

The Ichthyofauna of Lake Manguao, Taytay, Palawan, Philippines

Joie D. Matillano

State Polytechnic College of Palawan-Puerto Princesa Campus, Sta. Monica Heights, Puerto Princesa City 5300, Palawan, Philippines

ABSTRACT

Matillano, J. D. 2002. The Ichthyofauna of Lake Manguao, Taytay, Palawan, Philippines. *Ann. Trop. Res.* 24(2):23-45.

The fish fauna of Lake Manguao was investigated during two sample events last June and September 2002. The study was conducted in order to ascertain whether the unique fish fauna first catalogued by Day (1914) and later by Davies and Green (1990) is still present in the lake after the introduction of *Oreochromis niloticus* in 1992. This study also tried to find out whether there are two endemic species of *Puntius* in the lake, as described by Day (1914) and Herre (1924), or just one assumed by Davies and Green (1990), and if indeed a lake-endemic catfish is present in the area and to determine the local uses of the lake fishes.

Six types of fishing gears were used and a total of eight sampling stations were sampled representing both the littoral and open water zones of the lake.

A total of 11 fish species from ten genera belonging to eight families including Anabantidae, Channidae, Cichlidae, Clariidae, Cyprinidae, Eleotridae, Hemiramphidae, and Siluridae were caught from the lake. In addition to the species previously accounted for, a new fish species was recorded, *Clarias macrocephalus*, a native catfish of the Philippines. The two species of *Puntius* collected by Day (1914) were also collected, as well as the silurid catfish described by Herre (1924) as *Penisilurus palawanensis*. Apparently, fishery focuses mainly on Tilapia and of secondary fishery importance are the other introduced species.

Keywords: ichthyofauna, fish species, Lake Manguao

INTRODUCTION

Lake Manguao was first exposed to a scientific study during an expedition led by an American scientist named Day (1914). During this expedition, Day and his colleagues collected and described five fish species (*Puntius bantolanensis*, *P. manguaoensis*, *Boroda expatria*, *Rashora argyrotaenia everetti* and *Penesilurus palawanensis*), four of which are endemic to the lake as reported also by Herre (1924 a, b, and 1927).

In April 1989, the fish population was again studied by Davies and Green (1990). In addition to the species collected by Day (1914), Davies and Green (1990) recorded *Nematabramis alestes*, *Channa striata*, and *Anabas testudineus*. The later authors though did not separate *Puntius* into two species as Day (1914) did. They stated that the validity of the species status must await further taxonomic studies.

In 1992, the Bureau of Fisheries and Aquatic Resources (BFAR) introduced the Nile Tilapia *Oreochromis niloticus* for prospects of introducing a food fish and boost income from Tilapia fisheries for the lake community. This introduction of an exotic species, however, occurred without first conducting a study on its possible effects on the native fish fauna.

The present study was conducted to investigate whether the unique fish fauna first catalogued and described by Day (1914), Herre (1924 a, b, and 1927) and lately by Davies and Green (1990) are still present in the lake after the introduction of *Oreochromis niloticus* and to determine the local uses of the fishes.

Study area

Lake Manguao is situated at 10°45' N; 119°32' E in the rolling hill zone of Northern Palawan, 7 km south of the town proper of Taytay. It has a minimum area of 640 ha but increases considerably (up to 800 ha) during rainy seasons. It has a total catchment area of 4,425 ha (Davies and Green, 1990). The maximum depth of the lake varies between 9 and 14 m (Davis and Green, 1990; personal observations).

The lake was formed just a few centuries ago following a damming of a river valley by a lava flow from the recent volcanic eruption in the northeastern part of the lake. Before the valley was dammed, the river flowed unhindered to the sea at Bantolan bay. The lake apparently has only one permanent inflow referred to as Manguao Brook by Davies and Green (1990). There are also numerous streams of temporary nature. No surface outflow connects the lake to the sea; instead, it diffuses underground, passes a lava field and reappears as springs feeding the marsh created in the former river valley (Davies and Green, 1990).

The natural vegetation of the catchment area is mainly of tropical monsoon forest; some parts of it have been cleared by settlers for cultivation and residential purposes (Davies and Green, 1990).

At present, there are at least 40 households in the area surrounding the lake. Most of the inhabitants are dependent on the lake for their livelihood.

Farming complements the livelihood of some of the residents. Major part of the income is generated from dried (daing) Tilapia. During the conduct of the study in 2002, daing sold around Php 40.00/kilo.

METHODOLOGY

Eight sampling stations were sampled within the lake. Three stations (Stations 4, 6, 7) were located in the open water zone and the rest (Stations 1, 2, 3, 5, 8) were located along the lake shoreline.

Sampling was conducted in June and September 2002 using six different types of fishing gears such as gill net, hook and line, fish pot, scoop net, beach seine and push net. Samples were taken at different times of the day. Species identification for the endemic fishes of the lake was mainly based on Day (1914) and Heree (1924 a, b and 1927). For the non-endemics, the works of Kottelat *et al.* (1993), Inger and Chin (19620, and Rainboth (1996) were used. Samples were preserved in 10% formalin for at least 24 hours and later transferred to 75% ethanol. Morphometric measurements for *Puntius* spp. are based on the works of Kottelat *et al.* (1993) and were performed on the least ten individuals per species.

RESULTS AND DISCUSSION

A total of 11 fish species from ten genera belonging to eight families were caught (Table 1). In addition to the species previously accounted for, a new fish species was recorded from the lake, *Clarias macrocephalus*, a native catfish of the Philippines.

