Species Composition, Abundance, and Behavioral Patterns of Lizards in the Devanahalli Fort of the Bengaluru North City Region, Bengaluru, India

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Abstract

Species composition and abundance of lizard populations was studied in the historical monuments such as the Devanahalli fort of the Bengaluru North City region, Bengaluru, India. The quadrants laid in the fort was surveyed for the estimation of the population density, abundance, sex ratio, frequency and distribution of the lizards in the Devanahalli fort. A total of nine species of lizards were recorded during the study, thus highlighting the significance of historical forts in acting as important urban habitats for reptiles. The reptilian fauna of the historical monuments such as forts, temples and archeological sites were found to be more distinct than the rest of the urban landscapes. In addition to this, notes on the morphometric analysis, behavioral patterns and natural history of recorded lizards was observed. Therefore, the abundance of the lizard populations in the historical fort's call for its special concern for care because their archeological importance and will be of use for urban planning and conservation.

Highlights

- The present article aims to focus on the population density, sex ratio, abundance and behavioural activities; the habitat impact on survival and distribution; and prioritizing the conservation methods to maintain the lizard population in historical monuments such as Devanahalli fort.
- Increasing anthropogenic path/footprint pressure/ disturbance affected lizard abundance and density. Lizards increased at a higher frequency in the presence of lower anthropogenic path/ footprint pressure/ disturbance.
- This study offers evidence that species composition and density, making these indices a useful tool to study biodiversity processes.
- This study underlines the importance of preserving historical monuments such as forts and temples in urban landscapes as refuges for biodiversity.

Introduction

The vital functions of animal population and ecology deals with the population dynamics, utilization of their microhabitats and behavioral patterns. When animals commence their daily activities such as basking, foraging, searching for mates, then they may be inhibited to engage the activities to certain periods of the day (Schoener 1977). Most reptiles display the high activity during the times of the day and the factors monitoring the periodicity interactions in a complex manner (Heatwole and Taylor 1987).

Biological diversity can be improved by increasing the habitat size, reducing the habitat fragmentation and increasing the habitat quality through enhancing its structural diversity. Among the known 3000 lizard species in the world, about 270 species are found in the Indian subcontinent and also, in the Oriental biogeographic realm along with Southeast Asia (Wallace 1876; Mani 1974).

Among the various group of Reptilia, the order Squamata exhibited a distinctly different in the biogeographical pattern and Squamates (a diverse group of legged animals - lizards and legless animals - snakes) found mostly on the land masses of Gondwanan origin (Macey et al. 2000). Depending upon the habitat, prey availability and thermal ecology, the lizard communities complete themselves utilizing the resource partitioning by spatial or temporal separation with their regular and daily activities (Heatwole and Taylor 1987).

The modern lizards are capable of adapting themselves as swimmers, fast runners, accomplished burrowers, tree dwellers and perfect gliders. These lizards exhibit remarkable arboreal scansorial (climbing), saltatorial (fossorial or burrowing), cursorial (running), aquatic (swimming), and volant (fiying) adaptations. Lizards can be defined as exothermic (poikilothermic), secretive, diurnal or nocturnal, carnivorous, herbivorous and omnivorous creatures (Tikader and Sharma 1992). Lizards also utilizes the number of habitats; most primarily live on the ground, but others may live in rocks, on trees, underground and even in water (Bauer et al. 2002).

Urban areas including the Indian cities such as Ahmedanagar, Bengaluru, Chennai, Delhi, Kolkata, Mumbai, Guwahati, etc. illustrates the high biodiversity of several taxa (Purkayastha et al. 2011). Even though urbanization is detrimental for biodiversity, cities can be a hotspot for animal monitoring, assessment and their conservation (Aronson et al. 2014). While historical monuments such as forts, palaces and its premises, and archaeological sites, towers, temples and their habitats lodges >20% of the total urban area, such areas may dock up to half the biodiversity of the urban biota in different locations of India. Already the places in and around Devanahalli region of the Bengaluru city proved that the study is rich in various fauna such as avian communities (Rajashekar and Venkatesha 2008; Rajashekara and Venkatesha 2014, 2015a, 2017, 2018, 2020a, 2020b; Rajashekara et al. 2019), mammal communities (mongooses by Rajashekara and Venkatesha 2015b).

The lizard communities are abundant in the Devanahalli fort of the Bengaluru North city region in the earlier decades. Of late, the lizard population has been declining alarmingly in the region. As no valid documents are available, a study was piloted to know the abundance of this lizard species in different locations in the Devanahalli fort. The estimation of lizard population can be made for an individually identified historical monuments such as forts, temples and archeological sites, and relative abundance was estimated.

The main objective of this study was to better understand the abundance and frequency of lizards occupying in the fort of Devanahalli, Bengaluru region, India. Precisely, the surveys were done to (1) estimate the population density and sex ratio of lizards in an isolated historical monument (fort) of a specified area, and (2) identify the various behavioral patterns of the lizards with sexual differentiation between them.

