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MATURITY STAGE CATEGORIZATION OF ENDEMIC LIZARD (*Calotes nigrilabris*) IN THE GRASSLANDS OF HPNP

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ABSTRACT - Morphometric parameters of endemic endangered highland lizard *Calotes nigrilabris* were obtained utilizing three fixed length 200m line transects in the grassland habitat of Horton Plains National Park (HPNP). The PCA analysis of mophometric data revealed five discrete clusters which were categorized into five maturity stages as Adult male, Adult Female, Sub-adult Male, Sub-adult Female and Juvenile. Furthermore, principal component 1 (PC1) axis was representing a high percentage of variance (91.3%) with negative values for all the parameters indicating that if one morphometric parameter of an individual lizard increases, all the other parameters also increase. SVL was identified as the morphometric parameter with the highest PC1 value (-0.422), yet it wasn't significantly affecting the PC1 axis. SVL was used as a base for easy categorization of maturity stages. Adult Males recorded the highest values for all the parameters considered. Results of the present study indicate that morphometric data can be used as a successful tool for the categorization of maturity stage of this agamid species.

KEY WORDS : maturity stage categorization, *Calotes nigrilabris*, endemic lizard, Horton Plains National Park

INTRODUCTION

The present study focused on the morphometrics of the endemic *Calotes nigrilabris*, inhabiting the grasslands of Horton Plains National Park, because recording the ecological requirements and interactions of different maturity stages within the population helps to better understand the macro scale habitat requirements and finer scale microhabitat requirements of a species. *Calotes nigrilabris* was first described in 1860 using a holotype collected from Nuwara Eliya, Sri Lanka (Peters, 1860; Boulenger, 1890). This poorly known endemic species was re-described recently by Amarasinghe *et al.* (2011) using the holotype and new specimens. *C. nigrilabris* is known as the Black-cheek lizard in English and "Kalu kopul katussa" in Sinhala (Das and De Silva, 2005). It is restricted to montane forests above 1300 m elevation (Erdelen, 1984) and recorded only from a few localities in the central massif like Horton Plains, Nuwara Eliya, Ohiya, Pattipola, Hakgala and Knuckles region (Manamendra-Arachchi and Liyanage, 1994, Das and De Silva, 2005, Amarasinghe *et al.*, 2011). This species is known to inhabit open shrub and grassland areas of montane forests (Karunarathna *et al.*, 2011). The males and females of *C. nigrilabris* show sexual dimorphism, which also results in morphometric differences. This species can be distinguished from other *Calotes* of Sri Lanka using several characteristics such as backward or downward directed lateral body scales, a row of continuous spines above the tympanum and dorsal scales being smaller than the ventral scales (Somaweera and Somaweera, 2009). The general body coloration is green and usually

darker than that of other *Calotes*. Black-edged transverse bars or spots can be seen on greenish body. Underside of the head is greenish-white (Karunarathna *et al.*, 2011). Males have broad black bands on the upper lips and cheeks which extend to the posterior part of the head; females with whitish/yellowish lip areas (Somaweera and Somaweera, 2009). Other morphological characteristics include poorly developed gular sac with keeled scales, moderately developed nuchal and dorsal crests with continuous 17-27 lanceolate spines which gradually diminish in size. Tail tips brown or dark-olive colored (Amarasinghe *et al.*, 2011).

MATERIALS AND METHODS

Lizards were captured while walking along three 200m fixed length line transects and morphometric measurements were obtained. Head length (HL), head width (HW), snout vent length (SVL), tail base width (TBW) and tail length (TL) were measured using venire calipers and wet weight was measured using a weighing scale. Cheek coloration and other color patterns related to maturity stage were also recorded. "Hemipenial popping" method was used to identify gender when required (Stebbins, 2003). Lizards were released back to their natural habitat after taking the measurements within a short period of time. PCA analysis was performed on the collected morphometric data. Other descriptive analysis were also performed using "Minitb 14"™ statistical software.

RESULTS

Maturity stage categorization based on Principal Components Analysis

According to the results of Principal Components Analysis (PCA), the external measurements of *C. nigrilabris* showed five different clusters (Figure 1). This result was used to separate them into five maturity stages; adult male, adult female, sub-adult male, sub-adult female and juvenile. Additional information gathered during the study was used for further clarification of these categories.

