# New Distributional Record and Intra-Specific Variation of *Cerberus schneiderii* in Iyam River, Lucena City, Quezon, Philippines

**Wilfredo B. Barrera Jr.[1], Julius Caesar A. Jaluague[1], Shairah Dianne C. Albaño[1], and Glenn Lester L. Jalbuena[1]**

## ABSTRACT

*Cerberus* is a genus of semi-aquatic snakes that inhabit a wide range of aquatic habitats including estuarine environments. There are two species belonging to this genus known to occur in the Philippines. However, its distributional record is still not well established since only limited areas are surveyed despite of its wide distributional range in the coastal habitats of the country. This study primarily aims to document the occurrence of *Cerberus* in Iyam River, Lucena City. The scalation patterns and metric characters were also described to determine the range of individual variability among the species. Samples were collected from different habitat types in the sampling area by systematic transect walking. By close examination, it was revealed that the samples exhibit the established morphological description of *Cerberus schneiderii.* Moreover, population exhibit high variability in scalation pattern such as anal plate, anterior chin shield, lower labials at the first chin shield, type of scale, prefrontal plate, upper labials at loreal, and ocular ring; and metric characters such as total length, tail length, snout-vent length (SVL) and Tail:SVL ratio (H' = 0.67-1.0). Statistical analysis further showed a strong significant correlation (*P* = <0.01) between total length and SVL, total length and weight, SVL and weight, and total length and tail length. The occurrence of different morphotypes is very important in understanding the extent of intra-specific variation within *Cerberus schneiderii* and the possible role of local adaptations and habitat use.

*KEY WORDS :*

Morphotype
Scalation
Dog-faced water snake
Individual variability

## INTRODUCTION

Snakes are successful group of predatory vertebrates that occupy a wide range of environment such as terrestrial and aquatic habitats of tropical and temperate areas. Only few species of snakes can live in the aquatic area permanently which include sea snakes and freshwater snakes (Pauwels et al., 2008). One characteristic that differentiate each other aside from their habitat is that, almost all the sea snakes are venomous while most of the freshwater snakes are non-venomous. Another is the morphological structure of the tail; most sea snakes have flattened tails while fresh water snakes have pointed tail.

Members of the genus *Cerberus* are known to occupy aquatic habitats. They exhibit a number of aquatic adaptations including dorsally located eyes and valvular nostrils. Morphologically, they are rear-fanged snakes with two or three large, grooved maxillary teeth, and are considered mildly venomous. They can be differentiated from other homalopsines by details of scalation (Karns et al., 2000). *Cerberus* possessed nasal scales in contact by: keeled, striated dorsal scales; absence of rostral appendages; and parietal scales that are partially or completely fragmented. A detailed morphological description of *Cerberus* can be found on a recent article of Murphy et al. (2012).

The homalopsid genus *Cerberus* is one of the most geographically widespread reptile genera, with the most recent family reviews. It ranges from the vicinity of Mumbai, India eastward in coastal habitats to the Philippines, southward into the Indonesian archipelago, eastward to the south coast of New Guinea, and northern Australia. There is also an isolated population in the Palau Islands of Micronesia. Thus, the range of *Cerberus* approximates the distribution of the entire family, omitting most inland waters (Murphy et al., 2012).

[1]Department of Natural Sciences, Southern Luzon State University, Lucban, Quezon

Corresponding Author: barrerawilfredojr@gmail.com
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There are currently five recognized species under the genus *Cerberus*. Two of these species namely *C. microlepis* and *C. schneiderii* occur in the Philippines. The occurrence of *C. schneiderii* in Cagayan Valley (Brown et al. 2013) and *C. microlepis* in Lake Buhi, Camarines Sur have been documented while Alfaro et al. (2004) used voucher specimens originating from Pollilo Island, Lake Buhi, Camarines Sur and Siliman on the south end of Negros Island to study the phylogeny of *Cerberus*. Despite of these reports, the distributional record of *Cerberus* species in the Philippines is still not well established. This study is the first report of the occurrence, morphological description and the range of individual variability in terms of scalation pattern and metric characters of *Cerberus* in Iyam River, Lucena City. The result of this study will contribute to the new distributional record of *Cerberus* in the Philippine Islands. Moreover, the result about morphological differences and individual variability is essential to understand the extent of intra-specific variation in aquatic snakes which often exhibits cryptic morphological diversity.

