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Habitat preferences of the endemic shrub frog *Pseudophilautus regius* (Manamendra-Arachchi and Pethiyagoda 2005) at Mihintale Sanctuary, Sri Lanka

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***Abstract.*—Mihintalae is situated in the dry zone of the North Central Province of Sri Lanka, at an elevation of 108 m, and is an under studied site of the habitat of the endemic shrub frog *Pseudophilautus regius*. Six different habitat types which included forest edge, seasonal pond, rock, shrub, grassland, and home garden habitats were selected and systematically sampled to identify the habitat preference of *P. regius*. During the survey, a total of 143 *P. regius* individuals were counted. The highest percentage (53%) of individuals were recorded from the forest edge habitats, 23% from shrub land habitats, 20% from home gardens, and 2% from grassland and seasonal ponds. No individuals were found in the rocky areas. The number of observed individuals of *Pseudophilautus regius* increased with the rainfall in forest habitats and simultaneously decreased in the home gardens. During the dry season the overall turnout of the number of individuals increased in home gardens. However, more extensive and systematic studies, over a longer period of time, are required to estimate the population size and document the fluctuation of *P. regius* and implement suitable conservation measures, if necessary.**

Key words. *Pseudophilautus regius*, habitat preference, Sri Lanka, Mihintale Sanctuary

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Introduction

Sri Lanka is part of the Sri Lanka-Western Ghats biodiversity hotspot with a rich herpetofaunal assemblage (Meegaskumbura et al. 2002; Bossuyt et al. 2004; Meegaskumbura et al. 2009; De Silva 2009; Meegaskumbura and Manamendra-Arachchi 2011). A total of 112 amphibian species are known from Sri Lanka (De Silva et al 2005; Manamendra-Arachchi and Pethiyagoda 2005 and 2006; Meegaskumbura and Manamendra-Arachchi 2005; Meegaskumbura et al. 2010; Meegaskumbura and Manamendra-Arachchi 2011). Among the Sri Lankan amphibians, the most speciose family is the frog family Rhacophoridae. The Rhacophoridae consists of approximately 321 species within two subfamilies and distributed across a wide range of habitats in tropical Africa and south Asia, including India and Sri Lanka (Frost 2008; Li et al. 2008; Yu et al. 2008; Frost 2011). All the Sri Lankan rhacophorids belong to the subfamily Rhacophorinae that contains three genera *Pseudophilautus*, *Polypedates*, and *Taruga* (Manamendra-Arachchi and Pethiyagoda 2005; Meegaskumburaet al. 2010; AmphibiaWeb 2011; Meegaskumbura and Manamendra-Arachchi 2011), of which *Pseudophilautus* is the most diverse with 68 species (Manamendra-Arachchi and Pethiyagoda 2005; Meegaskumbura and Manamendra-Arachchi 2005; Meegaskumbura et al. 2009; Meegaskumbura and Manamendra-Arachchi 2011).

Amphibian diversity of Sri Lanka is directly influenced by climate, vegetation, topography, and geology, and its high rainfall and humidity provide ideal conditions for amphibians. The species richness of *Pseudophilautus* is greatest in the wet zone of Sri Lanka (Manamendra-Arachchi and Pethiyagoda 2005). The only two species of *Pseudophilautus* that have been reported hitherto from the dry zone of Sri Lanka are *P. fergusonianus* (Ahl 1927) and *P. regius* (Manamendra-Arachchi and Pethiyagoda 2005). *Pseudophilautus regius* is an endemic species listed as Data Deficient in the *2007 Red List of Threatened Fauna and Flora of Sri Lanka*. This species is distributed in localized patches of the dry zone (De Silva et al. 2004; Manamendra-Arachchi and Pethiyagoda 2005; Karunarathna and Amarasinghe 2007; Karunarathna et al. 2008; De Silva 2009) including the Mihinthale Sanctuary in the Anuradhapura District (Dissanayake et al. 2011).

