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Amphibian diversity and distribution in Courtallam, South Western Ghats Foothills, India

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An amphibian survey was conducted in Courtallam at the foothill of Southern Western Ghats and a total of 584 sightings of amphibians belonging to 17 species, six families and 14 genera were obtained between January and December 2012. Cluster analysis and multi dimensional scaling (MDS) analyses revealed diversity pattern(s) of similarity among group and between groups of amphibians in Courtallam.

Key words: Amphibians, foothill, Western Ghats, PRIMER and cluster analysis.

INTRODUCTION

The Western Ghats mountain range of southwestern India, considered as one of the 25 biodiversity hot spots in the world, Myers et al. (2000) is a hot spot of biological diversity. This region has vast number of flora and fauna, and also many endemic and endangered species. Amphibians are represented by high species richness and endemism in India, with two major centres of diversities: the north east India and the Western Ghats (Inger and Dutta, 1986; Jayaram, 1974). Globally 7,044 species of amphibians have been reported (Frost, 2013), and 342 species are known from India (Dinesh et al., 2012). Of the 157 species reported from the Western Ghats, 135 (85.99%) are endemic to the hill range (Dinesh and Radhakrishnan, 2011). Though there are few studies that have looked at the ecological aspects of the amphibians in the Western Ghats, inventories of amphibians are available for many parts of the Ghats; 33 species from the Kerala part of the Nilgiri Biosphere Reserve (Easa 1998), 35 from Kalakad Wildlife Sanctuary (Cherian et al., 2000), 32 from Kalakad-Mundanthurai Tiger Reserve (Vasudevan et al., 2001), and 40 from Anamalai Hills (Kumar et al., 2001)

However, amphibian diversity of the Western Ghats is facing major threats due to deforestation, human dominated land-scapes and rapid urbanization resulting in land use changes, loss and modification of habitat, pollution and traffic noise (Aravind and Gururaja, 2011). Amphibians in India are highly diverse with 337 species of which 301 are anurans (Anil et al., 2011a, b; Biju et al., 2011; Dinesh et al., 2011). The amphibians in India are beginning to be studied in detail (Dutta, 1997), and species are being discovered even now (Robin et al.,

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2013). To implement conservation programmes for amphibians it is important to understand the factors that control their diversity in the region. Amphibians play an important role in the ecosystem because they feed on insects, including many pest species of agricultural crops. They are also important food sources for many larger animals such as water birds, mammals, reptiles, and even spiders and large insects. They often have economical importance to humans as a food source (Mazzoni et al., 2003; Daszak et al., 2004), medical resource in some regions (Chinese medicine) (Zhou et al., 2006), and as an important potential source of future pharmaceutical drugs (Clarke, 1997). In this study, we presented a list of amphibians in and around wetlands of the study area

Most of the endemic species have restricted distribution, confined to the rainforests of the Western Ghats (Vasudevan et al., 2001). This tropical region is covered by large expanses of brooks, swamps, ponds and farm lands all of which have considerable amount of vegetation, breeding ground for amphibians. This area greatly supports the amphibian diversity and provides suitable shelter for the different species of amphibians. In this study, we conducted an extensive amphibian survey in Courtallam at the foothills of the Southern Western Ghats from January to December 2012.

MATERIALS AND METHODS

Study area

Courtallam (8.9342°N 77.2778°E; mean elevation of 160 m (520 ft)) is situated in the southern Western Ghats abutting Tirunelveli district of Tamilnadu. Courtallam has a mosaic and diverse geographical and physical features such as hills and low plains, thorn scrub jungles, rivers and cascades, thick inland forest. The mean daily maximum temperature is 30°C. The weather is quite hot in May and June and the maximum temperature sometimes reaches 39°C. This region enjoys winter (December to March), Summer (April - June), Southwest monsoon (June to September and North east monsoon (October to November). The month of November is generally with maximum rainfall. The annual precipitation ranges from 801 to 1000 mm. The study area includes six wetlands which spread across Tenkasi and chosen randomly for the study (Figure 1). The part of the study area, especially around landscape is dominated by agricultural lands and wetlands which are either rain fed or reservoir fed. Some mountain slopes are protected as reserved forests under the control of the Forest Department.

Survey

In the selected sampling sites, amphibians were systematically sampled between 18:30 - 20:30 h from January to December 2012, 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, quadrat search (size: 5 x 5 m) were demarcated on the forest areas and searched thoroughly by two observers for a period of one year between January and December 2012 on a seasonal basis; dry (December-May) and wet (June-November) seasons (Bhupathy and Sathishkumar, 2013) and time-constrained (visual encounter) survey (Figure 1). 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.

RESULTS AND DISCUSSION

Diversity of amphibian in the study sites

Seventeen (17) species of amphibians belonging to six families and 14 genera were documented (Table 1). Of the six families, Dicroglossidae had the highest number of species (nine species), followed by Microhylidae (three species), Bufonidae (two species), Rhacophoridae (one species), Ranidae (one species) and Nyctibatrachus (one species). Among the seventeen species, *Duttaphrynus melanostictus* and *Duttaphrynus scaber* were most common. It was a commonly encountered species and showed high relative abundance near human habitation. Family Dicroglossidae comprised of nine species and was widespread in the study area. *Sphaerotheca breviceps, Sphaerotheca rolandae,* was rare, each species were found only in burrows on river bank surveyed (Table 1; Plates 1, 2 and 3); *Holobatrachus tigerinus*, *Holobatrachus crassus, Euphlyctis aloysii and Euphlyctis cyanophlyctis* showed widespread occurrence and were relatively more common than the other species. This family represents most common and diverse habitat dwellers in this region. They can be observed in majority of the habitats, including human habitations

Family Rhacophoridae were mainly found in cultivation areas. However, common species, *Polypedates maculates* showed vide distribution even in other locations in the study area. Microhylid frog, *Microhyla rubra* showed restricted distribution and was found only in one site. *Uperodon systoma* was found with repeated occurrence in the same study area site 2, 3 and 6 and *Ramanella variegata* was found in all sites expect site 6 and its occurrence was more common. Microhylid frogs are known for their loud shouts during breeding season. *Nyctibatrachus aliciae* and *Clinotarsus curtipes* were found rarely in forest areas and only one specimen was observed in sites 5 and 2

Amphibians detected 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 water (7 species) followed by forest areas (5 species) and cultivation areas (5 species).

