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Research article

MORPHOLOGICAL DESCRIPTION OF *Rhinogobius giurinus* GOBY (Rutter, 1897): IT'S POTENTIAL FOR STUDIES ON ENVIRONMENTAL CHANGES

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ABSTRACT

A freshwater goby named Rhinogobius giurinus is widely distributed throughout the Asia-Pacific region and in the Philippines. Its endemicity may be attributed to the Philippine archipelagic nature, of which, only few literatures described the biology of the inhabiting goby species. Hence, this paper described the important morphological attributes of R. giurinus, which were linked to their distinct morpho-meristic attributes, sexual dimorphism and body proportionality. Specimens in this study were the R. giurinus collected from Dampalit River in Los Baños, Laguna. Results showed that mean total length for males and females were 49.37 ± 0.55 mm and 54.19 ± 1.44 mm, respectively. No significant differences (P>0.05) were observed on their morphometric and meristic attributes. They were sexually dimorphic and had well-proportioned body structures. The observed morphological attributes of R. giurinus, can be used to describe its species name comparable to other inhabiting Rhinogobius species in the Philippines. Also, the data can be used to account the potential influences of water quality conditions, food sources and habitat availability of Dampalit River, and may be to other river systems in the Philippines. The distinct morphology of this goby species can be used as baseline information for further related studies, especially in dealing with pollution impacts and changing climatic conditions.

Keywords: Rhinogobius giurinus., morphometric, meristic, Dampalit River

INTRODUCTION

The Philippine megabiodiversity nature is compromised by the occurrences of various threats of habitat destruction and fragmentation, increasing population growth, loss of species, uncontrolled pollution levels, and introduction of invasive exotic species in national and local scales. It is aggravated by the predicted adverse impacts of a changing climatic pattern, which is characterized by erratic rainfall patterns, increased in temperature, occurrence of strong typhoons and prolonged occurrence of drought. The loss of Philippine biodiversity has negative repercussions on the balance of various ecosystem functions and services, and eventually cease the provision of basic necessary socio-economic and ecological benefits for the present and future generations.

Rivers and small streams in the Philippine archipelago also harbor high biodiversity. In fish population diversity for instance, gobies are mostly diverse among other freshwater fish species accounting to 2, 117 species. To this, 330 species are Philippine endemics, with goby diversity in 48 genera and 127 species (Herre, 1927). However, only few studies on gobies are conducted with more concentrations recently in the inland waters of Southern Luzon (UPLB Limnological Research Station, 2011). Before, studies on gobies are concentrating on its life history (Manacop, 1953), including its fishery, biology, ecology and implications for conservation and management (Manacop, 1953; Montilla, 1931; Blanco, 1956, Herre, 1927).

In contrast to the Philippines, 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 (Bell and Brown, 1995; Bell et al., 1995; Bell, 1997), and its biology and genetics in Hawaii (Ego, 1956; Nishimoto and Fitzsimons, 1986; Radtke et al., 1988; Fitzsimons and Nishimoto, 1990; Fitzsimons et al., 1990; Kinzie, 1993). In Asia, several goby studies were also conducted. In particular, the freshwater fishes of genus, *Rhinogobius* (Gill, 1859) are common benthic fish fauna not only in Taiwan, the Ryukyus, and mainland Japan (Akihito et al, 1984; Akihito et al., 1993; Chen, 1994; Chen and Shao, 1996) but also in continental Southeast Asia from China to Thailand (Chen and Miller, 1998; Chen et al., 1999).

Among the goby species, *Rhinogobius* are yet to be studied further since its first documented study (Gill, 1859). 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 (Chen and Miller, 2008). 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* (Chen and Miller, 2008).

The relatively lack of goby studies urged the conduct of this study on *Rhinogobius*, and results can be used for further studies on other goby population as well. The continuing investigations on the systematics of *Rhinogobius*, of which, are still promising in the whole goby study in the Philippines, has led into the conduct of this study. Specifically, it aimed to describe its morphometric and meristic attributes leading to describe its sexual dimorphism and body proportionality. Further, its gonadal structure was also described, which might be a measure in knowing its reproductive potential. This is to describe the inherent morphological characteristics of *Rhinogobius* gobies found in Southern Luzon, which might be of similar or different species found in the Philippines and in Southeast Asia as earlier investigated. Results can be used to account the relative influences of environmental and anthropogenic-based disturbances on the biology and ecology of *Rhinogobius* and other goby species as future related studies.