In the following, the different species are described. Information on the habitat and the fisheries is based on this study. The taxonomic status of each species is discussed based on the results of this study in relation to earlier publications. The two *Puntius* species are discussed together due to previous disagreements in separating the two species.

***Puntius bantolanensis* (Day, 1914)**

Synonyms: *Barbus bantolanensis* Day (1914); *Barbus bantolanensis* Herre (1924)

Materials examined : Five specimens collected from Station 6 (June 27, 2002) in the middles of the largest bay, one from Station 4 (June 26, 2002) east of the smaller island and four from Station 7 in the open water zone (June 28, 2002).

Max. standard length (SL) : 130.65 mm

Min. SL : 104.3 mm. Some of the specimens were gravid.

Habitat: Open water zone of the lake

Fisheries: Not a target species for fishery but consumed locally if caught as by-catch; used also as animal feed. According to fishermen, it is only caught in the open water area.

Remarks : Not found by Davies and Green (1990) who apparently collected in the littoral zone. This species is endemic to the lake. It was also noted that the pelvic ray and spine count is II, 8 instead of I, 8 as

Table 1. Fish species collected from Lake manguao in June and September 2002

Family	Species Name	Local Name	Remarks
Anabantidae	<i>Anabas testudineus</i>	Puyo	Introduced
Channidae	<i>Channa striata</i>	Dalag, Aruan	Introduced
Cichlidae	<i>Oreochromis niloticus</i>	Tilapia	Introduced; exotic
Clariidae	<i>Clarias macrocephalus</i>	Pantat	Introduced
Cyprinidae	<i>Nematabramis alestes alestes</i>	Seluang	Endemic to Palawan and Mindanao
	<i>Rasbora argyrotaenia everetti</i>	Seluang	Subspecies of <i>R. argyrotaenia</i> , limited to Palawan and Mindanao
	<i>Puntius manguaoensis</i>	Paitan	Endemic to the lake
	<i>P. bantolanensis</i>	Paitan sa laod	Endemic to the lake
Eleotride	<i>Bosthyrcus expatria</i>	Bulukot	endemic to the lake
Hemiramphidae	Gen. sp.	Siriawan Tiol-tiol	Not well defined range
Siluridae	<i>Hito taytayensis</i>	Alabiyog	Endemic to Northern Palawan and Calamian Group of Islands

Table 2. Morphometric measurements for *Puntius bantolanensis*.

(Measurements in mm)	Specimen No.				
	1	2	3	4	5
Standard length	120	112.1	110.4	104.3	109.1
Length of head	0.308	0.330	0.310	0.309	0.306
Caudal peduncle length	0.180	0.174	0.170	0.171	0.172
Length of snout	0.082	0.095	0.082	0.089	0.090
Length of dorsal fin base	0.165	0.148	0.139	0.156	0.149
Length of anal fin base	0.087	0.087	0.084	0.086	0.083
Length of pectoral fin	0.208	0.209	0.197	0.208	0.217
Length of pelvic fin	0.178	0.189	0.175	0.173	0.184
Depth of caudal peduncle	0.125	0.126	0.124	0.136	0.124
Depth of body	0.35	0.339	0.313	0.336	0.320
Height of dorsal fin	0.201	0.208	0.216	0.211	0.215
Height of anal fin	0.165	0.172	0.152	0.167	0.159
Diameter of eye	0.058	0.058	0.063	0.057	0.061
Interorbital distance	0.110	0.121	0.126	0.114	0.117
Snout to occiput	0.243	0.237	0.243	0.244	0.238
Snout to dorsal	0.528	0.583	0.555	0.539	0.565
Snout to ventral	0.505	0.545	0.511	0.532	0.526
Dorsal rays and spine*	IV, 81/2	IV, 81/2	IV, 81/2	IV, 81/2	IV, 81/2
Anal rays and spine	III, 5 1/2	III, 5 1/2	III, 5 1/2	III, 5 1/2	III, 5 1/2
Pectoral rays and spine	I, 15	I, 15	I, 15	I, 15	I, 15
Pelvic rays and spine	II, 8	II, 8	II, 8	II, 8	II, 8
Lateral line scale count	23	24	25	24	23
Lateral line scale count (including caudal scales)	25	26	27	26	26
Predorsal scale count	9	9	9	9	9
Circumpeduncular scale count	12	12	12	12	12
Circumferential scale count	20	20	20	20	20
Transverse scale count	1/2 / 4 / 1 / 3 1/2	1/2 / 4 / 1 / 3 1/2	1/2 / 4 / 1 / 3 1/2	1/2 / 4 / 1 / 3 1/2	1/2 / 4 / 1 / 3 1/2

Proportional Measurements

Head length (HL) in standard length (SL)	3.25	3.03	3.22	3.24	3.26
Body depth in SL	2.99	2.95	3.20	2.98	3.12
Eye diameter in HL	5.27	5.69	4.89	5.41	5.02
Snout length in HL	3.77	3.46	3.81	3.48	3.39
Snout to occiput in SL	4.12	4.22	4.11	4.11	4.19
HL in body depth	1.09	1.03	1.01	1.09	1.04

All measurements are given in relation to standard length. (*) Spine and ray respectively.