Many species were sighted on agricultural lands species like *P. maculates, Fejervarya sahyadrensis* and *Fejervarya limnocharis* (Table 1; Plate 1, 2 and 3). Some frog species like *D. melanostictus* and *D. scaber* were distributed all over the study area while others were

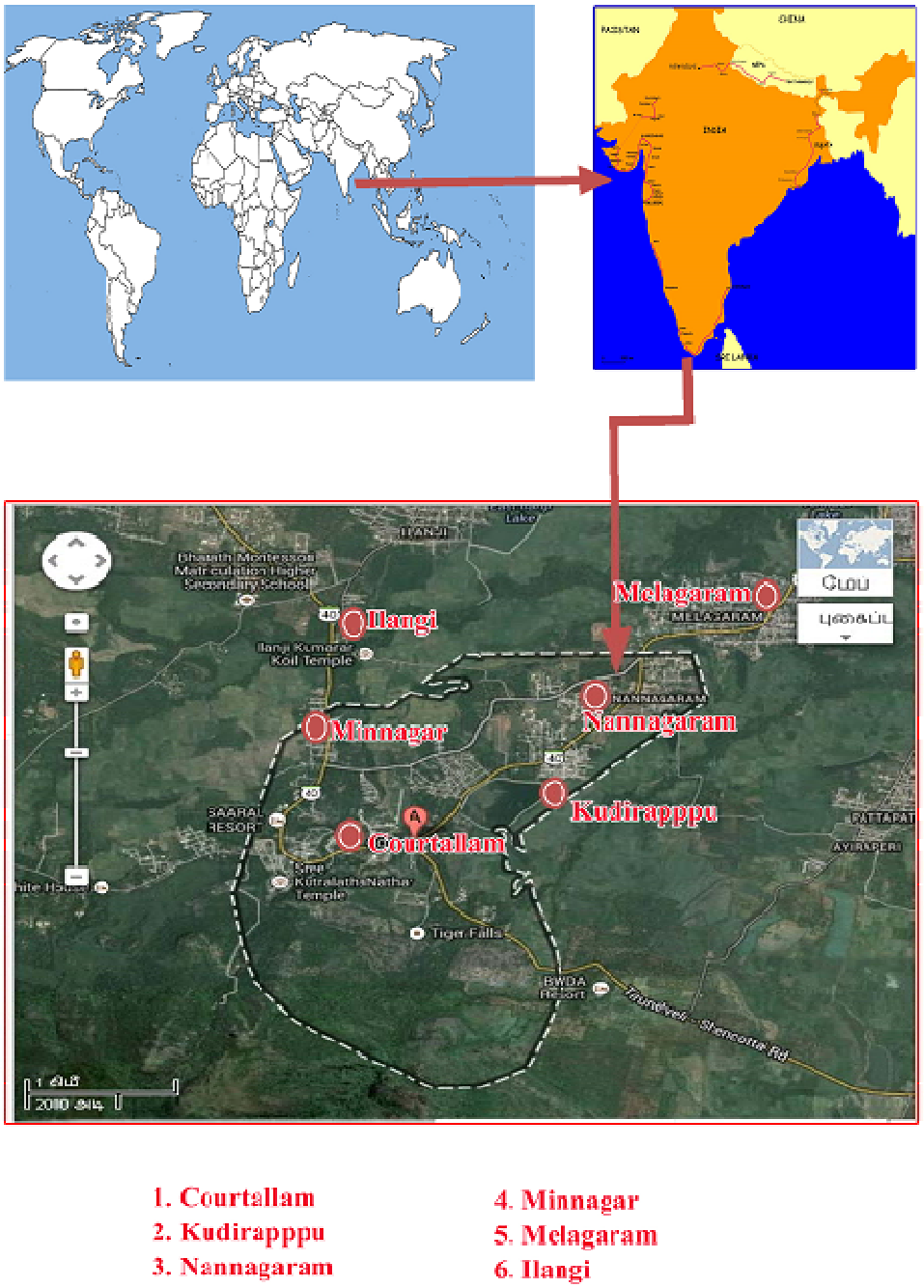

Figure 1. Map showing location of study area and points 1-6 indicate order in which wetlands were sampled.

found only in some places. *Euphlyctis aloysii* and *Holobatrachus* was found only in ponds and water logged areas. *Nyctibatrachus aliciae, Ramanella variegata* and *Clinotarsus curtipes* were found in forest areas. Many frogs were also observed to be 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.

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). As development continues to alter natural landscapes, habitat patches become increasingly isolated from one another and the intervening

Table 1. Amphibian species recorded across sampled study area. Number 1 - 6 indicates individual wet lands as in Figure 1; +indicates presence; C-cultivation lands.

