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Research Paper

Morphology of *Rhyacichthys aspro* (Valenciennes 1837) in mandulog river system, Iligan city, Northern Mindanao, Philipines

Sonnie A. Vedra[1] and Pablo P. Ocampo[2]
[1]School of Environmental Science and Management,
[2]Limnological Research Station and Institute of Biological Sciences,
University of the Philipines Los Baños,
4031 College, Los Baños, Laguna, PHILIPINES

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Abstract

A freshwater goby species *Rhyacichthys aspro* of Family Rhyacichthyidae captured at Mandulog River system was described in terms of its morphometric and meristic attributes, sexual dimorphism and body proportionality. Given its rare status in the river, only 18 total specimens were used in this study. The results showed that morphometric and meristic attributes were not significantly different. This may be due to its highly restricted habitat inside rock bottoms and crevices. Male and female exhibited sexual dimorphism, and that, a arent morphological distinction was observed. It has a well-proportioned body structure that in turn, could be related to a successful courtship, mating and spawning. The results of the study suggest that Mandulog River system, as the habitat and food sources of this goby species, did not pose any threat on the morphology of *R. aspro*, as it did not show any pattern of adaptations with respect to where it is found in the river system. Since this goby was not found at downstream part of the river would mean that it is sensitive to water pollution, as concentrations of pollutants increased. Thus, reduction of water pollutants and regulation of pollutant-generating human-related activities must be undertaken to protect and conserve this pollution-sensitive goby species.

Keywords*:* *Rhyacichthys aspro,* morphometric, meristic, sexual dimorphism, Mandulog River.

Introduction

Pollution impacts might restrict the distribution of certain species in the whole stretch of a river system. This is the case may be of *Rhyacichthys aspro*, a goby species belonging to Family Rhyacichthyidae, which can only be found in the upstream and midstream of Mandulog River system in Iligan City, Lanao del Norte. Its habitat is restricted to rock bottoms and crevices. This is founded on a concept that isolation of species due to the archipelagic nature of the Philipines might have unique morphological attributes that can be distinct to a species in certain geographic place. This study, therefore, described the morphometric and meristic attributes, sexual dimorphism, and body proportionality of the indigenous goby *R. aspro*. This could be a contribution on the continuing investigations of the systematics of other gobies, of which, are still promising in the whole goby study in the Philipines.

Only few studies described the goby population in the Philipines, despite its diversity with no less than 2, 117 species, including other freshwater fish species. Of this, 330 species are Philipine endemics, where

48 genera and 127 are goby species[1]. Recent studies were conducted in the inland waters of Southern Luzon [2]. Other specific studies focused on the morphology of *Rhinogobius* [3] and reproductive potential and morphology of *Glossogobius celebius* [4], still in Southern Luzon inland waters. Before, studies on gobies are concentrating on its life history [5], including its fishery, biology, ecology and implications for conservation and management [1,5,6,7]. The lack of goby studies in turn, has necessitated the conduct of this study, and results can be used for further studies on other goby population, particularly in Mindanao region.

In contrast to the Philipines, worldwide studies on gobies were done for scientific purposes and recently as part of the ornamental fisheries with high commercial values. Extensive studies on goby, particularly its early life history, recruitment dynamics and fisheries were conducted in Dominica, West Indies [8,9,10] and its biology and genetics in Hawaii [11,12,13,14,15]. In Asia, several goby studies were also conducted. In particular, the freshwater fishes of genus, *Rhinogobius* [16] are common benthic fish fauna not only in Taiwan, the Ryukyus, and mainland Japan [17,18,19] but also in continental Southeast Asia from China to Thailand [20,21].

Among the goby species, *Rhinogobius* species are well-studied since its first documented study [16]. Its systematic differences are well-established among various species in the Far East, mainland Southern China, Taiwan, and continental Southeast Asia, comprising both anadromous and landlocked species [22]. The systematic revision has recognized, by both morphological and molecular criteria, a related, but distinct new genus of *Rhinogobius*, which has transverse extensions of infraorbital and longitudinal papillae rows rather than the simple linear rows of typical *Rhinogobius* [22].

Material and Methods

Specimen collections and morpho-meristic analyses

Specimens of *R. aspro* were collected using small improvised spear guns with surrounding nets and hand-held seine, particularly in the upstream and midstream parts of Mandulog River system in Iligan City, Lanao del Norte (Figure 1A). This goby was not captured at downstream, despite the many fishing attempts done. Given its limited abundance, only 18 specimens were used *(*Figure 1B*)* to describe the morpho-meristic descriptions (Figure 1C). There were 24 morphometric characters used, total length (TL), standard length (SL), head length (HL), predorsal length (PDL1), snout to second dorsal fin origin (PDL2), prepelvic length (L), preanal length (PAL), snout to anus (SA), ventral fin to anus (VFA), caudal peduncle length (CPL), caudal peduncle depth (CDP), first dorsal fin base (DFB1), second dorsal fin base (DFB2), anal fin base (AFB), caudal fin length (CFL), pectoral fin length (PFL), ventral/pelvic fin length (VFL), anal fin length (AFL), body depth at pelvic origin (BDPO), body depth at anal fin origin (BDAO), body width at anal fin origin (BW), head depth (HD), head width (HW), and eye diameter (E) [19-23].

All measurements were rounded off to nearest 0.01 mm using a vernier caliper. Eight meristic characters were used, namely, number of lateral line scales (LLS), predorsal scales (PDS), first dorsal fin spine (DFS1), second dorsal fin spine (DFS2), anal fin spines (AFS), pectoral fin rays (PFR), ventral or pelvic fin rays (VFR), and caudal fin rays (CFR) [20,22]. Friedman's test was used to describe its morphometric and meristic differences, T-test for the differences in the sexual dimorphism of male and female, and Pearson correlation test for the differences in its body proportionality.

