

# An Assessment of the Endo-parasites of Littoral Fish from Lake Taal, Batangas, Philippines

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## ABSTRACT

Fish parasites are ecologically important because of their significant contributions to ecosystem integrity. This has gained the attention of both scientists and policy makers globally, but is not yet as evident in the Philippine setting. This is because the practical application of such knowledge requires a strong basal foundation on parasite biodiversity research, which has waned in the country in the last decades because of the retirement and passing of many prominent Filipino parasitologists. We aimed to contribute to the information on Philippine fish parasite biodiversity by surveying the parasites of various littoral fish species in Lake Taal - the third largest lake in the country. Fish were sampled in the lake from July to September 2015 through the aid of local fishermen, who employed gill nets and beach seines in the lake's littoral areas. From these, 711 specimens were gathered and necropsied for helminth endo-parasites. Parasites were retrieved from 4 of 16 fish species, with low prevalence and mean burden observed. Three parasite genera were identified, namely *Opegaster* sp. (Platyhelminthes: Opecoelidae), *Camallanus* sp. (Nematoda: Camallanidae), and *Andracantha* sp. (Acanthocephala: Polymorphidae). *Andracantha* sp. is the first report of its genera from Philippine fish, providing a contribution to the present Philippine parasite biodiversity listing, while *Opegaster* sp. represents a potential target species for biological lake monitoring because of its wide presence among gobiids throughout the country, as well as its transmission specificity. Overall, the present study provides new records for fish parasites in the country, and recommends specific targets for the conservation research of Lake Taal and Philippine inland waters, in general, through the exploration of potential keystone parasite biomarkers.

## KEY WORDS :

*Andracantha*  
*Opegaster*  
*Camallanus*  
parasite biodiversity  
parasite bioindicators

## INTRODUCTION

For decades, predation and competition were assumed to be the only major biotic determinants of aquatic community structure, but now fish parasites are attributed ecological importance because of their contribution to community and ecosystem structure through influences in trophic interactions, host fitness, and food webs (Thomas et al., 2000). In lieu of these contributions, analyzing parasite community dynamics has been proven useful, given its wide applications in environmental monitoring in light of continued habitat degradation and climate change.

The importance of fish parasite research is gaining traction not only from biodiversity scientists, but now also from ecologists and policy makers, as well. For example, water pollution can result in the increased burden of some fish parasite species due to a decrease in fish immunological defenses (Sasal et al., 2007). In contrast, fish parasites can also suffer secondary extinctions due to biodiversity loss because many require complex life cycles and diversity of host species (Lafferty, 1997). The species richness of parasites herein may in fact represent a healthy and sustainable system (Lafferty, 2013), while low species richness (with an abundance of only a few species) may reflect net decreases in parasite transmission due to environmental stressors (Lafferty & Holt, 2003). For these reasons, fish parasites can make good indicators of ecosystem integrity (see Wood et al., 2010) and indicators of environmental contaminants and stress (Sures, 2004) if the dynamics of their parasitism is consistently observed within selective fish hosts.

However, applied parasite research of such nature is not yet evidently observed in the Philippine setting. This is

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because interest in biodiversity-focused parasite studies, which is the most basal requirement of such applications, has waned in the last decade due to the retirement and/or passing of many notable Philippine parasitologists. In addition, a majority of the research conducted regarding fish parasites in the country were inclined towards aquaculture (see Arthur & Lumanlan-Mayo, 1997), with little focus on environmental applications. This present study is a survey of the parasite biodiversity of the third largest lake in the Philippines – Lake Taal, in the Batangas Province of Luzon Island. The few studies on the parasite biodiversity of this unique limnological ecosystem (see Cauyan et al., 2013, Briones et al., 2015) has called for further research regarding the lake's parasite biodiversity. Through this, we intend to contribute to the comprehensive parasites listing of Lake Taal, and in turn, assess potential host and parasite species that may serve as keystone biological markers for the lake's environmental monitoring and conservation.

## MATERIALS AND METHODS

**Study Site:** Lake Taal covers an area of 268 km<sup>2</sup> in the province of Batangas in Luzon Island. With a maximum depth of 198 meters, it is also one of the deepest lakes in the country. There are 38 small inlet rivers and streams in the lake, located at the heart of the Taal Volcano Protected Landscape (TVPL). Declared as one of the conservation and biodiversity priorities of the country, the lake has a highly diverse ecosystem (Ong et al., 2002). It's also a home to plethora of rare fauna and endemic marine species. Fish surveys done by Herre (1927) and Villadolid (1937) have listed 101 species from 32 families, including the freshwater sardine (*Sardinella tawilis*) and the freshwater sea snake (*Hydrophis semperi*) or duhol (see Papa & Zafaralla, 2011). The lake provides water and food resources to 13 municipalities and 3 cities as it forms a basin of 65,000 hectares within the TVPL.