Taxa	1	2	3	4	5	6	Micro habitat
Family: Rhacophoridae							
Polypedates maculatus (Gray, 1833)	+	+	+	+	+		C
Family:Dicroglossidae							
Fejervarya sahyadrensis (Annandale, 1919)	+			+			C
Fejervary limnocharis (Gravenhorst, 1829)					+	+	C
Euphlyctisaloysii (Joshy, Alam, Kurabayashi, Sumida and Kuramoto, 2009)	+			+	+	+	W
Euphlyctis cyanophlyctis(Schneider, 1799)		+	+	+			W
*Euphlyctis hexadactylus(*Lesson,1834)		+	+		+	+	W
Hoplobatrachus tigerinus(Daudin, 1802)	+	+	+	+	+	+	W
Hoplobatrachus crassus (Jerdon 1853)	+	+	+		+	+	W
Sphaerotheca breviceps (Schneider, 1799)						+	W
*Sphaerotheca rolandae (*Dubois ,1983)			+				W
Family :Nyctibatrachidae							
Nyctibatrachus aliciae (Inger, Shaffer, Koshy and Bakde, 1984)					+		F
Family: Bufonidae							
Duttaphrynus melanostictus(Schneider, 1799)	+	+	+	+	+	+	C
Duttaphrynus scaber(Schneider, 1799)	+	+	+	+	+	+	C
Family: Microhylidae							
Microhylarubra (Jerdon, 1854)	+	+		+	+	+	F
Ramanella variegata (Stoliczka, 1934)	+	+	+	+	+		F
Uperodon systoma(Schneider, 1799)		+	+			+	F
Family: Ranidae							
Clinotarsus curtipes (Jerdon, 1853)		+					F

W, water; f, forest area.

matrix is less suitable for amphibian movement.

To improve conservation effects and to help the change 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.

Statistical analysis (multivariate analysis of variance) shows the fact that there is a significant difference noticed in the diversity and the distribution pattern among 17 frog species ($F=55.25$; $p < 0.001$***) in the study area. It further proves that the number of individuals of the frog species, *D. melanostictus* is significantly more than the rest 16 frog species. This dominance may be due to the high adaptability of *D. melanostictus* to the study area. Such a way, there is a significant difference evidenced in the distribution pattern of frog species in the 12 months ($F=4.44$; $p < 0.001$***) during the study period.

Diversity and density of frogs over 12 month's period using the ecological software, PRIMER

Plymouth Routines In Multivariate Ecological Research (PRIMER) is an international software been exclusively used to analyze data of ecological studies. The scope of PRIMER is to analyze data from community ecology and environmental science which is multivariate in character. Cluster analysis and multi dimensional scaling (MDS) of PRIMER is used to find out similarity among group and between groups of organisms in a given area.

The dominance plot (Figure 2) further confirms the fact that the frog species are more and predominant in October and it is least in March. The MDS demonstrate that there are two groups in which October lie at the

Plate 1. Amphibian recorded in the study area.

centre in a group and the March lie at the centre in another group showing that the number of individuals as well as number of species are more in October and least in March (Figure 3).

The cluster analysis further proves that there are two cluster groups. The months of January, February, March, April and May form a cluster and June, July, August, September, October, November and December form