Pseudophilautus regius becomes active during the northeast monsoon and inter-monsoonal period (Bahir et

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al. 2005). However, very little is known about its breeding biology (Dubois 2004; Bahiret al. 2005), with the only report being that after amplexus, the female digs a small hole where she lays her eggs and then covers them with soil (Karunarathne and Amarasinghe 2007). Virtually nothing is known about the population size, behavior, dispersal of non-breeding individuals, and habitat preferences of *P. regius*. This study was carried out to unravel the habitat preference of *P. regius* in the Mihintale Sanctuary.

Methods and materials

Study area

Mihintale Sanctuary is located near the town of Mihintale (Anuradhapura District, North Central Province) in the dry zone of Sri Lanka. Annual rainfall in the area of Mihinthale is approximately 1,000-1,500 mm, with most of it occurring during the inter-monsoonal (October and November) and the north-east monsoonal (December until February) periods. The mean annual air temperature is 26 °C with a minimum of 19.5 °C and a maximum of 35 °C. The Mihintale Sanctuary is approximately 2,470 acres (999.6 ha) in extent with no proper demarcated boundaries (Fig. 1).

Methods

The study was carried out from October 2010 to March 2011, with the exception of February 2011. Quadrat sampling (Heinen 1992) in randomly selected points was performed within the Mihintale Sanctuary. A total of twenty-four 10 × 10 m quadrats were sampled at selected points in each habitat type. The habitat types sampled were: Forest Edge (FEH; Fig. 3), Seasonal Pond (SPH; Fig. 4), Rocky Area (RAH; Fig. 9), Shrub Area (SAH), Grassland (GLH; Fig. 5), and Home Garden (HGH). Each habitat consisted of four fixed-quadrat sampling points. Field surveys were conducted from 1800 to 2200 hrs and each sampling site was visited twice a week. A minimum of four people were engaged in the sampling which involved sorting through all leaf litter and searching the branches, tree trunks, and logs within plots. Specimens were identified, photographed, and released at the site of capture. A structured data sheet was used to record data, including environment parameters such as air temperature and relative humidity (RH), which were recorded using a thermometer (-20-100 °C, ± 0.5 °C) and hygrometer (± 4% RH at + 77 °F within 10 to 90% RH ± 5% RH at all other range) respectively.

Results and discussion

A total of 143 individuals of *P. regius* (Fig. 2) were observed from six habitat types during the survey. The highest number was recorded from dry FEH (53%) (Fig. 3), followed by SAH (23%), HGH (20%), GLH (Fig. 5), and SPH (2%) (Fig. 4). No individuals were recorded from RAH during the survey period.

These results suggest that the most preferred habitats of *P. regius* are FEH, SAH, and HGH. Seasonal ponds provide good breeding sites for anurans (Conant and Collins 1991; Gibbs 2000), and according to Dissanayake et al. (2011) SPH had the highest percentage of amphibians recorded in the Mihinthale Sanctuary. However, we recorded few individuals in SPH. This could be because the habitat was surrounded by rocks with no moisture, no thick leaf litter layer (20 mm), or any significant canopy layer (over 70%). GLH was not covered with leaf litter and the area had a higher percentage of *Imperata cylindrica* and *Panicum maximum* grasses, which might be a reason for the low number of individuals recorded in this habitat type, yet more than SPH.

