An Annotated Checklist on the Introduced Aquatic Fauna of Two River Systems on Negros and Panay, Philippines

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This paper presents an annotated list of 16 species of introduced aquatic fauna in Bago River in Negros Occidental and Jalaur River in Iloilo province in the Philippines. Eleven species of fish, three species of herptile, and two species of mollusk are discussed in this paper. The “janitor fish” or South American Sailfin Catfish (Pterygoplichthys disjunctivus), the Zebra Fish (Danio rerio), the Molly (Poecilia sphenops) appear to be new records of introduced species in Bago and Jalaur River systems. Introduction of these species are most likely through the aquaculture projects and the aquarium trade.

KEYWORDS: alien invasive species, freshwater, rivers, Negros, Panay

INTRODUCTION

Freshwater Aquatic Invasive Species (AIS) have become a major global concern as introduced species become invaders and competitors to local populations and cause ecosystem destabilization (Ayers, 2010). Introduced species threaten and often cause the demise of native species, especially the rare species and species endangered by other threatening factors (Coblentz, 1990; Moyle & Leidy, 1992; Black, 1995; Smith & Quin, 1996). In addition to this, some alien fish species have been known to infect local fish species with their parasites as the host-parasite complex is extended to the local species causing the native population to decline (Galli et al., 2005). In terms of contribution to loss of biodiversity in freshwater ecosystems, AIS is considered second to habitat destruction (Casal, Luna, Froese, Bailly, Atanacio, & Agbayani, 2007).

In the Philippines, AIS are known to compete in terms of food and space with the native species (Santos-Borja, 2002; Chavez, de la Paz, Manohar, Pagulayan, & Carandang, 2006). About 181 species (28 families) are known to have been introduced into the country (Cagauan, 2007). These include fish (circa 93%), mollusks (2.67%) and some crustaceans, frogs, and turtles (circa 4%). Casal et al. (2007) estimated that of the 159 species of exotic fishes introduced in the country, at least 39 species were able to establish in the wild. These exotic organisms were primarily used as ornamental or aquarium pets (76%), as food (21%) and as biological control (2%) (Cagauan, 2007). And although most of these species were brought in for the ornamental industry (aquarium and pet trade), their incidental release in the wild appears less significant than the volume released by the fisheries and aquaculture (Pullin, Palomares, Casal, Dey, & Pauly, 1997; Casal et al., 2007). Introduction of exotics, particularly fish species, was highest during the 1970s as a result of the government's attempt to augment food and fisheries production (Cagauan, 2007).

Documentation of introduced alien species in the Visayas, Philippines is inadequate. This paper attempts to augment information on AIS from two major river systems, the Bago River in Negros island and the Jalaur River in Panay island.

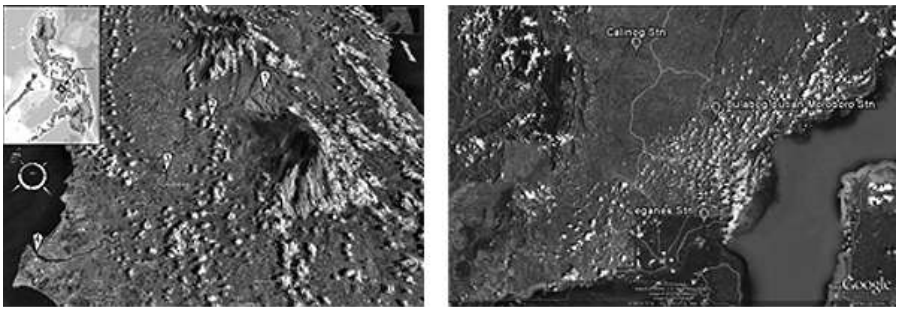

Figure 1. Satellite images: Black-and-white satellite image of Bago River showing location of the four stations and inset map of the Philippines (upper left). Black-and-white satellite view of upper Jalaur River showing the locations of the upper Calinog, mid-Dingle, and Leganes stations (upper right). Colored satellite image showing the respective positions of the Jalaur and Bago River mouths on the islands of Panay and Negros (lower large map).