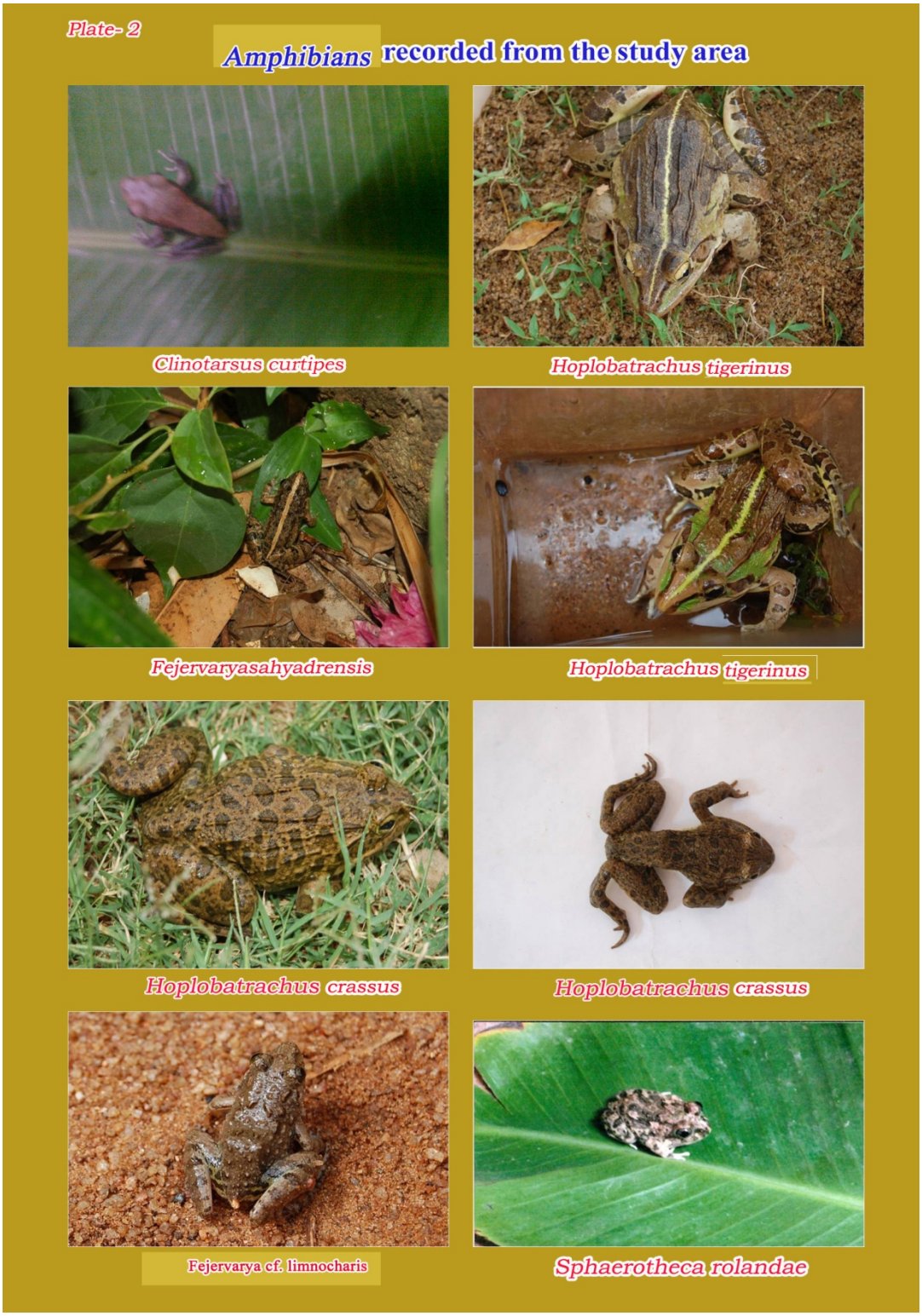

Plate 2. Amphibian recorded in the study area.

another cluster in which, the number of individuals as well as number of species of frogs are predominant in the month of October and least in March (Figure 4).

Frog diversity over the seasons using PRIMER

According to Karuppasamy (2008), the year is divided

Plate 3. Amphibian recorded in the study area.

into four season's namely 1) late post-monsoon (Mar, April and May), 2) pre-monsoon (June, July and Aug), 3) monsoon (September, October and November) and 4) post-monsoon (December, January and February). Pre-monsoon includes dry months whereas, monsoon and post monsoon seasons comprise rainy and wet months and the late post monsoon comprises moderate dry and wet months. The dominance plot of PRIMER further demonstrates the fact that the diversity of frogs is significant in monsoon and it is slightest in the late post monsoon seasons (Figure 5). Likewise, the MDS shows the diversity pattern of frogs in the study sites over four

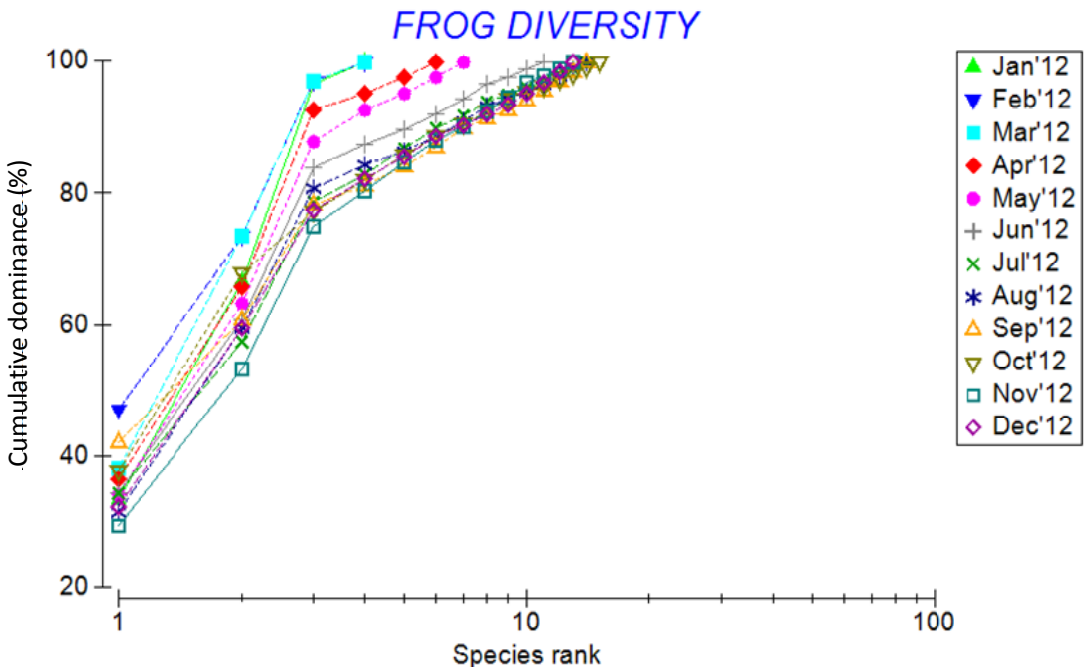

Figure 2. Dominance plot of frog diversity in and around Courtallam between January and December 2012 using PRIMER.

