Progress Report

February 2020

Project Title:

Bio-assessment and Monitoring Guidelines for Margalla Hills National Park, Islamabad, Pakistan.

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CONTENTS

SUMMARY

Lack of financial resources, unavailability of trained and skilled employees, dearth of scientific data and absence of bioassessment scale to measure changes in ecological conditions and wildlife populations preclude implementation of management plan and gauging success of wildlife conservation activities in the protected areas of Pakistan. Our proposed study on inclusive wildlife conservation intended to update inventory of amphibians, reptiles, and waterfowl, to develop indices of biotic integrity and to establish guidelines for monitoring of Margalla Hills National Park, Islamabad, across various habitats. We conducted study from March-2019 to February-2020, a total (n= 42) surveys were made and about 215 hours were spent in the field. The study area was stratified into four types likewise Hiking trails of Margllah Hills National Park (trail No. 3, 4 ,5 and 6), Undisturbed forest area , areas with urban settlements such as villages and recreational spots (Rumli, Saidpur, Talhar and Bruti) within the national park area and Rawal lake. Standard survey and trapping protocols for reptiles and amphibians viz. area constrained searches, pitfall traps; funnel traps and Visual Encounter Survey (VES) were used for abundance and diversity of species. A total, 135 circular searching plots (45 plots in each stratum) were established, radius of the plot maintained 5 m and thoroughly search for record of species. Each plot had an area of 25 m^2 or 0.1125 hectare (total area searched was 0.31125 hectares). We visited Rawal lake on weekly basis for the record of water bird's assemblage. The point count method was used to search the lake by using spotting scope and binocular, species were identified with the help of bird field guide. As many as 302 individuals of 7 amphibian species, 303 individuals of ten lizard species, 45 individuals of 10 snake species and 13 individuals of three species turtles were recorded from Margalla Hills National Park, Islamabad Capital Territory. The most common and frequently encountered amphibian species of the park were Indus Valley Toad (Duttaphrynus *stomaticus*) and Common skirting Frog (*Euphlyctis cyanophylctis*), of lizard was Spotted Barn Gecko (*Hemidactylus brookii*) and of snake was Rat Snake (*Ptyas mucosus mucosus*) A total, 15 species of water birds were reported from Rawal lake from September 2019- Januray 2020. We are conducting surveys for the record of water birds' particular migratory birds. The current study for the first time presented data on encounter rate of herpetofauna which could be used for monitoring of the park in the future. Likewise, index of bioassesmnet of the park has been presented for the first time. The index of biotoic integrity has been established for amphibians (Micacchian et al. 2015; Simon et al. 2000) and fish (Minns et al. (1994), but not for herpetofauna.

INTRODUCTION

One of the major challenges of conservation of biological communities in areas facing degradation is the unavailability of baseline studies during the pristine phase (Drumbrell et al. 2008; Trisurat et al. 2010). Monitoring is the process of determining state of a system and measuring changes in that system over time (Yoccoz et al. 2001). The role of different taxa such as invertebrates, vegetation and reptiles in bio-assessment methods have been documented (Beattie, et al., 1993; Dean & Milton, 1995; Abate, 1992; Cranston & Hillman, 1992). Few workers have made attempts to identify biodiversity indicators in agro-ecosystems (Duelli, 2003), forest and protected areas (Arijit et al., 2012; Barrett and Guyer, 2008; Bobrov, 1993; Botejue and Wattavidanage, 2012; Bousbouras and Ioannidis, 1997; Gardner et al., 2007; Kati et al., 2007; Katwate et al., 2013).

Despite gains in our understanding of which species of wildlife are present within the territorial range of Pakistan, our knowledge of use of herpetofauna for bioassesment and their responses to anthropogenic and climatic changes, is quite limited. We have not yet established bioassesment scale to measure changes in the ecological conditions and wildlife populations due to natural causes or anthropogenic activities or to gauge success of wildlife conservation activities. The country also lacks scientific data and community mobilization about conservation of herpetofauna in particular. We have designed the proposed study with the following goal and objectives:

Main Goal: Inclusive wildlife conservation through community participation
Objectives:

- To update and annotate species inventory of amphibians, reptiles and wetland dependent avian (particularly migratory birds) species of the national park.
- To develop indices of biotic integrity for bioassesment and to establish guidelines for the monitoring of the park based on studied taxa.
- To engage local community, build capacity of park personnel and support post-graduate studies on inclusive wildlife conservation.

MATERIALS AND METHODS

Study Area

The proposed project site is Margalla Hills National Park (MHNP) and its environs. The park (33.7481° N, 73.0051° E) spreads over an area of 17,386 ha. and was designated as a National Park under Islamabad Wildlife Ordinance in 1980 (Malik and Husain, 2003). The topography of the area is rocky and furrowed and varies in elevation (Yasir and Akther, 1987). The Rawal Lake is a part of the park and is situated in the south east of Islamabad city. The lake comprises of an area of 1902 hectares (ha.) with a buffer zone of 2 km^2 (Hussain et al., 2002). It is the main source of drinking water supply for Rawalpindi city in addition to irrigation of some surrounding areas. The area falls in monsoon zone with a mean monthly 254 mm of monsoon precipitation occurs in July and August. Underground water table is in moderate condition having pH of 7.4 (Shinwari, 1998). The hottest months are May and June when temperature may go as high as rises 42°C while the coldest months are December and January when temperature falls below zero (Hussain, 1986). As many as 37 small hamlets and villages of the park encompasses human population of about 92,000-100,000 people. About half of the population (about 60%) living in the park area is involved in agriculture, animal production and marketing. The significant threatened wild animals include Common leopard (*Panthera pardus*), gray goral (*Naemorhedus goral*), barking deer (*Munticus vaginalis*), leopard cat (*Prionailurus bengalensis*), yellow throated marten (*Martes flavigula*), Himalayan griffin vulture (*Gyps himalayensis*), Egyptian vulture (*Neophron Percopterus*) and Kalij pheasant (*Lophura leucomelanos*).