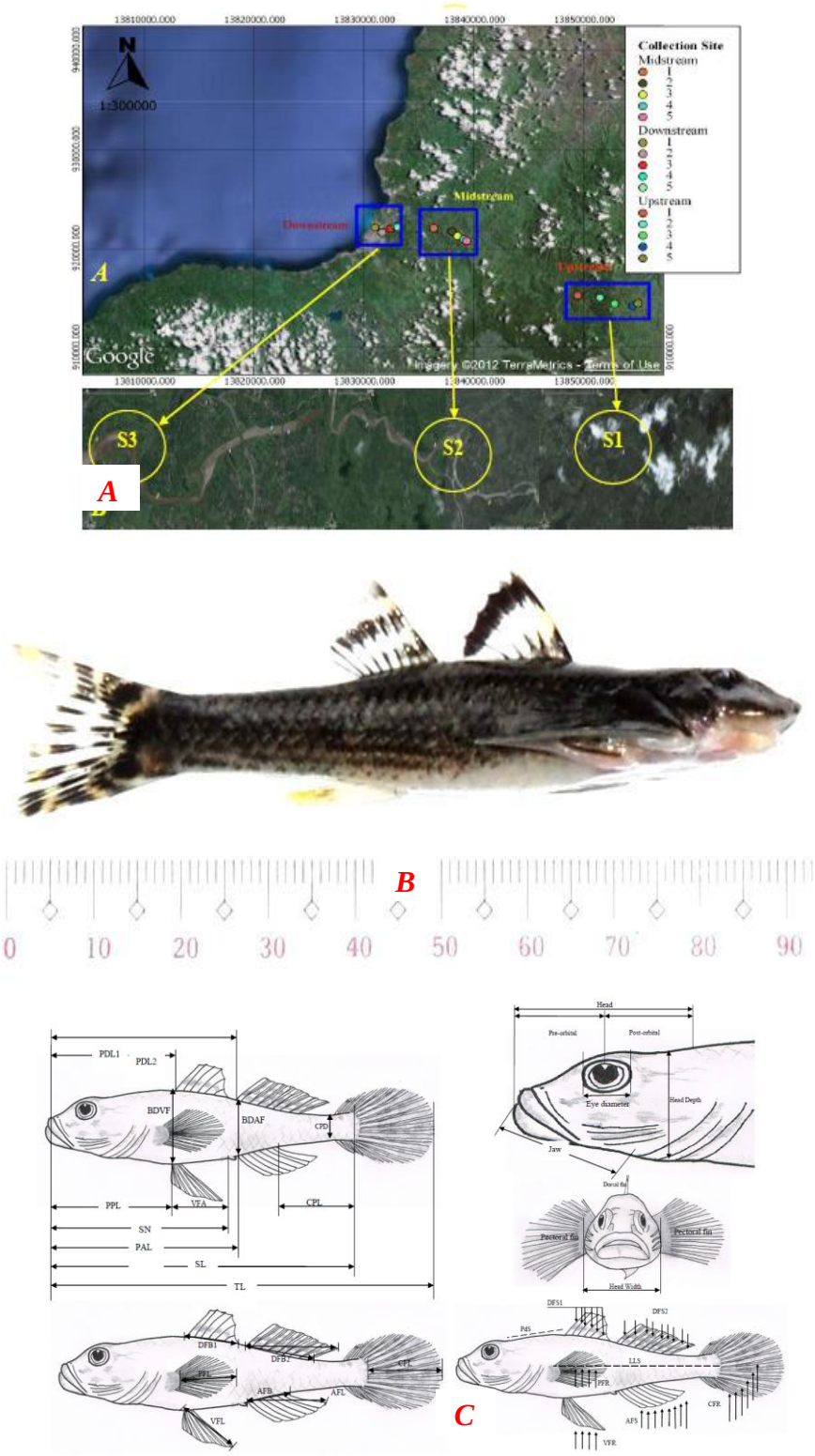

Figure 1: Map showing the collection sites in Barangays Rogongon (S1), Digkilaan (S2) and Hinaplanon (S3) representing the upstream, midstream and downstream of Mandulog River system, Iligan City, Lanao del Norte (A), the collected *Rhyacichthys aspro* (B), and the morpho-meristic analyses used (C), adapted from Corpuz (2011).

Results and Discussion

Bio-physical description of *Rhyacichthys aspro*

It is named as a loach goby. The adult *R. aspro* inhabits in relatively steep gradient streams in hilly or mountainous terrains. It can be found mostly in any tropical region at 24°N - 13°S. It is mostly found in Asia and Oceania, Indonesia, Philipines, New Guinea, Solomon Islands, Taiwan and some Japanese Islands. Its IUCN status was not evaluated yet, and observed to be harmless to humans. It is known to be source of minor commercial fisheries [24].

In Mandulog River system, *R. aspro* was found in its upstream and midstream, that is, closely associated in the crevices and bottoms of rocks and boulders. It was mostly found in highly aerated riffle areas of the river. As observed, it used to hook onto rock crevices using their pelvic fins. It has colorful black to yellowish fins with dark bands on its body.