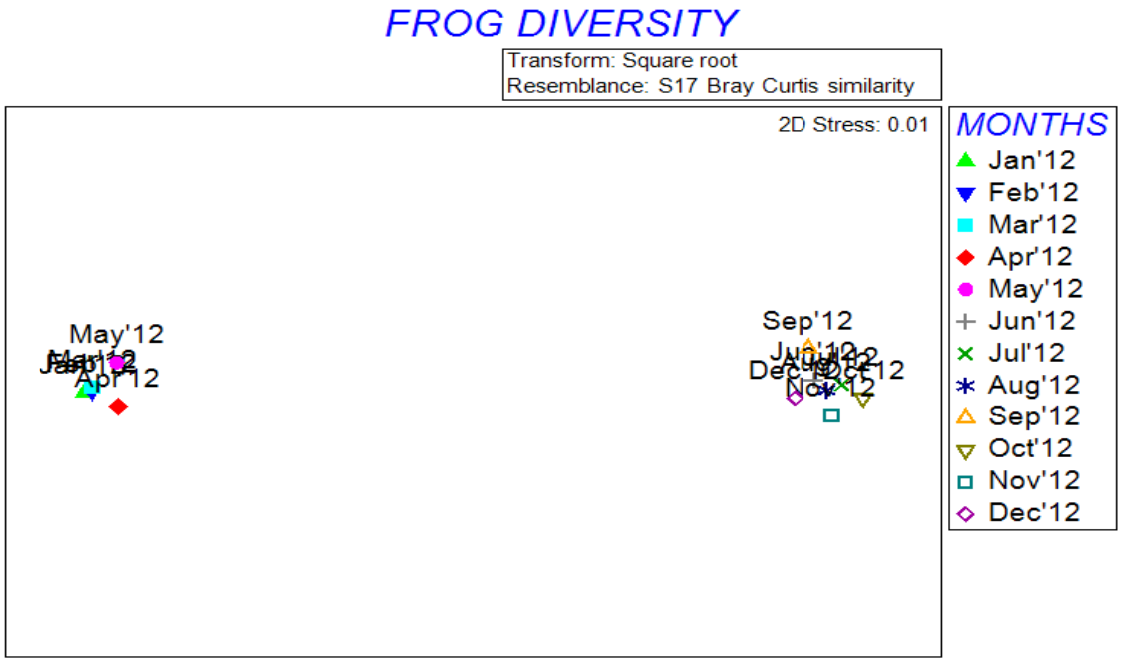

Figure 3. multi dimensional Scaling (MDS) of frog diversity in and around Courtallam over 12 months in 2012 using PRIMER.

different seasons and demonstrate seasonal diversity during the study period (Figure 6). Cluster analysis (Figure 7) illustrates two groups of diversity pattern in which LPM and POM form a group and PRM and MON form an another group, indicating seasonal diversity of frogs over dry and wet seasons in the year during the

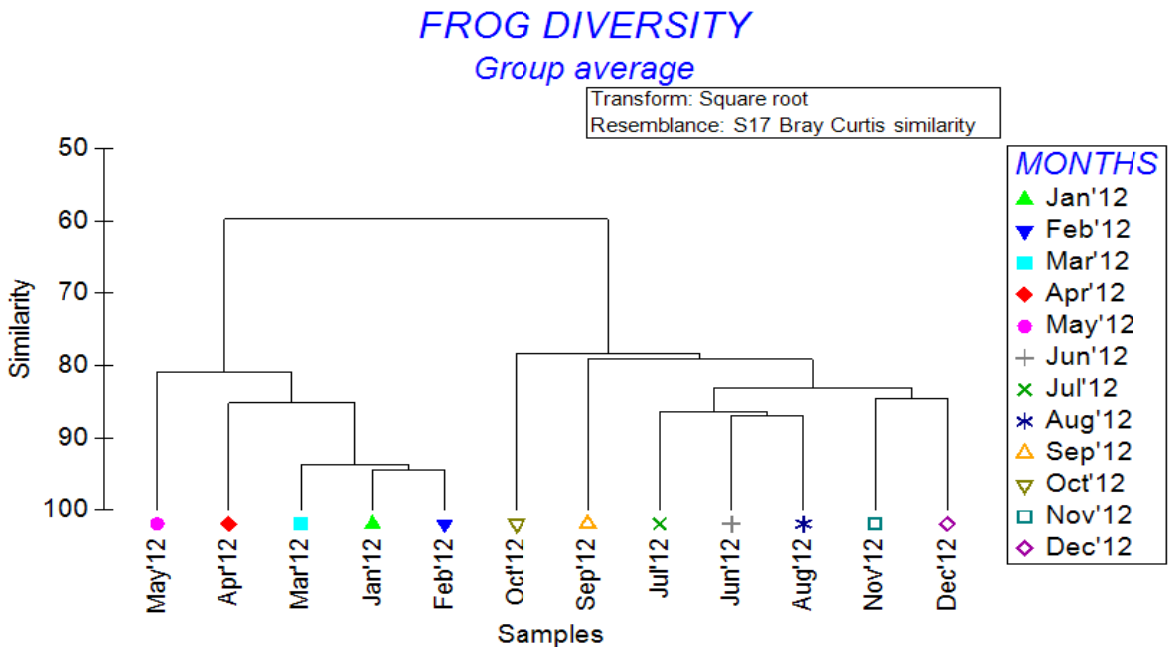

Figure 4. Cluster analysis of frog diversity in and around Courtallam over 12 months using PRIMER.

