Fauna of Protected Areas 20

AMPHIBIANS IN PROTECTED AREAS OF KERALA

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ABSTRACT

In a study on distribution and status of amphibians in the protected areas of Kerala, a total of 52 species belonging to 18 genera and six families were recorded from the wildlife sanctuaries and national parks; the most abundant family being Ranidae. Most protected areas showed high amphibian richness, with Periyar Tiger Reserve supporting the highest number of species (26) while Agasthyavanam Biological Park had the lowest number of species (5). The distribution is found to be varied in different protected areas. Habitat degradation and agricultural activities are the major threats to amphibians in the protected areas.

KEYWORDS

Amphibians, distribution, occurrence, protected areas, Kerala

In general, taxonomic studies on amphibians of Kerala are comparatively few and limited to documentation in the protected areas. In Kerala, there are 10 wildlife sanctuaries, two national parks, one tiger reserve, one bird sanctuary and one biological park. The amphibian fauna of some of these protected areas have been surveyed and studied by a few workers.

Pillai (1986) described the amphibians of Silent Valley National Park; Ravichandran and Pillai (1990) and Zacharias and Bhardwaj (1996) studied the faunal composition of Periyar Tiger Reserve; George *et al.* (1996) made a survey of the amphibians of Thattekad Bird Sanctuary; the amphibian fauna of Aralam Wildlife Sanctuary was described by Radhakrishnan (1996a), and Abraham and Easa (1999); and Radhakrishnan (1996b) published a list of the amphibians of Parambikulam Wildlife Sanctuary. The present work was carried out to study the amphibians in Kerala (Andrews *et al*., 2005) including all wildlife sanctuaries / national parks with special reference to their status and distribution.

STUDY AREA AND METHODS

The description of the study area is given elsewhere. The study was carried out from August 1999 to August 2002. The methodology adopted in the present study was strictly in accordance with the standard methods formulated for measuring and monitoring the amphibian diversity by IUCN/SSC- DAPTF (Heyer *et al*., 1994). Visual Encounter Survey (VES) methods were employed in the present study. All the protected areas in the state were visited regularly for observing amphibians and recording the field data on their ecology and biology with the help of a VES data sheet. Searching of amphibians included rolling and ripping of logs, turning of rocks, raking of litter and examination of vegetation. Amphibians were collected (one male and one female for most of the species as permitted by the Chief Wildlife Warden of Kerala) and preserved in 6% formalin for further taxonomic studies in the laboratory. Other specimens of each species were observed, their morphometric measurements taken and recorded and were released into the same areas from where they were captured. All the amphibian species were photographed (see web supplement of Andrews *et al*., 2005). Collected specimens are deposited in the Zoology Museum of Mar Thoma College in Tiruvalla, Kerala (see Table 1 of Andrews *et al*., 2005). Microhabitat, occurrence and distribution of each species were determined by field observations. Field studies and samplings were mainly done during the monsoon period; some samplings were done during the pre-and post-monsoon periods.

RESULTS AND DISCUSSION

The distribution of amphibian species in different protected areas such as Wildlife Sanctuaries, National Parks, Bird Sanctuary and Biological Park is given below:

1. Neyyar Wildlife Sanctuary

Neyyar Wildlife Sanctuary, which stretches to the Mundanthurai Tiger Reserve of Tamil Nadu in the east and Neyyatinkara taluk in the south, lies between $8^0$17' and $8^0$53'N latitude and $76^0$40' and $70^0$17'E longitude in Thriuvananthapuram district. Nestled in the southeastern corner of the Western Ghats, this sanctuary is the drainage basin of the Neyyar river and its tributaries Mullayar and Kallar. It was declared a sanctuary in 1958; covers an area of 128km^2 and has substantial natural vegetation comprising evergreen and deciduous forests and grasslands. The most important landmark is Agastiarkudam (1868m). The elevation of the area ranges from 90 to 1868m. The mean winter temperature is 16^0C and the mean summer temperature is 35^0C. The annual average rainfall is 3000mm.

During the present survey conducted in August 10-13, 2000 and July 16-19, 2002, 14 species belonging to three families were recorded (Table 1). The abundant species were *Rana temporalis, Nyctibatrachus major* and *Fejervarya keralensis. Rana aurantiaca* and *Philautus wynaadensis* were rarely seen and all other species were found commonly in the sanctuary.

2. Peppara Wildlife Sanctuary

Peppara Wildlife Sanctuary, formed in 1983, lies between $8^0$7' and $8^0$53'N latitude and $76^0$40' and $77^0$17'E longitude in Thiruvananthapuram district. The total area of the sanctuary is 53km^2. General topography of the area is hilly with elevation

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ranging from 100m to 1717m. The vegetation comprises of evergreen, semievergreen and deciduous forests; 60% of the tract along the lower slopes of the hills is of deciduous type forest. The temperature and rainfall are similar to that of Neyyar Wildlife Sanctuary. The field studies were carried out from 2-4 October, 1999 and 10-13, July 2001.

A total of 11 species belonging to two families were recorded (Table 1). The abundant species in the sanctuary were *Rana temporalis, Indirana beddomii* and *Fejervarya keralensis*. *Bufo parietalis, B. melanostictus, Micrixalus fuscus, Nyctibatrachus major, Euphlyctis hexadactylus* and *E. cyanophlyctis* were found commonly while *Nyctibatrachus minor* and *Sphaeroteca breviceps* were seen rarely in the sanctuary.

3. **Shenduruni Wildlife Sanctuary**
Shenduruni Wildlife Sanctuary, formed in 1984, is situated in southern Western Ghats. It lies between $8^0$15' and $8^0$55'N. latitude and $77^0$5' and $77^0$15'E. longitude in the Kollam district. The sanctuary covers a total area of 100.32km^2. The vegetation of the area comprises of tropical evergreen, semievergreen and moist deciduous forests; of these, the tropical evergreen forest forms one-fourth of the total area. The sanctuary was visited in November (14-17), 2000 and June (25-28), 2001 for field studies.

A total of six species belonging to two families were recorded from the sanctuary during the present survey (Table 1). All the species recorded were found commonly in the region.