## Materials and Methods

***Study Site.*** Snakes were collected from Iyam River, Lucena City, Quezon (Figure 1). The river has a length of 5.81 kilometers and is located on the west side of the Lucena City proper. There are few swamps along its sides which are converted into fish ponds by local communities. The sampling area is located near the mouth of Tayabas Bay where salt water and freshwater constantly mix making it an estuarine environment. The sampling site is also characterized by open tidal mudflats and tidal mudflats which are dominated by species of *Rhizophora* and *Nympha fruticans.*

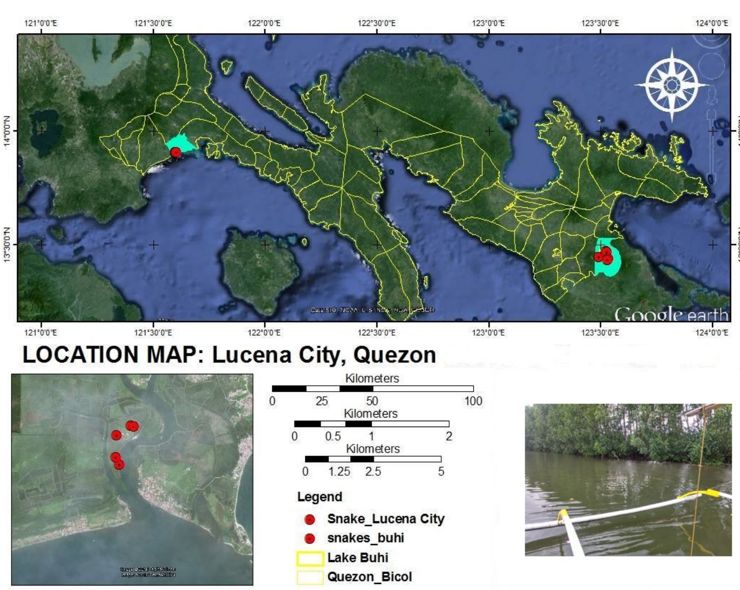


**Figure 1.** Topographical map of Lucena City, Quezon showing the sampling site

***Collection of Samples.*** Two consecutive nights were allotted for the collection of samples during the months of June – August 2015. Sampling sites were surveyed by transect walking for three to four hours at night (18:00–22:00) during low tides when the activity of the nocturnal snake is prominent. Surveys were conducted by walking slowly and systematically along the sides of the sampling sites. Snakes were located with headlights by trained observers. Different microhabitat types available in the study area such as tidal creeks, open mudflats, mangrove mudflats and nipa mudflats were considered during sampling. Sampling were conducted at the same tide levels and the same moon phase (full moon) as the activity of *Cerberus* species may be influenced by moonlight. Snakes were released at the site of capture within 48 hours after collection of data.

***Scalation and Metric Characteristics.*** Only adult samples (SVL ≥ 336mm) were considered for the observation of scalation pattern and metric characters. The sex was also determined using tail morphology and the presence of hemipenes (made possible by probing). The snout-vent length (SVL), tail length to the nearest mm and weight to the nearest 0.1 g were determined. Scalation patterns were determined by counting and observation of the scales namely: anal plate, chin shields, lower labials and upper labials, dorsal and ventral scales, prefrontal plate, loreal, ocular rings, dorsal scale count, and ventral scale count. Different morphotypes of the snake in terms of scalation pattern were described and determined using published literatures and scientific journals. Scalation pattern and scale morphology were described using binocular microscope (Ken α Vision) and by direct observation. Twenty seven individuals randomly chosen from the sampled snakes were chosen for the observation of scalation pattern and scale morphology.

***Data Analysis.*** The quantitative data were analyzed using descriptive statistics while other results were reported as percentage. The diversity in scalation patterns and metric characters were determined using standardized Shannon-Weaver diversity index (H’).

## Results and Discussion

***General morphology.*** Table 1 shows the general characteristics of the collected samples. The gathered data correspond to the morphological description of *Cerberus* from Murphy et al. (2012). Moreover, it appears that the samples fit with the characteristics of *C. schneiderii.* From the measured metric characters, body weight has the highest value for coefficient of variation which indicates high variability. In contrast, the coefficient of variation of the Tail: SVL ratio has the lowest percentage which indicates low variability (Table 2).