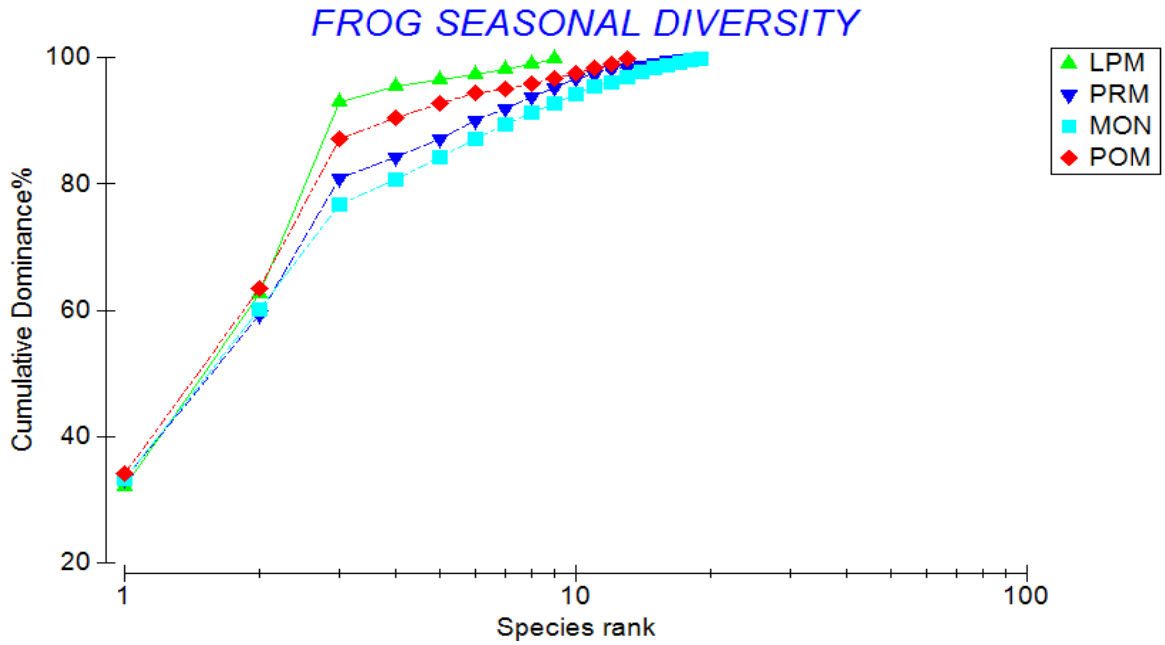

Figure 5. Dominance plot of seasonal diversity of frog species in and around Courtallam in the year 2012 (LPM- late post monsoon, PRM- premonsoon, MON- monsoon, POM-post monsoon).

study period.

Diversity indices of frogs among 17 species

The diversity indices like Margalef's richniess (d), Pielous's evenness (J'), Shanon's richness (H') and Simpson's richness (1/λ) reveal that even though four frog species are found throughout the year in all 12 months, wherein the number of individuals of three species like *D. melanostictus* (n=261), *D. scaber* (n= 197) and *Polypedates maculates* (n=28), the values of

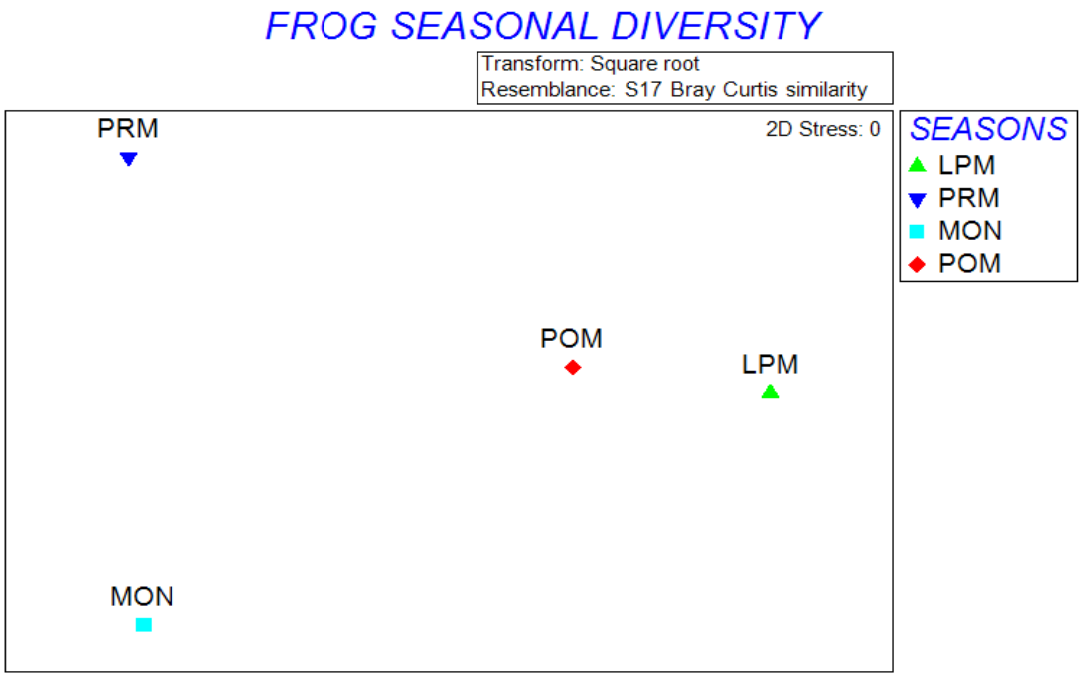

Figure 6. MDS plot of seasonal diversity of frogs in and around Courtallam in the year 2012 (LPM- late post monsoon, PRM- premonsoon, MON- monsoon, POM-post monsoon).

