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A survey on the amphibians of Ambagamuwa, a tropical wet mid-land area in Sri Lanka

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Abstract. A survey to assess the amphibian diversity of Ambagamuwa area in the mid-hills of Sri Lanka was carried out from January-February 2003 and in August 2007. Five different habitat types including gardens, primary forests, secondary forests, paddy fields and tea plantations were systematically sampled and investigated for amphibians. The survey revealed a total of 19 amphibian species with eleven of them endemic to the island and nine of them listed in the 2007 IUCN red list of threatened species. Two new frog species of the genus *Philautus* were discovered in this area. The overall existence of a high number of threatened species and the possible existence of so far undiscovered species strikes the importance of an urgent conservation of this area.

Keywords. Amphibians, Ambagamuwa, Sri Lanka, species diversity, endemism, conservation.

Introduction

Sri Lanka is a humid tropical country blessed with a rather high diversity as well as density of amphibian species (Meegaskumbura et al., 2002). It is located in the Indian Ocean at the southern tip of India.

Currently, 105 valid species of amphibians are known from Sri Lanka and 84 out of them are endemic to Sri Lanka (Pethiyagoda et al., 2006; Fernanado et al., 2007; Megaskumbura et al., 2007) represented in two main orders: Anura and Gymnophiona. The order Gymnophiona is represented by the the family Icthyophiidae. The order Anura includes six families, namely the Bufonidae, Dicroglossidae, Microhylidae, Ranidae, Rhacophoridae and Nyctibatrachidae.

The lowland wet zone and the montane zone of Sri Lanka are considered to be an area with a high diversity and endemism of vertebrate species (Crusz, 1986) and also amphibian species (Pethiyagoda et al., 2006). But the mid hills of Sri Lanka was not considered because not many research work had been carried out there and also not much of the former natural habitat remains intact at present. The few remaining habitats have been poorly surveyed for vertebrates or even for amphibians and reptiles.

This study here was conducted in a so far poorly surveyed area in the southwestern slopes of the mid hills in Sri Lanka. The objective of the study was to record and to inventory the unknown herpetofauna of Ambagamuwa. Published results on the reptile diversity in that area strike the high species diversity and endemism of this area (Ukuwela and Nayana Pradeep Kumara, 2004). Here, we report the findings with respect to the amphibian diversity.

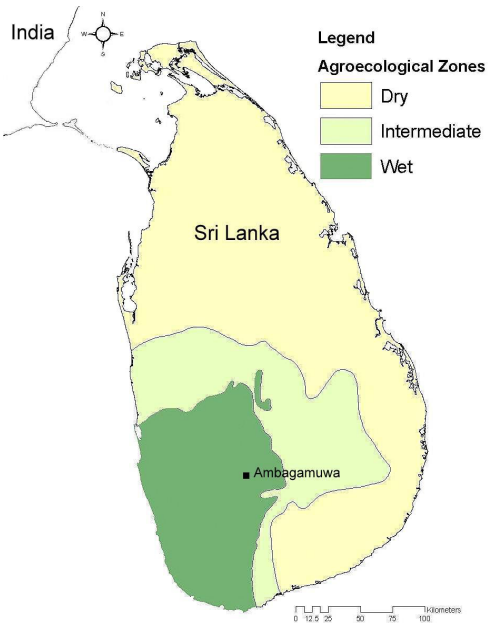

Figure 1. Location of the Study site.

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Table 1. Checklist, habitats and the number of the amphibians recorded in the survey.

