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# Microhabitat use and abundance estimates of understorey herpetofauna in the highlands of Southern Eastern Ghats, India, with observations on roadkill mortalities

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## ABSTRACT

**We examined the synecological community assemblage of herpetofauna in the montane zones (> 900 m asl) of four hill ranges in the Southern Eastern Ghats, peninsular India. We found out the microhabitat associations of herpetofauna by quantifying the frequency of resting substrate (=resource state) utilisation of the target taxa in terrestrial, aquatic, semi-fossorial and semi-arboreal strata (trees <5 m height from ground). We, based on a 2000 hr-long (500 hrs. per hill range) visual encounter survey, estimated the encounter rate of each taxa. Lastly, we comment upon the roadkill mortalities of herpetofauna in the study sites and provide an appraisal for conservation.**

**Key words:** amphibians, encounter rate, montane zone, reptiles, resource states, vehicular traffic.

## INTRODUCTION

The Eastern Ghats hill range in peninsular India is reported to be under-studied as regards herpetofauna (Das, 1996; Dutta, 1997). In southern India, studies on ecological assemblage and community structure of herpetofauna are mostly restricted to the Western Ghats (Bhupathy & Nixon, 2011; Bhupathy & Sathishkumar, 2013; Inger *et al*., 1987; Ishwar *et al*., 2001; Srinivas & Bhupathy, 2013; Vasudevan *et al.,* 2001) an adjacent mountain range and a recognised biodiversity hotspot (Myers *et al*., 2000). A few studies have also described the herpetological assemblages of the eastern coastal plains ecosystem (Kannan *et al*., 1994; Kalaiarasan, 1999). In the Eastern Ghats, ample information on habitat associations and qualitative data on abundance, including that of roadkills are available only in the more northerly site–the Nallamalai hills by Rao *et al*. (2005) and Srinivasulu & Das (2008).

Till date, studies on Southern Eastern Ghats herpetofauna (Daniels & Ishwar, 1994; Daniels & Kumar, 1998; Kumar & Daniels, 1999; Vanak *et al*., 2001), owing to their scope and timeframe, could not shed light on the herpetological assemblage structure. Daniels & Ishwar (1994) undertook herpetological surveys in many hill ranges in Southern Eastern Ghats and presented results bearing on rarity and threat status levels. However, their study duration of 167 man-hours was inadequate for a comprehensive area and taxonomic coverage. Daniels & Kumar (1998) and Kumar & Daniels (1999) who surveyed Kolli hills and Vanak *et al*. (2001) who surveyed Sirumalai hills presented only annotated checklists, sometimes with terms 'common' and 'rare' implying a qualitative impression of abundance. In this paper, the herpetofaunal assemblage structure of the montane regions (> 900 m asl) of Southern Eastern Ghats is presented. We provide the first ever quantitative data on herpetofaunal abundance and microhabitat associations estimated per unit effort, for this region, along with observations on roadkill mortalities.

## STUDY AREA

Southern Eastern Ghats sensu Jayakumar *et al.* (2008) extend from Jawadi hills in the northeast till Sirumalai hills to the southwest. We surveyed four select massifs namely Jawadi hills (JW) (12°25'N 78°42'E; 1200 m asl) in Vellore district; Shevaroy hills (SH) (11°60'N 78°15'E; 1620 m asl) in Salem district; Kolli hills (KH) (11°28'N 78°21'E; 1400 m asl) in Namakkal district and Sirumalai hills (SH) (10°12'N 78°00'E; 1400 m asl) in Dindigul district, all situated in Tamilnadu state. The dominant natural climax vegetation type in the higher slopes (> 900 m asl) is tropical evergreen forest (Jeyakumar *et al*., 2008). Cash crop plantations, mainly coffee (except Jawadi) and Silver Oak, and mixed fruit orchards form a major part of contemporaneous landscape. Since all these four hill ranges currently lack any protected areas, human disturbances to the landscape was comparatively high. As regards seasons, January-March is cold, April-May is hot and June-August (southwest monsoon) as well as September-December (northeast monsoon) are wet. Average annual air temperature ranges between 13 and 34°C (55 - 84°F) and average annual rainfall ranges between 1500 and 2000 mm in the wet zone (Jayakumar *et al*., 2008 and references therein).

## METHODOLOGY

We employed Time-Constrained Visual Encounter Surveys (TCVES, after Crump & Scott, 1994) for field data collection. Considering the enormity of geographic- (four massifs spanning over 350 km) and taxonomic- (62 species including several rare ones) coverage,

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TCVES was chosen over more time- and labour-intensive, yet refined methods such as quadrats and transects (abandoned after initial trials) that incorporate detection probability, or capture-mark-recapture techniques (reviewed in Doan, 2003; Ribiero-Junior *et al*., 2008). Visual encounter method involves active searches in all prospective microhabitats including under fallen logs, rocks and debris for a fixed time period. Sampling in arboreal strata was done from ground-level and hence detections were limited to < 5 m height.

