

Preliminary report on Herpetofauna of Mount Girnar, Gujarat, India

Harshil Patel^{1*}, Raju Vyas², Bhautik Dudhatra³, Vaibhav Naik⁴, Ashish Chavda³, Devendra Chauhan³, Amit Vaghashiya³, Ramesh Vagadiya³ and Pranav Vaghashiya³

¹Department of Biosciences, Veer Narmad South Gujarat University, Surat-365007, Gujarat, India

²505, Krishnadeep Tower, Mission Road, Fatehgunj, Vadodara-390002, Gujarat, India

³Vasundhara Nature Club, Amrutam, 193/Bapunagar, Joshipura, Junagadh-362002, Gujarat, India

⁴Valsad Pardi, Gopi Street, Valsad-396001, Gujarat, India

Corresponding author✉: harshilpatel121@gmail.com

Abstract

The Saurashtra Peninsula, the largest geographical region of Gujarat state, is a prominent place for herpetofauna in the state and recent herpetological explorations have uncovered three new reptilian species from this region. However, fine scale information on the distribution status of amphibians and reptiles, and baseline information about the regional herpetological diversity of many areas of Saurashtra is still lacking. In an attempt to fill the gaps in information, we surveyed the Girnar hill complex of Gujarat state for its herpetofaunal diversity from September, 2016 to August, 2018. In all, 56 species, comprising 10 species of amphibians belonging to 7 genera and 3 families and 46 species of reptiles, belonging to 31 genera and 15 families were recorded; of which, 2 unidentified frog and 2 unidentified lizard species need further taxonomic attention.

Received: 6 October 2019

Accepted: 27 December 2019

Published online: 31 December 2019

Key words: Amphibians, Anura, reptiles, Squamata, checklist, Saurashtra

Introduction

The Saurashtra Peninsula, also known as Kathiyawar, is the largest geographical region of Gujarat state, western India. Saurashtra accounts for the longest coastline in Gujarat, with two coastal gulfs with good mangrove forest. In addition to several hill complexes, large forest blocks of thorny scrub forest and dry deciduous forest alongside of grasslands creates a diverse habitat that supports a rich fauna (Mirza et al., 2016; Patel and Vyas, 2019). Herpetologically, Saurashtra is home to 74 reptiles (Patel and Vyas, 2019) and some 10 amphibians (Vyas, 2008; 2009). Despite having a large geographical area and rich habitat diversity, many regions of Saurashtra are herpetologically unexplored; one such region is Mount Girnar (Fig. 1) and the Girnar hill complex. The Girnar hill complex is situated near Junagadh city in the Junagadh District. The Girnar forest is bounded on three sides by the towns of Junagadh, Bilkha and Bhesan. The forest is considered sacred, having Hindu and Jain temples on the peaks of Mount Girnar that are frequented by hundreds of thousands of pilgrims every year (Banerjee et al., 2010). The area was gazetted as a Wildlife Sanctuary in May 2008 and is now known as Girnar Wildlife Sanctuary (GWS); a prime habitat of the Asiatic Lion, *Panthera leo persica* (Meyer) and an important protected area of the state. Apart

from a study (Giri et al., 2009), describing a new, endemic species of *Hemidactylus* namely, *Hemidactylus gujaratensis* Giri, Bauer, Vyas and Patil, 2009, from Girnar and some natural history, distribution reports regarding amphibians and reptiles and molecular investigation of *Hemidactylus gujaratensis* (Patel et al., 2016a, b; 2017; Lajmi et al., 2018; Vaghashiya et al., 2018) nothing is known about the herpetofauna of this region. Here, we provide the first documentation of reptiles and amphibians of the Girnar hill complex.



Figure 1: Scenic view of Mount Girnar from Bhavnath. Photo by Pranav Vaghashiya.

Study Area

The Girnar hill complex (Fig. 2), Gujarat, Western India (70°27'–70°28'N and 21°26'–21°30'E), is well known for its rich biodiversity. The Girnar Wildlife Sanctuary has a total area of 182 km². The Girnar hill complex is made up of several hills bordering and forming a crater and having two big mountains in the centre, namely Girnar and Datar. Mount Girnar, with a height of 1031 m, is the highest peak not only in this region but also in the state of Gujarat (Valdiya, 2016). The dominant forest type of the study region is mixed deciduous forest along with thorny scrub forest along the border region of the Girnar Wildlife Sanctuary (Fig. 3). The dominant tree species of the area is *Tectona grandis*, but other species such as *Butea monosperma*, *Haldina cordifolia*, *Holarrhena antidysenterica*, *Pithocellobium dulce*, *Randia spinosa*, *Zizyphus rotundifolia* and *Calotropis procera* are commonly found with other plants (Champion and Seth, 1968; Nakar and Jadeja, 2015).

The climate of Saurashtra is tropical with three distinct seasons, viz., the monsoon (mid-June

to October), winter (October to February) and summer (March to mid-June). The southwest monsoon is irregular, erratic and maximum rain is experienced in the month of July with occasional showers during November to January and March to May. Average annual rainfall in the study region is 820–900 mm. Temperatures begin to increase from March. May is the hottest month of the year with mean daily maximum temperature reaching above 40 °C and the mean daily minimum of about 27 °C. December is the coldest month of the year with the mean daily maximum temperature of about 26 °C and a mean minimum reaching below 14 °C. Relative humidity is comparatively high in this region, especially during the monsoon (data derived from Indian Meteorological Department website: <http://www.imd.gov.in>).

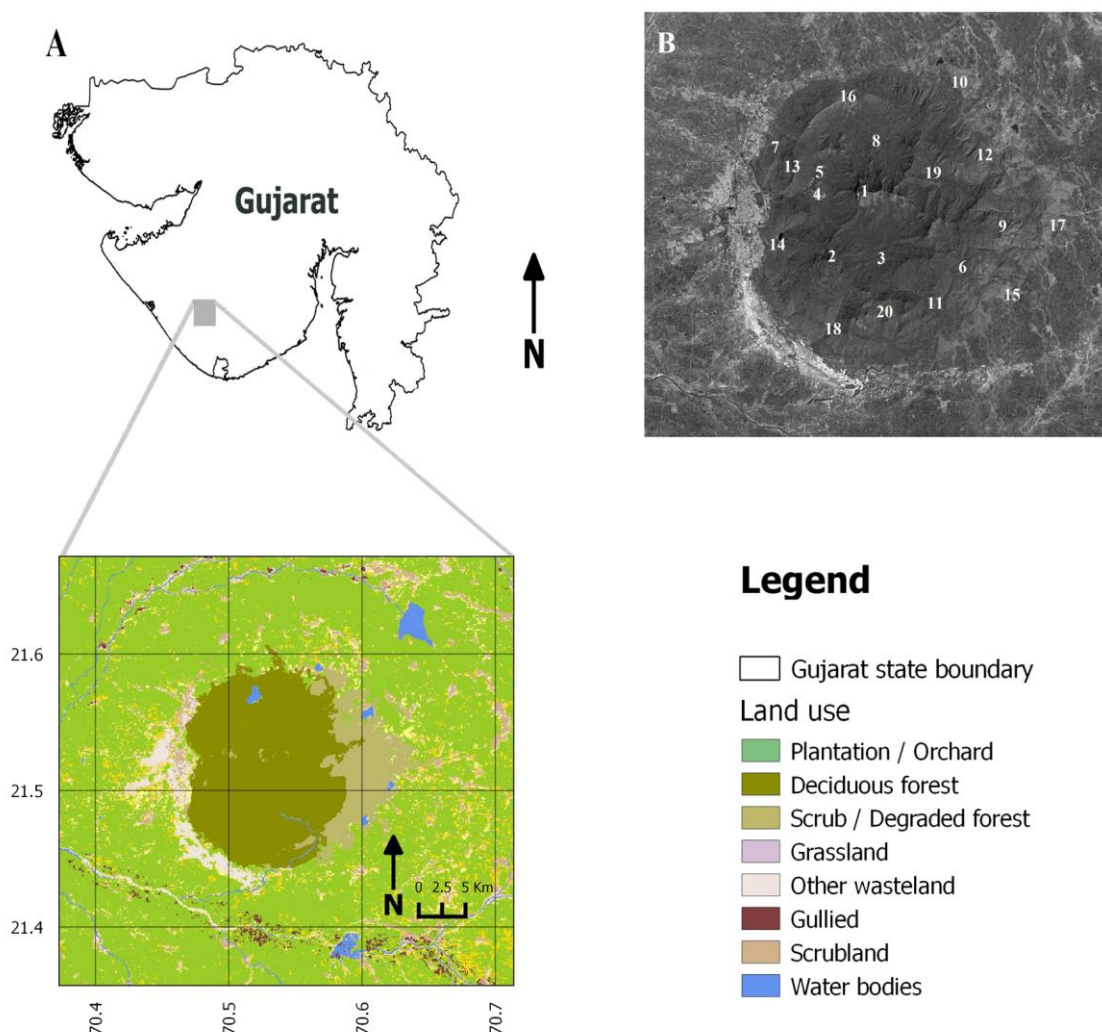


Figure 2: Map showing the Girnar hill complex, Gujarat, India. Location and land use pattern of the study region (A) and satellite image of the study region with sampling locations as follow (B): 1. Girnar, 2. Datar, 3. Bordevi, 4. Bhavnath, 5. Lal Dhori, 6. Mathureshwar, 7. Indreshwar, 8. Jambudi, 9. Ranshivav, 10. Paturan, 11. Ramnath, 12. Kala gadba, 13. Joganiyo, 14. Wellington dam, 15. Ravatsagar, 16. Hasnapur, 17. Machchariya, 18. Khodiyar ghuno, 19. Sarkhadiya hanuman, and 20. Lambdi dhar.