Table 2. Morphometric measurements for *Puntius manguaoensis*. (continuation)

(Measurements in mm)	Specimen No.				
	6	7	8	9	10
Standard length	113.3	107	130.65	102	113.2
Length of head	0.312	0.303	0.305	0.314	0.312
Caudal peduncle length	0.177	0.178	0.186	0.160	0.175
Length of snout	0.086	0.084	0.089	0.090	0.088
Length of dorsal fin base	0.148	0.152	0.153	0.157	0.160
Length of anal fin base	0.083	0.087	0.088	0.092	0.090
Length of pectoral fin	0.210	0.218	0.194	0.219	0.208
Length of pelvic fin	0.180	0.187	0.172	0.200	0.181
Depth of caudal peduncle	0.125	0.123	0.136	0.118	0.131
Depth of body	0.320	0.357	0.333	0.329	0.330
Height of dorsal fin	0.212	0.238	0.214	0.208	0.216
Height of anal fin	0.162	0.166	0.168	0.167	0.174
Diameter of eye	0.056	0.060	0.053	0.063	0.057
Interorbital distance	0.113	0.112	0.117	0.130	0.123
Snout to occiput	0.229	0.231	0.237	0.241	0.252
Snout to dorsal	0.556	0.565	0.558	0.567	0.581
Snout to ventral	0.511	0.514	0.509	0.534	0.552
Dorsal rays and spine*	IV, 81/2	IV, 81/2	IV, 81/2	IV, 81/2	IV, 81/2
Anal rays and spine	III, 5 1/2	III, 5 1/2	III, 5 1/2	III, 5 1/2	III, 5 1/2
Pectoral rays and spine	I, 15	I, 15	I, 15	I, 15	I, 15
Pelvic rays and spine	II, 8	II, 8	II, 8	II, 8	II, 8
Lateral line scale count	24	24	23	24	24
Lateral line scale count (including caudal scales)	26	26	25	26	26
Predorsal scale count	9	9	9	9	9
Circumpeduncular scale count	12	12	12	12	12
Circumferential scale count	20	20	20	20	20
Transverse scale count	1/2/4/1/3 1/2	1/2/4/1/3 1/2	1/2/4/1/3 1/2	1/2/4/1/3 1/2	1/2/4/1/3 1/2
Proportional Measurements					
Head length (HL) in standard length (SL)	3.21	3.30	3.28	3.19	3.20
Body depth in SL	3.12	2.80	3.00	3.04	3.03
Eye diameter in HL	5.52	5.07	5.78	4.96	5.52
Snout length in HL	3.60	3.61	3.44	3.50	3.54
Snout to occiput in SL	4.37	4.32	4.23	4.15	3.96
HL in body depth	1.03	1.18	1.09	1.05	1.06

All measurements are given in relation to standard length. (*) Spine and ray respectively.

described in all other references. The anal ray and spine count is III, 5 1/2 instead of III, 5 and the dorsal ray and spine count is IV, 8 1/2 instead of the earlier description IV, 8 (Table 2).

***Puntius manguaoensis* (Day, 1914)**

Synonyms: *Barbus manguaoensis* Day (1914);
Barbodes manguaoensis Herre (1924)

Material examined: Three from Station 2 (one inflow and two from the littoral zone) (June 25, 2002) four from Station 1 right in front of the campsite in the littoral zone (June 27, 2002) and three from Station 3 (June 26, 2002) in the littoral zone of the rocky shore. Most of the specimens examined are gravid.

Max. SL: 171.55 mm.

Min. SL: 115.3 mm.

Habitat: Littoral zone of the lake, areas close to the island and in the inflows draining into the lake.

Fisheries: Not a target species for fishery but consumed locally if present as by-catch; used also as animal feed. According to the fishermen, this species is commonly encountered in the littoral zone of the lake and in areas close to the islands.

Remarks: This species is endemic to the lake. It was also noted that the pelvic ray and spine count is II, 8 instead of I, 8 as described in all other references. The anal ray and spine count is III, 5 1/2 and the dorsal ray and spine count is IV, 8 1/2 instead of the earlier description IV, 8 (Table 3).

Davies and Green (1990) did not separate their collected *Puntius* into

two species. Based on their morphometric measurements which they compared with those of Day (1914) and Herre (1924 a) a separation into two species seemed not appropriate since their measurements did neither fit Day's and Herre's description of *P. bantolanensis* nor their description of *P. manguaoensis*. Moreover a type specimen was not available (was destroyed during Second World War), Davies and Green recommended further taxonomic studies to evaluate the status of *Puntius* spp.

Based on this study, it was possible to separate the two *Puntius* species and identify them as *P. bantolanensis* and *P. manguaoensis*. The two species can be clearly separated based on their distinctive morphometric measurements (Table 4). The proportional measurements for all parameters except for lateral line scales are clearly different for the two species. The main diagnostic parameters are head length in standard length, body depth in standard length, snout to occiput distance to standard length, head shape, hump and color. Comparing further the measurements with those of Day (1914) and Herre (1924a), a very striking similarity is revealed. It was also noted that each species occupies a different niche in the lake. *P. manguaoensis* occupies the open water zone. This result is supported by information from the local people who stated that *P. bantolanensis* is exclusively caught in the open waters, therefore they call it "paitan sa laod" which means "pelagic *Puntius*" if translated to English. This might explain why Davies and Green (1990) were not able to separate *Puntius* specimens into two species. They apparently collected only in the littoral zone, hence probably only caught *P. manguaoensis*. The color description of Davies and Green supports this assumption. Davies and Green (1990) described the live color of their specimens as dark above and a golden bronze sheen below. The anal and pelvic fins were deep red in most specimens as were the pectoral fins in some. The caudal and dorsal fins were dull orange with a darkening of the fin rays of the bottom half of the dorsal fin and the anterior portion of the caudal fin. The same color pattern was observed for *P. manguaoensis* collected during this study. *Puntius bantolanensis*, on the other hand, is more or less pale golden silver all over and the fins are red orange in color.

