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Preliminary Survey of Amphibians and Reptiles of Rajkot City and Vicinity Areas, Gujarat

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Abstract: ***A preliminary survey of amphibians and reptiles were carried out during August to December 2015 from Rajkot City and vicinity areas, Gujarat. This study reports systematics, species composition, conservation status, occurrence and distribution, diversity indices and Photographic documentation. Sampling methodology includes field survey by Visual encounter survey (VES) method, using Line transects (N= 21) and various sizes plotting (N= 32) at random, 2 or 3 days per week, spent 09 hrs per day and night. Entire survey accomplishedwithin total sampling units N=53 under 25 visits, explored all the possible macro and microhabitat from rural to urban gradients. Identification based through morphological details on photographs, close examination andvocalization for anurans during field survey and various literatures. A total of 545 individuals record total 18 species of amphibians belong to06 genera and 03 families, while reptiles record total 19 species, 15 genera and 08 families. Conservation status shownone endangered species Nilgiri Frog (Fejervarya nilagirica), a single data deficient Short-webbed Frog (Fejervarya brevipalmata) and 13 speciesfromLeast Concern (IUCN red list); 02 species were Schedule category IV (WPA, 1972) and a single one species of Appendix II (CITES) from amphibians; while status ofreptiles reveal 04 species Least Concern; 02 species Schedule category I ,02 species Schedule category II, single one species of Appendix I i.e. Common Indian Monitor (Varanus bengalensis), 02 species of Appendix II and 01 species from Appendix III i.e. Checkerd Keelback (Xenochrophis piscator). Frequency based status of amphibian species reveal 04 abundant, 02 common, 07 uncommon and 05 were seen rare; while reptilianspecies were 01 abundant, 01 common, 09 uncommon and 08 species rare.The species Density (n/N) and dominance (D) were higher in amphibians (n/N = 7.26, D = 0.417) than reptiles (n/N = 3.01, D=0.126). Simpson diversity (1/D and 1-D), Shannon-wiener (H'), Evenness-J and Margalef's species richness (d) were significant in reptiles (1/D= 7.968 and 1-D = 0.8745, H'=2.367, J= 0.5615 and d=3.547) than amphibians. This is the first records of such studies in these areas suggests that such high diversity in reptiles and dominancy of amphibian populationprovide more suitability and acclimatizationin urban ecosystem.***

Keywords: Amphibians and reptiles, systematics, species composition, status, indices, Rajkot.

1. Introduction

The world population growth and anthropogenic activities in the next thirty years will be mostly concentrated in the urban areas [1] leading to even more rapid degradation of compartments of residue natural habitats. Owing to urbanization, species with specific habitat preferences often experience either decreased density or extirpation, which can result in an increase in opportunistic species [2].Reptiles and amphibians face numerous challenges for co-existence in the urbanized world [3], [4, [5].

Globally, there are 7,860 species of amphibians [6] and 10,711 of reptiles [7]. Guntherwas pioneered in systematic description of Reptile of British India[8]. The first comprehensive checklist of amphibians of India was brought out by [9]; enlisted 212 species. Indian reptilian species record 489 species [10]; increase in 2011 records 518 species [11]. Indian herpetofauna is studied by several Indian herpetologists as a faunistic survey including systematics from various localities like [12], [13], [14], [15], [16],[17].

The amphibian and reptilian record of Gujarat state surveyed by [18], [19]; a review of Northern most and End of the Western Ghats by Vyas listed 20 species of amphibians. 107 species of reptiles [20]; 18 species of amphibians [21], 89 species of reptiles [22]; 39 species of Lizards [23], 112 reptilian species [24]were recorded from Gujarat state. Although, the amphibians and reptilianssurvey of Gujarat state highly concentrated in Protected Areas and Wildlife Sanctuaries. 06 species of amphibians and 36 reptilians [25]recorded from Gir Protected Area; 10 species of amphibians from Jambughoda Wildlife Sanctuary[26];01 species of anuran and 04 reptilians from Gir Forest Area [27];08 species of anurans and 33 reptiles from Hingholgadh Wildlife Sanctuary [28]; 05 amphibians and 23 reptiles from Rampara Wildlife Sanctuary[29], 07 species of amphibians and 19 reptiles[30]from Narayan Sarovar Sanctuary; 09 species of amphibians from Purna Wildlife Sanctuary [31]; 13 species of amphibians and 41 reptiles from Vansda National Park [32];10 species of amphibians from Barda Wildlife Sanctuary [33]; 19 species [34] and 13species of anurans [35]from Shoolpaneshwar Wildlife Sanctuary; 10 species of anurans in Polo Reserved Forests[36]. Such studies in urban and rural ecosystem are scanty.