Morpho-meristic attributes of *Rhyacichthys aspro*

Mean TL of male *R. aspro* ranged from 126.500 ± 5.000 mm to 136.125 ± 7.064 mm observed in midstream and upstream, respectively. Generally, males in the midstream were relatively bigger than the males in the upstream, based on the morphometric characters measured, which constituted 56.52%. These included SL (0.624 ± 0.166), HL (0.220 ± 0.047), PDL1 (0.405 ± 0.094), PDL2 (0.615 ± 0.105), L (0.314 ± 0.077), PAL (0.702 ± 0.147), SA (0.667 ± 0.149), VFA (0.302 ± 0.068), CPL (0.350 ± 0.083), DFB1 (0.180 ± 0.037), DFB2 (0.153 ± 0.031), AFB (0.111 ± 0.025), CFL (0.269 ± 0.068), PFL (0.356 ± 0.085), HW (0.256 ± 0.066) and E (0.057 ± 0.015). Meanwhile, CPD (0.137 ± 0.034), VFL (0.258 ± 0.076), AFL (0.240 ± 0.074), BDPO (0.170 ± 0.045), BDAF (0.185 ± 0.050), BWAF (0.179 ± 0.048) and HD (0.161 ± 0.049) VFA (0.190 ± 0.008), DFB1 (0.108 ± 0.006) and AFL (0.102 ± 0.003) were higher among males in the upstream. No significant difference (P>0.05) was observed on these varied morphometric characters measured (Table 1).

In females, mean TL ranged from 99.500 ± 10.116 mm to 102.625 ± 7.134 mm observed in midstream and upstream parts of the river. Generally, females in the midstream, with all of their morphometric characters measured, were higher than the females in the upstream. These included SL (0.784 ± 0.054), HL (0.201 ± 0.010), PDL1 (0.288 ± 0.017), PDL2 (0.460 ± 0.040), L (0.199 ± 0.016), PAL (0.482 ± 0.044), SA (0.403 ± 0.033), VFA (0.246 ± 0.022), CPL (0.358 ± 0.029), CPD (0.144 ± 0.006), DFB1 (0.158 ± 0.015), DFB2 (0.099 ± 0.005), AFB (0.144 ± 0.005), CFL (0.176 ± 0.013), PFL (0.186 ± 0.019), VFL (0.175 ± 0.018), AFL (0.164 ± 0.016), BDPO (0.165 ± 0.008), BDAF (0.165 ± 0.021), BWAF (0.178 ± 0.014), HD (0.127 ± 0.008), HW (0.173 ± 0.020) and E (0.066 ± 0.004). No significant difference (P>0.05) was observed on these varied morphometric characters measured (Table 2).

LLS (33.500 ± 1.472), PdS (14.250 ± 0.957), AS (8.125 ± 0.250), PS (20.250 ± 1.708), and VR (13.375 ± 0.750) were higher on males at midstream, while DS2 (9.125 ± 0.629) and CR (15.625 ± 2.926) were higher on males in the upstream. DS1 (6.875 ± 0.854) was similar to males in both sites. However, no significant difference (P>0.05) was observed on this varied meristic characters measured (Table 3).

Among the females, LLS (33.625 ± 2.926), DS1 (6.188 ± 0.239), DS2 (8.250 ± 0.500), AS (8.063 ± 0.125), PS (18.250 ± 0.289), VR (12.063 ± 0.125), CR (15.375 ± 0.479) were higher on females in the midstream, and while only PdS (13.000 ± 0.000) was higher on females in the upstream. There was no significant difference (P>0.05) observed on this varied meristic characters measured among the females in the two sites of the river (Table 4).

Data on the morphometric and meristic attributes might suggest that the river system, particularly on its upstream and midstream, is favorable for *R. aspro*, as it did not show any pattern of morphological adaptations. This may also show that its morphological attributes have adapted well given its habitat in the bottoms and crevices of rocks and boulders.

Table 1: Morphometric attributes (mean ± SE) of male *Rhyacichthys aspro* inhabiting the Mandulog River system in Iligan City, Lanao del Norte captured on February to November 2011.

	COLLECTION SITES			
CHARACTERS	**Upstream**	**Midstream**	**F Value**	**P Value**
(% TL)				
SL	0.592±0.118	0.624±0.166	0.200	0.663
HL	0.216±0.057	0.220±0.047	0.267	0.616
PDL1	0.397±0.112	0.405±0.094	0.286	0.675
PDL2	0.596±0.138	0.615±0.105	0.195	0.667
L	0.311±0.091	0.314±0.077	0.135	0.720
PAL	0.684±0.180	0.702±0.147	0.174	0.685
SA	0.647±0.177	0.667±0.149	0.151	0.705
VFA	0.299±0.081	0.302±0.068	0.180	0.679
CPL	0.347±0.097	0.350±0.083	0.286	0.604
CPD	0.137±0.034	0.135±0.026	0.264	0.618
DFB1	0.178±0.042	0.180±0.037	0.221	0.648
DFB2	0.153±0.039	0.153±0.031	0.122	0.733
AFB	0.111±0.029	0.111±0.025	0.272	0.613
CFL	0.266±0.078	0.269±0.068	0.149	0.707
PFL	0.347±0.097	0.356±0.085	0.123	0.733
VFL	0.258±0.076	0.257±0.064	0.152	0.704
AFL	0.240±0.074	0.238±0.059	0.126	0.729
BDPO	0.170±0.045	0.167±0.038	0.251	0.627
BDAF	0.185±0.050	0.182±0.041	0.182	0.678
BWAF	0.179±0.048	0.174±0.038	0.174	0.684
HD	0.161±0.049	0.157±0.040	0.172	0.686
HW	0.256±0.073	0.256±0.066	0.135	0.720
E	0.055±0.018	0.057±0.015	0.406	0.538

Descriptions: The morphometric characters used, total length (TL), standard length (SL), head length (HL), predorsal length (PDL1), snout to second dorsal fin origin (PDL2), prepelvic length (L), preanal length (PAL), snout to anus (SA), ventral fin to anus (VFA), caudal peduncle length (CPL), caudal peduncle depth (CPD), first dorsal fin base (DFB1), second dorsal fin base (DFB2), anal fin base (AFB), caudal fin length (CFL), pectoral fin length (PFL), ventral/pelvic fin length (VFL), anal fin length (AFL), body depth at pelvic origin (BDPO), body depth at anal fin origin (BDAO), body width at anal fin origin (BWAO), head depth (HD), head width (HW), and eye diameter (E).