A total of 500 man-hours of survey was carried out in montane zone (>900 m asl) of each hill range, thereby amounting to a total of 2000 hours of survey. In each hill range, within the montane zone, 16 to 19 sampling sites that were at least 1 airline km apart, spanning across the spatial and ecological extent of the hill range, were earmarked by GPS for field sampling. A total of 5 months (150 field days) were spent in each hill range and about 4 hours of fieldwork was done per day, amounting to 100 hours (4 hours X 25 field days) a month. One same sampling site was not resurveyed on immediate consecutive days and replicate surveys were typically a week later. Owing to logistic constraints, limited survey personnel and personal safety from large mammals, most (75%) of the survey was done during daytime (8:00-17:00 hrs) and limited surveys were done during night (19:00-21:30 hrs) mainly inside estates / plantations and along forest peripheries. Fieldwork was done mainly between May and December in all sites except for a high-elevation (> 1600 m asl) massif (Shevaroys) that was not surveyed during post-monsoon season (October-November) due to harsh weather conditions.

Fundamental categories of resource states were grouped or clumped together to much broader categories (after Inger *et al*., 1987) and the target taxa from species-level units to family-level units (Kumar *et al*., 2001; Vasudevan *et al*., 2001), except snakes that were retained as a single entity on its own due to very low detections even at higher taxonomic levels (after Ishwar *et al*., 2001). The sole representative of the family Lacertidae, which was present only in Sirumalai, was, owing to its ecological similarity, clubbed together with skinks. Roadkills once sighted were removed away from the road to avoid recounting and those too badly damaged to permit identification were omitted from the analyses presented here. No attempt was made to compare roadkill records among habitat types or hill ranges owing to the differences in physical features, road networks, vehicle intensity and species composition. Also, since the roadkill sightings reported here were recorded during general fieldwork targeting live animals, no distance-honoured calculations of roadkill rates were done. However, quantifications of roadkills of each species were made against the total live sightings of that species and also among roadkills of all species (see Bhupathy *et al*., 2009; Vijayakumar *et al*., 2001).

## RESULTS

Our observations reveal the presence of distinct patterns of microhabitat use by this herpetological community. In no hill range, was all the microhabitats occupied by all the species. For example, no lizard was sighted in ponds in any of the hills. Concerning the no. of species associated with a particular microhabitat (Table 1), most (5-8) species of amphibians were sighted in leaf-litter, followed by streams (3-6 species). Other resource states (pond, under log / rock, and on roads) had more or less equal or random representation of frog species. In Sirumalai hills, where as much as 8 species of amphibians were sighted in streams also harbours the highest no. of amphibians among the four sampled hills. Regarding lizards, most (11-12 species) were associated with large rock boulders, followed by those found under rocks (7-10 species) and those found on trees < 4 m height (5-9 species). In Jawadi hills, as much as 7 species of lizards were observed alive crossing the roads. However, it is noteworthy here that, among the four sampled hills, Jawadi was the one with the maximum no. of lizard species. Most species of snakes (4-5) encountered alive were observed in semi-fossorial and arboreal situations.

As regards the no. of sightings of (any) species found associated with a particular microhabitat, most (95-207) sightings of amphibians were in stream, except Jawadi. However, it is noteworthy here that this must be attributable to the frog fauna of Jawadi, which lacks stream-dwelling taxa (e.g. *Indosylvirana*) that are present in the other three hills. Secondly, most amphibian sightings were in ponds (87-135) and on leaf-litter (45-255). In Jawadi no amphibian was sighted on plants / trees because of complete absence of bush frogs; whereas Kolli recorded the maximum no. of 122 frog sightings on plants (vs. 25-75 in other two hills) because of the presence of two species of bush frogs (*Raorchestes* and *Pseudophilautus* vs. only one of these in the other two hills).

