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A Preliminary Survey of the Amphibian Fauna in Nilgala Forest Area and its Vicinity, Monaragala District, Sri Lanka

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ABSTRACT.—Herein, we present the findings of a preliminary study on amphibian diversity in Nilgala Forest Area of the Monaragala District, which is situated in the intermediate zone of Sri Lanka. We investigated the amphibian species diversity and various threats they face in this remote, unstudied area. We recorded 20 species of amphibians, comprising about 18.8% of the total Sri Lankan amphibians described to date. Several species were new records for the Nilgala Forest Area including *Philautus regius*, *P. fergusonianus*, and *Ichthyophis glutinosus*. There were seven (35%) endemic species and six (30%) nationally listed threatened species observed at the site. We also observed three unidentified amphibian species in Nilgala Forest Area. Nilgala Forest Area supports high amphibian diversity. However, human activities such as burning, illegal logging, chena cultivation, and road traffic threaten the ecology of this important forest.

Key Words.—amphibians; conservation; endemic; Nilgala Forest; Sri Lanka; threatened

INTRODUCTION

Sri Lanka and Western Ghats of India is a biodiversity hotspot, rich in herpetofaunal assemblages (Meegaskumbura et al. 2002; Bossuyt et al. 2004; Gunawardene et al. 2007). Favorable environmental factors such as high rainfall and humidity, and associated high density of undergrowth found in this region support a rich diversity of herpetofauna. About 200 species of reptiles (De Silva 2006; Samarawickrama et al. 2006; Manamendra-Arachchi et al. 2007; Wickramasinghe and Munindradasa 2007; Wickramasinghe et al. 2007) and 106 species of amphibians (belonging to 16 genera, 90 species) are endemic to the island. Among those genera, *Adenomus*, *Lankanectes* and *Nannophrys* are considered relict (De Silva 1996; Dutta and Manamendra-Arachchi 1996; Manamendra-Arachchi and Pethiyagoda 2005; Meegaskumbura and Manamendra-Arachchi 2005; Fernando et al. 2007; Pethiyagoda et al. 2006; Meegaskumbura et al. 2007). The poikilothermic nature of amphibian fauna restricts their distribution to areas with high rainfall, such as lowland wet-zone forest and montane forest areas (Giri and Chaturvedi, 2001).

Wet-zone forests harbor more than 60% of the indigenous amphibian fauna of Sri Lanka, and the southwest lowland forests have almost 90% of the endemic vertebrates (Senanayake et al. 1977; Wijesinghe and Dayawansa 2002; Bambaradeniya et al. 2003; IUCN Sri Lanka and Ministry of Environmental and Natural Resources 2007). There are few studies of the amphibian diversity in the dry and intermediate zone forests (De Silva et al. 2004). Amphibians play a vital role in the functioning of an ecosystem. Their diet of insects and small animals contributes to control of pests in human habitats, including crops and homes (Knopf 1998). However, many people in this region treat frogs with almost the same revulsion as snake, despite their ecological importance (Manamendra-Arachchi 2000).

Most researchers consider amphibians indicator species of environmental change (McCallum and Trauth 2003; Mendelson et al. 2006; McCallum 2007). Nilgala Forest Area (NFA) is one of the largest and most important forest areas in Monaragala District. However, the amphibian fauna of NFA requires study (Karunarathna et al. 2006). Several preliminary amphibian surveys took place in NFA prior to this study (Hettige et al. 2000; De Silva et al. 2004). Our new inventory work attempted to document the amphibian fauna of NFA through extensive field surveys made in 2004 and 2005. The loss of natural forests over the past 100 years contributed to the extinction of 19 species of shrub-frogs, *Philautus* sp. (Manamendra-Arachchi 2005; Meegaskumbura et al. 2007). Poorly described distributions and life histories are among the biggest hurdles for conserving amphibians in this country and abroad (e.g., Tadevosyan 2006; Jackson et al. 2007; D'Cruze et al. 2007) because only a fraction of the amphibians present in other areas of the country is known to science. This kind of information is paramount to making wise conservation decisions (Bury

