The diet composition of some economically important fishes in the three floodplain lakes in Agusan Marsh wildlife sanctuary in the Philippines

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Abstract

Food of freshwater fishes in the three floodplain lakes in Agusan Marsh, Philippines were identified and quantified. Different types of gear, namely, two types of hook and line, traps and scoop nets were used to collect samples. Results indicated that the volume of food in the guts of *Channa striata*, *Trichogaster pectoralis*, *Trichogaster trichopterus*, *Anabas testudineus*, *Oreochromis niloticus* and *Clarias batrachus* was generally larger during flood months than during the dry season. Feeding activity varies as water level fluctuates. Incidence of empty stomachs in *Channa striata* markedly increased as the dry season proceeded. Relative importance index showed that in the floodplain ecosystem, the utilization of detritus especially among belontiids, cichlids and cyprinids was high.

INTRODUCTION

Agusan Marsh, located between 8°00'N - 19°00'N and 125°52'E - 126°02'E is a protected area declared by the national government of the Philippines. It extends to an area of around 19197 ha. Being a freshwater marsh, it is composed of extensive floodplains and shallow lakes that shrink and partially dry up from April to October and floods from November to late March (CPPAP 1989; Davies et al. 1990). Motorized boats have easy access to the interior during high water but are limited to major river channels during low water or when *Eichhornia crassipes* clogs waterways. Only rowed dug-out canoes called 'baroto' carrying one or two persons could efficiently and slowly transport people and goods during low water.

Like in any other tropical marsh, annual flooding is the most important ecological phenomenon fundamental to fishes as the extent of inundation and water persistence time determine the composition and abundance of the fish fauna and their feeding as well (Welcomme 1979; Junk 1984; Junk et al. 1989; Cattela and Petrere 1996).

This study focuses on the diet composition of the fish community in the three floodplain lakes, namely, Ticgon, Dinagat and Mihaba in the southeastern portion of Agusan Marsh. No previous studies have been conducted in this area, yet the marketing of the catch in the towns fringing the marsh provides considerable revenue to the local economy and a cheap source of subsistence protein for the rural community.

Materials and methods

Monthly sampling was conducted from November 1998 to December 1999 in the three floodplain lakes — Mihaba, Dinagat, and Ticgon in the Province of the north eastern Mindanao of the Philippines (Figure 1). These lakes can be reached through Agusan River, the main waterway.

Fishing gear used in the present study included gillnets, long lines, individual hook and line, bamboo traps and scoop nets. However, the use of bamboo traps and scoop nets was discontinued since they were used only in riverbanks. Live baits were used in long lines subject to their availability. These baits were freshwater crabs, frogs (*Rana* sp.), earthworms (*Terrestris lumbricoides*), gastropod (*Pila* sp.), golden apple snail (*Pomacea canaliculata*), three-spot gourami (*Trichogaster trichopterus*) and *Puntius binotatus*. Baits for individual hook and line were mainly earthworms.

Two gillnets each 70 m in length and 1.5 m in height were used. One of them was with a stretch mesh size of 125 mm and the other was with a stretch mesh size of 25 mm. These were set in clear areas, i.e., near thick vegetation, with less current, and opposite the current flow. Four sets of long lines tied to trees, vegetation or bamboo poles were used in areas with submerged trees, stumps, or large clumps of decaying vegetation. Live baits were positioned on the water surface to bring about splashing and prevent them from seeking cover. Non-live baits were submerged to about half a meter from the water surface and tied to bamboo poles, its tip serving as a marker. An average of 100 units of individual hook and line baited with earthworms were set among the vegetation in the lake periphery.

