
Diversity and conservation of amphibians and reptiles in North Punjab, Pakistan.

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ABSTRACT - Amphibians and reptiles are the most neglected and least studied wildlife groups in Pakistan. The present study was conducted in the selected areas of districts Rawalpindi, Islamabad and Chakwal, North Punjab, Pakistan, to obtain data on herpetofaunal species richness and abundance from February, 2010 to January, 2011 using area-constrained searches. A total of 35 species of amphibians and reptiles (29 genera, 16 families, four orders) were recorded from the study area. Of the recorded species, 30 were reptiles (25 genera, 13 families, three orders) and five were amphibians (four genera, three families and a single order). A total of 388 individuals belonging to 11 recognizable taxonomic units (RTUs) with a population density of 0.22 individuals/ ha. and 4.10 encounters were recorded. Of the recorded RTUs, two (lacertids and skinks) were rated as uncommon, seven (hard-shell turtles, soft-shell turtles, agamids, gekkonids, medium and large-sized lizards, non-venomous snakes and venomous snakes) as frequent and two (toads and frogs) as common. Districts Rawalpindi/ Islamabad had higher species richness while District Chakwal had relatively higher species diversity and evenness. Threatened species of the area included the Narrow-headed Soft-shell Turtle (*Chitra indica*), Indian Soft-shell Turtle (*Nilssonia gangetica*), Peacock Soft-shell Turtle (*Aspideretes hurum*), and Brown River Turtle (*Pangshura smithii*). Threats to the herpetofauna are noted and conservation measures are discussed.

In Pakistan, amphibians are represented by a single order (Anura), while four categories of reptiles (Testudines, Sauria, Serpentes, Crocodylia) are recognised. Although inventories of the herpetofauna of Pakistan have been documented, more exploratory research on bio-ecological aspects are required. Boulenger (1890) described reptiles and amphibians of India, Pakistan, Burma and Ceylon (Sri Lanka), which was later updated by Smith (1931, 1935, 1943). Two classical and accurate records of the herpetofauna of Pakistan are by Mertens (1969) and Minton (1966). Khan (2006) also gave a detailed account of the amphibians and reptiles of Pakistan. A few notable studies from the North Punjab region of Pakistan are also available (Akbar et al., 2006; Khan, 1986; Tabassum et al., 2011; Yousaf et al., 2010), but there has been no comprehensive study of the region's herpetofauna.

Worldwide declines in amphibian and reptile populations have caused great concern in the scientific community in recent years, and regional

accounts are invaluable tools for informing ecological knowledge and conservation. Around 28% (470 out of 1678) assessed reptiles (IUCN, 2009a) and 30% (1895 out of 6285) of the assessed amphibians of the world are threatened (IUCN, 2009b). The most common causes of their population decline include climate change, increased exposure to ultraviolet radiation, pathogens, introduced species, habitat destruction and modification, acid rain, and chemical stressors such as pesticides and fertilizers (Blaustein et al., 1994; Blaustein et al., 2003; Boone & Bridges, 2003; Bridges, 1997, 1999, 2000; Gibbons et al., 2000).

Quantitative data are lacking in Pakistan. The present study was therefore conducted to obtain data on herpetofaunal species richness and abundance in the districts Rawalpindi, Islamabad and Chakwal, North Punjab, Pakistan. The results present data on abundance, conservation status and encounter rates for the first time from the area,



Figure 1. Map of the study area showing locations of the selected sites within Rawalpindi, Islamabad and Chakwal Districts.

which could serve as the basis for detailed studies in the future.

