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Amphibian diversity and distribution in KMTR (Southern Western Ghats) of Tirunelveli district, Tamil Nadu

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Abstract
The present paper deals with amphibian diversity at KMTR (Southern Western Ghats) of Tirunelveli district during the study period from June 2018 to March 2019. A rapid survey method was involved in careful visual estimation and amphibians were recorded in all possible habitats of the study area. A total of 17 species of amphibians belonging to 5 families and 12 genera were recorded. The study reveals that the cultivation area is rich in amphibian diversity and support many more species. Further studies are needed on population structure, habitat use by amphibians for better understanding and also to impose several conservation strategies at KMTR in Tirunelveli.

Keywords: Amphibians, diversity, KMTR, Southern Western Ghats, careful visual estimation

Introduction
India, one of the most populous countries, with an estimated population of 1.1 billion, also has the greatest amphibian species richness (321), endemics (180) and threatened species of all countries in the Indo – Malayan realm (Bain *et al*., 2005) [1]. According to the Global Amphibian Assessment (GAA) almost one –third of the worlds 6,638 known amphibian species are listed as threatened or extinct. These declines are attributed to two major factors, habitat loss and fungal disease with possible contributions from introduced species, climate change and pollution (Beirne, 2009) [2].

Amphibians are in danger of extinction world over. Habitat loss in considered to be one of the important causal factors. India is home to an astonishing diversity of amphibians. Over 170 species have been described and new species are being described in the Western Ghats. Much of this diversity is endemic and unique to the Western Ghats biodiversity hotspot. However, the studies on amphibians have remained largely taxonomic and have left wide gaps in the knowledge of natural history and ecology of these creatures. There are no field based continuous amphibian monitoring programs in India which is important given the high diversity and endemism of the taxa and the threats to this taxa is likely to face from land degradation and global climate change. This study attempts to narrow these gaps by relating seasonal variations with amphibian assemblages across various micro habits by setting up monitoring program for amphibians in Western Ghats.

Amphibians include frogs, toads, salamander and caecilians, are the first tetrapod vertebrates dwell on land. Rapid amphibian declines have been reported globally in recent years and have raised concern among scientists (Stuart *et al*., 2004) [17]. Except for few species, most of the amphibians show patchiness in their distribution. This patchy and restricted distribution makes them highly vulnerable to extinction, and has major implications in the context of habitat fragmentation (Kumar *et al*., 2002) [13]. Several studies in the Western Ghats on disturbance, loss and fragmentation of the habitat have shown to have negative impact on the amphibian communities (Krishnamurthy 2003; Gururaja *et al*., 2007; Gururaja., 2002; Kumar *et al*., 2002) [11, 13]. Generally, amphibians have relatively wide distribution, bimodal life style, ectothermic conditions with stable environmental temperature of 20-30°C and moist permeable skin. All these have made them highly sensitive and susceptible to the external changes. Hence amphibians are regarded as the best ecological indicators among the vertebrates. The main objectives of this study are to monitor the diversity and distribution of amphibian fauna of Southern Western Ghats and to prepare the checklists of species from different habitats by identifying different frogs available in different habitats.

Hence, the purpose of this study is to provide additional information on amphibian diversity.

Materials and Methods

Study Area

Kalakad Mundanthurai Tiger Reserve (KMTR) is biologically rich and known for high endemism. It is located in Tamil Nadu at the Southern tip of the Western Ghats. KMTR is part of the Agastyamalai Biosphere Reserve, an area rich in plants and animals. KMTR is hilly and quite steep in places (elevation: 100m – 1,880m). It is also a very wet place, getting rains from the advancing and retreating monsoon. It receives a minimum of 1,200 mm and a maximum of 5,000 mm of rain in a year. The dry season is a short 3 – 5 months between February and May. Its highest peak – Agastyamalai (1,880 m) and mountainous forests are often covered in mist.