Methods

Study areas

The study was conducted in the fort of Devanahalli, present in the Devanahalli taluk, Bengaluru rural district. The Devanahalli fort (13° 24’ 96 N and Longitude: 77° 70’ 93 E, elevation 897 m asl) is located 46 km from Bengaluru City Railway Station in north of Bengaluru city (Fig. 1a). This fort is spread over an area of about 8 ha (20 acres) comprising under the ancient monuments and temples. The fort was build using the stone in the year 1501, form one of the historical sites and archaeological protected monuments (hotspots) of Bengaluru Metropolitan Region Development Authority (BMRDA). This fort was built by the Chieftain, Malla Byre Gowda of Avathi, a Vijayanagara empire vassal, with built a mud fort (earlier known as Devanadoddi). The roughly oval east oriented fortification concealed with dressed stonework has as many as 12 semi-circular bastions at regular intervals (Fig. 1b). A spacious fortification was provided towards the inner side of the fortification. The fort has entrances decorated with cut plasterwork at the east and west. The bastions are provided with gun points built with lime and brick.

The fort enjoys a climate typical of Bengaluru City with the average maximum and minimum temperature of 36°C and 16°C respectively, and average humidity is of about 52 %. The annual rainfall of the Devanahalli is around 1028.5 mm (per year). The climate in Bengaluru from December to February is cold, March to May is hot, and from June to November is monsoon. The fort is an isolated peaceful place with diverse habitats comprising of vegetation patches of mixed deciduous trees, weeds, shrubs, scrubs, herbs, bamboo bushes, and ornamental plants.

Surveys and samplings

The locality of a fort is distributed in the region ranging 2.4 km diameter. Our survey team consists of 12 members and divided the whole fort into 11 quadrants/ sites (Fig. 1c). Each quadrant consisted of an area with 218 m approximately. The fort locality situated amidst the crowd of town is still unaffected by pollution to greater extent that was identified through our study. Survey of lizards was conducted to estimate population density during February 2018 to May 2018 using a visual encounter survey (Campbell and Chrisman 1982) and point counts methods (Corn and Bury 1990; Bungard et al. 2014) at different quadrants of the Devanahalli fort as followed by Ishwar et al. (2001), Des Roches et al. (2011) and Bungard et al. (2014). During each survey, two observers walked in the same direction approximately 20-m apart for 30 min (Des Roches et al. 2011). The point counts [for 6 min (1 min to settle and 5 min counting)] were conducted twice a day, in the morning and evening hours, for 10 minutes each simultaneously by different groups of observers at different sites (Bungard et al. 2014). Each observer was able to identify and counted the observed animals within a 6-m quadrant. The exercise was done once a week, with an average of four times (replicates) per month in each of the quadrants. We totaled the species occurrence (frequency) and relative abundance (ln transformed) of all individuals for each observer on each day (Bungard et al. 2014). In addition to this, we also measured perch characteristics for a random point not associated with a lizard. The random point was found by using a random number generator to select a distance between 1 and 20-m and a direction between 0º and 360º (Des Roches et al. 2011).

Activities of lizards were recorded following Daniel (2002) and Pandav et al. (2007). Sampling was done along the 11 prefixed quadrants by walking at a uniform pace of about 0.5–1.0 kmh^{-1} at 10.00–12.00 h and 14.00–18.00 h during their most active times of day (Des Roches et al. 2011). To identify the female and male lizards, we used differences in unchanging physical characteristics such as the colour of body (Smith 1935; Daniel 2002; Pandav et al. 2007). In addition to this, observations were made on the various behavioural activities of the lizards as followed by Pandav et al. (2007).

No animal was either harmed or killed for morphometric analysis in the field and none of the specimens was collected for any other purpose (Chakrapani et al. 2014). During the study period, the photographs and videos were made on the lizards using digital camera Canon 1300D with a 15-50 mm lens and 50-250 mm lens with a maximum pixel of 6300R. Flora in the study areas were identified from the field book of Ramaswamy and Razi (1973). The species of lizards were identified using the standard field guides and books (Smith 1935; Daniel 2002).

Measurements from photographs were extracted using software Image J (Rasband 2004). The body shape of each species was quantified using geometric morphometric analyses in the Morho J and Image J softwares (Ramírez-Bautista and Pavón 2009). We digitally photographed a total of 10 individuals on the left to right lateral side (starting point to ends in the starting point) with a reference scale (Fig. 2). We randomized the order of the digitized photographs using Morpho J to reduce potential bias associated with the sequence in which specimens were photographed (Elewa 2004; Rohlf 2009). On each specimen, 10 homologous landmarks were set on distinct anatomical points (Fig. 2).

