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An inventory on herpetofauna with emphasis on conservation from Gingee Hills, Eastern-Ghats, Southern India

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ABSTRACT

The report contributes to the community structure of the amphibians and reptiles and provides preliminary information on species diversity and their microhabitat association in Gingee hills. Gingee hills are located in Southern Eastern Ghats of Tamil Nadu and lying between 12°14′ N, 79°23′E. The forest habitats are composed of mixed dry deciduous forest and thorn scrub forest. A detailed herpetofauna survey was conducted from December 2015 to March 2016. Data collection were carried out by using Time Constrained Visual Encounter Survey method. Of 120 man hours harbors 56 species of herpetofauna, besides 15 species of amphibians belonging to 10 genera and 41 species of reptiles belonging to 30 genera were recorded, of which 21 species were ophidians (55%) and 20 species of lizards (45%). The microclimatic analysis of amphibian the temperature varied with 29.4ºC ± 3.57°C and 30.8ºC ± 2.73°C for reptiles. The amphibian humidity varied with 66.1±14.01% and 61.1 ± 10.21% for reptiles. The niche overlap index shows that many amphibian and reptiles overlapping between each other with maximum value of 0.98. This report indicated that the area is notably large in size of the richness of amphibians and reptiles.

Key words: Amphibians, Reptiles, Diversity, Temperature, Humidity, Niche Overlap

INTROIDUCTION

The Herpetofauna is comprised of five orders (Serpents, Sauria, Crocodylia, Testudines and Amphibia). The reptiles and amphibians are poikilothermic and most of the forms are aquatic, terrestrial, arboreal and saxicolous. India has rich Herpetofaunal diversity having a total of ~518 species of reptile's (Aengals *et al.,* 2011, Venugopal, 2012) and ~384 species of amphibians (Subramanian *et al.,* 2013 and Dinesh *et al.,* 2013a, 2015b). But due to rapid urbanization and anthropogenic pressure, invasive species, agriculture intensification and habitat loss are significant reasons to decline reptiles and amphibians population (Carpio *et al.,* 2015). According to "IUCN Red List", 57% of the amphibians are globally 'threatened' due to lack of a primary database of the species (Rout *et al.,* 2015). Even more tentative are attempts are carried out to estimate the herpetofauna species richness of particular eco-regions. Herpetofaunal research in the south and Southeast Asia has not received much the degree of attention in terms of ecological aspects rather than the other taxa, and much of the research has been in the state of infancy. Intensive field surveys have rarely been carried out and have been published even more rarely. Patterns of species richness on local, regional and global scales have been of great interest to biologists. Information on Herpetofaunal diversity and other ecological aspects are very scanty in Gingee hills than other parts of Eastern Ghats. In other hand developing other tools especially in advance science application, the ecologists and biologist unable to study entire communities, but instead interest is often focused on some convenient and tractable subset (on taxonomic/phylogeny) of a particular community or selective taxa's (Pianka, 1973). Nonetheless, these hills continue to receive less attention for conservation compared to the relatively better-known Western Ghats (Srinivasulu and Das, 2008). The Eastern Ghats hosts some of the very rare herpetofauna such as *Calodactylodes aureus* and *Duttaphrynus hololius* (Kalaimani *et al.,* 2012; Srinivasulu*et al.,*2013). In Eastern Ghats few taxonomic studies were carried out on the eco morphometric of *Duttaphrynus hololius* (Chandramouli *et al.,* 2011) and (Ganesh *et al.,* 2013) new record of *Colubar bholanathi* (Smart *et al.,* 2014) and recently *Chrysopela taprobanica* was discovered from the Eastern Ghats which is a new record & reveal to India (Guptha *et al.,* 2015). However, no attempt was made to carry out in Eastern Ghats for assessing diversity and other ecological aspects of Herpetofauna. Most of the studies are only exist in the form of new records to the area or in the form of regional checklists. In Gingee, most of the species are well adapted to live in rock boulders such as crevices and caves. Our investigation documented some rock cave species *Cnemaspis otai*, *Calodactylodes aureas*, and *Hemidactylus graniticolos* these species are very cryptic and found in rocky habitats. Our study bringing new insight of herpetofauna in detail and their conservation importance of Gingee hills.

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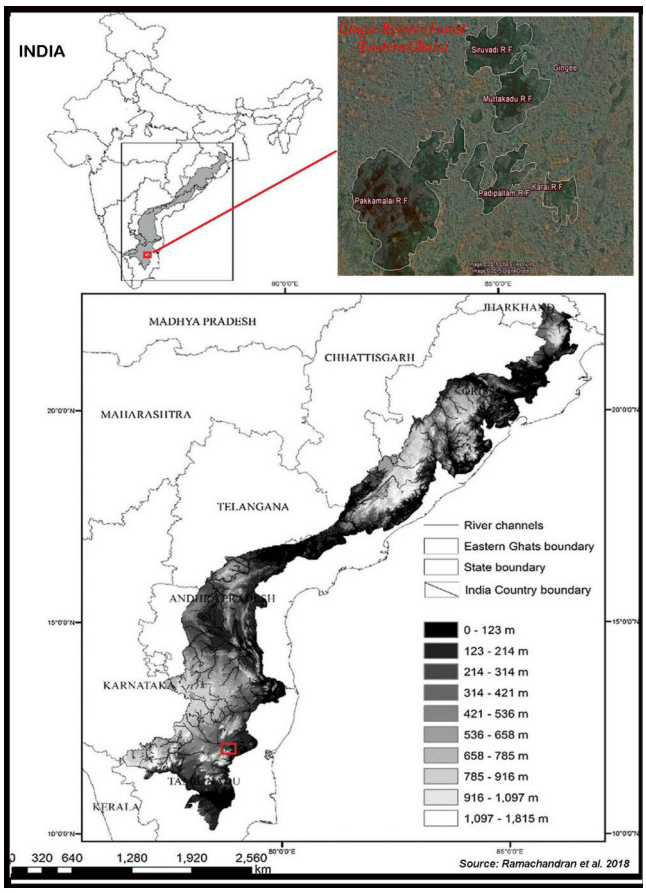

