Urban Herpetofauna: A Case Study in Ujjain City of Central India

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Abstract- This paper presents a herpetofaunal inventory of the urban city of Ujjain, Madhya Pradesh along with major threats existing in the study area, snake-human conflict and conservation steps taken. Herpetofaunal population in degraded while urban habitat is essential for their long term conservation measures. A total of 39 species of reptiles and amphibians representing 15 families were detected with special account of *Argyrogena fasciolata, Wallophis brachyurus, Lycodon aulicus, Ptyas mucosa, Xenochrophis piscator,* and *Lygosoma lineatum*. Snakes were the most collected reptilian species, while Amphibians comprised the little group of the sample. Reptile Conservation & Research Centre is established in the city by Sarpa Anusandhan Sangthan to minimize the snake-human conflict and to educate and familiarise people with them.

Keywords- Urban, Herpetofauna, Conservation, snake-human conflict, Ujjain, Central India

I. INTRODUCTION

The primary driver of the global decline of biodiversity is habitat loss and fragmentation resulting from anthropogenic pressures on natural ecosystems. Urbanization is arguably the most damaging, persistent and rapidly expanding form of anthropogenic pressure (Vitousek *et al.* 1997; Lugo 2002; McKinney 2002; Miller & Hobbs 2002).

Presently, 55% of the world's population lives in urban areas, a proportion that is expected to increase to 68% by 2050. Projections show that urbanization, the gradual shift in residence of the human population from rural to urban areas, combined with the overall growth of the world's population could add another 2.5 billion people to urban areas by 2050, with close to 90% of this increase taking place in Asia and Africa (United Nations 2018). Together, India, China and Nigeria will account for 35% of the projected growth of the world's urban population between 2018 and 2050. By 2050, it is projected that India will have added 416 million urban dwellers, China 255 million and Nigeria 189 million (UN DESA, 2018).

Intense and widespread modification of natural landscapes and ecosystems due to infrastructural development produces an environment so different from its natural state that even if anthropogenic activities were removed, complete recovery would be unlikely (Lugo 2002). Despite the significant destruction and degradation of habitats, urban areas have the capacity to support a wide diversity of vertebrate and invertebrate fauna species, perhaps due to the range of diverse natural and artificial habitat niches and conditions that occur in urban areas (Niemelä 1999a,b; Collins *et al*. 2000).

II. RELATED WORK

Reptiles and amphibians face numerous challenges for coexistence in the urbanized world (Rubbo and Kiesecker, 2005; McKinney, 2006; Hamer and McDonnell, 2008) and habitat degradation is the primary cause of population decline for both these groups (Gibbons et al., 2000). Thus, the study of herpetofaunal sensitivity to degraded urban habitat is essential for long term conservation measures and risk assessment (Raxworthy and Nussbaum, 2000).

Central India supports a rich assemblage of herpetofauna, with more than 100 species known from the region (Ingle, 2012). However, records on herpetofauna of the urban centers of this region are not available. In this paper, we present an inventory of the herpetofauna of Ujjain town, an urban settlement in the State of Madhya Pradesh, with some comments on existing threats observed in the study area and conservation measures made to minimize the snake-human conflict and to educate and familiarise people with them.

Study Area
Ujjain ((23°10'43.96"N, 75°46'47.77"E)) is an ancient city in Malwa Plateau of Madhya Pradesh situated on the eastern bank of River Kshipra. The total area of 93 sq km having a

population of 5, 15, 215 (Census, 2011, CDP 2014) with a population density of 5,559 per sq km. Ujjain has a tropical monsoon climate and receives about 892.9 mm. annual rainfall with an temperature range 8ºC to 40ºC. Certain patches of forest still exist within the city. The overall habitat type in the study area mainly comprises of forest patches, scrublands, grasslands, wetlands, plantations, agricultural lands and human settlements. The forest patches are of dry deciduous types.

For survey purposes the city was divided into five groups:
Residential Areas–All the major residential development can be seen in between Indore-Dewas road. Areas such as Vivekanand nagar (23°10'32.02"N, 75°47'2.61"E), Sant nagar (23°10'11.00"N, 75°47'23.74"E), Shastri nagar (23°10'16.17"N, 75°47'11.24"E), Ved Nagar (23° 9'41.57"N, 75°47'20.88"E), Rishi nagar(23°10'0.88"N, 75°47'46.11"E), Mahananda Nagar (23° 9'19.36"N, 75°48'16.37"E), Vasant Vihar (23° 9'4.80"N, 75°47'45.41"E), are high density residential areas.