Diet Composition

A total of 578 gut samples were preserved in 10% formalin right after the fish were caught and brought to the laboratory for further examination. Contents were removed from the gut by washing with 70 % ethyl alcohol. Identifiable food items were counted and recorded. Food items were quantified employing the volumetric method following Jude (1971) where volume of the stomach contents

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Figure 1. Agusan Marsh protected area in northeast Mindanao showing the stations sampled in this study.

was measured by allowing them to settle in a measuring vessel. The percent frequency, percent number and percent volume for each food item were determined. For *Oreochromis niloticus*, the digestive tube was measured and the contents from 1/3 of its length starting from the proximal end of the oesophagus were analysed (Palomares 1987). The relative importance index (RI) was determined using the formula of George and Hadley (1979) given below:

$$RI = 100 \times AI_a / \sum_{a=1}^n AI_a$$

where n = number of different food types,

AI_a = absolute importance of prey taxa in the diet

= % F_a + % N_a + % W_a where

% F_a = percent frequency of occurrence of taxa "a"

% N_a = percent of total number of organisms taxa "a"

% W_a = percent of total weight (volume) of food organisms represented by taxa "a."

RI index values ranges from 0-100, where the sum of all RI values for the prey taxa equal to 100.

Results and Discussion

Gut content analysis

Gut content analysis in this study as shown in Table 1 indicates some similarities as well as marked differences when compared with the existing literature. Insects and water mites were found in *Trichogaster pectoralis*, which is reported to be a herbivore and detritivore by Pethiyagoda (1991) and Conlu (1986). However, it is not clear whether the presence of such items is largely coincidental since relative importance index shows that both detritus and phytoplankton comprise its main diet component. Similarly, *Glossogobius giuris* which is reported to have a diet of mainly animal origin (Delmendo 1968) had plant debris in the food bolus. Furthermore, *Channa striata* from lakes Ticgon and Dinagat ingests large amount of detritus (Table 2), a food item not mentioned in the existing literature. Examination of the guts of *Clarias batrachus*, on the other hand, indicated that it feeds on varied food items such as insects, arthropods and mollusks. Many of these clariids were caught at the onset of rainy season when numerous potential food items are brought in by floodwaters.

Relative importance index shows that in the fishes of the same group, an overlap of food choices occurred. For instance, the bulk of the diet of belontid, *T. pectoralis* composed of detritus, phytoplankton and macrophyte, which is also the case in *T. trichopterus*. However, in both species, relative importance index showed that the order of preference for such food items differ in the three lakes (Table 2). *Clarias macrocephalus* and the introduced *C. batrachus* also exploited almost the

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Table 1. Food items of the Fishes in the three floodplain lakes in Agusan Marsh.

Family / Species	Present Study	Earlier Studies and Ethnobiological Survey
Anabantidae <i>Anabas testudineus</i>	Plant debris, arthropod fragments, insect larvae (chironomid), slugs, anopheline mosquito larvae, molluscan fragments	Macrophytes, shrimps, fish fry: In culture: chopped steak; (Pethiyagoda 1991); Insects, insect larvae and small fish (Conlu 1986); Human waste, algae (IKS)*
Belontiidae <i>Trichogaster pectoralis</i>	Algae, diatoms, plant debris, fern spores, insect larvae, spiders, mites, slugs, detritus	Plankton, macrophytes, algae (Pethiyagoda 1991); adult: phytoplankton, decayed green algae, <i>Ipomea</i> and <i>Lemna</i> , detritus (Conlu 1986); Human waste, algae (IKS)*
<i>Trichogaster trichopterus</i>	Diatoms, filamentous algae, copepods, cladocerans, detritus	Plankton, macrophytes, algae (Pethiyagoda 1991); Larvae: planktonic organisms; Adult: phytoplankton, decayed green algae, <i>Ipomea</i> and <i>Lemna</i> (Conlu 1986); Small insects, bran (bait), algae, water bubbles (IKS)*
Osphronemidae <i>Osphronemus goramy</i>	Plant debris, filamentous green algae, nematodes, other phytoplankton, crustaceans (shrimps)	Juvenile: small shrimps, worms; Adult: unicellular algae, plants and most type of vegetation (Pethiyagoda 1991); Human waste, algae (IKS)*
Cichlidae <i>Oreochromis niloticus</i>	Phytoplankton, green and blue green algae, diatoms, detritus (fine soil sediments)	Plankton, higher aquatic plants, artificial food like rice bran, soya, boiled <i>Ipomea</i> ; Young: diatoms, green algae, small crustaceans; Adult: plankton, filamentous algae such as chlorophyceae (Pethiyagoda 1991); Algae (IKS)*
Cyprinidae <i>Cyprinus carpio</i>	Nematodes, mollusks, algae, detritus, arthropods	Eats virtually everything (Pethiyagoda 1991); Crustaceans, human waste, algae (IKS)*
<i>Puntius binotatus</i>	Plant debris, arthropod fragments (insects), other unidentifiable materials	Live food preferred; chopped food when hungry or fasted (Pethiyagoda 1991); Shrimps (IKS)*
Channidae <i>Channa striata</i>	Nematodes, fish (scales and other fragments), chironomid larvae, plant debris, earthworms, slugs, detritus, soil pellets, shrimps, frogs, mollusks	Fish (<i>Trichogaster</i> spp.), snails, insects, worms, snakes, frogs, tadpoles, crustaceans (Lee & Ng 1994); Fish worms, tadpoles, crustaceans (Pethiyagoda 1991); Shrimp, fish, crabs, frog, earthworms, gastropods (<i>Pila</i> sp. <i>P. canaliculata</i>) (IKS)*