Figure 1. Gingee Hills, Eastern Ghats of Southern India

MATERIALS AND METHODS

Study area

The herpetofauna survey was conducted between December 2015 to March 2016 in Gingee hills (12°14´ N, 79°23´E), Eastern Ghats of Tamil Nadu (Fig. 1). The Eastern Ghats running parallel to east coastline (Bay of Peninsular India) with 1400km stretching from mahendragiri hills of Orissa to shevaroy hills of Tamil Nadu (Mohapatra, 2010 and; Ganesh & Arumugam, 2016). The area consists of low elevation hills having an average elevation of 600m asl, and having a total area of 7043.74ha. Besides, the Gingee hills cover five Reserve Forests namely Muttakadu Reserve Forest (1298.77 ha), Siruvadi Reserve Forest (1441.05 ha), Padipallam Reserve Forest (1457.27 ha), Pakkamalai Reserve Forest (2237.90 ha) and Karai Reserve Forest (608.35 ha). The dominant vegetation is a thorny scrub jungle and tropical dry deciduous forests (Kalaimani, 2011). The habitats of Gingee forest is comprised of thorny shrub jungle, tropical dry deciduous, tropical dry evergreen and the rocky mountains. The area experiences maximum temperature from 30° to 36°C and during winter season 24°C and mean annual rainfall of 700mm (Arulappan *et al.,* 2015).

Estimating species richness of amphibians and reptiles and their microhabitat assessment

The difficulty in collecting data on herpetofaunal communities is well documented, due to the mobility of species, their low density and ability to camouflage and seeking refuge due to human presence or changes in climatic conditions. Therefore, the observer needs to be flexible in the sampling and the surveys were made depends upon the accessibility to different parts of the study area (Neal, 2007). The present study involved an intensive search of herpetofauna on the floor, leaf litter, crevices, rock boulders and on the vegetation which was visually encountered. The random surveys were done by using time constrained visual encounter survey (VES) method (Heyer *et al.,* 1994), which is one of the most commonly used methods for estimating species richness and abundance of herpetofauna. Random walk along the forest trail, animal path, rocky mountains, water paths, grassy patch and forest adjoining areas such as Paddy field and household were undertaken on daily basis to document the herpetofauna. The sampling was made as time constraint during daytime (3 h) and nighttime (3 h) and occasionally afternoon sampling was performed depend upon to the accessibility of the area. Each area was sampling only once for the entire study period and also aim of our study to investigate the species presence / absence status. Whenever an animal has encountered the variables such as species name, a number of sightings, activity of the animal at the time of the sighting, GPS Co-ordinates and Elevation were noted to assess species richness and abundance of herpetofauna. Microhabitat descriptions in the field notes included specific details such as physical characteristics (rocks, ledges, temporary/ perennial stream banks on the ground etc.,) and associated with vegetation (Ward 2012). Microhabitat of the amphibians and reptiles were assessed at the time of sighting and following variables such as name of the species, number of sightings, type of microhabitat (bare ground, building, grass, leaf litter, shrubs, pool, rock and tree location of the animal, temperature, humidity and elevation of the location of the animal sighted were collected during sampling hours. For identification of reptiles and amphibians (Smith, 1935a &1943b; Das, 2002; Daniel, 2002; Whitaker & Captain, 2004; Gururaja, 2011; Deuti, 2014). All data entry, charts & tabulation were performed by using MS Office 2016 package. Estimating species diversity and richness one of the crucial role of in ecological studies. We have used Estimates S8 (Colwell, 2006) & Past 3.0 (Hammer, 2017), which is commonly used for calculating the diversity index. For diversity calculation we have used Shannon Wiener diversity index (H') which is proposed by Shannon & Weaver (1949) following H' = -Σ (pi) [ln(pi)] i =1 where, H' denotes the Shannon wiener index species diversity; n =number species in each communities; pi = proportion of total abundance represented by i^{th} species. Nath *et al.*(2012) and Pielou,(1966), the evenness (e) refers to the degree of relative dominance of each species in that area. It was calculated according to as Equitability (e) = H'/ ln S; where H = Shannon Wiener's index and S = Number of species. For Microclimatic analysis (influence of temperature & humidity), we have used Minitab (Mini. Inc., 2010).

Niche overlap prediction

We also raised question how reptiles and amphibians effectively sharing their habitats does it overlapping between the individuals. For instance and accurate we took

took niche overlap index which is proposed by Pianka (1973) (i.e. microhabitat choice) and followed Nath *et al.,* 2012.

$$Ojk = \frac{\sum pij\, pik}{\sqrt{\sum pij^2 \sum pik^2}}$$

Where, Ojk is the overlapping index between species j and k, and pi is the proportion of a single food item i in the diet of species j and k. Pianka index varies between 0 (total separation) and 1 (total overlap) (Pianka, 1973). Pianka's index (O) varies between 0 (total separation) and 1 (total overlap). When the value close to '1' it will consider as the species sharing their niche with closest one, whereas '0' denotes they never share their niche also called total separation. The present study we took at 8 common species of reptiles and amphibians and their niche sharing and utilization (Table 2 & 3).