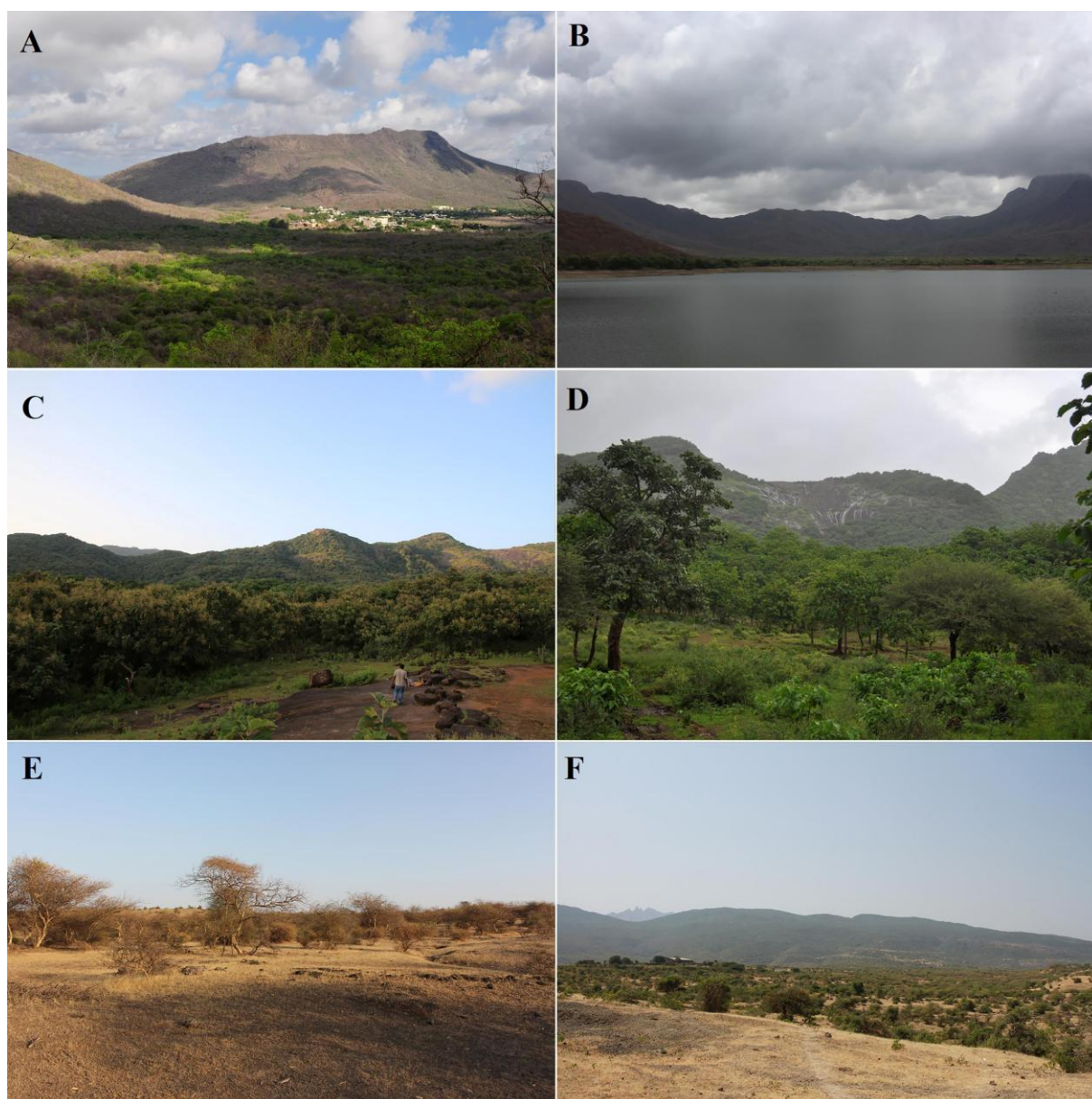


Figure 3: Some habitat types in the Girnar hill complex. Valley with deciduous forest near Bhavnath (A), Hasnapur reservoir and forested hills surrounding it (B), Teak dominant forest near Lal Dhor (C), Mixed deciduous forest near Joganiyo (D), Scrubland at Paturan (E), and Thorny scrub forest near Ranshivav (F). Photos by Pranav Vaghashiya (A, D), Harshil Patel (B, C, E), and Devendra Chauhan (F).

Material and Methods

The present study is based on several sessions of fieldwork from September, 2016 to August, 2018. The study was conducted with appropriate permissions granted by the Forest Department of Gujarat state under permit number WPS/T4/682/B/2931/2016-17 in accordance with the Indian Wildlife Protection Act, 1972. The study area was divided into various zones and each zone was randomly explored on the basis of habitat types and possibility of availability of the species (Vyas, 2004; Patel et al., 2018).

Many different techniques like visual encounter surveys (VES), opportunistic collection and nocturnal road cruising were employed for data collection; specimens encountered on snake rescue calls in and around Girnar hill complex were also included. Specimens encountered

were collected, examined and photographed in the field, and released in the same area, except for a few, which were preserved for further study. All specimens were carefully identified using diagnostic keys and available literature (Smith, 1931; 1935; 1943; Daniel, 1963a, b; 1975; Lajmi et al., 2016; Deepak et al., 2016; 2019).

Nomenclature follows all recent taxonomic advances (for amphibians: Frost, 2019; for Anura Duméril, 1805, Dubois and Ohler, 2019 was followed; and for reptiles: Uetz et al., 2019; Patel and Vyas, 2019). For taxonomic authorities, we followed Smith (1931; 1935; 1943), Wallach et al. (2014), Frost (2019), and Uetz et al. (2019). Snout to vent length (SVL) of some taxa is provided in the description in mm. Taxa that stand unresolved down to the species level are mentioned here with the prefix “cf.” before the specific epithet of the putatively most closely allied taxon. Species reported from each sampling site is provided in the Appendix 1.

Results

Species accounts

Class Amphibia Linnaeus, 1758

Order Anura Duméril, 1805

Family Bufonidae Gray, 1825

Genus *Duttaphrynus* Frost et al., 2006

Duttaphrynus melanostictus (Schneider, 1799) - Asian Common Toad (Fig. 4A)

One of the most common amphibians observed during the survey. Observed in various habitats including forest trails, plantations, roadside areas, and human habitations; active from pre monsoon to winter.

Duttaphrynus stomaticus (Lütken, 1864) - Indian Marbled Toad (Fig. 4B)

A medium sized toad having brownish or olive-gray dorsal coloration with several irregular flat warts and large but indistinct parotid glands. An uncommon toad, encountered during night in the monsoon in the valley of Girnar.

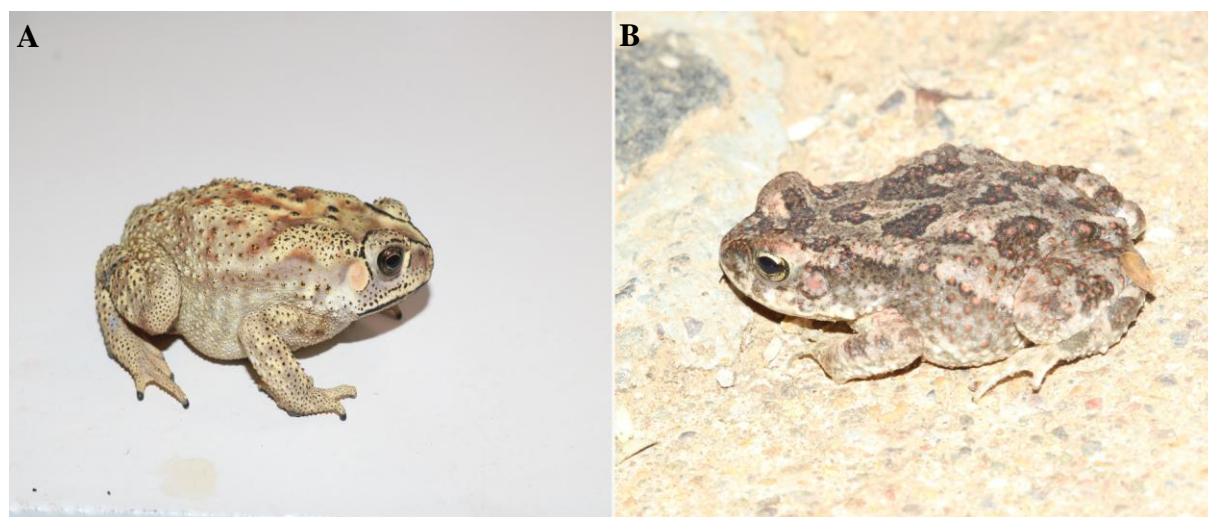


Figure 4: *Duttaphrynus melanostictus* (A), and *D. stomaticus* (B). Photos by Pranav Vaghashiya and Harshil Patel, respectively.