Species	Habitat				
	Home gardens	**Paddy fields**	**Secondary Forest**	**Primary Forests**	**Tea Plantations**
Icthyophiidae					
Icthyophis glutinosus [E]	+ (01)	+ (02)	-	-	+ (01)
Bufonidae					
Adenomus kelaartii [E,T]	-	-	-	+ (03)	-
Duttaphrynus melanostictus	+ (13)	+ (17)	+ (03)	-	+ (03)
Microhylidae					
Ramanella obscura [E,T]	+ (04)	-	+ (02)	-	-
Nyctibatrachidae					
Lankanectes corrugata [E]	+ (05)	-	+ (06)	+ (18)	-
Dicroglossidae					
Euphlyctis cyanophlyctis	-	+ (16)	-	-	-
Fejervarya kirthisinghei [E]	+ (12)	-	+ (23)	+ (27)	+ (14)
Fejervarya limnocharis	+ (09)	+ (36)	+ (08)	-	+ (07)
Nannophrys ceylonensis [E,T]	-	-	-	+ (08)	-
Ranidae					
Hylarana aurantiaca [T]	+ (06)	+ (08)	+ (07)	-	-
Hylarana temporalis [T]	+ (07)	-	+ (21)	+ (26)	+ (11)
Rhacophoridae					
Philautus cavirostris [E,T]	+ (06)	-	+ (04)	-	-
Philautus popularis [E]	+ (16)	-	-	-	+ (03)
Philautus pleurotania [E,T]	+ (03)	-	+ (07)	+ (02)	-
Philautus reticulatus [E,T]	+ (4)	-	+ (04)	-	-
Philautus sp. 1	+ (06)	-	+ (05)	+ (03)	-
Philautus sp. 2	+ (05)	-	+ (07)	+ (02)	-
Polypedates cruciger [E]	+ (07)	-	+ (02)	-	+ (02)
Polypedates longinasus [E,T]	+ (07)	-	+ (03)	+ (02)	-
Total no. of species	**15**	**5**	**11**	**9**	**7**

[E] corresponds to endemic species, [T] corresponds to threatened species. Number of individuals recorded from each species are shown in brackets.

Materials and Methods

Study Area

Ambagamauwa is located in the midland wet zone of Sri Lanka in the Nuwaraeliya district. The elevation of the study area ranges between 610-840 m above sea level. Geologically, the area consists of highland series and a group of precambrian rocks with phodosolic soil being prominent.

The annual rainfall is between 4500-5000mm with 60% of the annual precipitation during the southwest monsoon. The mean annual temperature is about 20-25°C and the mean daytime relative humidity (RH) is around 90%. Ambagamuwa has a rich flora and belongs to the 'Foothills of Adams peak and Ambagamuwa' floristic zone of Sri Lanka (Gunathilake and Gunathilake, 1990).

Five different habitat types could be identified in the study area: gardens, paddyfields, tea plantations, secondary forests and primary forests. Gardens in this area are densely planted with cash crops and contained cool, shaded humid areas with a recognizable canopy cover. All the gardens surveyed had a thick moist leaf litter layer. Tea plantations were dominated by the main crop *Camellia sinensis*. A recognizable canopy was absent in this sampling site. Paddy fields in the area were seasonally planted with rice paddy (*Oryza sativa*) under flooded conditions. This site was bordered by a perennial stream and a canopy was absent. The secondary forest habitat consisted of a small patch of tropical midland wet evergreen rainforest in a mountainous area. The elevation of the site ranged from 620- 720m above m.s.l. This habitat was

placed close to human habitations and high amount of anthropogenic disturbance were observed. A small perennial stream flows through this site. The primary forest habitat in the site was a patch of undisturbed tropical midland wet evergreen rainforest.

Sampling Method

The study was carried out in January and February 2003 and in August 2007. Each study site was visited three times a month and data were collected from visual encounter surveys made from 0900 hours to 1600 hours in the daytime and 1800 hours to 2100 hours in the nighttime. Survey efforts consisted of two people moving slowly along randomly selected 50m long transects actively searching in different microhabitats. Six replicates were conducted for each habitat type. The specimens were captured, identified, measured, photographed and released at the original capture location. Identification of species was done with the help of description and character diagnosis following Manamendraarachchi and Pethiyagoda (2005) and Meegaskumbura and Manamendraarachchi (2005).