Records of Rajkot district onamphibians and reptiles reveal 05 species of anurans [37]; 03 species of amphibians [18]; 07 species of amphibians and 18 reptiles [22], [21]were recorded from Rajkot.Recently, 20[38] and 27 [39] species of reptiles from Khirasara *Vidi*,Rajkot district and 14 species of anurans [40] from Jamnagar are recorded.The present paper deals with preliminary surveyof amphibians and reptiles in the urban ecosystem at City of Rajkot and surrounding rural areas of Western India; which includesystematics, species composition, ecological status, occurrence and distribution of amphibians and reptilians with update checklist to conserve as wildlife data base and monitoring for expansion and documentation with Photographs.

2. Materials and Methods

2.1 Study Area

Rajkot is located (22.3039° N, 70.8022° Eand 138 m MSL) at the centre of Peninsular Saurashtra region in Gujarat State. Total area of Rajkot city is 104.86 km². The city is located on the bank of River Aji and Nyari (Fig.1).

The climate of Rajkot is tropical arid to semi-arid with three distinct seasons each year, monsoon, winter and summer. The area receives annual rainfall is erratic in its occurrence, duration and intensity. Annual rainfallis 830.8 mm (2015) and average minimumand maximumtemperature ranges from 12.6 ºC to 26.4 ºC and 8.1 ºC to 42.7 ºC respectively (Source: Meteorological Department, Airport, Rajkot, 2015). Sampling sites and occurrence of amphibians and reptiles are shown in Figure 2 using GPS coordinates.

2.2 Sampling

Out of total 25 day and night field survey of amphibians and reptiles; total samplings unit N= 53 were undertaken during monsoon (August to December-2015)from Rajkot city and vicinity areas. The entire areas were explored and surveyed from macro to micro habitats as from sites of river, temporary ponds, water bodies, water reservoirs, seasonal freshwater shallow lake, scrub land, vegetation layer, protected areas such as Khirasara and Thorala vidi, agro land, urban and rural public and private gardens, human habitation (*viz* residential, industrial and commercial buildings), waste-land, dammar (Asphalt) and concrete roads.To explore the amphibians and reptiles all the possible microhabitats were surveyed by approaching under the stones and bricks, on shrubs and grass fragments, beneath fallen logs, near the water bodies and temporary bank ponds, puddles, ditches and between the buildings spaces.

During five monthsfield survey sampling records followed by Visual encounter survey (VES) method [41], scanning of leaf litter using Line transect (10 x 50m to 20 x 100m; N= 21) and various sizes plotting (50 x 50m to 250 x 250m; N=32) at random; day and night with 03 to 04 man hours per survey (07:00 to 10:00 hrs) by morning, (17:00 to 20:00 hrs), by evening and late night (23:00 to 02:00 and 03:00 to 06:00 hrs) using LED torch for nocturnal species. Identifications based on only morphotomical features followed by using various literatures and field guide [14], [15], [42], [43], [44], [45], [46], [47], [48], [49]photographs under Photoshop and close observation during field survey.The morphological features of amphibians and reptiles are documented (Plate A1 to A37).

2.3 Data analysis

Data analysis obtained checklist and conservation status with update systematics, species composition, familial population up to genus and species level. Distribution and occurrence of taxa are shown in Figure 2.

The local status of recorded amphibian and reptilian species were established on the basis of frequency of sightingsas, abundance consider 8-11timesrecords out of 25 visits, as common 5-7 times out of 25 visits, uncommon 2-4 times out of 25 visits and rare consider1time out of 25 visits. Ecological indices like Simpson diversity (1-Dand 1/D); Shannon diversity-H`, evenness - e^H/S and margalef‟s species richness (d) were computed using software PAST [50].