At each population, we selected the 10 photographs of identified individuals of adult lizard species and recorded the linear measurements in the form mean ± standard error (mm) values in accordance with Melville, Harmon, and Losos, (2006), and Ramírez-Bautista et al. (2013): snout-vent length (SVL), head length (HL), head width (HW), arm length (AL), forearm length (FOL), femur length (FL), tibia length (TL), and pelvic girdle length (PGL). All morphometric comparisons were made using the 10 photographs of identified individuals of adult lizard species irrespective of quadrants and sex determination was identified only for adult lizards. Measurements of body size and morphometric variables (SVL, HL, HW, AL, FOL, FL, TL, and PGL) were analyzed by sex (Ramírez-Bautista and Pavón 2009).

Field observations were also made on the various behaviors (Pandav et al. 2007) such as diet, competition, mating behavior, and predation, nesting and roosting sites, feeding habitats, and food sources of lizards in the fort of Devanahalli region. Observations were made on natural predation of lizards and their eggs. Body coloration of female and male lizards were used to locate them during observations.

All lizards sighted in a quadrant were noted down separately; their abundance was estimated as number of individuals per unit area called as population density. The population density (D) was calculated using the total number of lizards (N) in a particular area (A) and was expressed as D=N/A (Burnham et al. 1981). The occurrence of lizard species can be determined by the frequency method and is used for calculation of frequency index of any lizard population using the following formula as F = r x 100/ R (where, r = Number of samples in which a given species was recorded and R = Total number of samples). A particular species was considered as rare when they had a low frequency (F< 50%) (Soyer 1970). Data on the occurrence, sex ratio, population density, and

abundance of lizards at different study quadrants/ sites were analyzed using the Microsoft Excel spread sheets. The mean number of lizards in each quadrant/ site was assessed and used for further statistical analysis.

Results

A survey of lizards was prepared a checklist of the species diversity of lizards in the Devanahalli fort of the Bengaluru North City region, Bengaluru, India.

A total of nine lizard species belonging to seven genera and four families were recorded in the various quadrants/ sites of the Devanahalli fort during the survey (Table 1). A total of 152 lizards were recorded from 11 sites of Devanahalli fort during the study period (Fig. 1 and Table 1). All the observed lizard species were least concerned in the strategy of IUCN status (IUCN 2011).

Table 1
Abundance, frequency, and sex ratio of lizard fauna in the Devanahalli Fort of the Bengaluru North City region, Bengaluru, India (February-May 2018)

Family	Common Names	Species	Mean no. of adults		Total	% Abundance[a]	% Frequency	Sex ratio (Males: Females) [b]	IUCN Status
			Males	Females					
Agamidae	Ground Agama	*Agama aculeata* Merrem, 1820	02	06	08	05.26	22.22	0.25: 0.75	Least concerned
	Oriental Garden Lizard	*Calotes versicolor* (Daudin, 1802)	35	18	53	34.87	100.00	0.66: 0.34	Least concerned
	Peninsular Rock Agama	*Psammophilus dorsalis* (Gray, 1831)	25	12	37	24.34	77.78	0.68: 0.32	Least concerned
	Blanford's Rock Agama	*Psammophilus blanfordanus* (Stoliczka, 1871)	03	02	05	03.29	44.44	0.60: 0.40	Least concerned
Gekkonidae	Common House Gecko	*Hemidactylus frenatus* Schlegel, 1836	19	10	29	19.08	66.67	0.66: 0.34	Least concerned
	Giant Spotted Gecko	*Hemidactylus maculatus* Duméril & Bibron, 1836	10	03	13	08.55	11.11	0.77: 0.23	Least concerned
Scincidae	Keeled Indian Mabuya	*Eutropis carinata* (Schneider, 1801)	02	00	02	01.32	33.33	-	Least concerned
	Indian Forest Skink	*Sphenomorphus indicus* (Gray, 1853)	04	00	04	02.63	22.22	-	Least concerned
Varanidae	Bengal Monitor	*Varanus bengalensis* (Daudin, 1802)	01	00	01	00.66	11.11	-	Least concerned
		Total	101	51	152	100.00	-	0.66: 0.34	-

[a] Abundance of lizard fauna in different sites was not significantly different (χ^2=0.1573, d*f*=17, *P*>0.05);

[b] Sex ratio of lizard fauna was not significantly different (χ^2=10.4680, d*f*=17, *P*>0.05)

The sex ratio of lizards varied in different species of the Devanahalli fort of the Bengaluru North City region, Bengaluru, India. Moreover, the sex ratio is skewed toward males (Table 1).

Calotes versicolor (Oriental Garden Lizard) (family: Agamidae) was recorded as the highly abundant (34.87%) species. Of the nine lizard species, the frequency of occurrence of *C. versicolor* was 100%, whereas it was less (0.11% each) in the case of *Hemidactylus maculatus* and *Varanus bengalensis* (Table 1).