Lizard sightings were the highest in rocky habitats consisting of rock boulders (94-192) and inside rock crevices (55-273), followed by those on leaf-litter (95-108) and those on trees < 4m height (62-156 sightings). While the above microhabitat categories consistently hold high frequency of lizard sightings across hill ranges, some outliers and discernable patterns involving presence-absence of taxa and / or higher resource-availability in a given hill-range, exist. In Jawadi, inordinately high no. of 273 sightings of lizards (vs. 61-145 in other three hills) were in rock crevices mainly because of a large-bodied, nocturnal rock-dwelling gecko (*Calodactylodes aureus*) that is absent in the other three sampled hills. Similarly, in Shevaroys inordinately high no. of 198 sightings (vs. 63-78 in other three hills) were on building walls mainly because of a gecko *Hemiphyllodactylus aurantiacus*. However, since this gecko was also observed in other three hills too, it remains doubtful whether the considerably higher no. of houses in Shevaroys (pers. obs.) is responsible for either maximum detections of all lizards or of the above mentioned gecko species in particular. Also, like in the case of amphibians, clear taxonomic patterns exist for lizard habitat-use, with agamids mainly using arboreal strata, geckoes using rocky outcrops and skinks dominating the leaf-litter.

Snake sightings were overall much lower than that of amphibians and lizards. It is noteworthy that more snakes (17-28 sightings, 7-13 species) were detected as roadkills than live encounters. Live snake sightings were the highest under rocks (3-17 sightings, 1-8 species),

**Table 1.** Summary of microhabitat associations of frogs (F), lizards (L) and snakes (S) in the four massifs studied. Values denote sighting frequency; those within parenthesis denote no. of species

| Resource states | Jawadi | Shevaroys | Kolli | Sirumalai |
|---|---|---|---|---|
| Pond | F:124(3) L:0(0) S:1(1) | F:95(4) L:0(0) S:1(1) | F:87(2) L:0(0) S:2(1) | F:135(4) L:0(0) S:0(0) |
| Stream | F:43(4) L:1(1) S:5(1) | F:166(4) L:0(0) S:2(1) | F:95(3) L:0(0) S:2(1) | F:207(6) L:3(3) S:2(2) |
| Under log | F:85(4) L:17(4) S:6(3) | F:14(2) L:6(2) S:7(5) | F:9(4) L:20(3) S:6(4) | F:53(4) L:20(6) S:15(4) |
| Under rock | F:28(4) L:34(7) S:3(1) | F:22(2) L:81(9) S:17(8) | F:10(2) L:59(10) S:4(4) | F:41(3) L:50(8) S:12(6) |
| Bare ground | F:52(3) L:79(7) S:3(2) | F:22(4)L:36(10) S:4(4) | F:43(5) L:84(8) S:8(6) | F: 19(2)L:99(4) S:2(2) |
| Leaf litter | F:45(4) L:108(6) S:2(1) | F:121(5) L:95(5) S:0(0) | F:255(6) L:140(4) S:3(3) | F:75(8) L:103(4) S:3(2) |
| On rock | F:0(0) L:192(11) S:2(2) | F: 16(4)L:115(11) S:0(0) | F:5(3) L:94(8) S:1(1) | F:1(1) L:140(12) S:2(2) |
| Rock-crevice | F:0(0) L:273(8) S:2(1) | F:0(0) L:61(8) S:1(1) | F:1(1) L:55(4) S:0(0) | F:2(2) L:145(2) S:4(2) |
| Building wall | F:0(0) L:63(7) S:0(0) | F:21(2) L:198(9) S:1(1) | F:10(1) L:78(4) S:0(0) | F:2(1) L:63(6) S:0(0) |
| Plant | F:0(0) L:56(3) S:4(4) | F:75(2) L:62(5) S:5(4) | F:122(3) L:21(2) S:6(4) | F:25(2) L:42(2) S:5(4) |
| Tree | F:0(0) L:125(9) S:6(5) | F:16(2) L:62(7) S:2(2) | F:26(2) L:156(6) S:0(0) | F:1(1) L:125(5) S:1(1) |
| Tar road (live) | F:20(3) L:41(7) S:3(3) | F:28(3) L:0(0) S:1(1) | F:43(3) L:4(3) S:4(4) | F:28(2) L:15(5) S:4(3) |
| Roadkill | F:26(4) L:29(12) S:28 (10) | F:11(1) L:8(4) S:16(9) | F:10(4) L:6(3) S:35(13) | F:28(3) L:16(7) S:14(7) |