Most anurans are active during a confined period of time in the day or season (Peterson and Dorcas 1992). In many species, vocal advertisement represents the most energetically demanding behavior of males during the adult phase of the life cycle (Ryan 1983; Pough et al. 1992). Furthermore, the calls increase the probability of being exposed to predators. During the survey, most recordings of *P. regius* calling came from FEH and SAH. *Stachytarpheta indica*, *Ageratum conyzoide*, *Clidemia hirta*, *Pterospermum suberifolium*, *Lantana camara*, *Zizyphus oenopila*, *Leucaena leucocephala*, *Acacia leucophloea*, *Drypetes sepiaria, Bauhinia racemosa*, and *Bridelia retusa* were the abundant plant species in these two habitats. Average DBH in FEH was 16.26 cm, including trees with a DBH ≥ 120 cm like *Diospyrose ebenum* that, with small trees, provide a significant canopy layer (over 70%) and a thick leaf litter layer (20 mm). Therefore, FEH and SAH may provide the most preferred habitats for *P. regius*. The canopy cover (>70%) and a moist thick leaf litter layer (20 mm) are important to avoid desiccation and also to lay their direct developing eggs (Bahir et al. 2005; Karunarathne and Amarasinghe 2007). According to Menin et al. (2007) the contradictory relationship of anuran communities and the leaf litter layer can be related to different methods of quantifying litter characteristics such as volume, depth, and dry mass. On the other hand, relationships were found between the depth of leaf litter in many studies on anurans in forests of Costa Rica (Lieberman 1986), Central Amazonia (Tocher et al. 1997), Uganda (Vonesh 2001), and the Southeast region of Brazil (Van Sluys et al. 2007).

In the present study, analysis of rainfall patterns of the sampling locations revealed an increase in the number of observed individuals of *P. regius* immediately after rain in FEH and SAH. This study is in agreement with previous studies that seasonal variation of anuran populations is influenced by rainfall pattern (Das 1996; Weerawardhena et al. 2004). Our data indicates that during the rainy period (monsoon and inter-monsoonal), the number of