Family Dicroglossidae Anderson, 1871

Genus *Euphlyctis* Fitzinger, 1843

Euphlyctis sp. - Skittering Frog (Fig. 5A)

A medium sized microglossid inhabiting stagnant water bodies, ponds and slow flowing streams of valley to mid elevation (~700 m) of Girnar. This population superficially resembles *E. cyanophlyctis* (Schneider, 1799), but differs from it in snout structure, calls and finger length. A detailed study regarding its identity is underway.

Genus *Hoplobatrachus* Peters, 1863

Hoplobatrachus tigerinus (Daudin, 1802) - Indian Bull Frog (Fig. 5B)

A large sized frog (up to 150 mm) commonly encountered during monsoon near water bodies and forest floor. Significant color change is observed in the adults during breeding season.

Genus *Minervarya* Dubois, Ohler and Biju, 2001

Minervarya sp. - Cricket Frog (Fig. 5C)

A small sized (~20 mm) *Minervarya* encountered in forest floor and near streams in a couple of places like Jambudi and Lal Dhor. Members of this population superficially resemble *M. syhadrensis* (Annandale, 1919), but differ from it in having more numerous warts, calls and toe webbing. As of now this population cannot be assigned to any known species and further taxonomic investigation is needed.

Minervarya syhadrensis (Annandale, 1919) - Syhadra Frog (Fig. 5D)

A small sized frog (up to 30 mm) commonly encountered in paddy, forest floor, near streams and in the mid elevation hills during monsoon and post monsoon. Dorsum rusty greenish brown or brownish grey with warts and darker spots on the back, sometimes with a reddish suffusion.

Genus *Sphaerotheca* Günther, 1859

Sphaerotheca pashchima Padhye, Dahanukar, Sulakhe, Dandekar, Limaye and Jamdade, 2017 - Western Burrowing Frog (Fig. 6)

A medium sized burrowing frog that appears like a toad. Dorsum smooth or granular with some scattered tubercles, venter and lower surfaces of thighs are granulating; inner large and shovel-shaped metatarsal tubercle present, outer one absents. Males have a pair of external vocal sacs, turns black in breeding season. A common frog encountered during monsoon and post monsoon in the valley up to higher elevations.

Family Microhylidae Günther, 1858 (1843)

Genus *Microhyla* Tschudi, 1838

Microhyla ornata (Duméril and Bibron, 1841) - Ornate Narrow-mouthed Frog (Fig. 7)

A small sized microhylid (up to 26 mm); uncommon and encountered during monsoon in leaf litter. Dorsum light or yellowish brown with distinct dark brown diamond shaped mark on back and in between eyes; belly whitish with brown chest.

Genus *Uperodon* Duméril and Bibron, 1841

Uperodon globulosus (Günther, 1864) - Grey Balloon Frog (Fig. 8A)

A medium-sized, plump burrowing microhylid with baggy skin; toad like in appearance. Dorsum smooth red-brownish or green-greyish; belly and throat dirty white colored. A rare species, encountered only twice during the study period in the valley.

Uperodon taprobanicus (Parker, 1934) - Indian Painted Frog (Fig. 8B)

A medium sized microhylid with squarish rounded head and short and thick hind feet. Finger tips dilated; toes one third webbed, tips obtusely swollen; sub-articular tubercles distinct and present on fingers and toes. Shovel-shape metatarsal tubercles present, inner larger than the outer one. Dorsum black-brown or chocolate with scattered dark and light red spots. A wide and irregularly shaped red colored band runs from the eye to groin on both sides of the lateral

body portion. An uncommon frog found on the forest floor, on tree branches and in the tree holes up to 5 m high.

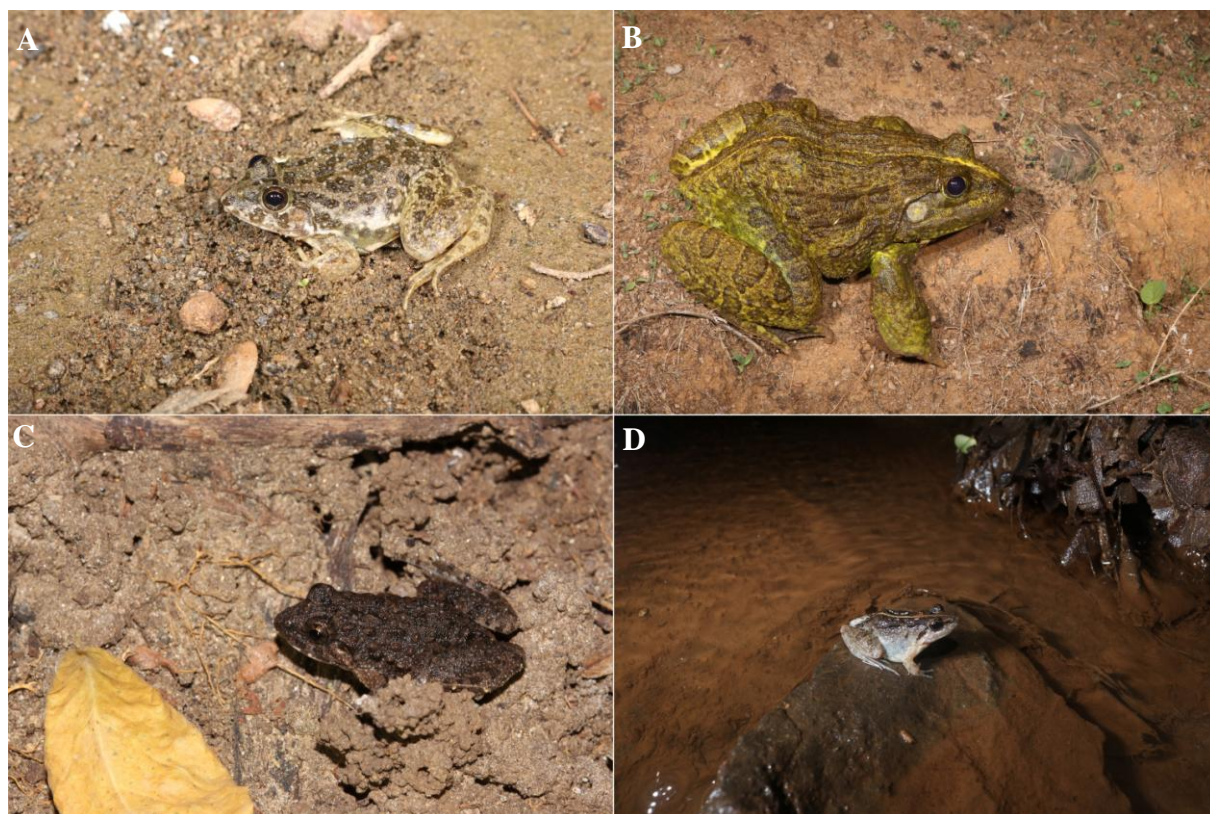


Figure 5: *Euphlyctis* sp. (A), *Hoplobatrachus tigerinus* (B), *Minervarya* sp. (C), and *Minervarya syhadrensis* (D). Photos by Pranav Vaghashiya (A, B, D), and Harshil Patel (C).



Figure 6: *Sphaerotheca pashchima*. Photo by Pranav Vaghashiya.