**Table 2.** Sighting frequency (no.) and relative abundance (Rel.ab.%) of higher-level taxonomic entities across the four studied massifs. * - includes lacertids also: For abbreviations see 'Study Area' instead of 'Materials & Methods'

| Taxa | JW No. | Rel. ab. % | SH No. | Rel. ab. % | KL No. | Rel. ab.% | SR No. | Rel. ab. % |
|---|---|---|---|---|---|---|---|---|
| Bufonid | 141 | 10 | 103 | 7.5 | 49 | 3 | 153 | 10 |
| Ranid | 0 | 0 | 146 | 10.5 | 149 | 10 | 63 | 4 |
| Rhacophorids | 0 | 0 | 168 | 12 | 227 | 15 | 66 | 5 |
| Microhylid | 56 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dicroglossids | 226 | 15 | 192 | 14 | 305 | 20 | 311 | 21 |
| Ranixalid | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 1.5 |
| Agamids | 222 | 14 | 143 | 10 | 81 | 5.5 | 144 | 9.5 |
| Gekkonids | 449 | 30 | 382 | 28 | 346 | 23 | 361 | 24 |
| Scincids* | 347 | 23 | 197 | 14 | 281 | 19 | 311 | 21 |
| Snakes | 71 | 5 | 53 | 4 | 67 | 4.5 | 64 | 4 |

followed by those under fallen logs (6-15 sightings, 3-5 species). Secondly arboreal species were represented in higher live detections, including those on trees (4-6 sightings, 4 species) and plants (0-6 sightings, 0-5 species). Snakes seen alive on tar roads (1-4 sightings, 1-3 species snakes) were much fewer than roadkill records. However, the necessarily-infrequent detections of live snakes in the present study warrants further field observations.

Regarding abundance and encounter rate estimates (Tables 2 & 3; Figure 1), among amphibians Bufonid was represented by one species in all the four hills with an abundance range of 49-153 sightings corresponding to 3-10% of total sightings of all species in a hill range, with 0.09-0.3 individuals per hr. and 3.33-11.11 hrs. for a sighting; Ranid was represented by one species in all hills except Jawadi (where it is absent); had an abundance range of 63-149 sightings corresponding to 4-10.5%, with 0.12-0.29 individuals per hr. and 3.44-8.33 hrs. for a sighting; Rhacophorids which were absent in Jawadi, represented by one species each in Shevaroys and Sirumalai and by two species in Kolli hills had an