MATERIALS AND METHODS

Study sites

The study focused on two major river systems, the Bago River in Negros and Jalaur River in Panay, Philippines (Figure 1). Bago River is a 76-km long river system that receives several tributaries coming from two large mountain ranges—Mount Kanlaon in the southeast and North Negros Mountain Range in the northeast. It drains into Guimaras Strait, located at the northwest portion of Negros Island.

The study sites in Bago River and their corresponding base reference points, starting from the upper stretch and going downstream are: Sitio Mambanao, Barangay Kumaliskis, Municipality of Don Salvador Benedicto (10° 31.760' N, 123° 12.854' E), Purok Urban, Barangay Lopez-Jaena, Municipality of Murcia (10° 33.450' N, 123° 04.140' E), Barangay Damsite, Municipality of Murcia (10° 33.234' N, 123° 02.143' E), and between Barangay Lag-asan, Bago City and Barangays Tapong and Ubay, Municipality of Pulupandan (10° 31.204' N, 122° 50.260' E). The elevation of the uppermost station (Station 1, Kumaliskis) is about 320 meters above sea level and is about 60 km away from the lowermost station (Station 4, Cavan-Lagasan).

The study sites in Jalaur River and their corresponding coordinates or base reference points, starting from the upper stretch of the river, are the upper Calinog Station (11° 09.208' N, 122° 29.012' E), the mid-stream Moroboro-Bulabog-Putian Station at Dingle (11° 01.700' N, 122° 39.433' E), and the lowermost estuarine station at Leganes (10°

47.343' N, 122° 38.145' E). The uppermost station has an elevation of about 80 meters above sea level and is about 90 km away from the lowermost station (Source: Google Earth, 2010). Jalaur basin has a total area of 1,827 square kilometers (Gonzales, 1984). The river drains into the Iloilo Strait.

Sampling was done using a variety of techniques. These included the local fishing gear called *taon* and fishing technique called *pahubas* (Figure 2). The former is an indigenous trap used to capture macrobenthos in Bago River while the latter is a fishing technique employed in Jalaur River that involves drying up river sections. Another local method used for collecting fish, macroinvertebrates, and other riverine vertebrates (e.g., frogs and turtle) was *panulo* or gleaning method. Sampling was done along the main river channel, in tributary streams joining the main channel, and in small pools along the river banks. Series of sampling runs were conducted during the wet and dry seasons to optimize collection and to compare seasonal variation.

Figure 2. Pahubas, a fishing technique involving stream drying. A portion of this river (Jalaur River in Calinog station) is being prepared for drying using rocks. The rock barrier functions to re-channel the stream flow to the right, later causing the portion on the left side to dry up. The dry portion of the stream is later subjected to gleaning and fish collection. *Taon* basket traps are laid down in preparation for their deployment.

Table 1.

List of Introduced Species Found in Bago and Jalaur River Systems and Their Ecological Impact and Status of Establishment in the River.

Species	Common Name	River		Adverse Impact	Establishment
		Bago	Jalaur		
Clariidae					
Clarias batrachus	Walking Catfish	+	+	Yes[1]	Yes[1]
Channidae					
Channa striata	Snakehead	+	+	Unknown[5]	Unknown[5]
Poeciliidae					
Poecilia sphenops	Molly	+	+	Unknown[5]	Unknown[5]
Poecilia reticulata	Guppy	+	+	Yes[1]	Yes[2]
Xiphiphorus helleri	Green Swordtail	+	+	Yes[2]	Yes[2]
Cyprinidae					
Cyprinus carpio	Common Carp	+	+	Yes[1]	Yes[1]
Danio rerio	Zebra Fish	+	-	Unknown[5]	Unknown[5]
Cichlidae					
Oreochromis niloticus	Nile Tilapia	+	+	Yes[1]	Yes[1]
Oreochromis mossambicus	Mozambique Tilapia	-	+	Yes[1]	Yes[1]
Osphronemidae					
Trichogaster trichopterus	Three-spot Gourami	-	+		
Loricariidae					
Pterygoplichthys disjunctivus	Sailfin Catfish	+	-	Unknown[5]	Unknown[5]
Ampullaridae					
Pomacea canaliculata	Golden Apple Snail	+	+	Yes[3]	Yes[3]
Unionidae					
Cristaria plicata	Folded Crown Mussel	+	+	Unknown[5]	Unknown[5]
Trionychidae					
Pelodiscus sinensis	Chinese Soft-shelled Turtle	+	-	Unknown[5]	Unknown[5]
Bufonidae					
Bufo marinus (Rhinella marina)	Cane Toad	+	+	Yes[4]	Yes[4]
Ranidae					
Rana (Hylarana) erythraea	Common Green Frog	+	+	Unknown[6]	Unknown[6]
Total 16 sp.		**14**	**13**		