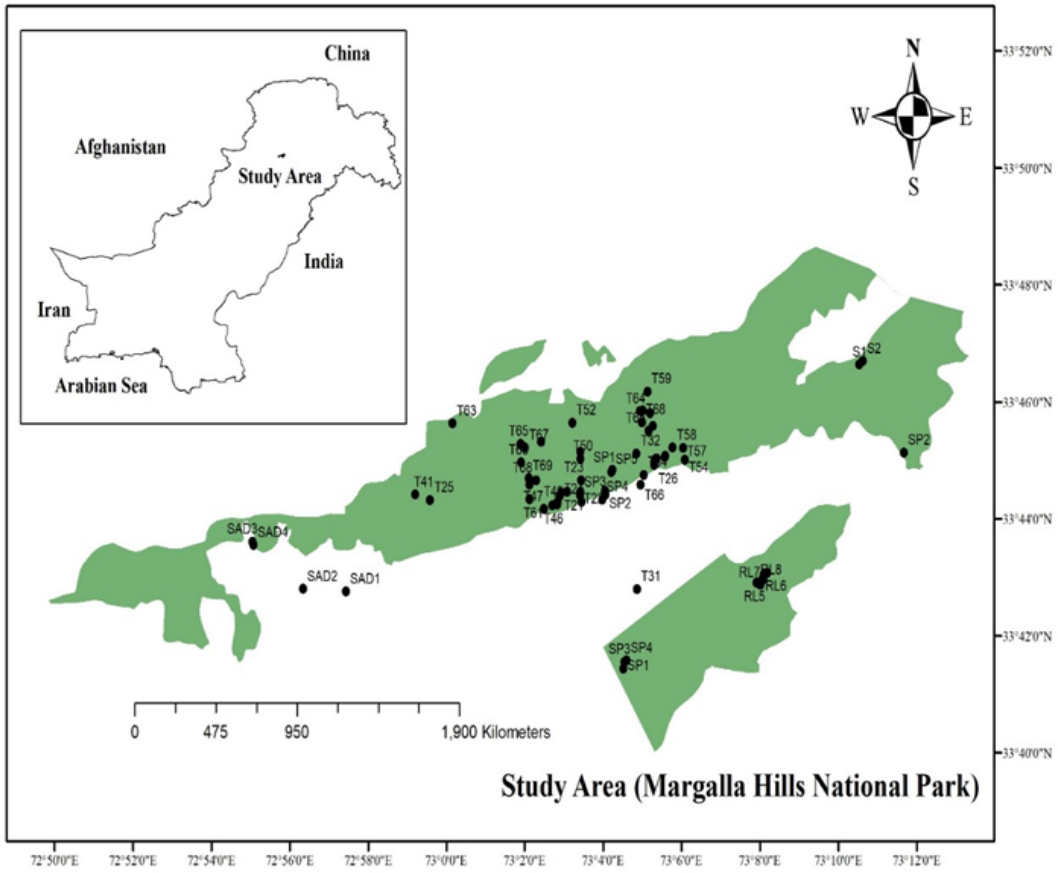

Figure 2.1: Map of study area showing sampling locations along hiking trails, undisturbed forest and urban area

Study Design
The proposed study was conducted in park from March 2019 to February 2020 on weekly basis. We made (n= 42) surveys and about 215 hours in the field. The surveys were carried out in early morning, after-noon and evening. The study area was stratified into four types likewise **Hiking trails** of Margllah Hills National Park (trail No. 3, 4 ,5 and 6), **Undisturbed forest area** , **areas with urban settlements** such as villages and recreational spots (Rumli, Saidpur, Talhar and Bruti) within the national park area and **Rawal lake** shown in figure 1.1

Survey Methods
Standard survey and trapping protocols for reptiles and amphibians viz. area constrained searches, pitfall traps, funnel traps and Visual Encounter Survey (VES) were used. At each site circular plots with 5 m radius were established. The plot was searched thoroughly. A total of 135 circular searching plots (45 plots in each stratum) were established. Each plot had an area of 25 m^2 or 0.1125 hectare (total area searched was 0.31125 hectares).

Pitfall Traps, Funnel Traps and PIT Tagging
A total of 13 Pitfall traps (Figure 3.2) were installed at selected sites along with drift fences (Figure 3.3) and were monitored at dawn and dusk for 4-5 days after installation to avoid mortality due to stress, avoiding the chances of predation by birds and exposure of sunlight to nocturnal species. The traps were plotted in different arrays (Liner, V-shape). Pitfall traps were buried (plastic buckets (28.6 cm diam x 26.6 cm deep) along one side of each fence at 2.1m intervals. A plastic rim-was placed into the top of each trap to prevent animals from escaping. About 32 Funnel traps (Figure 3.4) were placed in different circular plots, traps were made from steel window screening (80*30 cm wide) rolled into a tube 12-15 cm in diameter, the end had a screen funnel (pointing inwards) that was secured to the tube. No water, preservatives, or bait were used in the trap.

The specimens collected in the traps were tagged using a combination of methods depending upon genera, their conservation status and significance. For instance, specimens of endemic and threatened species were tagged using HDX PIT tags, 12 mm (Oregon) for frogs and lizards, 23 mm and 32 mm pit tags were used for snakes and lizards of large size and were read with hand-held PIT tag reader (model: GES3S) upon subsequent encounter or recapture, other species were tagged using Visible Implant Elastomers (360-468-3375) (VIE) (www.nmt.us) and read with UV torch (410upon subsequent encounter or recapture.