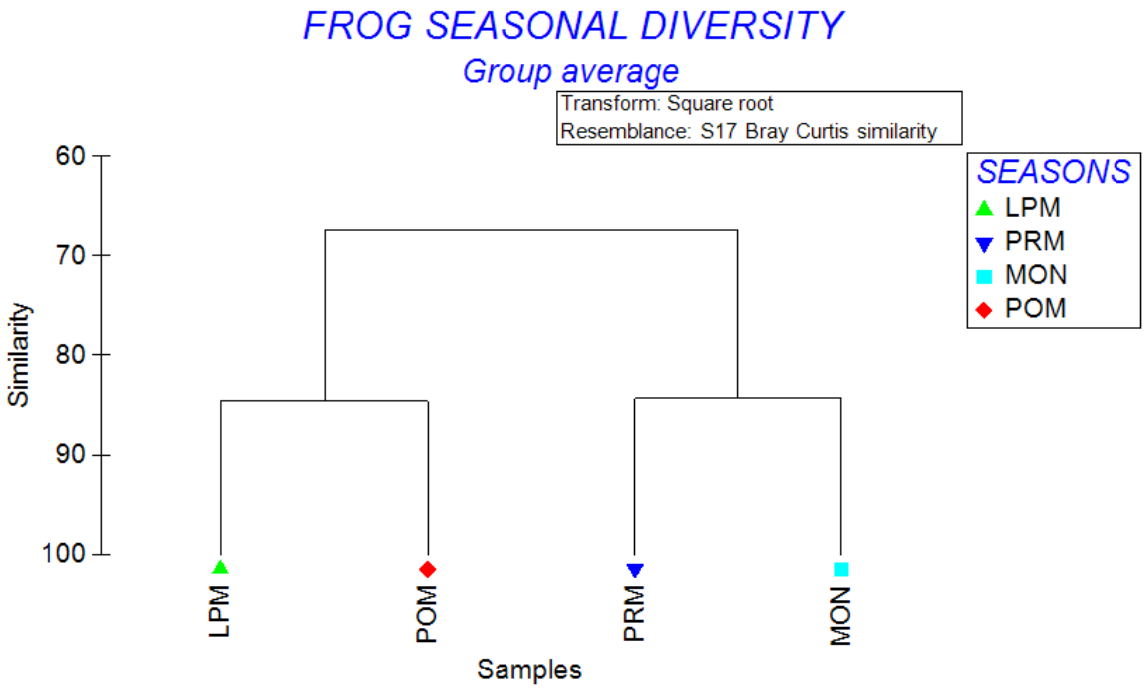

Figure 7. Cluster plot of seasonal diversity of frogs in and around Courtallam in the year 2012 (LPM- late post monsoon, PRM- premonsoon, MON- monsoon, POM-post monsoon).

diversity indices, are predominantly significant for the frog species *P. maculates* (d=3.301118; J'=0.978856; H'= 3.565765; 1/λ= 0.92328) than *D. melanostictus* (d=2.74681; J'=0.961036; H'= 3.445278 (Table 2).

Table 2. Diversity indices of 17 frog species collected over 12 months period in 2012 (N-Number of individuals; d- Margalef's richness, J' - Pielou's evenness, H'- Shanon's richness, 1/λ - Simpson's richness; 0 - denotes insufficient number for analysis).

Frog species	N	d	J'	H'(log2)	1-Lambda'
Polypedates maculates	28	3.301118	0.978856	3.565765	0.92328
Fejervarya sahyadrensis	2	1.442695	0	0	0
Fejervarya limnocharis	2	1.442695	0	0	0
Hoplobatrachus crassus	10	2.171472	0.946412	2.446439	0.888889
Hoplobatrachus tigerinus	12	2.717007	0.951796	2.855389	0.904242
Euphlyctis cyanophlyctis	3	0.910239	0.918296	0.918296	0.666667
Euphlyctis alloysi	3	0.910239	0.918296	0.918296	0.666667
Euphlyctis hexadactylus	3	1.820478	0	1.584963	0
Sphaerotheca breviceps	1	0	0	0	0
Sphaerotheca rolandae	1	0	0	0	0
Nyctibatrachus aliciae	1	0	0	0	0
Duttaphrynus melanostictus	261	2.74681	0.961036	3.445278	0.913831
Duttaphrynus scaber	197	2.78207	0.963193	3.453012	0.915159
Uperodon systoma	5	1.864005	0.950964	1.921928	0.9
Ramanella variegate	19	2.03774	0.953066	2.675596	0.877193
Microhyla rubra	10	2.605767	0.94957	2.721928	0.903333
Clinotarsus curtipes	1	0	0	0	0

1/λ= 0.918516), *Duttaphrynus scaber (*d=2.78207; J'=0.963193; H'= 3.453012; 1/λ= 0.91515159) and *(*d=2.74681; J'=0.961036; H'= 3.445278; 1/λ= 0.913831). This is mainly due to the deviation among the number of individuals collected in these four species every month during the study period.

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. This study generated a base line data on the amphibian fauna of this region, which may help in further studies.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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REFERENCES

Anil Z, Dinesh KP, Kunhikrishnan E, Das S, Raju DV, Radhakrishnan C (2011a). Nine new species of frogs of the genus Raorchestes (Amphibia: Anura: Rhacophoridae) from southern Western Ghats, India. Biosystematica 5(1): 25-48.

Anil Z, Dinesh, KP, Radhakrishnan C, Kunhikrishnan E, Palot MJ, Vishnudas CK (2011b). A new species of Polypedates Tschudi (Amphibia: Anura: Rhacophoridae) from southern Western Ghats, Kerala, India. Biosystematica 5(1): 49-53.

Aravind NA, Gururaja KV (2011). Theme paper on the amphibians of the Western Ghats. Report submitted to Western Ghats ecology panel. MoEF. Electronic database accessible at http://www.westernghatsindia.org/sites/default/files/Amphibians%20 of 20Western%Ghats.pdf.captured on 28 December 2011.

Bhupathy S, Sathishkumar N (2013). Status of reptiles in Meghamalai and its environs, Western Ghats, Tamil Nadu, India. J. Threat. Taxa 5(15): 4953-4961. http://dx.doi.org/10.11609/JoTT.o3595.4953-61.