[1]Adverse impact and establishment (based on Froese and Pauly, 2006)
[2]Adverse impact and establishment (based on http://en.wikipedia.org/wiki/Green_swordtail)
[3] Adverse impact and establishment (based on http://en.wikipedia.org/wiki/Pomacea_canaliculata)
[4] Adverse impact and establishment (based on http://en.wikipedia.org/wiki/Cane_toad)
[5]Unknown or no information
[6] Unknown or no information (Diesmos et al., 2006)

Samples are currently deposited in Silliman University-R.B. Gonzales Museum of Natural History (SU-RBG), Dumaguete City. Taxonomic identification followed Allen (1991), Parenti (2001), Harrison & Senou (2001), Poss (2001) for fishes and Alcala & Brown (1998) and Herpwatch Philippines (2009) for amphibians and reptiles.

RESULTS

A total of 16 introduced species were observed in Bago and Jalaur River systems (Table 1). These include 11 species of fish, two species of frog and one species of turtle, and two species of mollusks. The numbers of introduced species observed in the two rivers were about the same (14 and 13, respectively). The predominant exotics observed in the rivers were fishes (11 species) composed of six aquarium species and five fishery or aquaculture species. Some of the aquarium species have histories of deliberate introduction by government agencies to control mosquito larvae in freshwater environments. Six of the 15 species of exotics have no known information for their ecological role and capacity to establish in our river systems (Table 1). No introduced species of crab or shrimp were found living in the rivers.

Notes on species

FAMILY CLARIIDAE

Clarias batrachus (Walking Catfish)

Early accounts of the species in the Philippines include that of Herre (1924b). A neotype has been designated by Ng and Kottelat (2008) to avoid confusion with three other species listed under the same name. It is considered a "true" freshwater fish found in Philippine river systems (Herre, 1924a; Carumbana, 2002).

The species appears to be fairly common in stations 1 to 3 in Bago River and also in Stations 1 and 2 in Jalaur River. In contrast, Pagulayan (2001) found *C. batrachus* in only one out of five rivers studied in the Subic Bay Forest Reserve. The walking catfish fetches a higher price compared to other freshwater species and is sought after as a delicacy in the Bago River area (Figure 3).

Figure 3. Walking catfish, *Clarias batrachus*, from Bago River.

FAMILY CHANNIDAE

Channa striata (Snakehead)

We obtained our samples from Station 2 in Bago River and Station 1 in Jalaur River. Considered a potential pest (Froese & Pauly, 2010), the snakehead is nevertheless collected as food by locals in the area. It is not listed in the Global Invasive Species Database (GISD).

FAMILY POECILIIDAE

Poecilia sphenops (Molly)

This species was captured together with other species (e.g. *Anabas testudineus* and *Rhinogobius*) in Bago and Jalaur Rivers using fine-mesh nets (Figure 4). Identification of *P. sphenops* was confirmed by Dr. Lynne Parenti of the United States National Museum of Natural History (USNM).

P. sphenops was introduced in the Philippines to control mosquito larvae (Pamplona et al., 2007). They are often found in small streams and canals. Adults of this species are extremely aggressive and attack

Figure 4. Poecilia sphenops from Bago River.

other fish, shredding fins and sometimes killing them.

Poecilia reticulata (Guppy)

This species is usually captured together with gobies and *P. sphenops* using fine mesh scoop nets in Bago and Jalaur River systems. They have been observed in stream tributaries feeding into the main river channel and in small impoundments or pools along the river.