**Table 1.** General characteristics of *Cerberus* from Iyam River, Lucena City

| Characteristics | Iyam River, Lucena City *Cerebrus sp.* |
|---|---|
| | N= 27 |
| **Head Scale Patterns** | |
| Anterior chin shield | Attached |
| Chin shield counts | 3-4 |
| Eye position on head | Embossed |
| Loreal counts | 3-5 |
| Loreals at internasals | Attached |
| Internasal smaller than nasal | Yes |
| Prefrontal plate | not separated to separated (2-3) |
| Ocular ring | 1-3; 1-4; 1-5 |
| Supraocular | single to divided |
| Upper labials at loreal | 1-3; 1-4 |
| Lower labials at anterior chin shield | 1-3; 1-4 |
| Fragmented parietal scales | Yes |
| Posterior upper labials | horizontally divided |
| Temporal scales | Small and not plate-like |
| **Body Scale Patterns** | |
| Dorsal scale counts | 21-25; 23-25 |
| Ventral scale counts | 145-157; 149-155 |
| Scale type | strongly keeled |
| Anal plate | Divided |
| **Pigmentation** | |
| Ventral body color | anteriorly mottled and uniformly dark |
| Dorsal body color | ash gray |

***Intra-specific variability.*** Different morphotypes of scalation patterns were observed in the samples to determine the intra-specific variability. Two morphotypes of anal plate were observed which differs in terms of its size (length and width). The first morphotype (Figure 2A) is elongated but not wide divided anal plate while the second morphotype (Figure 2B) is shortened and wide divided anal plate. The observation is in accordance with Murphy et al. (2012) which also reported that *Cerberus* spp. exhibits divided anal plate. Two morphotypes were also observed in terms of anterior chin shield. The first morphotype (Figure 3A) is attached with no or slight mental groove anterior chin shields while the second morphotype (Figure 3B) is attached with deep mental groove anterior chin shields. Two morphotypes of lower labials at chin shields were also observed. The first morphotype (Figure 4A) exhibits four lower labials that touched the first chin shield, while the second morphotype (Figure 4B) exhibits three lower labials that touched the first chin shield. According to Murphy et al. (2012), the lower labials in contact with the first chin shield of *Cerberus* spp. ranges from 1-4. In terms of dorsal scales, there are two morphotypes observed. The first morphotype (Figure 5A) is elongated and narrow keeled scales while the second morphotype (Figure 5B) is short and wide keeled scales. Murphy et al. (2012) emphasized that *Cerberus* spp. possessed keeled and striated dorsal scales. On the other hand, three morphotypes were observed in terms of prefrontal plates. The first morphotype (Figure 6A) exhibits two prefrontal plates, the second morphotype (Figure 6B) exhibits three prefrontal plates with elongated oblong-shaped middle plate and the third morphotype (Figure 6C) exhibits three prefrontal plates with a short oblong middle plate. The prefrontal plates are fragmented which supports the report of Murphy et al. (2012) which state that head plates including prefrontal show a strong tendency to fragment into smaller scales. Two morphotypes were observed in terms of supraocular plate. The first morphotype (Figure 7A) exhibits undivided supraocular plate while on the other hand the second morphotype (Figure 7B) exhibits a divided supraocular plate. *Cerberus* spp. possessed single supraocular and rarely to be seen in double aspect or in divided form which is recorded only in *C. rynchops* (Murphy et al., 2012). Figure 8 shows the four ocular ring morphotypes. The first morphotype (Figure 8A) exhibits five ocular plates while the second morphotype (Figure 8B) exhibits three ocular plates. The third morphotype (Figure 8C) exhibits four ocular plates. Lastly, the fourth morphotype (Figure 8D) exhibits four ocular plates with reduced sub-ocular plate. According to Murphy et al. (2012) the common ocular ring scales of *Cerberus* spp. is five namely: the preoculars, presubocular, subocular, postsubocular and the post ocular plate. Among the scalation patterns observed, it is the upper labials at the loreal that exhibited the highest morphological variation which accounts for a total of 10 different morphotypes. The morphotypes include the following: (Figure 9A) four labials (Figure 9B) four labials; second labial not touching the loreal (Figure 9C) four labials; fourth labial overlapped with ocular ring (Figure 9D) Four labials; second labial very short (Figure 9E) five labials; second labial in between the first and third labials (Figure 9F) four labials; third labial divided (Figure 9G) four labials; first labial divided and fourth labial overlapped the ocular ring (Figure 9H) four labials; first labial divided and third labial not touching the loreal (Figure 9I) three labials; third labial overlapped with the ocular ring and lastly, (Figure 9J) three labials. The occurrence of highly differentiated scalation pattern in the population of *C. schneiderii* in Iyam River, somehow indicates a strong environmental influence to their morphology. It has been shown by several studies that

 