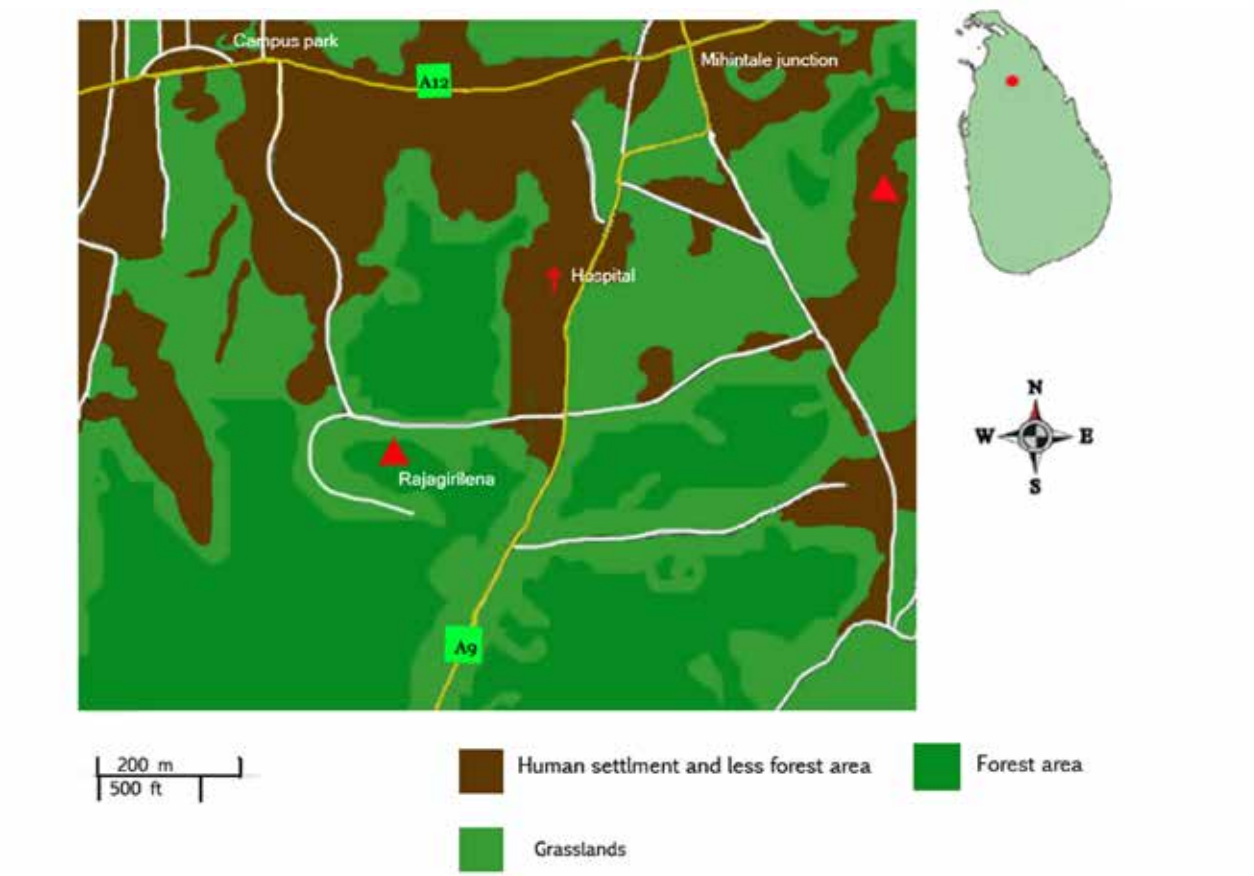

Figure 1. Map of study area.

Figure 2. *Pseudophilautus regius* (mature male).

Figure 3. View of Forest Edge Habitat (FEH).

Figure 4. View of Seasonal Pond Habitat (SPH).

Figure 5. View of Grassland Habitat (GLH).

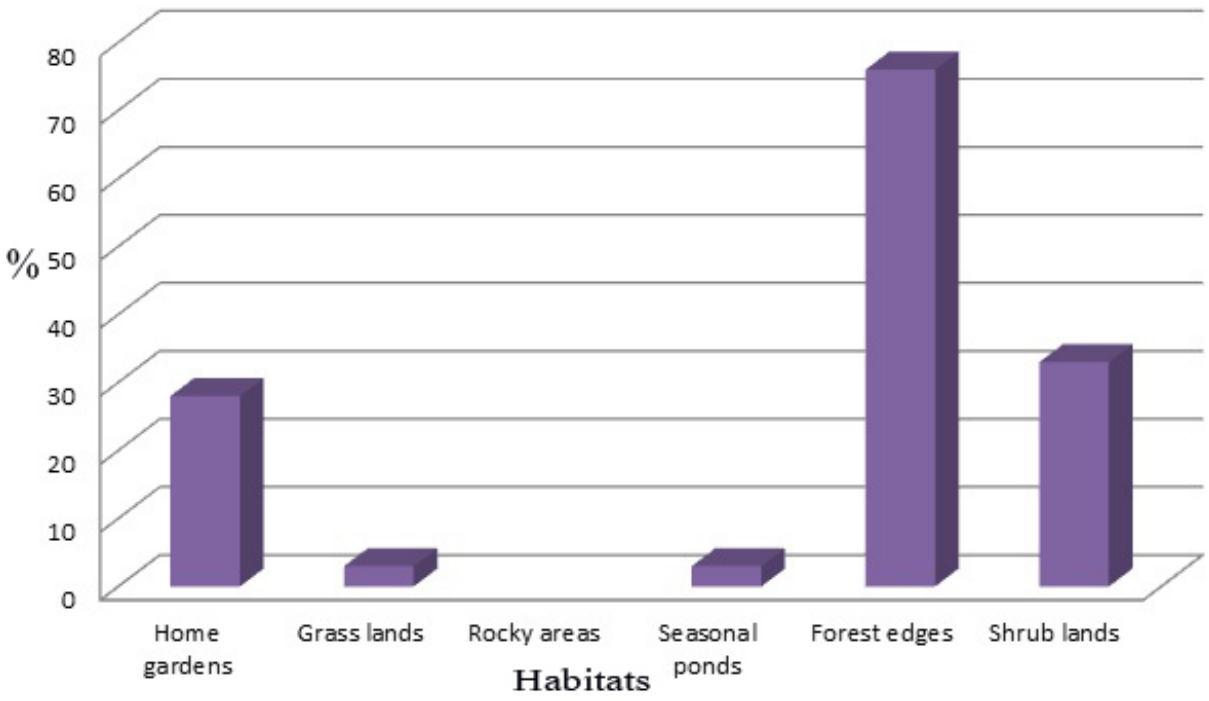

Figure 6. Comparison of the percentage of *Pseudophilautus regius* found in each habitat type.