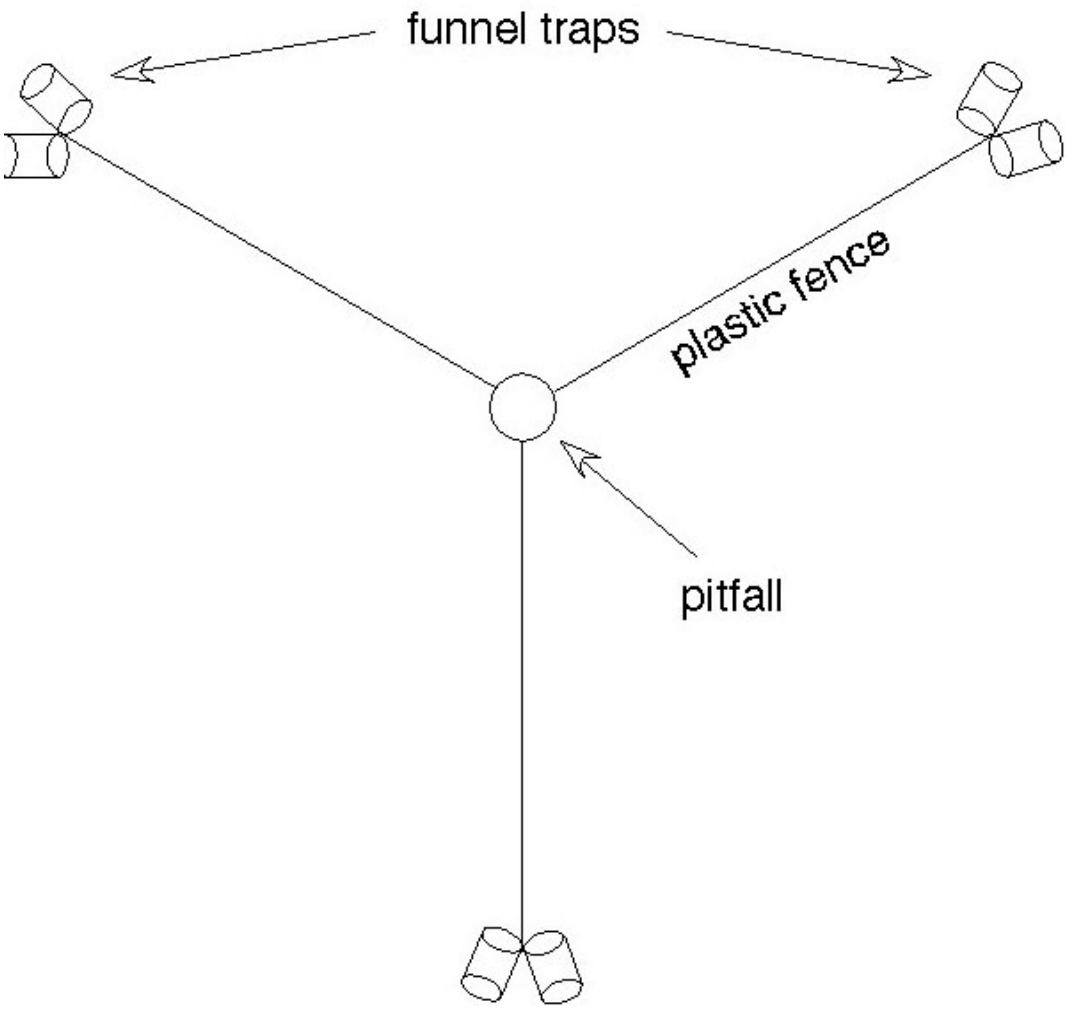

Figure 3.2: Three-armed pitfall without funnel traps

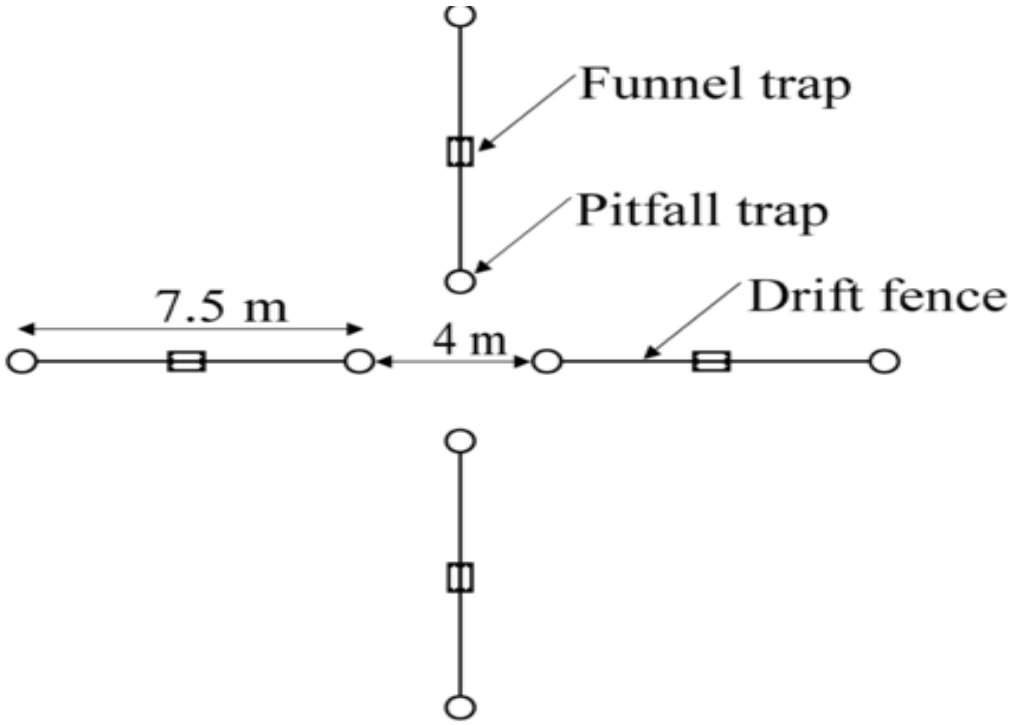

Figure 3.3: Pitfalls (non-centric) with funnel traps

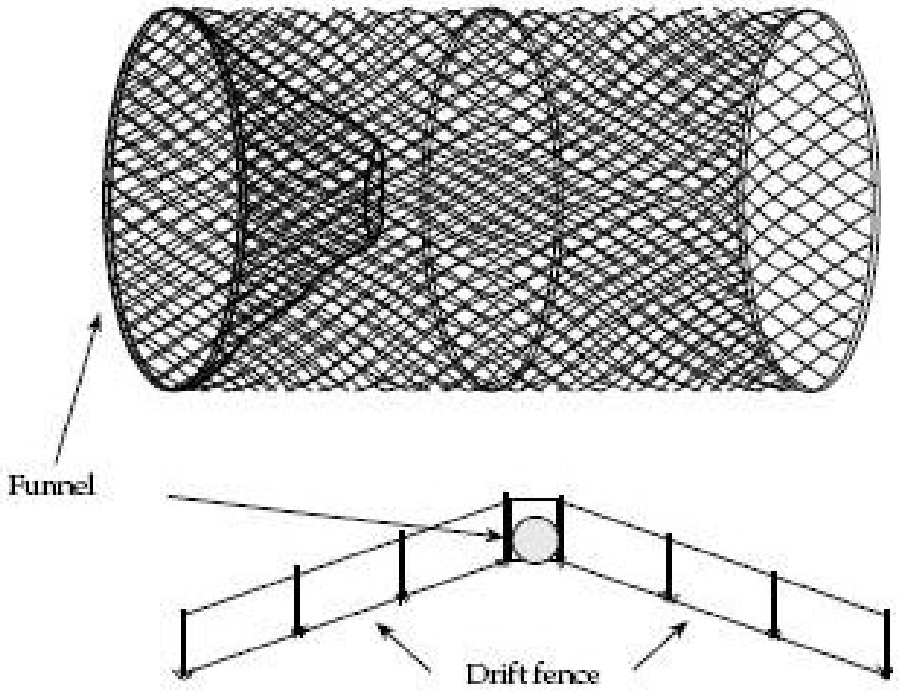

Figure 3.4: Funnel trap with drift fence

We visited Rawal lake on weekly basis for the record of water bird's assemblage. The point count method was used to search the lake by using spotting scope and binocular, species was identified with the help of bird field guide.

