Microhabitat Utilisation of Endemic Lizard Calotes nigrilabris in the Grasslands of Horton Plains National Park, Sri Lanka

Article · May 2019

DOI: 10.31357/jtfe.v9i1.3952

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DOI: https://doi.org/10.31357/jtfe.v9i1.3952

Microhabitat Utilisation of Endemic Lizard *Calotes nigrilabris* in the Grasslands of Horton Plains National Park, Sri Lanka

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Date Received: 20-02-2019 Date Accepted: 16-05-2019

Abstract

The endemic endangered agamid lizard *Calotes nigrilabris* inhabits the grasslands of Horton Plains National Park (HPNP) and it is restricted to a few localities in the central highlands of Sri Lanka. In this study, the microhabitat utilisation of *Calotes nigrilabris* was investigated utilising line transects and quadrate method. The comparison of available microhabitat variables with occupied microhabitat variables revealed that there was a significant difference between some of the variables (Man-Whiteney U test, $p<0.05$) indicating that *C. nigrilabris* was selective in its microhabitat utilisation. Based on PCA analysis, amount and type of vegetation was the main determining factor of microhabitat preference of this species. *Ulex* sp. cover (PC1, 0.606) and *Rhododendron* sp. cover (PC2,-0.603) were significantly affecting the occupied microhabitat structure. Microhabitat utilisation varied in the temporal and spatial scales also indicating clear resource partitioning between different maturity stages. The results of this study indicate that *C. nigrilabris* actively selects and utilises the most suitable grassland microhabitats of HPNP and provide important insights for the conservation and management of the species as well as its natural habitat.

Keywords: Black-cheeked lizard, grassland habitat, resource partitioning, Agamidae, Ulex europaeus

1. Introduction

A habitat can be defined as the sum of the specific resources that are needed by organisms (Thomas, 1979) which include food, cover, water and special factors needed by a species for survival and reproductive success (Leopold, 1933). Macrohabitat and microhabitat are two relatable terms which depend on the scale of landscape and relate more to a specific animal being studied rather than to a type of habitat (Krausman, 1999). According to Johnson (1980) microhabitat usually refers to finer scaled habitat features which are at the lower levels of the hierarchical structure of habitats. Since lizards are ectothermal animals, they tend to depend highly on smaller microhabitats for thermoregulation. However microhabitat selection may also depend on morphology and behavioral preferences of the animal (Adolph, 1990). According to Arnold (1983) force of natural selection on specific aspects of morphology, physiology and behaviour lead to differences in functional capabilities, which, in turn, are adaptive for the differing demands of different environments (Schulte et al., 2004). Therefore, animal populations develop certain traits which increase their fitness in the given habitat (Arnold, 1983) which is also reflected in microhabitat utilisation (Adolph, 1990). The term microhabitat utilisation can be defined as the practical and effective use of the available microhabitats by a species. Thus, understanding the microhabitat requirements and the utilisation of those microhabitats by a species requires considering different life history strategies, morphometry, behavioural characteristics as well as environmental parameters (Krausman, 1999).

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ISSN 2235-9370 Print/ISSN 2235-9362 Online

Horton Plains National Park is home for three of Sri Lanka's agamid lizards, all of which are endemic to the island. Critically endangered (CR) *Cophotis ceylanica* and endangered (EN) *Ceratophora stoddarti* occur in its montane cloud forests (De Silva, 2007). The association of endangered *C. nigrilabris* with the grasslands of HPNP and surrounding areas has long been observed (Manamendra-Arachchi and Liyanage, 1994; Bahir and Surasinghe, 2005; De Silva, 2007; Somaweera and Somaweera, 2009; Amarasinghe et al., 2011; Somaweera et al., 2012). *C. nigrilabris* is usually considered a diurnal sub-arboreal species (Das and De Silva, 2005) that prefer low shrubs and ferns. This species is restricted to montane forests above 1300 m elevation (Erdelen, 1984) and it is the only agamid species to occur in the tropical high altitude grasslands of the island (Bahir and Surasinghe, 2005). Even though some qualitative information regarding the habitat utilization of *C. nigrilabris* is available in the published literature (De Silva, 2007; Somaweera and Somaweera, 2009; Amarasinghe et al., 2011) no quantitative studies have been done, especially regarding the microhabitat utilisation, except for the study conducted by Somaweera et al. (2012) to find the effect of *Ulex europaeus* on habitat selection of *C. nigrilbris*. In this research we focused on the ecological aspects of *C. nigrilabris* with reference to microhabitat utilisation to provide relevant information to bridge the gaps in data availability to help the conservation and management. Therefore, the objectives of this study were to identify the microhabitat requirements, microhabitat preferences and utilisation of those microhabitats by this species.