More numbers (24 and 15.79%) and highest population density of lizards (0.11) were observed at the quadrant II of the in the Devanahalli fort (Table 2).

Table 2
Occurrence, distribution and population density of lizard fauna in different quadrants laid in the Devanahalli Fort of the Bengaluru North City region, Bengaluru, India (February-May 2018)

Quadrants	Total Numbers	% Abundance	Population density Index*
I	07	04.61	0.03
II	24	15.79	0.11
III	19	12.50	0.09
IV	17	11.18	0.08
V	22	14.47	0.10
VI	13	08.55	0.06
VII	12	07.89	0.06
VIII	03	01.97	0.01
IX	11	07.24	0.05
X	08	05.26	0.04
XI	16	10.53	0.07
Total	**152**	**100.00**	**0.70**

* Population density of lizard fauna was not significantly different (χ^2=0.2727, d*f*=10, *P*>0.05).

Morphometric measurements of head, abdomen and total length of the lizard specimens presented in the Table 3.

Table 3
Morphometric measurements of head, abdomen and total length of the lizard specimens

Family	Species	Sex (n=10)	Head mean ± SE (in mm)	Trunk mean ± SE (in mm)	Tail mean ± SE (in mm)	Forelimbs mean ± SE (in mm)	Hindlimbs mean ± SE (in mm)	Total body length mean ± SE (in mm)
Agamidae	*Agama aculeata*		2.704 ± 0.007	5.150 ± 0.017	11.330 ± 0.097	3.818 ± 0.074	5.202 ± 0.041	19.238 ± 0.063
	Calotes versicolor		3.220 ± 0.066	7.340 ± 0.088	15.300 ± 0.152	4.900 ± 0.028	6.540 ± 0.100	25.000 ± 0.223
			2.300 ± 0.102	5.260 ± 0.096	14.640 ± 0.108	3.790 ± 0.030	4.730 ± 0.033	22.240 ± 0.287
	Psammophilus dorsalis		4.660 ± 0.054	11.180 ± 0.191	15.520 ± 0.118	5.360 ± 0.140	7.360 ± 0.151	31.510 ± 0.221
			3.136 ± 0.038	0.066 ± 0.030	12.460 ± 0.137	4.120 ± 0.052	6.840 ± 0.046	21.140 ± 0.161
	Psammophilus blanfordanus		4.260 ± 0.061	10.282 ± 0.095	14.234 ± 0.059	4.638 ± 0.096	6.506 ± 0.109	28.856 ± 0.085
			2.530 ± 0.071	4.542 ± 0.072	11.296 ± 0.045	3.284 ± 0.071	5.262 ± 0.051	18.470 ± 0.124
Gekkonidae	*Hemidactylus frenatus*		1.480 ± 0.013	3.116 ± 0.031	07.764 ± 0.044	2.150 ± 0.016	3.154 ± 0.019	12.360 ± 0.064
	Hemidactylus maculatus		1.650 ± 0.063	3.600 ±0.089	08.300 ± 0.063	2.680 ± 0.096	3.540 ± 0.122	13.550 ± 0.214
Scincidae	*Eutropis carinata*	*	-	-	-	-	-	-
	Sphenomorphus indicus	*	-	-	-	-	-	-
Varanidae	*Varanus bengalensis*	*	-	-	-	-	-	-

*These species have not been measured.

Sexual dimorphism seen in different lizard species of the Devanahalli fort of the Bengaluru North City region, Bengaluru, India (Fig. 3). Coloration of lizard males during the breeding season in the in the Devanahalli fort of the Bengaluru North City region, Bengaluru, India (Fig. 4). The eggs of different lizard species deposited in the fort area of Devanahalli, Bengaluru (Fig. 5).

Behavioural pattern of different lizard species in the Devanahalli fort of the Bengaluru North City region, Bengaluru, India was listed in the form of Table 4. Among the most recorded behaviours, the hiding themselves in the crevices, holes and small spaces in the fort region.

Table 4
Behavioural pattern of lizard species in the Devanahalli Fort of the Bengaluru North City region, Bengaluru, India (February-May 2018)

Common Names	Reptilian Species	Behaviour patterns									
		Basking/ Resting	Chasing	Feeding	Hiding	Aggressive Fighting/ Attacking	Head Nodding	Burrowing/ Digging	Body Colouration	Mating	Egg Laying
Ground Agama	*Agama aculeata*	0	0	0	1	1	1	0	1	1	1
Oriental Garden Lizard	*Calotes versicolor*	0	0	0	1	1	1	0	1	1	1
Peninsular Rock Agama	*Psammophilus dorsalis*	1	1	1	1	1	0	0	1	1	1
Blanford's Rock Agama	*Psammophilus blanfordanus*	1	0	0	1	0	1	0	1	1	0
Common House Gecko	*Hemidactylus frenatus*	0	0	0	1	0	0	0	0	0	1
Giant Spotted Gecko	*Hemidactylus maculatus*	0	0	0	1	0	0	0	0	1	1
Keeled Indian Mabuya	*Eutropis carinata*	0	0	0	1	0	0	0	1	0	0
Indian Forest Skink	*Sphenomorphus indicus*	0	0	0	1	1	0	1	0	0	0
Bengal Monitor	*Varanus bengalensis*	0	0	0	1	0	0	1	1	0	0
0 indicate behaviour not observed; 1 indicate behaviour observed.											