Statistical Analysis

The data on abundance were subjected to basic statistics (mean± standard error). The encounter rate was calculated as number of individuals/ 6 field hours (total field hours/6, 215/6= 36 hours) and population density was calculated as number of individuals/ area (hectare). To compare herpetofauna diversity (number of individuals, encounter rate and population density), Student's t-test was used (α= 0.05). The data on following biometrics and score were used to develop biotic indices for bio-assessment: whether the species was habitat generalist (score 5) or specialist (10), conservation status evaluated (5) or not-evaluated (10), whether the species was invasive (score 5) or not (10), whether the species was uncommon (encounter rate 0.10-0.30, score 20), frequent (0.31-0.50, 15), common (0.51-0.80, 10) or abundant (0.81 and above, 5). The scores for each species at each stratum were summed to produce a total score which was then assigned a condition category. The maximum possible IBI score was 1000: 900-1000 represented excellent biological integrity, 500-800 indicated good biotic integrity while < 800 poor biotic integrity. The encounter rate was used as a reference for future monitoring of the herpetofauna in the park.

RESULTS

Reptiles and Amphibians of Margallah Hills National Park

As many as 302 individuals of 7 amphibian species, 303 individuals of ten lizard species, 45 individuals of 10 snake species and thirteen individuals of turtles of three species were recorded from Margalla Hills National Park, Islamabad Capital Territory. The most common and frequently encountered amphibian species of the park were Indus Valley Toad (Duttaphrynus *stomaticus*) and Common skirting Frog (*Euphlyctis cyanophylctis*), of lizard was Spotted Barn Gecko (*Hemidactylus brookii*) and of snake was Rat Snake (*Ptyas mucosus mucosus*) (Table 3.1, 3.2 & 3.3).

As many as 71 individuals of 7 amphibian species, 103 individuals of ten lizard species and 13 individuals of six snake species were recorded from the hiking; 142 individuals of 7 amphibian species, 145 individuals of ten lizard species and 16 individuals of five snake species from undisturbed forest while 89 individuals of 7 amphibian species, 303 individuals of ten lizard species and 36 individuals of four snake species were recorded from urban areas in and around the park (Table 3.1, 3.2 & 3.3).

Water birds

During the study period of November 2019 to January 2020 total 13 waterbirds were recorded belonging to 5 orders and 6 families, in them 8 birds are migratory and 5 are resident. Maximum number of individuals (n=189) of little cormorants were recorded and minimum (n=1) of Night heron. Total count of individual is 740. (Table 3.4)

No bird belonging to Family Anseriformes were seen at any sampling point during current study period (September,2019 to Janury,2020) even its occurrence data is available in literature. Bird count belonging to family Sternidae is also low as only River Tern was recorded in current study and no Gull species were reported during current field surveys.

Table 3.1: Checklist of amphibians and reptiles recorded from the studied strata (hiking trails, undisturbed forest and urban areas) of Margalla Hills National Park (MHNP), Islamabad Capital Territory

SN	Family	Herpetofauna	Trails	Undisturbed	Urban	Rawal lake	Plate no.
1	Bufonidae	Indus Valley Toad (Duttaphrynus *stomaticus*)	+	+	+		Plate: 5b
		Southeast Asian Toad (Duttaphyrnus melanostictus)	+	+	+		Plate: 5a
2	Microhylidae	Ant Frog (*Microhyla ornata*)	+	+	+		Plate: 6b
3	Dicroglossidae	Skittering Frog (*Euphylctis cyanophlyctis*)	+	+	+		-
		Cricket Frog (*Fejervarya spp.*)	+	+	+		Plate: 6c
		Bull Frog (*Hoplobatrachus tigerinus*)	+	+	+		Plate: 6a
		Burrowing Frog (*Sphaerotheca breviceps*)	+	+	+		Plate: 6d
Order Testudines (turtles/tortoises)							
4	Trionychidae	Indian Softshell Turtle, *Nilssonia gangeticus*	-	-	-	+	
		Indian Flapshell Turtle, *Lissemys punctate*	-	-	-	+	
		The Narrow-headed Softshell Turtles *Chitra indica*	-	-	-	+	
Order Squamata (Lizards & Snakes)							
Lizards							
5	Agamidae	Common Tree Lizard (*Calotes versicolor*)	+	+	+		Plate: 14a
		Agrore Valley Agama (*Laudakia agrorensis*)	+	+	+		Plate: 7a, 10b
6	Gekkonidae	Spotted Barn Gecko (*Hemidactylus brookii*)	+	+	+		Plate: 7c, 8a
		Common House Gecko (*Hemidactylus flaviviridis*)	+	+	+		Plate: 7b, 9a
7	Lacertidae	Rugose Spectacled Lacerta (*Ophisops jerdonii*)	+	+	+		-
8	Scincidae	Stripped Grass Skink *(Eutrophis dissimilis*)	+	+	+		Plate: 7d
		Himalayan Ground Skink *(Asymblepharus himalayanus*)	+	+	+		-
		Himalayan Skink (*Scincella himalayana*)	+	+	+		-
9	Varanidae	Bengal Monitor (*Varanus bengalensis*)	+	+	+		Plate: 10a
Snakes							
10	Leptotyphlopidae	Long Necked Worm Snake (*Myriopholis macrorhyncha*)	-	+	-		-
11	Typhlopidae	Blind Snake (*Ramphotyphlops braminus*)	+	+	+		Plate: 11b
12	Colubridae	Cliff Racer (*Platyceps rhodorachis*)	+	-	-		Plate: 11a
		Rat Snake (*Ptyas mucosus mucosus*)	+	+	+		Plate: 11c
		Bronze Back Snake (*Dendrelaphis tristis*)	+	-	-		Plate: 11d, 12a

		Checkered Keelback (*Xenochrophis piscator)*	+	-	-	-
13	Elipidae	Common Krait (*Bungarus caeruleus*	-	-	+	Plate: 10a
		Black cobera (*Naja oxiana*)	-	+	-	Plate: 11c
		Brown cobera (*Naja naja*)	-	-	+	Plate: 11c
14	Viperidae	Sochurek's saw-scaled viper (*Echis carinatus*)	+	+	-	Plate: 10a
		Russell's chain viper, (*Daboia russelii*)	-	+	-	Plate: 8a

Table 3.2: Number of species (S), number of individuals (N), encounter rate (ER, sightings/ 6 field hours) and population density (PD, number/ha.) of amphibians and reptiles recorded from the studied strata of Margalla Hills National Park (MHNP)