MATERIALS AND METHODS

Study area

We conducted the present study in selected areas of the districts of Rawalpindi, Islamabad (Loi Bher Wildlife Park, Rawal Lake and Simly Dam) and Chakwal (Kallar Kahar Lake, Dharabi Dam and Chumbi Surla Wildlife Sanctuary) (Figure 1). The districts experience a humid subtropical climate with long and very hot summers, a short monsoon and mild wet winters. The wetlands of the area comprise of Rivers Kurrang and Soan with slow-flowing water during most part of the year; and water storage reservoirs such as the Rawal Dam, Simly Dam, Nikka Dam, Dharabi Dam and several other small dams with associated marshes (Ashraf et al., 2007; Chaudhry & Rasul, 2004). The area represents a typical arid landscape with hard substrate and scrub vegetation. The dominant trees include: *Acacia modesta*, *Acacia nilotica*, *Albizia lebbek*, *Morus nigra*; *Malvastrum coromandelianum*, *Parthenium hysterophorus*; shrubs like *Dodonaea viscosa*, *Maytenus royleanus*, *Lantana camara*; and sedges such as *Calotropis procera*; and grasses *Cynadon dactylon*, *Phragmites karka*, *Sacchrum benghalense*, and *Setaria pumila*.

The Loi Bher Wildlife Park is situated in the Loi Bher forest on Islamabad Highway at a distance of 16 km from Rawalpindi City. The surface soil of

the forest consists of alluvial deposits of sand and clay mixed with boulders, generally of small size (Ahmad & Ehsan, 2012). Simly Dam is an earthen embankment dam on the Soan River located 30 km east of Islamabad city. The water stored in this dam is fed by the melting snow and natural springs of the Murree Hills. It has a rocky bottom, and scrub vegetation dominates the area. The Rawal Dam is built on the Kurrang River, the main source of water to the Rawal Lake, having an area of 19 km² (Hussain et al., 2001; PEPA, 2004).

Kallar Kahar Lake is located 25 km north of Chakwal City. It is a permanent saline/brackish lake. There is an abundant growth of aquatic vegetation such as *Phragmites* and *Typha* along the margins especially in the south-east and eastern side (Rais et al., 2011). Dharabi Dam is situated around 4 km north-west of the Bulkasar motorway interchange. The area features mountainous terrain with some sandy areas. The Chumbi Surla Wildlife Sanctuary occupies an area of over 55,000 ha. The area features mountainous terrain with rock base consisting predominantly of sand stone and patches of red sandy clay. Small dams are built inside the sanctuary. The core area consists of natural subtropical thorn scrub forests (Chaudhry et al., 2001).

Study design

We surveyed the selected sites from February 2010 to January 2011. We made a total of 46 survey visits made up of 947 field hours. We randomly selected three sampling units within each site (total 18). Within each unit, we systematically searched an area of 100 ha. (total sampled area: 1800 ha.) and recorded the presence/absence of species, number of individuals and time spent, following established procedures (Campbell & Christman, 1982; Corn & Bury, 1990; Fellers & Freel, 1995; Heyer et al., 1994; Sutherland, 1996). We searched beneath logs, within leaf litter, and under stones by turning them over. Reptiles were observed by eye, and using binoculars. Amphibians were detected using torchlight at night (on land and in water), and collected by hand or using a dip net. Dead specimens found during the surveys or by local people were brought to the laboratory. Live specimens were anaesthetised using chloroform,