Table 1. The diversity of herpetofauna in Gingee Hills

Sampling area	No. of sightings	Richness	Shannon H'	Evenness
Karai	300	13.6	1.391	0.432
Muttakadu	982	10.0	1.688	0.449
Paadipallam	486	10.7	1.679	0.446
Pakkamalai	919	7.7	1.481	0.394
Siruvaadi	537	8.0	1.482	0.394

RESULTS

Estimating species richness and abundance

The herpetofauna species are investigated from December 2015 to March 2016. However total 120 hours sampling and two-man efforts harbor 56 species of herpetofauna belonging to 15 families and 40 genera of reptiles and amphibians (Appendix I). Total 15 species of amphibians which belonging to four families Bufonidae (1 sp.), Dicroglossidae (7 sp.), Microhylidae (6 sp.) and Rhacophoridae (1 sp.) species. On the other hand, 41 species of reptiles belonging to 11 families were Geckonidae (9 sp.), Scinicidae, (5 sp.), Lacertidae, (1 sp.), Agamidae (4 sp.), Varanidae, (1 sp.), Typhlophidae, (1 sp.), Colubridae, (12 sp.), Pythonidae, (1 sp.), Boidae, (2 sp.), Elaphidae, (2 sp.) and Viperidae, (3 sp.) In term of abundance, a total of 1868 individuals of amphibian species and 1378 individuals of reptile's species were sighted during visual encounter survey method. The 56 species of herpetofauna belonged to five families. Most of the individuals recorded belonged to family Agamidae (n=874) and followed by Geckonidae (n=319), Scinicidae (n=98), Serpents (n=80) and Varanidae (n=7) (Appendix 1). Table 1 showing the number of the area covered during our sampling hours and their species richness & diversity index. The area Muttakadu showing the higher number in diversity H'1.68 and the least in Karai H'1.39.The species-area curve indicated that Muttkadu and Siruvadi had a comparatively higher number of rare species than other three areas (Karai, Paadipallam and Pakkamalai, Fig. 2). Since our sampling not good enough for testing rigorous statistics due to sampling unequal and restriction. Therefore the curve is not stabilized as compared with expected numbers (jackknife). But we have achieved the sampling its more close to the expected values (Jackknife). Fig. 2.1 representing the comparison between the actual sampling (Sobs) with the expected sampling (Jackknife).

Microhabitat utilized by amphibians and reptile species

Total 3246 sightings of herpetofauna associated with eight microhabitats (Fig. 3). During visual encounter method the most of the individual were encountered in grass habitat (n=946) followed by pool (n=872), rock boulders (n=752), plant (n=260), leaf litter (n=168), building (n=112), roadside (n=69), bare ground (n=35), tree (n=26), shrubs (n=4) and dead trees (n=2). The microhabitat grass and pool were mostly occupied by amphibian species it because in order to regulate their body temperature according to the ambient. Whereas the reptiles have sighted high number in respective microhabitats viz roadside (verge), rock, a substrate without elements, tree all these shows the species maintain a certain degree of body temperature and humidity from the ambient, since they both are poikilothermic. In terms of ophidians, most of the snake species are observed during road crush survey. None of the amphibian was recorded in only one microhabitat (Appendix II)**.**

Effects of microclimatic on Herpetofauna

Histogram showing the association with microhabitat temperature and herpetofauna in different areas of Gingee Hills, Eastern Ghats are shown in figure (4). The temperature of the herpetofauna ranged from 23ºC to 43° C. The amphibians temperature varied with 29.4 ºC ± 3.57 °C (n = 320) and 30.8 ºC ± 2.73°C (n=611) for reptiles. The relationship between numbers of amphibians and microhabitat temperatures showing a quadratic relationship with a coefficient of determination of 12.55% whereas the reptiles showed a cubic trend with a coefficient of determination of 0.41%. These lines indicated that the amphibians decreased with reference to temperature and would reach an asymptote. On the other hand, in reptiles after reaching an asymptote the increasing temperature decreased the number of reptiles. Histogram showing the association with microhabitat humidity and herpetofauna in different areas of Gingee Hills, Eastern Ghats are shown in figure (4.1). The humidity of the herpetofauna ranged from 40 to 100%. The amphibians humidity varied with 66.1 ± 14.01% (n = 320) and 61.1 ± 10.21% (n = 611) for reptiles. The relationship between numbers of amphibians and microhabitat humidity showing a linear negative relationship with a coefficient of determination of 14.96% whereas the reptiles showed a quadratic trend with a coefficient of determination of 19.02%. These lines indicating that the number of amphibians increased with reference to increasing in humidity. On the other hand, the number of reptiles decreased with reference to increase in humidity and then increased the number of reptiles.

Niche overlap between reptiles and amphibians

The most consistently significant correlate with reptiles and amphibians decline risk is geographic range size