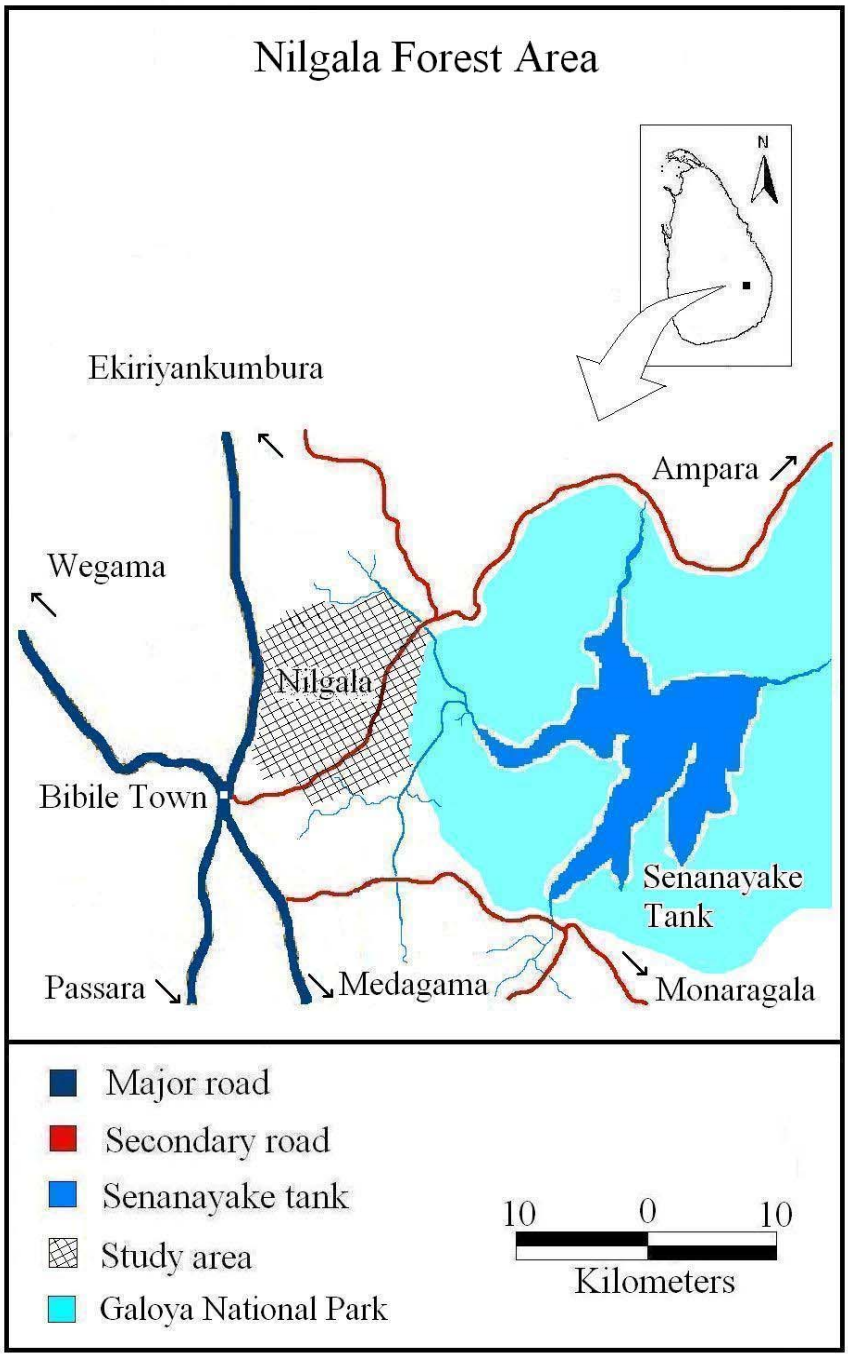

FIGURE 1. Map of the study area including its major and minor road networks in the Nilgala Forest Area and its vicinity, Monaragala District, Sri Lanka.

2006; McCallum and McCallum 2006). Hence, the biodiversity information we provide in this study is important for the conservation of Sri Lanka amphibians.

MATERIALS AND METHODS

Study site.—Nilgala Forest Area is a unique forest ecosystem covering 12,432 ha in the Bibile divisional secretariat division (Fig. 1). The major vegetation type is lowland tropical dry-mixed evergreen forest (Gunatilleke and Gunatilleke 1990; Fig. 2). Commonly found trees include Aralu (*Terminalia chebula*), Bulu (*T. bellirica*), and Nelli (*Phyllanthus emblica*). NFA occurs between 7° 08` - 7°14`N and 81°16` - 81°20` E, approximately 11 km southeast from the town of Bibile. The altitude ranges from 200-700 m above sea level within the boundaries of the NFA (De Silva et al. 2004; Karunarathna and Karunarathna 2005). The general