Table 1. Continued.

Family / Species	Present Study	Earlier Studies and Ethnobiological Survey
Clariidae		
<i>Clarias batrachus</i>	Ants, insect larvae, nematodes, insect body fragments, beetles, fish scales, soil (pellet-like)	Young: protozoa, small crustaceans, rotifers; Adult: Insect larvae, shrimps, worms, fish, organic debris, insects (Conlu 1986); Earthworms, insects, grasshoppers, small gastropods (IKS)*
<i>Clarias macrocephalus</i>	Thysanurans, dysticid larvae, fish scales, soil pellets	Young: copepods, cladocerans; Older fry: live food; Adult: feed on whatever organic debris at the bottom (Conlu 1986); Small shrimps, golden apple snail (<i>P. canaliculata</i>), and other gastropods (IKS)*
Eleotridae		
<i>Ophiocara porocephala</i>	Fish fragments (scales, bone parts), plant fiber and debris	Shrimps, <i>P. canaliculata</i> and other gastropods (IKS)*
Gobiidae		
<i>Glossogobius giuris</i>	Fish bones and scales, plant debris, egg-like structures	Nekton: main food (Delmendo 1968)

* IKS, Indigenous Knowledge System – information were retrieved through interviews with native residents/fisher folks (in this case a tribal chieftain and ordinary fisher folks) in the area during the study.

same food types. However, the order of preference for these food choices was different in the two species (Table 2). Competition for food may possibly be higher among related species with overlapping food preferences.

In Agusan marsh, potential food items of the carnivorous fishes such as channids, clariids, and omnivorous anabantids and cyprinids are found near or on thick stand of *E. crassipes*. Numerous odonates, such as dragonflies were observed to hover among *E. crassipes*. Examination of habitat preferences for many insects such as ants, aquatic beetles, midge larvae, arachnids as well as mollusks indicates that these animals are closely associated with vegetation, either clinging onto leaves or other plant parts using the vegetation both as shelter and as source of food. Junk (1984) observed colonization and feeding of floating vegetation such as *E. crassipes* by curculionid beetle. Eggs of the gastropod *P. canaliculata* were found attached to *E. crassipes* leaves while the eggs of *Pila* sp. were found attached to submersed tree trunks just above the water level. Other food items found in fish guts included the following: crustaceans - *Caridina* shrimps in cyprinid spp. and *Osphronemus goramy*; copepods and cladocerans in *T. pectoralis*; rotifers in *T. pectoralis*; small fishes such as *T. trichopterus* and *P. binotatus* in channids (Tables 2 and 3).