Similar superscripts within the row represents statistical significance difference																
	Hiking Trails				**Undisturbed Forest**				**Urban Areas**				**MHNP**			
	S	**N**	**ER**	**PD**	**S**	**N**	**ER**	**PD**	**S**	**N**	**ER**	**PD**	**S**	**N**	**ER**	**PD**
Amphib-ians	7	71	$0.28^{a} \pm 0.05$	$90.16^{b} \pm 14.83$	7	142	$0.56^{a} \pm 0.08$	$180.32^{b} \pm 25.42$	7	89	0.35± 0.14	25.94± 10.60	7	302	1.20± 0.17	127.04± 17.64
Lizards	10	103	$0.32^{a} \pm 0.04$	$91.56^{b} \pm 12.74$	9	145	$0.45^{a} \pm 0.06$	$143.21^{b} \pm 18.05$	9	55	$0.17^{a} \pm 0.04$	$54.32^{b} \pm 13.61$	9	303	0.94± 0.12	99.75± 12.90
Snakes	6	13	$0.36^{a} \pm 0.02$	$48.15^{b} \pm 2.51$	3	16	$0.44^{a} \pm 0.09$	$142.22^{b} \pm 27.54$	2	3	$0.08^{a} \pm 0.02$	$26.67^{b} \pm 5.62$	6	32	0.89± 0.08	94.81± 8.67s

Table 3.3 Checklist of water birds recorded from the Rawal lake of Margalla Hills National Park (MHNP), Islamabad Capital Territory

Order	Family	Species	Migratory/Residental
Podicipediformes			
	Podicipedidae	Little grebe (*Trachybaptus ruficollis*)	R
Pelecaniformes			
	Aredidae	Little egret (*Egretta garzetta*)	M
		Cattle egrat (*Bulbulcus ibis*)	M
		Pond heron (*Ardeola grayii*)	R
		Grey heron (*Ardea cinera*)	M
Charadriiforms			
	Charadridae	Red wattled lapwing (*Vanellus indicus*)	R
	Sternidae	Little stint (*Callidris minuta*)	M
		River Tern (*Sterna aurentia*)	R
Suliformes			
	Phalacrocoracidae	Little cormorant (*Microcarbo niger*)	R
Gruiiformes			
	Rallidae	Common coot (*Fulica atra)*	M
		White breasted waterhen (*Amourornis phoennicurus*)	R
		Common moorhen (*Gallinula chloropus*)	R
Coraciiformes			
	Alcedinidae	White breasted kingfisher (*Halcyon smyrnensis*)	R
		Pied kingfisher (*Ceryle rudis*)	R
		The common kingfisher (Alcedo atthis)	R

Development of indices of monitoring and Bioassessment

The encounter rate, shown in table 3.4., is presented as an index for future monitoring in the park. The most common and frequently encountered amphibian species along the hiking trail and urban areas was Indus Valley Toad (*Duttaphrynus stomaticus*) while Bull Frog (*Hoplobatrachus tigerinus*) in undisturbed forest. The most common and frequently encountered lizard species along the hiking trail and urban areas was Spotted Barn Gecko (*Hemidactylus brookii*) while Rugose Spectacled Lacerta (*Ophisops jerdonii*) in undisturbed forest. The most common and frequently encountered snake species along the hiking trail and undisturbed forest were Blind Snake (*Rampholylops braminus*) while Rat Snake (*Ptyas mucosus mucosus*) in urban areas (Table 3.4). The bioassesmnet, based on herpetofauna, of the park revealed good to excellent biotic integrity (Table 3.4). The present study reports seven amphibian species and 23 reptilian species from Margalla Hills National Park, Islamabad Capital Territory. The most common and frequently encountered amphibian species of the park were Indus Valley Toad (Duttaphrynus *stomaticus*) and Bull Frog (*Hoplobatrachus tigerinus*), of lizard was Spotted Barn Gecko (*Hemidactylus brookii*) and of snake was Rat Snake (*Ptyas mucosus*). Rais et al. (2015) recorded 5 species of amphibians and 22 of reptiles from Rawalpindi and Islamabad. Masroor (2011) recorded 41 species (which included nine amphibian and 32 reptilian species) during a seven-year study at Margalla Hills National Park (MHNP), Islamabad. Marbled Balloon Frog (*Uperodon systoma*) was only found from sub-tropical semi-evergreen forest while Oriental Garden Lizard (*Calotes versicolor*) was the most abundant species recorded from almost all types of habitats of park.

The present study for the first time presented data on encounter rate of herpetofauna which could be used for monitoring of the park in the future. Likewise, index of bioassesmnet of the park has been presented for the first time. The index of biotoic integrity has been established for amphibians (Micacchian et al. 2015; Simon et al. 2000) and fish (Minns et al. (1994), but not for herpetofauna.

Three species of turtles were reported from river Korang and Rawal lake viz. Indian Soft-shell turtle (*Nilssonia gangeticus*), Indian flap-shell turtle (*Lissemys punctate*) and the Narrow-headed Softshell Turtles (*Chitra indica*) (Endangered according to IUCN redlist, and species of high conservation importance at international level).

Involvement of students in project activities

Following postgraduate/master students were actively participated in field surveys and project activities.

M.Phil Students (Wildlife Managemnt)

Jamal Ahmed, Arooj Batool, Aqsa Shehzad, Maira Imtiaz,

M.Sc 3rd semester Students (Wildlife Management)

Amina Abid, Ansa Rani, Laraib Khadija, Zarish Maqsood, Faiqa Parveen, Khizer Hayat and Arish Saleem

Ph.D. Student (4th semester)
Wasim Ahmed (Wildlife Management)

Activities and Timescale (February 2020-Februray 2021)

- Data collection for field season 2 (amphibians, reptiles and resident water birds): February-September 2020
- Data collection for field season 2 (migratory water birds and turtles): October-December 2020
- Trapping session 3: Pre-monsoon, May-June 2020
- Trapping session 4 (herpetofauna): Post-monsoon, Late July-August 2020
- Hands-on training sessions: two-days (April) before the start of field season
- Conservation awareness workshop, seminar and walks: a day long at the park or PMAS-AAUR campus during December 2020
- Report writing January 2021
- Report submission and project termination: February 2021.

I am indebted to (my Ph.D. supervisor) Dr. Muhammad Rais, Assistant Professor Department of Wildlife Management- Pir Mehr Ali Shah Arid Agriculture University Rawalpindi for his active participation in field activities, guidance for design and execution of this project.