Gut measurements revealed that these fishes are omnivorous in nature, the gut being more or less twice the length of the body.

Table 3. Morphometric measurements for *Puntius manguaensis*.

(Measurements in mm)	Specimen No.				
	1	2	3	4	5
Standard length	171.55	133	135	130.55	152
Length of head	0.277	0.282	0.287	0.277	0.279
Length of caudal peduncle	0.173	0.183	0.156	0.179	0.164
Length of snout	0.076	0.093	0.093	0.077	0.082
Length of dorsal fin base	0.160	0.176	0.150	0.156	0.138
Length of anal fin base	0.095	0.100	0.099	0.094	0.088
Length of pectoral fin	0.198	0.215	0.181	0.191	0.192
Length of pelvic fin	0.167	0.192	0.148	0.167	0.164
Depth of caudal peduncle	0.143	0.148	0.136	0.138	0.143
Depth of body	0.393	0.368	0.372	0.363	0.374
Height of dorsal fin	0.191	0.229	0.185	0.189	0.183
Height of anal fin	0.134	0.168	0.152	0.147	0.135
Diameter of eye	0.059	0.058	0.057	0.061	0.053
Interorbital distance	0.123	0.118	0.116	0.108	0.119
Snout to occiput	0.210	0.209	0.215	0.214	0.220
Snout to dorsal	0.572	0.566	0.565	0.582	0.529
Snout to ventral	0.507	0.501	0.541	0.506	0.530
Dorsal rays and spine*	IV, 81/2	IV, 81/2	IV, 81/2	IV, 81/2	IV, 81/2
Anal rays and spine	III, 5 1/2	III, 5 1/2	III, 5 1/2	III, 5 1/2	III, 5 1/2
Pectoral rays and spine	I, 15	I, 15	I, 15	I, 15	I, 15
Pelvic rays and spine	II, 8	II, 9	II, 8	II, 8	II, 8
Lateral line scale count	24	25	24	23	25
Lateral line scale count (including caudal scales)	26	27	26	25	27
Predorsal scale count	10	10	10	10	10
Circumpeduncular scale count	12	12	12	12	12
Circumferential scale count	20	20	20	19	20
Transverse scale count	1/2 / 4 / 1 / 3 1/2	1/2 / 4 / 1 / 3 1/2	1/2 / 4 / 1 / 3 1/2	1/2 / 4 / 1 / 3 1/2	1/2 / 4 / 1 / 3 1/2
Proportional Measurements					
Head length (HL) in standard length (SL)	3.61	3.55	3.48	3.61	3.59
Body depth in SL	2.54	2.71	2.69	2.75	2.67
Eye diameter in HL	4.73	4.90	5.05	4.58	5.29
Snout length in HL	3.65	3.02	3.08	3.62	3.39
Snout to occiput in SL	4.77	4.79	4.66	4.66	4.55
HL in body depth	1.42	1.31	1.29	1.31	1.34

All measurements are given in relation to standard length. (*) Spine and ray respectively.

Table 3. Morphometric measurements for *Puntius bantolanensis*. (continuation)

(Measurements in mm)	Specimen No.				
	6	7	8	9	10
Standard length	160.1	134.45	115.3	123.55	128.7
Length of head	0.293	0.298	0.271	0.282	0.276
Caudal peduncle length	0.164	0.161	0.156	0.174	0.174
Length of snout	0.084	0.100	0.077	0.085	0.084
Length of dorsal fin base	0.151	0.169	0.178	0.172	0.159
Length of anal fin base	0.096	0.099	0.064	0.115	0.089
Length of pectoral fin	0.183	0.186	0.202	0.222	0.199
Length of pelvic fin	0.188	0.177	0.175	0.190	0.179
Depth of caudal peduncle	0.131	0.141	0.152	0.156	0.148
Depth of body	0.364	0.361	0.399	0.400	0.404
Height of dorsal fin	0.197	0.220	0.204	0.211	0.190
Height of anal fin	0.135	0.158	0.108	0.168	0.151
Diameter of eye	0.055	0.054	0.059	0.057	0.060
Interorbital distance	0.126	0.113	0.115	0.108	0.113
Snout to occiput	0.183	0.203	0.211	0.223	0.215
Snout to dorsal	0.462	0.565	0.551	0.607	0.565
Snout to ventral	0.431	0.487	0.498	0.515	0.510
Dorsal rays and spine*	IV, 81/2	IV, 81/2	IV, 81/2	IV, 81/2	IV, 81/2
Anal rays and spine	III, 5 1/2	III, 5 1/2	III, 5 1/2	III, 5 1/2	III, 5 1/2
Pectoral rays and spine	I, 15	I, 15	I, 15	I, 15	I, 15
Pelvic rays and spine	II, 9	II, 8	II, 8	II, 9	II, 8
Lateral line scale count	23	23	24	24	24
Lateral line scale count (including caudal scales)	25	25	26	26	26
Predorsal scale count	9	9	9	10	9
Circumpeduncular scale count	12	12	12	12	12
Circumferential scale count	20	20	22	20	20
Transverse scale count	1/2 / 4 / 1 / 3 1/2	1/2 / 4 / 1 / 3 1/2	1/2 / 4 / 1 / 3 1/2	1/2 / 4 / 1 / 3 1/2	1/2 / 4 / 1 / 3 1/2
Proportional Measurements					
Head length (HL) in standard length (SL)	3.42	3.36	3.68	3.54	3.63
Body depth in SL	2.75	2.77	2.51	2.50	2.48
Eye diameter in HL	5.35	5.48	4.60	4.99	4.61
Snout length in HL	3.47	2.97	3.54	3.32	3.27
Snout to occiput in SL	5.45	4.92	4.74	4.48	4.65
HL in body depth	1.24	1.21	1.47	1.42	1.46