Table 2: Morphometric attributes (mean ± SE) of female *Rhyacichthys aspro* inhabiting the Mandulog River system in Iligan City, Lanao del Norte captured on February to November 2011

	COLLECTION SITES			
CHARACTERS	**Upstream**	**Midstream**	**F Value**	**P Value**
(% TL)				
SL	0.758±0.090	0.784±0.054	0.177	0.682
HL	0.188±0.018	0.201±0.010	0.073	0.792
PDL1	0.278±0.028	0.288±0.017	0.001	0.972
PDL2	0.446±0.062	0.460±0.040	0.089	0.770
L	0.182±0.023	0.199±0.016	0.334	0.575
PAL	0.466±0.069	0.482±0.044	0.040	0.844
SA	0.391±0.055	0.403±0.033	0.086	0.775
VFA	0.236±0.030	0.246±0.022	0.162	0.695
CPL	0.343±0.046	0.358±0.029	0.258	0.622
CPD	0.136±0.013	0.144±0.006	0.772	0.400
DFB1	0.149±0.016	0.158±0.015	0.767	0.401
DFB2	0.091±0.008	0.099±0.005	1.217	0.295
AFB	0.135±0.009	0.144±0.005	0.340	0.572
CFL	0.171±0.021	0.176±0.013	0.001	0.967
PFL	0.173±0.024	0.186±0.019	0.339	0.573
VFL	0.168±0.024	0.175±0.018	0.193	0.669
AFL	0.153±0.021	0.164±0.016	0.310	0.589
BDPO	0.155±0.014	0.165±0.008	0.912	0.361
BDAF	0.152±0.022	0.165±0.021	0.669	0.432
BWAF	0.163±0.024	0.178±0.014	0.067	0.800
HD	0.117±0.015	0.127±0.008	0.897	0.365
HW	0.159±0.024	0.173±0.020	0.240	0.634
E	0.062±0.008	0.066±0.004	0.152	0.704

Descriptions: The morphometric characters used, total length (TL), standard length (SL), head length (HL), predorsal length (PDL1), snout to second dorsal fin origin (PDL2), prepelvic length (L), preanal length (PAL), snout to anus (SA), ventral fin to anus (VFA), caudal peduncle length (CPL), caudal peduncle depth (CPD), first dorsal fin base (DFB1), second dorsal fin base (DFB2), anal fin base (AFB), caudal fin length (CFL), pectoral fin length (PFL), ventral/pelvic fin length (VFL), anal fin length (AFL),

body depth at pelvic origin (BDPO), body depth at anal fin origin (BDAO), body width at anal fin origin (BWAO), head depth (HD), head width (HW), and eye diameter (E).

Table 3: Meristic attributes (mean ± SE) of male *Rhyacichthys aspro* inhabiting the Mandulog River system in Iligan City, Lanao del Norte captured on February to November 2011.

	COLLECTION SITES			
CHARACTERS	**Upstream**	**Midstream**	**F Value**	**P Value**
LLS	33.000±10.677	33.500±1.472	0.662	0.295
PdS	13.250±2.872	14.250±0.957	0.458	0.222
DS1	6.875±0.854	6.875±0.854	0.372	0.100
DS2	9.125±0.629	8.750±0.289	0.467	0.301
AS	8.000±0.000	8.125±0.250	1.217	0.595
PS	19.500±2.380	20.250±1.708	0.540	0.272
VR	12.750±1.893	13.375±0.750	0.401	0.367
CR	15.625±2.926	14.375±0.479	0.139	0.173

Descriptions: The meristic characters used, number of lateral line scales (LLS), predorsal scales (PDS), first dorsal fin rays (DFS1), second dorsal fin rays (DFS2), anal fin rays (AFS), pectoral fin rays (PFR), ventral or pelvic fin rays (VFR), and caudal fin rays (CFR).

Table 4: Meristic attributes (mean ± SE) of female *Rhyacichthys aspro* inhabiting the Mandulog River system in Iligan City, Lanao del Norte captured on February to November 2011.

	COLLECTION SITES			
CHARACTERS	**Upstream**	**Midstream**	**F Value**	**P Value**
LLS	32.000±0.000	33.625±2.926	0.664	0.118
PDS	13.000±0.000	12.875±0.250	0.321	0.248
DS1	6.000±0.000	6.188±0.239	0.522	0.533
DS2	8.000±0.000	8.250±0.500	0.672	0.113
AS	8.000±0.000	8.063±0.125	0.349	0.307
PS	18.000±0.000	18.250±0.289	0.623	0.433
VR	12.000±0.000	12.063±0.125	0.452	0.204
CR	15.000±0.000	15.375±0.479	0.726	0.129

Descriptions: The meristic characters used, number of lateral line scales (LLS), predorsal scales (PDS), first dorsal fin rays (DFS1), second dorsal fin rays (DFS2), anal fin rays (AFS), pectoral fin rays (PFR), ventral or pelvic fin rays (VFR), and caudal fin rays (CFR).