2. Methodology

2.1 Study site

We conducted the study for a period of one year from January to December 2016 in Horton Plains National Park. It is located on the southern plateau of the central highlands of tropical island Sri Lanka (6°47'-6*50'N, 80°46'-80°50'E) (Green, 1990; DWC, 2007). This is a unique national park in Sri Lanka with discrete weather patterns and climatic conditions which harbors a large number of flora and fauna with a high percentage of endemism (Pethiyagoda, 2012).

2.2 Grassland Habitat

We conducted sampling in the grassland (wet patana) habitat which makes up an area of 776 ha (25.8%) of HPNP. Grasses generally known as 'tussock grass" (*Chrysopogon nodulibarbis*, *Andropogon polyptychos* and *Garnotiaex aristata*) are the more dominant plants in this habitat (DWC, 2007). **"**Maha ratmal" (*Rhododendron arboreum)* and "european gorse" (*Ulexe uropaeus)* are commonly found scattered throughout these grasslands. Invasive *Ulex europaeus* sometimes grows as impenetrable stands threatening the native flora. Abandoned potato terraces have been colonized by carpet grass (*Axonopus fissifolius)* which gives the appearance of a lawn (DWC, 2007).

2.3 Sampling

We carried out our sampling work utilising visual encounter surveys (Doan, 2003) along 200 m line-transects (Garcia, 2008) in the grassland habitat. We recorded only the lizards we could observe within 2 m on either side of transect and up to a height of 4 m to reduce any possible bias caused by the variation in visibility. The maturity stage of each lizard (adult male, adult female, sub-adult male, sub-adult female and juvenile) was also determined based on morphometrics (mainly relative estimation of SVL) (Jayasekara et al., 2017) and secondary sexual characteristics when needed. We considered both sub-adult male and sub-adult female under one category called "sub-adult" in the data analysis.

Transect surveys were carried out by two people one day per month (for a period of one year) from 08.00 h to 17.00 h in three time periods; morning (08:00 h-11:00 h), midday (11:00 h-14.00 h) and evening (14:00 h-17:00 h), with a sampling effort of 216 person-hours and a total of 108 transects. We did observations by walking along transects at a very low speed (3-4 m/min) in order to carefully observe both sides of transect without disturbing the natural behavior of lizards (Chandramouli, 2009).

2.4 Microhabitat availability

Microhabitat availability was measured by putting five 1x1 m quadrates randomly along each transect using a random number table (Díaz et al. 2006). At each quadrate we recorded percentage cover of each plant species, rocks, leaf litter and bare soil. Ambient temperature and relative humidity at chest height (Blair, 2009) were measured using Kestrel 4,000 pocket weather meter, USA.

We also measured soil characteristics like soil penetration (using soil penetrometer-Land penetrometer INC.), soil pH and moisture content (using soil pH meter [Kelway soil acidity (pH) and moisture tester]). A metal ruler was used to measure the leaf litter depth. We recorded the percentage cover of each plant species, rocks, leaf litter and bare soil within each quadrate. In occasions where lizards were occupying random quadrates, we considered them as occupied quadrates and did not consider them under available microhabitats. A total of 320 unoccupied quadrates were sampled during the study period.

2.5 Microhabitat use of C. nigrilabris

We broadly classified the perch types where we sighted *C. nigrilabris* as ground, leaf litter, shrub, tree trunk, tree-branch and tree-leaf. We recorded the perch type where we first sighted each *C. nigrilabris*. To study the preferred microhabitat 1x1 m quadrates were put along each transect having the point of each lizard sighting as the center. A number of different parameters at the center of each occupied quadrate were recorded as follows.