Locations and Geography

KMTR is situated in the Ashambu Hills of the southern Western Ghats (southern India), with an area of 895 km2 (537 km² is core zone) lying between 8º 25' to 8º 53' N and 77º 10' to 77º 35' E. The elevation ranges from 40 meters to 1867 meters above sea level.

The hill slopes are steep with rugged and undulating terrain intercepted by deep gorges and ravines. The soil type in the upper reaches is clay loam to sandy loam; outer slopes have reddish yellow or sandy loam. The climate is dry, humid and hot at the lower levels, but cooler at elevations of 500 m and above. Temperature ranges between 24 ^{0}C and 44 ^{0}C. It receives rainfall from both southwest (May-August) and northeast monsoons (October- December), but more from the northeast and the rainfall varies from 750 to 3000 mm (Kant, 1994; Parthasarathy, 2001) [9].

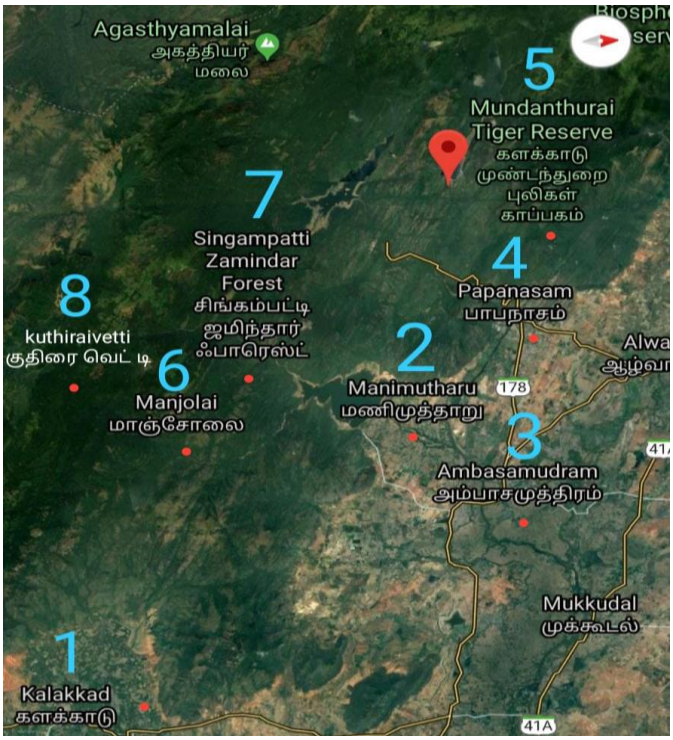
Climate

Three distinct seasons can be identified for the reserve, the northeast monsoon extend from September to December, followed by the dry during January to May and the southwest monsoon period from June to August (Karthikeyan *et al.*, 2001) [10]. The reserve is called a River Sanctuary because of the presence of many streams and rivers (Johnsingh, 2001) [8]. The major river, Tambarabarani and its tributaries flow eastward through the reserve and the 12 other rivers flowing within the reserve are also a perennial water source for irrigation and hydroelectric projects in Tirunelveli district, Southern India. There are a number of reservoirs and swampy areas found here.

Survey

In the selected sampling sites, amphibians were systematically sampled between 18:30 - 20:30hr from June 2018 to March 2019, to quantify seasonal changes in diversity. In the study we analyzed the weekly field observations that were made throughout the study period. Using *ad hoc* searches, we sampled the amphibian diversity in different sites (quadrate) and time-constrained (visual encounter) survey.

Survey was done along streams, in agricultural land and forest patches. No specimens were collected for want of permits but each morpho species was photographed for proper identification. The exact location of different amphibian species was noted. All species encountered were identified using Bossuyt and Dubois (2001), Daniels (2005) and Biju and Bossuyt (2009) and the same were later confirmed by consulting taxonomists.