According to the Eigen analysis, first PCA axis accounts for 91.3% of the variance. First four axes together represent 99% of the variance. Axis 1 accounts for a high percentage of 91% variance. (Table 1)

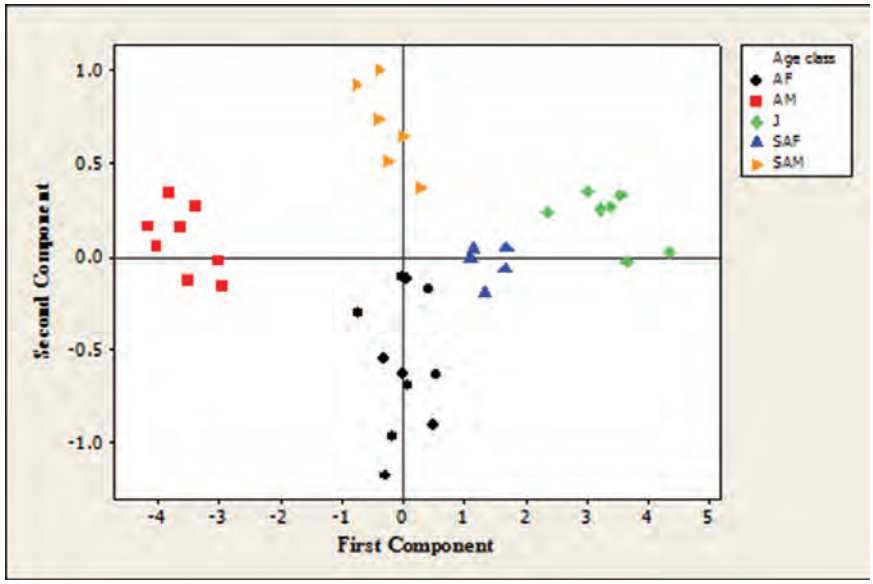

FIGURE 1: Scatter plot using principal component analysis (PCA) showing five maturity stage clusters. F- Adult female, M – Adult male, J – Juvenile, SAF – Sub-adult female, SAM – Sub-adult male

TABLE 1: Eigen analysis of the Correlation Matrix

	Axis 1	**Axis 2**	**Axis 3**	**Axis4**	**Axis 5**	**Axis 6**
Eigen value	5.4810	0.2419	0.1475	0.0706	0.0392	0.0198
Proportion	0.913	0.040	0.025	0.012	0.007	0.003
Cumulative	0.913	0.954	0.978	0.990	0.997	1.000

The first principal component (PC1) was negatively correlated with all the variables and none of the variables had a strong correlation. However, since all the variables had negative values, they vary together. Hence, if one of the variables increases all other variables also increase. Their contribution for PC1 was very much similar indicating that PC1 is a combination of all the morphometric variables. Furthermore, Snout Vent Length (SVL) had the highest score for PC1. PC2 showed a strong positive correlation with Head width (HW) and PC3 with Head Length (HL). PC4 correlated positively with SVL and negatively with HW (Table 3.2)

Average morphometric measurement values for different maturity stages of C. nigrilabris

Morphometric measurements varied between the five age classes. Males (Plate 1) were larger in both adult and sub adult classes. *C. nigrilabris* adult males were relatively larger than adult females in all morphometric parameters considered. SVL of males ranged from (93.8 -106.0) mm. For females it was (73.9-78.8) mm. Sub-adults males and females were also differed in SVL length [sub-adult male – (76.2-83.0) mm, sub-adult females – (65.0-69.8) mm]. Juveniles were very small with an SVL between (35.5-57.8) mm and did not show any external characteristics to determine gender. (Table 3)

Since SVL had the highest PC1 value, it can be used as a base for this maturity stage categorization; SVL of Adult Male > 90 mm (Figure 2), Adult Female 70-80 mm (Figure 3), Sub-adult Male 75-85 mm (Figure 4), Sub-adult Female 60-70 mm (Figure 5), Juveniles < 60 mm (Figure 6).