Table 2. Relative Importance Index of food items in the fish sampled from Agusan Marsh from November 1998 to October 1999. (As - Aschelminthes; An - annelids; Ar - arthropods; At - mollusks; Cr - crustaceans; In - insects; Ar - arachnids; Fi - fish; Ap - amphibians; Eg - eggs; Ph - phytoplankton; Mt - macrophytes; De - detritus; Dm - digested matter. T, D, M - Pooled samples from Tiegon, Dinagat and Mihaba.

Species	Lake	As	An	MI	At	Cr	In	Ar	Fi	Ap	Eg	Ph	Mt	De	Dm
<i>A. testudineus</i>	T, D, M	7.4	0.0	14.5	5.1	34.1	22.0	0.0	1.9	0.0	1.8	5.7	14.2	10.6	17.7
<i>T. pectoralis</i>	Mihaba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	23.4	11.7	50.0	8.3
	Dinagat	0.0	0.0	3.8	1.7	0.0	9.1	0.0	0.0	0.0	0.0	33.0	13.8	29.5	9.1
	Tiegon	6.7	0.0	1.5	0.0	2.2	9.0	0.8	1.5	0.0	1.9	41.6	6.0	27.8	0.8
<i>T. trichopterus</i>	Mihaba	5.0	0.0	0.0	6.0	8.0	7.0	0.0	0.0	0.0	8.0	2.0	4.0	1.0	3.0
	Dinagat	10.4	0.0	0.0	1.1	2.3	0.0	0.0	0.0	3.5	25.5	1.2	37.1	15.3	0.0
	Tiegon	2.3	0.0	0.0	0.0	0.0	0.0	0.0	31.7	4.5	0.0	31.7	4.5	55.6	6.0
<i>O. goramy</i>	T, D, M	5.7	0.0	0.0	16.0	11.6	0.0	0.0	0.0	0.0	46.7	12.8	0.0	7.1	0.0
<i>O. niloticus</i>	T, D, M	0.0	0.0	5.1	0.0	0.0	5.8	0.0	0.0	0.0	2.9	44.8	8.8	7.9	0.0
<i>C. carpio</i>	T, D, M	2.9	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	11.1	11.8	17.7	53.7
<i>P. biotatus</i>	T, D, M	0.0	0.0	0.0	8.0	7.2	20.6	0.0	5.7	0.0	0.0	10.4	12.0	9.2	0.0
<i>C. striata</i>															
	Mihaba	3.6	0.0	2.9	3.6	0.0	9.2	3.9	24.7	0.0	0.0	3.6	5.4	0.0	41.5
	Mihaba	11.9	0.0	3.4	4.5	0.0	2.8	0.0	4.5	0.0	0.0	0.0	4.3	0.0	67.3
	Dinagat	3.4	6.7	5.5	0.0	0.0	8.0	0.0	10.5	12.0	12.0	0.0	2.7	51.0	0.0
	Dinagat	10.4	0.9	0.9	1.8	5.4	0.0	0.0	3.9	0.0	0.0	0.0	4.3	0.9	71.4
	Dinagat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.5	0.0	91.5
	Tiegon	3.5	0.0	3.5	8.3	0.0	3.5	0.0	3.7	0.0	0.0	0.0	3.5	10.7	63.4
	Tiegon	16.5	0.0	2.5	4.6	1.0	0.0	5.9	6.0	0.0	0.0	0.9	1.9	59.8	0.0
	Tiegon	18.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	76.6
	Mihaba	7.0	0.0	0.0	2.1	0.0	29.1	2.1	6.7	0.0	12.5	4.1	6.2	4.1	26.3
	Dinagat	8.4	0.0	17.6	0.0	0.0	27.0	0.0	0.0	6.8	0.0	0.0	11.2	3.7	25.4
	Tiegon	9.5	0.0	4.8	0.0	4.9	35.3	0.0	0.0	0.0	0.0	4.7	0.0	11.0	29.6
<i>C. macrocephalus</i>	T, D, M	11.6	9.2	16.7	0.0	0.0	32.3	0.0	0.0	0.0	0.0	0.0	5.8	0.0	30.0
<i>O. porocephala</i>	Dinagat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.0	29.0	0.0	26.7	0.0	0.0	44.3
<i>G. giurus</i>	Mihaba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.0	57.0	15.4	0.0	0.0	0.0	27.5