All measurements are given in relation to standard length. (*) Spine and ray respectively.

Table 4. Proportional measurements of *Puntius* spp. collected from Lake Manguao by different studies

Researcher	Head in body	Depth in body	Eye in head	Snout in head (*)	Lateral line scales	Snout to occiput distance in standard length	Head length in body depth	Snout to occiput distance in head length
<i>Puntius bantolanensis</i>								
Day (1914)	2.85-3.20	2.50-2.90	5.30-5.80	3.45-4.14	25-26	No data	No data	No data
Herre (1924)	2.70-3.26	2.55-3.20	4.20-5.10	No data	24-26	No data	No data	No data
This study (2002)	3.03-3.30	2.80-3.20	4.89-5.78	3.39-3.81	23-25 (25-27)	3.96-4.37	1.01-1.18	1.24-1.46
<i>Puntius manguaoensis</i>								
Day (1914)	2.75-3.0	2.50-2.70	4.0-6.0	3.32-4.14	27-28	No data	No data	No data
Herre (1924)	3.24-4.0	2.75-3.60	3.50-4.13	No data	27-28	No data	No data	No data
Davies and Green (1990)	2.76-3.7	2.55-3.80	3.22-5.42	2.13-3.60	24-26	No data	No data	No data
This study (2002)	3.36-3.68	2.48-2.77	4.58-5.48	2.97-3.65	23-25 (25-27)	4.48-5.45	1.21-1.47	1.27-1.60

Note: Lateral line scale counts in parenthesis include scales on the caudal fin; (*) Day measured snout length from the tip of the snout to the nostril, while the other measurements refer to the distance between tip of snout and anterior margin of the eye

***Hito taytayensis* (Herre, 1924)**

Synonyms : *Penesilurus palavanensis* Herre 1924;
Silurus palavanensis Fish Base 2000.

Materials examined: Two gravid females (SL 152 and 156 mm) from Station 1 near inflow of Manguao Stream on June 27, 2002 and 1 juvenile (SL 113 mm) from the inflow itself on June 28, 2002.

Habitat: Littoral areas of the lake and inflows, particularly of Manguao stream. According to the local fishermen, it is found throughout the littoral zone of the lake during dry season and in nearby streams during rainy seasons.

Fisheries: This species is considered to be of good eating quality and was commonly fished during the times when *Tilapia* was not yet introduced. Some locals say that after the introduction of *Tilapia*, they had noted a sharp decline of the population of this species. This claim though was based mainly on their by-catch of this species and no survey was conducted to support such claim. Their observation might be related to the mesh size locally used, which is designed for catching *Tilapia*, and is big enough for this catfish to escape. During this study, *H. taytayensis* was caught with a small mesh size gill net that was set overnight.

Remark: This species is the only representative of the Silurid catfish family in the Philippines. *H. taytayensis* is endemic to northern Palawan and the Calamian Group of Islands. Herre (1924b) collected *H. taytayensis* in a small freshwater creek near Taytay.

In 1924, Herre described two new silurid genera with one species each, *Hito taytayensis* and *Penesilurus*. The description of *H. taytayensis* was based on 17 specimens collected from a creek near Taytay, while the species description of *P. palavanensis* was based on only one poorly preserved specimen collected by Day (1914) from Lake Manguao. Herre (1924b)

separated the two genera based on the presence of two pairs of mandibular barbels in *Penesilurus* versus one pair of mandibular barbels in *Hito*. In 1950, Haig revised the classification of Silurid catfishes. She redescribed *H. taytayensis* and established *P. palawanensis* as a synonym of *H. taytayensis*. This decision was based on the fact that the number of mandibular barbels varies (i.e. one pair in some and two pairs in others) between specimens of *H. taytayensis* she examined and thus is not of generic validity. In addition, the difference in ray counts given by Herre (1924b) for *Penesilurus* may be attributed to the fact that his description of *P. palawanensis* was based on a single specimen that was in poor condition.

The present study confirms Haig's (1950) view because of the three specimens collected, one had two pairs of mandibular barbels while two had only one. The fact that the number of mandibular barbels varies within the same sex indicates that this trait bears no relation to sexual dimorphism. Furthermore, comparison of the morphometric measurements of Herre (1924b) with those of this study (Table 5) shows that they fit the description for *H. taytayensis*. It is therefore concluded that *H. taytayensis* is the only silurid catfish in lake Manguao (and all over the Philippines) and that *P. palawanensis* is a junior synonym.