Commercial Areas–The major commercial activities can be observed near areas such as Gopal Mandir (23°11'16.86"N,75°46'19.42"E), Dewasgate (23°10'57.74"N, 75°46'51.86"E), Nai Sadak (23°11'9.84"N, 75°46'36.94"E), Daulatganj (23°10'52.08"N, 75°46'38.05"E), Freeganj (23°10'44.81"N, 75°47'19.42"E), Shaheed Park (23°10'44.42"N, 75°47'28.31"E), Sabji Mandi (23°10'49.39"N, 75°47'50.14"E). This area can be considered as the main commercial area of the city.

Sensitive Areas–Mela ground (23°11'24.20"N, 75°45'44.61"E), Shipra ghats (23°11'9.04"N, 75°45'49.26"E) and some parts of the city are under sensitive zone.

Industrial Areas-Maxi Road Industrial area (23°10'58.92"N, 75°48'49.96"E), Nagzhiri Industrial (23° 9'0.45"N, 75°49'5.82"E) area and Agar Road Industrial areas(23°12'35.08"N, 75°47'28.92"E) comes under this.

Natural/forested Areas-Mangalnath (23°13'18.15"N, 75°47'6.81"E), Kaliyadeh Palace (23°14'58.53"N, 75°46'40.67"E) Garhkalika (23°13'2.35"N, 75°46'56.49"E), University Campus(23° 9'32.65"N, 75°48'39.87"E), Naulakhi beed (23°11'35.96"N, 75°51'25.79"E), Engineering College Campus (23° 8'42.22"N, 75°47'38.22"E).

The classification of the commercial and residential areas was done as per Ujjain Municipal Corporation (UMC) regulations.

Fig. 1 Map of the study area (Source: Map data, 2019)

Acronyms used are:
UMC: Ujjain Municipal Corporation, CDP: City Development Plan, CA: Commercial Areas, RA: Residential Areas, NA: Natural or Forested Areas, IA: Industrial Areas, SA: Sensitive Areas, IUCN: International Union for the Conservation of Nature and Natural Resources, IWPA: Indian Wildlife Protection Act, LC: Least Concerned, Sch: I, II & IV: Schedule I, II, & IV, C: Common, UC: Uncommon, and R: Rare.

III.   METHODOLOGY

The study was conducted from June 2012 to September 2018 (Pre monsoon, Monsoon and Post-monsoon) and an average of 60 days was invested per year for the survey. The survey was carried out during both day and night, and four man hours was invested per survey. The survey was carried out in the morning mostly from 06:00h till noon and in the evening mostly from 17:00 to 20:00h. Few late night surveys extending up to sunrise were also conducted to find nocturnal species. Visual Encounter Survey (Crump and Scott, 1994) employing randomized walk (Lambert, 1984), Opportunistic sightings and community feedback was carried out along with active searches. Specimens were collected/observed, photographed, identified and released. Identification of the species was done using the keys in Smith (1931, 1935, and 1943); Das and Dutta (1998), Das (2002), Whitaker and Captain (2004). For amphibians, we followed Taxonomy of Frost (2019) and for Reptiles we followed Uetz et al. (2019).

For the evaluation of Herpetofaunal species, we referred IUCN Red List (2019), Indian wildlife (Protection) Act 1972. We encountered a set of cryptic species and species whose specific status yet to be determined. We also documented the natural history information for some species encountered during fieldwork.

IV.   RESULTS AND DISCUSSION

During the study period we encountered 7 species of anurans representing 4 families. Among the amphibians the most commonly encountered was *Duttaphrynus melanostictus,* found in and around small water bodies with or without vegetation cover. *Sphaerotheca breviceps* was sighted only in the marshes of the natural areas. With the filling up of small water bodies in the residential areas, *Euphlyctis cyanophlyctis*, *Hoplobatrachus tigerinus and Microhyla ornata* disappeared from the areas and could be encountered only in the natural areas exhibiting an extremely patchy distribution, with fewer sightings. Interestingly *Polypedates maculatus* was found around University Campus only. *Duttaphrynus melanostictus* was found to be hardy and was encountered in most of the areas including the commercial areas. Breeding population of D. *melanostictus*, *E. cyanophlyctis*, *and M. ornata* were also found in temporary pools and ponds during monsoon seasons. Their tadpoles were found in aggregation in slow flowing parts of ponds amidst aquatic vegetation.

