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Assessment of abundance, diversity and stomach content of freshwater fishes in Pampanga River along the municipality of Cabiao, Nueva Ecija, Philippines

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Abstract
This present study was conducted in order to assess the abundance, diversity and stomach content of freshwater fishes caught in Pampanga River along the municipality of Cabiao, Nueva Ecija, Philippines. A total of six fish species were collected namely rohu carp (*Labeo rohita*), silver carp (*Hypoththalmichthys molitrix*), common carp (*Cyprinus carpio*), striped snakehead (*Channa strita*), Nile tilapia (*Oreochromis niloticus*) and crucian carp (*Carassius carassius*). Nile tilapia comprised the highest relative abundance (50.88%; n = 29) from the total fish catches (N = 55). The Cabiao area of the Pampanga River has a fish species diversity index value of 1.42, with evenness of 0.73 and species dominance (Simpson's index) of 0.67.

Keywords: Pampanga river, freshwater fishes, abundance, diversity, gut content analysis

1. Introduction
The Philippines is considered as a globally essential geographical region for biological diversity and indigenousness. However, little is known about the diversity and status of endemic freshwater fishes which are both valuable as bio-indicators of ecosystem health and as an integral part of our country's natural heritage [1, 2] because much of the studies are centered in terrestrial and marine biodiversity [3, 4]. Several diversity indices are commonly applied to the study of fish composition and distribution, primarily to assess the current health status of rivers and adjacent tributaries [5, 6]. Similarly, multivariate gradient analyses are being employed to associate the patterns of fish community data to multiple environmental parameters [7].
Bodies of water are important for life as well as for fisheries, hydrology, and ecotourism. Inland waters of the Philippines such as rivers, lakes and waterfalls are known to have very diverse biotic community [8]. Rivers are known for their rich aquatic life. Thus, one of the most affected ecosystems by human activities is the freshwater ecosystem. It is alarming to know that there is a decrease of freshwater biodiversity and its decline is faster than marine or terrestrial biodiversity [9]. Knowledge of the fish fauna is essential in conservation [10].
Food habits of different species have been investigated nowadays for variety of important reasons of acquiring knowledge about the species natural diet which is essential in understanding the dynamics within and across species in various habitats, trophic levels, materials and trophic dynamics and the entire ecosystem they belong to [11, 12]. Data on feeding ecology can be used to construct food webs and predict possible changes in food chains and material and energy transfers between and within ecosystems [13]. It helps us to explain interactions with other organisms - potential competitive interactions among sympatric and predator–prey interactions species [14]. Information on the diet also contributes to the understanding of ecosystem structure, community composition and population dynamics [15].
In Ichthyology, fish ecology and fisheries, the information on diet and food habits are valuable in the decision-making process related to natural resources [16], quantifying the thread of an introduced or even invasive fish species to native fish populations [17]. Moreover, this information is also important in assessing ecosystem integrity and assemblage functional redundancy [18], understanding of such subjects as resource partitioning, habitat preferences, prey selection, and developing conservation strategies.

It is, therefore, a key element in the protection of species and ecosystems, understanding the natural history of a species and its role in the trophic ecology of aquatic ecosystems. Consequently, the study of the gut content is not only way to know the diet but also superior source of information on many aspects of fish biology and ecology [19]. This present study was conducted in order to assess the abundance, diversity and stomach content of freshwater fishes caught in Pampanga River along the municipality of Cabiao, Nueva Ecija, Philippines.

2. Materials and Methods

2.1 The study area

Pampanga River with a total length of 260 km is the second largest river in the whole of Luzon, Philippines. It traverses the provinces of Nueva Ecija, Pampanga and Bulacan. The headwaters of Pampanga River came from the mountains of the Sierra Madre and drains via the Lanbangan Channel into Manila Bay. Pampanga River provides irrigation to about 363, 246 ha of farmlands in the provinces of Nueva Ecija, Pampanga and Bulacan. The river has small branches that empty to several fishponds especially in the town of Candaba, Pampanga [20].