1. Kalakkad 5. Mundanthurai
2. Manimutharu 6. Manjolai
3. Amasamudram 7. Kannikatti (Singampatti Zamindar Forest)
4. Papanasam 8. Kuthiraivetti

Location map of KMTR in Tirunelveli District, Tamil Nadu

Data Collection

Data were collected on toads and frogs between June 2018 - March 2019, each month one or two field trips of about 3 days duration were completed. During each trips each forest fragment was searched at least once by day and once by night. Each search period lasted 40 min to 3 hours, depending on the size of the fragment and the same total search time was invested during the day and night. Each animal found was characterised with respect to its local location (height above ground, distance from the nearest from the water) and water type (permanent running water, temporary running water, permanent pond or temporary pond and swamps); if the frog was >10 m from one of these aquatic habitats its position was scored as far from water.

To ensure that most of the species existing in each study site were being found, the search for amphibians in each fragment continued until the species accumulation curve against time reached a plateau. The searching time in each fragment varied between 22 and 90 h. Visual encounter surveys were conducted after dark along 100m long transects that originated at each of the set sample points. Surveys were conducted over 2 consecutive nights for minimum 1 person hour per night. The amphibian species were captured from the region preserved in the laboratory. The species were preserved with the help of 80% ethanol. To document the colour, photographs of the animals were taken.

Diversity Indices

Species richness was calculated by using Margalef's index and species dominance was calculated by using Berger-Parker index. They were calculated by using the formulae given below,

1) Margalef's index

Species richness measures provide an instantly comprehensible expression of diversity. It is calculated using the formula,

$D_{mg} = (S – 1)/ \text{In } N$

Where,
S = Number of species present in study area
N = Number of individuals

2) Berger-Parker diversity index

Berger-Parker index is employed to determine whether there is any change in the dominance of species in each habitat. It expresses the proportional importance to the most abundant species. The formula for calculating the Berger-Parker index is

$d = N_{max}/N$

Where,
N = the total number of individuals.
N_{max} = Number of individuals in the most abundant species.

Results and Discussion

Table 1: Amphibian species recorded across sampled study area. Number 1 - 8 indicates individual Micro Habitat; +indicates presence; C-cultivation lands W-water; f-forest area

Name of the species	1	2	3	4	5	6	7	8	Micro Habitat
Family: Rhacophoridae									
Polypedates maculates (Gray, 1833)	+	+	+	+		+	+	+	C
Family: Dicroglossidae									C
Fejervarya sahyadrensis (Annandale, 1919)	+			+			+		C
Fejervarya limnochairs (Gravenhorst, 1829)	+		+		+		+	+	C
Zakerana keralensis (Dubois, 1981)	+	+		+					C
Zakerana caparata (Kuramoto, Joshy, Kurabayashi and Sumida, 2007).	+		+		+		+		C
Hoplobatrachus tigerinus (Daudin, 1802)	+	+	+	+	+	+		+	W,C
Hoplobatrachus crassus (Jerdon 1853)	+	+	+		+		+		W
Euphlyctisaloysii (Joshy, Alam, Kurabayashi, Sumida and Kuramoto, 2009)	+			+	+		+		W
Euphlyctis hexadactylus (Lesson, 1834)				+	+	+		+	W
Sphaerotheca breviceps (Schneider, 1799)	+			+		+			F
Family : Nyctibatrachus									
Nyctibatrachus aliciae (Inger, Shaffer, Koshy & Bakde, 1984)					+			+	F
Family: Bufonidae									
Duttaphrynus melanostictus (Schneider, 1799)	+	+	+	+	+	+		+	C
Bufo scaber (Schneider, 1799)	+	+	+	+		+			C
Family: Microhylidae									
Microhylarubra (Jerdon, 1854)	+	+			+				F
Ramanella variegate (Stoliczka, 1934**)**	+	+	+		+	+		+	F,C
Ramanella montana (Jerdon, 1859)		+	+			+	+	+	CF
Uperodon systoma (Schneider, 1799)		+	+	+				+	F