Species	Rawalpindi/ Islamabad			Chakwal			Study area		
	Number	Relative Abundance	Abundance Rank	Number	Relative Abundance	Abundance Rank	Number	Relative Abundance	Abundance Rank
Order Testudines, Family Emydidae									
1. Brown River Turtle (<i>Pangshura smithii</i>)	21	20.19	1	06	7.4	3	27	14.59	1
2. Saw-back Turtle (<i>Pangshura tecta</i>)	02	1.92	7	0	0	8	2	1.08	11
Family Trionychidae									
3. Indian Soft-shell Turtle (<i>Nilssonina gangetica</i>)	04	3.84	6	01	1.23	7	5	2.7	8
4. Indian Flapshell Turtle (<i>Lissemys punctata andersoni</i>)	17	16.34	3	06	7.4	3	23	12.43	3
Order Squamata, Sub-order Sauria, Family Agamidae									
5. Common Tree Lizard (<i>Calotes versicolor versicolor</i>)	09	8.65	4	11	13.58	1	20	10.81	4
6. Black Rock Agama (<i>Laudakia melanura melanura</i>)	0	0	9	02	2.46	6	2	1.08	11
7. Field Agama (<i>Trapelus agilis pakistanica</i>)	0	0	9	01	1.23	7	1	0.54	12
Family Eublepharidae									
8. Fat-tail Gecko (<i>Eublepharis macularius</i>)	02	1.92	7	0	0	8	2	1.08	11
Family Gekkonidae									
9. Spotted Barn Gecko (<i>Hemidactylus brookii</i>)	18	17.3	2	08	9.87	2	26	14.05	2
10. Common Tuberculate Ground Gecko (<i>Cyrtopodion scabrum</i>)	04	3.84	6	02	2.46	6	6	3.24	7
Family Lacertidae									
11. Blue-tail Sand Lizard (<i>Acanthodactylus cantoris</i>)	0	0	9	02	2.46	6	2	1.08	11
12. Rugose Spectacled Lacerta (<i>Ophisops jerdonii</i>)	01	0.96	8	0	0	8	1	0.54	12
13. Smooth Spectacled Lacerta (<i>Ophisops elegans</i>)	0	0	9	06	7.4	3	6	3.24	7
Family Scincidae									
14. Earless Snake-eyed Skink (<i>Ablepharus grayanus</i>)	01	0.96	8	01	1.23	7	2	1.08	11
15 Spotted Garden Skink (<i>Lygosoma punctata</i>)	01	0.96	8	0	0	8	1	0.54	12
Family Varanidae									
16. Bengal Monitor Lizard (<i>Varanus bengalensis</i>)	04	3.84	6	08	9.87	2	12	6.48	5
17. Yellow Monitor Lizard (<i>Varanus flavescens</i>)	0	0	9	02	2.46	6	2	1.08	11
Family Uromastycidae									
18. Indus Valley Spiny-tailed Lizard (<i>Sara hardwickii</i>)	02	1.92	7	06	7.4	3	8	4.32	6
Order Squamata, Sub-order Serpentes, Family Typhlopidae									
19. Brahminy Blind Snake (<i>Ramphotyphlops braminus</i>)	01	0.96	8	0	0	8	1	0.54	12
Family Colubridae									
20. Spotted Keel Back (<i>Amphiesma platyceps</i>)	01	0.96	8	02	2.46	6	3	1.62	10
21. Banded Kukri Snake (<i>Oligodon arnensis arnensis</i>)	01	0.96	8	03	3.7	5	4	2.16	9
22. Streaked Kukri Snake (<i>Oligodon taeniolatus taeniolatus</i>)	01	0.96	8	01	1.23	7	2	1.08	11
23. Plains Racer (<i>Platyceps ventromaculatus</i>)	01	0.96	8	02	2.46	6	3	1.62	10
24. Dhaman (<i>Ptyas mucosus mucosus</i>)	02	1.92	7	03	3.7	5	5	2.7	8

25. Blotched Diadem Snake (<i>Spalerosophis diadema diadema</i>)	0	0	9	02	2.46	6	2	1.08	11
26. Checkered Keel Back (<i>Xenochrophis piscator piscator</i>)	06	5.76	5	0	0	8	6	3.24	7
Family Elapidae									
27. Common Krait (<i>Bungarus caeruleus caeruleus</i>)	01	0.96	8	0	0	8	1	0.54	12
Family Viperidae									
28. Saw-scaled Viper (<i>Echis carinatus</i>)	02	1.92	7	05	6.17	4	7	3.78	6
29. Russell's Chain Viper (<i>Daboia russelii russelii</i>)	02	1.92	7	01	1.23	7	3	1.62	10
Total	1/04			81				185	

Table 1. Abundance of reptiles recorded from Rawalpindi, Islamabad and Chakwal Districts from February 2010 to January 2011.