**Fish Sampling and Necroscopy:** Fish were sampled from the lake's littoral areas through the aid of local fishermen during every survey trip (n=3). During sampling, drift gill nets were deployed for at least 12 h from 6 pm to 6 am to obtain commercially targeted species in capture fisheries. Beach seines were also utilized for active sampling, usually from 6 am to 10 am, to catch non-commercially targeted fish. Collected fish were then either necropsied on site or placed in cold storage. All specimens were necropsied within 24 hours of capture. Photo-documentation and morphometrics were taken per sample to ensure species identification. The gastrointestinal tract, including organs such as liver, gall bladder, and kidney, were extracted and immersed in 0.9% saline solution for examination. Organs were teased or compressed between glass slides (adapted from Knapp & Mueller, 2004) to detect the presence of parasites.

**Parasite Specimen Preparation:** Most isolated parasites were heat-fixed and placed in 95% ethanol. The proboscis of

acanthocephalan worms were first everted in distilled water for 24 hours before fixation (adapted from Lasee, 2004), while nematodes were placed in glycerol alcohol for long-term storage after heat-fixation (adapted from Upton, 2005). Helminth worms were mounted in glass slides with coverslip, together with threads for structural support, and processed using Heidenhain's Hematoxylin technique. Herein, 4% FeNH<sub>4</sub>(SO<sub>4</sub>)<sub>2</sub>-H<sub>2</sub>O was utilized as both a mordant and a de-stain for mounted specimens stained with Heidenhain's Hematoxylin. These were then dehydrated in gradients of ethanol (95%, 99%, and 100%), cleared in xylene, and mounted in Canada Balsam, following a 1-day interval for each step.

## RESULTS

From July to September 2015, a total of 711 fish samples were retrieved from 19 sampling sites, spanning three survey trips to Lake Taal, Batangas (Fig. 1). These comprised 16 fish species (Fig. 2) from 13 families (Table 1). Cichlidae was the most represented family in both specimen and species counts (specimen  $n=214$  of 711, species  $n=3$  of 16), while Bleniidae and Clariidae were the least observed, with only 1 specimen per species.

The fish samples retrieved for parasitological necroscopy represented a wide breadth of fish sizes (Kruskal-Wallis  $H=313.2$ ,  $df=13$ ,  $p<0.001$  for fish species with  $n>1$ ). The snakehead *Channa striata* represented the largest in size (ave. total length= $43.5 \pm 2.1$  cm) among the specimens sampled (Mann-Whitney pairwise  $p<0.05$  across all fish species), followed only by the walking catfish *Clarias batrachus* (total length 42.5 cm,  $n=1$ ) while the fang-toothed blenny *Omobranchus ferox* was the smallest (total length 3.4 cm,  $n=1$ ), with the next representative, archerfish *Toxotes jaculatrix* (ave. total length= $6.2 \pm 1.2$  cm), almost two-fold in size from the latter (Mann-Whitney pairwise  $p<0.001$  across all fish species). The Nile tilapia *Oreochromis niloticus* and the tank goby *Glossogobius giuris* had the widest length spread (min-max range: 1.8-26.5 cm *O. niloticus*; 3.5-23.2 cm *G. giuris*) of size representatives (total length SD~6 cm, Mann-Whitney pairwise  $p=0.41$ ).

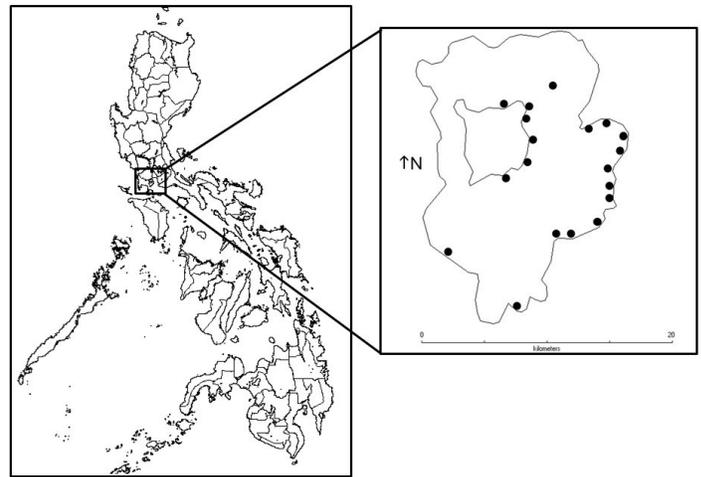
Three parasite genera representing three different phyla were identified from the fish hosts (Fig.3), namely *An-dracantha* sp. cystacanth (Acanthocephala: Polymorphidae) from *T. jaculatrix*, juvenile *Opegaster* sp. (Platyhelminthes: Opecoelidae) from *G. giuris*, and *Camallanus* sp. (Nematoda: Camallanidae) from *C. striata*. Endo-parasitism was low among the fish sampled (overall % $P<8\%$ , highest mean intensity ~3 parasites/infected fish), with infected fish within the average size for each species sampled. Only 10 of the 711 specimens and only 4 of the 16 fish species analyzed were observed to be infected.

