarval and recruitment traits. Similar observations were observed with *Cotylopus acutipinnis* (Teichert1 et al., 2012).

The observed reproductive potential of *pijanga* will increase knowledge and may improve standard assessment due to its commercial value. This is in response to observed fluctuations of weather patterns, tolerance to water quality conditions, wide range of food preference and may project a record of the level of water contamination.

CONCLUSION AND RECOMMENDATION

The *Glossogobius giuris,* locally known as *pijanga* in Lake Mainit exhibited certain patterns with spawning peaks both male and female nearly on the onset of dry season preferably in relatively 'cleaner' areas. Both male and female specimens captured had a good proportion of matured and maturing individuals that indicated a good quality of habitat and food sources. The histological formations of male and female gonads suggested a year-round spawning pattern. This study suggested that *G. giuris* did vital responses to fluctuations of weather patterns, tolerance to water quality conditions, and wide range of food preference. Therefore, as a proactive means for conservation, it is imperative that catch limit and restrictions be observed to allow adults to spawn, protect the habitat and the entire Lake ecosystem. A concerted efforts among the stakeholders is needed to allow the natural stocks of *pijanga* to attain its optimum growth, and henceforth, would protect the livelihood and food sources especially the marginal fishing communities.

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