MATERIALS AND METHODS

Collection and rearing of the specimens

Live specimens of *R. giurinus* were collected using nets and hook and line in the southern part of Laguna Lake, particularly in the whole stretch of Dampalit River, Los Baños, Laguna. They were immediately brought to the UPLB Limnological Research Station ($14^0$11'N; $121^0$14'E), Mayondon, Los Baños, Laguna on August 2010, were acclimatized and reared successfully in tanks under laboratory conditions. There were a total of 100 individuals used for morphological (i.e. morphometric and meristic characters) that is, 47 males and 53 females, respectively.

Morphometric and meristic analyses

Twenty four morphometric characters were used such as total length (TL), standard length (SL), head length (HL), predorsal length (PDL1), snout to second dorsal fin origin (PDL2), prepelvic length (PPL), 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) (adapted from Chen, 1994; Chen and Shao, 1996; Chen and Miller, 1998; Chen et al., 1999, Chen and Miller, 2008). 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) (adapted from Chen and Miller, 1998; Chen and Miller, 2008; Chen and Miller, 1998; Chen and Miller, 2008).

RESULTS AND DISCUSSIONS

Physical attributes of *R. giurinus*

Body. Body was slender, cylindrical in anterior portion while compressed in its posterior end. Head was moderately larger than the its body down to its tail end. Snout of male was relatively longer than female. Lower lip was slightly prominent. Red-orange midlines along the operculum were more prominent in males than females (Figure 1).

Fins. Meristic counts of fin rays were described in Table 2. Lengths and number of fin rays did not vary significantly (P>0.05) between the male and female species. Filamentous rays were manifested in the first three predorsal spines.

Scales. *R. giurinus* had moderately large ctenoid scales, where the lateral line scales ranged from 30-31 for both male and female species. Predorsal scales ranged from 6-7 for both male and female. Prepelvic area was devoid of scales (naked). Detailed meristic scale counts were described in Table 2.

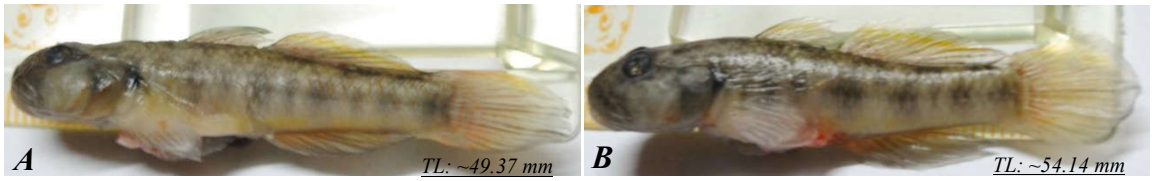

Figure 1. Morphological features of live male (A) and female (B) *R. giurinus* specimens collected from Dampalit River, Los Baños, Laguna on August 2010.

Morpho-meristic attributes of *R. giurinus*

The average total length (TL) of male *R. giurinus* was 49.37 ± 0.55 mm, while females had 54.14 ± 1.44 mm, respectively. However, 86.95% of the morphometric characters among males were relatively higher than the females, including SL (82.16±2.54), HL (34.22±0.22), PDL1 (42.25±1.21), PDL2 (55.39±0.90), PPL (33.82±0.63), PAL (48.34±0.06), SA (50.49±0.47), VFA (27.03±2.07), CPL (31.93±3.65), CPD (20.58±1.94), DFB1 (24.04±1.10), DFB2 (28.83±0.80), CFL (30.42±0.78), PFL (30.63±2.24), AFL (24.48±6.49), BDAF (26.13±3.03), BWAF (20.94±0.54), HD (26.35±1.03), HW (26.01±1.48) and E (16.93±1.53). Only three morphometric characters were relatively higher among females, including AFB (22.44±1.81), VFL (24.76±0.23) and BDPO (25.61±0.63). No significant difference (P>0.05) was observed on the morphometric variations between males and females (Table 1).

In terms of the meristic attributes of *R. giurinus.*, it was observed that LLS (30.50±0.71), PdS (6.50±0.71), DS2 (10.50±0.71) and PS (14.50±2.12) were relatively higher among males, while AS (10.50±0.76), VR (15.75±0.71) and CR (32.00±1.69) were relatively higher among females. DS1 was similar to both sexes. No significant difference (P>0.05) was observed on these varied meristic characters measured on both sexes (Table 2).

