Ontogenetic Variation in the Diet Composition of *Glossogobius Giuris* from Taal Lake, Batangas, Philippines

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Abstract- *Glossogobius giuris is an indigenous fish in Taal Lake and is considered to be very important not only due to its reasonable price but also because unlike any other fish, it contains all the nutrients and essential amino acids. Furthermore, this fish is also suitable candidate for artificial culture in the future. Knowledge on the food habits or diet composition is important in evaluating the feeding success of G.giuris which can lead to successful management of stocks in the future.*

Based on the relative importance, it was found out that the insect larvae and debris were the most important prey items of the juvenile G.giuris while the nematode was the least important. Among the prey items consumed by the adult G.giuris, crustacean eggs and fish larvae had the highest relative importance while the cladocerans had the lowest importance. This revealed that the small or juvenile G.giuris tended to consume more midge larvae and copepods. The adult fish tended to consume mostly crustacean eggs and fish.

The trophic level of the juvenile and adult G.giuris revealed that this fish belongs to the second and third level. Based on the calculated trophic level, it showed that this fish can be carnivore, herbivore and omnivore. Lastly, there was a significant difference in the trophic level of the two groups of G.giuris, the juvenile and the adult.

Keywords*: Glossogobius giuris, indigenous fish, Taal Lake, Batangas*

INTRODUCTION

The gobies are one of the largest families of fish. The members of this family are known for their small sizes. They are usually the most abundant freshwater fish that can be found in the oceanic islands. They are concentrated in the tropics and subtropics. Some species of gobies have short marine life-stage and exhibit island endemism. Most gobies are bottom-dwellers and can exploit microhabitats that are not accessible to most other fishes.

There is no exact number of existing gobies but it is estimated that about 2,000 species in more than 200 genera comprised this family. One genus known to this family is the Glossogobius. Glossogobius is a genus that is native to fresh and marine waters but sometimes they can also be found in brackish waters [1]. One species known under this genus is the *Glossogobius giuris*.

Glossogobius giuris or commonly known as the Tank goby can be found not only in freshwater , estuaries and sea but also in canals , ponds, streams with rock and sometimes in gravel or sand bottoms.

G. giuris is indigenous in Taal Lake. This fish is considered very important not only due to its reasonable price but also because, unlike any other fish, it contains all the nutrients and essential amino acids. Furthermore, this fish is also suitable candidate for artificial culture in the future, therefore, many aspects of its biology including the feeding biology are considered as prerequisite.

The main problem of *G. giuris*, being a goby is feeding it because it prefers live food rather than flakes or feeds. Feeding is part of the ecology of fish and as pre-requisite for its management, the studies on this aspect are considered important to properly manage the species, utilize and provide sustainable resources. Knowledge on the food habits or diet composition is important in evaluating the feeding success of fish and understanding of production dynamics of fish stocks. However, it is basically impossible to gather sufficient information of food and feeding habits of fish in their natural habitat without examining and studying its gut contents[2**] .**

One of the objectives of the aquaculture is to determine the food and feeding habits of different fishes. Food studies are important to the fisheries..

Due to the importance of food studies in the fisheries and the significant ecological and economical importance of *G.giuris* and its suitability to aquaculture, there is a pressing need to study the ontogenetic variation / shift in the food and feeding habits of this fish. Since no studies have been conducted in feeding biology of this fish from the site, the researchers have enough reasons in conducting the study. Moreover, if the prey items consumed by the juvenile and adult *G.giuris* are determined, the aquaculture can be established in the future. Data on the food items can help the fisheries in the selection of the live food organism suitable for the fish which is considered very important to the fish especially during the early stages of life. Thus this plays an important role in aquaculture. Success of aquaculture depends on healthy stock and this can be maintained by feeding live food to the fish. The study can serve as an informative reference for the fisheries management.

MATERIALS AND METHODS

Collection of Samples

The researcher requested the fishermen to catch juvenile *G.giuris*. The length of the juvenile ranges from 3 cm to 5.5 cm. To work on the juveniles, an approved special permit for the contact fishermen to catch juvenile was requested from the Municipal Office of Agoncillo, Batangas. Adult G.giuris were also collected by the fishermen for three consecutive months (June- August , 2014). The length of the adult is 6cm to 30.4 cm. A total of 76 individuals (38 juvenile and 38 adult) were collected and also made a three-month study on diet composition of fish[3]. The juvenile and adult samples were stored in separated ice creston, one for adults and the other for juveniles on each sampling and were taken to the laboratory for further analysis.