***Bosthrycus expatria* (Herre, 1927)**

Synonyms: *Boroda expatria* Herre, 1927

Materials examined: Seven specimens collected from Station 4 and 8 in the open water zone of the lake on June 26 and 27, 2002; 12 specimens from Station 1, 3, and 5 in the littoral on June 26, 27 and 28, 2002. The largest specimen is about 200 mm in SL and the smallest is 50 mm in SL. The latter was caught among debris using a scoop net.

Habitat: Specimens were collected on both littoral and open water stations but some were also encountered among floating vegetation as a skulking predator.

Table 5. Morphometric measurements of *Hito taytayensis*

(Measurements in mm)	Specimen		
	1	2	3
Standard length	152	156	113
Total length	172	177.5	131.1
Head length	24.05	26.8	16.3
Body length	37.9	36	21.15
Depth of dorsal fin	9.95	10.8	7.3
Pectoral fin length	22.4	24.55	16.3
Pelvic fin length	8.95	10.7	6.85
Anal fin length	95.3	96.5	66
Mouth width	16.85	17.25	11.2
Eye diameter	3.85	3.85	2.6
Interorbital distance	18.75	19.8	11.55
Snout to occiput	19.35	22.5	10.85
Snout to dorsal	45	48.9	31.4
No. of dorsal ray	4	4	4
No. of anal ray	61	57	58
No. of Pectoral ray and spine	I, 11	I, 11	I, 11
No. of pelvic ray and spine	7	7	7
Branchiostegal ray	12	13	12
Length of maxillary barbel	64	51.9	36
Length of mandibular barbel (anterior)	21.45	24.8	14.8
Length of mandibular barbel (posterior)		13.4	
<hr/>			
Proportional measurements			
Body depth in standard length	4.01	4.33	5.34
Head length in standard length	6.32	5.82	6.93
Eye Diameter in head length	6.25	6.96	6.27
Eye in interorbital distance	4.87	5.14	4.44
Maxillary barbel in standard length	2.38	3.01	3.14
Pectoral fin in standard length	6.79	6.35	6.93

Fisheries: Valued for home consumption. This species is of good eating quality although it is not good for drying because the flesh is very thick and soft. Usually it is caught with a gill net.

Remarks: A large species of eleotrid goby reaching almost 200 mm in standard length. *B. expatria*, known as bulukot by the locals, is endemic to the lake. This was the second most commonly encountered fish during the sampling. They are commonly caught in the lower part of the gill net, an indication that this is a benthic dweller. Observations made in aquaria showed that they ambush their prey. This species is undoubtedly a pure carnivore owing to its large, well-developed short gut and sharp large teeth. Examination of the gut content revealed remains of scales most probably that of *Puntius* or *Rasbora*. Of special interest is that according to the fisher folks, there seems to be a very similar species in Bantolan Bay, which may suggest that *B. expatria* is a migrant from the sea that was trapped during the volcanic eruption that created the lake. As a result, it may have adapted permanently in a freshwater. This assumption, however, needs further studies to determine its validity.

***Nematabramis alestes alestes* Seale and Bean, 1907**

Synonyms: None

Materials examined: Seven specimens collected from Manguao Stream in a push net set against the current on June 28, 2002. The largest specimen was 59.7 mm in SL and the smallest was 53.6 mm in SL.

Habitat: This species is restricted to the inflows draining into the lake, particularly Alipuran Stream (called Manguao Stream by Davies and Green, 1990)

Fisheries: No fishery value at all; most inhabitants do not even know its existence.

Remarks: *N. alestes* is confined to Borneo, Palawan and some areas in Mindanao. Inger and Chin (1962) divided the species into two subspecies: *Nematabramis alestes borneensis* occurring in Borneo and *Nematabramis alestes alestes* occurring in the Philippines. Both species are known to occur in running waters. In this study, specimens of *N. alestes alestes* were only collected about 100 m upstream of Alipuran Stream (Manguao Stream) and never from within the lake. They were caught together with juvenile *Rasbora* and *Puntius*.

***Rasbora argyrotaenia everetti* Boulenger, 1954**

Synonyms: *Leuciscus argyrotaenia* Bleeker, 1850; *Rasbora argyrotaenia* Bleeker, 1850; *Rasbora dusonensis non* Bleeker, 1850; *Rasbora everetti* Boulenger, 1895; *Rasbora vaillanti* Popta, 1905

Materials examined: Six specimens from littoral zone in Station 1 on November 23, 2001. Two specimens from the littoral zone in Station 8 using on June 28, 2002. The largest specimen has a SL of 90.5 mm and the smallest was 65 mm in SL.

Habitat: *Rasbora argyrotaenia everetti* was found in close association with *P. manguaoensis* and halfbeaks in the littoral zone. It is also common in the nearby streams.

Fisheries: This species has almost no fishery value, although it is important to note that some of the inhabitants do use them as animal feed (e.g. for pigs, dogs, and chicken). All specimens were caught using hook and line baited with earthworms. Specimens of about 130 mm in SL are common in the lake.

Remarks: *Rasbora argyrotaenia* is common throughout Southeast Asia including Thailand, Indo-China, Malay Peninsula, Java, Sumatra, and Borneo. *R. argyrotaenia everetti* is a well-differentiated subspecies occurring nowhere else except in mainland Palawan and the Calamian

Group of Islands (Brittan and Brattstrom, 1952).

Gut analysis revealed that this species is an omnivore owing to its relatively long coiled gut and the contents found inside. Locally, they are called seluang, a name used by the Malays in referring to fishes belonging to this genus (Davies and Green, 1990).