Diversity of Amphibian in the study sites

A total of 17 species of amphibians belonging to 5 families and 12 genera were documented (Table-1). Among the five families recorded Dicroglossidae had the highest number of species (nine species) followed by Microhylidae (four species), Bufonidae (two species), Rhacophoridae (one species) and Nyctibatrachus (one species). Among the seventeen species, *Duttaphrynus melanostictus* and *Bufo scaber* were most common. It was a commonly encounterd species and showed high relative abundance near human habitation, Family Dicroglossidae contributed 9 species and was wide spread in the study area. *Holobatrachus tigerinus*, *Holobatrachus crassus, Zakerana keralensis, Euphlyctis aloysii and Sphaerotheca breviceps* showed widespread occurrence and were relatively more common than the other species. This family represents most common and diverse habitat dwellers in this region.

Family Rhacophoridae were mainly found in cultivation areas (Ambasamudram landscape). However, common species *Polypedates maculates* showed wide distribution even in other locations in the study area. Microhylid frog, *Microhyla rubra* showed restricted distribution and was found only in specific places. *Uperodon systoma* was found repeated occurrence in the same study area 2,3 and 6 whereas *Ramanella variegate*, *Ramanella montana* was found in all habitat and its occurrence was more common. Microhylid frogs are known for their loud advertisement calls during breeding season. *Nyctibatrachus aliciae* was found rarely in forest areas. Four amphibian species such as *Polypedates maculates, Ramanella variegate, Bufo scaber* and *Duttaphrynus melanostictus* are collected in all 10 months of the study period. *Euphlyctis aloysii* is the most abundant and most frequently encountered species. According to IUCN red list (2009), it is least concerned in threat status.

Table 2: Species, genera and endemics represented in each family recorded from KMTR

S. No	Family	Genera	Species	Endemics
1	Rhacophoridae	1	1	1
2	Dicroglossidae	5	9	4
3	Nyctibatrachus	1	1	1
4	Bufonidae	2	2	1
5	Microhylidae	3	4	2

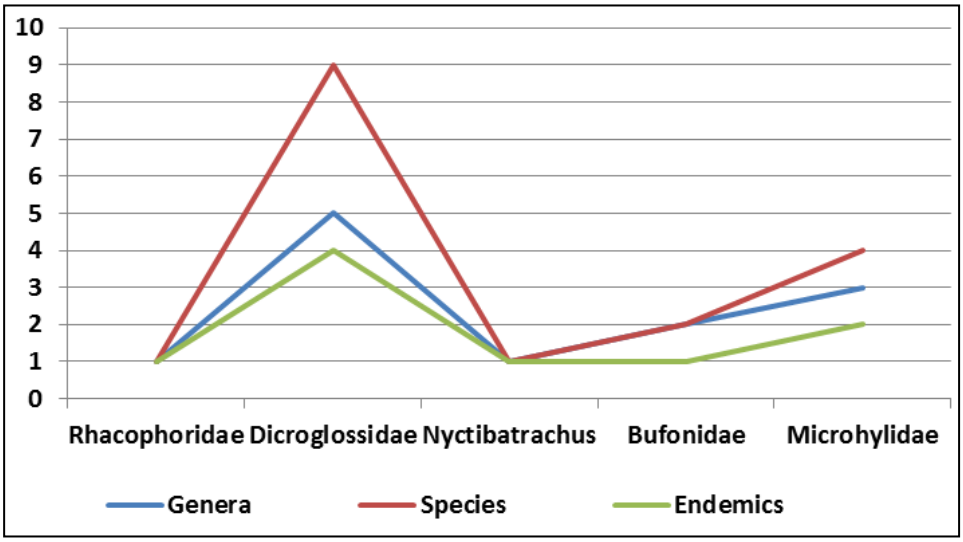


Chart 1: Species, genera and endemics represented in each family recorded from KMTR

Amphibians detected during outside the sampling period were broadly categorize as being found in three habitats; forest, water and cultivation areas. The highest number of species were sighted on Cultivation areas (10 species) followed by forest areas (4 species) water (3 species).