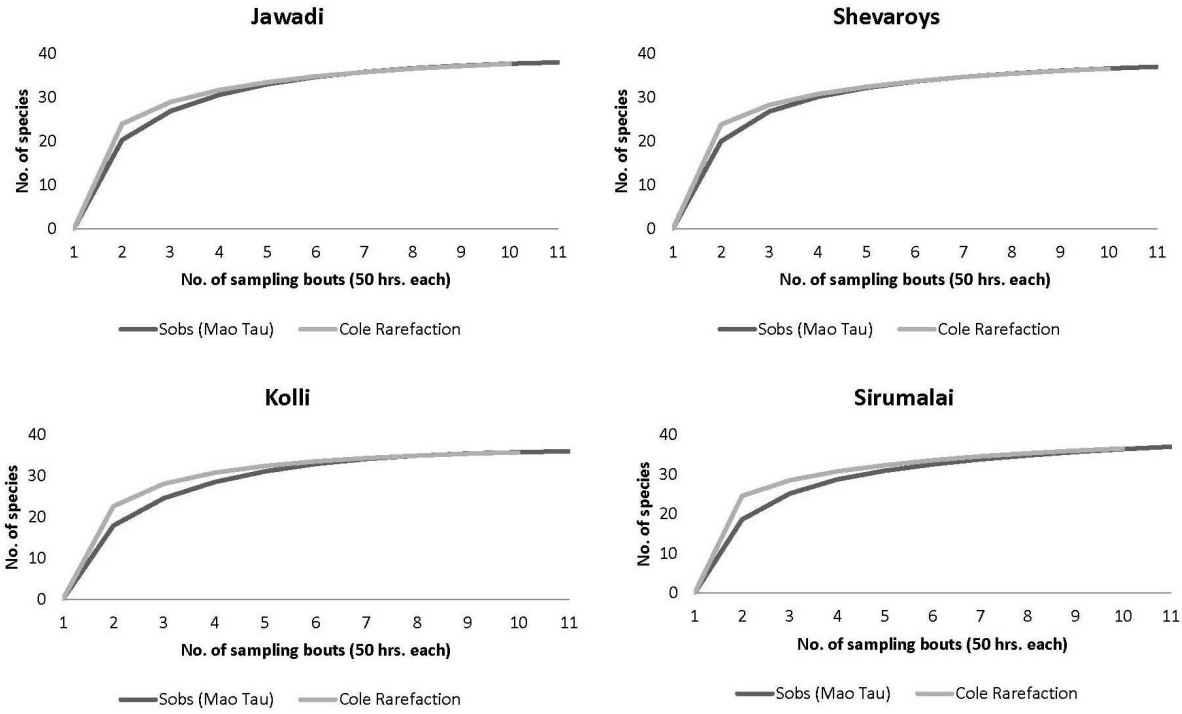


**Figure 1.** Species-accumulation curves for sampling herpetofauna of the Southern Eastern Ghats, India.

abundance range of 66-227 sightings corresponding to 5-15%, with 0.13-0.45 individuals per hr. and 2.22-7.69 hrs. for a sighting; Microhylid was present only in Jawadi, represented by a single species accounting for 56 sightings corresponding to 3% with 0.11 individuals per hr. and 9.09 hrs. for a sighting; Dicroglossids represented by 2-3 species per hill range had an abundance range of 192-311 sightings corresponding to 14-21% with 0.38-0.62 individuals per hr. and 1.61-2.63 hrs. for a sighting; Ranixalid was represented only in Sirumalai by a single species accounting for 28 sightings, corresponding to 1.5% with 0.05 individuals per hr. and 20 hrs. for a sighting.

Among lizards, Agamids were represented by 4-5 species per hill range and had an abundance range of 81-222 sightings corresponding to 5.5-14% with 0.16-0.44 individuals per hr. and 2.27-6.25 hrs. for a sighting; a Gekkonids were represented by 6-8 species per hill range; had abundance range of 346-449 sightings corresponding to 23-30% with 0.69-0.89 individuals per hr. and 1.12-1.44 hrs. for a sighting; Scincids (including the sole ecologically similar lacertid present that too in only one hill) were represented by 5-6 species per hill range; had an abundance range of 197-347 sightings corresponding to 4-23% with 0.39-0.69 individuals per hr. and 1.44-2.56 hrs. for a sighting. Snakes were represented by 18-19 species per hill range but had an abundance range of 53-71 sightings corresponding to 4-5% with 0.1-0.14 individuals per hr. and 7.14-10 hrs. for a sighting.

Roadkills (Table 4) were frequent and regular in this landscape. A total of 227 roadkills out of 5901 total sightings (live and dead) amounting to 3.8%, belonging to 42 (67.7%) out of 62 species were recorded during the study. Regionally, 83 roadkills out of 1512 sightings

**Table 3.** Encounter rate (ER) per hr. and time (in hrs.) needed to get one sighting of higher-level taxonomic entities in the four studied massifs. * - includes lacertids also. For abbreviations of hill-ranges, see Materials & Methods.

| Taxa | JW-ER 500 h | Hours / 1 ind. | SH-ER 500 h | Hours / 1 ind. | KL-ER 500 h | Hours / 1 ind. | SR-ER 500 h | Hours / 1 ind. |
|---|---|---|---|---|---|---|---|---|
| Bufonid | 0.28 | 3.57 | 0.2 | 5 | 0.09 | 11.11 | 0.3 | 3.33 |
| Ranid | 0 | 0 | 0.29 | 3.44 | 0.29 | 3.44 | 0.12 | 8.33 |
| Rhacophorids | 0 | 0 | 0.33 | 3.03 | 0.45 | 2.22 | 0.13 | 7.69 |
| Microhylid | 0.11 | 9.09 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dicroglossids | 0.45 | 2.22 | 0.38 | 2.63 | 0.61 | 1.63 | 0.62 | 1.61 |
| Ranixalid | 0 | 0 | 0 | 0 | 0 | 0 | 0.05 | 20 |
| Agamids | 0.44 | 2.27 | 0.28 | 3.57 | 0.16 | 6.25 | 0.28 | 3.57 |
| Gekkonids | 0.89 | 1.12 | 0.76 | 1.31 | 0.69 | 1.44 | 0.72 | 1.38 |
| Scincids* | 0.69 | 1.44 | 0.39 | 2.56 | 0.56 | 1.78 | 0.62 | 1.61 |
| Snakes | 0.14 | 7.14 | 0.1 | 10 | 0.13 | 7.69 | 0.12 | 8.33 |

**Table 4.** Roadkill records of herpetofauna observed in the four hill ranges during 2011-2015. No. within parenthesis denote the proportion (in %) of sightings formed by roadkills among the total sightings of that species including live ones. Those within square brackets denote the relative abundance of roadkills in terms of the proportion (in %) of roadkills of a species in a hill range among the total roadkills of all the species recorded in that hill range.