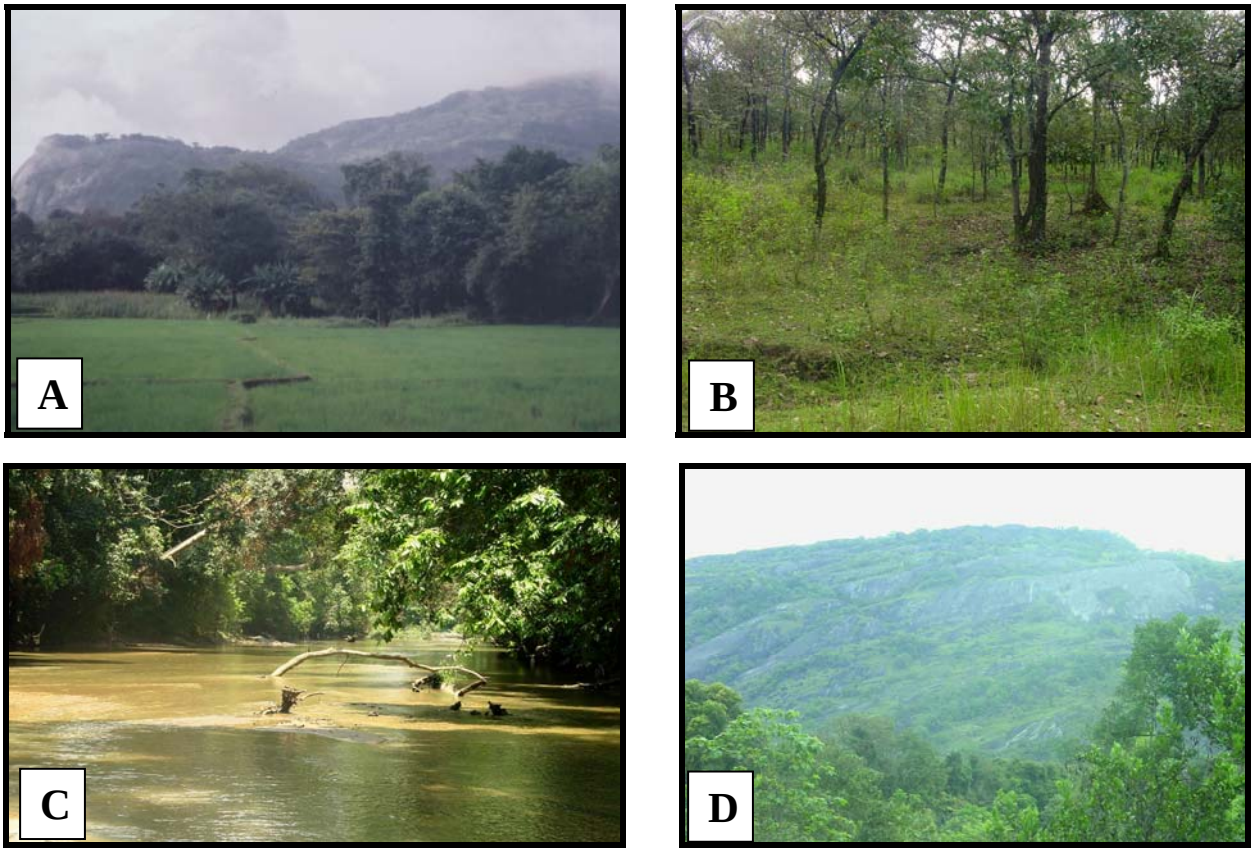

FIGURE 2. Some of the habitats present at Nilgala Forest Area and its vicinity, Monaragala District, Sri Lanka. A) Paddy field, B) Savannah forest, C) Riverine forest, D) Rock-outcrop in Yadunhela.

climatic conditions in Nilgala are moderately cool throughout the year, with high humidity during the northeast monsoon season.

The average annual rainfall is about 1750 mm. Most of this occurs from the end of December to the middle of March. The weather gradually dries from the middle of August to early December with the warmest temperatures in August. The mean annual temperature in the NFA is 28°C (Range = 24-32°C). NFA is also an important major watershed for Gala Oya and Panmedilla Oya throughout the year (Karunarathna and Karunarathna 2005). There are several mountain peaks within the NFA with Yakun Hela being the highest peak (>700 m). We sampled 11 habitat types during this survey (Table 1).