Preparation of Sample for Laboratory Analysis

The samples were collected in the morning. Just after collection, the juvenile and adult samples were placed in separated container with ice to slow down the digestion. As demonstrated by the BFAR, the fishes were dissected immediately to minimize the bias introduced by the post-mortem digestion. The individual fish gut was carefully extracted by opening the abdominal portion of the fish with the aid of a pointed nose pair of scissors, then it was carefully removed with the use of forceps. The extracted guts were fixed separately in 10 percent formalin solution in order to stop the digestion. The contents were transferred to a petri dish and were kept for five minutes to remove excess formalin.

Determination of the Prey Items that Constitute the Diet of Juvenile and Adult G. giuris

Each content was placed on a slide and was examined through the use of microscope and was identified up to the lowest taxonomy possible with the help of the taxonomist. The contents were then grouped into taxonomic groups/ categories.

Determination of the Relative Importance of each Prey Item.

The relative importance of prey items was determined wherein the frequency occurrence and relative volumetric abundance of each prey item were taken into consideration. The relative importance of each food item was determined by using the formula below:

Pinka's formula for relative importance:

$$RIi = Fi \times Vi$$

where:

RIi = relative importance of prey (i)
Fi = the frequency of occurrence
Vi = the relative volumetric abundance

To determine the frequency occurrence, the number of fish containing prey (i) and the number of fish with food in the stomach were counted .The formula of frequency occurrence (Zacharia) was used:

$$Oi = \frac{Ji}{P}$$

where:

Oi= frequency occurrence of prey (i)
Ji = number of fish containing the prey (i)
P = number of fish with food in the stomach

To determine the relative volumetric abundance of a particular item found in the stomach, a method based on BFAR practice was used wherein the average weight of the stomach was determined and marked as the standard weight (SW). Then, point/s was/were ascribed to each stomach sample based on the weight. Four points were given. If the weight of the stomach falls exactly near the SW, this was then divided by four to ascribe one point ; then it was multiplied by three to ascribe three points, then four and so on. Eight points were ascribed if it is double the SW. Then the points were distributed for each food item in proportion to the volume that each item occupied. The total of the items should be equal to the ascribed point of each stomach. The lowest point was given to each item in proportion to its volume which was 0.5.

The formula below was used to determine the volumetric abundance:

$$V(i) = 25x\ M(i)$$

where:

V(i)= Volumetric abundance

25= Multiplication constant

M(i)= Mean of ascribed points for the (i) food item

To determine the mean of the ascribed points for the (i) food item, the formula below was used:

$$M(i) = \sum(i) / n$$

Where:

M(i)= Mean of the ascribed points for the (i) food item

∑ (i) = Sum of the ascribed points for the (i) item

n = Total number of stomach with food in the sample.

Determination of the Trophic Position of Prey Items of G.giuris

To determine the trophic position of each identified food item, table of values of trophic position by Pauly et al. (2010) was used.

Determination of the Trophic Level of Juvenile and Adult G.giuris.

To determine the trophic level of the juvenile and adult G.giuris, the formula below was used:

Trophic Level (TL) = 1+ (mean of the trophic position)

Statistical Treatment of Data

Independent Samples t-test was used to determine if there is a significant difference in trophic level of juvenile and adult *G.giuris.*

RESULTS AND DISCUSSION

Table 1 presents the prey items that constitute the diet of adult and juvenile glossogobiusgiuris.

Table 1. Prey Items of Juvenile and Adult *G.giuris*

Diet Component	
Juvenile	**Adult**
Insect Larvae (Midge Larvae)	Insect Larvae (Midge Larvae)
Cladocerans (waterfleas)	Cladocerans (waterfleas)
Copepods (Calanoida)	Fish Larvae
Nematode	Debris/Detritus
Debris/Detritus	Crustacean eggs
Small Fish Larvae	Unidentifiable

The present study revealed the identified prey items of the *G.giuris* in Taal Lake. It was found out that it feeds on insects, cladocerans, fish larvae and debris, which are all common to juvenile and adult *G.giuris*. However, there is a difference in the diet of the juvenile and adult *G.giuris*. Copepods and crustacean eggs were also identified but was present only in the stomach of the adult *G.giuris*. Nematode on the other hand was present only in the stomach of the juvenile *G.giuris.*

Furthermore, as stated earlier both the juvenile and adult *G.giuris* feed on debris including sand and mud, this is quite common for fishes since they mistake them for food. Another reason may be due to the fact that this fish is a demersal fish or bottom feeder or fish which creeps on the ground.