Many species were sighted on agricultural lands species like, *Zakerana keralensis, Polypedates maculates, Ramanella variegate, Fejervarya sahyadrensis* (Table 1 and plate-1 & 2). Some frog species like *Duttaphrynus melanostictus* and *Bufo scaber* were distributed all over the study area while others were found only in some places. *Euphlyctis aloysii, Euphlyctis hexadactylus* and *Holobatrachus spp* was found only in streams and water logged areas. *Nyctibatrachus aliciae* was found in forest areas. Many frogs were also observed dead on the road due to encounters with passing vehicles. The intensity of the road-kill will increase drastically due to the new state highway, and will be a major cause for the decline in the populations.

Table 3: Diversity indices of 17 frog species collected over 10 month's period in 2018- 2019 Lower = below 500 meters, Upper = above 500 meters

	Total number of species in summer		Total number of species in winter		Individual species in summer		Individual species in winter	
Elevations	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
Margalef (D)	6.016	6.231	5.479	5.479	6.275	7	6.107	6.325
Berger- Parker (d)	0.05714	0.1143	0.05528	0.08543	0.06349	0.127	0.06122	0.1122

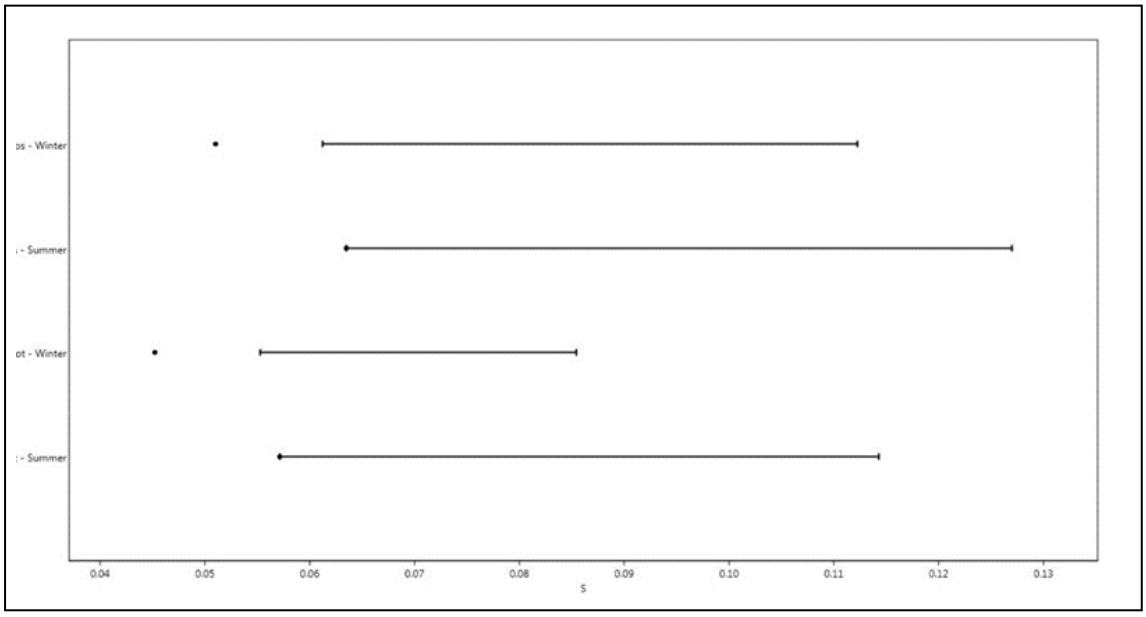


Chart 2: Diversity indices of 17 frog species collected over 10 month's period in 2018- 2019