Table 3. Percent volume of food items in the fish collected Agusan Marsh from November 1998 to October 1999. Abbreviations are as given in Table 2. * - Volumes of food items are <0.01 ml.

Species	Lake	As	An	Ml	At	Cr	In	Ar	Fi	Ap	Eg	Ph	Mt	De	Dm
<i>A. testudineus</i>	T,D,M	*	0.0	12.1	11.3	0.8	14.5	0.0	0.40	0.0	*	8.3	6.0	23.0	23.7
<i>T. pectoralis</i>	Mihaba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	*	*	86.7	10.0
	Dinagat	0.0	0.0	9.3	*	0.0	9.6	0.0	0.0	0.0	0.0	*	23.2	40.4	17.6
	Ticgon	*	0.0	0.2	0.0	*	7.0	*	0.02	0.0	*	46.2	0.3	45.6	0.6
<i>T. trichopterus</i>	Mihaba	*	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	*	*	85.4	14.6
	Dinagat	*	0.0	0.0	*	*	*	0.0	0.0	0.0	0.0	*	*	85.9	14.1
	Ticgon	*	0.0	0.0	*	*	*	0.0	0.0	0.0	*	*	*	85.4	14.6
<i>O. goramy</i>	T,D,M	*	0.0	0.0	0.0	2.7	0.5	0.0	0.0	0.0	0.0	91.4	*	22.3	5.5
<i>O. niloticus</i>	T,D,M	0.0	0.0	*	0.0	0.0	*	0.0	0.0	0.0	*	31.3	*	18.3	7.7
<i>C. carpio</i>	T,D,M	*	0.0	0.0	*	4.4	0.0	0.0	0.0	0.0	0.0	8.6	22.3	22.3	69.1
<i>P. binotatus</i>	T,D,M	0.0	0.0	0.0	*	1.1	25.9	0.0	1.8	0.0	0.0	11.0	3.7	18.3	38.3
<i>C. striata</i>															
< 30 cm	Mihaba	*	0.0	4.4	*	0.0	1.1	1.1	63.0	0.0	*	*	*	0.00	30.3
	Dinagat	*	11.9	6.0	0.0	0.0	8.0	0.0	9.9	0.0	4.0	0.0	0.0	2.00	58.3
	Ticgon	*	0.0	*	3.8	0.0	3.8	0.0	0.8	0.0	0.0	0.0	*	0.80	93.7
30-45 cm	Mihaba	*	0.0	7.1	5.9	0.0	*	0.0	1.0	0.0	*	0.0	0.2	0.00	85.8
	Dinagat	*	0.3	*	0.3	0.6	0.0	0.0	1.6	0.0	0.0	0.0	*	*	97.6
	Ticgon	*	0.0	2.4	*	0.2	*	0.0	1.5	15.3	0.0	0.0	*	0.00	80.5
> 45 cm	Dinagat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*	0.00	100.0
	Ticgon	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*	0.0	0.0	0.00	100.0
<i>C. batrachus</i>	Mihaba	*	0.0	0.0	0.0	35.5	35.5	*	3.1	0.0	2.4	*	*	*	59.1
	Dinagat	*	0.0	32.3	0.0	4.6	4.6	0.0	0.0	15.4	0.0	0.0	*	0.00	15.4
	Ticgon	*	0.0	0.5	0.0	5.4	5.4	0.0	0.0	0.0	0.0	**	0.0	34.2	58.8
<i>C. macrocephalus</i>	T,D,M	*	5.7	1.4	0.0	4.3	4.3	0.0	0.0	0.0	0.0	0.0	1.5	0.00	71.4
<i>O. porocephala</i>	Dinagat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.8	0.0	0.0	*	0.0	0.00	88.2
<i>G. giurii</i>	Mihaba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.1	0.0	4.4	0.0	0.0	0.00	46.5