The aforementioned findings are similar with some of the studies on food consumption of this species from other countries. The present study is parallel to the study [4] whose samples were obtained from the Gosthani Estuary. The current study showed that, indeed, this species of fish feed on copepods, cladocerans and insect larvae and are part of their diet. However, a study conducted by [5] on this species differed from the present study when it comes to the diet of juvenile.

Table 2 presents the relative importance of prey items consumed by juvenile and adult G. giuris

Table 2. Relative Importance of Prey Items Consumed by Juvenile *G. giuris*

Prey Item	Frequency Occurrence	Volumetric Abundance	Relative Importance
Insect Larvae	0.5946	22.2975	13.2581
Cladocerans	0.1081	2.365	0.2557
Copepods	0.0811	1.69	0.1371
Nematode	0.0270	0.675	0.0182
Debris/ Detritus	0.4594	16.89	7.759
Fish Larvae	0.1081	7.4325	0.8035

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As shown table 2, frequency occurrence and volumetric abundance are the indices that were taken into consideration in the determination of the relative importance of each prey item.

The table reveals that the insect larvae are the most frequently consumed prey items of the juvenile *G.giuris* with frequency occurrence of 0.5946 while the nematode is the least frequently consumed prey with 0.0270 frequency occurrence. The midge larvae and debris also obtained the highest volumetric abundance of 22.2975 and 16.89, respectively and nematode has the least volumetric abundance of 0.675 only.

The table shows that among the prey items consumed by the juvenile *G.giuris,* the midge larvae and the debris have the highest relative importance of 13.2581 and 7.759 while the nematode have the lowest importance, 0.0182 respectively. Findings imply that juvenile fishes prefer to consume insect larvae. They feed mainly on the midge larvae.

These findings are in consonance with those of Alikunhi's findings that the main food of the juvenile fish was insect larvae. However, they were different from Bhowmick's study which showed that the main food of juvenile is crustaceans. Nematodes on the other hand have low importance because of its very low volumetric and abundance d is the least frequently consumed prey. This may account to [6] findings that the prey nematode has qualities such as thick cuticle, annulations and secretions that may protect them from predation.

Table 3 presents the relative importance of prey items consumed by the adult *G. giuris*.

Table 3. Relative Importance of Prey Items Consumed by Adult *G. giuris*

Prey Item	Frequency Occurence	Volumetric Abundance	Relative Importance
Insect Larvae	0.2703	8.1075	2.1915
Cladocerans	0.1081	1.69	0.1827
Crustacean Egg	0.4324	28.715	12.4164
Debris/Detritus	0.2703	14.5275	3.9268
Fish Larvae	0.2973	15.8775	4.7204

Table 3 shows the frequency occurrence and volumetric abundance are also taken into consideration. The table reveals that among the prey consumed by the adult *G.giuris.* Crustacean eggs and fish larvae are the most frequent, having frequency occurrence value of 0.4324 and 0.2973, respectively, while the cladocerans are the least frequently consumed prey with the value of 0.1081. The table also indicates that the crustacean eggs and fish larvae have the highest relative volumetric abundance of 28.715 and 15.8775, respectively, while the cladocerans have the lowest relative volumetric abundance of 1.69.

It reveals that among the prey items consumed by the adult *G.giuris,* the crustacean eggs and fish larvae have the highest relative importance while the cladocerans have the lowest importance. The table indicates that the adult *G.giuris* prefers crustacean eggs and fish larvae. The adult fish tend to consume mostly crustacean eggs and fish because of their ability to ingest larger prey items rather than small prey item. This explains why cladoceran is the least consumed prey item. This supports that as fishes grow, they tend to broaden the size of prey items ingested due to the ontogenetic increase in the mouth dimension of the fish allowing them to consume larger prey successfully .