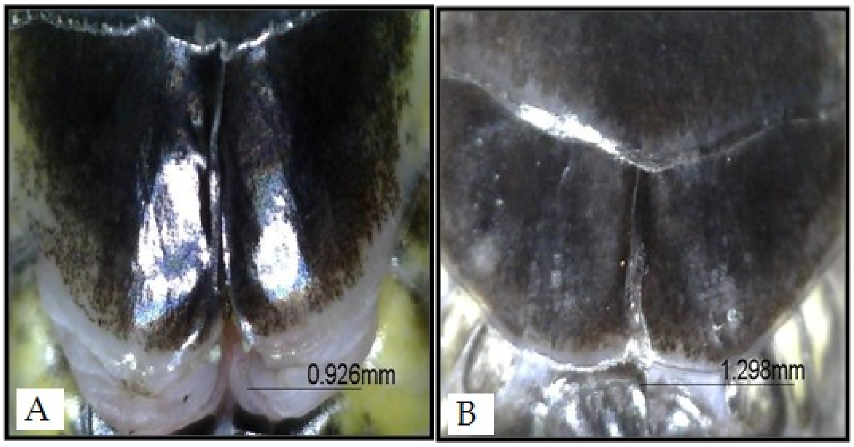


**Figure 2.** Morphological variation in anal plate.
(A) Elongated but not wide divided anal plate
(B) Shortened and wide divided anal plates.

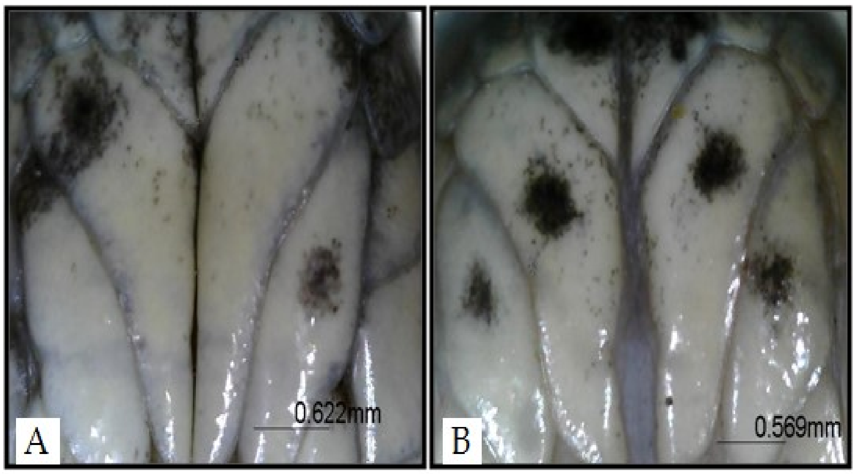


**Figure 3.** Morphological variation in anterior chin shields. (A) Attached with no or slight mental groove anterior chin shields (B) Attached with deep mental groove anterior chin shields.

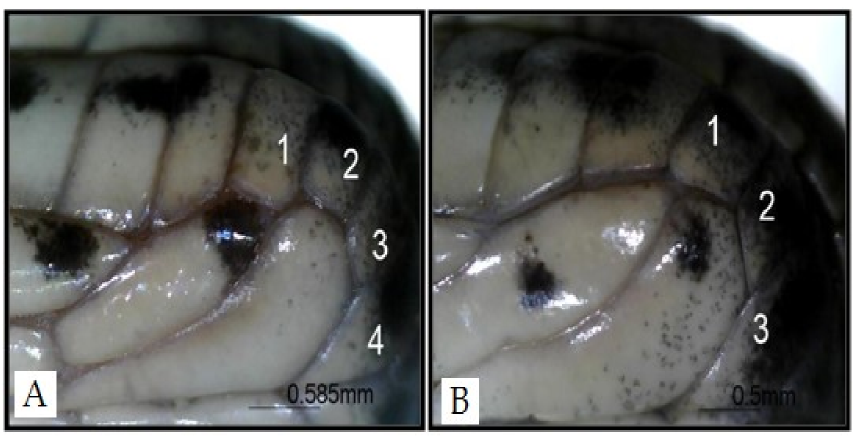


**Figure 4.** Morphological variation in lower labials that touched the anterior chin shield. (A) Four lower labials (B) Three lower labials.