Amongst reptiles, 13 species of lizards representing 5 families, 18 species of snakes representing 5 families and 1 species of turtle representing 1 family were detected during the study. The most commonly sighted lizard species was *Hemidactylus gleadowi*, which was also observed in all the five classes of study area. *Calotes versicolor, Eutropis macularia* and *Varanus bengalensis* were not observed in the commercial areas. However, *Hemidactylus leschenaultia* and *Ophisops jerdonii* were observed only in some old trees and leaf-litter of natural areas showing a patchy distribution in the study sites. *Lygosoma lineatum* was extremely rare (1sightings) only in Sensitive areas. It was found below a decomposed leaf litter heap inside a garden. *Hemidactylus flaviviridis* was encountered only in some pockets of commercial and residential areas. *Hemidactylus sahgali* and *Lygosoma albopunctata* were found mostly in forested/natural areas. Though, *Lygosoma albopunctata* was occasionally seen in residential areas.

Amongst snakes, *Indotyphlops braminus, Lycodon aulicus, Ptyas mucosa, Xenochrophis piscator, Bungarus caeruleus* and *Naja naja* were the most commonly encountered species. We also observed two or more colour morphs for these species (except *I. braminus*) which exhibited variation from the 'typical morphs' of their respective species. *Argyrogena fasciolata, Coelognathus helena* and *Daboia russelii* appeared to have more or less uniform distribution, occurring in the three classes of study sites. Of these, the sighting rates of *Lycodon aulicus* increased during the study period and the species was rescued frequently from buildings (mostly from gaps in between the bricks of unplastered wall of buildings) in residential areas and the commercial area. This species was probably forced to move to the buildings in search of food and a secure place to reside

and retreat. Two species of snakes *Macropisthodon plumbicolor* and *Oligodon arnensis* were found both in residential and natural areas and three species *Wallophis brachyurus*, *Grypotyphlops acutus* and *Sibynophis subpunctatus* were recorded only from the natural/forest areas. One species *Eryx johnii* was recorded only in sensitive area.

Lissemys punctata is found only in ponds, Solah Sagar and river Shipra of the sensitive area.

On the basis of occurrences in various habitat types, we categorized the species as either **'matrix-occupying'**, **'matrix-sensitive'** or **'urban sensitive'**. Matrix-occupying species are those that commonly dominate the urban matrix due to their ability to move through and live within the built matrix. Conversely, matrix-sensitive species perceive the built matrix as unsuitable habitat with a lack of food and shelter resources, a barrier to movement and an area of increased risk of predation. *Duttaphrynus melanostictus, Euphlyctis cyanophlyctis, Hoplobatrachus tigerinus, Hemidactylus gleadowi, Lygosoma albopunctata, Eutropis macularia, Indotyphlops braminus, Eryx conicus, Lycodon aulicus*, *Xenochrophis piscator, Ptyas mucosa*, *Bungarus caeruleus, Naja naja* can be considered Matrix-occupying species. On the other hand *Duttaphrynus stomaticus, Sphaerotheca breviceps, Polypedates maculatus*, *Hemidactylus flaviviridis, Hemidactylus frenatus, Hemidactylus leschenaulti Hemidactylus sahgali, Lissemys punctata, Lygosoma lineatum, Ophisops jerdonii, Eryx johnii Grypotyphlops acutus, Boiga trigonata*, *Wallophis brachyurus* and *Sibynophis subpunctatus* can be categorized as Matrix-occupying species. These species often restricted to vegetation patches of suitable habitat, resulting in fragmentation of populations and are increasing the risk of localized extinctions. Species classed as urban-sensitive are unable to persist in urban landscapes, even in remnant patches of native vegetation. Characteristics shared by these species include limited dispersal ability and narrow or specialized dietary requirements. Prior to the 1990s, urban areas were largely overlooked or ignored in ecological studies as they were considered to be non-viable habitat for fauna populations and therefore of no use for conservation efforts (Botkin & Beveridge 1997; McDonnell *et al*. 1997; Savard *et al*. 2000). As a result, the impacts of urbanization on fauna populations are not well understood, often resulting in poorly targeted conservation actions (Niemelä 1999a; Recher 2002).