***Clarias macrocephalus* Gunther, 1864**

Synonyms: *Clarias liacanthus* Fowler, 1934; *Clarias macrocephalus* Gunther, 1864

Habitat: It is encountered on the deeply indented bays where the substrate is muddy and waters are relatively shallow. More often, this species occurs on the lower reach of the inflows.

Fisheries: This species makes one of the favorite delicacies of the inhabitants owing to its good eating quality. It is the second most important catch commanding relatively high price of up to Php40.00 a kilo. However, it takes a lot of effort and time to catch this species, hence are not widely utilized by the lake's inhabitants. Most of the specimens were caught in gill nets set overnight during the sampling events.

Remarks: *C. macrocephalus* is distributed throughout Asia from Cambodia, Laos, Vietnam, Thailand, China Peninsular Malaysia, and the Philippines. It is not sure whether this species occurs naturally in the lake or not. Information from the local people however, indicated that this fish was introduced way back in the early 1980s. Hence, the information that was given to Davies and Green (1990) that "hito" exists in the lake most probably refers to *Clarias* since this is the widely accepted local name for clarid catfishes in the country.

***Channa striata* (Bloch, 1793)**

Synonyms : *Channa striata* Bloch, 1793; *Channa striatus* Bloch, 1793; *Ophicephalus striatus* Bloch, 1793; *Ophiocephalus striatus* Bloch, 1793; *Ophicephalus vagus* Peters, 1868.

Materials examined: Eight juveniles from the littoral zone in Station 8 on September 21, 2002.

Habitat: Littoral zone of the lake amongst aquatic macrophytes.

Fisheries: This species locally known as dalag or aruan used to be a valuable food fish sought after for its delicious white meat, and was favored especially when processed as dried fish (daing). It is caught using hook and line, especially if baited with small frogs. Occasionally, it is also caught in gill nets and traps set against the current of narrow inflows. At present, this species is not widely utilized since most of the inhabitants focus on Tilapia fishery.

Remarks : *C. striata* is found throughout Asia from Sri Lanka to Indonesia, China and the Philippines. It was introduced to the lake in the 1940s. It was found to be more common in the inflows although it also occurs in the lake itself. This benthic carnivorous fish is commonly encountered among the aquatic vegetation in the littoral zone. Specimens of more than a foot long are common in the lake.

***Anabas testudineus* Bloch, 1792**

Synonyms : *Amphiprion testudineus* Bloch, 1792; *Amphiprion scansor* Bloch and Schneider, 1801; *Anabas elongates reuvens*, 1895; *Anabas microcephalus* Bleeker, 1857; *Anabas scandens* Daldorff, 1797; *Anabas spinosus* Gray, 1834; *Anabas testudineus* Bloch, 1792; *Anabas trifolius* Kaup, 1860; *Anabas variegates* Bleeker, 1851; *Anthias testudineus* Bloch, 1792; *Anthias testudineus* Bloch, 1792;

Cojus cobujius Hamilton, 1822; *Lutjanus scandens* Daldorff, 1797; *Lutjanus testudo lacepede*, 1802; *Perca scandens* Daldorff, 1797; *Sparus scandens* Daldorff, 1797; *Sparus testudineus* Bloch, 1792

Materials examined : Information is based on observations only.

Habitat: Littoral zone of the lake among vegetation and in the inflows and rice field in the areas around the lake.

Fisheries : This species locally known as puyo, has almost no fishery value in the lake due to the presence of more desirable species. However, some of the locals do eat them at times when present as by-catch.

Remarks : *Anabas testudineus* occurs from Sri Lanka to China, Indonesia and the Philippine islands. The species was introduced to lake Manguao in the 1940s by migrants from a neighboring locality for local consumption. *Anabas testudineus* is occasionally found within the lake but it is more commonly encountered in the inflows. During the sampling, it was observed that after a strong rainfall, a massive migration of this species occurred. The fish were observed to have emerged from the lake and traversed upstream towards the several tributaries draining into the lake. It could be, as the locals say, that these fish go down to the lake during the dry season, and go back to the streams when the rainy days come. This is not surprising because of the sheer ability of this to walk overland (hence the English name is climbing perch) in search of remaining water bodies during the summer months.

***Oreochromis niloticus* (Linnaeus, 1757)**

Synonyms : *Chromis guentheri* Steindachner, 1864; *Chromis nilotica* Linnaeus, 1758; *Chromis niloticus* Linnaeus, 1758; *Labrus niloticus* Linnaeus, 1758; *Oreochromis niloticus niloticus* Linnaeus; *Sarotherodon niloticus* Linnaeus, 1758; *Tilapia calciati* Gianferrari,

1924; *Tilapia nilotica* Linnaeus, 1758; *Tilapia nilotica nilotica* Linnaeus, 1758

Materials examined : Three specimens were collected from Station 8 in the littoral zone on June 28, 2002 two specimens from Station 1 near the rocky shore on June 27, 2002 and one specimen from Station 4 between the two islands collected on June 26, 2002. All were caught using gill net. Specimens range in size from 70-80 mm in SL.

Habitat: Littoral zone and pen water of the lake.

Fisheries : This species is the most important fish in terms of fishery value. All the families residing near the lake depend on *Tilapia* fisheries as the major source of income. In fact, during seasons when the sea at Bantolan Bay is rough, some fishermen from this area go to the lake to switch into *Tilapia* fishery. Dried *Tilapia* sells at the local market not lower than Php 40.00/kg.