3. Results and Discussion

Out of 385 samplings record of amphibian representing total 18species, 06 genera and 03 families; whereas total of 160 samplings of reptile belong to 19 species,15 genera and 08 families during five months survey inRajkot city and their vicinity areas (Table 1, 2; Figure 3, 4).

3.1. Species Composition

A record of18 species of amphibians distributed in a single Order: Anura with 03 families (*viz* Bufonidae, Dicroglossidae, Microhylidae) and 06 genera; of these members of Dicroglossid record most dominant population (n=358), genera (n= 4) and 14 species (Figure 3). While record of 19 species of reptiles are distributed in 02 Order (i.e. Testudines and Squamata) with 08 families (*viz* Trionychidae, Agamidae, Scincidae, Gekkonidae, Lacertidae, Varanidae, Colubridae and Elapidae) and 15 genera; of these members of Agamidpossess most dominant population (n=48); while Colubridae comprise maximum(n=4) genera and species (Figure 4).

The most abundant amphibian species were *Euphlyctis cyanophlyctis* (Skipper Frog, n=244)and *Fejervarya limnocharis*(Indian Cricket Frog,n=29)during entire survey period. Most common species were *Hoplobatrachus tigerinus* (Indian Bull Frog, n=25)and *Fejervarya keralensis* (Verrucose Frog, n=16). Most uncommon species were *Duttaphrynus scaber* (Ferguson's toad, n=06)and *Fejervarya nilagirica* (Nilgiri Frog, n=05)and single time rare seen species were *Fejervarya rufescens* (Rufescent Burrowing Frog, n=2)and *Fejervarya chilapata*(Chilapata Rain-pool Frog, n=2).

Most dominant reptilian species were*Calotes versicolor* (Oriental Garden Lizard, n=39), commonly seen species *Hemidactylus brookii* (Brook's House Gecko, n=22); uncommon species *Hemidactylus flaviviridis* (Northern House Gecko, n=18)and single time rarely seen predominant species were*Sitana spinaecephalus* (Spiny-headed Fan-Throated Lizard, n=3).

3.2. Conservation Status

The conservation status fromamphibiansrepresent 13 species of Least concern (LC)category, 01 species (*Fejervarya brevipalmata*)Data-deficient (DD) and 01 species (*Fejervarya nilagirica*)Endangered (EN) [51]. Total 02 species *(Hoplobatrachus crassus* and *Hoplobatrachus tigerinus*)are comes under Schedule IV category[52]. Only one species Indian Bull Frog (*Hoplobatrachus tigerinus*)are comes under Appendix II category as per CITES (Table 1) [53]. Reptiliansrecord 04 Species under Least concern (LC); 02 species (*Lissemys punctata* and *Varanus bengalensis*)under Schedule I category and 02 species i.e.

*Xenochrophis piscator*and *Naja naja*under Schedule II. As per CITES single species *Varanus bengalensis* comes under Appendix I, 02 species (*Lissemys punctata*and*Naja naja*)from appendix II and one Species (*Xenochrophis piscator*)of appendix III. Frequency based status record05 abundant and 03 species common, 16 species were uncommon, 13 speciesrare, during entire survey (Table 1).

3.3 Distribution and occurrence

There were total 17 occurrence sites (Figure 2);where theamphibians and reptiles are foundfrom urban to rural gradients at Rajkot city and vicinity areas. Among them the Skipper Frog (*Euphlyctis cyanophlyctis*)and Indian Cricket Frog (*Fejervarya limnocharis*)of amphibians were found 65 % distribution and recorded from 11 occurrence sites *viz*Aji-1, Aji-2, Madhapar village, Alidhara Nursery, Munjka, Vinayaka Farm, Nyari-1, Parshuram mandir, Rajkot-Ahmedabad Highway, Saurashtra University Campus, Shephard park. Whereas the Oriental Garden Lizard (*Calotes versicolor*)of reptiles were found 47 % distribution and recorded from 8 occurrence sites *viz*Aji-1, Aji-2, Alidhra Nursery, Anandpar lake, Vinayaka Farm, Nyari-1, Rajkot-Ahmedabad Highway, Shepherd Park, (Figure 2).