Parasites were retrieved from *C. striata* (2 infected fish of 2 total samples), *G. giuris* ( $n=3$  of 63), *P. managuensis* ( $n=1$  of 109), and *T. jaculatrix* ( $n=4$  of 51). Among specimens with  $n>1$  infected fish, the size of infected *C. striata* ( $43.5 \pm 2.1$  cm), infected *G. giuris* ( $14.1 \pm 5.3$  cm), and infected *T. jaculatrix* ( $6.4 \pm 0.9$  cm) were within the average total length of the sampled size for each said species (Fig. 4).

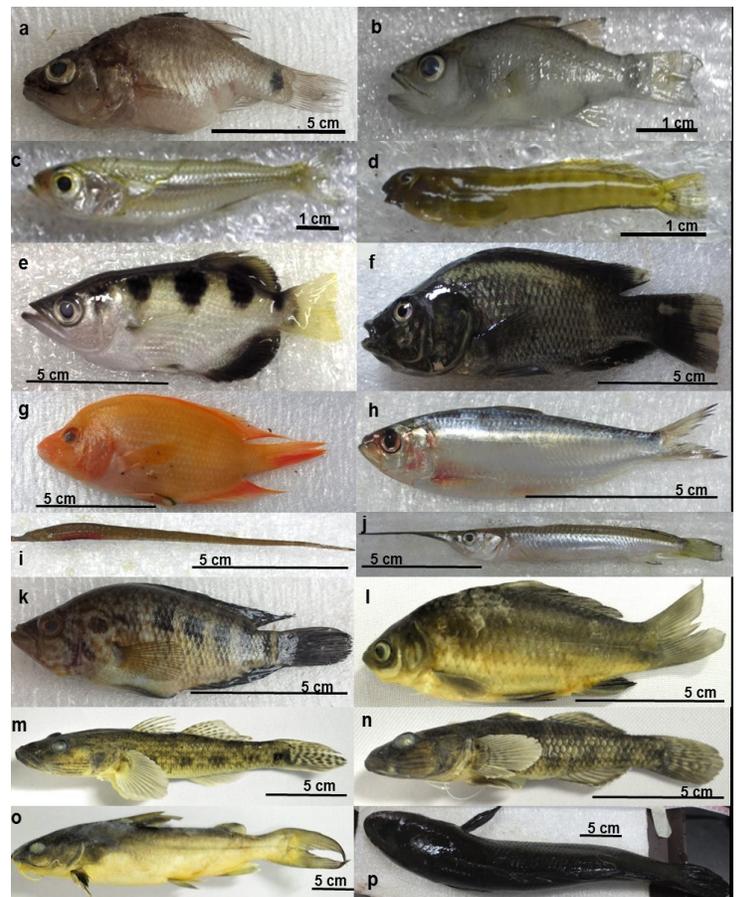
## DISCUSSION

Fish parasites recorded from previous studies were found, as well as a new Philippine record. Representatives of the genus *Opegaster* have been consistently found from fish species belonging to family Gobiidae (Tubangui, 1928; Tubangui & Masilungan, 1944; Lopez, 1979, 1986, & 1988). The juvenile worm of *Opegaster* sp. (Fig.3c) is identifiable by the presence of large acetabulum in the median aspect of the worm, together with the presence of lobular vitellaria in both lateral aspects of the body, whose presence beyond the acetabulum is attributed to the genera (Gibson, Jones, & Bray, 2002). Representatives of the genus *Camallanus* (Fig.3d) have also been consistently found from fish under family Channidae (Velasquez, 1986a, 1988; Lopez, 1986, 1988; Natividad, 1987; Quines & Fernandez, 1986). This genus is confirmed through the yellowish color and entire shape of its buccal capsule, as well as the reddish color of its body (Anderson, Chabaud, & Willmott, 2009). However, this is the first time that a representative from the genus *Andracantha* (Fig.3a) has ever been recorded from a Philippine fish (see Briones et al., 2015). The adult representatives of this genus are found in fish-eating birds, with cystacanths being retrieved from fish hosts. They can be discerned by the presence of spines (Fig.3b) that is arranged in two distinct collars in the anterior section of the trunk, with the lower spine located within a bulbous section of trunk (Monteiro et al., 2006). Briones et al. (2015) seem to have isolated a similar specimen ( $n=1$ ), but relegated it to *Bolbosoma* sp. because of few specimens for examination.