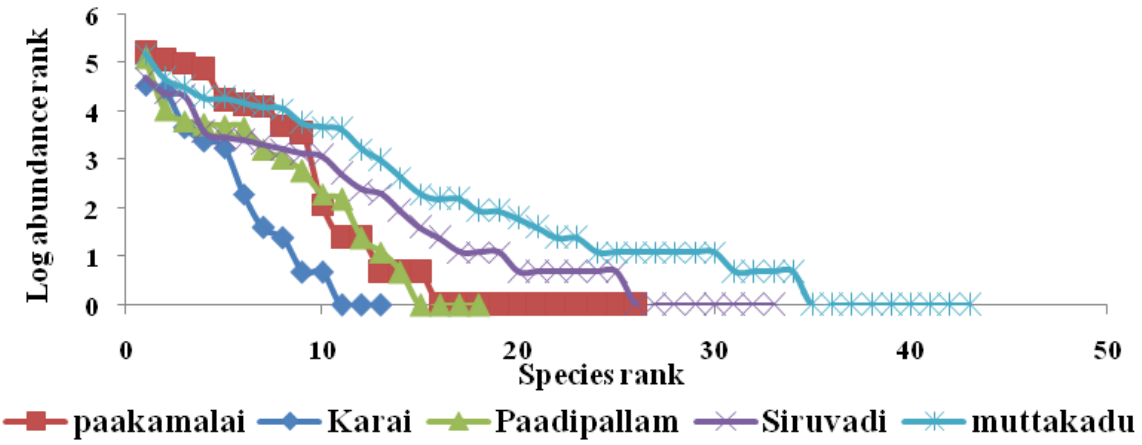

Figure 2. Species-area curve for herpetofauna in different areas of Gingee Hills

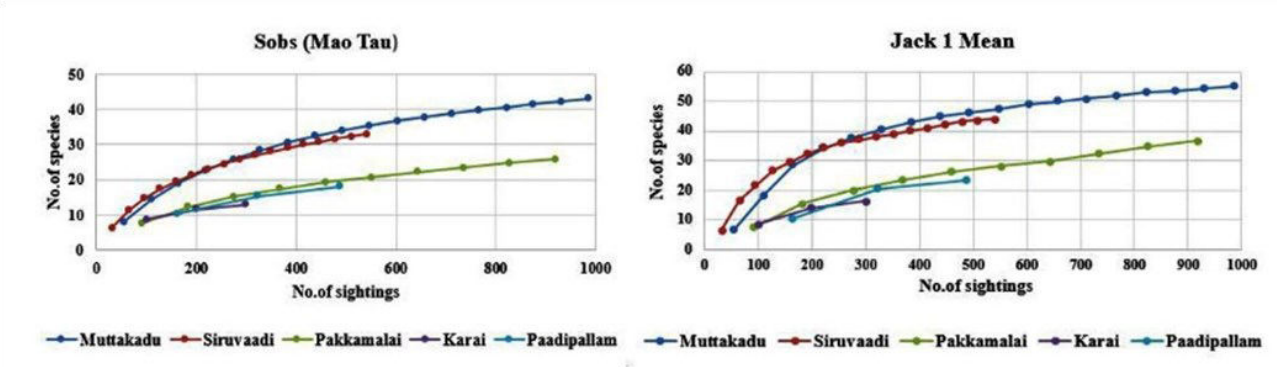

Figure 2.1. The diversity index of herpetofauna

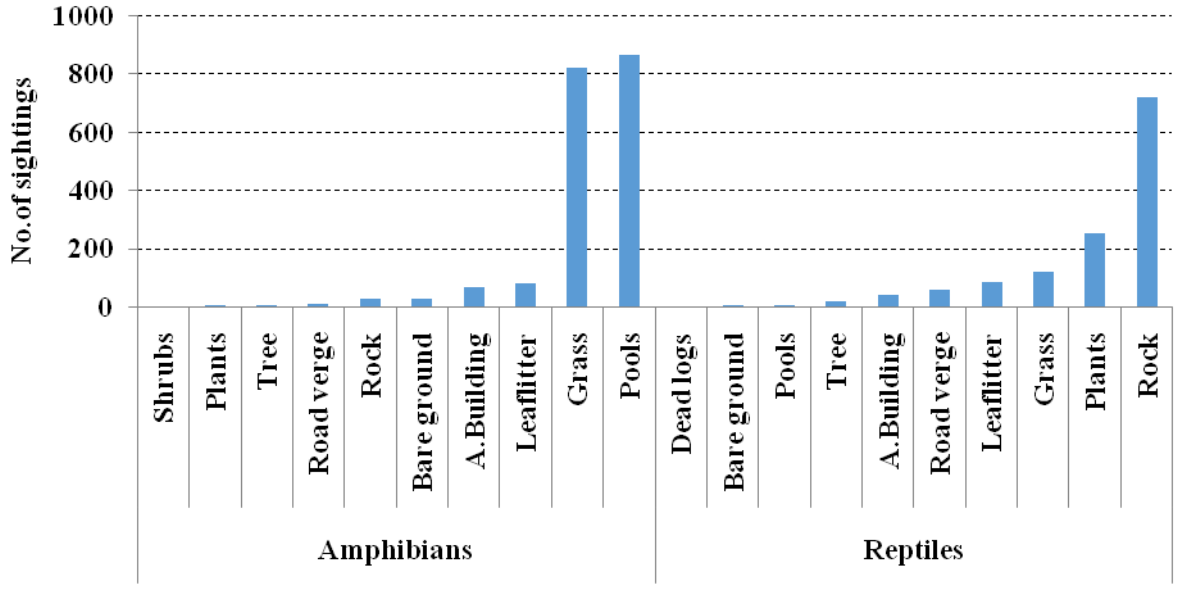

Figure 3. Micro-habitats association of Herpetofauna

and resource availability. The range-restricted species are more likely to decline and become threatened. A species occupy an area based on three requirements: (i) the environmental suitability;(ii) the species must be able to disperse and (iii) the successfully compete with other species and survive predation (Botts *et al.,* 2012). Those are important factors to understanding the niche concept. We found the most of the individuals sharing their habitat with sister species and others (Table 2 & 3). Which shows the species sympatry but they never compete each other's. The amphibian has a higher number of overlap than the reptile species (i.e) *Euphlyctis hexadactylus* overlap with *Euphlyctis cf. cyanophlyctis* in **0.9** and following species *Microhyla ornatai* with *Fejervarya cf. limnocharis* **(0.9)** and *Duttaphrynus melanostictus* **(0.9).**The *Hoplobatrachust igerinus* with *Euphlyctis cf. cyanophlyctis* **(0.9)** and *Euphlyctis hexadactylus* **(0.9).** The species *Microhylarubra* with *Fejervarya cf. limnocharis* **(0.9) ;** *Euphlyctis cf. cyanophlyctis* **(0.9)**; *Duttaphrynusmelanostictus* **(0.9)** and *Microhylaornate* **(0.9)**. The species *Sphaerotheca breviceps* with *Fejervarya cf. limnocharis* **(0.9)** ; *Duttaphrynus melanostictus* **(0.9).** *Microhylaornate* **(0.9)** and *Microhylarubra* **(0.9)** (Table 2)**.** Whereas the reptile niche overlaps the species *Calotes cf. versicolor* with *Psammophilus cf. dorsalis* **(0.8)** and following species *Calodactylodes aureas* with *Psammophilus cf. dorsalis* **(0.9)**; *Ophisops leschenaultia* with *Psammophilus cf. dorsalis* and *Calodactylodes aureas* **(0.8)**.The species *Atretium schistosum* with *Amphiesma stolatum* **(0.8)** (Table 3)**.**