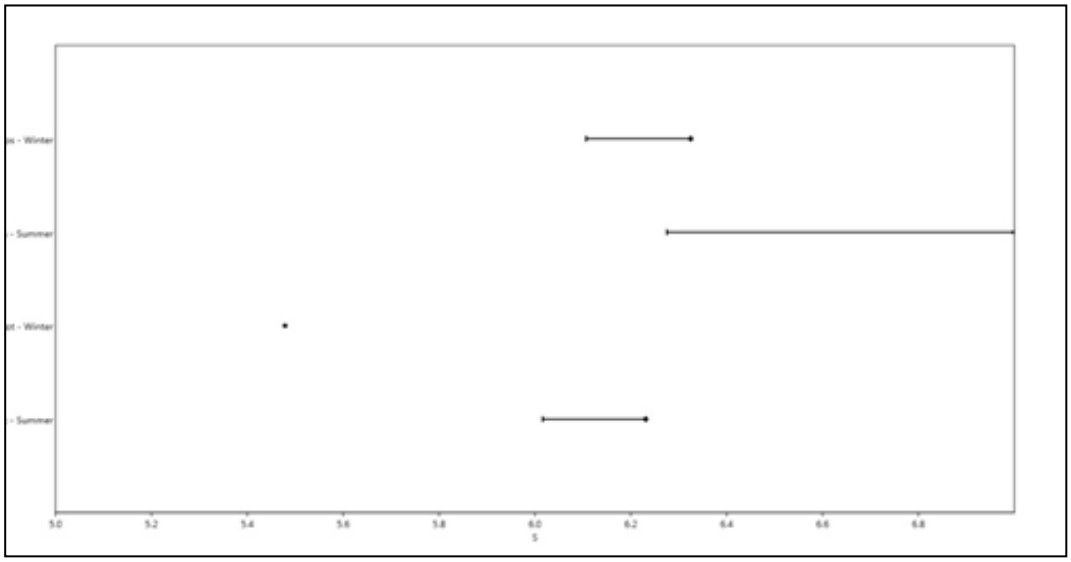


Chart 3: Diversity indices of 17 frog species collected over 10 month's period in 2018- 2019

Diversity Indices of frogs among 10 months

Due to the onset of monsoon, the diversity indices values are more in the month of October **(**winter**)** (D= 5.479) and the values are least in the month of March (summer) (d= 0.08543). The least diversity indices indicates drought during the study period (Table 3). The diversity indices like Margalef's richness (D) and Berger Parker (d) Diversity reveal that even though four frog species are found throughout the study period in all 10 months, wherein the number of individuals of four species like *Polypedates maculates* (n=16), *Ramanella variegate* (n= 14), *Bufo scaber* (n=9) and *Duttaphrynus melanostictus* (n= 4), the values of diversity indices, are predominantly significant for the frog species *Polypedates maculates* (n=16) than and *Duttaphrynus melanostictus* (n= 4). The dots platted in the graph indicates maximum diversity in winter when compare to summer in chart 2 Where as chart 3 depices species richness during winter.

1. *Polypedates maculates*

2. *Zakerana CF. caperata*

3. *Fejervarya sahyadrensis*

4. *Fejervarya limnocharis*

5. *Zakerana keralensis*

6. *Euphlyctis aloysii*

Plate 1: Amphibians recorded in the KMTR

7. *Euphlyctis hexadactylus*

8. *Sphaerotheca breviceps*

9. *Hoplobatrachus tigerinus*

10. *Hoplobatrachus crassus* 11. *Nyctibatrachus aliciae* 12. *Duttaphrynus melanostictus*

Plate 2: Amphibians recorded in the KMTR

13. *Bufo scaber* 14. *Microhyla rubra* 15. *Ramanella variegate* 16. *Ramanella montana*