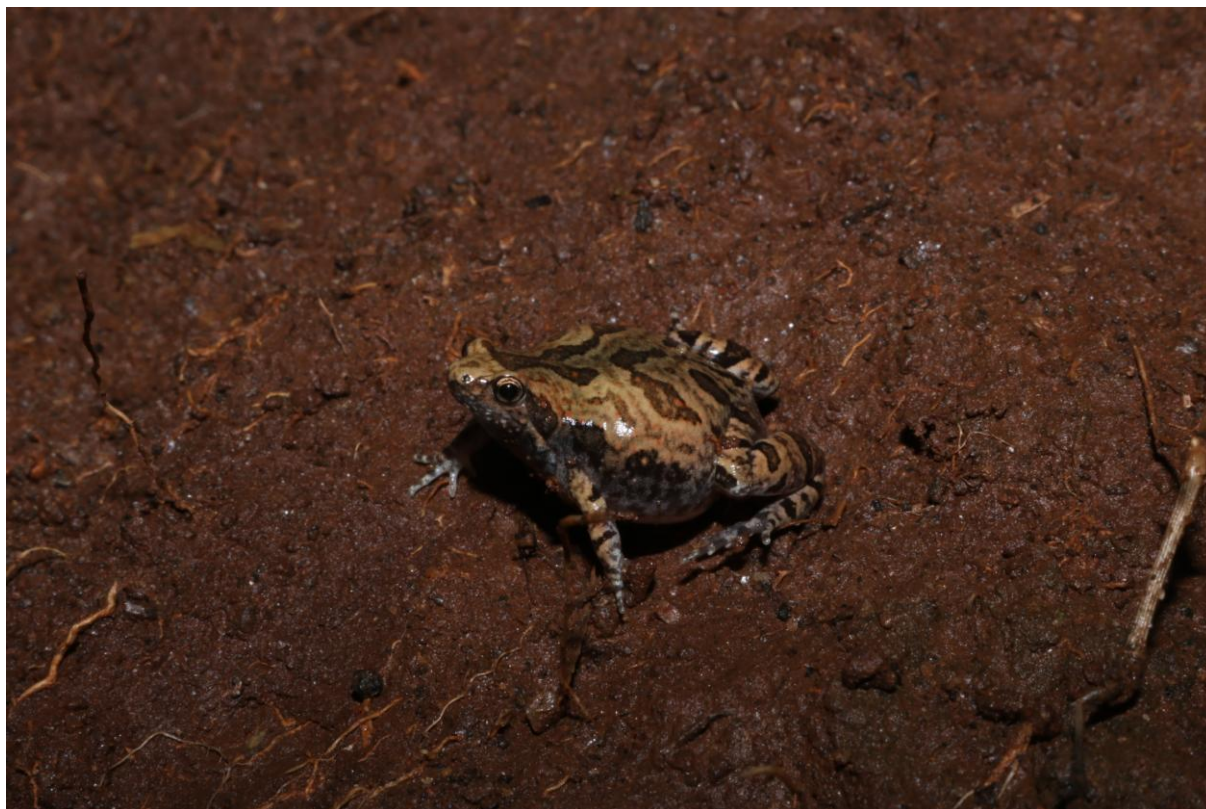


Figure 7: *Microhyla ornata*. Photo by Pranav Vaghashiya.

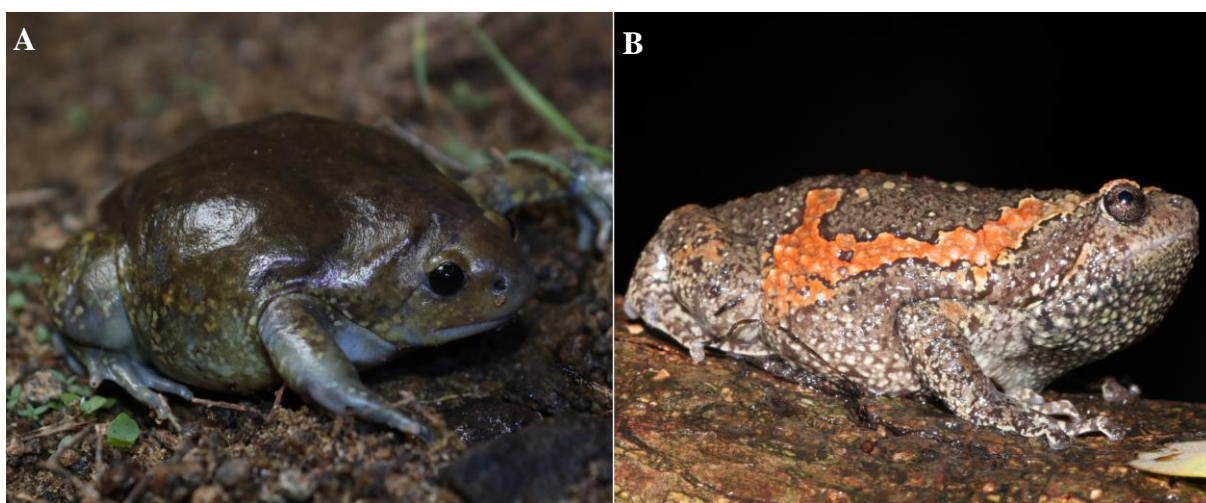


Figure 8: *Uperodon globulosus* (A), and *U. taprobanicus* (B). Photos by Pranav Vaghashiya.

Class Reptilia Laurenti, 1768

Order Testudines Batsch, 1788

Family Testudinidae Batsch, 1788

Genus Geochelone Fitzinger, 1835

Geochelone elegans (Schoepff, 1795) - Star Tortoise (Fig. 9A)

Two specimens were recorded on the onset of monsoon in 2018; one subadult female near Mathureshwar and one male near Bordevi. An uncommon species of the area, as they generally prefer thorny forests or grassland and the predominant forest type of Girnar is deciduous forests.

Family Trionychidae Fitzinger, 1826**Genus *Lissemys* Smith, 1931**

Lissemys punctata (Bonnaterre, 1789) - Indian Flap-shelled Turtle (Fig. 9B)

Many individuals were observed basking and swimming in water bodies, including Wellington Dam, Hasnapur Dam, Lal Dhori, Machchariya, and Mathureshwar. During the monsoon and post monsoon a few juveniles and adults were observed crossing roads near water bodies.

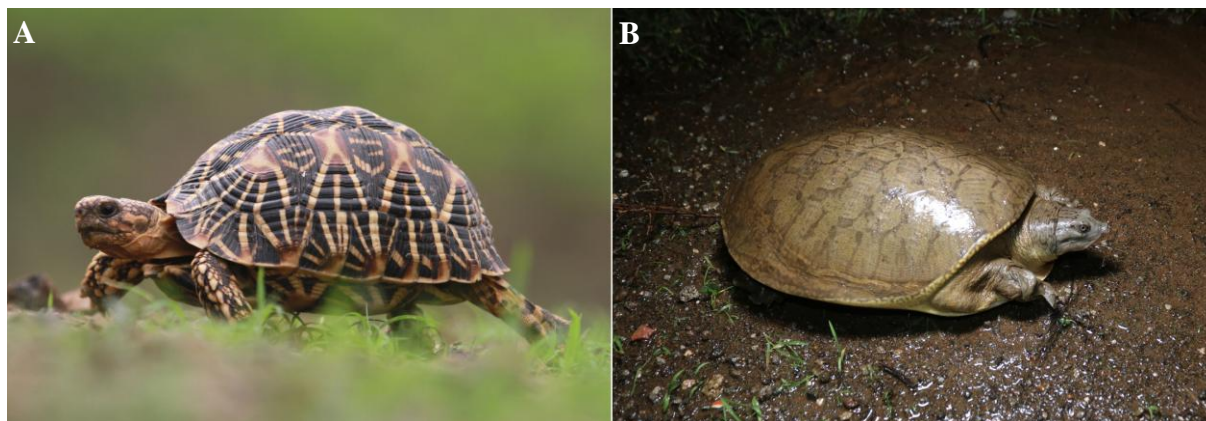


Figure 9: *Geochelone elegans* (A), and *Lissemys punctata* (B). Photos by Bhautik Dudhatra and Pranav Vaghashiya, respectively.

Order Squamata Oppel, 1811**Suborder Lacertilia Owen, 1841****Family Agamidae Theobald, 1868****Genus *Calotes* (Daudin, 1802)**

Calotes versicolor (Daudin, 1802) - Eastern Garden Lizard (Fig. 10A)

Many individuals were observed on the trunks of large trees, in bushes and shrubs, and also on rock boulders. The size of the specimens observed in the hilly region of Girnar was slightly smaller than that seen in other areas of the state.

Genus *Sitana* Cuvier, 1829

Sitana spinaecephalus Deepak, Vyas and Giri, 2016 - Spiny-headed Fan-throated Lizard (Fig. 10B)

Many individuals were reported during the summer and pre-monsoon in lower elevation forest and scrublands at Paturan, Ranshivav, Bordevi and Indreshwar. Juveniles were observed during post monsoon and early winter but adults were not found during these seasons. A detailed study on the life history of this species is needed.

Family Chamaeleonidae Rafinesque, 1815**Genus *Chamaeleo* Laurenti, 1768**

Chamaeleo zeylanicus Laurenti, 1768 - Indian Chameleon (Fig. 11)

Few individuals were reported during the monsoon and post monsoon at lower to mid elevation forest at Bhavnath, Ranshivav, Bordevi, Kala gadba, Indreshwar and Jambudi.

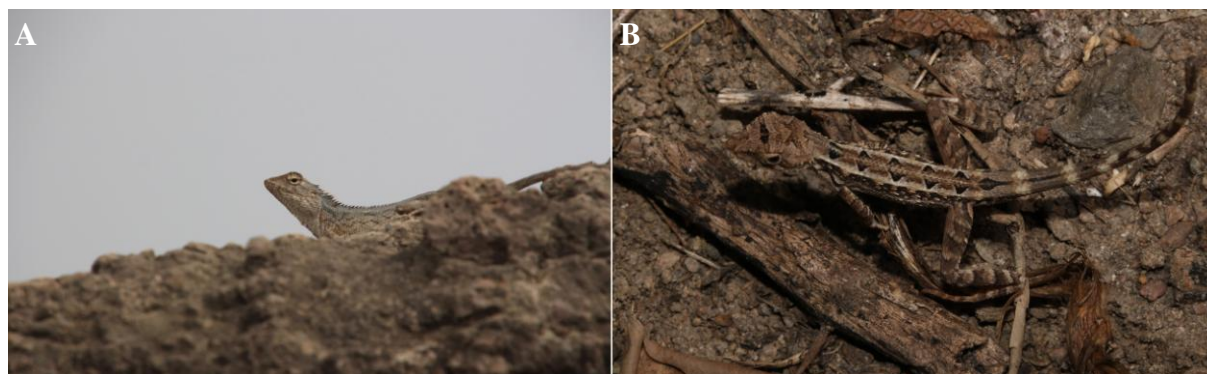


Figure 10: *Calotes versicolor* (A), and *Sitana spinaecephalus* (B). Photos by Harshil Patel and Pranav Vaghashiya, respectively.