| Species | Jawadi | Shevaroys | Kolli | Sirumalai |
|---|---|---|---|---|
| *Duttaphrynus melanostictus* | 11(7.8%)[13.2%] | 11(10.6%)[31.4%] | 4(8.6%)[7.8%] | 19(12.4%)[32.7%] |
| *Fejervarya* sp. | 2 (1%)[2.4%] | 0 | 3(1%)[5.8%] | 8(3.2%)[13.7%] |
| *Sphaerotheca* cf. *dobsonii* | 8(33.3%)[9.6%] | 0 | 0 | 0 |
| *Indosylvirana sreeni* | 0 | 0 | 2(1.4%)[3.9%] | 0 |
| *Microhyla* cf. *sholigari* | 5(8.9%)[6%] | 0 | 0 | 0 |
| *Pseudophilautus* cf. *wynaadensis* | 0 | 0 | 1(1.8%)[1.9%] | 1(1.5%)[1.7%] |
| *Calotes calotes* | 1(2.5%)[1.2%] | 2(13.3%)[5.7%] | 0 | 1(2.7%)[1.7%] |
| *Calotes versicolor* | 4(12.9%)[4.8%] | 0 | 0 | 4(11.1%)[6.8%] |
| *Psammophilus blanfordanus* | 1(2.2%)[1.2%] | 0 | 0 | 1(2.6%)[1.7%] |
| *Psammophilus dorsalis* | 1(1.6%)[1.2%] | 1(5.8%)[2.8%] | 0 | 0 |
| *Cyrtodactylus speciosus* | 6(85.7%)[7.2%] | 2(100%)[5.7%] | 2(100%)[3.9%] | 0 |
| *Cyrtodactylus* cf. *collegalensis* | 0 | 0 | 0 | 1(25%)[1.7%] |
| *Hemidactylus* cf. *acanthopholis* | 0 | 0 | 0 | 1(3.4%)[1.7%] |
| *Hemidactylus* cf. *brookii* | 1(1%)[1.2%] | 0 | 0 | 0 |
| *Hemidactylus graniticolus* | 5(10.8%)[6%] | 0 | 3(100%)[5.8%] | 0 |
| *Hemiphyllodactylus aurantiacus* | 1(16.6%)[1.2%] | 0 | 0 | 0 |
| *Eutropis beddomei* | 1(1.2%)[1.2%] | 0 | 0 | 0 |
| *Eutropis carinata* | 5(8.4%)[6%] | 0 | 1(5.5%)[1.9%] | 3(5%)[5.1%] |
| *Eutropis macularia* | 0 | 0 | 0 | 5(3.3%)[8.6%] |
| *Lygosoma punctatum* | 2(2%)[2.4%] | 0 | 0 | 0 |
| *Lygosoma* cf. *pruthi* | 1(10%)[1.2%] | 3(100%)[8.5%] | 0 | 0 |
| *Gerrhopilus* cf. *beddomei* | 3(27.2%)[3.6%] | 1(8.3%)1[2.8%] | 1(25%)[1.9%] | 0 |
| *Rhinophis goweri* | 0 | 0 | 7(77.7%)[13.7%] | 0 |
| *Uropeltis shorttii* | 0 | 0 | | 0 |
| *Uropeltis* cf. *ceylanica* | 0 | 0 | 8(61.5%) [15.6%] | 0 |
| *Uropeltis* cf. *phipsonii* | 3(100%)[3.6%] | 0 | 0 | 0 |
| *Uropeltis dindigalensis* | 0 | 0 | 0 | 5(38.4%)[8.6%] |
| *Uropeltis ellioti* | 10(90.9%)[12%] | 2(33.3%)[5.7%] | 0 | 0 |
| *Coelognathus helena monticollaris 1* | 0 | 2(100%)[5.7%] | 2(40%)[3.9%] | 0 |
| *Coelognathus helena monticollaris 3* | 1(100%)[1.2%] | 0 | 0 | 0 |
| *Lycodon travancoricus* | 2(40%)[2.4%] | 4(50%)[11.4%] | 6(75%)[11.7%] | 4(30.7%)[6.8%] |
| *Dendrelaphis* cf. *chairecacos* | 0 | 0 | 1(25%)[1.9%] | 1(50%)[1.7%] |
| *Chrysopelea taprobanica* | 1(50%)[1.2%] | 0 | 0 | 0 |
| *Amphiesma stolatum* | 2(28.5%)[2.4%] | 0 | 1(33.3%)[1.9%] | 0 |
| *Macropisthodon plumbicolor* | 3(100%)[3.6%] | 2(50%)[5.7%] | 1(50%)[1.9%] | 2(50%)[3.4%] |
| *Xenochrophis piscator* | 1(12.5%)[1.2%] | 2(50%)[5.7%] | 2(22.2%)[3.9%] | 0 |
| *Boiga forsteni* | 2(66.6%)[2.4%] | 1(100%)[2.8%] | 2(100%)[3.9%] | 1(100%)[1.7%] |
| *Boiga nuchalis* | 0 | 1(33.3%)[2.8%] | 2(40%)[3.9%] | 0 |
| *Calliophis beddomei* | 0 | 0 | 1(100%)[1.9%] | 0 |
| *Calliophis nigrescens pentalineatus* | 0 | 0 | 0 | 1(50%)[1.7%] |
| *Trimeresurus gramineus* | 0 | 1(33.3%)[2.8%] | 1(50%)[1.9%] | 0 |