Species	Rawalpindi/ Islamabad			Chakwal			Study area		
	Number	Relative Abundance	Abundance Rank	Number	Relative Abundance	Abundance Rank	Number	Relative Abundance	Abundance Rank
Order Anura									
Family Bufonidae									
1. Hazara Toad (<i>Duttaphrynus hazarensis</i>)	14	12.72	4	11	11.82	4	25	12.31	4
2. Indus Valley Toad (<i>Bufo stomaticus</i>)	29	26.36	2	18	19.35	3	47	23.15	2
Family Microhylidae									
3. Ant Frog (<i>Microhyla ornata</i>)	02	1.81	5	0	0	5	2	0.98	5
Family Ranidae									
4. Skittering Frog (<i>Euphlyctis cyanophlyctis cyanophlyctis</i>)	49	44.54	1	38	40.86	1	87	42.85	1
5. Bull Frog (<i>Hoplobatrachus tigerinus</i>)	16	14.54	3	26	27.95	2	42	20.68	3
Total	110			93			203		

Table 2. Abundance of amphibians recorded from Rawalpindi, Islamabad and Chakwal Districts from February 2010 to January 2011.

and later preserved in formalin (10%) solution. Amphibians and reptiles were identified using Daniels (2002) and Khan (2006). For taxonomy, www.amphibianweb.org, www.reptile-database.org and www.iucnredlist.org were followed.

The recorded amphibians and reptiles were grouped into 11 recognizable taxonomic units (RTUs) (modified from Oliver & Beattie, 1995 and 1996). These RTUs do not represent any

strict taxonomic rule; rather they represent a simplified categorisation with two benefits. Firstly, it helped to avoid taxonomic complications and misidentification, for several amphibian and reptile species were elusive, less conspicuous and less abundant in the wild. Secondly, abundance data such as population density and status could be grouped, analysed and presented in a more meaningful way. The RTUs were:

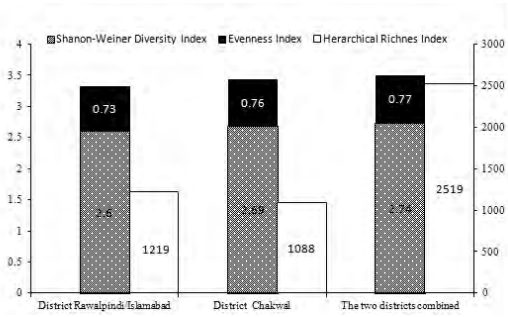


Figure 2. Comparison of indices of herpetofauna species diversity, richness and evenness recorded from Rawalpindi, Islamabad and Chakwal districts and the study area.

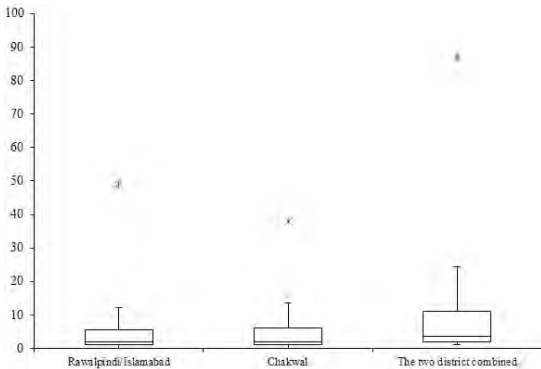


Figure 3. Box plots showing comparison of abundance of amphibians and reptiles recorded from Rawalpindi, Islamabad and Chakwal districts and the study area.

hard-shell turtles (family Emidyidae), soft-shell turtles (Trionychidae), agamids (Agamidae), gekkonids (Gekkonidae, Eublepharidae), lacertids (Lacertidae), skinks (Scincidae), medium and large-sized lizards (Varanidae, Uromastycidae), non-venomous snakes (Typhlopidae, Colubridae), venomous snakes (Elapidae, Viperidae), toads (Bufonidae) and frogs (Ranidae, Microhylidae).