We categorised and recorded perch light to lizard's location as full sun light (75% or greater sunlight) filtered sun light (25% to 75% sunlight) and shade (less than 25% sunlight) (Angert et al., 2002). Photo analysis was assisted in determining the light percentage. Perching plant species of lizards were identified and the percentage cover of each plant species within the quadrate was determined by visual estimation. We recorded percentage cover of each plant species, rocks, leaf litter and bare soil, ambient temperature, relative humidity, soil penetration, soil pH and moisture content, leaf litter depth, percentage cover of rocks, leaf litter and bare soil within each quadrate were also measured. A total of 303 occupied quadrates were sampled.

2.6 Data analysis

Minitab version 17 statistical software package and Microsoft Excel were used for statistical analysis and graphical representation of results. Principal components analysis (PCA) together with Eigen analysis was performed to find out important microhabitat variables of occupied quadrates. Non parametric Mann-Whitney U-test at significance level (p=0.05) was conducted to compare the microhabitat variables between occupied and unoccupied quadrates of *C. nigrilabris.* Sample data were checked for normality and other assumptions of parametric tests when required. One way ANOVA (Analysis of Variance) was used to examine variations in perch height between different age classes of *C. nigrilabris.* Non parametric Kruskal-Wallis test was performed when assumptions for parametric tests were not met. Kruskal-Wallis analysis was used to examine significant differences in perch plant preference.

3. Results

3.1 Microhabitat preference of C. nigrilabris

Characteristics of microhabitats occupied by *C. nigrilabris* were different from the available random unoccupied quadrate characteristics. Variables that significantly differed include; *Ulex* sp. cover, *Rhododendron* sp. cover, Tussock grass cover, fern (*Pteridium* sp.*)* cover, other plant cover, bare soil percentage, temperature (ambient), relative humidity and soil moisture percentage. Therefore, those variables correlated with microhabitat occupancy of *C. nigrilabris* (Table 1).

Table 1: Characteristics of available habitat variables vs. occupied microhabitats (Mean±SD).

Variable	Random unoccupied quadrate (n=320)	Occupied quadrate (n=303)	Mann-Whitney U-test *p* value
Ulex sp. cover (%)	12.77±13.00	28.58±32.19	**0.0001***
Rhododendron sp. cover (%)	13.58±20.41	25.59±30.23	**0.0001***
Tussock grass cover (%)	28.41±17.25	14.109±14.91	**0.0001***
Fern(*Pteridium sp.)* cover (%)	8.75±13.01	12.112±14.66	**0.0000***
Dwarf bamboo cover (%)	3.45±7.48	3.564±9.81	0.0787
Other plant cover (%)	14.75±11.58	7.574±7.67	**0.0001***
Cover of rocks (%)	1.606±3.40	1.436±3.66	0.0644
Bare soil (%)	6.33±6.12	7.079±15.57	**0.0000***
Leaf Litter depth (cm)	4.403±2.41	4.607±5.55	0.0711
Leaf Litter cover (%)	11.53±8.31	11.271±10.39	0.2172
Temperature (ambient)	23.823±4.27	21.445±3.75	**0.0000***
Relative Humidity (%)	76.60±11.79	73.002±14.37	**0.0133***
Soil penetration (MPa)	11.71±2.32	12.041±2.61	0.3644
Soil pH	6.73±0.07	6.7282±0.07	0.4097
Soil moisture (%)	10.97±7.81	14.439±5.35	**0.0001***

Significantly different variables marked with "" and in bold.

First five axes of the PCA analysis of microhabitat variables which were significantly different from available habitat characteristics accounted for 75.3% of the total variance according to the Eigen analysis of the Correlation Matrix. The first principal component (PC1) correlated positively with *Ulex* sp. (PC1, 0.606**)** cover having the highest impact on PC1. It correlated negatively with Tussock cover. Hence an increase in *Ulex* sp. cover will lead to a decrease in Tussock cover. The second component (PC2) gave high scores to sites with high values of *Rhododendron* sp. cover (PC2, -0.603). PC3 correlated negatively with *Rhododendron* sp. (PC3, -0.513) cover and positively with bare soil cover (PC3, 0.577). Soil moisture percentage, other plant cover and relative humidity were significant respectively in PC4 and PC5. The overall PCA result indicated that availability of different plant species (vegetation) is important in deciding the preferred microhabitat of *C. nigrilabris* (Table 2).

Table 2: Factor loadings for the first five principal component (PC) axes of occupied microhabitat variables.