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Detrital material appeared to be an important food source for *T. trichopterus*, *T. pectoralis*, *O. niloticus* and *Cyprinus carpio* although preference for live food was also observed among them (Tables 2 and 3). A recent study on Curimatidae species in Baia da Onca, a floodplain in Orinoco indicated that detritus and algae comprised the main food items of these species (Catella and Petreire 1996). This study seems to be consistent with the observation that the main route of energy flow in shallow waters is the detritus food chain (Bowen 1983). The importance of the non-living organic fraction, i.e., detritus, lies in the fact that it is a principal source of nutrition for primary consumer fishes. This non-living organic matter, which is selectively ingested by fishes is actually the extra cellular matrix called the biofilm or detritus secreted by the microorganisms. Detritus is combined with other organic material that tends to bind to it either from particulate or dissolved phase. It is very digestible and serves as a rich source of nutrients. But since biofilm becomes refractory as it ages, the nutrient becomes increasingly unavailable to the consumers so that nitrogen-containing protein becomes limiting to most detrital feeders (S.H. Bowen pers. comm.).

In the shallow waters of Agusan Marsh, the soft bottom sediments may be the source of such detrital aggregates or biofilm. Their abundance may be attributed to the fact that fluctuations in water level may have allowed decomposition processes to proceed probably at a higher rate than in other deeper water/lake systems. As the volume of aquatic habitat is increased during high water, terrestrial vegetation and animals get trapped, rot and die thus providing necessary materials for decomposition to proceed. While this process goes on, low water sets in and consequently flooded areas along with the aquatic vegetation and animal community get exposed and dry up. Thus again, the raw materials necessary for decomposition become readily available. Decomposition process acted upon by microorganisms finally produces the non-living organic detritus preferred by detrital feeding fishes.

Although specific groups of fishes have preference for a particular diet, it can be gleaned from this study that the freshwater fauna in the Agusan Marsh is depauperate, as reflected in the diet. Herre (1924) stated that there are only four families of true freshwater fishes in the country, with one or two representative species in each except for cyprinids, which is wholly derived from Western Malaysia. These include the osphronemids, channids, anabantids in addition to cyprinids. These families in addition to the gobiidae, eleotridae and cichlidae, which comprise the majority of the fish community in Agusan Marsh, appeared to be generalists and do not have any preference for specific diet and feeding habits.

Feeding behavior

As shown in Figure 2, the mean values for the volume of the food bolus for *C. striata*, *T. pectoralis*, *A. testudineus* and *C. batrachus* were larger at the onset of the rainy season when the water logged areas gradually flood starting from late November than during the succeeding dry season in late May or early June. Feeding of these species peaked around February and coincided with the periods of

Figure 2. Average food volume in the guts of fishes in relation to water depth.

'backwater' i.e., when the water from the depressions or low lying areas joins with the overflowing waters of the streams and rivers. For *O. niloticus*, *C. carpio*, and *T. trichopterus*, feeding was observed to decline in October which is the end of the dry season. However, no representative samples of these species were caught during the flood season.

During the dry season, *C. striata*, *T. pectoralis* and *T. trichopterus* were found to have large percentage of empty stomachs. Percentage of empty stomachs increased as the dry season proceeded. In *C. striata*, it increased from 2.9 % in June to 3.3% in October; in *T. pectoralis*, from 4.0 % in August to 9.1 % in September; and in *T. trichopterus*, from 13% in June to 11 % in October. No empty stomachs were found at the onset of rainy season and during the flood months except for *C. striata*. Ten percent of the stomachs of this species caught in the receding flood waters in March were empty. Furthermore, at the onset of the rainy season in late November to early December, volumes of gut contents were less than those recorded at the succeeding rainy months suggesting that water pulses had an effect on the feeding activity of the Agusan Marsh fish community.