Several key metrics were calculated: relative abundance (total number of individuals per species, divided by total number of individuals of all species, multiplied by 100), population density (number of individuals/area) and encounter rate (number of individuals per 10 hours of survey) = number of individuals multiplied by 10, divided by total field hours. On the basis of number of individuals recorded, species were also given an integer abundance rank, with 1 being the most abundant.

Species with an encounter rate of 0.00 - 0.01 were rated as scarce; 0.02 - 0.10 as uncommon; 0.11 - 0.50 as frequent; and over 0.50 as common. The Shannon-Weiner Diversity Index ($H' = \sum p_i \ln p_i$) was calculated, where p_i is the number of individuals of a species as a proportion of total individuals of all species, and \ln is the log of p_i . The Evenness Index ($E = H' / \ln(S)$) was also calculated, where H' is the Shannon-Weiner Diversity Index and S is the number of species and Hierarchical Richness Index (for calculation details see French, 1994). Based on the data, non-parametric tests were applied using SPSS 17.0. The abundance data were plotted as box plots, and medians were compared using Wilcoxon test.

RESULTS

A total of 35 species of amphibians (examples in Figure 6) and reptiles (29 genera, 16 families, four orders, see examples shown in Figures 4 & 5) were recorded from Rawalpindi, Islamabad and Chakwal districts during the present study. Of the recorded species, 30 (86%) were reptiles (25 genera, 13 families, three orders) and five (14%) were amphibians (four genera, three families and a single order) (Table 1 & 2). A total of 185 individuals of 29 reptile species, and 203 individuals of five amphibian species, were recorded. Brown River Turtle (*Pangshura smithii*) (14.59%) and Skittering Frog (*Euphlyctis cyanophlyctis cyanophlyctis*) (42.85%) were recorded as the most abundant reptilian and amphibian species, respectively (Tables 1 & 2).

Species richness was high in Rawalpindi and Islamabad districts (Hierarchical richness index = 1219). Chakwal District had high species diversity (Shannon-Weiner diversity index = 2.69). Chakwal District also showed a slight even distribution in the number of individuals (Evenness index = 0.76) (Figure 2). However, Wilcoxon test showed that the difference between the medians of the total number of individuals recorded from Rawalpindi, Islamabad districts and Chakwal District was not-significant ($Z = -0.67$; $P = 0.498$). We therefore attribute the observed difference in species richness and diversity to chance encounter with the species and individuals. Box plot of District Rawalpindi and Islamabad districts showed bunched data while

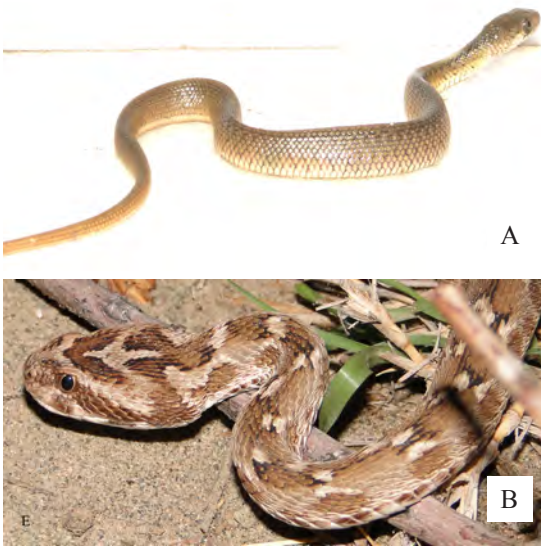


Figure 4. Examples of snake species recorded during the survey. A: Dhaman (*Ptyas mucosus mucosus*) (Juvenile); B: Saw scale Viper (*Echis carinatus*).