Variable	PC1	PC2	PC3	PC4	PC5
(OQ) *Ulex sp.* cover	**0.606**	0.379	0.163	-0.073	0.029
(OQ)*Rhododendron sp.* cover	-0.097	**-0.603**	**-0.513**	0.032	0.074
(OQ) Tussock cover	**-0.51**	0.325	-0.062	0.043	-0.282
(OQ)Fern (*Pteridium sp.)* cover	-0.472	0.414	0.004	-0.113	-0.039
(OQ) Other plant cover	-0.342	-0.033	0.265	0.128	**0.615**
(OQ) Bare soil	-0.017	-0.251	**0.577**	0.131	-0.153
(OQ) Temperature (a)	-0.105	-0.247	0.473	-0.143	0.27
(OQ) Soil moisture	0.003	-0.044	0.109	**0.872**	-0.291
(OQ)Relative Humidity	0.108	0.296	-0.261	0.405	**0.595**

*Significant variables of each axis are in bold.

3.2 Microhabitat variables in occupied quadrates

C. nigrilabris preferred microhabitats with high percentages of larger grassland plant species like *Ulex* sp. (28.58±32.19)% and *Rhododendron* sp. (25.59±30.23)%. The percentages of Tussock grass (14.11±14.9)% and other plants (7.57±7.67)% were relatively low in occupied microhabitats of *C. nigrilabris* when compared to random sites. Average percentage of Fern (*Pteridium* sp.*)* cover was 12.11±14.66%. Average ambient temperature and substrate temperatures of the preferred microhabitats were (21.45±3.75)^{o} C and (20.22±4.00)^{o} C respectively. Bare soil percentage cover (7.08±15.57)% and soil moisture percentage (14.44±5.35)% recorded high average values. Average value for relative humidity was (73.00±14.37)% within microhabitats (Table 3).

Table 3: Microhabitat variables in occupied quadrates.

Variable	Mean±SD *n*=330	Minimum	Maximum
Ulex sp. cover (%)	28.58±32.19	0	60
Rhododendron sp. cover (%)	25.59±30.23	0	80
Tussock grass cover (%)	14.11±14.91	5	60
Fern (*Pteridium* sp.) cover (%)	12.11±14.66	0	40
Other plant cover (%)	7.57±7.67	5	40
Bare soil (%)	7.08±15.57	0	25
Ambient Temperature (ºC)	21.45±3.75	2	30.9
Substrate Temperature (ºC)	20.22±4.00	11	31.2
Relative Humidity	73.00±14.37	61	98.2
Soil moisture (%)	14.44±5.35	5	40

3.3 Perch type preference of C. nigrilabris

We observed the highest average percentage of individuals perching on branches (55.12±11.97)%. Second most preferred perch type of *C. nigrilabris* was leaves (35.84±14.23)%. Relatively low percentages of lizards were perching on shrubs (3.33±5.53)% and ground (5.49±8.3)%. Very low percentage of lizards (0.22±0.76)% used tree trunks for perching. (Figure 1A).

3.4 Preferred perch plant of different maturity stages

There was a significant difference in preferred perch plant within maturity stages of *C. nigrilabris* adult male, adult female, sub-adult and juvenile [Kruskal-Wallis, $p<0.05$]. Highest percentage of adult males was recorded perching on *Rhododendron sp.* (75.27±17.25) % (Figure 3A). Most preferred perch plant of adult females was *Ulex* sp. (70.88±14.29) % (Figure 3B). A high percentage of sub-adults were observed perching on *Ulex* sp. (35.05±30.72) % while their second most preferred plant species was *Rhododendron* sp. (Figure 3E). There was no significant difference in average percentage of juveniles observed in different plant species [Kruskal-Wallis, $p=0.071$, $p>0.05$]. However, juveniles most preferred *Rhododendron* sp. and fern–*Pteridium* sp. (Figure 1B).

3.5 Diurnal perch light preference

In the morning time period highest percentage (78.47%) of *C. nigrilabris* were perching in full sun light. Filtered sun light and shaded perches were used by 10.42% and 11.11% of lizards respectively in the morning. During mid day time period lizards used all three perch types in approximately equal amounts (31.88%, 30.43 % and 37.68 %). Most used perch light condition in the evening time period was shade (82.02 %). (Figure 2A).