Results on the morpho-meristic attributes of *R. giurinus* may imply that males and females were not subjected to some morphological adaptations in response to microhabitat restrictions or geographical isolation, either through the physical topography of the river, by pollution impacts or by the availability of food sources and habitat within Dampalit River. Morphometric measures like TL and SL can be used as benchmarks on the maturity of *R. giurinus*, and might also serve as a reference on its fecundity. The phenotypic characteristics, as indicated by the distinct morphology of *R. giurinus,* can be used to establish its species diversity or its evolutionary adaptations to all *R. giurinus* species found in different inland waters of the Philippine archipelago.

Table 1. Morphometric attributes (mean ± SE) of male and female *R. giurinus* inhabiting the Dampalit River, Los Baños, Laguna captured on August 2010.

Characters (% TL)	Males	Females	F value	P value
SL	82.16±2.54	80.86±2.46	0.185	0.833
HL	34.22±0.22	34.08±7.79	0.161	0.853
PDL1	42.25±1.21	40.61±1.14	0.226	0.802
PDL2	55.39±0.90	52.60±0.94	0.281	0.760
PPL	33.82±0.63	33.41±1.52	0.164	0.851
PAL	48.34±0.06	45.89±2.72	0.259	0.776
SA	50.49±0.47	49.93±2.62	0.252	0.782
VFA	27.03±2.07	26.27±2.76	0.161	0.853
CPL	31.93±3.65	31.26±1.65	0.212	0.812
CPD	20.58±1.94	19.70±1.35	0.357	0.708
DFB1	24.04±1.10	21.33±1.29	0.234	0.796
DFB2	28.83±0.80	28.07±1.93	0.256	0.779
AFB	22.44±1.81	24.62±2.45	0.283	0.760
CFL	30.42±0.78	28.46±1.63	0.253	0.781
PFL	30.63±2.24	27.69±1.27	0.369	0.701
VFL	24.76±0.23	25.14±1.15	0.190	0.830
AFL	24.48±6.49	20.50±3.71	0.231	0.798
BDPO	25.61±0.63	26.99±1.03	0.205	0.818
BDAF	26.13±3.03	23.98±1.80	0.176	0.840
BWAF	20.94±0.54	20.49±1.47	0.269	0.770
HD	26.35±1.03	25.12±1.09	0.171	0.845
HW	26.01±1.48	25.48±0.81	0.223	0.803
E	16.93±1.53	16.54±2.08	0.220	0.806

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 (PPL), 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).

Sexual dimorphism of *R. giurinus*

All morphometric characters for both sexes were significantly different (P<0.05) (Table 3). This means that *R. giurinus* species were sexually dimorphic, and that, apparent morphological distinctions were observed between males and females. Besides, differences in their coloration and genital papillae could give visual distinction between both sexes. The results on sexual dimorphism of *R. giurinus* might be used as a measure on determining the gravidity and pre-spawning stage of females, that logically, might differ their morphological attributes from the males. In some cases, this result can be used to compare other *Rhinogobius* species in other parts of the Philippines, that may or may not exhibit sexual dimorphism.

Table 2. Meristic attributes (mean ± SE) of male and female *R. giurinus* inhabiting the Dampalit River, Los Baños, Laguna captured on August 2010.

Characters	Males	Females	F value	P value
LLS	30.50±0.71	30.13±0.35	0.212	0.712
PdS	6.50±0.71	6.38±0.52	0.121	0.813
DS1	6.00±0.00	6.00±0.00	0.242	0.842
DS2	10.50±0.71	10.13±0.35	0.317	0.718
AS	10.00±0.00	10.50±0.76	0.274	0.736
PS	14.50±2.12	14.13±1.89	0.226	0.729
VR	14.00±0.00	15.75±0.71	0.243	0.710
CR	31.00±1.41	32.00±1.69	0.213	0.741

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 3. Sexual dimorphism based on the mean ± SE (combined sexes) of *R. giurinus* inhabiting the Dampalit River, Los Baños, Laguna captured on August 2010.