3.4 Ecological indices

A total of 545 individuals, 385 individualswasamphibians and 160 reptiles; among them estimated Species Density (n/N)and dominance (D) were higherin amphibians (7.26, D=0.417) than reptiles (3.01, D=0.126).Simpson diversity (1/D and 1-D), Shannon-wiener (H'), Evenness-J and Margalef's species richness (d) were significantin reptiles (1/D= 7.968 and 1-D= 0.8745,H'=2.367, J=0.5615 and d=3.547) than amphibians (Table 2).

Overallmembers of the reptilian are highly diverse, high species richness and evenly distributed than amphibians at Rajkot city and vicinity areas. This support as evenness increases with decreases environmental stress [54]; and amphibians were less diverse may due to specific habitat preferences of them. Beside this the almost the occurrence and records of sampling sites are located in rural areas so, the environmental stress and anthropogenic activities are less comparing to urban areas, it mayexistence of enough food availability, vegetation layer,habitat suitability and climatic factors are responsibleto sustain their establishment.

4. Conclusion

Our research suggests that the population growth for amphibians rather than highly divers fauna of reptiles were greater may due to their spread in rural areas and their specific habitat characteristic provide more suitability. Whereas significant diversity and distribution of reptiles in urban ecosystem provide wide range of habitat selection and their presence in human habitation may due variousanthropological activities like expansion of vegetation stratum by developing forest land from wasteland, many urban parks, nurseries, implant fragments, ornamental plantations, orchard land, agro-lands, water reservoirs, check-dam in rural areas, constructions of buildings, climatic impact and food availability. Large numbers of rare species (amphibian=5,reptile=8) also indicates that their occurrence at various site clear as high disperserdue to not acclimatized in urban-ecosystem.

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Table and Figures

Table 1: Checklist of Amphibians and Reptilesof Rajkot city and vicinity areas, Gujarat. (N = 53)

English Name	Scientific Name	Status			
		Local	IUCN	WPA	CITES
Amphibian Fauna					
Order: Anura (i) Family: Bufonidae (Gray, 1825)					
1. Common indian toad	*Duttaphrynus melanostictus*	A	LC	-	-
2. Ferguson's toad	*Duttaphrynus scaber*	UC	LC	-	-
3. Marbled toad	*Duttaphrynus stomaticus*	R	LC	-	-