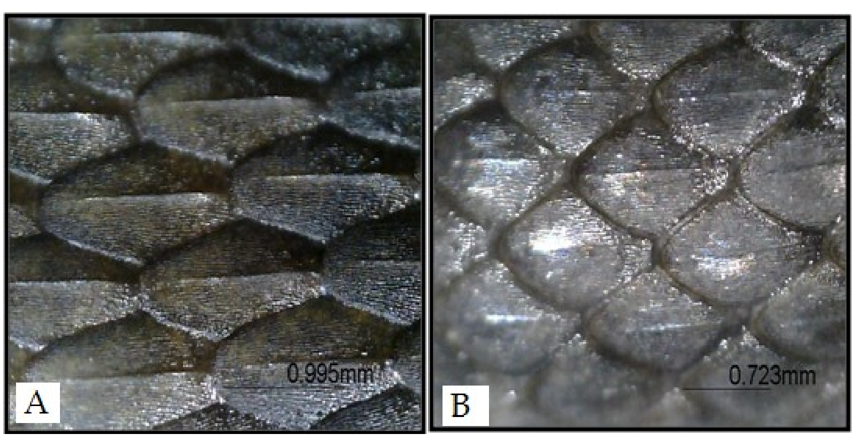


**Figure 5.** Morphological variation in dorsal scale. (A) Elongated and narrow keeled scales (B) Short and wide keeled scales.

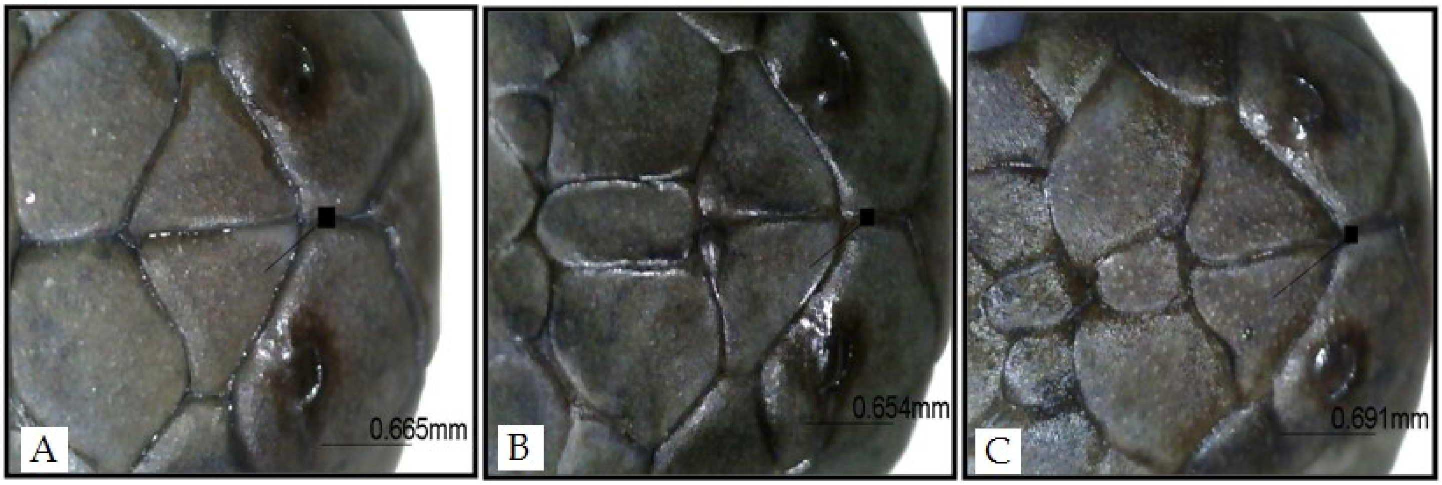


**Figure 6.** Morphological variation in prefrontal plates. (A) Two prefrontal plates (B) Three prefrontal plates with elongated oblong middle plate (C) Three prefrontal plates with short oblong middle plate.