Morphometrics (% TL)	Male	Female	T value	P value
SL	82.16±0.003	80.86±0.007	0.032	0.001*
HL	34.22±0.003	34.08±0.003	9.650	0.000*
PDL1	42.25±0.004	40.61±0.003	20.603	0.000*
PDL2	55.39±0.004	52.60±0.004	20.354	0.000*
PPL	33.82±0.006	33.41±0.003	18.041	0.000*
PAL	48.34±0.010	45.89±0.004	17.534	0.000*
SA	50.49±0.010	49.93±0.003	14.765	0.000*
VFA	27.03±0.001	26.27±0.002	22.810	0.000*
CPL	31.93±0.006	31.26±0.003	19.494	0.000*
CPD	20.58±0.001	19.70±0.001	19.895	0.000*
DFB1	24.04±0.001	21.33±0.001	9.059	0.000*
DBF2	28.83±0.005	28.07±0.002	12.846	0.000*

AFB	22.44±0.001	24.62±0.002	12.467	0.000*
CFL	30.42±0.004	28.46±0.002	17.361	0.000*
PFL	30.63±0.002	27.69±0.001	10.936	0.000*
VFL	24.76±0.002	25.14±0.001	24.146	0.000*
AFL	24.48±0.002	20.50±0.004	19.435	0.000*
BDPO	25.61±0.003	26.99±0.001	27.324	0.000*
BDAF	26.13±0.002	23.98±0.001	35.719	0.000*
BWAF	20.94±0.002	20.49±0.001	22.375	0.000*
HD	26.35±0.003	25.12±0.001	26.535	0.000*
HW	26.01±0.007	25.48±0.002	13.057	0.000*
E	16.93±0.000	16.54±0.001	2.581	0.003*
Meristics				
LLS	30.50±0.048	30.13±0.012	23.005	0.000*
PdS	6.50±0.018	6.38±0.035	25.891	0.000*
DS1	6.00±0.060	6.00±0.051	22.566	0.000*
DS2	10.50±0.029	10.13±0.012	37.233	0.000*
AS	10.00±0.033	10.50±0.027	4.877	0.000*
PS	14.50±0.037	14.13±0.042	0.246	0.000*
VR	14.00±0.011	15.75±0.015	0.232	0.000*
CR	31.00±0.012	32.00±0.006	1.704	0.000*

* significantly different at α 0.05.

Descriptions: The morpho-meristic characters used: total length (TL), standard length (SL), head length (HL), predorsal length (PDL1), snout to second dorsal fin origin (PDL2), prepelvic length (PPL), 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). 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).

Body proportionality of *R. giurinus*

Result showed 14.37% of all morphometric characters measured among males were not significantly correlated (P>0.05), while the rest were highly correlated (P<0.01). Among all morphometric characters measured, SL (95.65%) has the most number of insignificant correlations to HL, PDL1, PDL2, PPL, PAL, SA, VFA, CPL, CPD, DFB1, DFB2, AFB, CFL, PFL, VFL, AFL, BDPO, BDAF, BWAF, HD, HW and E (Table 4).

In females, 17.39% of the morphometric characters measured were not significantly correlated (P>0.05), while the rest were highly correlated (P<0.01). AFB, constituting 82.61% out of all morphometric characters measured, was not significantly correlated to all morphometric characters except CPD, HW and E (Table 5).

With only a difference of 3.02% between the morphometric characters of male and female *R. giurinus*, this means that majority of them had relatively well-proportioned body structures. Other individuals that did not exhibit a well-proportioned body structure might be due to some genetic variations or perhaps were subjected to some adverse impacts of water pollution during their early stages of development. Theoretically, individuals of well-proportioned body structures attract the opposite sex, and in turn, could have influence in successful courting, mating and spawning necessary for the recruitment of their population over time.