4. **Periyar Tiger Reserve**
Periyar Tiger Reserve lies between $9^0$18' and $90^0$41'N latitude and $76^0$55' and $77^0$25'E longitude on the Western Ghats in Idukki district. It covers an area of 777.54km^2 and its elevation ranges from 900-2000m. It has a variety of habitats such as evergreen, semievergreen and moist deciduous forests, grasslands and eucalyptus plantation. It was the first sanctuary in Kerala notified in 1934 and later extended and renamed as Periyar Wildlife Sanctuary. In 1979 it was selected as the tenth Tiger Reserve in India. The temperature varies from 15^0C to 31^0C. The annual average rainfall is 2500mm. Field surveys were conducted in September (16-17) 1999, June (20-23) 2000 and June (7-10) 2001.

A total of 26 species belonging to five families were recorded from the Tiger Reserve (Table 1). The abundant species were *Rana temporalis* and *Fejervarya keralensis*. *Bufo melanostictus, Micrixalus fuscus, M. nudis, Nyctibatrachus major, Rana curtipes, R. malabarica, Indirana beddomii, Euphlyctis cyanophlyctis, E. hexadactylus, Fejervarya limnocharis* and *Philautus nasutus* were found commonly and all other species rarely in the reserve.

Ravichandran and Pillai (1990) conducted a survey in the Tiger Reserve and recorded 14 species of amphibia. In another survey and collection made by Zacharias and Bhardwaj (1996), 16 species were reported. *Rhacophorus lateralis* and *Micrixalus gadgili,* included in the list of amphibian species collected by Ravichandran and Pillai (1990), were not recorded in the present survey. However, species like *Microhyla ornata, Nyctibatrachus minor, Rana aurantiaca, Euphlyctis hexadactylus, Fejervarya nilagirica* and *Polypedates pseudocruciger,* which were not reported earlier were recorded in the present study.

5. Idukki Wildlife Sanctuary
Idukki Wildlife Sanctuary, which came into existence in 1976, spreads over an area of 77km^2 in Idukki district. It lies between $9^0$45'30" and $90^0$53'30"N latitude and $76^0$55'9" and $77^0$4'5"E. longitude and has an altitude ranging from 800m to 1272m. The temperature varies from 13^0C to 29^0C. The annual average rainfall is 2200mm. The different habitats in the area are the tropical evergreen, semievergreen and moist deciduous forests, sholas and grasslands. A total of 11 days (July 13-15, 2000; April 6-8, 2001 and July 4-8, 2002) were spent in the sanctuary for the survey.

A total of six species belonging to three families were recorded (Table 1). *Fejervarya keralensis* was abundantly found in the sanctuary; the common species were *Bufo melanostictus, Euphlyctis cyanophlyctis, Indirana beddomii* and *Philautus leucorhinus.* Other species were seen rarely in the area.

6. **Eravikulam National Park**
Eravikulam National Park, established as a sanctuary in 1975 and declared as a National Park in 1978, lies between $10^0$10' and $10^0$20'N latitude and $77^0$0' and $77^0$10'E longitude in Idukki district. This park, situated between the Chimmini Wildlife Sanctuary in the north-east and the Indira Gandhi Wildlife Sanctuary of Tamil Nadu in the north-west, has an area of 97km^2. The vegetation of the park comprises of evergreen forest, grasslands, sholas and scrub jungles. The altitude of the area varies from 1400m to 2694m. Anamudi in the southern region is the highest peak (2694m). The temperature ranges from 3^0C to 29^0C and the annual average rainfall is 4500mm. The faunal surveys were conducted in October (19-20) 1999, July (1-4) 2000 and August (12-14) 2001.

A total of 11 species belonging to three families were recorded (Table 1). *Bufo parietalis, Nyctibatrachus major, Rana temporalis* and *Fejervarya nilagirica* were found commonly and other species seen rarely in the national park.

7. Chinnar Wildlife Sanctuary
Chinnar, situated in Idukki district, was declared as a wildlife sanctuary in 1984. The sanctuary lies between $10^0$15' and 10^0 21'N latitude and $77^0$15' and $77^0$17'E longitude in the shallow rain region of the Western Ghats. It has an area of 90.422km^2 and its elevation ranges from 500m to 2400m. Unlike in most other forests of Kerala, this sanctuary gets only about 48 raining days (1000mm). The temperature varies from 18^0C to 35^0C. The dry deciduous and dry evergreen forests, high sholas and cultivated lands are the habitats found in the region.

During the present survey conducted for nine days in August

(11-12) 2001, December (3-5) 2001 and July (10-13) 2002, eight species belonging to three families were recorded (Table 1). *Fejervarya keralensis* was abundantly found while *Bufo melanostictus, Nyctibatrachus major, Rana temporalis* and *Euphlyctis cyanophlyctis* were seen commonly in the sanctuary. *Nyctibatrachus minor, Rana aurantiaca* and *Polypedates pseudocruciger* were rare.

8. Thattekkad Bird Sanctuary

Thattekkad, the only Bird Sanctuary in Kerala, lies between 10^0 7' and 11^0N latitude and $76^0$40' and $76^0$45'E longitude in Ernakulam district. The sanctuary, notified as a bird sanctuary in 1983, has an area of 25.16km^2. The vegetation comprises of tropical evergreen, semievergreen and deciduous forests; patches of grasslands and teak plantation are also seen in the area. The sanctuary has an elevation ranging from 35m to 523m; the tallest region is Njayapilli peak (523m). The mean annual temperature varies from 20^0C to 30^0C. The annual average rainfall is 2500m. Field studies were carried out in December (26-27) 1999, June (10-13) 2000 and November (22-26) 2001.

A total of 16 species belonging to three families were recorded (Table 1). The abundant species found in the sanctuary were *Rana temporalis, Indirana beddomii* and *Fejervarya limnocharis.* Species seen commonly were *Bufo melanostictus, Micrixalus nudis, Rana aurantiaca, Hoplobatrachus tigerinus, Euphylctis cyanophlyctis, E. hexadactylus, Fejervarya keralensis* and *Philautus leucorhinus.* All other species were rare in the area.

George *et al.* (1996) studied the amphibian fauna of Thattekkad Bird Sanctuary and reported 14 species. *Rana temporalis* and *Philautus leucorhinus,* which were not reported by them, were recorded in the present study.