(ii) Family Dicroglossidae (Anderson, 1871)					
4. Skipper frog	*Euphlyctis cyanophlyctis*	A	LC	-	-
5. Short webbed frog	*Fejervarya brevipalmata*	A	DD	-	-
6. Verrucose frog	*Fejervarya keralensis*	C	LC	-	-
7. Indian cricket frog	*Fejervarya limnocharis*	A	LC	-	-
8. Manoharan's burrowing frog	*Fejervarya manoharani*	UC	NE	-	-
9. Nilgiri frog	*Fejervarya nilagirica*	UC	EN	-	-
10. Rufescent burrowing frog	*Fejervarya rufescens*	R	LC	-	-
11. Chilapata rain-pool frog	*Fejervarya chilapata*	R	NE	-	-
12. Jerdon’s bull frog	*Hoplobatrachus crassus*	UC	LC	Sch IV	
13. Indian bull frog	*Hoplobatrachus tigerinus*	C	LC	Sch IV	App. II
14. Indian burrowing frog	*Sphaerotheca breviceps*	UC	LC	-	-
15. Dobson's burrowing frog	*Sphaerotheca dobsonii*	UC	LC	-	-
16. Western burrowing frog	*Sphaerotheca pashchima*	R	NE	-	-
17. Jerdon's burrowing frog	*Sphaerotheca pluvialis*	R	LC	-	-
(iii) Family: Microhylidae (Günther, 1858)					
18. Ornate narrow-mouthed frog	*Microhyla ornata*	UC	LC	-	-
Reptilian Fauna					
Order: Testudines (i) Family: Trionychidae (Fitzinger, 1826)					
19. Indian flapshell turtle	*Lissemys punctata*	R	LC	Sch I	App. II
Order: Squamata (i) Family: Agamidae (Gray, 1827)					
20. Oriental garden lizard	*Calotes versicolor*	A	NE	-	-
21. Fan-Throated lizard	*Sitana ponticeriana*	UC	LC	-	-
22. Fan-Throated lizard	*Sitana spinaecephalus*	R	NE	-	-
(ii) Family: Scincidae (Gray, 1825)					
23. Bronzy brown skink	*Asymblepharus sikimmensis*	UC	NE	-	-
24. Bhramini skink	*Eutropis carinata*	UC	LC	-	-
25. Bronze grass skink	*Eutropis macularia*	UC	NE	-	-
26. Snake skink	*Lygosoma punctata*	R	NE	-	-
(iii) Family: Gekkonidae (Gray, 1825)					
27. Northern house gecko	*Hemidactylus flaviviridis*	UC	NE	-	-
28. Brook's house gecko	*Hemidactylus brookii*	C	NE	-	-
(iv) Family: Lacertidae (Oppel, 1811)					
29. Jerdon's snake-eye	*Ophisops jerdonii*	UC	NE	-	-
30. Leschunault's snake-eye	*Ophisops leschenaulti*	UC	NE	-	-
(v) Family: Varanidae (Merrem, 1820)					
31. Common indian monitor	*Varanus bengalensis*	R	LC	Sch I	App. I
(vi) Family: Colubridae (Oppel, 1811)					
32. Common trinket	*Coelognathus helena*	UC	NE	-	-
33. Common wolf snake	*Lycodon aulicus*	R	NE	-	-
34. Common kukri snake	*Oligodon arnesis*	R	NE	-	-
35. Checkerd keelback	*Xenochrophis piscator*	UC	NE	Sch II	App.III
(vii) Family: Elapidae (F. Boie, 1827)					
36. Indian cobra	*Naja naja*	R	NE	Sch II	App.II
37. Common krait	*Bungarus caeruleus*	R	NE	-	-