Discussion

A total of nine lizard species belonging to seven genera and four families were recorded in the Devanahalli fort during the survey. A total of 152 lizards were recorded from 11 sites of Devanahalli fort during the study period. All the observed lizard species were least concerned in the strategy of IUCN status (IUCN 2011).

The sex ratio of lizards varied in different species of the Devanahalli fort region due to owing themselves with the sex ratio is skewed toward males, then agonistic interactions between males for access to females during reproductive season should be intense; thus, sexual dimorphism would be explained by sexual selection (Hierlihy et al. 2013). Moreover, in our studies quadrants used were large in size and, males and females of lizards were retained in a nearby 1: 1 ratio. This might have led to elimination of competition for space or a mate. The habitat selection, resting behavior, diet, competition, nesting and roosting sites, feeding habitats, and food sources of the lizard species change greatly between the sexes, with males perching at a greater height than their female counterparts. The mating behavior, and predation of lizards is bimodal and is controlled by environmental temperature (Radder et al. 2005).

Calotes versicolor (Oriental Garden Lizard) was the highly abundant and almost frequently observed species owing to their wide occurrence all over India. It is a seasonally breeding and breeds from late May to October coinciding with the south-west monsoon. Its reproductive cycle can be divided into recurrence, breeding and postbreeding phases as in other lizards. The males are spermatogenetically active from April–September (Gouder and Nadkarni 1979; Radder et al. 2001) and gravid lizards may be seen from May–October. It is a polyautochronic and multiclutched lizard (Shanbhag and Prasad 1993; Shanbhag et al. 2000; Radder et al. 2001). Increasing anthropogenic path/footprint pressure/ disturbance affected the frequency, abundance and density of lizard populations. Lizards increased at a higher frequency in the presence of lower anthropogenic path/footprint pressure/ disturbance (Harings et al. 2014). We had low species abundance preventing the estimation of occurrence for most of lizard species observed despite of our sampling effort.

The highly abundant and population density of lizards were observed at the quadrant II of the Devanahalli fort which could be due to the more presence of a green spaces compared to the other quadrants (Fig. 1c). Indian lizards are found in the drier parts of most of peninsular India (Daniel 2002), reaching their highest densities where there are flat rocks or boulders, interspersed with scrub (Radder et al. 2005). Reptile diversity and abundance is also known to be positively influenced by habitat heterogeneity (Steen et al. 2012).

The morphometric measurements of head, abdomen, tail and total length of the lizard species are mainly attributed characteristics of the higher fitness exhibited by the males (Aguilar-Moreno et al. 2010). At the sexual maturity, the adults body size is larger in males than in females. Also, the males have a higher growth rate and are faster to defend territory and reproduce successfully (Andrews 1976).

The basic factors of an individual's life history are the body size of females and number of offsprings produced by those females (Radder and Shanbhag 2004). They are bright orange or red dorsally and black ventrally in the breeding season. Normally, the adult females, sub-adult males, sub-adult females and juveniles are usually mottled brown and grey dorsally and cream ventrally, so that they form cryptic coloration and camouflage with their rocky environment (Radder et al. 2005). Sexual dimorphism of lizard species could be due to the resources (e.g., space and food) limitations. The male populations are locally dense and may be intrasexual competition. The niche divergence forms a degree of overlapping in the diet between males and females results in a strong competition for food sources (Schoener 1967; Hierlihy et al. 2013). Thus, a divergence in eating habits might be indicative of sexual dimorphism (Ramírez-Bautista and Pavón 2009; Hierlihy et al. 2013).

Coloration of males during the breeding season in the fort area of Devanahalli, Bengaluru was the important criterion for the sexual selection of mating partner. The females make adaptive decisions depending upon the breeding time and is probably responsible for enhancing survival rate of offspring under varying ecological conditions (Radder and Shanbhag 2004). They are territorial and show sexual dimorphism in size and coloration (Radder et al. 2006).

The clutch size of eggs and survival of offsprings are related to each other and also mainly depends upon the maternal body size in many reptilian species. The breeding period forms an important factor so that an upper limit for the number of offsprings and their body size, is also mainly based on the body mass and environmental condition in lizard communities (Radder and Shanbhag 2004).