Results

A total of 19 amphibian species representing all of the seven recent amphibian families in Sri Lanka were recorded from the study site. Eleven of these species are endemic to the island. Nine species are considered threatened in the IUCN red list (IUCN Sri Lanka and MENR, 2007). The 19 species belonged to the following families: Icthyophiidae (1), Bufonidae (2), Dicroglossidae (4), Microhylidae (1), Nyctibatrachidae (1), Ranidae (2) and Rhacophoridae (8) (see Table 1.). Two species belonging to the genus *Philautus* could not be identified on the species level on the available literature record. We therefore conclude that they might represent new species.

The most abundant species recorded from the survey area were *Fejervarya kirthisinghei* (17.76%) (Figure 1), *Hylarana temporalis* (15.19%) (Figure 1) and *F. limnocharis* (14.02%). The least abundant species in the survey area was *Adenomus kellaartii* (0.7)%) and *Icthyophis glutinosus* (0.93%). Among the five study sites surveyed gardens contained the highest number of species 15 (78.95%) followed by secondary forests 11 (57.89%) and primary forests 9 (47.37%). The lowest diversity was observed in the paddy field habitats 5 (26.32%) followed by tea estates 7 (36.84%). The most dominant species in the garden habitats were *Philautus popularis* (14.41%) and *Duttaphrynus melanostictus* (11.71%). The paddyfield habitats were dominated by *F. limnocharis* (45.57%), *D. melanostictus* (21.52%) and *Euphlyctis cyanophlyctis* (20.25%). *F. kirthisinghei* (23.23%) and *H. temporalis* (21.21%) were the two most dominant species in the secondary forest habitats. The primary forest habitat was also dominated by *F. kirthisinghei* (29.67%) and *H. temporalis* (28.57%). Similarly the dominant species in the tea plantations were *F. kirthisinghei* (31.11%) and *D. melanostictus* (24.44%).

Discussion

The present survey revealed a high diversity of amphibians from the study area. The highest diversity was observed among the rhacophorids and particularly in the genus *Philautus*. Home garden habitats had the highest amphibian species diversity among the five habitats studied. The garden habitats in this region of Sri Lanka are documented to contain a rich diversity of herpetofauna (Somaweera and Ukuwela, 2004). Furthermore, two species that we assume new to science were also discovered highlighting the importance of conservation of these little known areas.

Diversity trends

High amphibian species diversity was observed in gardens and secondary forests during the survey. A similar trend was observed for reptiles in a previous study conducted in the same area (Ukuwela and Nayana Pradeep Kumara, 2004). This might be due to the fact that amphibians and reptile species are easier to observe in more simply structured environments compared to forest habitats. This trend has also been reported in many instances throughout the tropics (Dixo and Martins, 2008). It is very interesting to note that all of the *Philautus* species recorded in the survey are equally capable of

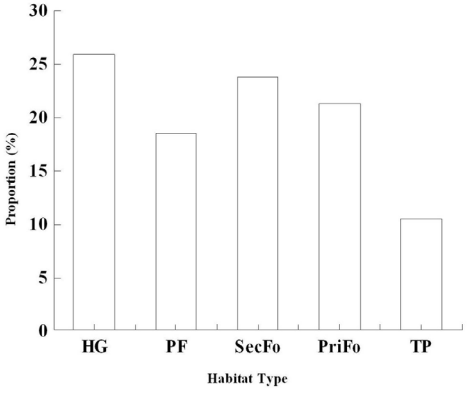

Figure 2. Proportional abundance of species recorded from each habitat type. (HG- Home gardens, PF- Paddy fields, SecFo- Secondary forests, PriFo- Primary forests, TP- Tea plantations)

Figure 3. Some species observed during the survey (a) *Fejervarya kirthisinghei* (b) *Philautus reticulatus* (c) *Hylarana temporalis*.