Abbreviations: LC-Least concern, DD- Data deficient, EN- Endangered (IUCN, 2017-3). WPA - Indian Wildlife Protection Act, 1972. CITES - Convention on International Trade in Endangered Species, A- Abundance, UC- Uncommon, C- Common, R- Rare.

Table 2: Statistical Analysis of Amphibians and ReptilesDuring Study Period

No.	Statistical Analysis	Value	
		Amphibians	Reptiles
1	Total Sampling Units (N)	53	53
2	Total no. of individuals (n)	385	160
3	Total no. of Species (S)	18	19
4	Species Density (n/N)	7.26	3.01
5	Dominance(D)	0.4171	0.1255
6	Simpson's Index (1/D)	2.3975	7.9681
7	Simpson's Index (1-D)	0.5829	0.8745
8	Species diversity (H') by Shannon Weiner Index	1.54	2.367
9	Evenness index (e) by Pielou's (1966)	0.2592	0.5615
10	Species richness (d) by Margalof (1959) d=(S-1)/ log N	2.856	3.547

Figure 1: Map showing location of the Study Site. (Rajkot City in Gujarat State).

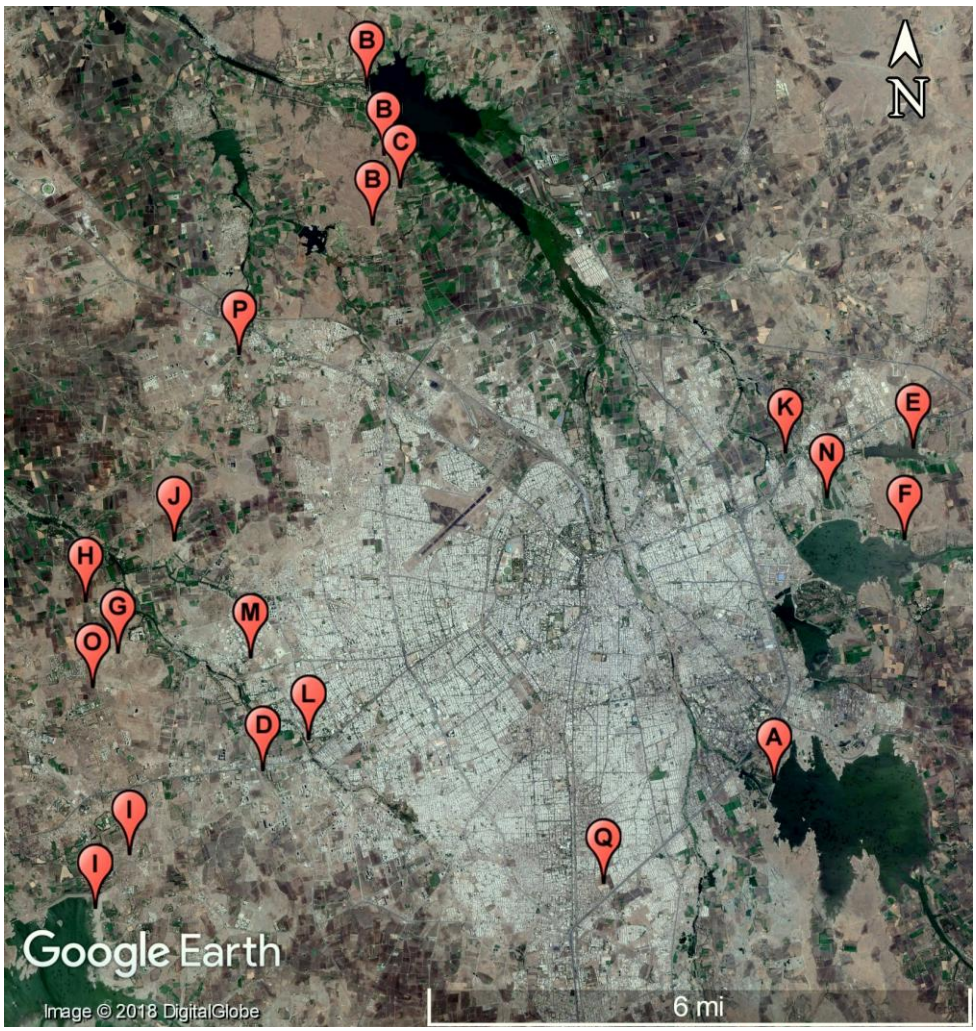

Figure 2: Sampling sites of Amphibians and Reptilesof Rajkot City and their Vicinity Areas, Gujarat.
[A. Aji-1,**B.** Aji-2, **C.** Madhapar village, **D.**Alidhra Nursery, **E.** Anandpar lake, **F.** Lalpari Lake, **G.** Munjka, **H.** Vinayaka Farm, **I.** Nyari-1, **J.** Parshuram Temple, **K.** Rajkot-Ahmedabad Highway, **L.** Ravi Park Society, **M.** Saurashtra University Campus, **N.** Shepherd Park, **O.** Royal Enclave, **P.** Ghanteshwar village, **Q.** Khodiyar Temple].