Among the most recorded behaviours, the hiding themselves in the crevices, holes and small spaces in the fort region. The lizards exhibited a diurnal variation in their activity pattern (basking, foraging, seeking refuge, etc.). Aggression, approach, body wrap, chase, circling, color change, copulation, dewlap, flee, follow, four-leg push-up, grip release, half head bob, head bob, head up/lift, limp, neck bite hold, nuchal crest, push-up, stand high, stationary, straddle, tail up at base, tail twist, throat inflation are 25 distinctive types of postures/ gestures observed as behavior activities (Pandav et al. 2007). The activity pattern in reptiles may vary with the species or ecological conditions (Ellinger et al. 2001).

Based on our observations, we suggest some measures for the conservation and welfare of the population of reptilian fauna in the Devanahalli fort:

- Mowing the grasses, cutting of trees, removal of dead wood logs, dumping of garbage and human interventions during the breeding season of the reptiles must be strictly avoided in the fort of Devanahalli, Bengaluru North city region.
- Grazing of domestic animals such as cattle, goats, and sheep should be avoided during the period of reptiles breeding for the conservation of grasses that are used for nesting.

This fort surveyed for the lizard communities and other wildlife monitoring should be made sporadically; ancient trees standing in these green patches should be identified and conserved; should be afforested with nectar-yielding flower plants and fruit-yielding local tree species. The important efforts should be made to understand the habitat and population status of the species through long term monitoring research and *in situ* conservation projects.

Conclusion

Furthermore, the proper management strategies should be developed to promote and conserve the reptile richness and diversity. Findings of this study divulge that the availability of a variety of food sources for both adults and nestlings, safe habitat for nesting/roosting in and around the landscapes are important for the occurrence and abundance of lizard populations in the urban region. This work therefore provides baseline information for further studies aimed at supporting management and conservation efforts in historical monuments such as fort, temples and archeological sites of the urban region. The long-term monitoring of lizard species should be conducted in historical monuments, and also, inspired to understand the effect of urbanization on the changes in the biodiversity.

Abbreviations

Not applicable

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and material

The sharing of data is not applicable.

Competing interests

The authors declare that they have no conflict of interests.

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Authors' contributions

SR and DVP designed the experiments and prepared the first draft of manuscript, [b-l] Authors performed the experiments. SR analyzed the data, wrote the draft and edited the paper. All authors read and provided helpful discussions for the manuscript.