The species was introduced in the Philippines for mosquito control (Casal et al., 2007). It is known to eat the eggs of native fish species and serves as host for the parasitic nematode, *Camallanus cotti*, and the Asian tapeworm *Bothriocephalus acheilognathi* in Hawaii (Eldredge, 2000).

Xiphiphorus helleri (Green Swordtail)

The species was captured using fine-mesh nets in Bago and Jalaur Rivers. *Xiphophorus helleri* can be distinguished by the presence of a sword-like extension on the caudal fin of males (Figure 6). The species is native to Central America but has been introduced to many countries around the world through the aquarium trade. Although

Figure 5. Gambusia affinis, also known as mosquitofish, was introduced in the Philippines as aquarium fish and as control against mosquito larvae.

Figure 6. Xiphiphorus helleri, or Green Sword-tail was introduced to the Philippines as aquarium fish. This male specimen is distinguished by its extended sword-like tail.

little information is known of the species outside its natural habitat, its introduction to other habitats has been suspected to constitute a threat to the native fish population (GISD, 2010).

FAMILY CYPRINIDAE

Cyprinus carpio (Common Carp)

Samples of this species were collected from both Bago and Jalaur Rivers (Figure 7). Herre (1924b) accounted its introduction in the Philippines in 1915. Global Invasive Species Database cited carps as a major cause for the decline in aquatic macrophytes and the natural ecosystem (Global Invasive Species Database, 2010). The adverse effects of carps in various parts of the world have been discussed by various authors (Zambrano et al., 1999; Arlinghaus & Mehner, 2003).

Figure 7. Zebra Fish *Danio rerio* is an introduced species with no apparent invasive record on the environment.

Danio rerio (Zebra Fish)

Three specimens were collected in Bago River (Station 2 in Lopez-Jaena) using fine-mesh nets (Figure. 8). A few individuals were also collected in a creek near the Central Philippine Adventist College (CPAC) campus in Murcia, a few kilometers away from Station 2. The species is believed to have been introduced through the aquarium trade. No prior information on the species' introduction in Negros is

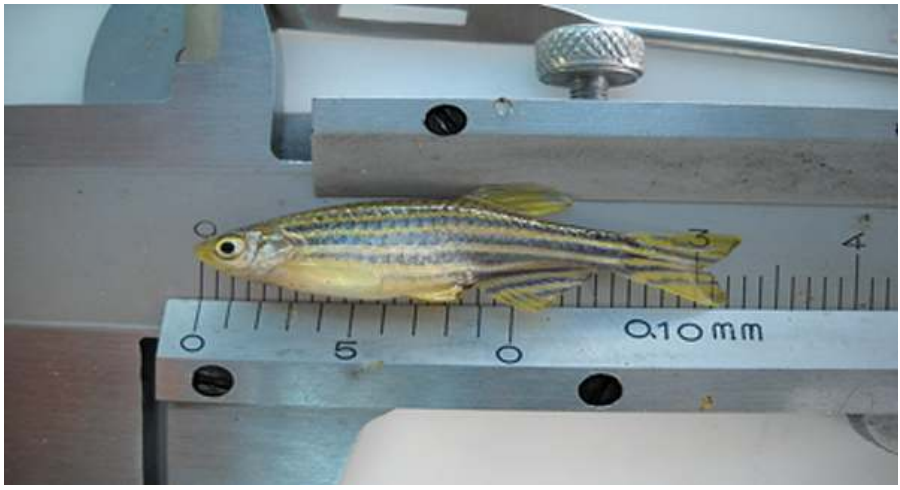

Figure 8. Cyprinus carpio, or Common Carp is a commonly fished species in the upstream portions of Bago and Jalaur Rivers.

available. This species was not observed in Jalaur River.

The Zebra Fish is considered harmless by Froese and Pauly (2010) and is not listed as an invasive species in the Global Invasive Species Database (GISD) and Casal et al. (2007).