DISCUSSION

The herpetofauna species were investigated from December 2015 to March 2016 in five areas *viz*., Karai, Muttakadu, Paddipallam, Pakkamalai and Siruvadi of Gingee hills, Eastern Ghats, Southern India. Totally 56 herpetofauna species were recorded during study period belonging to 15 families and 40 genera of both reptiles and amphibians. The microclimatic analysis shows there is not much influence of temperature and humidity with reference to reptile and amphibians diversity. It's because we had lack of seasonal sampling and large sampling too. But though we highlighting the association of reptile and amphibians according to the number of amphibians increased with reference to increasing humidity, whereas in reptiles the number of individual decreased with reference to increasing the humidity. The account of temperature when the number of amphibians decreased with reference to increasing temperature, whereas the number of reptiles decreased when the temperature reaches asymptote level. The niche overlap among the amphibians and reptiles, the amphibians has a high number of overlaps (i.e) the species such as *Euphlyctis hexadactylus, Euphlyctis cf. cyanophlyctis, Hoplobatrachus tigerinus* and *Fejervarya cf. limnocharis* always found in the water bodies and following grassy species *Microhyla ornate*and *Microhyla rubra*. The *Duttaphrynus melanostictus* and *Sphaerotheca breviceps* found almost all microhabitats. For reptile the rock associated species *Calodactylodes aureas* and *Psammophilus cf. dorsalis* highly overlapping due to the same niche (rock) specialization. Following the leaf litter associated species *Ophisops leschenaultia* and *Eutropis carinatus*. The *Calotes versicolor* and the *Sitana ponticeriana* found almost all habitats (especially in lower elevation). During our study, we record *Eutropis beddomei* which is first sighting in Gingee hills and also after long gap (after Whitekar & Captain, 2004), we had sighted *Trimeresurus gramineus* from this study. Among the amphibians, 9 species (*Duttaphrynus melanostictus, Euphlyctis cyanophlyctis, Euphlyctis hexadactylus, Fejervarya cf. limnocharis, Hoplobatrachust igerinus, Sphaerotheca breviceps, Sphaerotheca rolandae, Microhyla ornate* and *Microhyla rubra*) were found commonly during the whole study period and 5 species (*Hoplobatrachus crassus, Uperodon taprobanica, Uperodon variegate, Uperodon systoma* and *Polypedates cf.maculatus*) were found occasionally and almost similar observations were made by Srinivasulu & Das 2008. Among the reptiles, 8 species (*Calodactylodes aureas, Hemidactylus frenatus, Hemidactylus trietrus, Eutropis carinata, Ophisops leschenaultii, Calotes cf. versicolor, Psammophilus cf. dorsalis,* and *Sitana ponticeriana*) found commonly during the whole study period, 8 species (*Cnemaspis otai, Hemidactylus graniticolos, Hemidactylus leschenaultii, Hemidactylus cf. brooki, Eutropis macularia, Lygosoma punctatus, Calotes calotes*, and *Varanus bengalensis*) found occasionally and 6 species (*Indotyphlops cf. braminus, Ahaetulla cf. nasuta, Amphiesma stolatum, Atretium schistosum, Coelognathus h. helena, Dendrelaphis tristis, Dryocalamus nympha, Macropisthodon plumbicolor, Oligodon arnensis, Oligodon taeniolatus, Ptyas mucosa, Xenochrophis piscator, Lycodon aulicus, Python m. molurus, Eryx johnii, Eryx conicus*, *Bungarus caeruleus, Naja naja, Trimeresurus gramineus, Daboia russelii* and *Echis carinata*) found very uncommon. Most of these uncommon species are snakes and can only sight during night hours as they were nocturnal habitat an earlier, a report by Srinivasulu & Das (2008) also indicated almost the similar pattern which was recorded in this research.

Conservation importance of "Eastern Ghats" and "Gingee Hills"

The Eastern Ghats though being unique and is less studied compared to the Western Ghats (Srinivasulu & Das, 2008). The research reports on the herpetofauna were mostly on the taxonomy, checklist in different parts of Eastern Ghats. But this study was attempted the virgin areas of Eastern Ghats i.e. Gingee hills which were not explored earlier. The list indicated that the research on the herpetofauna was scanty and sporadic in Eastern Ghats in general and the Gingee Hills in particular. But the current study fulfilled the lacuna. Subsequently many surveys, reconnaissance explorations and studies were undertaken (Murthy, 1968a &1980b ; Mahony, 2009 ; Rao & Rao, 1998); Mohabatra *et al.,* 2010; Chettri & Bhupathy, 2010; Rao *et al.,*2005a & 2010b; Srinivasulu *et al.,*2005a & 2006b; Gupta,2012a & 2012b & 2015c; Javed *et al.,*2010; Murthy, 2008; Srinivasulu & Das, 2008; Srinivasulu *et al*., 2009; Seetharamaraju *et al.,* 2009; Upadhye, 2010; Javed *et al.,* 2011; Seetharamaraju *et al.,* 2011; Jena *et al.,* 2013 ; Reddy *et al.,* 2013; Seetharamaraju &Srinivasulu, 2013 ; Srinivasalu *et al.,* 2013; Ganesh *et al.,* 2013 and Ganesh