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Figures

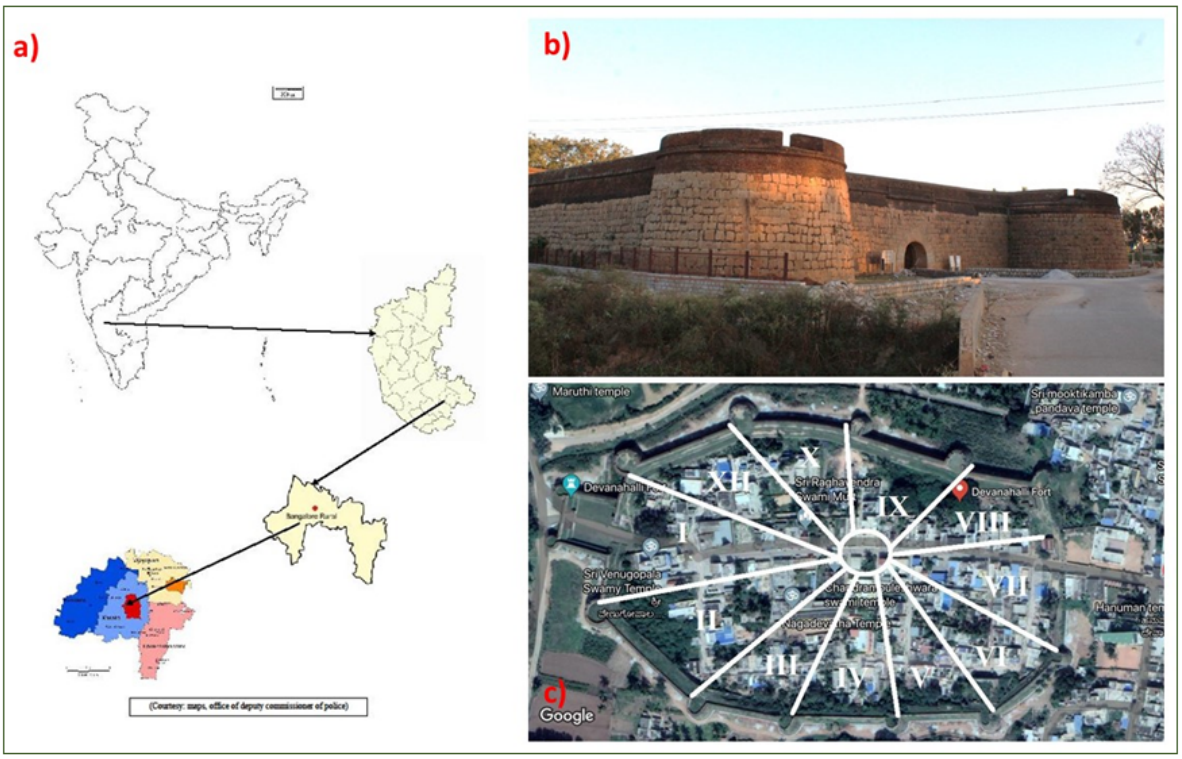

Figure 1

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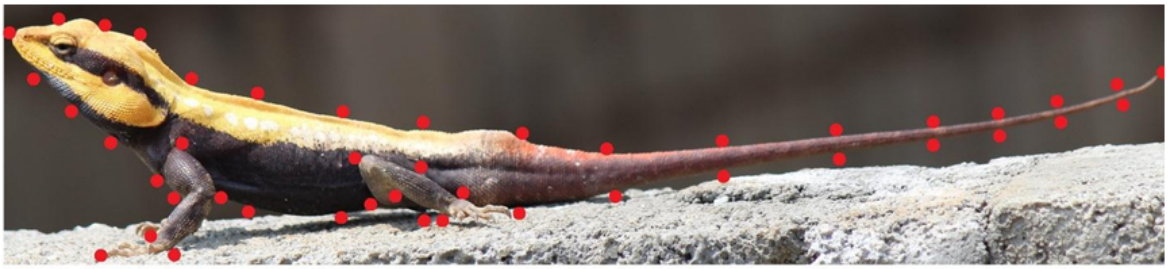

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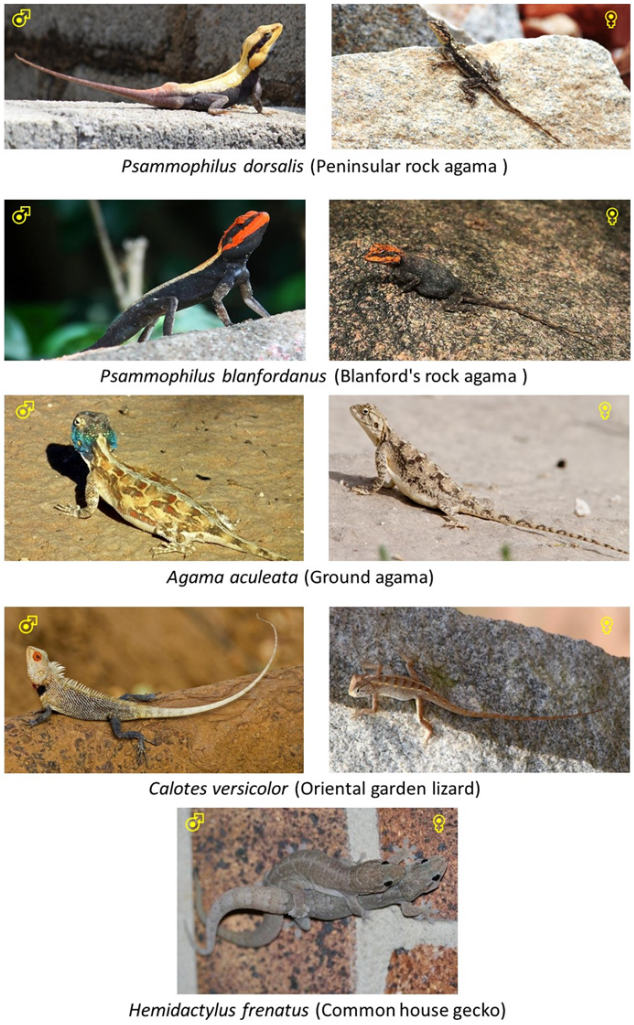