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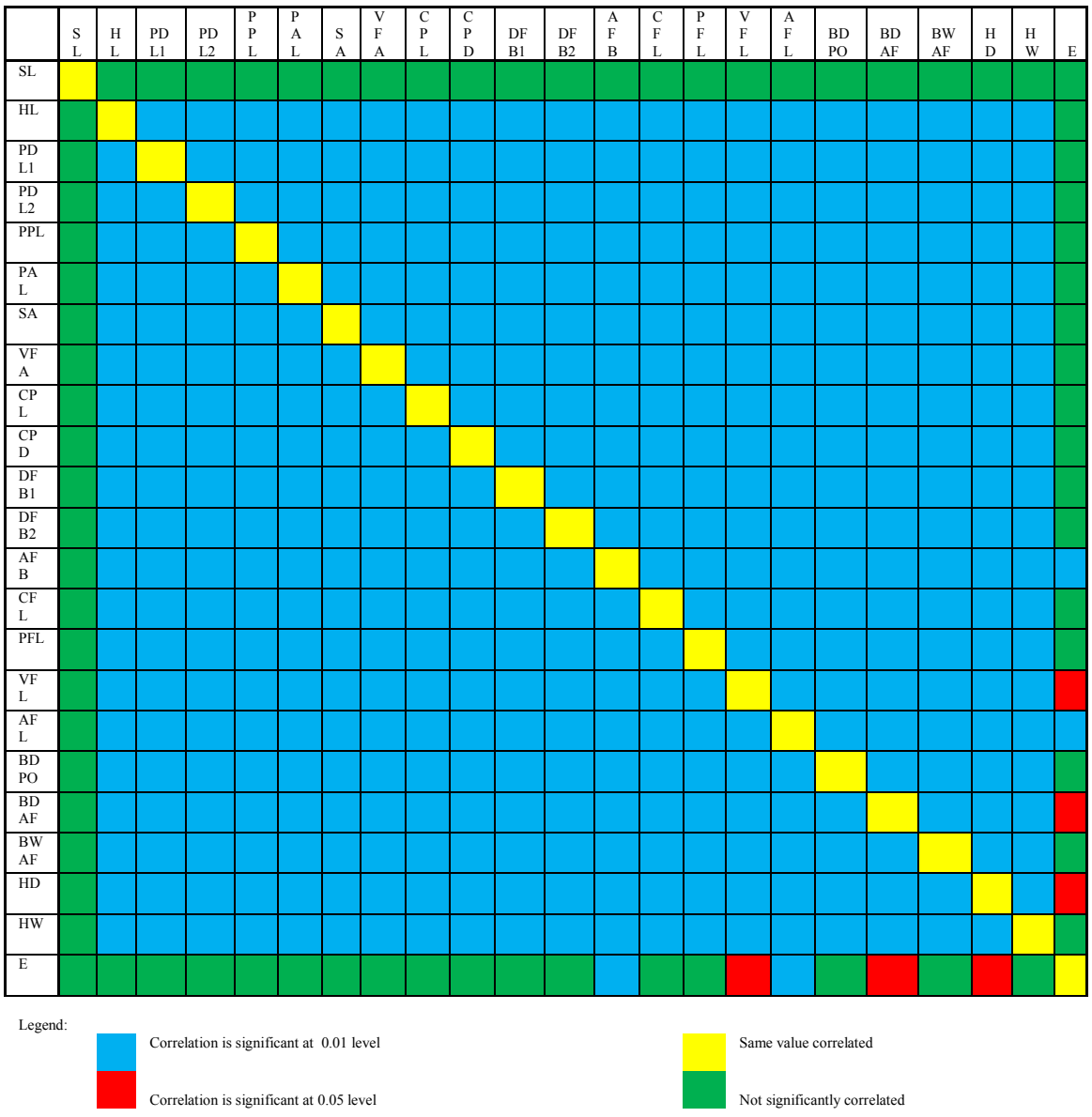
Table 4. Modified correlation matrix on the morphometric characters of male *R. giurinus inhabiting* the Dampalit River, Los Baños, Laguna captured on August 2010.



Descriptions: total length (TL), standard length (SL), head length (HL), predorsal length (PDL1), snout to second dorsal fin origin (PDL2), prepelvic length (PPL), 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).