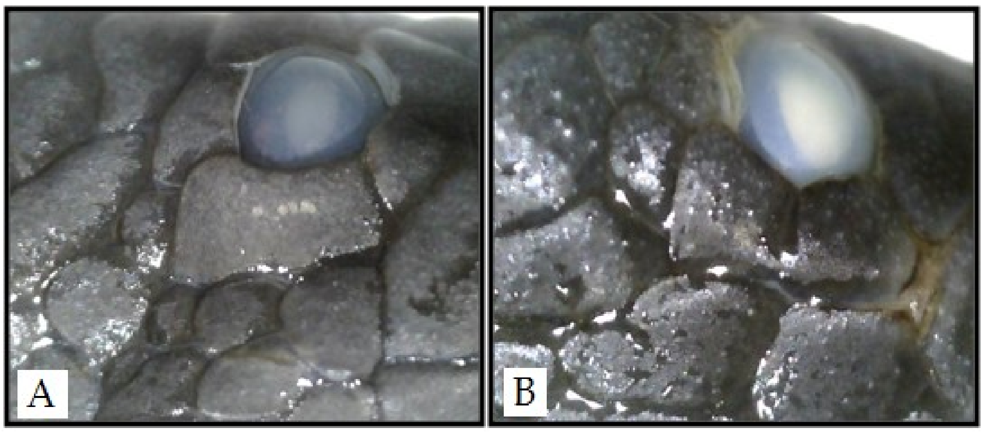


**Figure 7.** Morphological variation in supraocular plates. (A) single supraocular plate (B) divided supraocular plate.

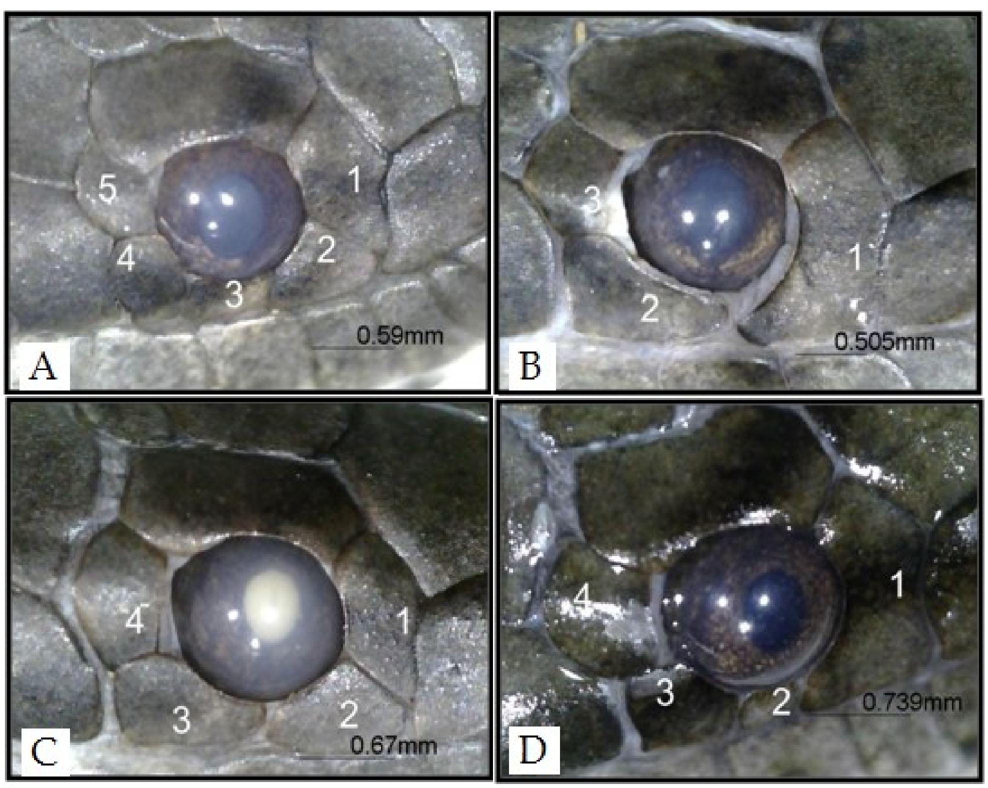


**Figure 8.** Morphological variation in ocular ring. (A) five ocular plates (B) three ocular plates (C) four ocular Plates (D) four ocular plates, second plate reduced in size.