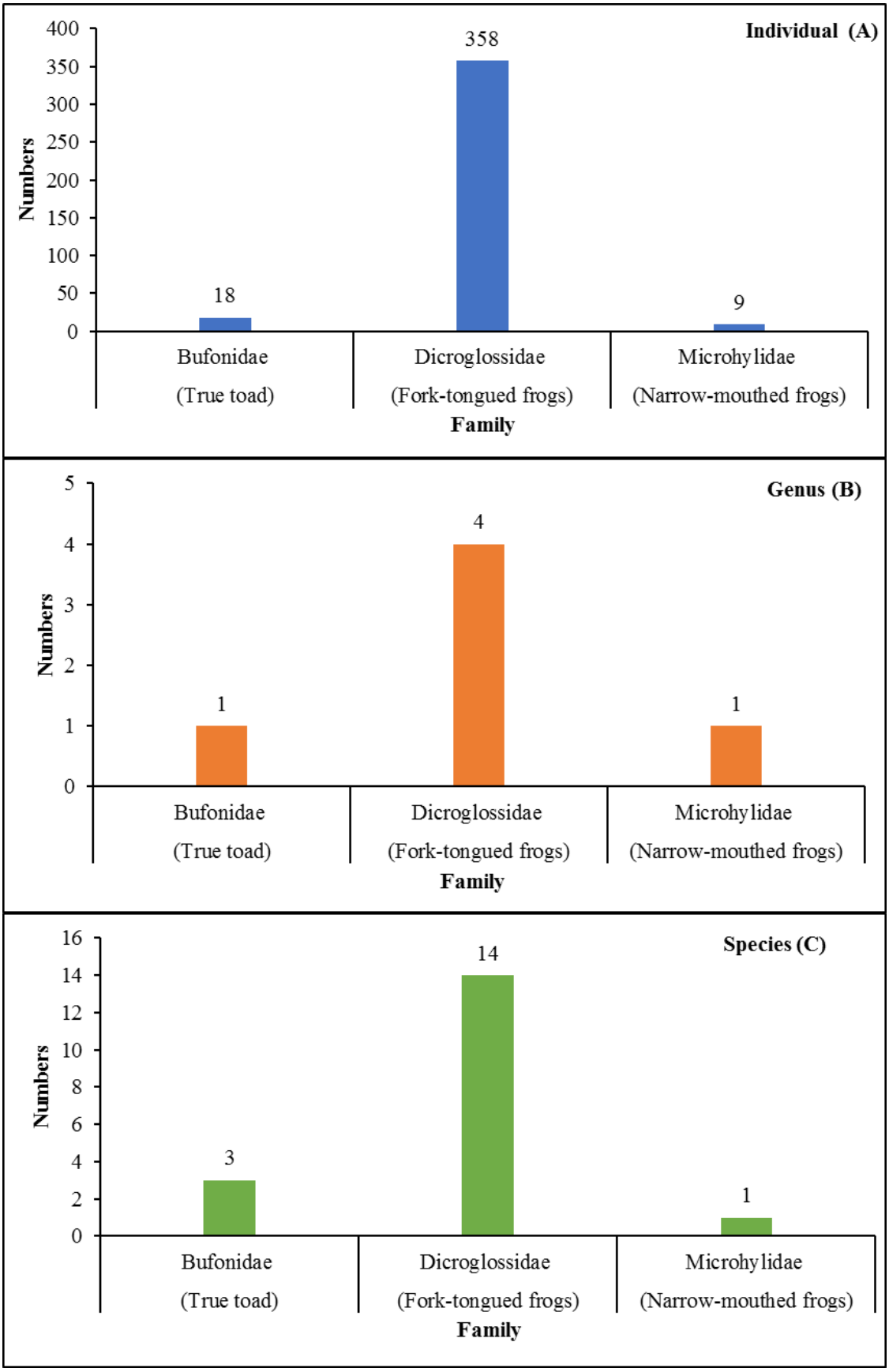

Figure 3: Familial Numbers of Individual (A), Genus (B) and Species (C) of Amphibians during survey period