3.6 Diurnal Perch height variation in maturity stages

Perch height varied significantly between different maturity stages of *C. nigrilabris* [ANOVA, $F=21.93$, $p<0.05$]. Average perch heights of adult males (103.60±63.48) cm and females (93.28±54.04) cm were significantly higher than sub-adults (67.40±42.07) cm and juveniles (26.03±36.58) cm. Average perch height juveniles was the lowest and it was significantly different from the average perch height of sub-adults and the two adult maturity stages. There was no significant difference in the observed average perch height in the three time periods (ANOVA, $p>0.05$). However, average perch height increased from morning to mid day. We observed a decrease in the average perch height in the evening time period in all four maturity stage categories (Figure 2b).

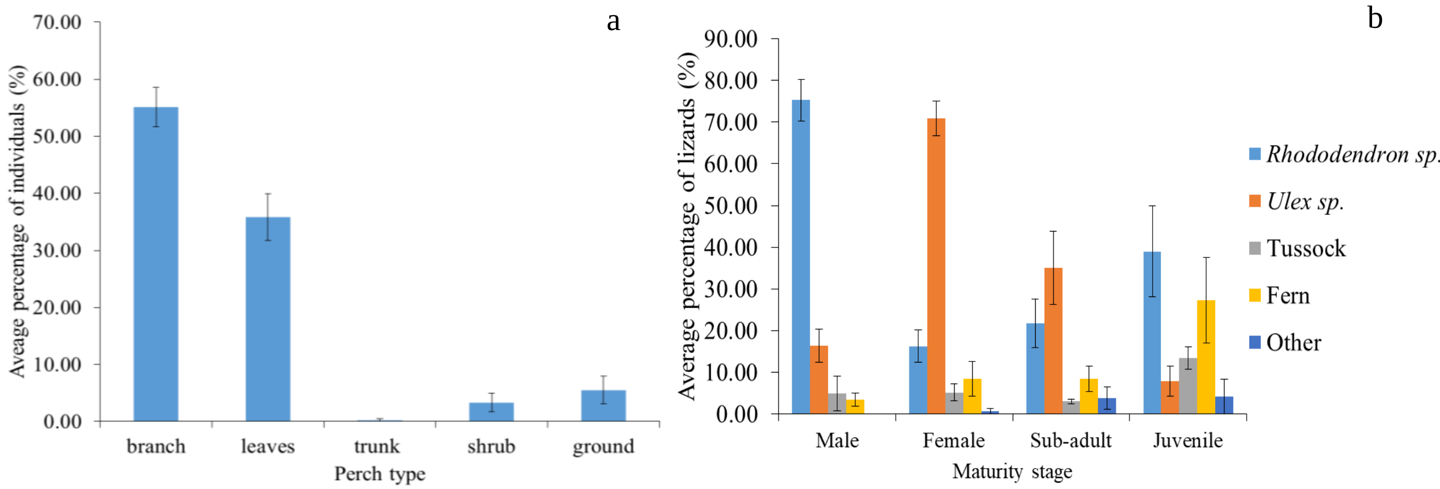

Figure 1: a-Perch type preference of *C. nigrilabris*; b-Perch plants of different maturity stages.