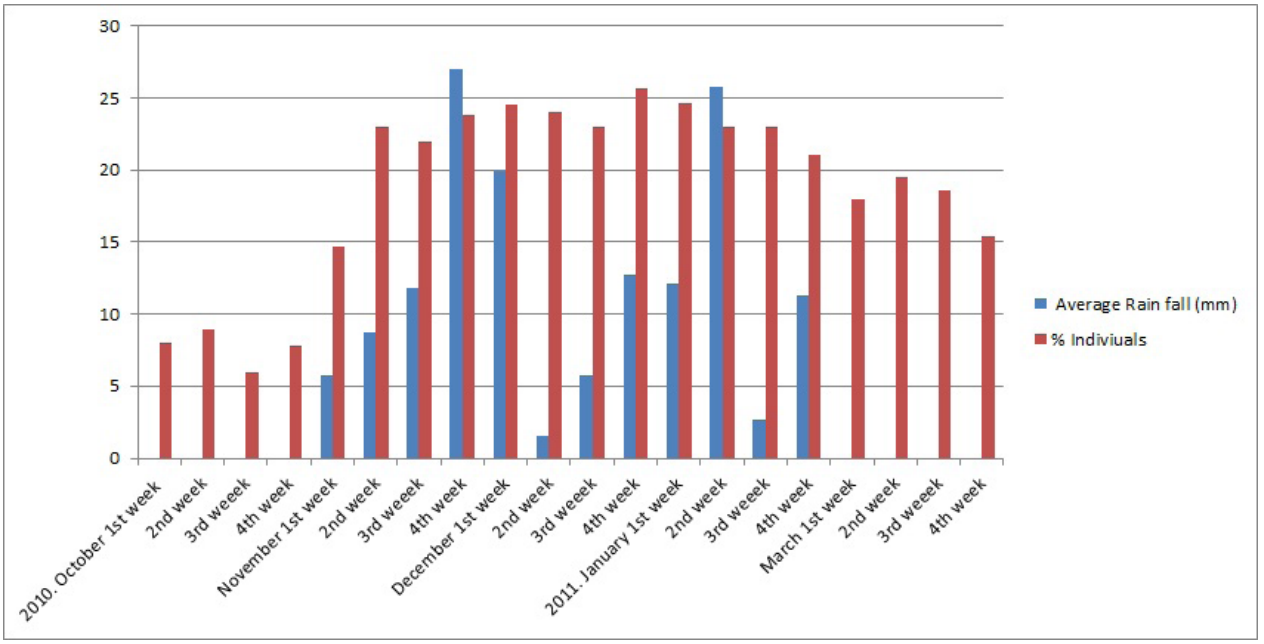

Figure 7. Average rainfall (mm) from October 2010 to March 2011 at the Mihintale Sanctuary, indicating Forest Edge Habitat (FEH).