Sampling methods.—We implemented this study from 24 March 2004 to 23 April 2005. We spent 56 days (10 hrs/day) in the field encompassing both the wet and dry seasons. We carried out general area surveys in the different habitat types within the NFA. These took place during the day and night. We searched a variety of habitats (e.g., water bodies, under rocks, logs and decaying vegetation, trees and bushes up to 5 m). We examined species carefully, recorded their presence, and then released them back where they were captured. When needed, we used previously published keys to identify species (Dutta and Manamendra-Arachchi 1996; Manamendra-Arachchi and Pethiyagoda 2005; and

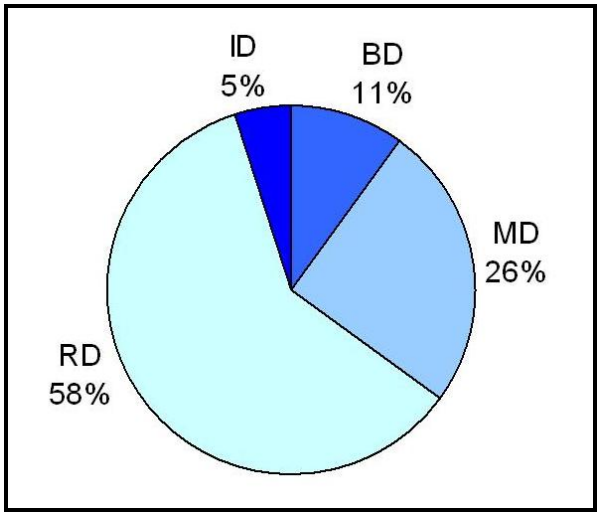

FIGURE. 3. Species composition of amphibian families in NFA. (BD- Bufonidae / MD- Microhylidae / RD- Ranidae / ID- Ichthyophiidae).

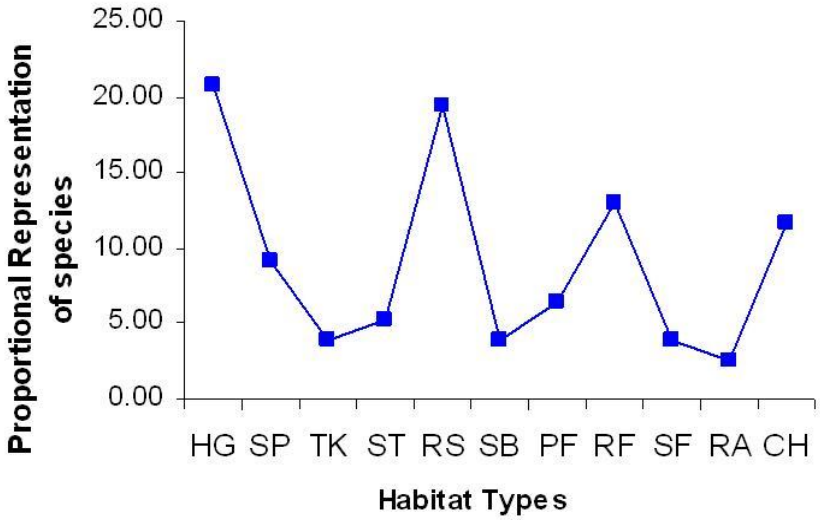

FIGURE 4. Species richness of Amphibians in various habitat types in NFA. (HG- Home Garden / SP- Small Pond / TK- Tank / ST- Stream / RD- Road Side / SB- Shrub & Bush / PF- Paddy field / RF- Riverine forest / SF- Savannah forest / RA- Rockout area / CH- Chena)

TABLE 1. Description of major habitat types in Nilgala Forest Area and its Vicinity, Monaragala District, Sri Lanka .

Habitat Type	Description of Habitat Types
1. Chena	Trees belong to family Rutaceae are dominant and grow up to 5 m; scattered bushes present; main cultivation is maize, banana, and finger millet. Leaf litter is very low.
2. Home Garden	Mixed cropping with woody plants like a *Mangifera indika*, *Chloroxylon swietenia*, *Schleichera oleosa*, *Tamarindus indika*; trees grows up to 15 m; shade is about 50%; leaf litter content is high and wet.
3. Paddy field	Paddy fields are moderate in extent (about 1 acre); wallowing sites are frequent along the fields; field bunds are narrow.
4. Riverine forest	Shade 80% with large tall trees growing up to 20 m; *Mangifera ceylanica*, *Maduca longifolia*, *Terminalia chebula Diospyros ebenum and Diospyros malabarica* are the dominant species; thick wet leaf litter layer available; shady forest; decaying logs are common.
5. Road Side	Generally consist of small bushes growing up to 2 m. Species such as *Maduca longifolia*, *Terminalia bellirica* and *Mangifera zeylanica* can also be found in several areas.
6. Rock-outcrop	Large rock boulders and grassy areas with seasonally moist cascade habitats. Shade 20% with tall trees. *Ficus mollis*, *Diospyros ebenum* and *Terminalia bellirica*
7. Savannah forest	Only *Terminalia chebula*, *Terminalia bellirica* and *Phyllanthus emblica* forest.
8. Shrub / Bush area	1-2 m tall randomly distributed on open soil.
9. Small Pond	Seasonally flooded, mud pond, gem pits, agricultural wells, drinking wells, mud pits, clay pits
10. Stream	Perennial flowing water bodies; 1m to 10m wide; visibility high; turbidity low.
11. Tank	Open water bodies; covered by macrophytes (25%)