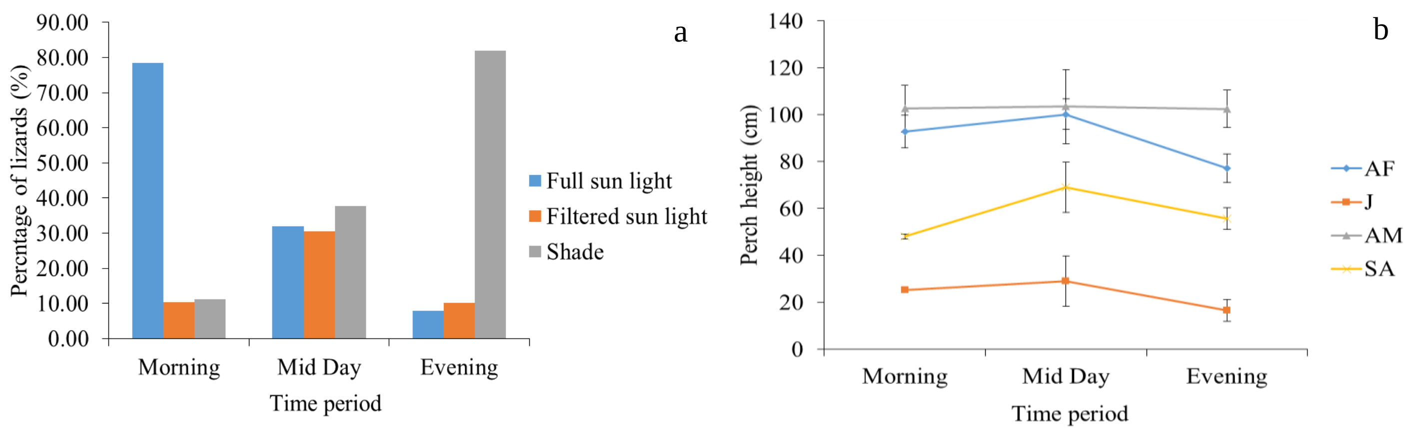

Figure 2: a-Diurnal perch light preference of *C. nigrilabris*; b-Diurnal Perch height variation of different maturity stages (AF-Adult female, J-Juvenile, AM-Adult male, SA-Sub-adult).

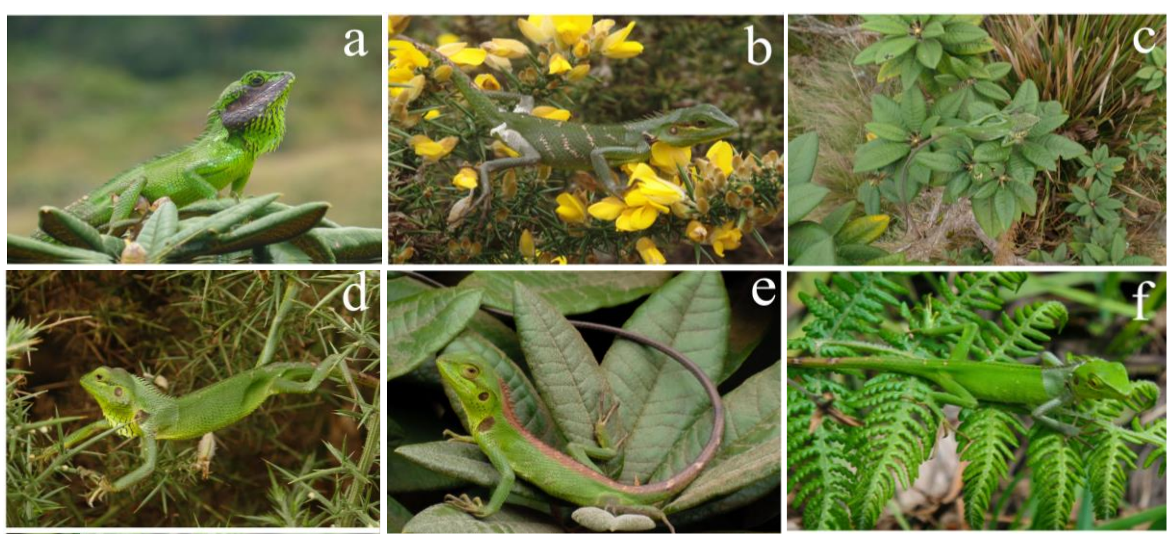

Figure 3: a=*C. nigrilabris* adult male; b=*C. nigrilabris* adult female preying near the flowers of *Ulex europeus;* c=Arial view of an adult male *C. nigrilabris* being camouflaged among the *Rhododendron* sp. Leaves; d=Acrobatic movement of female *C. nigrilabris* between thorny *Ulex* sp. Branches; e=A sub-adult female on the leaves of *Rhododendron* sp.; f-A juvenile on the leaves of fern (*Pteridium* sp.).