Biju SD, Bossuyt F (2009). Systematics and phylogeny of PhilautusGistel, 1848 (Anura,Rhacophoridae) in the Western Ghats of India, with descriptions of 12 new species. Zool. J. Linn. Soc.155: 374-444. http://dx.doi.org/10.1111/j.1096-3642.2008.00466.x.

Biju SD, Bocxlaer IV, Mahony S, Dinesh KP, Radhakrishnan C, Anil Z, Giri V, Bossuyt F (2011). A taxonomic review of the Night Frog genus Nyctibatrachus Boulenger, 1882 in the Western Ghats, India (Anura: Nyctibatrachidae) with description of twelve new species. Zootaxa 3029:1-96

Bossuyt F, Dubois A (2001). A review of the frog genus PhilautusGistel, 1848 (Amphibia, Anura, Ranidae, Rhacophorinae). Zeylanica 6:1-112.

Cherian PT, Dev KR, Ravichandran MS (2000). Ichthyo and herpetofaunal diversity of Kalakad WildlifeSanctuary. Zoos Print J. 15(2): 203-206. http://dx.doi.org/10.11609/JoTT.ZPJ.15.2.203-6.

Clarke BT (1997). The natural history of amphibian skin secretions, their normal functioning and potential medical applications. Biol. Rev.

72:365-379. http://dx.doi.org/10.1017/S0006323197005045; http://dx.doi.org/10.1111/j.1469-185X.1997.tb00018.x; PMid:9336100.
Daniels RJR (2005). Amphibians of peninsular India. Universities Press, Hyderabad, p. 268.
Daszak P, Strieby A, Cunningham AA, Longcore JE, Brown CC, Porter D (2004) Experimental evidence that the bull frog (Rana catesbeiana) is a potential carrier of chytridiomycosis, an emerging fungal disease of amphibians. Herpetol. J. 14:201-207.
Dinesh KP, Radhakrishnan C (2011). Checklist of amphibians of Western Ghats. Frog leg 16: 15-21.
Dinesh KP, Radhakrishnan C, Gururaja KV Deuti K, Bhatta G (2012). A Checklist of Amphibia of India with IUCN Red list Status. Updated till September 2012. <http://zsi.gov.in/checklist/Amphibia_final.pdf> downloaded on 25 December 2012.
Dinesh KP, Radhakrishnan C, Gururaja KV, Deuti K, Bhatt GK (2011). A checklist of amphibian of India. http://zsi.gov.in/checklist/Amphibia_final.pdf
Dutta SK (1997). Amphibians of India and Sri Lanka (Checklist and Bibliography), Odyssey Publishing House, Orissa, p. 342.
Easa PS (1998). A report on the herpetofauna of the Periyar Tiger Reserve. KFRI Research Report No. 148, 40pp
Frost DR (2013). Amphibian Species of the World: an Online Reference. Version 5.6 (9January2013).ElectronicDatabase accessible at <http://research.amnh.org/herpetology/amphibia/index.html> American Museum of Natural History, New York, USA. Downloaded on 1 March 2013.
Inger RF, Dutta SK 1986. An overview of the amphibian fauna of India. J. Bombay Nat. Hist. Soc. 83 (suppl.), 135-146.
Jayaram KC (1974). In Ecology and Biogeography in India (ed. Mani,M. S.), Dr W. Junk, the Hague, p. 535.
Karuppasamy K (2008). Species diversity, distribution and behavior of mosquitoes of Srivilliputhur taluk,Tamilnadu. Ph.D. thesis, Madurai Kamaraj University, Madurai.
Krishnamurthy SV (1996). Habitat features of amphibians in Sringeri, Western Ghats. Zoos Print J. 8: 2-6.
Kumar A, Chellam R, Choudhury BC, Mudappa D, Vasudevan K, Ishwar NM, Noon B (2002). 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.
Kumar A, Chellam R, Choudhury BC,Muddappa D, Vasudevan K, Ishwar NM, Noon B (2001). Impact of rainforest fragmentation on small mammals and herpetofauna in the Western Ghats, south India. A summary of research findings. Wildlife Institute of India, Dehra Dun.
Mazzoni R, Cunningham AA, Daszak P, Apolo A, Perdomo E,Speranza G (2003). Emerging Pathogen of Wild Amphibians in Frogs (Rana catesbeiana) Farmed for International Trade. Emerg. Infect. Dis. 9: 995-998. http://dx.doi.org/10.3201/eid0908.030030; PMid:12967500; PMCid:PMC3020601.
Myers N, Mittermeier RA, Mittermeier CG, da Fonescaand GAB, Kent J (2000). Biodiversity hotspots for conservation priorities. Nature 403: 853 - 858. http://dx.doi.org/10.1038/35002501; PMid:10706275.
Robin KAR, Alexander P, Ansil BR, Arun Z, Anil Z (2013).Two novel genera and one new species of tree frog (Anura: Rhacophoridae) highlight cryptic diversity in the Western Ghats of India. Zootaxa 3640 (2):177-189. http://dx.doi.org/10.11646/zootaxa.3640.2.3.
Vasudevan K, Kumar A, Chellam R (2001). Structure and composition of rain forest floor amphibian communities in Kalakad-Mundanthurai Tiger Reserve. Curr. Sci. 80:405-412.
Zhou M, Liu Y, Chen T, Fang X, Walker B, Shaw C (2006). Components of the peptidome and transcriptome persist in lin wa pi: The dried skin of the Heilongjiang brown frog (Rana amurensis) as used in traditional Chinese medicine. Peptides 27:2688-2694. http://dx.doi.org/10.1016/j.peptides.2006.05.009; PMid: 16790295.