During the study period, the following threats were supposed to affect the herpetofaunal assemblage of the study sites-

Habitat Destruction: In the last two decades (1999-2009 & 2009-2019) the numbers of households in the UMC area were increased rapidly. In this decade Ujjain has seen the building of extensive structures causing the destruction of

herpetofaunal habitat in an exponential fashion. Habitat that was once natural areas or agricultural lands are marked for the construction of houses. A rapid increase in brick manufacturing places and filling up of wetlands were found to be the prime contributor to habitat destruction.

Lack of breeding grounds: With most of the road being tarred and residential areas being concreted, temporary water pools in the city of Ujjain were almost absent. Further, almost all the water bodies were polluted by dumping activity. Thus, amphibians probably failed to find suitable places to breed and it appeared that this is one of the prime reasons for the decline in amphibian sightings in the study site.

Human exploitation: Many a species of herpetofauna, especially turtles are facing grave danger due to trade and human consumption. Cruel killing and exhibit of snakes by snake charmers may also be one of the factors of the declines in snake populations.

Human Ignorance: Though the study site is one of the religious and developing places in the country, there still exists ignorance and superstitions regarding herpetofauna, especially snakes, which results in unjustified killings of these animals. In the study site, the snakes with the potential of being fatal are *Naja naja*, *Bungarus caeruleus* and *Daboia russelii*.

V. CONCLUSION AND FUTURE SCOPE

Snakebite is a major problem and snakebite management is a totally overlooked and misunderstood issue in the study site. **Sarpa Anusandhan Sangthan** also functioning dynamically on the issue of Snake-human conflict and started the program of snake rescue & relocation in a systematic way in collaboration with M.P Forest and wildlife Department to minimize the conflict. **Reptile Conservation & Research Centre** is also established by the organization with the kind support of Ujjain Development Authority and Madhya Pradesh Council of Science & Technology along with a REGIONAL SNAKEBITE INITIATIVE with the emergencies arising out of Snakes, Snake Attacks, Do's & Don's of Snakebites, Information on first aid, Envenomation Treatment, Trainings, Facilities, Studies & education. Awareness programs are being conducted regularly at the Centre in order to make people acquainted with herpetofauna and their importance for a balanced ecosystem.

In this study, we encountered a total of 39 species of herps of which 13 species are Least Concerned of IUCN. 2 species are Sch. I, 4 species are Sch II and 16 species are Sch IV of IWPA that stressing the need to study reptiles and amphibians in urban areas.

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Table No. 1 A Table showing Species Sighting in the Five Divisions in the study area.
'+denotes the species was detected, '-denotes the species was not detected.

S. No.	Name of the Species	RA	CA	IA	NA	SA	IUCN Status	IWPA Status	Local Status
1.	**Class: Amphibians** **Family: Bufonidae Gray,1825** Common Asian Toad, *Duttaphrynus melanostictus* (Schneider,1799)	+	-	+	+	+	LC	Not Listed	C
2.	Marbled Toad, *Duttaphrynus stomaticus* (Lutken,1864)	-	-	-	+	+	LC	Not Listed	UC
3.	**Family: Dicroglossidae Anderson, 1871** Indian Skipping Frog, *Euphlyctis cyanophlyctis* (Schneider,1799)	+	-	+	+	+	LC	Sch. IV	C
4.	Indian Bull Frog, *Hoplobatrachus tigerinus* (Daudin, 1802)	+	-	+	+	+	LC	Sch. IV	C
5.	Short-headed Burrowing Frog, *Sphaerotheca breviceps* (Schneider,1799)	-	-	-	+	-	LC	Not Listed	R
6.	**Family: Microhylidae Gunther, 1858** Ornate Narrow-mouthed Frog, *Microhyla ornata* (Dumeril & Bibron, 1841)	+	-	-	+	+	LC	Not Listed	UC
7.	**Family: Rhacophiridae Hoffman, 1932** Indian Tree Frog, *Polypedates maculatus* (Gray, 1830)	-	-	-	+	+	LC	Not Listed	UC
8.	**Class: Reptilia** **Family: Trionychidae Bell, 1828** Indian Flap-shell Turtle, *Lissemys punctata* (Bonnaterre, 1789)	-	-	-	-	+	LC	Sch. I	R
9.	**Family: Agamidae Gray, 1825** Indian Garden Lizard, *Calotes versicolor* (Daudin, 1802)	+	-	+	+	+	Not Listed	Not Listed	C
	Family: Gekkonidae Gray, 1825								