District Chakwal data showed relatively higher spread (Figure 3).

A total of 388 individuals belonging to 11 recognizable taxonomic units (RTUs) with a population density of 0.22 individuals/ha and 4.10 encounters were recorded. Of the recorded RTUs, two (lacertids and skinks) were recorded as uncommon; seven (hard-shell turtles, soft-shell turtles, agamids, gekkonids, medium and large-sized lizards, non-venomous snakes and venomous snakes) as frequent; and two (toads and frogs) as common (Table 3).

As per IUCN red list of threatened species the status of one species viz. Narrow-headed Soft-shell Turtle (*Chitra indica*) is Endangered; two viz. Indian Soft-shell Turtle (*Nilssonina gangetica*) and Peacock Soft-shell Turtle (*Aspideretes hurum*) are Vulnerable while one Brown River Turtle (*P. smithii*) is Near Threatened. The majority of the recorded species (n = 21; 60%) are unprotected under territorial laws (Punjab Wildlife Acts and Rule, 1974; and Islamabad Wildlife Protection, Preservation, Conservation and Management Ordinance, 1979) while species belonging to families Emydidae, Trionychidae, Varanidae, Uromastycidae and Colubridae and the genus *Naja*

enjoy protection under law (Khan & Mahmood, 2004).

Hunting and trapping of turtles (particularly soft-shell turtles), trapping of snakes by snake charmers, killing of snakes out of fear, varanid roadkill, and aquatic pollution due to organic matter and pesticides were recorded as the main threats to the herpetofauna.

DISCUSSION

A relative dearth of literature precludes a detailed discussion on herpetofauna species abundance and conservation status in these districts of Pakistan, and this study adds significantly to the available knowledge. Khan (1986) reported one species of toad, three frogs and nine species of lizards and snakes each from the District of Mianwali which is located 164 km from Chakwal District, North-western Punjab. Of 24 previously-reported species (Khan, 1986), 12 were recorded during the present study. The difference in species number is attributed to different study sites. Akbar et al. (2006) reported eight species of freshwater turtles from the Punjab province with Brown River Turtle (*P. smithii*) as the most abundant species. During the present study, Brown River Turtle was also reported as the most abundant (14.59%).

By comparison, Khan and Mahmood (2004) collected 215 individuals of reptiles belonging to two agamid species from Karachi in Sindh, with Common Tree Lizard (n = 187) as the most abundant species. Common Tree Lizard was found to be the fourth most abundant reptile in our study (Abundance Rank = 4; 10.81%). It is therefore concluded that Brown River Turtle is the most abundant freshwater turtle, and Common Tree Lizard is the most abundant arboreal lizard in much of the country.

An estimated 13,000 metric tonnes of live turtles were traded in 1999 from different countries of Southeast Asia of which soft-shell turtles constitute the major proportion (Anonymous, 2001; Lau & Shi, 2000; McCord, 1997; Salzberg, 1998). Data relating to the trade of testudines, particularly freshwater soft-shell turtles, are lacking in Pakistan. Based on field observations during the present study, it is maintained that freshwater turtles, particularly soft-shell turtles, are being