FAMILY CICHLIDAE

Oreochromis niloticus (Nile tilapia)

This species (Figure 9) was collected from all stations of the two river systems and appears to have established itself in all study stations in the river systems of Negros and Panay. The species tops the catch-per-unit effort for most fishing gears and is regularly consumed locally particularly in Station 2 in Jalaur River.

Introduction of this species into the Philippines was done because of its high reproductive rate and relative ease of culture (Figueredo & Giani, 2005). Its effective mouth-brooding reproductive strategy allows it to increase in numbers at a rate that competitively overwhelms native species populations (Figueredo & Giani, 2005).

The fish is considered a highly invasive species that plagues a variety of ecosystems especially in the tropics (GISD, 2010). They cause

Figure 9. Oreochromis niloticus or Nile Tilapia is a ubiquitous species that has proliferated and established in Bago and Jalaur Rivers.

algal bloom and eutrophication of small ponds and slow-flowing river waters when farmed under intensive conditions (Figueredo & Giani, 2005).

Oreochromis mossambicus (Mozambique Tilapia)

This species was captured using fishnets and fishing lines (hook-and-line) in significant numbers in downstream station of Jalaur River but was not observed in Bago River.

O. mossambicus is a eurytopic and vagile species of fish known for its capacity to invade habitats of other fish species (de Moor & Bruton, 1988). The mouth-brooding habit of the species allows it to nurture and carry its young over long distances and invade habitats far from the original site of introduction (Costa-Pierce, 2003). Its potential threat to the native species is perceived by way of competition for food and nest space. Juveniles have been documented to feed on other fish (de Moor et al., 1986). This species is currently considered a pest. In Hawai'i, this species is suspected to be a threat to native species such as striped mullet (*Mugil cephalus*) (see Randall, 1987; Devick, 1991). The species has been considered a major contributing factor in the decline of the desert pupfish (*Cyprinodon macularius*) in the Salton Sea area (Courtenay & Robins, 1989). In addition to this, eradication of the

species has been suggested on Tarawa and Nauru because of their potential threat to the local species and the ecosystem (Eldredge, 2000).

FAMILY LORICARIIDAE

Pterygoplichthys disjunctivus (South American Sailfin Catfish; "janitor fish")

Six large mature individuals measuring 30-35 cm were captured by gillnets in Bago River at Barangay Lopez-Jaena in Murcia. The capture of this species is believed to be the first record for the Visayas region. The genus has been reported in Zamboanga in Mindanao and Aparri, Cagayan in Northern Luzon (Chavez et al., 2006).

Although the species has not been recommended for consumption by Chavez et al. (2006), fisherfolk in Bago collect this fish for food.

FAMILY BELONTIDAE

Trichogaster trichopterus (Three-spot Gourami)

Only one individual was collected in Jalaur River using scoop net. This species is a native of mainland Asia, particularly in the Mekong Area.

Figure 10. Cristaria plicata was commonly found in Bago and Jalaur Rivers, including sections attached to the rivers like irrigation canals.

Geheber, McMahan, & Piller (2010) cited evidence on the introduction of this species in India, Taiwan, North Western Australia, Philippines, Papua New Guinea, Southern Africa and Dominican Republic.

The species was introduced in the Philippines primarily to control *Aedes aegypti* larvae (Pamplona, Lima, Cunha, & Santana, 2007). Juliano, Guerrero & Ronquillo (1989) first recorded the establishment of the species in the Philippines. The potential threat of the species to the native population has been attributed to the species' territorial nature and aggressive behavior, being an opportunistic carnivore (Webb, Maughan, & Knott, 2007).

MOLLUSCA

PELECYPODA

Cristaria plicata

This bivalve (Figure 10) is collected by local residents for food in Bago and Jalaur Rivers. They are harvested by hand by divers equipped with goggles and net bags. Harvesting of the shell appears to have a seasonal cycle that is dictated by the shallowness and accessibility of the shell habitat or channel bottom. During high stream flow (flooding), the shells are often spared from collection allowing them to grow in numbers (this species form clustered layers of dead and live shells in sandy areas) because of the difficulty in accessing them and the apparent poor quality of the shell meat that tends to accumulate silt/sand during the period. Local accounts indicate that the shells become more meaty and palatable during the dry season.