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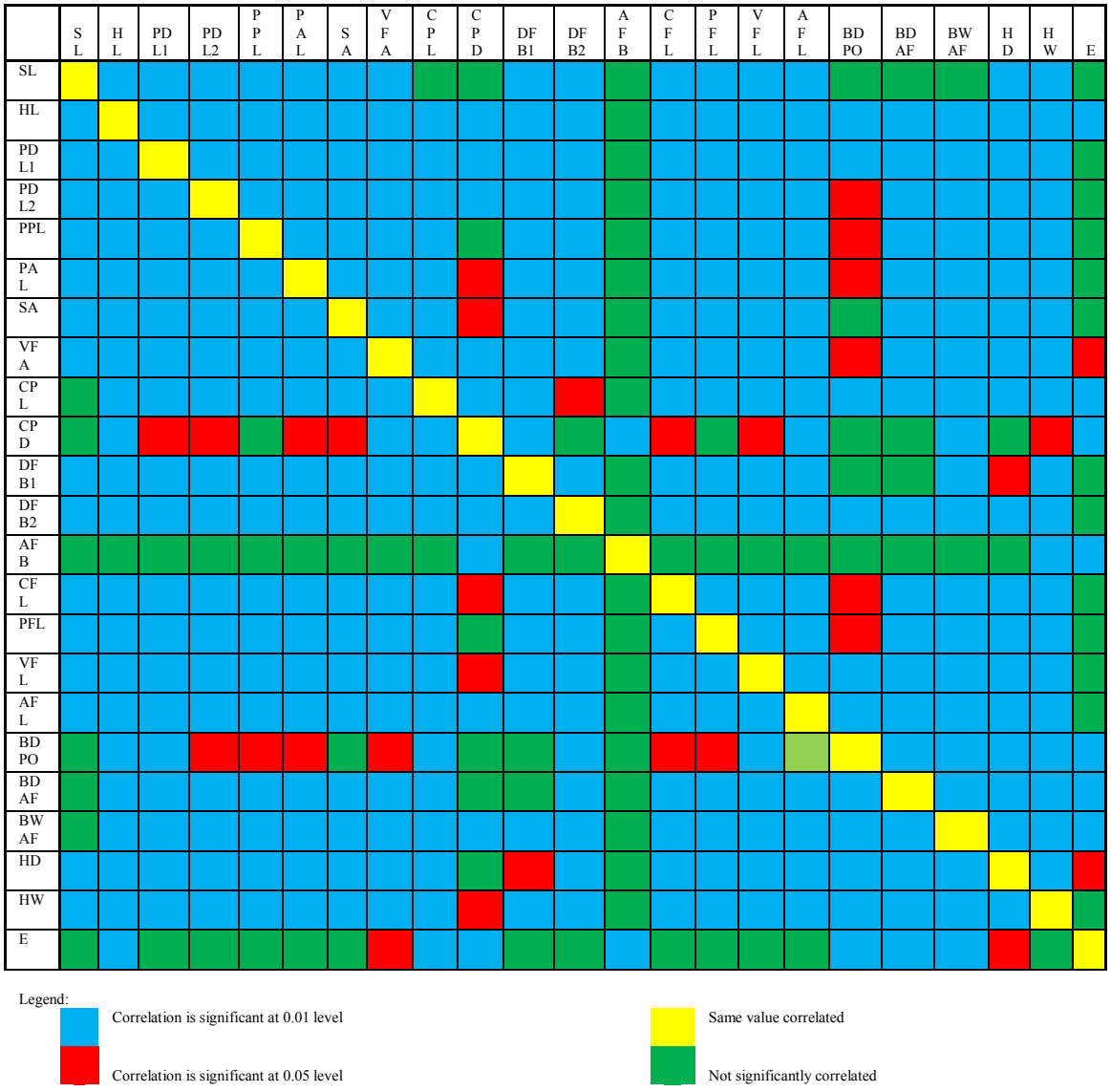
Table 5. Modified correlation matrix on the morphometric characters of female *R. giurinus* inhabiting the Dampalit River, Los Baños, Laguna captured on August 2010.



Descriptions: total length (TL), standard length (SL), head length (HL), predorsal length (PDL1), snout to second dorsal fin origin (PDL2), prepelvic length (PPL), 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).

SUMMARY AND CONCLUSIONS

R. giurinus as described in this study had a slender body structure, cylindrical anteriorly, and compressed posteriorly. Head was moderately larger than its body. Distinct feature of male from female was the prominent presence of red-orange midlines along the operculum area. The morpho-meristic attributes were not significantly different among males and females. However, significant differences were observed on their morphometric and meristic characteristics between sexes, thus becoming sexually dimorphic. Hence, apparent morphological distinctions were observed between sexes. Both males and females possessed well-proportioned body structures. Body proportionality among males and females were highly correlated, and therefore, were observed to be well-proportioned and were assumed to have a successful courtship, mating and spawning necessary for the recruitment of their population.

RECOMMENDATIONS

The results of the study revealed that this goby species were not affected by the adverse impacts of microhabitat restrictions and geographical isolations due to pollution and other environmental problems. However, the data can be used to describe other *Rhinogobius* species in the Philippines. Thus, future related studies are highly recommended, such that, should there be changes in the water quality of the river due to pollution impacts, the sexual attributes of the gobies might probably change as well to adapt the certain conditions, and therefore, a good subject for further study of other *Rhinogobius* found in the inland waters of the Philippines. The known threats of a changing climatic condition that will adversely affect their spawning behavior and may be their morphological attributes are good points to study in the future.

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