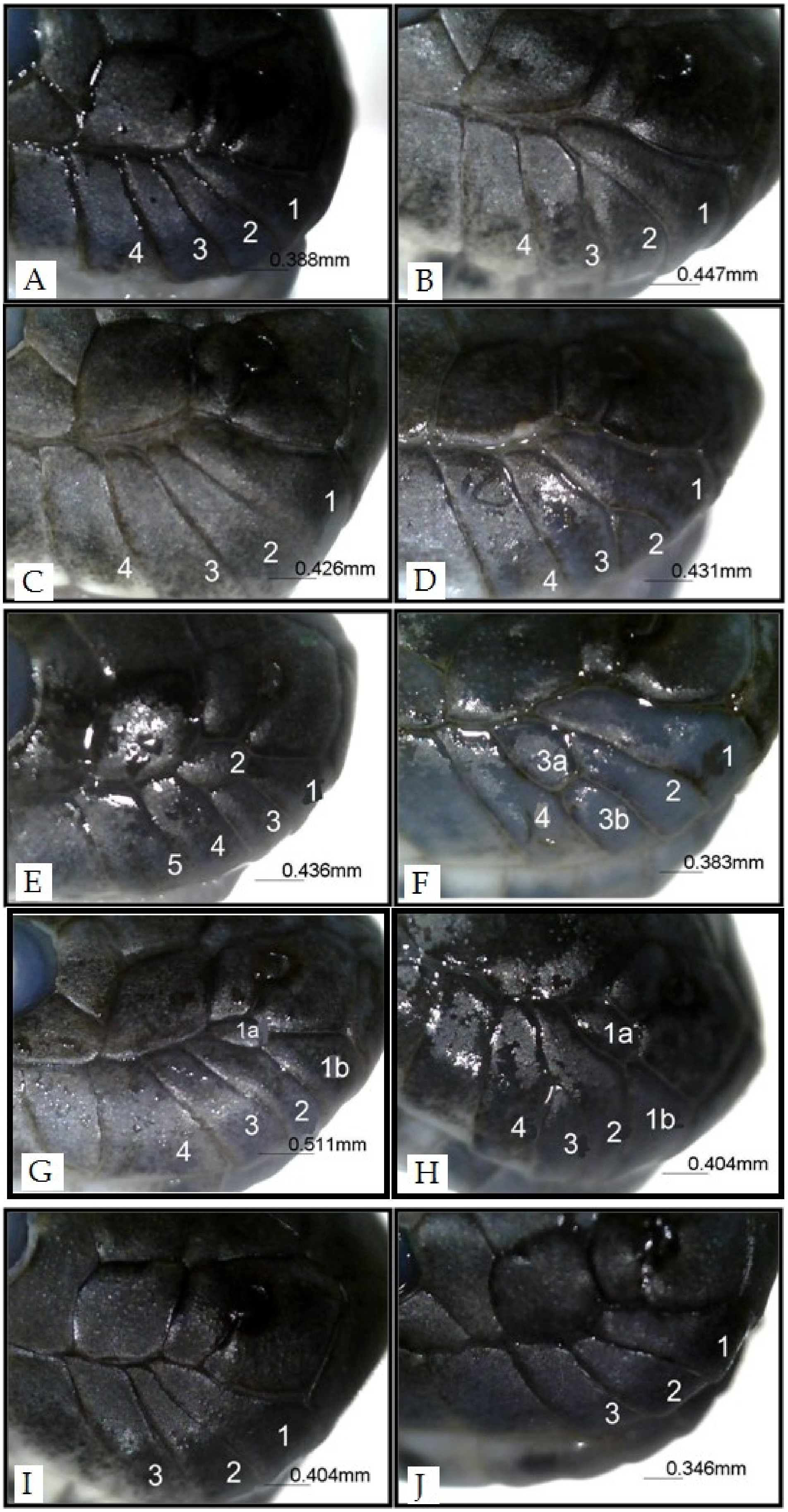


**Figure 9.** Morphological variation in upper labials that touched the loreal. (A) Four labials (B) Four labials; second labial not touching the loreal (C) Four labials; fourth labial overlapped with ocular ring (D) Four labials; second labial very short (E) Five labials; second labial in between the first and third labials (F) Four labials; third labial divided (G) Four labials; first labial divided and fourth labial overlapped the ocular ring (H) Four labials; first labial divided and third labial not touching the loreal (I) Three labials; third labial overlapped with the ocular ring (J) Three labials.

**Table 2.** Descriptive statistics in Metric Characters of *Cerberus* in Iyam River

| | Metric Characters | | | | |
|---|---|---|---|---|---|
| | TOL | TL | SVL | BW | T:SVL |
| Mean | 64.69630 | 12.50370 | 52.19259 | 104.59667 | 0.23864 |
| Standard Deviation | 4.85422 | 1.36986 | 3.95454 | 27.18037 | 0.02147 |
| Sample Variance | 23.56345 | 1.87652 | 15.63840 | 738.77225 | 0.00046 |
| Range | 55.3-72.6 | 10.0-15.2 | 44.5-59.5 | 66.35-194.65 | 0.1761-0.2754 |
| Coefficient of Variation (%) | **7.503** | 10.956 | 7.577 | **25.986** | 8.952 |

TOL- total length, TL- tail length, SVL- snout-vent length, BW- Body Weight, T: SVL- Tail:SVL ratio

changes in scale number and scalation pattern are correlated with different ecological variables such as precipitation and habitat use (Calsbeek et al., 2006).