Sexual Dimorphism between male and female *Rhyacichthys aspro*

There were 67.74% of the morphometric characters of male and female *R. aspro*, namely SL, PDL1, PDL2, L, PAL, SA, VFA, DFB1, DFB2, AFB, CFL, PFL, VFL, AFL, LLS, PdS, DS1, DS2, PS and VR differed significantly ($P<0.05$). The rest of the morphometric and meristic characters measured were not significantly different ($P>0.05$) (Table 5). Since more than 50% of the morpho-meristic characters differ significantly, this means that some of the male and female *R. aspro* exhibited a arent morphological distinctions, within the upstream and midstream part of the river system.

Table 5: Sexual dimorphism based on the mean ± SE (combined sexes) of *Rhyacichthys aspro* inhabiting the Mandulog River system in Iligan City, Lanao del Norte captured on February to November 2011.

CHARACTERS (% TL)	MALE	FEMALE	T VALUE	P VALUE
Morphometric				
SL	0.602±0.029	0.765±0.023	4.241	0.001*
HL	0.216±0.011	0.194±0.003	1.955	0.077
PDL1	0.389±0.025	0.286±0.008	4.074	0.002*
PDL2	0.587±0.032	0.450±0.015	4.261	0.001*
L	0.296±0.023	0.192±0.006	4.568	0.001*
PAL	0.668±0.044	0.475±0.017	4.435	0.001*
SA	0.629±0.047	0.400±0.013	5.028	0.000*
VFA	0.292±0.017	0.237±0.007	3.112	0.010*
CPL	0.352±0.017	0.346±0.011	0.300	0.769
CPD	0.136±0.006	0.136±0.004	0.027	0.979
DFB1	0.176±0.009	0.147±0.006	2.744	0.019*
DBF2	0.144±0.010	0.098±0.004	4.049	0.002*
AFB	0.117±0.006	0.135±0.004	3.995	0.002*
CFL	0.256±0.019	0.173±0.005	4.419	0.001*
PFL	0.330±0.029	0.186±0.008	4.919	0.000*
VFL	0.245±0.018	0.175±0.007	3.674	0.004*
AFL	0.226±0.017	0.155±0.004	4.370	0.001*
BDPO	0.167±0.008	0.170±0.007	0.237	0.817
BDAF	0.176±0.010	0.168±0.013	0.450	0.662
BWAF	0.172±0.008	0.170±0.004	0.251	0.807
HD	0.153±0.010	0.128±0.008	1.901	0.084
HW	0.244±0.018	0.168±0.007	4.011	0.002*
E	0.059±0.003	0.063±0.002	0.958	0.359
Meristic				
LLS	35.750±1.216	31.867±0.159	3.064	0.011*
PdS	14.167±0.366	12.983±0.017	3.201	0.008*
DS1	6.958±0.168	6.083±0.056	4.988	0.000*
DS2	8.917±0.135	8.250±0.169	3.546	0.005*
AS	8.000±0.000	8.117±0.061	1.902	0.084
PS	20.625±0.465	17.583±0.511	4.155	0.002*
VR	13.333±0.284	11.750±0.345	3.101	0.010*
CR	14.667±0.333	15.367±0.281	1.445	0.176

***** significantly different at α 0.05 in two collection sites.

Descriptions: total length (TL), standard length (SL), head length (HL), predorsal length (PDL1), snout to second dorsal fin origin (PDL2), prepelvic length (L), preanal length (PAL), snout to anus (SA), ventral fin to anus (VFA), caudal peduncle length (CPL), caudal peduncle depth (CPD), first dorsal fin base (DFB1), second dorsal fin base (DFB2), anal fin base (AFB), caudal fin length (CFL), pectoral fin length (PFL), ventral/pelvic fin length (VFL), anal fin length (AFL), body depth at pelvic origin (BDPO), body depth at

anal fin origin (BDAO), body width at anal fin origin (BWAO), head depth (HD), head width (HW), and eye diameter (E).

Body Proportionality of *Rhyacichthys aspro*

Results revealed that 8.31% of all morphometric characters measured among males were not significantly correlated (P>0.05), while the rest were highly correlated (P<0.01). AFB, constituting 65.21%, was not correlated to PDL1, PDL2, L, PAL, SA, DFB1, DFB2, CFL, PFL, VFL, AFL, BDAF, HD and HW (Table 6). Meanwhile, SL, HL, CPL, CPD, DFB1, BDPO, and BWAF were correlated significantly to other morphometric characters.

In females, 32.70% of the morphometric characters measured were not significantly correlated (P>0.05). CPD, constituting 60.86%, was uncorrelated to all morphometric characters except CPL, DFB1, DFB2, AFB, AFL, BDPO, BDAF, and HD. With similar percentage, DFB2 was correlated to L, CPD, DFB1, AFB, PFL, BDPO, BDAF and HD (Table 7).

Between sexes, males had lower percentage of uncorrelated morphological attributes. This means that more than 90% of male body morphology might be well-proportioned, that in turn, may attract the females for the fertilization of their matured eggs prior to spawning. Females, in some way, had more than 50% morphometric characters that were correlated. Having a male partner, where courting and mating were done, spawning would take place depending on favorable environmental cues like temperature, food, substrates and others.

Conclusion and recommendations

Data on the morphometric and meristic attributes of *R. aspro* were not significantly different. This means that they were not subjected to geographical isolation either the topographical nature of the river or by pollution impacts with respect to its preferred habitat only. However, since they were not present at downstream would mean that they are sensitive to the increasing level of pollution at downstream. Absence of their habitat and food sources might be the reasons, and other unknown factors. They had exhibited sexual dimorphism, wherein males can be distinguished from females, especially when the females are gravid when morphological changes may occur prior to spawning. Body proportionality measures showed a well-proportioned body structure among the species, which may be related to the success of their courting, mating and spawning behaviors.