Low parasite richness and burden from lake fish in the study corresponds well with a variety of known factors. This observed low parasite distribution may be related to the isolated aggregation of fish host communities within such large lake area coverage. According to Gouriere et al. (2015), the universal pattern of parasite distribution is at most times aggregated, originating from the understanding of host-parasite interactions which affect many facets of parasite and host ecology and evolution. Host-parasite interactions are found to be highly asymmetric as specialist parasites tend to interact more often with hosts having elevated parasite richness, while those hosts with low parasite richness tend to interact with generalist parasites. In support to this, parasite infections of host species are commonly skewed to the right, with most parasites exploiting only one or a few host species. Looking into the perspective of host species distribution, most



**Figure 1.** Map of Lake Taal, Batangas, depicting 19 survey sites sampled from July to September 2015.

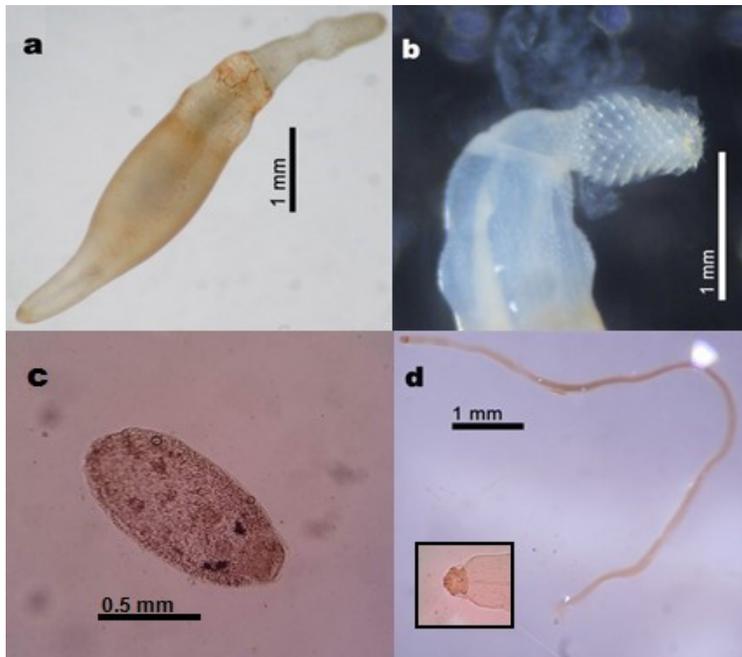


**Figure 2.** Photographs of fish species collected in Lake Taal, Batangas namely, a: *Apogon hyalosoma*, b: *Apogon* sp., c: *Atherinomorus lacunosus*, d: *Omobranchus ferox*, e: *Toxotes jaculatrix*, f: *Oreochromis niloticus*, g: *Oreochromis* sp. (*Amphilophus citrinellum*), h: *Sardinella tawilis*, i: *Doryichthys* sp., j: *Zenarchopterus* sp., k: *Parachromis managuensis*, l: *Carassius carassius*, m: *Psammogobius biocellatus*, n: *Glossogobius giuris*, o: *Clarias batrachus*, and p: *Channa striata*.

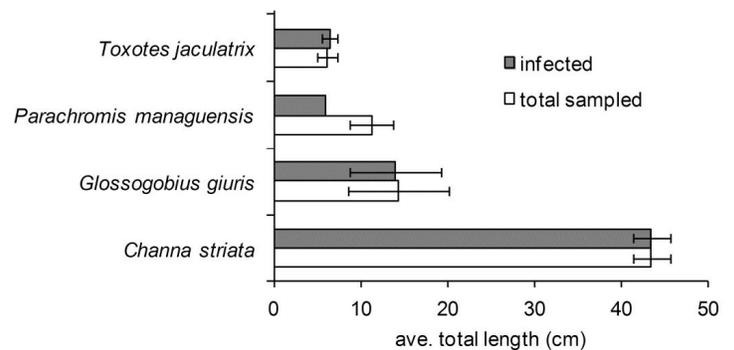
**Table 1.** Summary of classification and size of fish specimens sampled from Lake Taal during three survey trips spanning July to September 2015.