17. *Uperdon systoma*

Plate 3: Amphibians recorded in the KMTR

Our studies show that there are turnover and abundance changes even on local scales, from one area to another within a hill range. A large proportion (52%) of the arboreal amphibians inhabiting the rainforests of the Western Ghats, in contrast, only 26% of the stream and forest floor amphibians 22% of the caecilians of the Western Ghats rainforests were represented. Animal diversity is traditionally estimated with species inventories. However, such inventories rely on a series of difficult tasks. In most cases, specimens have first to be collected in the field. Once brought back in a Museum collection, specimens have to be sorted out, prepared for examination, and eventually each specimen needs to be identified by a taxonomic expert. Alternatively, vocalising species can be estimated in the fields through aural identification with trained human listeners (Petraborg *et al*., 1953; Bridges and Dorcas, 2000; Rempel *et al*., 2005; Diwakar *et al.*, 2007) [15, 3, 16]. Such remote sampling can produce a large dataset only if it relies on a massive network of observers (Devictor *et al*., 2008) [4]. A global assessment of animal diversity through remote and automatic methods of acoustics cues appears then as an attractive solution to fastidious species inventories. Based on a global analysis of the sound produced by an animal community, two indices were initially developed (Sueur *et al*., 2008b) [18].

The Western Ghats is the flag bearer of biodiversity wealth of India for the very reason that it harbours not only a vast number of flora and fauna, but also many endemic and endangered species; hence it is aptly called biodiversity hotspot for conservation priorities (Myers *et al.*, 2000) [14]. Amphibians as one such group, have led to a number of new descriptions from the region, as many as 21 new species in biogeography, evolution and Gondwara relicts are the other dimensions of research on the amphibian in the Western Ghats.

Nyctibatrachus hussaini is the largest among wrinkled frog (Anura; *Nyctibatrachidae*) described from the Western Ghats. It was a new finding and was given common name as giant wrinkled frog. During a recent fanatic survey at kudremukh national park an anuran specimen was collected from an area close to the type locality of *N. Hussaini*. It is a species of *Nyctibatrachidae* the name is *Nyctibatrachus karnatakaensis. Nyctibatrachus karnatakaensis* adult female collected from shoal forest in *Manikyathara Betta*, Kudremukh national park Karnataka by Rajmohana on 19 October 2005. The specimen is deposited in the faunal holdings of the Western Ghats field research station (WGFRS), Zoological survey of India (ZSI) Calicut, Kerala *N. karantakaensis* is named in honour of the state of Karnataka where in the type locality Kudremukh national park is situated (Aravind *et al*., 2004) discovered more frogs in the Western Ghats. The genus *Philautus* was discovered in India in 1854. Over the 155 year period since then, 32 species under this genus have been reported from the

Western Ghats.

The Toads species were occurred more in number in this area, mainly collected from terrestrial environment. They have hard skin. The Rhacophorus species were occurred more in number in this area, mainly collected from both aquatic and terrestrial environment. They have soft skin. The species Rhacophorus was very large diverse amphibian family and most common group of amphibians. Amphibian research in the Western Ghats looks promoting as 21 new species have been described since 2000 moreover; it has also provided better insights into the aspects of biogeography, Gondware relicts and endemism. Amphibian populations have been declining worldwide due to a number of environmental and human factors with habitat destruction, alteration and fragmentation considered to be the primary causes (Krishnamurthy, 1996; Kumar *et al*., 2002) [12, 13]. As development continues to alter natural landscapes, habitat patches become increasingly isolated from one another and the intervening matrix less suitable to amphibian movement. To improve conservation effects and to help the migrate habitat loss, the design of traditional land uses can be adapted to include critical habitat environments that are spatially arranged with respect to the physiological constrains of amphibians. Landscapes throughout the world are being modified drastically by humans, with profound effects on wildlife.

Conclusion

Due to habitat loss, fragmentation and urbanization a vast land area that provide roost resource for amphibians starts depleting at a greater rate. Hence study on the diversity and habitat is a need of the hour in order to make conservation priorities. The study thus presents well potential habitats of amphibian diversity, furthermore exclusive studies needed from different locations of KMTR to better understand their distributional ranges.