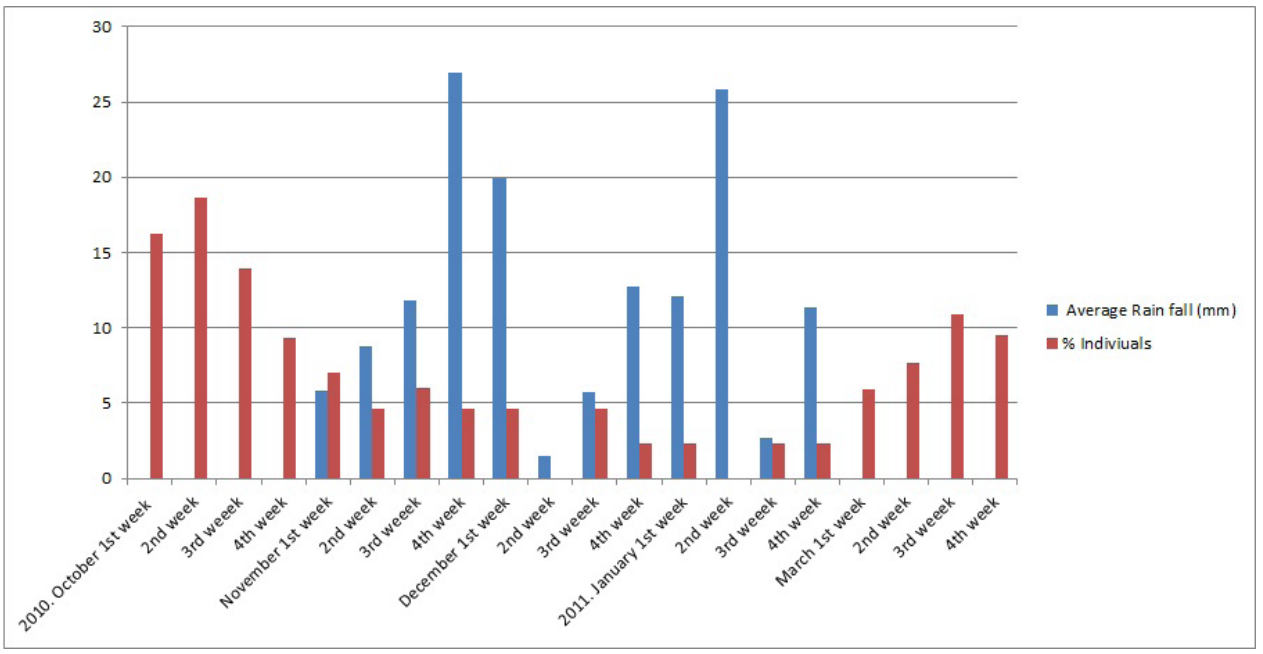

Figure 8. Average rainfall (mm) from October 2010 to March 2011 at the Mihintale Sanctuary, indicating Home Garden Habitat (HGH).