9. Chimmini Wildlife Sanctuary

Chimmini Wildlife Sanctuary, established in 1984, lies between $10^0$22' and $10^0$26'N latitude and $76^0$31' and $76^0$37'E longitude at the valley of Nelliyampathi in Thrissur district. A part of the sanctuary lies adjacent to the Peechi-Vazhani Wildlife Sanctuary and other parts to the Parambikulam Wildlife Sanctuary. The sanctuary covers an area of 65km^2 and its altitude varies from 40m to 1116m. The habitats in the area are evergreen, semi-evergreen and deciduous forests. The annual temperature ranges from 15^0C to 30^0C. The annual average rainfall is 2980mm. The sanctuary was visited in June (14-17) 2001 and August (7-9) 2002 for the survey.

A total of eight species belonging to three families were recorded (Table 1). The common species in the sanctuary were *Bufo melanostictus, Rana temporalis, Indirana beddomii, Euphlyctis cyanophlyctis, Fejervarya keralenisis* and *Philautus leucorhinus. Ramanella montana* and *Micrixalus fuscus* were seen rarely in the region.

10. Peechi-Vazhani Wildlife Sanctuary

Peechi-Vazhani Wildlife Sanctuary, established in 1958, lies between $10^0$28' and $10^0$38'N latitude and $76^0$18' and $76^0$28'E longitude in Thrissur district. The total area of the sanctuary is 125km^2. The altitude ranges from 45m to 923m. The winter minimum temperature is 15^0C and the summer maximum temperature 38^0C. The annual average rainfall is 3000mm. The vegetation consists of the tropical evergreen, semievergreen and deciduous forests; the evergreen forest is sparcely seen in the area.

A total of 13 species belonging to three families were recorded during the surveys carried out in June (18-22) 2001 and August (10-13) 2002 (Table 1). *Euphlyctis cyanophlyctis* was found abundantly in the sanctuary. The common species were *Rana temporalis, Indirana bedomii, Hoplobatrachus tigerinus, Euphlyctis hexadactylus, Fejervarya nilagirica, F. keralensis, F. limnocharis* and *Philautus leucorhinus.* The remaining four species were rarely found in the area.

11. Silent Valley National Park

Silent Valley National Park, in the core of the Nilgiri Biosphere Reserve, is a unique preserve of tropical rain forests. It lies between $11^0$4' and $11^0$13'N latitude and $76^0$24' and $76^0$29'E longitude in the north-eastern corner of Palakkad district. It was declared as a national park in 1984. This park, which arises abruptly to the Nilgiri plateau in the north and overlooks the plains of Mannarkad in the south, has an area of 90km^2. The river Kunti, which descends from the Nilgiri Hills, traverses the entire length of the valley. The altitude of the region varies from 685m to 2383m. The temperature ranges from 8^0C to 29^0C. The annual average rainfall is 3200mm. The tropical evergreen and semievergreen forests, reed, bamboo and canebrakes, and grasslands constitute the vegetation in the park. Field studies were carried out in April (8-10) 2000, September (4-8) 2000 and July (17-19) 2001.

A total of 19 species belonging to five families were recorded from the park (Table 1). *Rana temporalis* and *Indirana beddomii* were seen in abundance. Species present commonly in the area were *Bufo parietalis, Nyctibatrachus major, Fejerarya limnocharis, Philautus signatus, P. pulcherrimus* and *P. wynaadensis.* All other species were found rarely.

Pillai and Pattabiraman (1981) reported a new species of torrent toad *Ansonia rubigina* from Silent Valley. Another two new species *Micrixalus thampii* and *Bufo silentvalleyensis* were recorded by Pillai (1981). Pillai (1986) conducted a faunistic survey in the national park from 1979 to 1980 and reported 19 species of amphibia. *Ichthyophis longicephalus, Bufo silentvalleyensis, Pedostibes tuberculosus, Ramanella triangularis, Micrixalus thampii* and *Nannobatrachus beddomii* from his list of collection could not be recorded in the present survey. However, *Uraeotyphlus oxyurus, Bufo melanostictus, Ramanella montana, Micrixalus fuscus, Nyctibatrachus aliciae* and *Philautus nasutus,* which were not collected by him, were recorded in the present survey.

12. Parambikulam Wildlife Sanctuary

Parambikulam Wildlife Sanctuary is situated in the valley between the Anamalai Ranges of Tamil Nadu and Nelliampathy

ranges of Kerala on the Western Ghats. It lies between 10°20' and 10°20'N latitude and 76°35' and 76°50'E longitude in Palakkad district. This sanctuary, notified in 1973, has a total area of 277.50km². There are tropical evergreen, semievergreen and moist deciduous forests, sholas, grasslands and teak plantation in the area. The minimum altitude is 300m and the maximum altitude 1438m. The temperature in the sanctuary ranges from 18.8°C to 32.8°C. The annual average rainfall is 1720mm. A total of 11 days (March 11-13, 2000; December 6-8, 2001; and June 3-6, 2002) were spent in the sanctuary for field studies.

A total of 17 species belonging to three families were recorded from this sanctuary (Table 1). *Rana temporalis* and *Fejervarya keralensis* were abundant in the sanctuary. Species commonly seen were *Bufo melanostictus, B. parietalis, Nyctibatrachus major, Indirana beddomii, Euphlyctis cyanophlyctis, Hoplobatrachus tigerinus, Fejervarya limnocharis* and *Philautus leucorhinus.* All other species were rare in the area.

Rao (1937) described *Sphaeroteca parambikulamana* from the Parambikulam forests (type locality). The occurrence of *Rana leptodactyla (Indirana leptodactylus)* was reported from Parambikulam by Satyamurti (1967). Recently Radhakrishnan (1996b) made two faunistic surveys in the sanctuary and reported 16 species. *Sphaeroteca parambikulamana,* reported earlier, could not be obtained during the present survey. *Nyctibatrachus minor* and *Fejervarya brevipalmata,* not included in the earlier collections, were recorded for the first time from the sanctuary in the present study.