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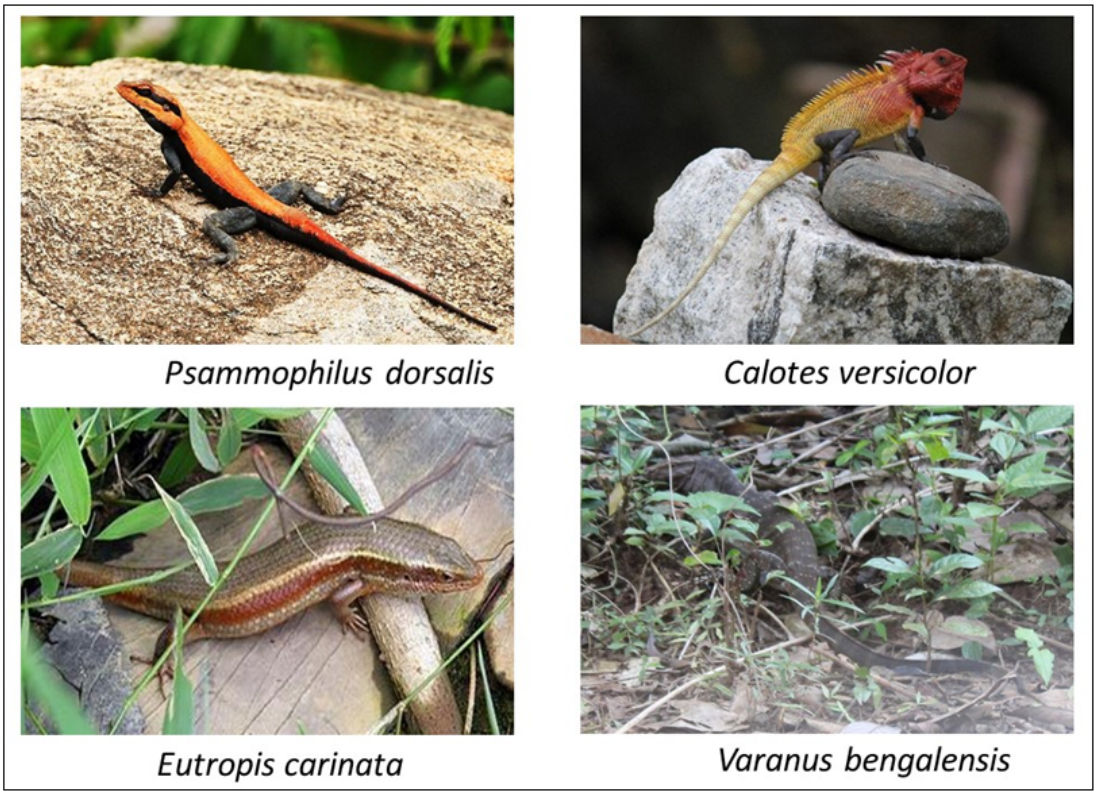

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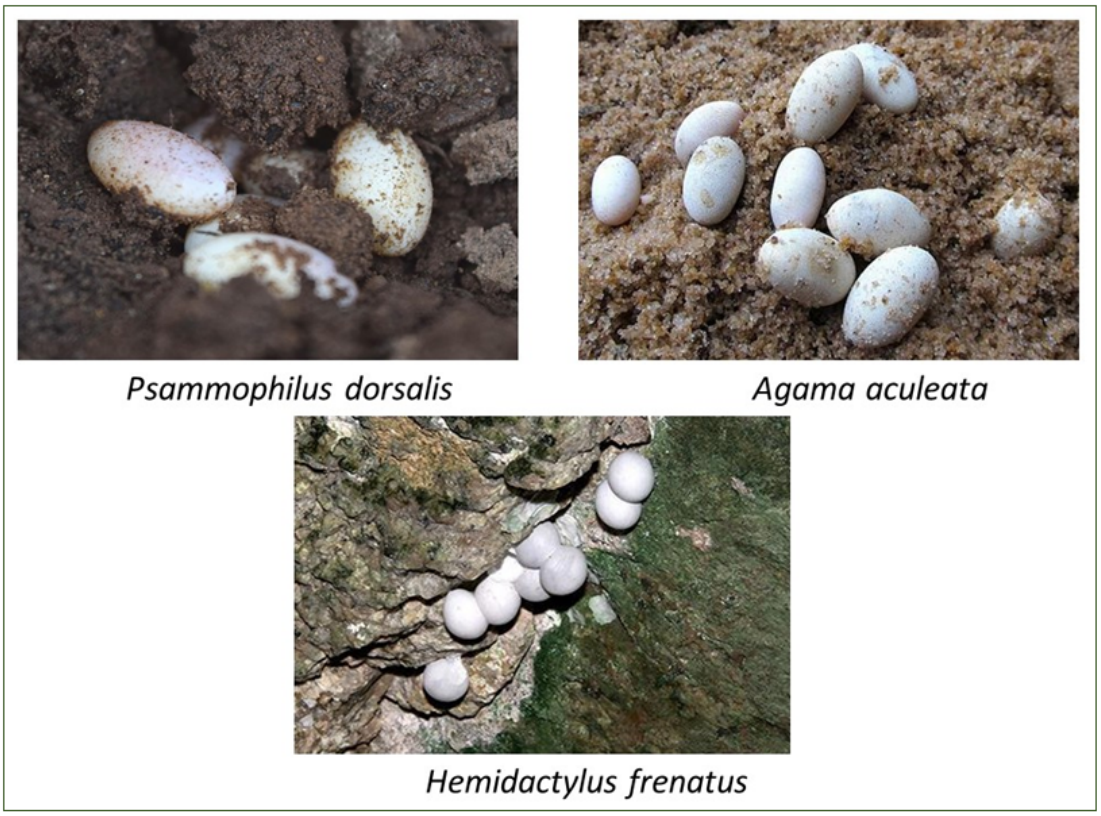

Figure 5

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