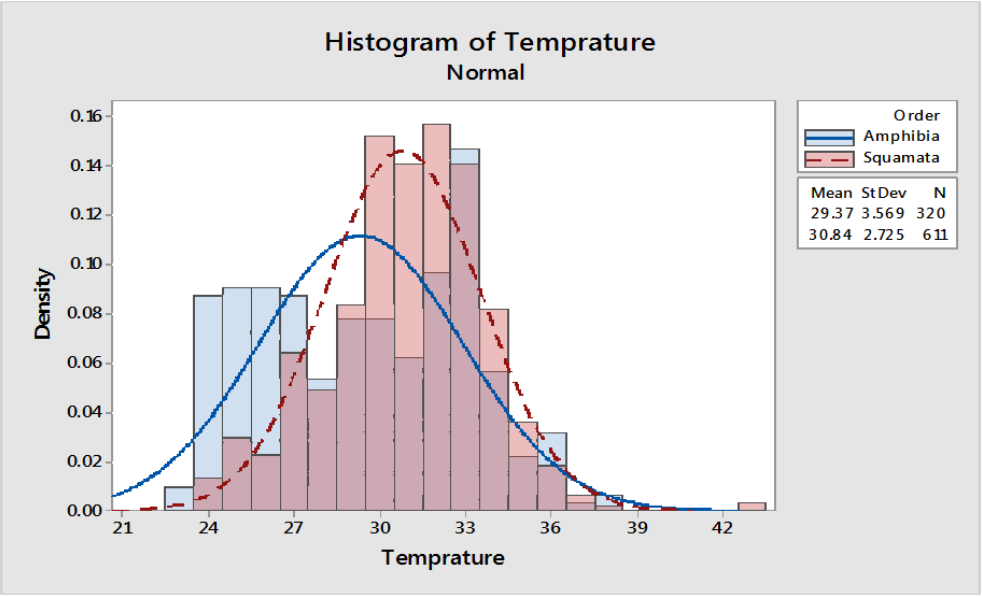

Figure 4. Histogram showing the association between temperature and herpetofauna in different areas of Gingee Hills, Eastern Ghats

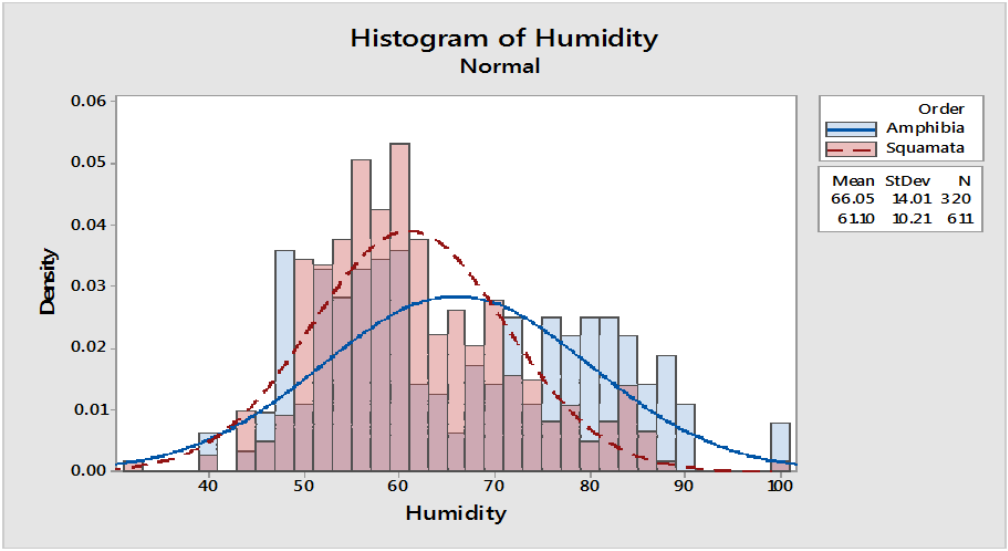

Figure 4.1. Histogram showing the association with humidity and herpetofauna in different areas of Gingee Hills, Eastern Ghats

& Arumugam,2015a, 2016b which documented the herpetofaunal species in the Eastern Ghats. New regional records of *Duttaphrynus hololius* by Bharkavi *et al.* (2013) and *Duttaphrynus hololius* ecological component see by Chandramouli *et al.* (2011). *Hemidactylus treultrii* by Srinivasulu *et al.* (2014), *Eutropis innota* by Rao *et al.* 2010) and *Oligodon teaniolota* by Seetharamaraju *et al.* (2011) in the Eastern Ghats of Andhra Pradesh. In addition, *Colubar bholanathi* was recorded by Smart *et al.*(2014) in Gingee Hills of Eastern Ghats. All information shows how the Eastern Ghats being unique and having such mass diversity of flora and faunal species, these hills shelter for many cryptic species as reported by earlier authors. However, due to developmental pressure, anthropogenic activity and other agriculture intensification the Eastern Ghats habitats are questioned. The Eastern Ghats needs to protect by taking effective conservation measures and long-term monitoring of flora and faunal species. According to the local information in Gingee hills and their vicinity, the abundance of herpetofauna is in decreasing trend due to loss of habitat, poaching, killing and consuming by local people. Especially, *Varanus bengalensis*, *Eryx johnii*, *Eryx conicus* and *Geochelon eelegans* were being killed by local people for meat and illegal smuggling and the same kinds of threats were reported by Walmiki *et al.* (2012) and also information obtained from the forest department of Gingee. Similarly, *Python molurus molurus* was poached for leather. *Naja naja* is highly poisonous and hence the people kill this species whenever they encounter them. In Gingee Forest, NH 66 (Tindivanam Road) lying or closer between the two reserve forests (Muttakaadu R.F and Siruvaadi R.F) and in this highway lots of vehicles passing with high speed. A 30% of Herpetofauna species has been killed by vehicular traffic. Hence, the speed control in the higher animal dense areas the speed limit should be