TABLE 2: Factor loadings on the first four principal component (PC) axes on the six morphometric measurement variables used to distinguish age class

Variable	**PC1**	**PC2**	**PC3**	**PC4**
SVL	-0.422	-0.019	-0.473	0.532
HL	-0.407	0.247	**0.639**	0.344
HW	-0.395	**0.705**	-0.084	**-0.531**
Tail	-0.408	-0.413	0.455	-0.060
TBW	-0.414	0.018	-0.355	0.204
Weight	-0.406	-0.520	-0.166	-0.521

TABLE 3: Average morphometric measurement values for different age classes of *C. nigrilabris*

	Adult male	Adult female	Sub-adult male	Sub-adult female	Juvenile
Measurements	**mean ± S.D**	**mean ± S.D**	**mean ± S.D**	**mean ± S.D**	**mean ± S.D**
SVL (mm)	97.48 ± 3.86	75.57 ± 1.50	79.92 ± 2.69	67.56 ± 2.36	43.52 ± 7.22
HW (mm)	22.24 ± 1.33	14.44 ± 1.19	18.37 ± 1.52	13.48 ± 0.30	11.58 ± 1.05
TBW (mm)	28.19 ± 1.33	7.43 ± 0.42	8.03 ± 0.41	5.88 ± 0.30	3.09 ± 0.55
Tail (mm)	283.63 ±13.32	207.73 ± 28.75	180.13 ± 10.44	147.00 ± 13.51	114.16± 21.68
Weight (g)	11.18 ± 0.96	17.09 ± 2.73	11.67 ± 0.61	10.40 ± 0.74	2.21 ± 0.49

FIGURE 2: *C. nigrilabris* adult male

FIGURE 3: *C. nigrilabris* adult female

FIGURE 4: *C. nigrilabris* sub-adult male

FIGURE 5: *C. nigrilabris* sub-adult female

FIGURE 6: *C. nigrilabris* juvenile

Percentages of different maturity stages

A total of 303 individual lizards were encountered throughout the study. Maturity stage "adult female" was the highest accounting for 36% of total individuals. Adult males were 34%. When sub-adult males and females were considered under a single group named "sub-adults", their percentage was 16%. Juvenile percentage was the lowest with a value of 14%. Sub-adults and juveniles together made up 30% of the total individuals and it was little less than half the total adult percentage. (Figure 7)

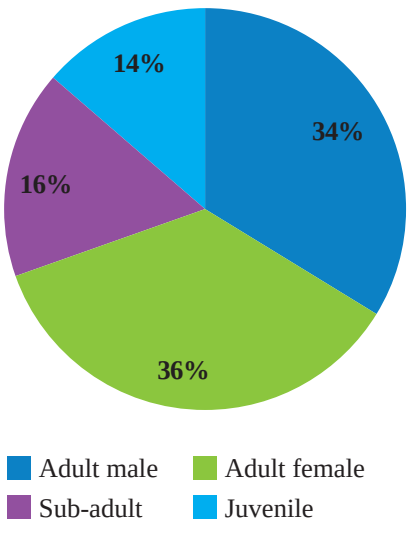

FIGURE 7: Chart showing the percentages of different maturity stages

DISCUSSION

C. nigrilabris is an agamid species that shows sexual dimorphism. Secondary sexual characteristics could be used to determine the gender of lizards together with other methods like "hemipenial popping" method (Stebbins, 2003). However, in this study the external measurements of *C. nigrilabris* showed five discrete clusters in PCA analysis. This result was used to separate them into five maturity stages; adult male, adult female, sub-adult male, sub-adult female and juvenile, considering the gender and maturity. In a previous study by Karunaratne and Amarasinghe (2013), another lizard species named *Lyriocephalus scutatus* has been categorized into three maturity stages and they had used gender for further categorization. However, this is the first time where five discrete maturity stages were recorded based on morphometric measurements for an agamid in Sri Lanka.

Presence of five discrete maturity stages can be attributed to sexual dimorphism *C. nigrilabris* shows. Adult males were larger in all the parameters considered. There was a morphometric difference between sub-adult female and male individuals as well. This morphomeric difference may assist them to utilize a wide range of resources to help their survival during different maturity stages. Therefore, this maturity stage categorization will be helpful for the conservation ecology and management of this species. Maturity stage structure of *C. nigrilabris* shows that total

juvenile and sub-adult percentage was little less than half the adult population. This indicates that there should be two prominent breeding seasons to make up this maturity stage structure. Furthermore, results of the present study indicate that morphometric data can be used as a successful tool for the categorization of maturity stage of this agamid species.

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