4. Discussion

C. nigrilabris was selective in its use of microhabitats. Most of the observed variables within occupied microhabitats of *C. nigrilabris* were significantly different from the variables that were available in random unoccupied sites. Therefore, variables such as *Ulex* sp. cover, *Rhododendron sp.* cover, Tussock grass cover, fern (*Pteridium* sp.*)* cover, other plant cover, bare soil percentage, temperature (ambient), relative humidity and soil moisture percentage were the determining factors of the microhabitat of *C. nigrilabris*. According to the PCA results, *Ulex* sp. cover, *Rhododendron* sp. cover, Tussock grass cover, and other plant cover were significantly affecting the microhabitat conditions. Therefore it can be concluded that available vegetation type directly affects the microhabitat utilisation of *C. nigrilabris*. High percentages of larger grassland plant species like *Ulex sp.* (28.58±32.19%) and *Rhododendron* sp. (25.59±30.23%) were present within the occupied microhabitats. Both of these plants were utilised by *C. nigrilabris* for a number of different behaviours. Lizards tend to bask on leaves or branches of these two plant species in the morning sun light. They perch near the flowers of either *Ulex* sp. or *Rhodhodendron* sp. to catch the prey that is attracted to the nectar of these flowers. They also used these plants for resting and sleeping. We observed courtship behaviour on *Rhodhodendron* sp. leaves which are broad and relatively rigid. Thorny *Ulex* sp. plant also provides good refuge from the possible predators of *C. nigrilabris*. Somaweera et al. (2012) also suggested this type of a relationship between *Ulex* sp. (European Gorse) and *C. nigrilabris*. These two plants are also the only species that grow several meters taller than the dominant grasses of the grassland habitat. PCA results indicate that increase in percentage cover of these two species leads to the decrease in the cover of tussock grasses within microhabitats. Hence, mean percentage cover of tussock grass (14.11±14.91%) and other plants (7.57±7.67%) were relatively low in occupied sites than random sites. Fern (*Pteridium* sp.*)* was another frequently occurring plant within preferred microhabitats but in rather low percentages (12.11±14.66%).

Ambient temperature and substrate temperatures of occupied microhabitats were significantly different from the random unoccupied. This result can be attributed to the thermoregulatory behaviour of *C. nigrilabris* and lizards as a whole. Since lizards are ectothermic animals, the environmental temperature has a high impact on their body temperature. Therefore, they tend to utilise microhabitats which provide them suitable temperature conditions. Hence, *C. nigrilabris* was selective in microhabitats with such conditions. Bare soil percentage cover (7.08±15.57%) and soil moisture percentage (14.44±5.35%) were another two variables that were significantly higher in occupied microhabitats. These two factors increased the presence of egg laying females providing suitable conditions for them, which in turn increased the number of individuals of other maturity like newly hatched juveniles and mate seeking adult males in the nearby microhabitats.

Dwarf bamboo cover, leaf litter depth, leaf litter cover, soil penetration and soil pH did not vary significantly between occupied microhabitats and unoccupied random sites. Therefore, we can consider those factors less important and not having a high impact on microhabitat selection and utilisation of *C. nigrilabris*. Furthermore, leaf litter amount was relatively low within the grassland habitat in general since not many woody plants were occurring. However, top soil layer was a thick humus layer within most of the grassland habitat which is considered slightly acidic as Person (1899) mentioned (Pethiyagoda, 2012) and results of the present study go in accordance with that.

From the available perch types within their microhabitat, *C. nigrilabris* mostly used plant leaves and branches for perching indicating that it is an arboreal species as Somaweera and Somaweera (2009) and Amarasinghe et al. (2011) described. A lower percentage of individuals were perching on tree trunks. This result may be related to the greenish body colour of this species which is easily camouflaged with leaves and leafy branches rather than darker tree trunks. They were also found on low shrubs and on the ground as well. We observed ground foraging during sunny mornings where they fed on small invertebrates. Therefore, *C. nigrilabris* can be considered as a sub-arboreal species in concordance with Karunarathna et al. (2011).

Since *C. nigrilabris* is largely arboreal and their microhabitat preference was highly determined by the vegetative cover. Therefore, it was interesting to study the perch plant preferences of this species. The most preferred perching plants of *C. nigrila*bris were *Rhododendron sp.* and *Ulex* sp. However there was a significant difference between preferred perch plant of different age classes. Adult males (Figure 3A) mostly preferred *Rhododendron* sp. whereas adult females preferred *Ulex* sp. (Figure 3B, D). We can attribute this result to the body colour difference between the two genders. Adult males with relatively darker green body colour were better adapted to utilize *Rhododendron sp.* which also has leaves with a darker shade of green. The triangular heads of matured males with black bands on the upper lips which easily merge with *Rhododendron* sp. leaves makes it difficult for the aerial predators to spot them. Sometimes even the dorsal scales of the head region were also occupied with blackish edges resembling the venation of leaf blades making them better camouflaged (Figure 3c).