13. Wayanad Wildlife Sanctuary

Wayanad Wildlife Sanctuary, which is contiguous with the protected area network of Rajiv Gandhi (Nagarahole) National Park and Bandipur Tiger Reserve of Karnataka in the northeast and Mudumalai Wildlife Sanctuary of Tamil Nadu in the southeast, was established in 1973. This sanctuary, an integral part of the Nilgiri Biosphere Reserve, lies between 11°35' and 11°51'N latitude and 76°2' and 76°27'E longitude in the Wayanad district. It has an elevation ranging from 650m to 1150m. The total area of the sanctuary is 344km². The vegetation includes semievergreen and moist deciduous forests and plantations of teak and eucalyptus. The winter minimum temperature is 13°C and the summer maximum temperature 32°C. The annual average rainfall is 2000mm.

A total of 20 species belonging to six families were recorded from the sanctuary during the surveys conducted in March 31-April 2 2000, July (24-27) 2001 and June (10-13) 2002 (Table 1). Species present abundantly in the Sanctuary were *Rana curtipes, R. temporalis, Euphlyctis cyanophlyctis* and *Fejervarya keralensis.* Of the total species observed, 11 species were sighted commonly in the area. *Uraeotyphlus menoni, U. narayani, Bufo microtympanum, Kaloula taprobanica* and *Micrixalus nudis* were found rarely in the area.

Abraham *et al.* (2001) made a survey and reported 30 species of amphibia from Wayanad, but the exact number of species recorded from the Sanctuary alone was not mentioned. No other workers have conducted any survey in the sanctuary.

14. Aralam Wildlife Sanctuary

Aralam Wildlife Sanctuary, which forms a part of the chunk of reserve forests covering the states of Kerala and Karnataka, is located between 11°50' and 11°52'N latitude and 75°49' and 75°57'E longitude in the Kannur district. It is the northern most wildlife sanctuary of Kerala, notified in 1984 and covers an area of 55km² falling partly in the vested forests and partly in the Brahmagiri slopes of the Western Ghats. The area ranges in elevation from 50m to 1489m. Tropical evergreen forests dominate the vegetation and patches of the semievergreen and deciduous forests with bamboo thickets are distributed over the area. Sholas and plantations are also seen in certain regions of the sanctuary. The temperature varies from 11°C to 40°C in the foot hills and from 8°C to 25°C in the high ranges. The annual average rainfall is 3000mm. Field work was carried out in July (28-30) 2000, April (3-6) 2000 and July (28-30) 2001.

A total of 25 species belonging to five families were recorded (Table 1). Of these, nine species were found commonly and 15 species seen rarely; one species (*Rana temporalis)* was abundant in the sanctuary. The common species recorded were *Bufo melanostictus, Micrixalus saxicola, Nyctibatrachus major, Rana temporalis, Indirana beddomii, Euphlyctis cyanophlyctis, E. hexadactylus, Fejervarya keralensis, F. limnocharis* and *Philautus leucorhinus.*

Radhakrishnan (1996a) made a faunistic survey in Aralam Wildlife Sanctuary and recorded 14 amphibian species. Five more species were added to the faunal list of this sanctuary by Abraham and Easa (1999). *Indirana leithii* could not be sighted during the present survey, even though it was reported by Radhakrishnan (1996a). However, *Fejervarya keralensis, Nyctibatrachus minor, Philautus beddomii, P. glandulosus, P. leucorhinus, P. temporalis* and *Polypedates maculatus,* which were not reported by earlier workers were recorded from the sanctuary during the present survey.

15. Agasthyavanam Biological Park

Agasthyavanam, which lies between the Neyyar and Peppara wildlife sanctuaries, was proposed as a biological park in 1992. It covers a total area of 23km². The vegetation in the area comprises of evergreen forest. Faunal studies were carried out in March (5-6) 2000, August (20-23) 2001 and June (8-11) 2002.

A total of five species belonging to two families were recorded (Table 1). *Bufo melanostictus, Nyctibatrachus major, Rana temporalis and Fejervarya keralensis* were commonly found while *Micrixalus fuscus* was rarely seen in this sanctuary.

A total of 52 species belonging to 18 genera and six families were recorded from 15 protected areas. The most abundant family was Ranidae in all the protected areas. The highest number of species was recorded from Periyar Tiger Reserve (26 species) followed by Aralam Wildlife Sanctuary (25 species), Wayanad Wildlife Sanctuary (20 species) and Silent Valley National Park (19 species). The lowest number of species was