Table 3.4: Comparison of number of individuals (N) and population density (PD, number/ha.) of amphibians and reptiles recorded from the studied strata (hiking trails, undisturbed forest and urban areas) of Margalla Hills National Park (MHNP), Islamabad Capital Territory

	Hiking Trails		**Undisturbed Forest**		**Urban Areas**		**Margalla Hills National Park**	
Herpetofauna	**N**	**PD**	**N**	**PD**	**N**	**PD**	**N**	**PD**
1. Indus Valley Toad	13.00	115.56	18.00	160.00	11.00	97.78	42.00	124.44
2. Asian Common Toad	15.00	133.33	8.00	71.11	41.00	364.44	64.00	189.63
3. Ant Frog	11.00	97.78	19.00	168.89	3.00	26.67	33.00	97.78
4. Skittering Frog	9.00	80.00	21.00	186.67	5.00	44.44	35.00	103.70
5. Alpine Cricket Frog	6.00	53.33	28.00	248.89	8.00	71.11	42.00	124.44
6. Bull Frog	14.00	124.44	31.00	275.56	19.00	168.89	64.00	189.63
7. Burrowing Frog	3.00	26.67	17.00	151.11	2.00	17.78	22.00	65.19
8. Common Tree Lizard	14.00	124.44	6.00	53.33	1.00	8.89	21.00	62.22
9. Agrore Valley Agama	7.00	62.22	11.00	97.78	2.00	17.78	20.00	59.26
10. Spotted Barn Lizard	17.00	151.11	21.00	186.67	15.00	133.33	53.00	157.04
11. Common House Gecko	12.00	106.67	17.00	151.11	3.00	26.67	32.00	94.81
12. Rougose Spectacled Lacerta	17.00	151.11	24.00	213.33	8.00	71.11	49.00	145.19
13. Stripped Grass Skink	8.00	71.11	14.00	124.44	6.00	53.33	28.00	82.96
14. Himalayan Ground Skink	4.00	35.56	11.00	97.78	6.00	53.33	21.00	62.22
15. Himalayan Skink	10.00	88.89	18.00	160.00	3.00	26.67	31.00	91.85
16. Bengal Monitor Lizard	14.00	124.44	23.00	204.44	11.00	97.78	48.00	142.22
17. Long Necked Worm Snake	2.00	17.78	6.00	53.33	0.00	0.00	8.00	23.70
18. Blind Snake	4.00	14.81	8.00	71.11	1.00	8.89	13.00	38.52
19. Cliff Racer	3.00	11.11	0.00	0.00	0.00	0.00	3.00	8.89
20. Rat Snake	4.00	14.81	8.00	71.11	2.00	17.78	14.00	41.48
21. Bronze Back Snake	1.00	3.70	0.00	0.00	0.00	0.00	1.00	2.96
22. Checkered Keelback	1.00	3.70	0.00	0.00	0.00	0.00	1.00	2.96

Table 3.5: Indices for monitoring (encounter rate) and bio-assessment established for the studied strata (hiking trails, undisturbed forest and urban areas) of Margalla Hills National Park (MHNP), Islamabad Capital Territory.

Index of biotic integrity scoring criteria (IBI): Habitat generalist (score 5) or specialist (10), conservation status evaluated (5) or not-evaluated (10), whether the species was invasive (score 5) or not (10), whether the species was uncommon (encounter rate 0.10-0.30, score 20), frequent (0.31-0.50, 15), common (0.51-0.80, 10) or abundant (0.81 and above, 5). IBI score: 900-1000 represented excellent biological integrity, 700-900 good biotic integrity and < 700 poor biotic integrity.									
				Encounter Rate			**Index of Biotic Integrity Score**		
Herpetofauna	**Habitat**	**Conservation Status**	**Invasive**	**Hiking Trails**	**Undisturbed Forest**	**Urban Areas**	**Hiking Trails**	**Undisturbed Forest**	**Urban Areas**
Indus Valley Toad	HG	LC	Yes	0.36	0.5	0.31	30	30	30
Asian Common Toad	HG	LC	Yes	0.42	0.22	1.14	30	35	20
Ant Frog	HG	LC	No	0.31	0.53	0.08	35	30	40
Skittering Frog	HS	LC	No	0.25	0.58	0.14	45	35	45
Alpine Cricket Frog	HS	LC	No	0.17	0.78	0.22	45	35	45
Bull Frog	HG	LC	No	0.39	0.86	0.53	35	25	30
Burrowing Frog	HS	LC	No	0.08	0.47	0.06	45	40	45
Common Tree Lizard	HS	NE	No	0.39	0.17	0.03	45	50	50
Agrore Valley Agama	HS	NE	No	0.19	0.31	0.06	50	45	45
Spotted Barn Lizard	HG	LC	No	0.47	0.58	0.42	35	30	35
Common House Gecko	HS	NE	Yes	0.33	0.47	0.08	40	40	45
Rougose Spectacled Lacerta	HS	LC	No	0.47	0.67	0.22	40	35	45
Stripped Grass Skink	HS	NE	No	0.22	0.39	0.17	50	45	50
Himalayan Ground Skink	HS	NE	No	0.11	0.31	0.17	50	45	50
Himalayan Skink	HS	NE	No	0.28	0.5	0.08	45	45	50
Bengal Monitor Lizard	HG	LC	Yes	0.39	0.64	0.31	30	25	30
Long Necked Worm Snake	HS	NE	No	0.06	0.17	0	50	50	0
Blind Snake	HS	NE	No	0.11	0.22	0.03	50	50	50
Cliff Racer	HS	NE	No	0.08	0	0	50	0	0
Rat Snake	HG	NE	No	0.11	0.22	0.06	45	45	45
Bronze Back Snake	HS	NE	No	0.03	0	0	50	0	0

Checkered Keelback	HS	NE	No	0.03	0	0	50	0	0
							945	**735**	**750**
							Excellent	**Good**	**Good**

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PLATES

Plate 1: a) Trail 4 undisturbed area, b) Trail 5 undisturbed area, c) Shahdra undistrubed area, d) Talhar village