Manamendra-Arachchi and Pethiyagoda 2006). Furthermore, we recorded basic environmental data at each location where we caught specimens.

RESULTS AND DISCUSSION

We recorded 20 amphibians from 14 genera (Table 2) belonging to four families residing at NFA. There were seven endemic and six nationally listed threatened species among them (IUCN Sri Lanka 2000; IUCN Sri Lanka and MENR 2007). The most abundant amphibians were ranids (*Fejervarya limnocharis*, *Philautus regius*, *Euphlyctis cyanophlyctis*, *E. hexodactyla*), while caecilians were the least encountered (Fig. 3). There were 10 terrestrial, four arboreal, four aquatic, and two fossorial species. Several captures were species records for NFA (*Philautus regius*, *P. fergusonianus*, and *Ichthyophis glutinosus*). We also recorded three species of *Philautus* (shrub-frog sp.) that are probably new to science.

Fejervarya limnocharis (12.73%) and *Philautus regius* (10.11%) were the most abundant species at NFA. The abundance of aquatic and semi aquatic habitats (small ponds, streams, and paddy fields) present at NFA is likely critical for supporting the large numbers of *Fejervarya limnocharis*; whereas, the large component of shrub vegetation here helps maintain the abundance of *Philautus regius.* It is interesting that no previously published studies recorded *P. regius* in NFA. This species is rare and or data deficient in the dry and intermediate zones (Manamendra-Arachchi and Pethiyagoda 2005).

The highest species richness occurred in home

gardens (20.78%) followed by roadside habitats (19.48%) and riverine forests (12.99%); whereas, rock outcrop habitats had the lowest species richness (2.60%) (Fig. 4). Several factors may cause the high species richness in the home gardens, including the large amount of leaf litter, shade, and the abundant of prey items (e.g., insects) attracted to artificial lighting surrounding these human-use areas. However, we sampled longer in home gardens than the in other habitats. Consequently, this may reflect a simple sampling bias in our study. Nevertheless, home gardens such as these occur in the vicinity of NFA and provide important refugia for amphibians. It appears that a higher species richness of amphibians occur in disturbed habitats such as home gardens, chena, and roadside shrub. This may be due to edge effect (Murcia 1995).

The species richness is also high along the road side (on Bibila–Ampara main road). Sampling bias may contribute to these findings as well. The lowest species richness (2.60%) occurred in the rock-outcrop habitats. Outcrops are xeric due to direct sun exposure much of the year, and are not highly suitable for amphibians (Karunarathna et al. 2006; Pough et al. 2004). Only *Nannophrys naeyakai* and *Bufo melanostictus* used rocky outcrops.

Conservation implications.—We anecdotally observed several potential threats to the amphibians occurring in the NFA. These include forest fires, illegal logging, extensive use of agrichemicals, forest clearing for chena cultivation, and roads. Local farmers use slash-and-burn (Fig. 5), cropping technologies, and they hunt throughout the area (Karunarathna et al. 2005). Fires are very frequent in the months of August and September and probably destroy the habitats suitable for amphibians. Illegal logging takes place around and within the NFA, and this seriously degrades the quality of the forests. Deforestation is known to reduce soil

FIGURE 5. A fire scorched area arising from slash-and-burn agricultural practices in Nilgala Forest Area, Monaragala District, Sri Lanka.

TABLE 2. List of amphibian species recoded from the Nilgala Forest Area and its vicinity, Monaragala District, Sri Lanka. (Abbreviations**: CR** – Critically Endangered, **DD** – Data Deficient, **TR** – Threatened Species, * – Endemic species, ** - Endemic Genus (Source: IUCN Sri Lanka, 2000; IUCN Sri Lanka and Ministry of Environmental and Natural Resources, 2007).