The Pampanga river basin is regarded as one of the most important river basins in the Philippines in terms of economic activities. This river basin is located in Region III of the country. The Pampanga river basin is the fourth largest basin in the Philippines and covers an approximate aggregate area of 10,434 km^2, including an allied basin of the Guagua River. The average annual rainfall in the Pampanga basin is 2,155 mm. This river basin has two multipurpose dams (Pantabangan and Angat) and two swamp (Candaba and San Antonio).

2.2 Collection and identification of fish samples

With the supervision of the local fisher folks, the collection of fish samples was carried out last May 2019 at three different sites of Pampanga River in the municipality of Cabiao, Nueva Ecija using dragnets with 2 cm mesh size. Information on Fish Base was used to confirm the identity of the collected fish species.

2.3 Determination of individual length and weight

Individual length and weight was determined using ruler and electronic weighing scale, respectively. Body weight was measured after drying the specimen with a tissue paper. Standard length was also taken for the computation of the condition coefficient following the formula used by Reyes *et al.* [21]. After length and weight were gathered, the specimens were stored in an ice chest to preserve its freshness until gut extraction and analysis at the laboratory was performed.

2.4 Stomach content identification and analysis

Before processing, fish specimens were thawed at room temperature. Stomachs were dissected, and contents were separated into unique prey items, weighed, prepared into mounted slides and identified individually. Concerning the diet analysis, the vacuity index was calculated following the formula of Mrinelli *et al.* [22]. Then, the gastric contents were observed in order to evaluate the feeding strategy, the importance of a prey, and the size of the trophic niche. The Costello [23] diagram method was used, which relates the prey specific abundance to the occurrence frequency.

2.5 Computation of relative abundance and diversity

The relative abundance for each species was calculated using the formula adopted by Paller *et al.* [24]. Diversity index and species evenness was computed following the formula of Shannon-Weiner [25]. Species dominance was calculated using the Simpson's index formula (λ) [26].

3. Results and Discussions

3.1 Relative abundance and diversity of freshwater fishes

A total of six fish species (Figure 1) were caught during sampling in Pampanga River that run in the municipality of Cabiao, Nueva Ecija. Rohu carp (*Labeo rohita*) and silver carp (*Hypoththalmichthys molitrix*) were the most common freshwater fish present in all three study sites. Comon carp (*Cyprinus carpio*) and striped snakehead (*Channa strita*) were found to be absent in Site 1 and in Site 2 but present in Site 3. Nile tilapia (*Oreochromis niloticus*) was found to be present in Site 1 and 3. Crucian carp (*Carassius carassius*) was present in Site 2 only. Therefore, rivers possessed little percentage of variation among its fishes which could be due to the locality, diversity or even other factors that can affect the numbers of fishes in the river.

Nile tilapia comprised the highest relative abundance (50.88%; n = 29) of the total fish catches (N = 55) followed by crucian carp (21.05%, n = 12), rohu carp (12.28%; n = 7), common carp (7.02%; n = 4), silver carp (3.51%; n = 2) and striped snakehead (1.75%; n = 1) (Table 1).

The Cabiao area of the Pampanga River has a fish species diversity index value of 1.42, with evenness of 0.73 and species dominance (Simpson's index) of 0.67 (Table 1). According to Shannon-Weiner diversity index, this area of river was categorized as very low in terms of fish species diversity (<1.99), wherein values of 2.00-2.49 as low, 2.50-2.99 as moderate, 3.00-3.49 as high, and >3.50 as very high. Diversity and distribution of riverine fish assemblages are generally influenced by biotic and abiotic factors [27]. These factors include, among others, stream water levels and flow variability [28], geo-hydrological feature of the river [29, 30], microhabitat heterogeneity [31], and to a certain degree, aggravated by urbanization, habitat alteration, anthropogenically-induced climate change [32, 33] and presence of invasive alien fish species [34]. A positive relationship exists between environmental stability and species diversity, and a more stable environments support more species-rich assemblages. The environmental stability of the area of river has affected the fish species diversity. The evenness index of the river defines the distribution of individuals per species. As the evenness come closer to 1, the distribution comes equal. The 0.73 evenness index of the river which was computed in this study implies that individuals were distributed equally and there was dominance (0.63) within the group of species.