***Diversity in scalation pattern and metric characters.*** Diversity in the scalation pattern and metric characters were determined to provide information about the rarity and commonness of *Cerberus* morphotypes. Table 3 shows that majority of the characters observed exhibit high diversity (H' = 0.67-1.0) except for supraocular (H' = 0.22854) and body weight (H' = 0.53039) which exhibits low and moderate diversity respectively. Correlation analysis further indicates that some of the metric characters exhibit significant relationship (*P* = <0.01). For example, high positive relationship was observed between total length and snout vent length (r = 0.9722), total length and body weight (r = 0.8491) and snout vent length and body weight (r = 0.8607). On the other hand, positive moderate high relationship (r = 0.7370) was observed between total length and tail length. The variability between two different species has always been the subject of taxonomy but studies about the extent of differences of the same species tend to be limited and often neglected. Thus, the occurrence of high diversity in scalation pattern of *Cerberus* can provide a clue about habitat-driven traits and the importance of ecological adaptation.

**Table 3.** Diversity in scalation pattern and metric characters of *Cerberus* in Iyam River

| Scale Morphotypes | | Metric Characters | |
|---|---|---|---|
| Anal plate | 0.95096 | Total length | 0.89391 |
| Anterior chin shield | 0.87672 | Tail length | 0.83718 |
| Lower labials that touched the first chin shield | 0.76420 | Snout-vent length | 0.94331 |
| Type of scale | 0.70958 | Body weight | 0.53039 |
| Prefrontal plate | 0.80757 | Tail:SVL | 0.83645 |
| Loreal | 0.86984 | | |
| Ocular ring | 0.71077 | | |
| Supraocular | 0.22854 | | |

0-0.33(Low diversity); 0.34-0.67(Moderate diversity); 0.68-1.00 (High Diversity)

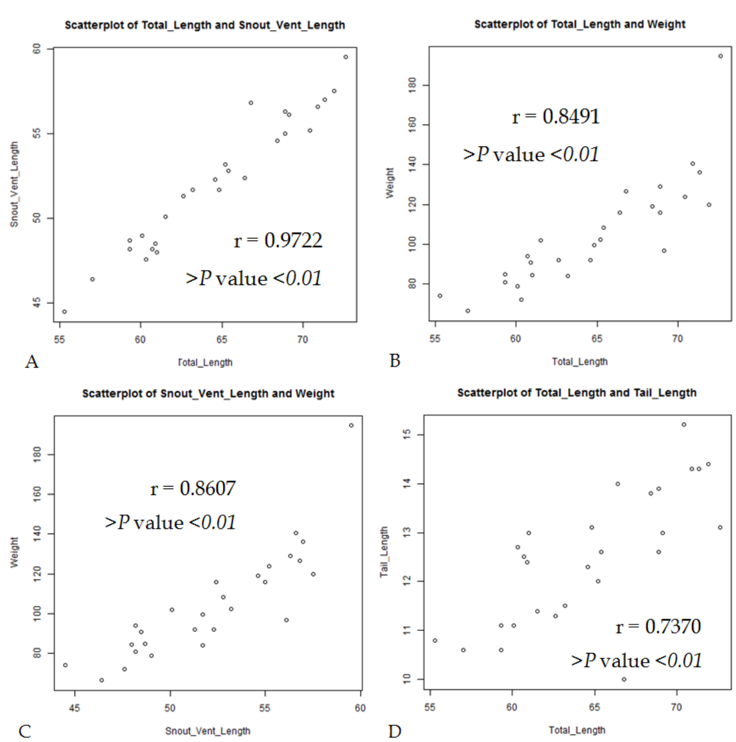


**Figure 10.** Scatterplots showing the relationship of some metric characters. (A) total length and snout vent length (B) total length and weight (C) snout vent length and weight (D) total length and tail length

 

## Conclusions

The occurrence of *Cerberus* in Iyam River, Lucena City, Quezon has been reported in this paper. Close examination of scalation pattern and metric characters indicate that the samples exhibit the characteristics of *C. schneiderii.* The high intra-specific variability in the population of *C. schneiderii* indicates a strong influence of different environmental factors and habitat use.

## Recommendations

Large number of samples and larger sampling area should be considered to represent the extent of habitat variation and to study the relationship between ecological adaptation and the occurrence of different morphotypes. *Cerberus* is one of the genera of aquatic snakes where geographical distribution has not given much attention. It is therefore imperative to document its distribution in the aquatic ecosystems of the country. The identification of the specimens can also be verified using advanced molecular techniques while the genetic diversity of the population can be assessed using different techniques such as cytological and biochemical.

## Acknowledgement

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