The results of the study suggest that the upstream and midstream of Mandulog River system did not pose any threat on *R. aspro*, as they did not show any pattern of morphological adaptations. However, it is imperative that the river must be protected from various pollutants and contaminants that might lead to some morphological adaptations of the goby species, and in turn, would alter their phylogenetic and morphological characteristics. Regulation on pollutant discharges into the river system is highly recommended, especially urinary wastes, as these contain amounts of hormones (estrogen, progesterone and testosterone) that might have some adverse impacts of the gonadal structures of the developing postlarvae, a good subject area for further studies as well.

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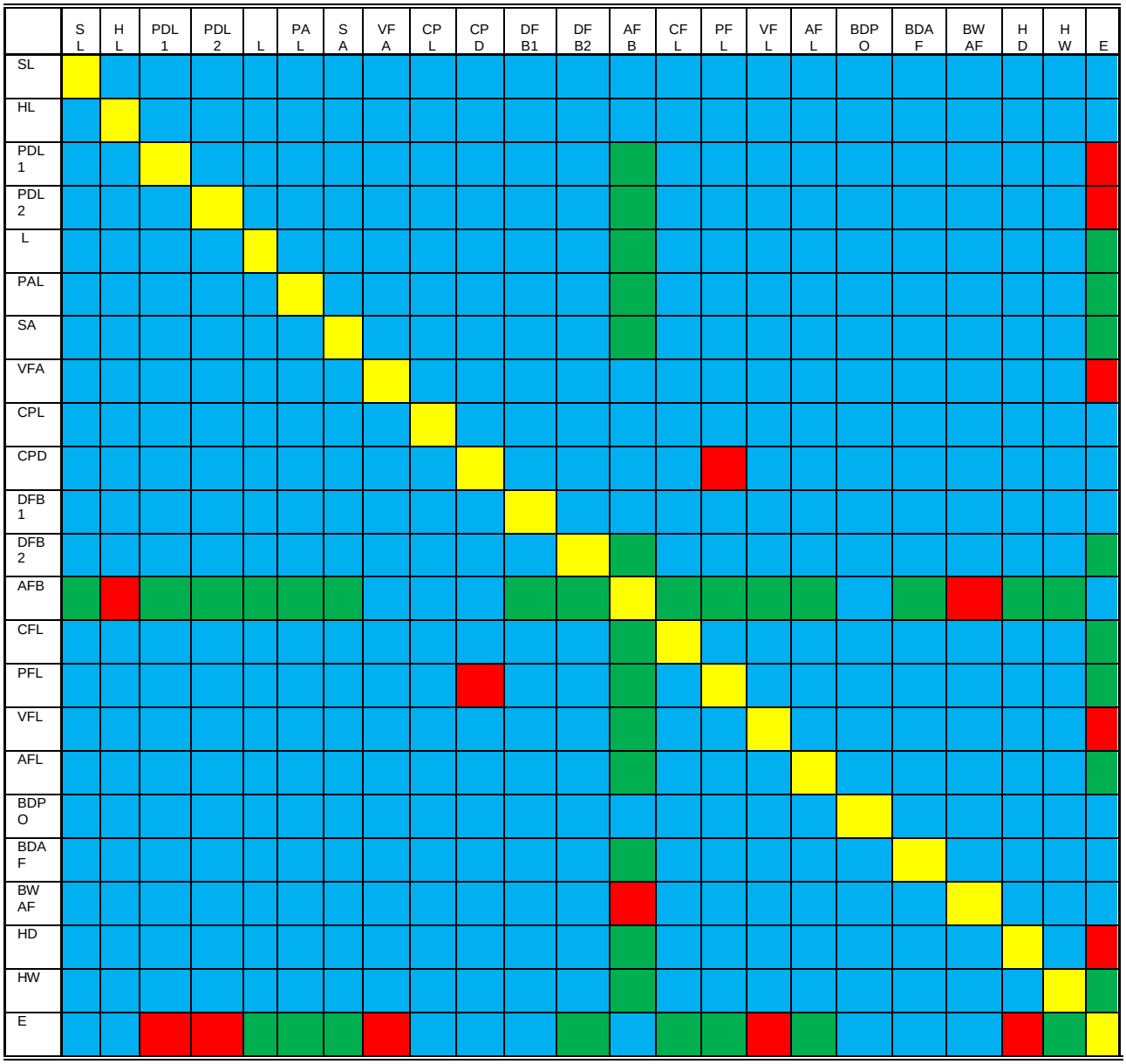
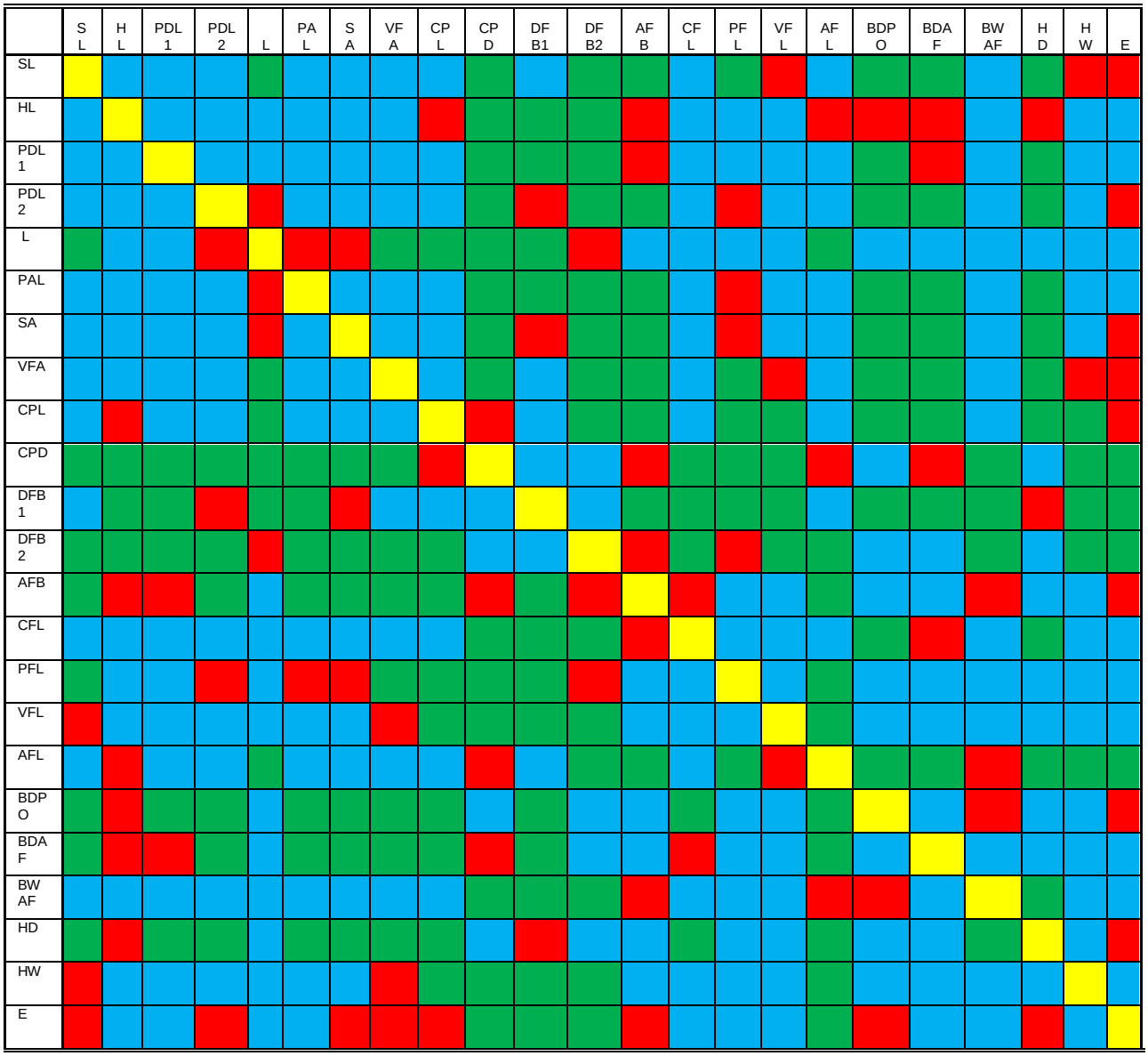
Table 6: Modified correlation matrix on the morphometric characters of the male *Rhyacichthys aspro* inhabiting the Mandulog River system in Iligan City, Lanao del Norte captured on February to November 2011