Table 1. Distribution of amphibians in the protected areas of Kerala

	Species	Habitat	Microhabitat	Occurrence	Location
Agasthyavanam Biological Park					
1	*Bufo melanostictus*	MDF, CL	on bare soil and under stone	C	Kottor, Mankode
2	*Fejervarya keralensis*	MDF, CL	on leaf litter, in wet soil and on stream beds	C	Mankode, Kottor
3	*Micrixalus fuscus*	MDF	on wet boulders and sand and in streams	R	Tribal settlement
4	*Nyctibatrachus major*	EGF	under water in streams	C	Kottor, Park border
5	*Rana temporalis*	CL, MDF	on stream banks, in wet soil / crevices and on boulders	C	Tribal settlement, Kottor, Mankode
Aralam Wildlife Sanctuary					
1	*Bufo melanostictus*	SEF	on leaf litter	C	Aralam farm, Narikadavu, Ambayamthodu
2	*Euphlyctis cyanophlyctis*	SEF	on the surface of stagnant water	C	Narikkadavu, Parappinthodu, Ramachi
3	*E. hexadactylus*	MDF	in water	C	Narikkadavu, Parappinthodu, Ramachi
4	*Fejervarya brevipalmata*	SEF	among grasses in forest floor	R	Aralam farm
5	*F. keralensis*	SEF	under rocks or in soil of river floor	C	Ramachi, Ambayamthodu, Narikadavu
6	*F. limnocharis*	MDF, SEF	on leaf litter and among grasses	C	Aralam farm, Narikkadavu,
7	*Hoplobatrachus tigerinus*	MDF	in marshy areas	R	Aralam farm
8	*Ichthyophis malabarensis*	SEF	under soil	R	Narikadavu
9	*I. tricolor*	SEF	under soil	R	Uruppukunnu
10	*Indirana beddomii*	SEF	among leaf litter and on rocks	C	Aralam farm, Narikkadavu, Parappinthodu, Uruppukunnu
11	*I. leithii**	-	-	-	
12	*Micrixalus nudis*	SEF	under rocks in streams	R	Ambayamthodu
13	*M. saxicola*	SEF	on rocks or boulders in streams	C	Ramachi, Ambayamthodu, Narikadavu
14	*Nyctibatrachus major*	SEF	in streams-under water or rocks	C	Narikadavu, Ramachi, Ambayamthodu
15	*N. minor*	SEF	under stones or litter in wet areas/streams	R	Aralam farm
16	*Philautus beddomii*	SEF	on leaf litter	R	Near forest TB
17	*P. glandulosus*	SEF	on shrubs or herbs	R	Ramachi
18	*P. leucorhinus*	SEF	on herbs and shrubs	C	Narikkadavu, Ruppukunnu, Parappinthodu
19	*P. pulcherrimus*	SEF	on shrubs or herbs	R	Aralam farm
20	*P. temporalis*	SEF	on shrubs and herbs	R	Near forest TB
21	*Polypedates maculatus*	SEF	on shrubs and trees	R	Narikadavu
22	*Rana curtipes*	SEF	on bare soil	R	Narikadavu, near forest TB
23	*R. temporalis*	SEF	on rocks/logs in and near the streams	VC	All places
25	*Rhacophorus malabaricus*	MDF	on shrubs	R	Ramachi
24	*Sphaeroteca rufescens*	MDF	in wet soil	R	Aralam farm
25	*Uraeotyphlus menoni*	SEF	under soil	R	Ramachi Uruppukunnu
Chimmini Wildlife Sanctuary					
1	*Bufo melanostictus*	MDF	on bare soil	C	All places
2	*Euphlyctis cyanophlyctis*	MDF	in water	C	Dam area
3	*Fejervarya keralensis*	MDF	on wet sand and in streams	C	Dam area
4	*Indirana beddomii*	MDF	on leaf litter	C	Dam area
5	*Micrixalus fuscus*	SEF	on boulder in streams	R	Chimmini
6	*Philautus leucorhinus*	MDF	on herbs	C	Dam area
7	*Ramanella montana*	MDF	forest floor –on wet soil	R	Amballoore
8	*Rana temporalis*	MDF	marsh-in water	C	Dam area
Chinnar Wildlife Sanctuary					
1	*Bufo melanostictus*	DDF	forest floor - on bare soil	C	Sanctuary border
2	*Euphlyctis cyanophlyctis*	CL, DEF	stagnant water bodies	C	Tribal settlement
3	*Fejervarya keralensis*	DDF, DEF	close to streams - on wet soil and leaf litter	VC	All places
4	*Nyctibatrachus major*	DEF	submerged in water	C	All places
5	*N. minor*	DEF	under decayed leaf litter	R	Chinnar
6	*Polypedates pseudocruciger*	DDF	on shrubs	R	Chinnar
7	*Rana aurantiaca*	DDF	forest stream-under boulders	R	Chinnar
8	*R. temporalis*	DDF, CL, ESH	stream sides (on wet soil) and on rocks in the stream	C	All places
Eravikulam National Park					
1	*Bufo parietalis*	ESH	on leaf litter	C	Eravikulam, Vattachathupu, Poovar
2	*Indirana brachytarsus*	ESH	on leaf litter	R	Vagavarai
3	*I. leptodactylus*	ESH	on leaf litter	R	Vattachathuppu
4	*Fejervarya nilagirica*	GL	in marsh-among grasses	C	Vagavarai, Rajamalai, near Anamudi, Poovar
5	*Micrixalus nudis*	EGF	on or under boulders	R	Poovar
6	*Nyctibatrachus major*	ESH, EGF	in water or on wet soil	C	Vattachathuppu, Vagavarai, Eravikulam, Hut area
7	*N. minor*	ESH, EGF	on wet soil or under wet litter	R	Vattachathuppu
8	*Rana temporalis*	SH	on boulders in streams	C	Vattachathuppu, Vagavarai, Eravikulam, Poovar