Plate 2: a) Undisturbed area of Shakarpariyan b) Dried Lotus Lake

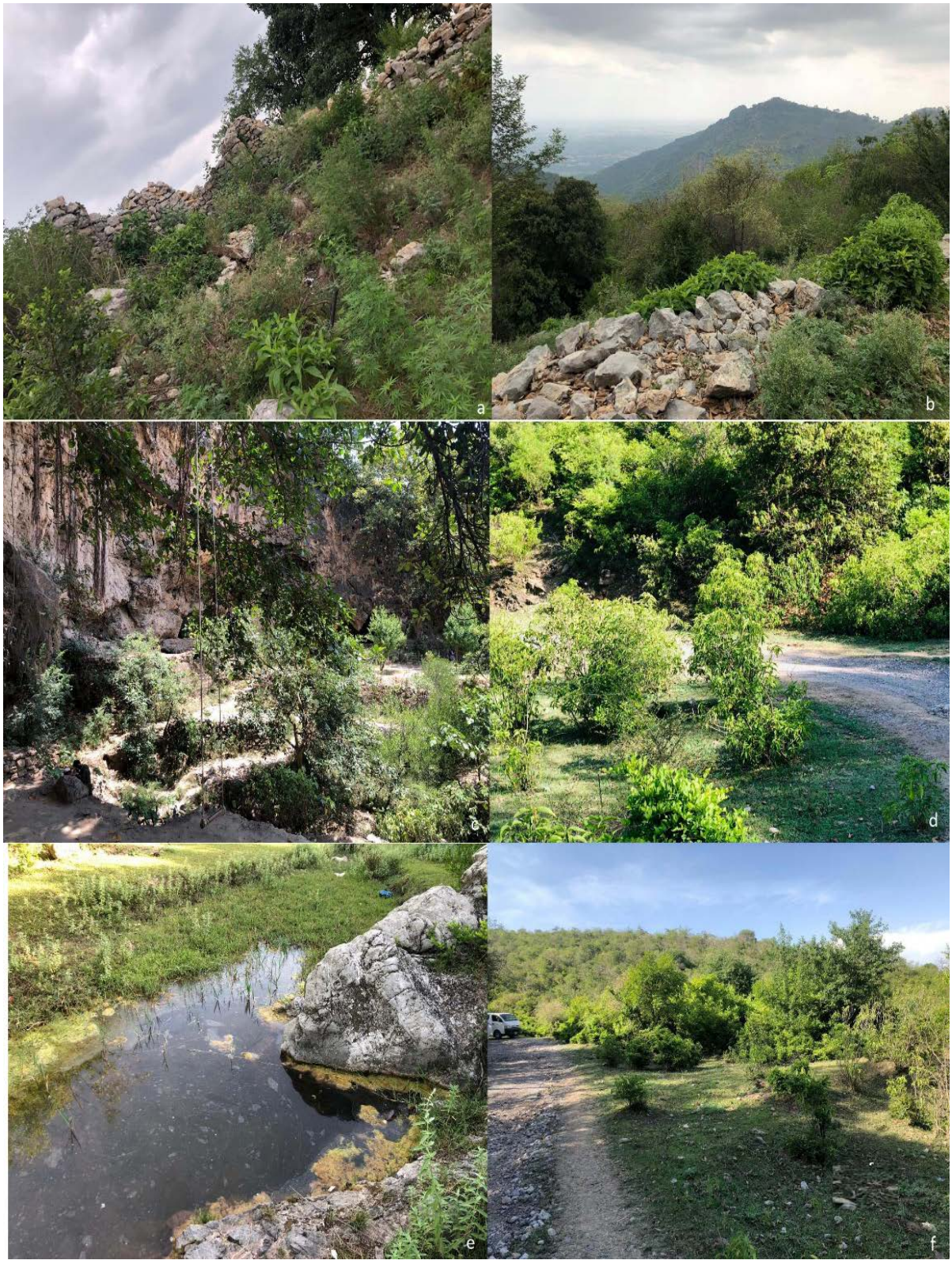

Plate 3: a) Top of Trail 6, b) Jhabi Village, c) Shah Allah Ditta Caves, d) Ramli Village, e) Saidpur village, e) Barakahu

Plate 4: a) Pitfall traps (with drift fence) in V-shape array, b) Installation of funnel trap along drift fence

Plate 5: a) Southeast Asian Toad (*Duttaphyrnus melanostictus*), b) Indus Valley Toad *(Duttaphrynus stomaticus*)

Plate 6: a) Bull Frog (*Hoplobatrachus tigerinus*), b) Ant Frog (*Microhyla ornata*), c) Cricket Frog (*Fejervarya spp.*), d) Burrowing Frog (*Sphaerotheca breviceps*)

Plate 7: a) Agrore Valley Agama (*Laudakia agrorensis*), b) Common House Gecko (*Hemidactylus falviviridis*) c) Spotted Barn Gecko (*Hemidactylus brookii*), d) Stripped Grass Skink *(Eutrophis dissimilis*)