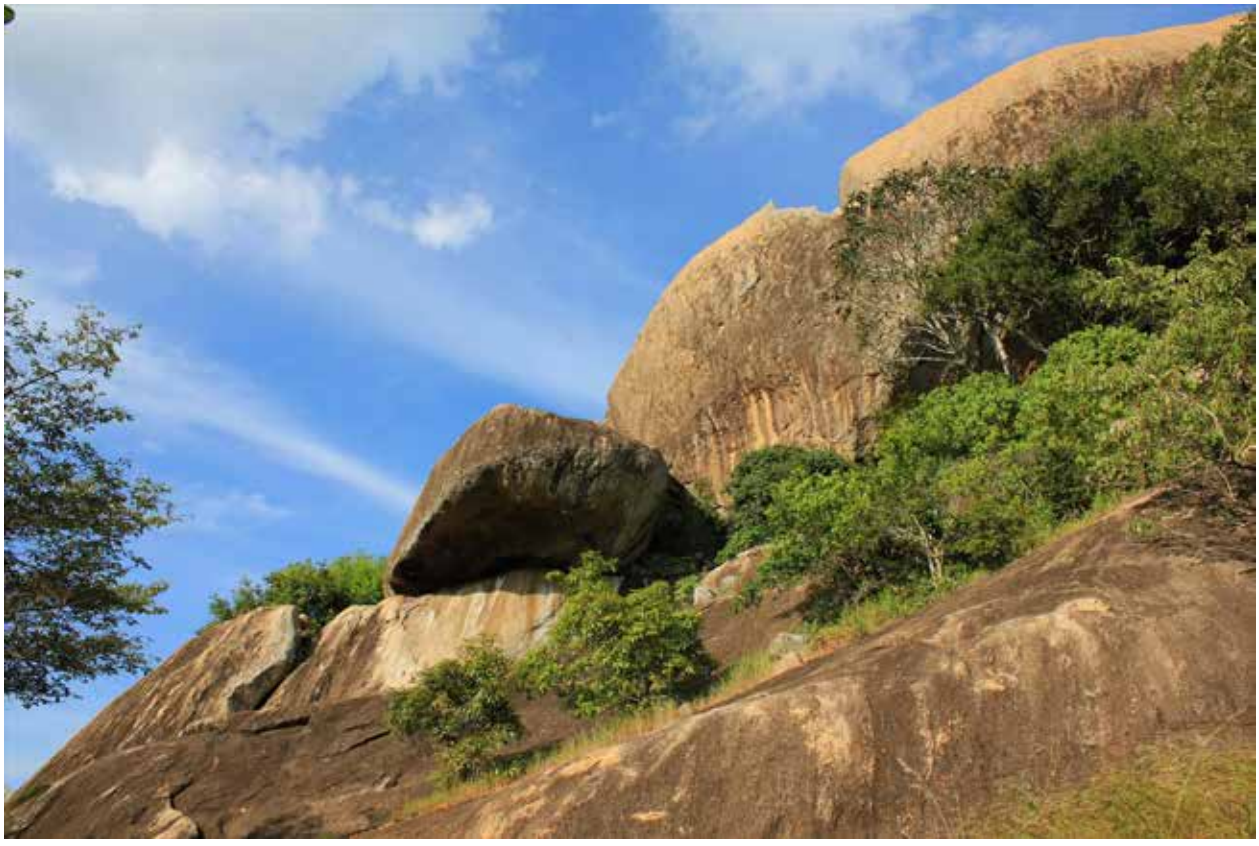

Figure 9. View of Rocky Area Habitat (RAH).

Figure 10. Inside forest: Dry mixed evergreen vegetation with good leaf litter.

individuals of *P. regius* increase in FEH (Fig. 7). However, our study was not conducted in February, although it rained in that month. This study is also in agreement with a study conducted in Madagascar where all amphibian species were edge-avoiders in the dry season but showed different patterns during the wet season (Lehtinen et al. 2003).

In the dry months (October and March) however, the percentage of the number of individuals of *P. regius* were higher in HGH than in the rainy season (November-January) (Fig. 8). This could be because HGH provide various human modified microhabitats that attract frog species like *P. regius*. A high number of individuals were observed near garden water taps and also near bathrooms. This may be because during the dry season forest litter and soil dry-up, although some moisture remains around water taps due to dispersal of water during usage or due to leakages. However, this observation does not indicate that *P. regius* is solely found in disturbed habitats, and could be because this study was conducted for a short time period. Further research conducted at least for a year could reveal possible relationships with relative humidity

Conclusions and recommendations

The habitat type most preferred by *P. regius* is Forest Edge Habitat (53%), whereas Rocky Area Habitat was not. The present study also demonstrates that Home Garden Habitat might provide suitable habitats during the dry season. Additional studies are needed using different sampling methods coupled with behavioral studies to determine the distribution of *P. regius* across the forest habitat and through home garden during the dry season. It was observed that villagers used Mihintale Sanctuary for daily activities including the forest edge for collecting firewood. Furthermore, some residents on the sanctuary boundary disturb the shrubs. These activities can have an adverse effect on the population of *P. regius*. We also saw garbage accumulation in the sanctuary (Fig. 11), which may affect the breeding grounds as it pollutes the forest floor. We strongly suggest that management authorities take necessary steps to minimize and mitigate these adverse impacts in order to conserve the habitat of this endemic shrub frog. Long-term monitoring programs should be conducted to estimate the population fluctuation and implement suitable conservation measures if necessary.

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Figure 11. Garbage accumulation in Mihintale Sanctuary.

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Figure 12. View of forest in Mihintale Sanctuary.

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