	Species	Habitat	Microhabitat	Occurrence	Location
9	*Philautus femoralis*	GL	on herbs	R	Vagavarai
10	*P. pulcherrimus*	EGF	on leaf of herbs	R	Poovar
11	*P. signatus*	GL	on herbs	R	Rajamalai
Idukki Wildlife Sanctuary					
1	*Bufo melanostictus*	MDF	on bare soil	C	Vellapara, Dam area, Valakad
2	*Euphlyctis cyanophlyctis*	MDF	in water	C	Dam area, Valakod, Vellappara
3	*Fejervarya keralensis*	MDF	in water, on bare wet soil, under stones and on leaf litter	VC	All places
4	*Indirana beddomii*	MDF	on leaf litter / bare soil and under leaf litter	C	Dam area, Valakod, Vellappara
5	*I. leptodactylus*	ESH	among leaf litter	R	Vagavanam
6	*I. semipalmatus*	MDF	clinging to wet rocks	R	Vellappara
7	*Micrixalus nudis*	ESH	on wet soil and boulders	R	Valakod
8	*Philautus leucorhinus*	MDF	on herbs and shrubs	C	Vellappara, Dam area, Vagavanam
Neyyar Wildlife Sanctuary					
1	*Bufo melanostictus*	MDF, GL	on bare soil and under stones	C	Dam area
2	*Euphlyctis cyanophlyctis*	MDF, CL	in stagnant water bodies	C	Dam area
3	*E. hexadactylus*	MDF, CL	in marsh-half submerged in water	C	Dam area, Amboori
4	*Fejervarya brevipalmata*	MDF	among grasses in marsh	C	Dam area
5	*F. keralensis*	MDF, EGF	on wet soil. in marsh and small streams	VC	All places
6	*F. limnocharis*	MDF	among grasses in marsh	C	Catchment area, Crocodile farm
7	*Indirana beddomii*	MDF	on leaf litter	C	Dam area
8	*Micrixalus fuscus*	EGF	stream banks - on wet soil, leaf litter and boulders	C	Amboori
9	*Nyctibatrachus major*	SEF	submerged in water	VC	All places
10	*N. minor*	EGF	under wet leaf litter	C	Dam area
11	*Philautus leucorhinus*	MDF, CL, GL	on herbs and shrubs	C	Amboori
12	*P. wynaadensis*	MDF, CL, GL	on herbs and shrubs	R	Amboori
13	*Rana aurantiaca*	MDF	in marsh-among grasses	R	Boating area
14	*R. temporalis*	MDF, SEF	on logs, leaf litter and boulders; stream banks - mud crevices	VC	All places
Parambikulam Wildlife Sanctuary					
1	*Bufo melanostictus*	FS, OL	on bare soil or litter and under rock crevices	C	Thunakadavu, Anappady, Medanchal, Venkoli
2	*B. parietalis*	MDF	on leaf litter and bare soil	C	Karimala, Orukomban, Sungam
3	*Euphlyctis cyanophlyctis*	FS, OL	in stagnant pools	C	Thunakadavu, parambikula, Sunkam
4	*Fejervarya brevipalmata*	MDF	in marsh	R	Parambikulam
5	*F. keralensis*	MDF	forest floor -on litter or bare soil and stream bed	VC	All places
6	*F. limnocharis*	MDF	among grasses	C	Thunakadavu, Parambikulam, Kuriarkutty
7	*Hoplobatrachus tigerinus*	MDF	in water	C	Parambikula, Sunkam, Thunakadavu,
8	*Indirana beddomii*	MDF, SEF	forest floor - on leaf litter or under stones	C	Thunakadavu, Parambikula, Sunkam
9	*I. leptodactylus*	MDF	on leaf litter	R	Parambikulam
10	*I. semipalmatus*	MDF	under wet rock	R	Thunakadavu
11	*Nyctibatrachus major*	SEF	submerged in water	C	Kuriarkutty, Orukomban, Thunakadavu
12	*N. minor*	SEF	under stones in very shallow streams	R	Kottayali
13	*Philautus chalazodes*	MDF	on herbs	R	Orukomban
14	*P. leucorhinus*	MDF	on herbs	C	Kottayali, Orukomban, Parambikulam
15	*Rana curtipes*	MDF	on leaf litter	R	Parambikulam
16	*R. temporalis*	MDF, SEF	stream banks - on logs, rocks and leaf litter	VC	All places
17	*Sphaeroteca parambikulamana**	-	-	-	
18	*Sphaeroteca rufescens*	MDF	on wet soil/in narrow streams	R	Kuriarkutty
Peechi-Vazhani Wildlife Sanctuary					
1	*Bufo scaber*	TP	lake shore - on bare soil	R	Dam area
2	*Euphlyctis cyanophlyctis*	TP, MDF	in stagnant water pools	VC	All places
3	*E. hexadactylus*	CL, MDF	in marshes and ponds	C	Reservoir side
4	*Hoplobatrachus crassus*	TP	in marsh (lake side)	R	Reservoir side
5	*H. tigerinus*	MDF	in or near stagnant water bodies	C	Peechi, Vazhani
6	*Indirana beddomii*	MDF, SEF	forest floor – on soil and liter, under stones or in crevices	C	Vazhani, Dam area
7	*Fejervarya keralensis*	MDF, SEF	wet soil and leaf litter (close to water)	C	Peechi, Vazhani
8	*F. limnocharis*	MDF	in marshy areas or among leaf litter	C	Vazhani, Dam area
9	*F. nilagirica*	TP	among grasses in marshes	C	Reservoir side, Vazhani
10	*Rana temporalis*	MDF	in marsh	C	Peechi, Vazhani
11	*Sphaeroteca rufescens*	TP	lake shore – on wet clay soil	R	Dam area
12	*Philautus leucorhinus*	MDF	on shrubs and herbs	C	Peechi, Vazhani
13	*Polypedates maculatus*	MDF	on shrubs	R	Vazhani