10.	Gleadow's Rock Gecko, *Hemidactylus gleadowi* (Murray,1884)	+	+	+	+	+	Not Listed	Not Listed	C
11.	Yellow-Green House Gecko, *Hemidactylus flaviviridis* (Ruppell, 1835)	+	+	-	-	-	Not Listed	Not Listed	UC
12.	Asian House Gecko, *Hemidactylus frenatus* (Dumeril & Bibron, 1836)	-	-	-	+	+	LC	Not Listed	UC
13.	Bark Gecko, *Hemidactylus leschenaulti* (Dumeril & Bibron, 1836)	-	-	-	+	-	Not Listed	Not Listed	R
14.	Sahgal's Termite Hill Gecko, *Hemidactylus sahgali* sp. Nov. (Mirza et al, 2018)	-	-	-	+	+	Not Listed	Not Listed	UC
15.	**Family: Scincidae Gray, 1825** White-spotted Supple Skink, *Lygosoma albopunctata* (Gray,1846)	+	+	+	+	-	Not Listed	Not Listed	C
16.	Spotted Supple Skink, *Lygosoma punctata* (Gmelin,1799)	-	-	-	+	+	Not Listed	Not Listed	UC
17.	Keeled Grass Skink, *Eutropis carinata* (Schneider, 1801)	-	-	-	+	+	LC	Not Listed	UC
18.	Bronze Grass Skink, *Eutropis macularia* (Blyth, 1853)	+	-	+	+	+	Not Listed	Not Listed	C
19.	Lined Supple Skink, *Lygosoma lineatum* (Gray, 1839)	-	-	-	+	-	Not Listed	Not Listed	R
20.	**Family: Lacertidae** Snake-eyed Lacerta, *Ophisops jerdoni* (Blyth,1853)	-	-	-	+	-	Not Listed	Not Listed	R
21.	**Family: Varanidae Gray, 1827** Bengal Monitor, *Varanus bengalensis (*Daudin, 1802)	+	-	+	+	+	LC	Sch. I	C
22.	**Family: Typhlopidae** Brahminy Worm Snake, *Indotyphlops braminus* (Daudin,1803)	+	+	+	+	+	Not Listed	Sch. IV	C
23.	Beaked Worm Snake, *Grypotyphlops acutus* (Duméril & Bibron, 1844)	-	-	-	+	-	Not Listed	Sch. IV	UC
24.	**Family: Boidae** Red Sand Boa, *Eryx johnii* (Russell,1801)	-	-	-	-	+	Not Listed	Sch. IV	R
25.	Common Sand Boa, *Eryx conicus* (Schneider, 1801)	+	-	+	+	+	Not Listed	Sch. IV	C
26.	**Family: Colubridae** Buff-striped Keelback, *Amphiesma stolatum* (Linnaeus, 1758)	+	-	+	+	+	Not Listed	Sch. IV	C
27.	Banded Racer, *Argyrogena fasciolata* (Shaw, 1802)	+	-	+	+	-	Not Listed	Sch. IV	UC
28.	Common Indian Cat Snake, *Boiga trigonata* (Bechstein, 1802)	-	-	-	+	-	LC	Sch. IV	R
29.	Common Trinket Snake, *Coelognathus helena* (Daudin, 1803)	+	-	-	+	+	Not Listed	Sch. IV	UC
30.	Common Wolf Snake, *Lycodon aulicus* (Linnaeus, 1758)	+	+	+	+	+	Not Listed	Sch. IV	C
31.	Indian Smooth Snake, *Wallophis brachyurus* (Gunther, 1866)	-	-	-	+	-	Not Listed	Sch. IV	R
32.	Green Keelback, *Macropisthodon plumbicolor* (Cantor, 1839)	+	-	-	+	-	Not Listed	Sch. IV	UC
33.	Banded Kukri Snake, *Oligodon arnensis* (Shaw, 1802)	+	-	-	+	-	Not Listed	Sch. IV	UC
34.	Indian Rat Snake, *Ptyas mucosa* (Linnaeus, 1758)	+	+	+	+	+	Not Listed	Sch. II	C
35.	Black-Headed Snake, *Sibynophis subpunctatus* (Dumeril & Bibron, 18	-	-	-	+	-	Not Listed	Sch. IV	R
36.	Checkered Keelback Water Snake, *Xenochrophis piscator* (Schneider,	+	+	+	+	+	Not Listed	Sch. II	C
37.	**Family: Elapidae** Common Indian Krait, *Bungarus caeruleus* (Schneider, 1801)	+	-	+	+	+	Not Listed	Sch. IV	C