Descriptions: total length (TL), standard length (SL), head length (HL), predorsal length (PDL1), snout to second dorsal fin origin (PDL2), prepelvic length (L), preanal length (PAL), snout to anus (SA), ventral fin to anus (VFA), caudal peduncle length (CPL), caudal peduncle depth (CPD), first dorsal fin base (DFB1), second dorsal fin base (DFB2), anal fin base (AFB), caudal fin length (CFL), pectoral fin length (PFL), ventral/pelvic fin length (VFL), anal fin length (AFL), body depth at pelvic origin (BDPO), body depth at anal fin origin (BDAO), body width at anal fin origin (BWAO), head depth (HD), head width (HW), and eye diameter (E).

Table 7: Modified correlation matrix on the morphometric characters of the female *Rhyacichthys aspro* inhabiting the Mandulog River system in Iligan City, Lanao del Norte captured on February to November 2011



Descriptions: total length (TL), standard length (SL), head length (HL), predorsal length (PDL1), snout to second dorsal fin origin (PDL2), prepelvic length (L), preanal length (PAL), snout to anus (SA), ventral fin to anus (VFA), caudal peduncle length (CPL), caudal peduncle depth (CPD), first dorsal fin base (DFB1), second dorsal fin base (DFB2), anal fin base (AFB), caudal fin length (CFL), pectoral fin length (PFL), ventral/pelvic fin length (VFL), anal fin length (AFL), body depth at pelvic origin (BDPO), body depth at anal fin origin (BDAO), body width at anal fin origin (BWAO), head depth (HD), head width (HW), and eye diameter (E).