	Scientific Names and Family	Common Name	IUCN 2000	IUCN & MENR 2007	Total Individuals	Proportion Represented
Bufonidae						
1	*Bufo cf. atukoralei*	Atukorale's Toad *	TR		3	1.12
2	*Bufo melanostictus*	Common House Toad			17	6.37
Microhylidae						
3	*Kaloula taprobanica*	Common Bull Frog			8	3
4	*Microhyla ornata*	Ornate Narrow Mouth Frog			11	4.12
5	*Microhyla rubra*	Red Narrow Mouth Frog			13	4.87
6	*Ramanella variegata*	White Bellied Pug Snouted Frog			3	1.12
7	*Uperodon systoma*	Balloon frog			16	5.99
Ranidae						
8	*Hoplobatrachus crassus*	Jerdon's Bull Frog			19	7.12
9	*Fejervarya limnocharis*	Common Paddy Field Frog			34	12.73
10	*Euphlyctis cyanophlyctis*	Skipper Frog			24	8.99
11	*Euphlyctis hexodactyla*	Six Toed Green Frog			24	8.99
12	*Nannophrys naeyakai*	Trible Rock Frog **		CR	14	5.24
13	*Rana gracilis*	Sri Lanka Wood Frog *	TR		4	1.5
14	*Sphaerotheca breviceps*	Banded sand frog			7	2.62
15	*Sphaerotheca rolendae*	Marbled Sand Frog			9	3.37
16	*Philautus fergusonianus*	Ferguson's Shrub Frog *	TR		3	1.12
17	*Philautus regius*	Polonnaruwa Shrub Frog *		DD	27	10.11
18	*Polypedates cruciger*	Common Hourglass Tree Frog *	TR		12	4.49
19	*Polypedates maculatus*	Chunam Tree Frog			18	6.74
Ichthyophiidae						
20	*Ichthyophis glutinosus*	Yellow Banded Caecilian *	TR		1	0.37

FIGURE. 6. A road-killed *Hoplobatrachus crassus* (Jerdon's Bullfrog) observed at Nilgala Forest Area, Monaragala District, Sri Lanka.

moisture, a critical resource for maintenance of amphibian populations (Camargo and Kapos 1995).

Local paddy and chena cultivation in the vicinity of the NFA leads to agrichemical use. Such chemicals could harm many animals, including amphibians (Burgett et al. 2007; Kapfer et al. 2007; Gray et al. 2007). Another significant threat to the amphibian fauna of the area is road mortality (Fig. 6). Bibila–Ampara road cuts across the NFA, and we observed many road mortalities. We observed especially high numbers of dead amphibians after a rain. Certainly, direct and indirect effects observed in previous studies (Karraker 2007; Glista et al. 2008) could significantly impact NFA amphibians.

Our preliminary study of the amphibian fauna of the Nilgala Forest and its vicinity demonstrates that NFA is an important natural area in terms of amphibian diversity. The NFA may be an important refuge for threatened amphibians residing in the intermediate zone of the Uva province (Karunarathna et al. 2006). More detailed studies are needed to document the poorly understood amphibian community at this site, and to better understand how potentially hazardous human activities may influence this important ecological resource so that conservation officials can select appropriate mitigation strategies to conserve Nilgala Forest and its surrounding habitats.

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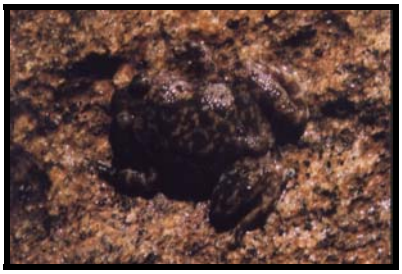
APPENDIX. Species observed at Nilgala Forest Area, Monaragala District , Sri Lanka.

Pollonnaruwa Shrub Frog
(*Philautus regius*)

Ferguson's Shrub Frog
(*Philautus fergusonianus*)



Trible Rock Frog
(*Nannophrys naeyakai*).

Common House Toad
(*Bufo melanostictus*).

Red Narrow Mouth Frog
(*Microhyla rubra*).

Chunam Tree Frog
(*Polypedates maculates*).

Common Bull Frog
(*Kaloula taprobanica*).

Banded Sand Frog
(*Sphaerotheca breviceps*).

Sri Lanka Wood Frog
(*Rana gracilis*).

Common Hourglass Tree Frog
(*Polypedates cruciger*).

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