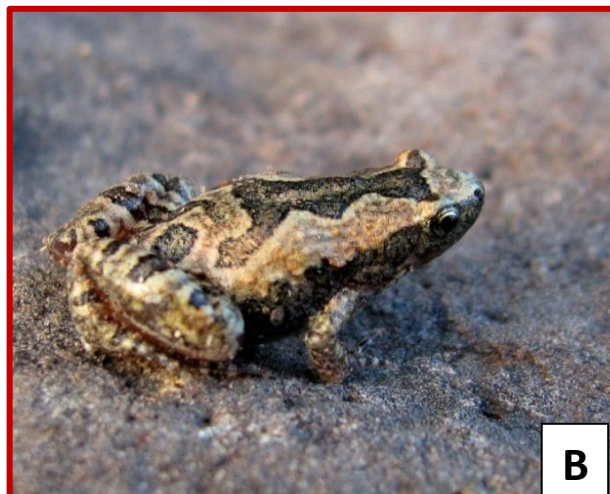| 38. | Spectacled Cobra, *Naja naja* (Linnaeus, 1758) | + | + | + | + | + | Not Listed | Sch. II | C |
| | **Family: Viperidae** | | | | | | | | |
| 39. | Russell's Viper, *Daboia russelii* (Shaw & Nodder, 1797) | + | - | - | + | + | LC | Sch. II | C |