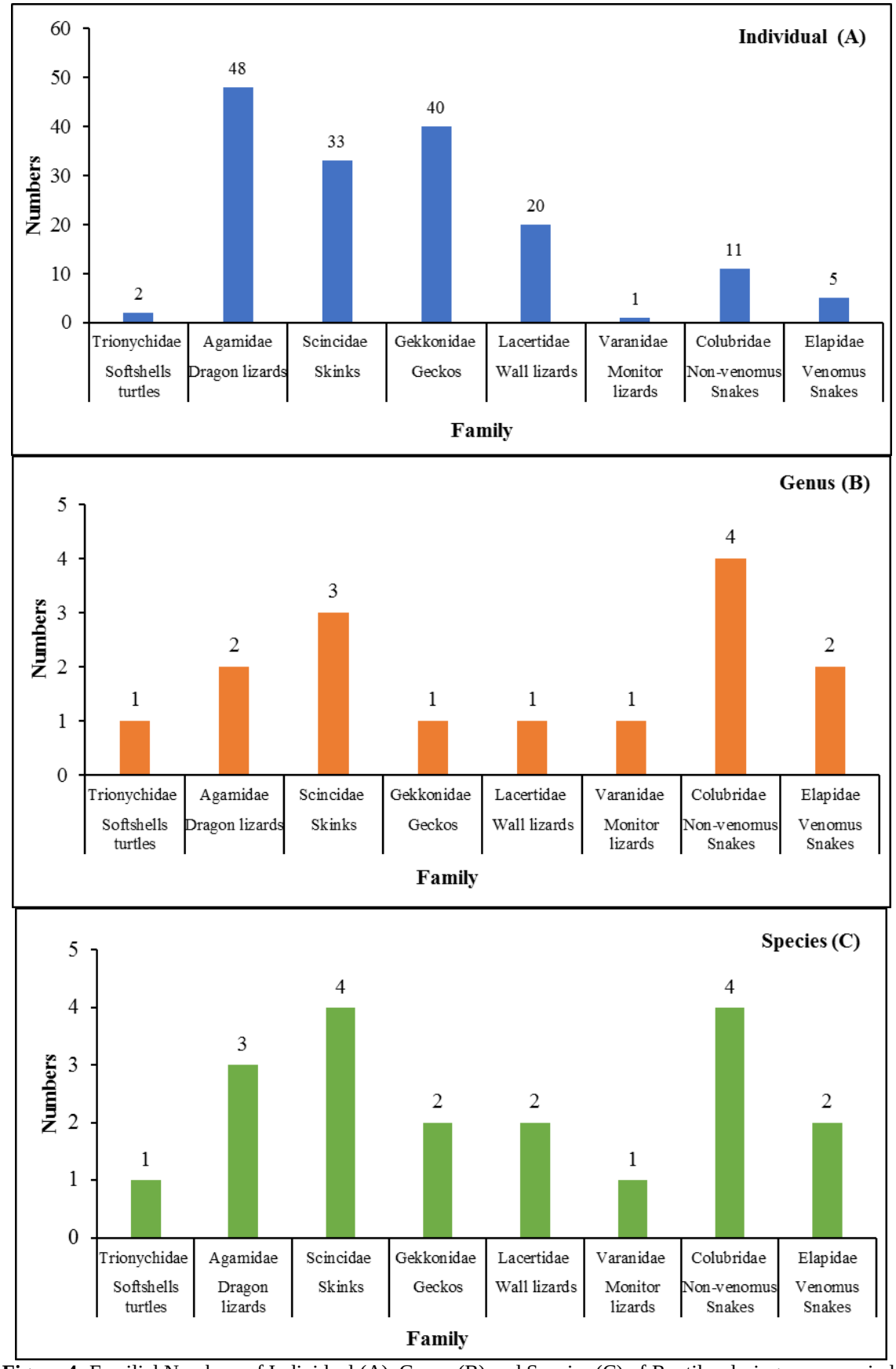

Figure 4: Familial Numbers of Individual (A), Genus (B) and Species (C) of Reptiles during surveyperiod.

1.*Duttaphrynus melanostictus* 2.*Duttaphrynus scaber* 3.*Duttaphrynus stomaticus*

4.*Euphlyctis cyanophlyctis*5.*Fejervarya brevipalmata* 6.*Fejervarya keralensis*

7.*Fejervarya limnocharis*8.*Fejervarya manoharani*9.*Fejervarya nilagirica*

10. *Fejervarya rufescens* 11.*Fejervarya chilapata*13.*Hoplobatrachus tigerinus*

14.*Sphaerotheca breviceps* 15.*Sphaerotheca dobsonii* 16.*Sphaerotheca pashchima*

17.*Sphaerotheca pluvialis*18.*Microhyla ornata*

Plate. A1-18. Recorded amphibian faunaduring study period.

19.*Lissemys punctata* 20. *Calotes versicolor* 21. *Sitana ponticeriana*

22. *Sitana spinaecephalus* 23. *Asymblepharus sikimmensis*

24. *Eutropis carinata* 25. *Eutropis macularia*

26. *Lygosoma punctata* 27. *Hemidactylus brookii*

28. *Hemidactylus flaviviridis* 29.*Ophisops jerdonii*

Plate. A19- 29. Recordedreptilian fauna during study period

30. *Ophisops leschenaulti*

31. *Varanus bengalensis*

32. *Coelognathus helena*

33. *Lycodon aulicus*

34. *Oligodon arnesis*

35. *Xenochrophis piscator*

36. *Naja naja*

37. *Bungarus caeruleus*

Plate A30- 37. Recordedreptilian fauna during study period