Figure 11: *Chamaeleo zeylanicus*. Photo by Pranav Vaghashiya.

Family Gekkonidae Oppel, 1811

Genus *Hemidactylus* Oken, 1817

Hemidactylus flaviviridis Rüppell, 1835 - Northern House Gecko (Fig. 12A)

One of the most commonly encountered lizards in the study region; commonly found during night on rock boulders, tree trunks, human habitations etc., also active during day time in winter and rainy days; occurs in valley up to the high elevation hills. Many individuals are typical of the species without any enlarged tubercles on the back, but some have small enlarged tubercles on the dorsum.

Hemidactylus frenatus Duméril and Bibron, 1836 - Common House Gecko (Fig. 12B)

One male specimen with a partially regenerated tail was recorded from Indreshwar. The specimen was found during late evening on a wall of a small temple.

Hemidactylus cf. *gleadowi* Murray, 1884 - Gleadow's House Gecko (Fig. 12C)

A fairly common, ground dwelling gecko of the area; individuals were reported from the lower to mid elevation forests; encountered on the forest floor, chiefly found on the ground and under rocks.

Hemidactylus gujaratensis Giri, Bauer, Vyas and Patil, 2009 - Gujarat Gecko (Fig. 12D)

A common species of low to mid elevation hills (up to 600 m); encountered on rock boulders, in caves and walls of temples, chiefly during the night but also active during the day. The species is endemic to the Girnar hill complex.

Hemidactylus murrayi Gleadow, 1887 - Murray's House Gecko (Fig. 12E)

Another common gecko of the region, commonly found during the night on rocks, tree trunks and in houses. Found in various habitats in the valley as well as up to high elevation hills.

Hemidactylus sahgalii Mirza, Gowande, Patil, Ambekar and Patel, 2018 - Sahgal's Termite Hill Gecko (Fig. 12F)

One individual was found during a nocturnal field survey on steps made up of rocks near the Datar Hill.

Hemidactylus sp. (Fig. 13)

Three individuals were observed on the rocky boulders near Ramnath. Superficially resembles *H. gujaratensis*, but with a much more slender body and small subtriangular tubercles on the dorsum. A detailed study is needed to confirm the identity of this population.



Figure 12: *Hemidactylus flaviviridis* (A), *H. frenatus* (B), *H. cf. gleadowi* (C), *H. gujaratensis* (D), *H. murrayi* (E), and *H. sahgalii* (F). Photos by Pranav Vaghashiya (A, B, D, F) and Harshil Patel (C, E).



Figure 13: *Hemidactylus* sp.; Photo by Harshil Patel.

Family Lacertidae Oppel, 1811

Genus *Ophisops* Blanford, 1870

Ophisops jerdonii Blyth, 1853 - Jerdon's Snake-eyed Lacerta (Fig. 14A)

Many individuals were recorded from scrublands of Paturan, Ranshivav and near Ravatsagar. Mostly active at morning and evening, but in winter they were encountered during the afternoon.

Ophisops sp. (Fig. 14B)

Two individuals (one male and one female) were observed at Datar hill at around 800 m. The specimens had two frontonasal scales, a key character of *Ophisops beddomei* (Jerdon) complex. However, a detailed taxonomic study is required for the correct taxonomic identification of this population.

Family Scincidae Gray, 1825

Genus *Eutropis* Fitzinger, 1843

Eutropis carinata (Schneider, 1801) - Common Keeled Skink (Fig. 15A)

Many individuals were observed basking on rocks and boulders, foraging on the ground and in rock crevices. The species was recorded in all types of habitats from valley to high elevation hills (up to 1000 m).

Eutropis macularia (Blyth, 1853) - Bronze Grass Skink (Fig. 15B)

Many individuals were observed foraging in leaf litter and near streams; occurs in low to mid elevation forest. During the breeding season, i.e., summer and early monsoon, males develop a bright orange colour from the gular region to the shoulders.

Genus *Riopa* Gray, 1839

Riopa lineata (Gray, 1839) - Lined Supple Skink (Fig. 15C)

One individual was reported on a forest trail near Bhavnath; found while rock turning under a boulder during day time.

Riopa punctata (Linnaeus, 1758) - Spotted Supple Skink (Fig. 15D)

A couple of individuals were reported in leaf litter and under rocks in Bordevi and Jambudi; few juveniles with bright red tails were found in leaf litter in monsoon and post monsoon season.

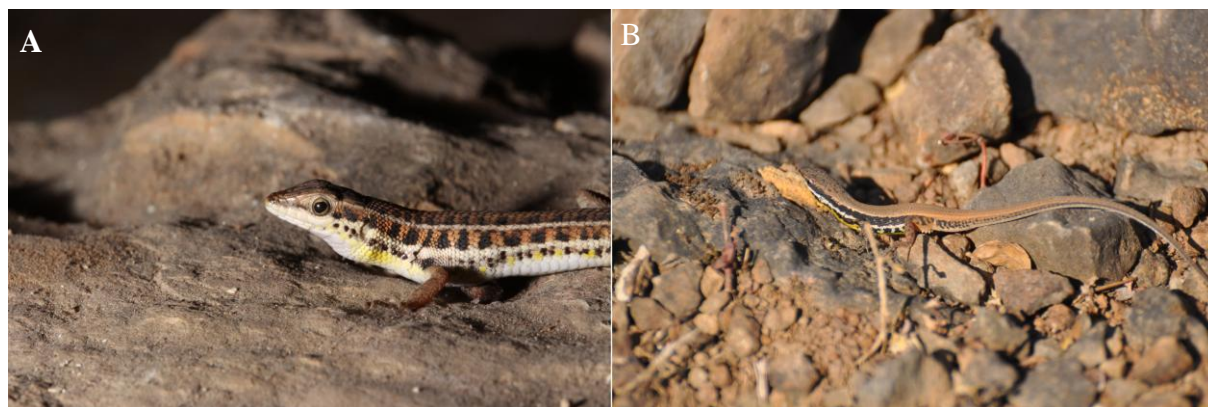


Figure 14: *Ophisops jerdonii* (A) and *Ophisops* sp. (B). Photos by Harshil Patel and Pranav Vaghashiya, respectively.



Figure 15: *Eutropis carinata* (A), *Eutropis macularia* (B), *Riopa lineata* (C) and *Riopa punctata* (D). Photos by Pranav Vaghashiya (A, C, D) and Harshil Patel (B).

Family Varanidae Merrem, 1820

Genus *Varanus* Merrem, 1820

Varanus bengalensis (Daudin, 1802) - Bengal Monitor (Fig. 16)

Many individuals were observed during daytime in the low to mid elevation forest. Generally encountered foraging on the forest floor, some were observed climbing trees and rocky boulders.



Figure 16: *Varanus bengalensis*. Photo by Pranav Vaghashiya.

Suborder Serpentes Müller, 1832

Family Colubridae Oppel, 1811

Genus *Ahaetulla* Link, 1807

Ahaetulla laudankia Deepak, Narayanan, Sarkar, Dutta and Mohapatra, 2019 - Laudankia Vine Snake (Fig. 17A)

A subadult individual of this recently described species was found crossing a road near Bhavnath during an afternoon in late winter in 2018. This species had not earlier been reported from the state of Gujarat and a detailed study reporting this species from the state along with few more locations is communicated elsewhere (Patel et al., 2019).

Ahaetulla nasuta (Lacépède, 1789) - Green Vine Snake (Fig. 17B)

Many individuals of this species were reported from the lower to mid elevation forest regions of Girnar; both green and brown morphs of the species were reported, green being commoner than the brown morph.



Figure 17: *Ahaetulla laudankia* (A) and *Ahaetulla nasuta* (B). Photos by Pranav Vaghashiya.

Genus *Amphiesma* Duméril, Bibron and Duméril, 1854

Amphiesma stolatum (Linnaeus, 1758) - Buff Striped Keelback (Fig. 18A)

A common snake encountered during monsoon and post monsoon season in low elevation to mid elevation forests. Generally encountered during day time on the forest floor, paddies and near streams; on few occasions individuals were seen feeding on frogs of genus *Minervarya*.

Genus *Argyrogena* Werner, 1924

Argyrogena fasciolata (Shaw, 1802) - Banded Racer (Fig. 18B)

A couple of individuals were reported from mid elevation hills of Girnar during day time. One road killed individual was found near Kala Gadba.

Genus *Boiga* Fitzinger, 1826

Boiga forsteni (Duméril, Bibron and Duméril, 1854) - Forsten's Cat Snake (Fig. 18C)

Two individuals were observed; one resting in a tree hollow at a height of about 6 m from the ground near Bordevi; another individual was found foraging on a rough wall made up of rocks near the steps of Girnar during day time.