Table 2. Niche overlap between amphibian species

	Fejervarya cf. limnocharis	*Euphlyctis cf. cyanophlyctis*	*Duttaphrynus melanostictus*	*Euphlyctis hexadactylus*	*Microhyla ornata*	*Hoplobatrachus tigerinus*	*Microhyla rubra*	*Sphaerotheca breviceps*
Fejervarya cf. limnocharis		0.18803	**0.93119**	0.19028	**0.98258**	0.21727	**0.98084**	**0.92916**
Euphlyctis cf. cyanophlyctis			0.13402	**0.99999**	0.02239	**0.99955**	**0.98422**	0.00226
Duttaphrynus melanostictus				0.13680	**0.92494**	0.06151	**0.97131**	**0.97492**
Euphlyctis hexadactylus					0.00467	**0.99966**	0.10066	0.00454
Microhyla ornata						0.03224	**0.98127**	**0.94793**
Hoplobatrachus tigerinus							0.12763	0.03049
Microhyla rubra								**0.98280**
Sphaerotheca breviceps								

Table 2.1. Niche overlap between reptile species

	Psammophilus cf. dorsalis	*Calotes cf. versicolor*	*Calodactylodes aureas*	*Sitana ponticeriana*	*Ophisops leschenaulti*	*Eutropis carinata*	*Amphiesma stolatum*	*Atretium schistosum*
Psammophilus cf. dorsalis		**0.08304**	**0.99775**	0.14469	**0.90588**	0.49241	0.00369	0
Calotes cf. versicolor			**0.71267**	0.18291	0.07733	0.23937	0.01763	0
Calodactylodes aureas				0.13307	**0.89549**	0.47570	0	0
Sitana ponticeriana					0.29529	0.72653	0.19606	0.01315
Ophisops leschenaulti						0.76262	0.09654	0.00491
Eutropis carinata							0.205144	0.042318
Amphiesma stolatum								**0.86941**
Atretium schistosum								

enforced. During our survey we got frequently road kills highly in serpents (Fig. 5). Most of the macaque and langurs got injured highly (losing hands & tails, jaw dislocation & disease symptoms) it's because the highway crossing and people threw food garbage on the roadside. So the recent decade these animals use to stay on either side of the roads because of the garbage. So not only snakes even other large taxa like such as Golden jackal, Macaque, Langur, Rudy mongoose & Wild boar also hit by the vehicle trafficking (Personal observation). The anthropogenic pressures such as Non-Wood Forest Product i.e. firewood collection, medicinal plants collection, and cattle grazing, hunting and human encroachment are significant factors which are causing declined the herpetofauna species population and their distribution. Further, (Ward, 2012) also emphasized the impact of these factors on the conservation of herpetofauna. Gingee hills are an urge to protect habitat and flora/fauna by taking effective conservation measures. In this investigation, it is clear that a long-term study in this area is needed on the ecology and distribution of herpetofauna to learn the wealth of this virgin ecosystem and there are possibilities to recover/rediscover/occurrence of new species.

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Appendix I: Checklist of herpetofauna from Gingee Hills, Eastern Ghats, Southern India

S.No	ORDER	SPECIES/FAMILY	COMMON NAME	IUCN STA-TUS
		Bufonidae		
1		*Duttaphrynus melanostictus*	Black-Spectacled Toad	LC
		Dicroglossidae		
2		*Euphlyctis cf. cyanophlyctis*	Common Skittering Frog	LC
3		*Euphlyctis hexadactylus*	Indian Pond Frog	LC
4		*Fejervarya cf. limnocharis*	Indian Cricket Frog	LC
5	**Amphibia**	*Hoplobatrachus crassus*	Jerdon's Bullfrog	LC
6		*Hoplobatrachus tigerinus*	Indian Bullfrog	LC
7		*Sphaerotheca breviceps*	Indian Burrowing Frog	LC
8		*Sphaerotheca rolandae*	Roland's Burrowing Frog	LC
		Microhylidae		
9		*Uperodon taprobanica*	Sri Lankan Painted Frog	LC
10		*Microhyla ornata*	Ant Frog	LC
11		*Microhyla rubra*	Red narrow-mouthed frog	LC
12		*Uperodon variegata*	Eluru Dot Frog	LC
13		*Uperodon systoma*	Marbled Balloon Frog	LC
14		*Uperodon* sp.		
		Rhacophoridae		
15		*Polypedates maculatus*	Common Tree Frog	LC
		Geckonidae		
16		*Calodactylodes aureas*	Golden Gecko	NA
17		*Cnemaspis cf. otai*	Vellore day Gecko	Vul
18		*Cnemaspis* sp.	Dwarf Gecko	-
19		*Hemidactylus frenatus*	Common House Gecko	LC
20		*Hemidactylus graniticolos*	Common Rock Gecko	NA
21	**Squamata**	*Hemidactylus leschenaultii*	Bark Gecko	NA
22		*Hemidactylus trietrus*	Termite hill Gecko	NA
23		*Hemidactylus cf. brooki*	Brook's Gecko	NA
24		*Hemidactylus* sp.	-	-
		Scinicidae		
25		*Eutropis beddomii*	Beddome's Skink	NA
26		*Eutropis carinata*	Keeled Indian Mabuya	LC
27		*Eutropis macularia*	Bronze Grass Skink	NA
28		*Lygosoma punctatus*	Snake Skink	NA
29		*Eutropis* sp.	-	-
		Lacertian		
30		*Ophisops leschenaultii*	Leschenault's Snake-Eye Skink	NA
		Agamidae		
31		*Calotes calotes*	Green lizard	NA
32		*Calotes cf. versicolor*	Oriental Garden lizard	NA
33		*Psammophilus cf. dorsalis*	South Indian Rock Agama	LC
34		*Sitana ponticeriana*	Fan Throated lizard	LC
		Varanidae		
35		*Varanus bengalensis*	Common Indian Monitor	LC
		Typhlophidae		
36		*Indotyphlops cf. braminus*	Brahminy Wormsnake	NA