	Species	Habitat	Microhabitat	Occurrence	Location
Peppara Wildlife Sanctuary					
1	*Bufo melanostictus*	CL, MDF	on bare soil and leaf litter	C	Chathencode
2	*B. parietalis*	MDF	forest floor- on leaf litter	C	Chathencode
3	*Euphlyctis cyanophlyctis*	CL, MDF	floats in stagnant water bodies	C	Jercy farm, Chathencode
4	*E. hexadactylus*	MDF	in marsh	C	Jercy farm, Chathencode
5	*Fejervarya keralensis*	MDF	on wet soil, leaf litter and sand; under stones in stream bed	VC	All places
6	*Indirana beddomii*	MDF, SEF	forest floor- on / under leaf litter, wet soil and under stones; close to water bodies	VC	All places
7	*Micrixalus fuscus*	EGF	stream bank - on wet soil and boulders	C	Chathencode, Pandipothu
8	*Nyctibatrachus major*	MDF, SEF	submerged in water or in sand in very narrow streams	C	Vilakkampara, temple area, Chathencode
9	*N. minor*	MDF	under leaf litter in marsh	R	Vilakkampara
10	*Rana temporalis*	MDF, SEF	on boulders in streams and on stream banks	VC	All places
11	*Sphaeroteca breviceps*	CL	on wet soil	R	Kanithadam,
Periyar Tiger Reserve					
1	*Bufo melanostictus*	MDF, SEF	on bare soil, in rock crevices and on litter	C	Thannikkudy, Mullakkudy, Mangaladevi, Vellimala
2	*B. microtympanum*	EGF	under stones	R	Thannikkudy
3	*Euphlyctis cyanophlyctis*	MDF, SEF	floats on the water surface	C	Anavachal, Cheriyakanam, Manakavala
4	*E. hexadactylus*	MDF	in water	C	Thekkady, Lake area, Mullakkudy
5	*Fejervarya brevipalmata*	SEF, EGF	among leaf litter	R	Mlappara
6	*F. keralensis*	EGF, SEF, MDF	stream banks - on litter and in humid soil	VC	All places
7	*F. limnocharis*	MDF	on grass, litter or bare soil	C	Thekkady, Kokkara, Karadikavala
8	*F. nilagirica*	MDF	on grass, litter or bare soil	R	Karadikavala
9	*Hoplobatrachus tigerinus*	MDF	in marsh	R	Thekkady
10	*Indirana beddomii*	MDF, SEF, EGF	on leaf litter and in rock crevices	C	Anchuruli, Thekkady, Thannikkudy
11	*Micrixalus fuscus*	EGF, SEF	on boulders or in humid soil	C	Anchuruli, Parayoda, Kokkara
12	*Micrixalus gadgili*[*]	-	-	-	
13	*M. nudis*	EGF, SEF	under boulders or in humid soil	C	Thekkady, Kokkara, Mulathodu
14	*Microhyla ornata*	MDF	in shallow water	R	Anavachal
15	*Nyctibatrachus major*	EGF, SEF	in rock crevices or submerged in shallow water	C	Thekkady, Kokkara, Mulathodu
16	*N. minor*	MDF, SEF	under leaf litter in marsh	R	Vallakadavu
17	*Philautus beddomii*	EGF	on herbs	R	Mlappara
18	*P. nasutus*	SEF	on herbs	C	Vallakadavu, Kokkara
19	*P. wynaadensis*	MDF	on herbs	R	Vallakadavu
20	*Polypedates maculatus*	MDF	on leaf or trunk of trees	R	Vallakadavu
21	*P. pseudocruciger*	MDF	on leaves or stems of trees and shrubs	R	Thekkady
22	*Rana aurantiaca*	SEF	in water or on wet soil	R	Thekkady
23	*R. curtipes*	MDF, SEF	forest floor – on leaf litter or bare soil and on stream banks	C	Thekkaday, Cheriyakanam, Vallakadavu
24	*Rana malabarica*	SEF	on wet soil	C	Thannikkudy,Thekkady, Mullakkudy
25	*R. temporalis*	MDF, SEF, EGF	on stream banks, rocks, logs and humid soil	VC	All places
26	*R. lateralis*[*]	-	-	-	
27	*Rhacophorus malabaricus*	SEF	on trees	R	Thekkady
28	*Uraeotyphlus narayani*	EGF	under soil	R	Mullakkudy
Shenduruni Wildlife Sanctuary					
1	*Bufo melanostictus*	MDF, SEF	on bare soil	C	Kulathupuzha range, Kattalappara, Thenmala
2	*Euphlyctis cyanophlyctis*	MDF	floats on the surface of stagnant water bodies	C	Kulathupuzha range, Kattalappara, Thenmala
3	*E. hexadactylus*	CL	in water	C	Kulathupuzha range, Kattalappara, Thenmala
4	*Fejervarya keralensis*	MDF	stream banks- on leaf litter, in wet soil and sand	C	Venkolla Kulathupuzha range, Kattalappara, Thenmala
5	*F. limnocharis*	TP	among grasses	C	Kulathupuzha range, Kattalappara, Thenmala
6	*Haplobatrachus tigerinus*	CL	on the edge of ponds	C	Kulathupuzha range, Kattalappara, Thenmala
Silent Valley National Park					
1	*Ansonia rubigina*	EGF	on rocks in rivers	R	Kummattanthodu
2	*Bufo melanostictus*	GL	under rocks or logs and among litter	R	Sairandri, Chempatty
3	*B. microtympanum*	EGF	on leaf litter	R	Sairandri
4	*B. parietalis*	EGF	among leaf litter and on bare soil	C	Sairandri, Chempatty, Kummattanthodu
5	*Bufo silentvalleyensis*[*]	-	-	-	
6	*Fejervarya limnocharis*	EGF	among grasses	C	Panthencode, Kummattanthodu, Poochppara, Punamala
7	*Ichthyophis longicephalus*[*]	-	-	-	
8	*Indirana beddomii*	EGF	on leaf litter and under rocks or logs	VC	Sairandri, Chempatty, Mukkola,