Fig. 1 A-*Duttaphrynus melanostictus,* B- *Microhyla ornata,* C - *Duttaphrynus stomatictus,*
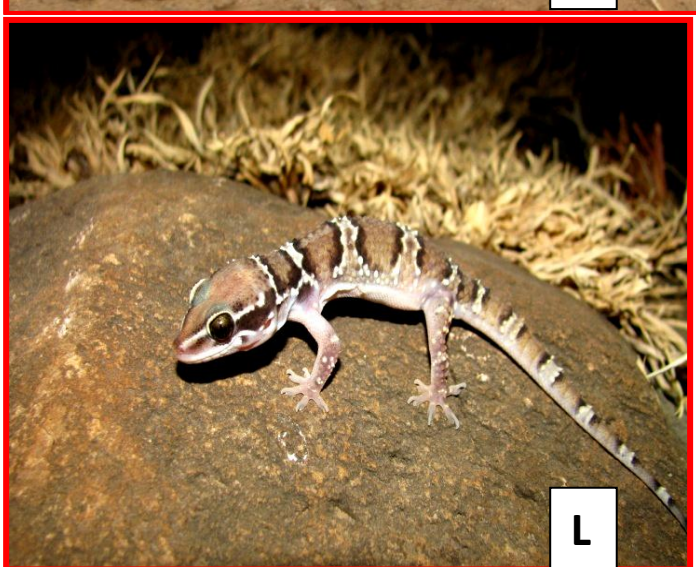D- *Hoplobatrachus tigerinus,*   E- *Sphaerotheca breviceps,* F- *Polypedates maculatus*
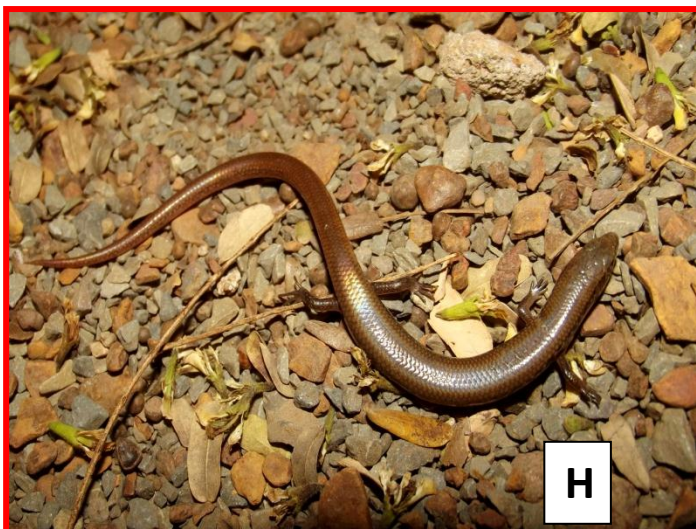
Fig. 2 G- *Calotes versicolor,* H- *Lygosoma albopunctata* , I- *Lygosoma lineatum,*
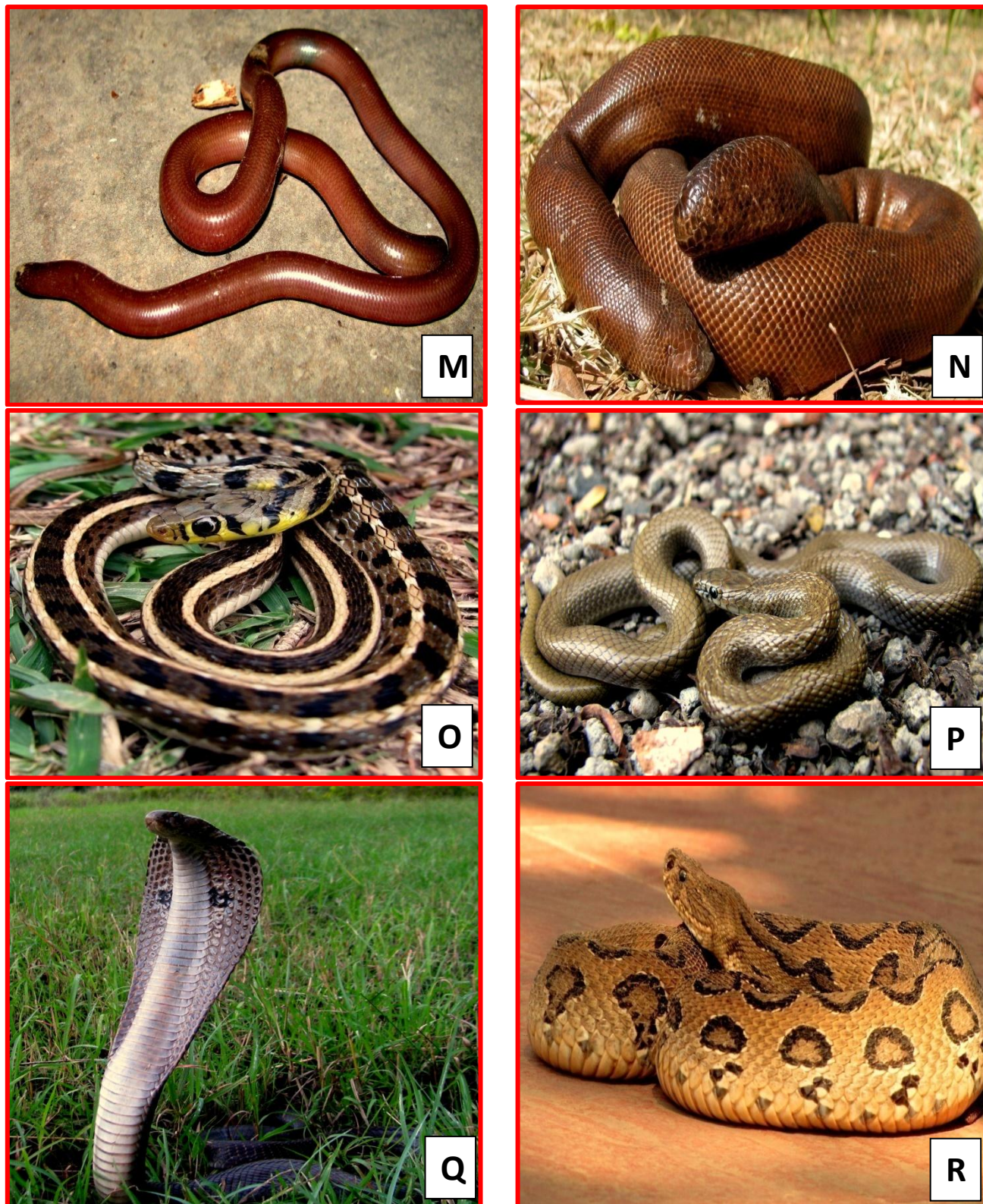J- *Ophisops jerdoni,*   K. *Hemidactylus flaviviridis,* L- *Hemidactylus sahgali*

Fig. 3 M- *Grypotyphlops acutus,*   N- *Eryx johnii,*   O- *Amphiesma stolatum,*
P- *Wallophis brachyurus,*   Q- *Naja naja,*   R- *Daboia russelii*