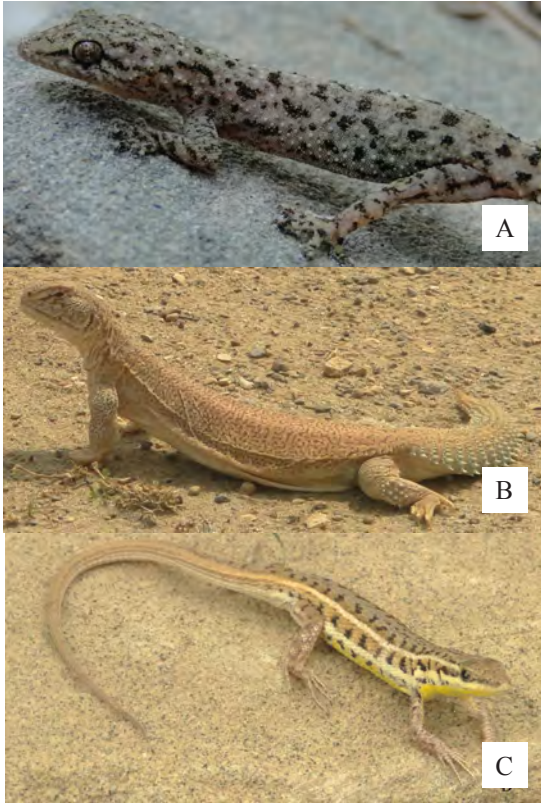


Figure 5. Examples of lizards recorded during the survey. A: Spotted Barn Gecko (*Hemidactylus brookii*); B: Indus Valley Spiny-tailed Lizard (*Sara hardwickii*); C: Rugose Spectacled Lacerta (*Ophisops jerdonii*).

trapped and traded to be smuggled out of Pakistan. It is of great concern, as the turtle species such as Indian Soft-shell Turtle (*Nilssonia gangetica*) involved in the trade are not as common as that of hard-shell turtles, which do not fall victim of illegal trade. Although all freshwater turtle species are now protected and have now been included in the Third Schedule of the Punjab Wildlife Acts and Rule (1974) and Islamabad Wildlife Protection, Preservation, Conservation and Management Ordinance (1979), but still weak law enforcement encourages poachers to capture turtles in large numbers. Globally, large lizards account for over 50% of all lizards which are considered threatened (IUCN, 2009a). Many populations of monitor lizards are threatened due to habitat destruction and fragmentation (Pianka, 1969). Of all the lizard species we found, the varanids and the Indus

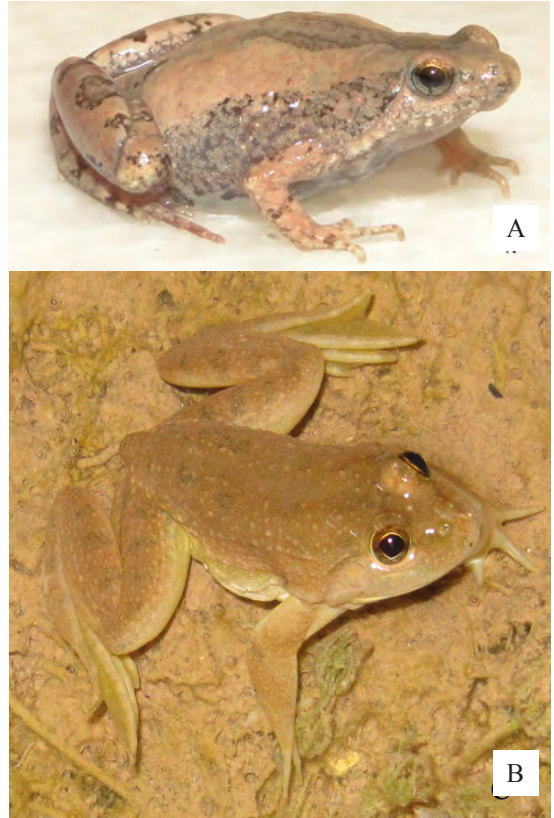


Figure 6. Examples of anurans recorded during the survey. A: Ant Frog (*Microhyla ornata*); B: Skittering Frog (*Euphlyctis cyanophlyctis*).

Valley Spiny-tailed Lizard (*Uromastix hardwickii*) were found to be threatened by killing and trapping respectively. Quantitative data regarding amphibian population are lacking in most southeast Asian countries with Pakistan having almost no amphibian experts at present (Molur, 2008). The present study revealed low amphibian population densities. Frogs belonging to family Ranidae were recorded as common with 0.07/ha.