The species has been introduced in other freshwater systems in Negros Oriental, including Balanan Lake in Siaton and Calango Small-Water-Impoundment in Zamboanguita.

GASTROPODA

Pomacea canaliculata (Golden Apple Snail)

We usually observed this snail in river banks and rice paddies. *Pomacea canaliculata* was originally introduced from South America to Southeast Asia around 1980, as a local food resource and as a potential gourmet export item. The markets never developed; the snails escaped or were

released, and *P. canaliculata* became a serious pest of rice throughout many countries of Southeast Asia. In the Philippines, it is considered the number one rice pest and has caused huge economic losses. Potential impacts of the species include destruction of native aquatic vegetation leading to serious habitat modification and competition with native snails. Introduced *P. canaliculata* has been implicated in the decline of native species of Pila Apple Snails in Southeast Asia. Moreover, climatic-change modeling has shown that the species has the potential to spread to other parts of the world that have not been infested, like the rice-growing areas of India (CIDG, 2010).

AMPHIBIA

FAMILY BUFONIDAE

Bufo marinus (Rhinella marina)

Common throughout the Philippines, this species was introduced during the 1930s by the Bureau of Plant Industry (BPI) to control beetles in sugarcane fields (Diesmos, Diesmos & Brown, 2006). Although the species is considered terrestrial, part of its larval life cycle is in aquatic environments.

This species was found in all sampling stations, usually in pools formed along the river bank. Although records from other countries indicate that the species became a pest under introduced conditions, its impact on Philippine ecosystems is not that apparent (A. Alcala pers. observ.). However, the species has been suspected to compete for breeding sites with three frog species, *Fejervarya cancrivora, Polypedates leucomystax,* and *Kaloula conjuncta negrosensis* in Philippine lowland areas (Joshi, 2005). A. Alcala (pers observ), however, could not confirm having observed this competition with the latter species on Negros Island.

RANIDAE

Rana (Hylarana) erythraea

We observed the species in both river systems, often encountered along the banks of the rivers, streams, and rice paddies. Despite its widespread distribution in Southeast Asia, Diesmos et al. (2006) suspect that this species may be introduced in the Philippines due to

Figure 11. Pelodiscus sinensis, is a soft-shelled turtle found in Bago River. This species appears to have established in the area as indicated by regular capture of individuals.

its absence in Palawan and Sulu archipelago.

REPTILIA

FAMILY TRIONYCHIDAE

Pelodiscus (Trionyx) sinensis

This soft-shelled turtle (Figure 11) is believed to have been accidentally introduced through the pet trade. However, accounts of the species being brought in by early Chinese traders for personal consumption (food) is also being entertained since the species is also found in places known for its intensive contact with early Chinese traders (A. Ong, pers. comm).

An individual of this species was captured in the Bago River sampling station in Lopez-Jaena (Municipality of Murcia) by the research team while gleaning through a rock pile in a fast-flowing part of the river. Although the species appears to be uncommon, often times it is accidentally captured by fish nets. Captured individuals eventually end up as food. This species appears to have established in Bago River because it is regularly captured there. This turtle grows to a large size, sometimes reaching 30 cm in carapace length.

CONCLUSIONS

Information on introduced invasive aquatic species (AIS) in the Philippines appears to be gaining as more studies are being conducted. However, studies on AIS impacts on Philippine aquatic habitats and ecosystems are insufficient. Such inadequacy added to the lack of capacity to deal with AIS has contributed to the proliferation of exotic species. There is a need for the aquaculture and aquarium trade industries to strictly comply with the biosafety and quarantine regulations. In addition to this, government agencies like the Department of Agriculture (DA) and Department of Environment and Natural Resources (DENR) should put more effort into the monitoring and control of these exotic species. Furthermore, private and government academic institutions can provide significant contributions in the monitoring and control of AIS through their research programs. Last but not least, further study and monitoring of AIS are recommended, particularly the least known species, so that proper control and management by authorities can be done, especially to determine if they compete with the native species in the Bago and Jalaur River systems and in other river systems of the country.

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