Boiga trigonata (Schneider, 1802) - Common Cat Snake (Fig. 18D)

Few individuals were observed in lower elevation forest and scrubland; individuals were active during nighttime. On one occasion, Pranav Vaghashiya found three dead individuals on a rescue call near Indreshwar which were killed by laymen, one was a large female and the other two were males.

Boiga westermanni (Reinhardt, 1863) - Indian Egg-eating Snake (Fig. 18E)

One road killed individual was observed near Ramnath during the night in post winter season.

Genus *Coelognathus* Fitzinger, 1843

Coelognathus helena (Daudin, 1803) - Trinket Snake (Fig. 18F)

A common species of low to mid elevation forest, generally encountered during night time, but also active during the day, a few road killed individuals were also reported.

Genus *Dendrelaphis* Boulenger, 1890

Dendrelaphis tristis (Daudin, 1803) - Common Bronzeback Tree Snake (Fig. 18G)

Three individuals were reported from mid to high elevation forested hills, generally encountered basking on shrubs during day time. One individual and a shed skin were found in the valley region near Bhavnath and Bordevi; the individual was observed feeding on a gecko of the genus *Hemidactylus*.

Genus *Fowlea* Theobald, 1868

Fowlea piscator (Schneider, 1799) - Checkered Keelback (Fig. 18H)

A common snake species found in or near water bodies throughout the Girnar hill complex. Very common during monsoon and post monsoon but encounters during the dry season are also possible if water is available. On some occasions, many individuals were observed in one place. During the post monsoon and early winter in 2016–2017, nearly 8–10 adult individuals were observed during the night in a span of 15 m near a check dam in Lal Dhor.

Genus *Lycodon* Boie in Fitzinger, 1826

Lycodon aulicus (Linnaeus, 1758) - Common Wolf Snake (Fig. 19A)

Few individuals were observed at night in low to mid elevation forest; generally found foraging in leaf litter, climbing on trees or rough walls and on roads. On a couple of occasions, individuals were seen feeding on geckos of the genus *Hemidactylus*.

Lycodon striatus (Shaw, 1802) - Barred Wolf Snake (Fig. 19B)

Three individuals were observed in the lower elevation forest while rock turning or under fallen logs. Not a common species of the area.



Figure 18: *Amphiesma stolatum* (A), *Argyrogena fasciolata* (B), *Boiga forsteni* (C), *Boiga trigonata* (D), *Boiga westermanni* (E), *Coelognathus helena* (F), *Dendrelaphis tristis* (G), and *Fowlea piscator* (H). Photos by Pranav Vaghashiya (A-D, F-H) and Bhautik Dudhatra (E).

Genus *Oligodon* Boie in Fitzinger, 1826

Oligodon arnensis (Shaw, 1802) - Common Kukri Snake (Fig. 19C)

Four individuals were found during late evening and night in low elevation forest. A couple of individuals were found as road kill during early morning in monsoon season near Paturan and Bhavnath.

Oligodon taeniolatus (Jerdon, 1853) - Streaked Kukuri Snake (Fig. 19D)

Two adult individuals were found; one on a road near Jambudi in the late evening and another on a forest trail near Lal Dhor. A juvenile individual was found under a rock at the elevation of 700 m a.s.l. at Datar hill.

Genus *Ptyas* Fitzinger, 1843

Ptyas mucosa (Linnaeus, 1758) - Oriental Rat Snake (Fig. 19E)

One of the most common snake species found throughout the Girnar hills from lower elevation forest to high elevation hills, also near human habitats. Generally found foraging on ground during day time and sometimes found climbing on trees to raid bird nests.

Genus *Sibynophis* Fitzinger, 1843

Sibynophis subpunctatus (Duméril, Bibron and Duméril, 1854) - Black-headed Snake (Fig. 19F)

One individual was found under a rock near Jambudi in post winter season in 2017.



Figure 19: *Lycodon aulicus* (A), *Lycodon striatus* (B), *Oligodon arnensis* (C), *Oligodon taeniolatus* (D), *Ptyas mucosa* (E), and *Sibynophis subpunctatus* (F). Photos by Pranav Vaghashiya (A-C, E, F) and Harshil Patel (D).

Family Elapidae Boie, 1827**Genus *Bungarus* Daudin, 1803**

Bungarus caeruleus (Schneider, 1801) - Common Krait (Fig. 20A)

A strictly nocturnal snake species, encountered during monsoon, post monsoon and winter in low elevation forests, generally foraging on the ground or on roads.

Genus *Calliophis* Gray, 1835

Calliophis melanurus (Shaw, 1802) - Slender Coral Snake (Fig. 20B)

Two individuals were found; one in leaf litter near Lal Dhor and another was under a rock at Ranshivav.

Genus *Naja* Laurenti, 1768

Naja naja (Linnaeus, 1758) - Indian Cobra (Fig. 21)

Many individuals were found, foraging on the ground in leaf litter, near human habitation or temples during day time. Two individuals were found during late evening and at night while crossing the road.

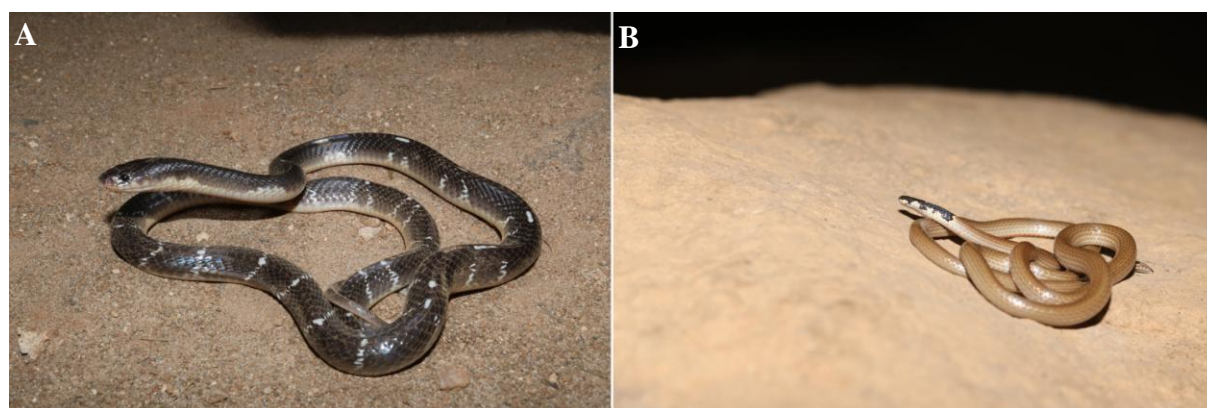


Figure 20: *Bungarus caeruleus* (A) and *Calliophis melanurus* (B). Photo by Pranav Vaghashiya.



Figure 21: *Naja naja*. Photo by Pranav Vaghashiya.

Family Erycidae Daudin, 1803**Genus *Eryx* Daudin, 1803**

Eryx conicus (Schneider, 1801) - Common Sand Boa (Fig. 22A)

Two individuals were observed crossing the road during late evening near Bhavnath and Paturan; one subadult individual was observed basking on a boulder during daytime on a forest trail near Joganiyo.

Eryx johnii (Russell, 1801) - Red Sand Boa (Fig. 22B)

One juvenile was observed crossing the road during night near Indreshwar; one road killed individual was observed near Mathureshwar.



Figure 22: *Eryx conicus* (A) and *Eryx johnii* (B). Photos by Pranav Vaghashiya.

Family Pythonidae Fitzinger, 1826**Genus *Python* (Linnaeus, 1758)**

Python molurus (Linnaeus, 1758) - Indian Rock Python (Fig. 23)

Few individuals (adults as well as juveniles) were observed in low elevation forested areas of Bordevi and Indreshwar.



Figure 23: *Python molurus*. Photo by Pranav Vaghashiya.

Family Typhlopidae Merrem, 1820**Genus *Grypotyphlops* Peters, 1881**

Grypotyphlops acutus (Duméril and Bibron, 1844) - Beaked Worm Snake (Fig. 24A)

One individual was found under a rock near an active termite mound near Indershwar.

Genus *Indotyphlops* Hedges, Marion, Lipp, Marin and Vidal, 2014

Indotyphlops braminus (Daudin, 1803) - Brahminy Blind Snake (Fig. 24B)

Two individuals were found in the leaf litter and under decaying log during post winter near Bordevi.

Family Viperidae Oppel, 1811**Genus *Daboia* Gray, 1842**

Daboia russelii (Shaw and Nodder, 1797) - Russel's Viper (Fig. 25A)

Many individuals were found in low to mid elevation forest, also near human habitats, active during day and night but generally encountered during the night.

Genus *Echis* Merrem, 1820

Echis carinatus (Schneider, 1801) - Saw-scaled Viper (Fig. 25B)

Three individuals were reported; one under a rock in a dry scrubland in Paturan, another was found while crossing a road during the night near Lal Dhor and one individual was found basking on a rock at the height of about 800 m near a trail at Girnar Hill.