An important conservation measure would be stricter implementation of existing wildlife protection laws (Punjab Wildlife Acts and Rule, 1974; Islamabad Wildlife Protection, Preservation, Conservation and Management Ordinance, 1979). Although the situation is better in Islamabad, reports of freshwater turtle trapping were still obtained. Inhabitants of the area need to be counselled regarding the values of different herptile

	Rawalpindi/Islamabad					Chakwal					Study area				
	Numbers	Relative frequency	Population density	Encounter rates	Status	Numbers	Relative frequency	Population density	Encounter rates	Status	Numbers	Relative frequency	Population density	Encounter rates	Status
Hard-shell Turtles	23	10.75	0.03	0.32	F	6	3.45	0.01	0.27	F	29	7.47	0.02	0.31	F
Soft-shell Turtles	21	9.81	0.02	0.29	F	7	4.02	0.01	0.31	F	28	7.22	0.02	0.30	F
Agamids	9	4.21	0.01	0.12	F	14	8.05	0.02	0.63	C	23	5.93	0.01	0.24	F
Gekkonids	24	11.21	0.03	0.33	F	10	5.75	0.01	0.45	F	34	8.76	0.02	0.36	F
Lacertids	1	0.47	0.00	0.01	S	8	4.60	0.01	0.36	F	9	2.32	0.01	0.10	U
Skinks	2	0.93	0.00	0.03	O	1	0.57	0.00	0.04	O	3	0.77	0.00	0.03	U
Medium and Large-sized Lizards	6	2.80	0.01	0.08	O	16	9.20	0.02	0.71	C	22	5.67	0.01	0.23	F
Non-venomous Snakes	13	6.07	0.01	0.18	F	13	7.47	0.01	0.58	C	26	6.70	0.01	0.27	F
Venomous Snakes	5	2.34	0.01	0.07	O	6	3.45	0.01	0.27	F	11	2.84	0.01	0.12	F
Toads	43	20.09	0.05	0.59	C	29	16.67	0.03	1.29	C	72	18.56	0.04	0.76	C
Frogs	67	31.31	0.07	0.93	C	64	36.78	0.07	2.86	C	131	33.76	0.07	1.38	C
Total	214		0.24	2.96		174		0.19	7.77		388		0.22	4.10	

Table 3. Number, relative frequency, population density and status of the recorded Recognizable Taxonomic Units of herpetofauna recorded from Rawalpindi, Islamabad and Chakwal Districts during February 2010 to January 2011. *Status C = Common = 0.5 and above; F = Frequent = 0.11 to 0.5; U = Uncommon = 0.02 to 0.10; S = Scarce = 0.00 to 0.01.

species, to lessen the pressure of indiscriminate killing of snakes, varanids and other lizards. A few steps that could be taken in this regard include: i) 'roadshows' of herptiles to familiarise people with different species, ii) distribution of brochures containing information on occurrence and identification of venomous and aggressive vs non-venomous and harmless species, and iii) educating people what to do if they encounter such species. Encouraging people to take up herpetoculture of a few economically-important species such as frogs, freshwater turtles and venomous snakes might be difficult, but is highly recommended. We suggest provision of tunnels under roads in all construction projects would reduce road mortality of anurans migrating to breeding ponds.

ACKNOWLEDGEMENTS

We owe a deep gratitude to PMAS-Arid Agriculture University, Rawalpindi for funding the study. We are truly thankful to Dr. M.I Lone, Director Research and Mr. Shahid Ali Khan, Manager Research Operation, PMAS Arid Agriculture University Rawalpindi for their guidance during the execution of the project. We greatly acknowledge Pakistan Wetlands Programme (PWP), WWF-Pakistan, for providing the topographic map of the lake. We thank our students particularly Muhammad Saeed, Gul Zada, Nadeem Munawar, and Bilal Kabeer for their active participation during the project. We also thank Muhammad Sharif Khan for his assistance in preparing this manuscript.

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