	Colubridae		
37	*Ahaetulla nasuta*	Green Vine Snake	NA
38	*Amphiesma stolatum*	Striped Keelback	NA
39	*Atretium schistosum*	Olive Keelback Water Snake	LC
40	*Coelognathus helena helena*	Common Trinket Snake	NA
41	*Dendrelaphis tristis*	Common Bronze Back Tree Snake	NA
42	*Dryocalamus nympha*	Bridal Snake	NA
43	*Macropisthodon plumbicolor*	Green Keelback	NA
44	*Oligodon arnensis*	Common Kukri Snake	NA
45	*Oligodon taeniolatus*	Russel's Kukri Snake	NA
46	*Ptyas mucosa*	Indian Rat Snake	NA
47	*Xenochrophis piscator*	Checkered Keelback	NA
48	*Lycodon aulicus*	Common Wolf Snake	NA
	Pythonidae		
49	*Python m. molurus*	Indian Rock Python	LC
	Boidae		
50	*Eryx johnii*	Red Sand Boa	NA
51	*Eryx conicus*	Common Sand Boa	NA
	Elaphidae		
52	*Bungarus caeruleus*	Common Krait	NA
53	*Naja naja*	Indian Spectacled Cobra	NA
	Viperidae		
54	*Trimeresurus gramineus*	Bamboo Pit Viper	LC
55	*Daboia russelii*	Russell's Viper	LC
56	*Echis carinata*	Saw Scale Viper	NA

Figure 5. Roadkill. A. *Oligodon arnesis*, B. *Macropisthodon plumbicolor*, C. *Atretium schistosum*, D. *Eryx conicus*, E. *Amphiesma stolatum*, F. *Bungarus caeruleus,* G. *Coelognathus helena helena*, H. *Echis carinata*, I. *Python m. morulus*.

Appendix II: Micro-habitat utilized by amphibians and reptiles

S.No	SPECIES	Microhabitats							
		BG	BU	GR	Leaf	Po	SH	ROC	Tree
	Bufonidae								
1	*Duttaphrynus melanostictus*	√	√	√	√	√	√		
	Dicroglossidae								
2	*Euphlyctis cf. cyanophlyctis*			√		√			
3	*Euphlyctis hexadactylus*	√		√		√			
4	*Fejervarya cf. limnocharis*			√		√			
5	*Hoplobatrachus crassus*			√		√			
6	*Hoplobatrachus tigerinus*			√		√			
7	*Sphaerotheca breviceps*	√		√	√				
8	*Sphaerotheca rolandae*			√	√	√			
	Microhylidae								
9	*Uperodon taprobanica*		√	√			√		
10	*Microhyla ornate*			√	√				
11	*Microhyla rubra*	√		√	√	√			
12	*Uperodon variegata*		√			√			
13	*Uperodon systoma*	√	√	√			√		
14	*Uperodon* sp.	√	√						
	Rhacophoridae								
15	*Polypedates cf. maculatus*	√	√	√	√	√	√		
	Geckonidae								
16	*Calodactylodes aureas*		√					√	
17	*Cnemaspis cf. otai*							√	
18	*Cnemaspis* sp.							√	
19	*Hemidactylus frenatus*		√					√	√
20	*Hemidactylus graniticolos*		√					√	
21	*Hemidactylus leschenaultii*								√
22	*Hemidactylus trietrus*	√	√						√
23	*Hemidactylus cf. brooki*		√						
24	*Hemidactylus* sp.	√							
	Scinicidae								
25	*Eutropis beddomii*			√	√				
26	*Eutropis carinata*			√	√	√	√	√	√
27	*Eutropis macularia*			√	√			√	
28	*Lygosoma punctatus*							√	
29	*Eutropis* sp.				√				

	Lacertian								
30	*Ophisops leschenaultii*								
	Agamidae								
31	*Calotes calotes*	√							
32	*Calotes cf. versicolor*			√	√		√	√	√
33	*Psammophilus cf. dorsalis*							√	√
34	*Sitana ponticeriana*			√	√				
	Varanidae								
35	*Varanus bengalensis*	√						√	√
	Typhlophidae								
36	*Indotyphlops cf. braminus*	√			√				
	Colubridae								
37	*Ahaetulla nasuta*	√					√		√
38	*Amphiesma stolatum*	√		√	√				
39	*Atretium schistosum*	√		√		√			
40	*Coelognathus h. helena*	√							
41	*Dendrelaphis tristis*						√		√
42	*Dryocalamus nympha*	√							
43	*Macropisthodon plumbicolor*	√							
44	*Oligodon arsensis*	√							
45	*Oligodon taeniolatus*	√							
46	*Ptyas mucosa*	√		√				√	
47	*Xenochrophis piscator*	√				√			
48	*Lycodon aulicus*	√							
	Pythonidae								
49	*Python m. molurus*	√							
	Boidae								
50	*Eryx johnii*	√							
51	*Eryx conicus*	√						√	
	Elaphidae								
52	*Bungarus caeruleus*	√							
53	*Naja naja*	√							
	Viperidae								
54	*Trimeresurus gramineus*	√							
55	*Daboia russelii*	√							
56	*Echis carinata*	√							
	Total species	**30**	**11**	**20**	**15**	**13**	**8**	**13**	**9**

[a]**BG-** Bare ground, **BUI-** Building, **GR-** Grass, **Leaf-** Leaf litter, **Po-** Pool, **SH-** Shrubs, **Roc-** Rocky boulders.