amounting to 5.4% were in Jawadi, 35 roadkills out of 1384 sightings amounting to 2.5% were in Shevaroys, 51 roadkills out of 1504 sightings amounting to 3.3% were in Kolli and 58 roadkills out of 1501 sightings amounting to 3.8% were in Sirumalai. All the three taxa, amphibians, lizards and snakes were represented as roadkills in all the four massifs studied. Amphibians were represented by 70 roadkills (33%) but only accounted for 6 (60%) out of 10 species. Similarly, lizards were represented by 59 roadkills (25.9%) but only accounted for 15 (57.6%) out of 26 species. However, snakes although represented by only 39 roadkills (17.1%) accounted for 21 (80.7%) out of 26 species. Taxa-wise enumeration of roadkill mortalities is given in the following.

In amphibians, out of the 10 species, six (60%) were represented in roadkills. No amphibian was represented solely (100%) as roadkill records. Proportional sightings of amphibian roadkills ranged from 1% for *Fejervarya* sp. in Jawadi to 33.3% for *Sphaerotheca* cf. *dobsonii* in Jawadi. Generally, more aquatic and arboreal species like stream frogs (*Indosylvirana*) and bush frogs (*Raorchestes* and *Pseudophilautus*) were less represented among roadkill samples, compared to ground-dwelling ones like the burrowing frog (*Sphaerotheca* cf. *dobsonii*) 33.3% and the toad (*Duttaphrynus melanostictus*) 7.8-12.4%. However, another species of burrowing frog in Sirumalai (*Sphaerotheca* sp.) was not represented in roadkills. As regards relative abundance, the toad *Duttaphrynus melanostictus* had the highest mortality of 7.8-32.7% of all roadkills. A total of 75 roadkills (33%) in all the four massifs, were of amphibians.

In lizards, of the 26 species, 15 (57.6%) were recorded by roadkills. Proportional sightings of lizard roadkills ranged from 1% for *Hemidactylus* cf. *brookii* in Jawadi to 100%, in three cases: *Cyrtodactylus speciosus* in Shevaroys and Kolli hills and for *Lygosoma* cf. *pruthi* in Shevaroys. As with amphibians, terrestrial forms like *Cyrtodactylus* 25-100% were represented very much in the roadkills, compared to arboreal forms like *Calotes* 2.5-13.3%. Fast moving skinks however, although terrestrial, were under represented as roadkills, with 1.2-8.4% records. Only one species of skink (*Lygosoma* cf. *pruthi*) in only one hill range Shevaroys, was represented solely (100%) by roadkill records. As regards relative abundance, the skinks *Eutropis macularia* in Sirumalai had high abundance of roadkills (8.2%), followed by the gecko *Cyrtodactylus speciosus* (7.2%) in Jawadi. A total of 59 roadkills (25.9%) in all the four massifs were of lizards.

In snakes, out of 26 species, as much as 21 species (80.7%) were represented in roadkills. Proportional sightings of snake roadkills ranged from 12.5% for *Xenochrophis picator* in Jawadi, to 100% in eight cases: *Uropeltis* cf. *phipsoni* in Jawadi, *Coelognathus helena monticollaris 1* in Shevaroys, *C. h. monticollaris 3* in Jawadi, *Boiga forsteni* in Shevaroys, Kolli and Sirumalai and *Calliophis beddomei* in Kolli hills. It is very noteworthy to mention here that more than any other taxa, several species of snakes were represented entirely by roadkill records. As regards relative abundance, the shieldtail snakes *Uropeltis* cf. *ceylanica* (15.6%), *Rhinophis goweri* (13.8%), *U. ellioti* (12%) and *U. dindigalensis* (8.6%) had the highest representation among roadkills. Secondly, the wolf snake *Lycodon travancoricus* consistently had high representation as roadkills ranging 6.8-11.7% among the four massifs. A total of 39 roadkills (17.1%) in all the four massifs were of snakes.