Figure 24: *Grypotyphlops acutus* (A) and *Indotyphlops braminus* (B). Photos by Harshil Patel and Pranav Vaghashiya, respectively.



Figure 25: *Daboia russelii* (A) and *Echis carinatus* (B). Photos by Pranav Vaghashiya.

Order Crocodylia Owen, 1842**Family Crocodylidae Cuvier, 1807****Genus *Crocodylus* Laurenti, 1768***Crocodylus palustris* (Lesson, 1831) - Mugger Crocodile (Fig. 26)

Many individuals were observed in almost every water body in lower elevation in the Girnar hill complex from small seasonal streams to large ponds and dams. Commonly seen basking during daytime in winter on the banks near water bodies such as, Wellington Dam, Hasnapur Dam, Lal Dhor, Machchariya and Mathureshwar. During monsoon, some individuals were also observed near human habitations and on roads passing near a water body.



Figure 26: *Crocodylus palustris*. Photo by Pranav Vaghashiya.

Discussion

During this study, we recorded 10 species of amphibians and 46 species of reptiles. All recorded amphibians were anurans. Among anurans, the highest diversity was observed in the Family Dicroglossidae (5 species), followed by Microhylidae (3 species) and Bufonidae (2 species). Among reptiles, 1 species of crocodile (Fig. 26) belonging to the Family Crocodylidae; 1 species of tortoise belonging to Family Testudinidae (Fig. 9A); 1 species of turtle belonging to Family Trionychidae (Fig. 9B); 17 species of lizards belonging to 8 genera and 6 families; and 26 species of snakes belonging to 6 families and 20 genera were recorded. Among the lizards, highest diversity was observed in the Family Gekkonidae (7 species, all from the genus *Hemidactylus*), followed by Scincidae (4 species), Lacertidae (2 species) and Agamidae (2 species). Chamaeleonidae and Varanidae also contribute to the species diversity, each represented by a single species. Snakes are represented by the families Elapidae (3 species), Viperidae (2 species), Typhlopidae (2 species), Erycidae (2 species), Pythonidae (1

species) and Colubridae (16 species, and 11 genera), which has the highest species diversity in the region.

The highlight of the present study is the record of a recently described snake species, *Ahaetulla laudankia* and two Microhylid frogs, namely *Uperodon taprobanicus* and *Uperodon globulosus*. *Ahaetulla laudankia* was recently described from Odisha and Rajasthan and was not known from Gujarat state (Deepak et al., 2019); a separate study reporting this species along with another snake is published elsewhere (Patel et al., 2019). *Uperodon taprobanicus* and *U. globulosus* both were reported for the first time from the Saurashtra Peninsula. Giri et al. (2009) described the endemic *Hemidactylus gujaratensis* from around 110 m elevation a.s.l. in the foothills of Girnar. However, during the present study we were able to observe specimens of this endemic gecko up to the elevation of 600 m a.s.l., which is a significant increase.

During our study, several species were recorded whose identities are either unknown or conferred to closely related species. For positive identification of such species additional surveys will be planned with detailed morphological comparison and further collaborative work with appropriate taxon specialists. These provisionally identified species may represent species yet to be named, or morphological variants of known species. Among amphibians such poorly identified species include *Euphlyctis* sp. (Fig. 5A) and *Minervarya* sp. (Fig. 5C), and among reptiles, includes *Hemidactylus* sp. and *Ophisops* sp. (Figs. 13, and 14B, respectively).

Among the recorded species, *Python molurus*, *Crocodylus palustris*, *Lissemys punctata*, *Boiga westermanni* and *Varanus bengalensis* have been accorded the highest legal protection status, under Schedule I of the Indian Wildlife Protection Act (WPA), 1972. Five species, including: *Chamaeleo zeylanicus*, *Naja naja*, *Daboia russelii*, *Ptyas mucosa* and *Fowlea piscator* are listed in Schedule II, all other snake species, *Hoplobatrachus tigerinus* and *Geochelone elegans* are listed under Schedule IV of the WPA 1972.

The Girnar Wildlife Sanctuary harbours some of the last remaining deciduous forest patches in the Saurashtra Peninsula. Despite being a small geographical area of Saurashtra, Girnar contributes more than 60% of reptilian and nearly 100% of amphibian species of Saurashtra. In considering the scarcity of knowledge of diversity, distribution and many other aspects of the amphibians and reptiles of the region, the present study is highly significant. Further herpetological explorations in Gujarat and especially Saurashtra, including the poorly studied regions, is our next priority.

Acknowledgment

We are grateful to PCCF, Gujarat Forest Department and CCF, Junagadh Circle for giving permissions to carry out herpetological surveys in the Girnar Wildlife Sanctuary, Gujarat. Professor Sushil Kumar Dutta, Zeeshan Mirza and Varad Giri are thanked for providing some valuable literature and important suggestions from which this study benefited. We thank Kaushal Patel for his help in preparation of the map (Fig. 2). We thank Pratyush Mohapatra for his discussion regarding the distribution of *Ahaetulla laudankia*. We also thank the Vaghashiya family, Junagadh for hosting us at their place during the study period. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. We thank Aaron M. Bauer and Ali Gholamifard for their comments and suggestions from which the manuscript has greatly benefited.

References

- Banerjee, K., Jhala, Y. V. and Pathak, B. (2010). Demographic structure and abundance of Asiatic lions *Panthera leo persica* in Girnar Wildlife Sanctuary, Gujarat, India. *Oryx*, 44 (2): 248–251. <https://doi.org/10.1017/S0030605309990949>
- Champion, H. G. and Seth, S. K. (1968). *A revised survey of the forest types of India*. Manager of Publications, Delhi, India. 404 pp.
- Daniel, J. C. (1963a). Field guide to the amphibians of Western India. Part 1. *The Journal of the Bombay Natural History Society*, 60 (2): 415–438.
- Daniel, J. C. (1963b). Field guide to the amphibians of Western India. Part 2. *The Journal of the Bombay Natural History Society*, 60 (3): 690–702.
- Daniel, J. C. (1975). Field guide to the amphibians of Western India. Part 3. *The Journal of the Bombay Natural History Society*, 72 (2): 506–522.
- Deepak, V., Giri, V. B., Asif, M., Dutta, S. K., Vyas, R., Zambre, A. M., Bhosale, H. and Karanth, K. P. (2016). Systematics and phylogeny of *Sitana* (Reptilia: Agamidae) of Peninsular India, with the description of one new genus and five new species. *Contributions to Zoology*, 85 (1): 67–111. <https://doi.org/10.1163/18759866-08501004>
- Deepak, V., Narayanan, S., Sarkar, V., Dutta, S. K. and Mohapatra, P. P. (2019). A new species of *Ahaetulla* Link, 1807 (Serpentes: Colubridae: Ahaetullinae) from India. *Journal of Natural History*, 53 (9–10): 497–516. <https://doi.org/10.1080/00222933.2019.1589591>
- Dubois, A. and Ohler, A. (2019). The nomina Anura, Urodela, Ecaudata and Caudata, credited to ‘Fischer von Waldheim, 1813’, do not exist, with comments on the nomenclature of higher zoological taxa and on the authorships and dates of other amphibian nomina. *Bionomina*, 14(1): 1–68. <http://dx.doi.org/10.11646/bionomina.14.1.1>
- Duméril, A. M. C. (1805). *Zoologie analytique, ou méthode naturelle de classification des animaux, rendue plus facile à l'aide de tableaux synoptiques*. Allais, Paris, 1806. 344 pp. [in French]
- Frost, D. R. (2019). Amphibian Species of the World: an Online Reference. Version 6.0. American Museum of Natural History, New York, USA. www.research.amnh.org/herpetology/amphibia/index.html (Accessed 14 September 2019).
- Giri, V. B., Bauer, A. M., Vyas, R. and Patil, S. (2009). New species of rock-dwelling *Hemidactylus* (Squamata: Gekkonidae) from Gujarat, India. *Journal of Herpetology*, 43 (3): 385–393. <https://doi.org/10.1670/08-137R1.1>
- Lajmi, A., Datta-Roy, A., Vyas, R., Agarwal, I. and Karanth, P. (2018). The curious case of *Hemidactylus gujaratensis* (Squamata: Gekkonidae). *Zootaxa*, 4388 (1): 137–142. <http://dx.doi.org/10.11646/zootaxa.4388.1.11>
- Lajmi, A., Giri, V. B. and Karanth, K. P. (2016). Molecular data in conjunction with morphology help resolve the *Hemidactylus brookii* complex (Squamata: Gekkonidae). *Organisms Diversity & Evolution*, 16 (3): 659–677. <https://doi.org/10.1007/s13127-016-0271-9>
- Mirza, Z. A., Vyas, R., Patel, H., Maheta, J. and Sanap, R. V. (2016). A new Miocene-divergent lineage of old world racer snake from India. *PLOS ONE*, 11 (3): e0148380. <https://doi.org/10.1371/journal.pone.0148380>
- Nakar, R. N. and Jadeja, B. A. (2015). Flowering and fruiting phenology of some herbs, shrubs and undershrubs from Girnar Reserve Forest, Gujarat, India. *Current Science*, 108 (1): 111–118.