The frequency occurrence, volumetric abundance and the relative importance of the prey items of the juvenile and adult *G.giuris* differ. This diet difference can be due to energy requirements, which vary according to developmental stages. This may suggest that juvenile fishes tend to consume more midge larvae to provide them more sources of animal protein to sustain their continuous growth. Adult fishes, on the other hand, tend to consume more crustacean eggs and larger fishes. Indeed this supports that during ontogeny, fish often change their diet because of morphological changes to be able to exploit sequentially series of prey ranging from small to much larger prey.

Trophic Position of the Prey Items of Juvenile and Adult G.giuris

Juvenile

The juvenile *G.giuris* frequently consume prey items belonging to the second trophic position. Through this, it was found out that this fish belongs to the third and second levels. It is in the second level since it feeds on the first trophic level or the producers. It is in the third level since it feeds on the level two of the trophic chain which consists of organisms that consume primary producers and the one that feeds on other animals.

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Adult

Adult *G.giuris* feeds on both prey items belonging to both first and second trophic position. These trophic positions define the position of organisms within the webs. It can be seen that this fish feed at more than one trophic level. This suggests that this fish can both belong to the second and third levels, that is, carnivore and herbivore specifically.

Trophic Level of the Juvenile and Adult G.giuris

Through the calculated trophic level of each of the juvenile and adult *G.giuris*, the fish was classified according to the feeding type. Findings reveal that this fish can be carnivore, herbivore and omnivore. The fish or consumer is classified as carnivore or those which consume animals if it has a trophic level equal to or greater than 2.8[7]. This fish is also a primary consumer or herbivore which consumes 'mainly plant/detritus' since there are calculated trophic values between 2.0 and 2.19. This fish is also said to be omnivore, those which are partly herbivore and partly carnivore, which consume 'plants/detritus + animals' and have trophic levels between 2.2 and 2.79.

Figure 1 presents the mean trophic level of juvenile and adult *G.giuris*

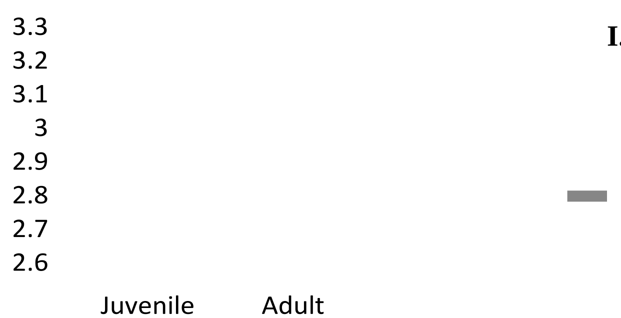

Figure 1. Mean Trophic Level of Juvenile and Adult G.giuris

The bar graph reveals that there is a difference in the trophic position of adult and juvenile *G.giuris*. It shows that adult fish have a higher trophic position which is 3.183 than the juvenile which have mean trophic position of 2.817. From the calculated mean above, it was found out that both the juvenile and adult *G.giuris* are carnivores are those which consume animals and have trophic levels equal or greater than 2.8.[7].

Table 4 presents the difference in the trophic level of the juvenile and adult G.giuris.

Table 4. Difference of the Mean Trophic Level of Juvenile and Adult *G.giuris*

Computed t- value	df	p-level	Ho Decision	Interpretation
-2.409	65	0.019	Reject	Significant

The difference in the trophic position of the prey items of juvenile and adult *G.giuris* has a computed t-value of -2.409 and p-level of 0.019 which is less than the 0.05 level of significance. Thus, the null hypothesis that there is no significant difference in the trophic level of juvenile and adult *G.giuris* is rejected.

The significant difference in trophic position between the two suggests that they do not belong to the same trophic position, although they belong to the same species, they feed on different level. The large/ adult fish showed higher trophic position than the juvenile, indicating that they have the capability to feed on larger prey items. Some organisms undergo life cycle changes and they consume at different trophic levels for different life stages[8]. Some species may not always occupy the same trophic level.

I. CONCLUSION

The juvenile *G.giuris* feeds mainly on the insect larvae which has the highest relative importance while the adult feeds mainly on crustacean eggs and fish, both having high relative importance. However in Prey items belonging to the second and third trophic positions are consumed frequently by both the juvenile and adult G.giuris. G.giuris can be carnivore, herbivore and omnivore. On the other hand the juvenile and adult *G.giuris* showed significant difference in the mean trophic level, suggesting that although they belong to the same species, they do not belong to the same trophic position.

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