## DISCUSSION

Lack of any quantitative data on the abundance and ecological structure of herpetofauna in earlier studies in Southern Eastern Ghats precludes us from elaborately comparing and contrasting with our present work. Among the past works in this region, the only study that mentioned the no. of individuals and sampling-duration is that of Daniels & Ishwar (1994). However, their survey was predominantly on low-elevation, dry plains habitat and consequently their data set include a large portion of widespread pan-Indian species. Our attempted comparison between the two works concentrating on their records of hill forest species that are present in our data set reveal under-representation of such forms in their work. For example, we considered the species *Calotes rouxii* for such comparisons, because of their precise records of this species from their grids. Daniels & Ishwar (1994) reported five sightings of *C. rouxii* from grids 74 and 80 (corresponding to Shevaroy hills) and also informed by our own extensive field surveys, we consider their search efforts in *C. rouxii*-occupied massifs namely Mettur (4 hrs.), Jawadi (30 hrs.), Yercaud (7 hrs.), Kumaragiri (5 hrs.), Kalrayanmalai (6 hrs.) and Amirthi (6 hrs.) amounting to 58 hrs. Overall, their encounter rate estimate for *C. rouxii* is 0.08 individuals per hour, with 12.5 hrs. for a sighting vs. 0.11 individuals per hour, with 9.09 hrs. for a sighting in our work. The slight increase in encounter rate in our work may probably be because of our targeted survey exclusively in the montane zone focused on such forms.

Studies on roadkill mortalities of herpetofauna are available aplenty for the Western Ghats (Baskaran & Boominathan, 2010; Bhupathy *et al*., 2009; Gokula, 1997; Kannan, 2007; Seshadri *et al*., 2009; Vijayakumar *et al*., 2001). However, in the Eastern Ghats, only Rao *et al*. (2005) provide data and photographic evidence of roadkills, but without quantitative representation. Here, we for the first time provide quantitative data on roadkill mortalities of herpetofauna in the Eastern Ghats. Our findings on roadkills are in accordance with literature in that the toad *Duttaphrynus melanostictus* was dominant among amphibian roadkills, while the shieldtail snakes dominated the reptile roadkills (Vijayakumar *et al*., 2001). Also, in accordance with Vijayakumar *et al*. (2001) several species of snakes were recorded only as roadkills and were never encountered alive despite long-term fieldwork.

Among amphibians ground-dwelling forms have dominated the roadkills, however the genus Indirana has been recorded as roadkills from the Western Ghats before (Seshadri *et al*., 2009; Vijayakumar *et al*., 2001), but not in the present work. Also, Sehadri *et al*. (2009) reported more *Fejervarya* roadkills than *Duttaphrynus*, unlike in our case and in Vijayakumar *et al*. (2001). Among lizards, it is interesting to note that *Hemiphyllodactylus aurantiacus* has never been reported in roadkills before (Baskaran *et al*., 2010; Bhupathy *et al*., 2009; Gokula,

1997; Seshadri *et al*., 2009; Vijayakumar *et al*., 2001). Among snakes, several genera such as *Coelognathus, Lycodon, Macropisthodon, Boiga, Calliophis* have been well reported in studies from Western Ghats (Bhupathy *et al*., 2009; Vijayakumar *et al*., 2001). Studies (Baskaran & Boominathan, 2009; Gokula, 1997; Kannan, 2007) from deciduous forests in the Western Ghats did not record shieldtail snake roadkills, owing to extreme rarity or complete absence of shieldtail snakes in such habitat types (pers. obs.). As poikilothermic vertebrates (Porter, 1972), herpetofauna have been consensually reported to be adversely affected by road traffic (Spellerberg, 1998; Trombulak & Frissell, 2000) and the present observations on roadkills from the Eastern Ghats, including many rare and unidentified species support this. We also note here that some shortfalls in sampling strategies including limited night surveys could be responsible for many snakes being recorded only as roadkills.

Our study highlights the absence of ecological information on herpetological communities in the Eastern Ghats. This lack of data from Eastern Ghats, further promotes a false-impression that only the Western Ghats support high herpetological diversity and endemism (Aengals *et al*., 2001; Biju, 2001; Daniel, 2002; Das, 2002). We believe that the accessibility and commonness have promoted ecological studies on coastal plains herpetofauna (Kannan *et al*., 1994; Kalaiarasan, 1999), while the uniqueness, endemism and rarity have promoted ecological studies in the rainforests of Western Ghats (Ishwar *et al*., 2001; Kumar *et al*., 2001; Vasudevan *et al*., 2001). A recent study by Vijayakumar *et al*. (2006) has highlighted lack of adequate ecological information on herpetological communities in the dry forests of Western Ghats. We too concur with Vijayakumar *et al*. (2006) and posit that the wet forests of Southern Eastern Ghats parallels the dry forests of Western Ghats, as both these 'atypical' areas have been largely ignored or understudied by previous researchers. Nevertheless, our study highlights that even within such a small, confined landscape like the wet forests of Southern Eastern Ghats, habitat types and distribution pattern at a local-scale play a major role in shaping the ecological organistaion of this herpetological community.

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