	Species	Habitat	Microhabitat	Occurrence	Location
					Kummattanthodu, Poochppara
9	*Micrixalus fuscus*	EGF	hill streams –on boulders, wet soil or on stream banks	R	Kunthipuzha
10	*M. nudis*	EGF	under boulders and wet rocks	R	Kummattanthodu, Punamala
11	*M. saxicola*	EGF	on boulders	R	Kunthipuzha
12	*Micrixalus thampii**	-	-	-	
13	*Nannobatrachus beddomii**	-	-	-	
14	*Nyctibatrachus aliciae*	EGF	in streams	R	Kummattanthodu
15	*N. major*	EGF	in water and under stones	C	Sairandri, Chemmpatty, Kummattanthodu
16	*Pedostibes tuberculosus**	-	-	-	
17	*Philautus nasutus*	GL, EGF	on leaf or stem of shrubs /herbs	R	Sairandri
18	*P. pulcherrimus*	EGF	on leaf	C	Sairandri, Chemmpatty, Poochappara
19	*P. signatus*	GL	on leaf or stem of shrubs/herbs	C	Sairandri, Chemmpatty, Kummattanthodu
20	*P. wynaadensis*	EGF	on shrubs	C	Sairandri, Chemmpatty, Kummattanthodu
21	*Ramanella montana*	EGF	under stones	R	Poochappara
22	*Ramanella triangularis**	-	-	-	
23	*Rana temporalis*	EGF	on banks of streams	VC	Al places
24	*Rhacophorous malabaricus*	EGF	on trees/herbs	R	Dam site
25	*Uraeotyphlus oxyurus*	EGF	in wet soil and under stones	R	Kummattanthodu
Thattekkad Bird Sanctuary					
1	*Bufo melansostictus*	TP	under stones and on bare soil	C	Thattekkad, Blavana
2	*B. microtympanum*	MDF	under stones and on bare soil	R	Thattekkad
3	*B. scaber*	MDF	on bare soil and under stones	R	Blavana
4	*Euphlyctis cyanophlyctis*	TP, MDF	in stagnant water bodies	C	Thattekkad, Blavana
5	*E. hexadactylus*	MDF	in stagnant pools	C	Pool area
6	*Fejervarya keralensis*	SEF, MDF	on wet soil and among leaf litter	C	Mathuchathapara, Mamangalam
7	*F. limnocharis*	MDF, SEF	in marsh	VC	All places
8	*Hoplobatrachus tigerinus*	TP	among water plants in stagnant pools	C	Pol area, Mathuchathapara
9	*Indirana beddomii*	TP, SEF	on wet soil and under leaf litter	VC	All places
10	*I. semipalmatus*	SEF	on bare soil and under stones	R	Thattekkad
11	*Micrixalus nudis*	SEF	on wet soil	C	Mathuchathapara, Mamangalam
12	*Philautus leucorhinus*	TP	on herbs and shrubs	C	Poyamkutty
13	*Polypedates maculatus*	TP	on trees	R	Blavana
14	*Rana aurantiaca*	SEF	on wet soil	C	Thattekkad
15	*R. malabarica*	MDF	on bare soil and under stones	R	Thattekkad, near forest office
16	*R. temporalis*	TP, MDF, SEF	in marsh and on bare soil of stream banks	VC	All places
Wayanad Wildlife Sanctuary					
1	*Bufo melanostictus*	MDF, SEF, TP, CL	among leaf litter, under stones or on plain ground	C	Tholpetty, Kuppadi, Kurichiyad, Begur, Muthanga
2	*B. microtympanum*	MDF	on leaf litter	R	Tholpetty
3	*Euphlyctis cyanophlyctis*	MDF, SEF, CL	in water	VC	All places
4	*E. hexadactylus*	MDF, CL	in water	C	Muthanga, Chethalayam, Kurichiyad
5	*Fejervarya keralensis*	MDF, TP	on leaf litter or in wet regions	VC	All places
6	*F. limnocharis*	MDF, CL	among wet grasses or in marshy areas	C	Kuppady, Betheri, Tholptty, Muthanga
7	*F. nilagirica*	MDF	in marshy areas	C	Kuppady, Betheri, Tholptty, Muthanga, Kurichiyad
8	*Hoplobatrachus tigerinus*	MDF, CL	on banks of streams	C	Tholpetty, Kurichiyad, Muthanga
9	*Ichthyophis beddomei*	MDF	under soil	C	Muthanga, Kurichiyad, Begur
10	*Indirana beddomii*	SEF	among leaf litter or on rocks	C	Tholpetty, Kurichiyad, Muthanga
11	*Kaloula taprobanica*	MDF	under wet decayed litter	R	Tholpetty
12	*Micrixalus nudis*	SEF	under logs or rocks	R	Kurichiyad
13	*Nyctibatrachus major*	SEF	in water	C	Kuppady, Tholptty, Muthanga, Kurichiyad
14	*Philautus leucorhinus*	MDF	on herbs	C	Kurichiyad, kuppadi
15	*P. wynaadensis*	MDF	on herbs	C	Pulpally, Mullenkolli, Perikkallore
16	*Rana curtipes*	MDF	on banks of rivers or in water	VC	All places
17	*R. temporalis*	MDF, SEF	on banks of rivers	VC	All places
18	*Rhacophorus malabaricus*	MDF	on bamboo leaves	C	Pulpally, Kurichiyad, Tholpetty
19	*Uraeotyphlus menoni*	MDF	under soil	R	Thirunelli
20	*U. narayani*	MDF	under soil	R	Begur

CL - Cultivated land; DDF - Dry deciduous forest; DEF - Dry evergreen forest; EGF - Evergreen forest; SEF - Semievergreen forest; ESH - Evergreen shola; MDF - Moist deciduous forest; TP - Teak plantation; FS - Forest; GL - Grassland; SH - Shola; OL - Open land.
C - Common; VC - Very common; R - Rare
*Reported by other workers.

observed in Agasthyavanam Biological Park (5 species). Idukki Wildlife Sanctuary and Shenduruni Wildlife Sanctuary had six species each. The representation of amphibians in other sanctuaries was: Parambikulam WLS - 17 species, Thattekkad BS - 16 species; Neyyar WLS - 14 species; Peechi-Vazhani WLS - 13 species, Peppara WLS - 11 species; Eravikulam NP - 11 species; Chinnar WLS - 8 species; Chimmini WLS - 8 species.

The distribution of amphibian species is varied in different sanctuaries. Some species recorded in the present study were found in several sanctuaries while a few species were not recorded from any sanctuary at all. *Fejervarya keralensis* was recorded from 14 protected areas, followed by *Bufo melanostictus* and *Rana temporalis* (13 each), *Euphlyctis cyanophlyctis* (12), *Indirana beddomii* (11), *Nyctibatrachus major* (10), *Fejervarya limnocharis* (9), *Philautus leucorhinus* and *Euphlyctis hexadactylus* (8 each), *Micrixalus nudis*, *Nyctibatrachus minor* and *Hoplobatrachus tigerinus* (7 each) and *Micrixalus fuscus* (6); few other species were found in 2-4 protected areas.

Threats to amphibians

The major threats to amphibians in the protected areas in Kerala are habitat degradation and agricultural activities. The location of dams and reservoirs within the protected areas has led to the destruction of habitats of amphibians in many wildlife sanctuaries like Neyyar, Peppara, Shenduruni, Idukki, Peechi-Vazhani, Chimmini, Parambikulam and Periyar. This has also resulted in the scarcity of water downstream, which poses problems to existence of several riparian species of amphibians during the summer period. The extensive cattle grazing in certain regions of the wildlife sanctuaries such as Peechi-Vazhani, Chimmini, Neyyar, Idukki and Periyar is another factor causing severe damage to vegetation comprising grasses, herbs, shrubs etc. which harbour several species of *Philautus*, *Rhacophorus* and other non-riparian species. Amphibians in the majority of sanctuaries / parks are adversely affected by human interference. Tribal people and others regularly encroach protected areas for collecting fodder, firewood and forest products, which negatively impacts habitat quality of amphibians.

Agricultural operations, which are carried out in large areas within or in the neighborhood of some protected areas like Wayanad, Aralam, and Agasthyavanam Biological Park, can be considered as a threat to amphibians. Moreover, extensive stretches of tea, rubber, cardamom and coffee plantations are located in the vicinity of Idukki, Wayanad, Aralam, Periyar and Eravikulam protected areas. The indiscriminate use of pesticides in these plantations is definitely causing environmental pollution that might be harmful to amphibians in the protected areas. No attempt was made to study the extent of threats to amphibians in the protected areas during the present investigation. Proper management of species, population and habitats and complete stopping of human interference are to be enforced strictly to conserve the populations of amphibian species in the protected areas of Kerala.

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