Results of this study suggest that a periodic pattern of feeding occurs in the fish in Agusan Marsh, viz: a general increase in the volume of the food ingested at the onset of the rainy season (November) and the flood months (February to late April) compared to the dry season (June-October); feeding peaked around February and fluctuates downward in the succeeding dry season. Food volume is least at the end of the dry season in October for all species sampled and for *C. striata*, trapped in shallow waters, aestivation was evident as large amounts of detritus were observed in the gut contents.

Food of floodplain fishes

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References

- Bowen, S.H. 1983.
Quantitative description of the diet. In: Fisheries Techniques (L.A. Nielsen & D.L. Johnson eds), pp. 325-331. American Fisheries Society, Maryland.
- Cattela, A.C. & M. Petrere 1996.
Feeding patterns in a fish community of Baia da Onca, a floodplain lake of the Aquidauana River, Pantanal, Brazil. *Fisheries Management and Ecology* 3: 229-37.
- Conlu, P.V. 1986.
Guide to Philippine Flora & Fauna: Fishes. Ministry of Natural Resources & University of the Philippines.
- CPPAP (Conservation of Priority Protected Areas of the Philippines), 1989.
GEF Through WB, Manila, 30 p.
- Davies, J., P.M. Magsalay, R.M. Rigor, A. Mapalo & H. Gonzalez 1990.
A Directory of Philippine Wetlands. Manila: AWBPFI, Haribon Foundation and DENR, Manila, 421 p.
- Delmendo, M.N. 1968.
Food and feeding habits of the economic species of fish in Laguna de Bay. Proceedings of the Indo-Pacific fisheries council at the 13th session of the IPFC Secretariat, FAO Regional Office for Asia and the Far East, Bangkok, Thailand; Brisbane, Queensland, Australia: IPFC Secretariat.
- George, E.L. & W.F. Hadley 1979.
Food and habitat partitioning between rock bass *Ambloplites rupestris* and small mouth bass *Micropterus dolomieu* young of the year. *Transactions of the American Fisheries Society* 108:253-261.
- Herre, A. 1924.
Distribution of the true freshwater fishes in the Philippines. *The Philippine Journal of Science* 24: 249-307.
- Jude, D.J. 1971.
Food and feeding habits of gizzard shad in pool 19, Mississippi River. *Transactions of the American Fisheries Society* 102: 378-383.

Junk, W.J. 1984.

Ecology of the *Varzea*, floodplain of Amazonian Whitewater Rivers. In: The Amazon, limnology and landscape ecology of a mighty tropical river and its basin (H. Sioli ed.), pp. 215-243. Dr. W. Junk Publishers, Netherlands.

Junk, W.J., P.B. Bailey & R.E. Sparks 1989.

The flood-pulse concept in river-floodplain systems. In: Proceedings of the International Large River Symposium (D.P. Dodge ed.), pp. 110-127. A Special Publication of the Fisheries Aquatic Science.

Lee, P.G. & P.K.L. Ng 1994.

The systematics and ecology of snakeheads (Pisces: Channidae) in Peninsular Malaysia and Singapore. *Hydrobiologia* 285:59-14.

Palomares, M.L.D. 1987.

Comparative Studies on the Food Consumption of Marine Fishes with Emphasis on Species Occurring in the Philippines. Ph.D. dissertation. University of the Philippines, Diliman, Quezon City.

Pethiyagoda, R. 1991.

Freshwater Fishes of Sri Lanka. The Wildlife Heritage Trust of Sri Lanka, Colombo, 362 p.

Welcomme, R.L. 1979.

Fisheries Ecology of Flood Rivers. Longman, London, 317 p.