In contrast adult females with relatively lighter body colour preferred *Ulex* sp. which has a similar shade of green. Thorny branches of *Ulex* sp. provide them protection while making up a rich microhabitat with high abundance of nectaring insect species as food sources. Relatively smaller bodied females were able to move around the *Ulex* sp. bushes with ease than larger bodied males further separating the two genders into these two plant species. However there were shifts in usual perching plants of these maturity stages in specific behaviours. We observed adult males preying for insects on *Ulex* sp. during periods with high insect densities around *Ulex* sp. flowers. During heavy ground frost conditions both males and females were resting and sleeping under the broad leaf blades of *Rhododendron* sp. In all courtship behaviours observed females moved on to *Rhododendron* sp. plants where males were perching. Sub-adults (Figure 3e) used both these plant types. However percentage of individuals that used *Ulex* sp. for perching was slightly higher. Juveniles mostly preferred young *Rhododendron* sp. plants that were close to the ground. Another important result was high percentage of juveniles that used to perch on leaves of fern-*Pteridium* sp. Juveniles which have the lightest shade of green among the five maturity stages were benefited by perching on these fern leaves (Figure 3f) which were also light green in colour during young stage.

Diurnal perch light preference of *C. nigrilabris* varied in different time periods of the day. To cope with the temporal variation in the thermal environment, lizards need precise thermoregulation strategies which involve flexible use of structural habitat (Porter et al., 1973; Adolph, 1990). According to Bennett (1980) many lizard species have a relatively narrow range of preferred body temperatures and it in turn corresponds to various physiological optima. Because of the spatial variation of thermal microclimates, thermal biology and habitat use are interrelated (Roughgarden et al., 1981; Waldschmidt, and Tracy, 1983; Grant and Dunham, 1988; Adolph 1990). During the morning time period *C. nigrilabris* spent most of the time in full sunlight which provide them required thermal energy for their activities. To maintain optimal body temperatures they were utilising more filtered sun light and shaded perches in the mid day and evening time periods.

There was a significant difference between average perch height of different age classes. Adult males were occupying the highest perches closely followed by adult females. Average perch heights of sub-adults and juveniles were significantly lower than adults. Juveniles were perching at the lowest level more close to the ground. This result indicates a clear resource partitioning between the four age classes. This behaviour would help them to utilise their microhabitat more effectively by sharing the resources between maturity stages. Even though average perch height of any of the age classes did not vary significantly in temporal scale, we could observe some variation in average perch height between the three time periods considered. Perch height gradually increased from morning to mid day to reach a peak height for each age class. This result indicates that *C. nigrilabris* start from lower sleeping perches to reach thermally suitable perches to help their activity. They used high perches for basking and feeding during morning and mid day time periods. In all maturity stages perch height gradually decreased from mid day to evening. A similar behaviour has been observed by De Silva (2007) and Somaweera and Somaweera (2009). This is because *C. nigrilabris* descend down to sleep in more thermally preferable lower shrubs and grasses during colder late evenings and nights.

5. Conclusions

C. nigrilabris in the grasslands of HPNP was actively selecting its microhabitats. We can conclude that *Ulex* sp., *Rhododendron* sp. and fern (*Pteridum* sp.) are the most important plants for the survival of this species in the grasslands habitat. However, it is not applicable to the areas outside the park where the habitat composition is different. Most importantly *Ulex* sp. and *Pteridium* sp. are considered as invasive species. Therefore, eradication programs (which are currently in operation) of these plant species should be re-evaluated to ensure that it would not negatively affect the survival of this grassland adapted endangered lizard. Furthermore, clear resource partitioning in microhabitat selection and microhabitat utilisation between different maturity stages of *C. nigrilabris* has allowed it to thrive in the grasslands and to be the only agamid to do so. Present study in the grasslands habitat of HPNP generated important data regarding the microhabitat utilisation of *C. nigrilabris*. This may aid in present and future conservation (in-situ and ex-situ) and management of this unique endangered endemic lizard species as well as the grassland habitat as a whole.

Acknowledgement

We acknowledge the generous corporation of the Horton Plains National Park staff, Department of Wildlife Conservation for granting permission (Permit no. WL/3/2/9/16) to conduct this research, University of Sri Jayewardenepura and Department of Zoology, for the facilities granted to conduct this research, IDEA WILD for providing us field instruments which were of great value during field excursions.

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