breeding in forests and as well as in gardens. Gardens in this area have a good canopy cover and a thick moist leaf litter layer - factors being important for the survival of amphibians. Moisture in leaf litter and soil is a crucial factor for direct developing species of *Philautus*, since they lay their eggs in moist leaf litter or soil (Bahir et al., 2005). The presence of lentic water bodies such as ponds and wells in gardens in the study site also contributes to the high diversity of amphibians observed in home gardens. Many specimens of *P. longinasus, P. cruciger* and *D. melanostictus* were found around these lentic water bodies indicating that they breed in these habitats. Tadpoles of *D. melanostictus* and a species of *Polypedates* were found in these lentic habitats confirming our speculations. A low relative abundance of *A. kelaartii, Nannophrys ceylonensis* and *I. glutinosus* were recorded from the study. Our observations indicate that *A. kelaartii* is a very rare species in the study area. The low turnout of *I. glutinosus* might be due to their fossorial and secretive life style. However we cannot explain the low abundance of *N. ceylonensis,* a species considered to be common in the southwestern wet zone of Sri Lanka (Manamendraarachchi and Pethiyagoda, 2006). Lower species diversity was observed in paddy field habitats (five species). However, large numbers of *F. limnocharis* and *D. melanostictus* were present in the paddy field habitats. The tadpoles of these two species were also observed in paddy field water indicating that they breed there. Lower diversity of amphibians in this habitat could be due to the absence of a closed canopy and a thick leaf litter layer. Furthermore, intense human activity, seasonal fluctuations of the water levels and the use of pesticides in these habitats could be other factors affecting the lower diversity of amphibians. Our observations did not clearly show effects of pesticides on amphibians by means of abnormalities or mass mortalities. However, it is well known that pesticides affect negatively on amphibian populations (Boone and Bridges, 2003). This site is marked by the complete absence of *Philautus* species. On a previous study in the same habitat *L. corrugatus, H. temporalis* and *F. kirthisinghei* were recorded (Nayana Pradeep Kumara and Wijayagunasekara, 2004), but the present survey failed to record these three species from the paddy fields.

Amphibian communities

We observed several amphibian communities in the study site. The communities were home garden community, paddy field community , secondary forest community , primary forest community and tea plantation community. Amphibian species observed in each community are listed in Table 1. The most diverse community was the garden community.

Habitat Preferences

Our study also made some interesting observations on habitat preferences of amphibians in the study site. In the study *P. cavirostris* and *P. reticulatus* (Figure 1,b) were observed in home gardens and secondary forests. However these observations do not indicate that these species are solely found in disturbed habitats. Interestingly, Manamendraarachchi and Pethiyagoda (2005) mention that these species are habitat specialists and are restricted to close canopy rainforests. The reason for not recording *P. cavirostris* and *P. reticulatus* in primary forested habitats in our survey could be a sampling artefact. However, this observation indicates that these two species are able to adapt to secondary forests and also that home gardens represent a suitable habitat for specialized species like *P. cavirostris* and *P. reticulatus*. Our observations indicate that species such as *F. kirthisinghei*, *F. limnocharis, H. temporalis* and *D. melanostictus* can be considered as generalists in habitat preferences since these four species were recorded from four of the five habitats sampled. In contrast, species like *A. kelaartii*, *E. cyanophlyctis* and *N. ceylonensis* can be considered as specialists in habitat preferences since these species were only observed in a single habitat in the survey. Species like *A. kelaartii* is a forest species but *N. ceylonensis* is also known to occur in disturbed

habitats (Manamendraarachchi and Pethiyagoda, 2006). However, in our survey *A. kelaartii* was found only among leaf litter and on rock surfaces close to streams in the Primary forest habitats while *N. ceylonensis* were only encountered on a rock surface on a mountain peak that is surrounded by a patch of undisturbed rainforest.

Conclusion

The results of our study reveal a high diversity and as well as high degree of endemism of amphibian species in this area. Furthermore it is highlighted by the discovery of two new species of frogs from the area which will be formally described later. But these habitats face threats due to illegal felling and clearing of forest and encroachment. We observed encroachment of the forest along the primary forest border and illegal felling in the secondary forest area. Unfortunately these forest fragments in the study area enjoys no protection at all. Therefore we strongly recommend authorities to initiate steps to protect these little known yet important forest fragments in order to conserve the wealth of herpetofauna as well as rest of the biodiversity.

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