References

1. Herre A.W., Gobies *of the Philipines and the China Sea. Monographs of the Bureau of Science 23.* Philipine Bureau of Science, Manila. 352, **(1927).**

2. UPLB Limnological Research Station. Freshwater fishes in Southern Luzon. University of the Phili ines Los Baños, 4031 College, Laguna, Philipines. 1-35, **(2011).**

3. Vedra S.A. and Ocampo P.P., Morpho-meristic attributes and gonadal architectures of indigenous freshwater *Rhinogobius* goby (Herre, 1927), Implications to biodiversity and conservation potentials. List of abstracts for paper presented (oral category) during the 1st National DOST-ASTHRDP Scholar's Conference at DLSU-CSB, Manila, Philipines. 25, **(2012).**

4. Corpuz M.N., Morphological variations, sexual dimorphism, and gonadal analysis of populations of the Celebes goby, *Glossogobius celebius* (Perciformes, Gobiidae) from Southern Luzon, Phili ines. MS Thesis. University of the Philipines Los Baños, Laguna, Philipines. 25-26, **(2011).**

5. Manacop P. R., The life history and habits of the *goby, Sicyopterus extraneus Herre (añga) Gobiidae with an account of the goby*-fry fishery of Cagayan River, Oriental Misamis [Province, Mindanao, Philipines]. Philipine J. Fish. 2, 1-60, **(1953).**

6. Montilla J., The ipon fisheries of Northern Luzon. Phili. J. Sci. 45, 61-75, **(1931).**

7. Blanco G. J., 1956. Assay of the *goby fry (ipon*) fisheries of the *Laoag iver* and its adjacent marine shores*, Ilocos Norte Province.* Phili . J. Fish. 4, 31-80, **(1995).**

8. Bell K.I. and Brown J.A., Active salinity choice and enhanced swimming endurance in *0 to 8- d-old larvae of diadromous gobies*, with emphasis on *Sicydium punctatum (Pisces), in Dominica, West Indies.* Marine Biology 121,409–417, **(1995).**

9. Bell K.I., Pepin P. and Brown J.A., Seasonal, inverse cycling of length- and age-at-recruitment in the *diadromous gobies Sicydium punctatum and Sicydium antillarum (Pisces)* in Dominica, West Indies. Canadian Journal of Fisheries and Aquatic Sciences 52, 1535–1545 **(1995)**.

10. Bell K.I., Complex recruitment dynamics with *Do ler*-like effects caused by shifts and cycles in age-at-recruitment. Canadian Journal of Fisheries and Aquatic Sciences 54, 1668–1681, **(1997).**

11. Ego K., *Life history of freshwater gobies*. Project No. 4-4-R. Freshwater Game and Fisheries Management Research, Department of Lands and Natural Resources, Honolulu. 23, **(1956).**

12. Nishimoto R.T. and Fitzsimons J.M., *Courtship, territoriality, and coloration in the endemic Hawaiian freshwater goby, Lentipes concolor, In, Uyeno, T., R. Arai, T. Taniuchi and K. Matsuura (eds.), Indo-Pacific fish biology.* Proceedings of the Second International Conference on Indo-Pacific fishes. Ichthyological Society of Japan, Tokyo. p. 811–817, **(1986).**

13. Radtke R.L., Kinzie R.A. and Folsom S.D., Age at recruitment of Hawaiian freshwater *gobies.* Environmental Biology of Fishes 23, 205–213, **(1988).**

14. Fitzsimons J.M., and Nishimoto R.T., Territories and site tenacity in males of the Hawaiian stream *goby Lentipes concolor (Pisces, Gobiidae).* Ichthyological Exploration of Freshwaters 1, 185–189, **(1990).**

15. Kinzie R.A., Reproductive biology of an endemic*, amphidromous goby Lentipes concolor* in Hawaiian streams. Environmental Biology of Fishes 37, 257–268, **(1993).**

16. Gill T. N., Notes on a collection of Japanese fishes by Dr. J. Morrow. Proc. Acad. Nat. Sci. Phila. 1859, 144-149, **(1859).**

17. Akihito P., Hayashi M. and Yoshino T., *Suborder Gobioidei.* In The Fishes of the Japanese *Archipelago.* H. Masuda, K. Amaoka, C. Araga, T. Uyeno and T. Yoshino eds., Tokai Univ. Press, Tokyo. . 228-289, **(1984).**

18. Akihito A. Iwata, Sakamoto K. and Ikeda Y., *Suborder Gobioidei.* In Fishes of Japan with pictorial key to the species. T. Nakabo ed., Tokai Univ. Press, Tokyo. 997-1392, **(1993).**

19. Chen I. S. and Shao K. T., *A taxonomic review of the gobiid fish genus Rhinogobius Gill, 1859, from Taiwan, with descriptions of three new species.* Zool. Stud. 35(3), 200-214, **(1996).**

20. Chen I. S. and Miller P. J., *Redescription of Gobius davidi (Teleostei, Gobiidae) and comparison with Rhinogobius lentiginis.* Cybium 21(3), 211-221, **(1998).**

21. Chen I. S., Kottelat M. and Miller P. J., Freshwater *gobies of the genus Rhinogobius* from the Mekong basin in Thailand and Laos, with descriptions of three new species. Zool. Stud. 38(1), 19-32, **(1999).**

22. Chen I.S. and Miller P. J., Two new freshwater *gobies of genus Rhinogobius (Teleostei, Gobiidae)* in Southern China, around the Northern Region of the South China Sea. The Raffles Bulletin of Zoology. 19,225-232, **(2008).**

23. Chen I. S., *The systematic studies of Rhinogobius brunneus complex from Taiwan.* Unpl. Master thesis Natl. Sun Yat-sen Univ. Kaohsiung, Taiwan. 112, **(1994).**

24. Allen G.R., Field guide to the freshwater fishes of New Guinea. Christensen Research Institute, Madang, Papua New Guinea. 268, **(1991).**

25. City Environment and Management Office of Iligan City and Mines and Geo-Sciences Bureau Region-10. Baseline study on the replenishment rate and sedimentation process within the active sand and gravel quarry areas of Mandulog River. Terminal Report. 1-71, **(2006).**

26. Fitzsimons J.M., Zink R.M. and Nishimoto R.T., Genetic variation in the Hawaiian stream *goby, Lentipes concolor.* Biochemical Systematics and Ecology 18, 81–83, **(1990)**.