Plate 8: a) *Hemidactylus brookii* lateral view b) ventral side

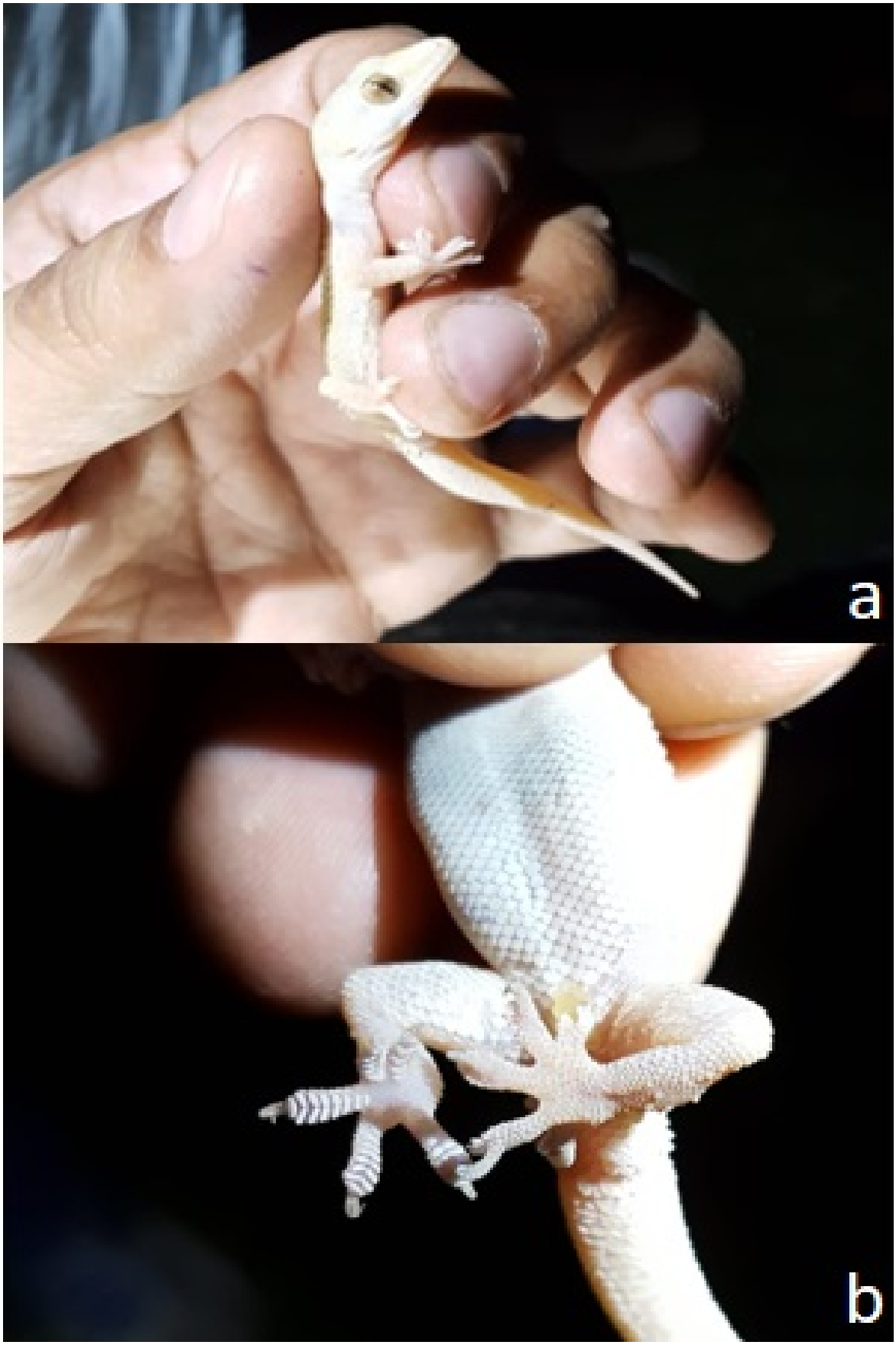

Plate 9: a) *Hemidactylus flaviviridis* lateral view b) dorsal view

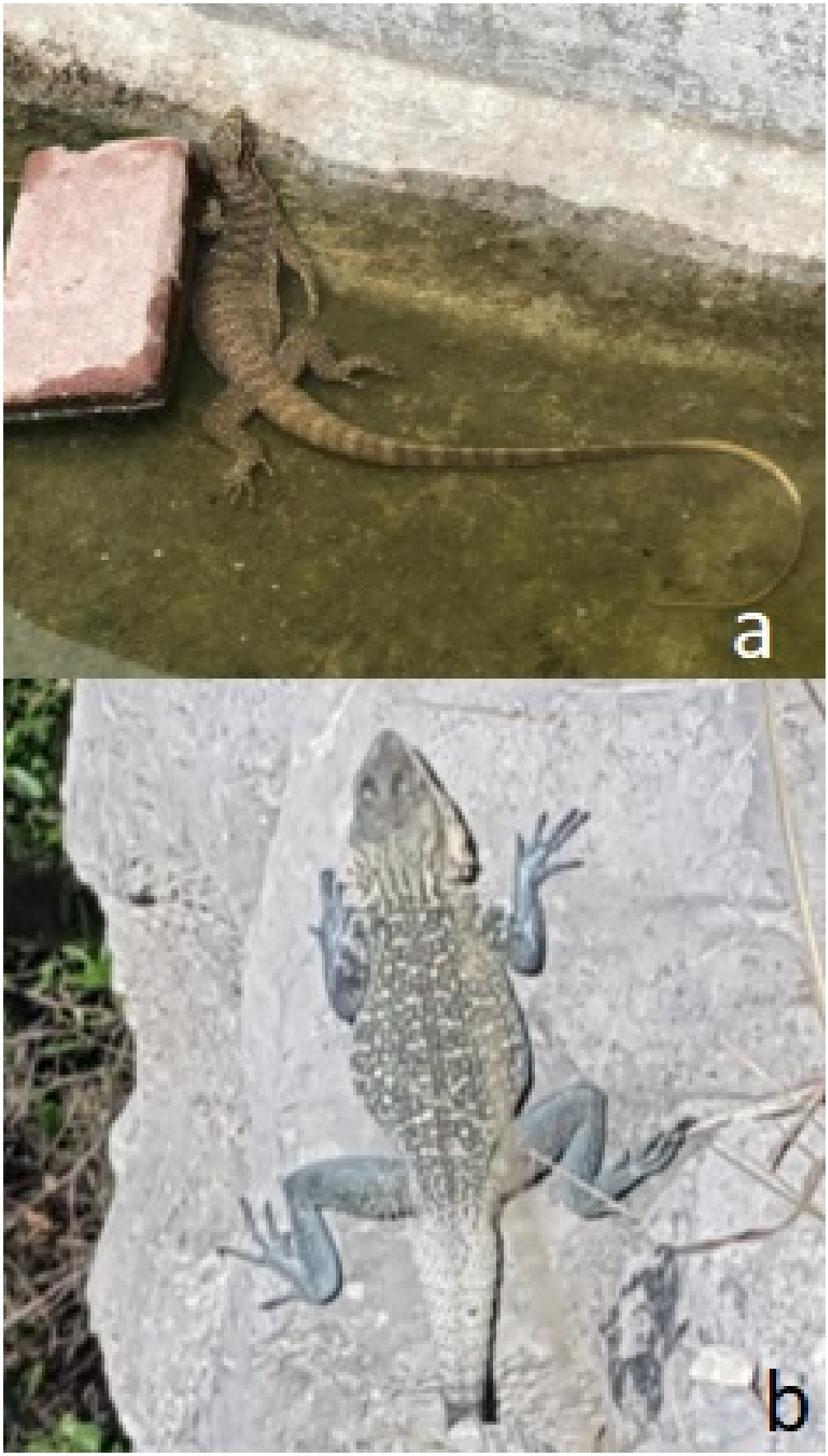

Plate 10: a) Moniter lizard (*Varanus bengalensis)* b) Agrore Valley Agama (*Laudakia agrorensis)*

Plate 11: a) Cliff Racer (*Platyceps rhodorachris*), b) Blind Snake (*Rampholylops braminus*), c) Rat Snake (*Ptyas mucosus*, d) Bronze Back Snake (*Dendrelaphis tristis*)

Plate 12: a) Bronze Back Snake (*Dendrelaphis tristis*), b) Russell's Chain Viper (*Daboia russelii russelii*)

Plate 13: a-b) Black Cobra (*Naja naja)*

Plate 14: a- Indian narrow-headed softshell turtle (*Chitra indica*) b- Indian softshell turtle (*Nilssonia gangeticus*)

Plate 15: Indian flap shell turtle (*Lissemy spunctata*)

Plate 16: a- Red Wattled Lapwing (*Vanellus indicus*) b- Pond Heron (*Ardeola grayii*)

Plate 17: a- Cattle egret (*Bubulcus ibis*) b- Night Heron (*Nycticorax nycticorax*)

Plate 18: Little cormorant (*Microcarbo niger*)