CONCLUSION

This study proved the existence of two species of *Puntius*, *P. bantolanensis* and *P. manguaoensis* in the lake for the first time since the original collection made by Day in 1914. In addition to the separation of *Puntius* into two species, it was further found out that they occupy different niches i.e. the littoral zone for *P. manguaoensis* and the pelagic zone for *P. bantolanensis*. The result of this study is contrary to that of Davis and Green (1990) wherein they stated that all the fishes of the lake are concentrated in the littoral zone. This study further confirmed Hig's (1950) suggestion that the catfish described as *P. palavanensis* by Herre (1924b) is just a synonym of *H. taytayensis*.

Of the seven native fish taxa found in the lake (*Puntius bantolanensis*, *P. manguaoensis*, *Bosthrycus expatria*, *H. taytayensis*, *R. argyrotaenia everetti*, *N. alestes slestes*, and *Hemiramphidae*), 43% are endemic to the lake (*P. bantolanensis*, *P. Manguaoensis*, *B. expatria*). In addition, the

other native species are of limited distribution too. *H. taytayensis* is restricted to the northern parts of Palawan and the Calamian Group of Islands, *R. argyotaenia everetti* is confined to Palawan and the Calamian group Islands, while *N. alestes alestes* occurs only in the Philippines. Thus, the lake holds six Philippine endemic freshwater fishes out of seven native inhabitants or a remarkable endemism of 86%. The taxonomic status of the *Hemiramphidae* still needs further study.

Of the eleven fish species recorded so far, four were found to be introduced - *Channa macrocephalus* and *Oreochromis niloticus*, the latter being an exotic species. Although the adverse effects of introducing an exotic species to native fish fauna are well documented in many places like Lake Lanao in Mindanao (Lowe-McConnell, 1987), the potential effects of *O. niloticus* on the native fish fauna of Lake Manguao is presently unknown. Except for the information given by the locals that the population of *H. taytayensis* decreased after the introduction of *O. niloticus*, no concrete evidence is available to prove any adverse effect of the introduction of this exotic species to the lake's native ichthyofauna. A thorough study on the feeding habits, niche occupation, and spawning season of the Lake Manguao fishes is therefore recommended.

At present, local fishery focuses on Tilapia. Of secondary importance are the other introduced species such as *C. striata*, *A. testudineus* and *C. macrocephalus*. Apparently, there is no fishing pressure on the native fish fauna.

ACKNOWLEDGEMENT

The author would like to thank all the individuals and agencies that in a way or another have contributed to the success of this study. First and foremost, my deepest gratitude goes to Dr. Sabine Schoppe, my adviser, for without her, this research would be an almost impossible task to accomplish. To the SPCP Administration for their support during the convention and to the following faculty and staff namely: Prof. Roger Dolorosa, Prof. Honorio Pagliawan, Ms. Ianthe Marie Benliro, and Mr. Edwin Rodriguez for their sound advice and support during the course of this study. To my colleague, Mr. Samuel Sayson for accompanying me during my fieldwork in the lake.

I would also like to acknowledge the support extended to me by the PCSD staff from Puerto Princesa City and Taytay Offices. Special thanks goes to the mayor of the municipality of Taytay, Hon. Roberto Rodriguez and his staff for allowing me to conduct this study in lake Manguao and to Manong Chito Edep for all his help during my fieldwork on the lake.

To my family who has always been supportive of me in all my difficulties during the conduct of this study.

Finally, I thank God for giving me all these wonderful people who had helped me in accomplishing this research and for looking after my safety every day that I spent working on this study.

LITERATURE CITED

- BRITTAN, M. R. and BRATTSTROM, B. H. 1952. The Philippine species of the cyprinid fish genus *rasbora*. *COPEIA* 2:105-109.
- DAVIES, J. and J. GREEN. 1990. A preliminary survey of Lake Manguao, Palawan, Philippines. AWB/CRAB, Kuala Lumpur and Cebu. p. 42.
- DAY, A. L. 1914. Two new cyprinids from Lake Manguao, Palawan. *Philippine Journal of Science* 9 (2) Section D: 187-193.
- FishBase. 2000. FishBase: A biological database on fish. <http://www.fishbase.org>
- HAIG, J. 1950. Studies on the classification of the catfishes of the oriental and palearctic family Siluridae. *Rec. Indian Museum*. 48 (3,4):59-116.
- HERRE, A. W. C. T. 1924a. Distribution of true freshwater fishes in the Philippines. I- The Philippine Cyprinidae. *Philippine Journal of Science* 23 (3): 249-307.
- HERRE, A. W. C. T. 1924b. Distribution of true freshwater fishes in the Philippines. II- The Philippine Labyrinthici, Clariidae, and Siluridae. *Philippine Journal of Science* 24 (6):683-709.
- HERRE, A. W. C. T. 1927. Gobies of the Philippines and the China Sea. Monograph 23. Manila Bureau of Science: 15-391.
- INGER, R. F. and CHIN, P. K. 1962. The freshwater fishes of North Borneo. *FIELDIANA (Zool.)* 45: 1-268.
- KOTTELAT, M., WHITTEN, A. J. KARTIKASARI, S. N., and WIRJOATMODJO, S. 1993. Freshwater fishes of Indonesia and Sulawesi. Peripus Editions (HK) Ltd. In Collaboration with the Environmental Management Bureau of Indonesia (EDMI) Project, Ministry State for Population and Environment, Republic of Indonesia. p. 293.