- Patel, H. and Vyas, R. (2019). Reptiles of Gujarat, India: updated checklist, distribution, and conservation status. *Herpetology Notes*, 12: 765–777.
- Patel, H., Vaghashiya, P. and Tank, S. K. (2016a). Necrophiliac behavior in the Common Asian Toad, *Duttaphrynus melanostictus* (Schneider 1799) in Western India. *IRCF Reptiles and Amphibians*, 23 (1): 32–33.
- Patel, H., Naik, V. and Tank, S. K. (2016b). The Common House Gecko, *Hemidactylus frenatus* Schlegel in Duméril and Bibron 1836 (Reptilia: Gekkonidae) in Gujarat, India. *IRCF Reptiles and Amphibians*, 23 (3): 178–182.
- Patel, H., Tank, S. K. and Vaghashiya, P. (2017). *Euphlyctis cynophlyctis* (Indian Skipper Frog). Diet. *Herpetological Review*, 48 (1): 161.
- Patel, H., Vyas, R., Naik, V., Dudhatra, B. and Tank, S. K. (2018). Herpetofauna of the northern Western Ghats of Gujarat, India. *Zoology and Ecology*, 28 (3): 213–223. <https://doi.org/10.1080/21658005.2018.1499237>
- Patel, H., Vyas, R. and Vaghashiya, P. (2019). On the distribution of *Ahaetulla laudankia* Deepak, Narayanan, Sarkar, Dutta & Mohapatra, 2019 and *Lycodon travancoricus* (Beddome, 1870) (Squamata, Colubridae) from Gujarat, India. *Check List*, 15 (6): 1045–1050. <https://doi.org/10.15560/15.6.1045>
- Smith, M. A. (1931). *The Fauna of British India, including Ceylon and Burma. Reptilia and Amphibia. Volume I. Loricata, Testudines*. Taylor and Francis, London. 185 pp.
- Smith, M. A. (1935). *The Fauna of British India, including Ceylon and Burma. Reptilia and Amphibia. Volume II. Sauria*. Taylor and Francis, London. 441 pp.
- Smith, M. A. (1943). *The Fauna of British India, Ceylon and Burma, Including the Whole of the Indo-Chinese Sub-Region. Reptilia and Amphibia. Volume III. Serpentes*. Taylor and Francis, London. 583 pp.
- Uetz, P., Freed, P. and Hošek, J. (2019). The Reptile Database. www.reptile-database.org (Accessed 14 September 2019).
- Vaghashiya, P. M., Dudhatra, B. and Vyas, R. (2018). Parental behaviour of mugger (*Crocodylus palustris*) at Lal Dhor, Junagadh, Gujarat, India. *CSG Newsletter*, 37 (2): 16–18.
- Valdiya, K. S. (2016). Geological marvels, hallowed shrines and unification of people of India. *Current Science*, 110 (6): 987–995.
- Vyas, R. (2004). Herpetofauna of Vansda National Park, Gujarat. *Zoos' Print Journal*, 19 (6): 1512–1514.
- Vyas, R. (2008). Review of the current diversity and richness of amphibians of Gujarat, India. *The Indian Forester*, 134 (10): 1381–1392.
- Vyas, R. (2009). *A field guide to amphibians of Gujarat*. Nature Club, Surat. 56 pp.
- Wallach, V., Williams, K. L. and Boundy, J. (2014). *Snakes of the World: A Catalogue of Living and Extinct Species*. First Edition. CRC Press, Boca Raton, Florida, USA. 1237 pp.

Appendix 1: Checklist of Amphibians and Reptiles collected from Girnar hill complex. The number in the table are in accordance with the sampling locations as follow; 1. Girnar, 2. Datar, 3. Bordevi, 4. Bhavnath, 5. Lal Dhor, 6. Mathureshwar, 7. Indreshwar, 8. Jambudi, 9. Ranshivav, 10. Paturan, 11. Ramnath, 12. Kala gadba, 13. Joganiyo, 14. Wellington dam, 15. Ravatsagar, 16. Hasnapur, 17. Machchariya, 18. Khodiyar ghuno, 19. Sarkhadiya hanuman, 20. Lambdi dhar.

Species	IUCN	Localities																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
AMPHIBIA																					
Bufonidae																					
<i>Duttaphrynus melanostictus</i>	LC	P	P	P	P	P	P	P	P	P	P	P	P				P	P	P		P
<i>Duttaphrynus stomaticus</i>	LC	P		P				P													
Dicroglossidae																					
<i>Euphlyctis</i> sp.		P	P	P	P	P	P	P	P			P			P	P	P	P			
<i>Hoplobatrachus tigerinus</i>	LC			P	P	P	P	P	P	P					P	P	P	P			
<i>Minervarya</i> sp.					P	P		P													
<i>Minervarya syhadrensis</i>	LC	P	P	P	P	P	P	P	P	P		P	P	P				P		P	P
<i>Sphaerotheca pashchima</i>	NE	P	P	P	P	P	P	P		P			P	P							
Microhylidae																					
<i>Microhyla ornata</i>	LC	P		P		P			P					P							
<i>Uperodon globulosus</i>	LC					P															
<i>Uperodon taprobanicus</i>	LC	P			P	P			P												
REPTILIA																					
Crocodylidae																					
<i>Crocodylus palustris</i>	VU			P	P	P	P								P	P	P	P			
Testudinidae																					
<i>Geochelone elegans</i>	VU			P			P														
Trionychidae																					
<i>Lissemys punctata</i>	LC				P		P								P	P	P	P			
Agamidae																					
<i>Calotes versicolor</i>	LC	P	P	P	P	P	P	P	P	P	P	P	P	P					P	P	P
<i>Sitana spinaecephalus</i>	LC			P		P		P		P	P										
Chamaeleonidae																					
<i>Chamaeleo zeylanicus</i>	LC			P	P		P	P	P	P			P								P

.....continued on the next page

Appendix 1. (Continued)

Species	IUCN	Localities																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Gekkonidae																					
<i>Hemidactylus flaviviridis</i>	LC	P	P	P	P		P	P			P		P					P	P	P	P
<i>Hemidactylus frenatus</i>	LC						P												P		
<i>Hemidactylus gleadowi</i>	NE	P	P	P	P			P	P												
<i>Hemidactylus gujaratensis</i> *	VU	P	P	P	P								P								
<i>Hemidactylus murrayi</i>	NE	P	P	P	P	P	P	P	P		P		P						P	P	P
<i>Hemidactylus</i> sp.													P								
<i>Hemidactylus sahgalii</i>	NE	P																			
Lacertidae																					
<i>Ophisops jerdoni</i>	LC								P	P					P						
<i>Ophisops</i> sp.																					
Scincidae																					
<i>Eutropis carinata</i>	LC	P	P	P	P	P	P	P	P	P		P	P	P				P			P
<i>Eutropis macularia</i>	LC		P	P	P	P	P	P			P		P						P		
<i>Riopa lineata</i>	LC				P																
<i>Riopa punctata</i>	LC			P				P		P			P								
Varanidae																					
<i>Varanus bengalensis</i>	LC			P	P	P	P	P	P				P					P	P		
Colubridae																					
<i>Ahaetulla laudankia</i>	NE																				
<i>Ahaetulla nasuta</i>	LC			P	P	P		P				P									
<i>Amphiesma stolatum</i>	LC	P	P	P	P	P		P	P		P							P			P
<i>Argyrogena fasciolata</i>	LC	P										P									
<i>Boiga forsteri</i>	LC	P		P																	
<i>Boiga trigonata</i>	LC				P		P			P											
<i>Boiga westermanni</i>	LC										P										
<i>Coelognathus helena</i>	LC	P	P	P	P	P		P	P				P					P			
<i>Dendrelaphis tristis</i>	LC	P	P	P	P																
<i>Fowlea piscator</i>	LC	P	P	P	P	P	P	P	P		P		P		P	P	P	P	P	P	P
<i>Lycodon aulicus</i>	LC	P	P	P	P	P		P													
<i>Lycodon striatus</i>	LC	P		P			P														
<i>Oligodon arnensis</i>	LC				P	P															
<i>Oligodon taeniolatus</i>	LC		P		P	P															
<i>Ptyas mucosa</i>	LC	P	P	P	P	P	P	P	P		P								P		
<i>Sibynophis subpunctatus</i>	LC							P													

.....continued on the next page

Appendix 1. (Continued)

Species	IUCN	Localities																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Elapidae																					
<i>Bungarus caeruleus</i>	LC			P	P	P		P				P									
<i>Calliophis melanurus</i>	LC					P			P												
<i>Naja naja</i>	LC	P	P	P	P	P		P					P							P	
Erycidae																					
<i>Eryx conicus</i>	LC				P					P				P							
<i>Eryx johnii</i>	LC						P	P													
Pythonidae																					
<i>Python molurus</i>	LC			P																	
Typhlopidae																					
<i>Gryptotyphlops acutus</i>	LC																				
<i>Indotyphlops braminus</i>	LC			P																	
Viperidae																					
<i>Daboia russelii</i>	LC	P		P	P	P					P	P									
<i>Echis carinatus</i>	LC	P				P					P										