References

1. Bain R, Biju SD, Brown R, Das I, Stuart B, Wilkinson M *et al*. Amphibians of the Indomalayan Realm, 74 – 84. In: Stuart, S.N., Hoffmann, M., Chanson, J.S., Cox, N.A., Berridge, R, Ramani, P and Young, B.E. eds. Threatened Amphibians of the world. Lynx Edicioner, with IUCN – The world conservation Union, conservation International and Native Serve, Barcelona 2005.
2. Berine C, Escolar J, Whitworth A. Yachana Reserve Amphibian and Benthic Surveys. Amazon Phase Report 092, Bergmann's rule in amphibians: combining demographic and ecological parameters to explain body size variation among populations in the common toad Bufobufo. Journal of Zoological Systematics and Evolutionary Research 2009;47:171-180
3. Bridges S, Michael E. *Dorcas.* Recent awareness of *amphibian* declines has raised the need for effective... Article (pdf available) in copeia 2000;2:587-592.
4. Devictor, Romain Julliard, Frédéric Jiguet. First published: Distribution of specialist and generalist species along spatial gradients of habitat disturbance and fragmentation 2008.
5. Dinesh KP, Radhakrishnan CKV, Gururaja, GK Bhatt. An annotated checklist of amphibian of India with some insights into the patterns of species discoveries, distribution and endemism. Records of Zoological Survey of India, Occasional Paper no 2007;302:1-153.
6. Dinesh KP, Radhakrishnan C, Gururaja KV, Deuti K, Bhatt GK. A checklist of amphibian of India 2002. http://zsi.gov.in/checklist/Amphibia_final.pdf
7. https://doi.org/10.1111/j.0030-1299.2008.16215.x
8. Johnsingh AJT. The Kalakad-Mundanthurai Tiger Reserve; A global heritage of biological diversity. Current Science. 2001;80:378-388.
9. Kant P, Report on the management plan of KMTR, 1995-1996 to 2000-2001, 1994, Tamil Nadu Forest Department, Tirunelveli, South India.
10. Karthikeyan V, Kumar A, Chellam R. Structure and composition of the rainforest floor amphibian communities in Kalakad-Mundanthurai Tiger Reserve, 2001. Current Science. 2001;80:406-412
11. Krishnamurthy SV. Amphibian assemblages in undisturbed and disturbed areas of Kudremukh National Park, Central Western Ghats, India. Environmental Conservation 2003;30(3):274-282.
12. Krishnamurthy SV. Habitat features of amphibians in Sringeri, Western Ghats. Zoo's Print Journal 1996;8:2-6.
13. Kumar A, R Chellam, BC Choudhury, D Mudappa, K Vasudevan, NM Ishwar *et al*. Impact of rainforest fragmentation on small mammals and herpetofauna in the Western Ghats,south India. Final Report, April 2002. A Project Funded by the U.S. Fish and Wildlife Service 2002.
14. Myers N, Mittermeier RA, Mittermeier CG, da Fonescaand GAB, Kent J. Biodiversity hotspots for conservation priorities. Nature 2000;403:853-858.
15. Petraborg WH, Wellein EG, Gunvalson VE. Roadside drumming counts a spring census method for ruffed grouse. Journal of Wildlife Management 1953;17:292-295.
16. Rempel JG. Amphibian diseases with bacterial etiologies include... ILAR Journal 2005;48(3):235-254.
17. Stuart L, Janice S, Chanson Neil, A Cox, Bruce E Young, Ana SL *et al*. Rodrigues, Debra L. Fischman, 2004, Status and Trends of Amphibian Declines and Extinctions Worldwide Dec 2004;306(5702):1783-1786. DOI: 10.1126/science.1103538
18. Sueur, Sandrine Pavoine, Olivier Hamerlynck. Stéphanie Duvail Rapid Acoustic Survey for Biodiversity Appraisal, 2008, Published: December 30, 2008. https://doi.org/10.1371/journal.pone.0004065