Fig 1: The collected freshwater fish species in the Cabiao area of the Pampanga River (A = Nile tilapia; B = crucian carp; C = rohu carp; D = common carp; E = silver carp; F = striped snakehead)

Table 1: Relative abundance, diversity, evenness and dominance of collected freshwater fish species in the Cabiao area of the Pampanga River

Fish Species	Number (pieces)	Relative Abundance (%)	Diversity	Evenness	Dominance
Oreochromis niloticus	29	50.88	1.42	0.73	0.67
Carassius carassius	12	21.05			
Labeo rohita	7	12.28			
Cyprinus carpio	4	7.02			
Hypophthalmichthys molitrix	2	3.51			
Channa striata	1	1.75			

3.2 Stomach content analysis

Condition coefficient is one of the parameters used in fishery research that biologically assess the relationship of the weight and length of fishes in order to estimate its growth pattern. Among the six species of obtained fishes, striped snakehead was recorded with highest condition coefficient value of 38.94% which was accounted to its piscivorous diet evident with the gathered whole prey in its stomach during the gut content analysis. Adult snakeheads feed mostly on other fishes but will eat crustaceans, frogs, smaller reptiles, and the larger species of snakehead may consume birds and small mammals [35]. Silver carp had a condition coefficient value of 24.66% notable to its omnivorous diet evident on the observed semi-digested plant material and zooplankton species found in its gut. Silver carp, like all *Hypophthalmichthys* species feed more or less constantly, largely on phytoplankton. They also consume zooplankton and detritus [36]. Rohu carp with its herbivorous diet was recorded of having 12.54% condition coefficient which was evident on the semi-digested plant material found in its stomach during the gut content analysis. This species is an omnivore with specific food preferences at different life stages. During the early stages of its lifecycle, rohu carp eats mainly zooplankton, but as it grows, the fish eats more phytoplankton, and as a juvenile or adult, it is herbivorous column feeder, eating mainly phytoplankton and submerged vegetation [37]. Tilapia compiled 6.40% condition coefficient value which was attributed to its feeding habit that was comprised mainly of plant material, phytoplankton and benthic algae, and this was confirmed in the results of the gut content analysis of having traces of phytoplankton and several semi-digested plant materials in its gut. Nile tilapia is omnivorous, where phytoplankton, macrophytes, insects, detritus and zooplankton were the most important food items [38]. Crucian carp having 4.02% condition coefficient value was attributed to its feeding habit which occurs all day but mainly at night on plankton, benthic invertebrates, plant materials and detritus [39]. But with the gut content analysis, the authors were able to trace semi-digested plant materials and some plankton species present on its gut. This may be due to the time of collection which was near mid-day in which fish species were most active. Common carp had a condition coefficient value of 0.78% which was evident on its feeding diet. Both adults and juveniles feed on a variety of benthic organisms and plant material which was confirmed by the gut content analysis in which traces of semi-digested plant materials were observed in its gut.

Table 2: Gut content analysis parameters of collected freshwater fish species in the Cabiao area of the Pampanga River

Fish Species	Condition Coefficient (Kc)	Vacuity Index	Prey Specific Abundance (P*i*)	Occurrence of Frequency (O*i*)
Oreochromis niloticus	6.40	33.3	33.3	50.0
Carassius carassius	4.02	33.3	40.0	66.7
Labeorohita	12.54	20.0	60.0	40.0
Cyprinus carpio	0.78	50.0	50.0	33.3
Hypoththalmichthys molitrix	24.66	20.0	60.0	60.0
Channa striata	38.94	0.0	100	100

4. Conclusion
The fish species found in Cabiao area of Pampanga River were Nile tilapia, crucian carp, rohu carp, common carp, silver carp and striped snakehead. Cabiao area of the Pampanga River had very low fish species diversity. The collected fish species had different feeding habits that resulted to their differences in condition coefficient value.

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