Classification	Species name	Vernacular name	N	Ave. size ±SD (cm)
Apogonidae	<i>Apogon hyalosoma</i>	muang	20	7.7±2.5
	<i>Apogon</i> sp..	dangat	3	6.9±1.0
Atherinidae	<i>Atherinomorus lacunosus</i>	guno	4	6.3±0.3
Blenniidae	<i>Omobranchus ferox</i>	palos	1	3.4
Channidae	<i>Channa striata</i>	dalag	2	43.5±2.1
Cichlidae	<i>Oreochromis niloticus</i>	tilapia	86	11.8±6.1
	<i>Amphilosoma cf. citrinellum</i> *	red tilapia	19	10.8±1.2
	<i>Parachromis managuensis</i>	dugong	109	11.3±2.5
Clariidae	<i>Clarias batrachus</i>	hito	1	42.5
Clupeidae	<i>Sardinella tawilis</i>	tawilis	100	10.8±0.7
Cyprinidae	<i>Carassius carassius</i>	karpita	25	9.2±0.9
Gobiidae	<i>Glossogobius giuris</i>	biya	63	14.3±5.8
	<i>Psammogobius biocellatus</i>	Biyang-tulog	71	5.3±3.8
Syngnathidae	<i>Doryichthys</i> sp.	kambabalo	95	10.5±1.4
Toxotidae	<i>Toxotes jaculatrix</i>	kataba	51	6.2±1.2
Zenarchopteridae	<i>Zenarchopterus</i> sp.	siliw	61	14.4±3.1

\* This specimen requires further identification but is designated as such until confirmed otherwise.



**Figure 3.** Micrographs of parasites retrieved from fish in Lake Taal, Batangas, namely, *Andracantha* sp. a: cystacanth with orange tegument, and b: worm anterior section showing proboscis armature and the presence of two regions of collar trunk spines; c: juvenile *Opegaster* sp. with clear median-placed acetabulum and two lateral regions of vitellaria; and d: *Camallanus* sp. showing the distinct red color of the vermiform body typical of the genera and the yellowish buccal capsule (onset).



**Figure 4.** Intra-species comparison of infected fish size with the size representation of all samples for each fish species.

are determined to be infected by few parasite species, with only a few observed to be infected with high mean intensities. Another factor that may also merit attention is the different size classes of fish in the study, wherein parasitism was most observable among fish species that were larger (*C. striata*) or had the widest size breadth (*G. giuris*). Such a situation is supported Ebert et al. (2005), wherein the likelihood of parasitism seems to be linked with increasing body size. This may be because increasing fish size directly increases food uptake capacity, and provides higher opportunities in encountering intermediate hosts and other infective stages, in comparison to smaller fish with a stricter gape limitation (Timi et al. 2011). Indeed, host body size, in many instances, can be considered a determinant of parasite species richness (Poulin & Leung, 2011). It is an

important feature that affects parasite diversity by influencing the rates of parasite speciation or colonization by new parasites. The presence of larval parasites may also be linked towards the vulnerability of small fish hosts to wider breadth of predators (Poulin & Leung, 2011), while a parasite community comprised of adult parasites may be associated towards larger hosts (Belle & Burt, 1991). Although fish size is an important factor that is linked to the profile of the parasite community, the immediate environment also plays a big role in the dynamics of parasite infection. Littoral fish species can be exposed to a variety of parasite species because of the availability of diverse food resources. Fish inhabiting littoral areas are offered a wide array of prey, which includes terrestrial insects, macrophytic vegetation, benthic invertebrates, and forage fish (Thornton et al., 1990). These variable feeding opportunities may have a strong influence on parasite distributions (Knudsen et al., 2004).

### CONCLUSIONS AND RECOMMENDATIONS

Overall, this study provided an opportunity to obtain new records of parasites from littoral fish from Lake Taal and the Philippines, in general. Although a large sampling size (n=711) was achieved, we believe that further parasite-surveys will yield more parasite species, given the limited time frame (3 months) of the current study. Given more survey effort, Lake Taal may provide an ideal sampling point in studying parasite life cycle dynamics in relation to host spatial distribution, feeding habits, and environmental changes. Trematodes, such as *Opegaster* sp., which have been consistently found in gobiids from Philippine literature as well as in the present study, may potentially be tapped as key stone biological markers. Trematodes require a snail intermediate host, and as such may also reflect changes in the detritus-based food web of the lake in addition to the nektonic nature of gobiid fish hosts. We recommend that further research be focused on this gobiid–snail-trematode transmission dynamics, since it may be of potential application in many sites among Philippine inland waters.

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