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Ecobiology of Monitor lizard (Varanus bengalensis) in Cholistan Desert Bahawalpur, Punjab

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ABSTRACT

Recent study was conducted to gather information on the ecology and behavior of monitor lizard (*V. bengalensis*) in Cholistan desert Bahawalpur during May 2017 to April 2018. Selected areas were eight in number with eight different habitats for monitoring, these habitats comprised on; Desert, Agriculture crop land, Canal side, Forest area, Ponds & Lakes, Orchards, Nurseries, and Human settlements. The procedure opted for survey was visual encounter followed by line transect. Focal sample method was also used for observing all the activities of an individual lizard from dawn to dusk. Preferred habitat observed was dry land or deserted areas followed by forested areas. Its diet comprised of crustaceans, earthworms, arthropods, beetles, fishes, frog and vegetables & fruits. Breeding period starts from end of February to mid of May in this area. Eggs laid in month of April but eggs could be found until end of May in felled logs or in termite mounds. Incubation period ranges between 5-6 months. Hatchlings emerged in the months of August and September. Out of total 126 eggs, total eggs hatched were 39. According to our calculation, there were ~50-70 individual in each of eight study sites and approximately total 700 number of individual of *V. bengalensis* found in the area of Cholistan desert. Due to illegal hunting or poaching, the population of *V. bengalensis* in these areas is at decline; long-term study has been recommended to know the trend of monitor lizard population throughout its range.

Key words: Cholistan desert, Ecobiology, Lizards, *Varanus bengalensis*, Visual encounter survey method (VES)

INTRODUCTION

Reptiles are fundamental part of ecosystem and play important role in world biomass. These are tetra pod, cold blooded and found almost in all part of the world. Reptiles contain three orders, one of them is Squamata comprises lizards and snakes. At least 165 reptile species belonging to 104 genera and 30 families are used in conventional folk medicine around the world. All over the world; the numbers of reptiles are decreasing day by day in numbers (Gibbons *et al*., 2000) as these are more defenseless than birds and mammals (Bohme *et al*., 2006).

In Pakistan, 15 turtles, tortoises, 2 crocodilian, 103 lizards, and 79 snake species are represent the reptilian fauna. Out of this, an overall 39 species are represented in the cholistan desert. Lizards (Sauria) are represented by 16 species belonging to 6 families viz. Gekkonidae, Agamidae, Scincidae, Lacertidae, Varanidae, and Uromastycidae (Baig *et al*., 2008). All monitor lizards belongs to Family Varanidae, Genus Varanus. At present more than 46 species of monitor lizards are identified and found in three continents; Africa, Australia and Asia (Koch *et al*., 2013). Monitor lizards were first reported over 90 million year ago in Northern Asia and further expand to reach Europe (Bennet, 1995). Daudin (1802), is the first who revised, published and described two renowned and long spread Asian and Indo-Australian monitor lizard species: Varanus indicus and the *Varanus bengalensis* (Koch *et al*., 2013). *V. bengalensis* (Daudin, 1802), is locally known as “Goo” “Goohira” and belongs to the Family Varanidae fall in the Order Squmata. Its common name is derived from the Latin word monere meaning “to warn”. These large Lizards have received the name of Monitors because they are thought to give warning by a loud hiss of the

come within reach of of the Crocodile. Arabs call this animal waran; hence the generic name of Varanus (Bateman *et al*., 2014).
V. bengalensis is inhabitant to Afghanistan, Bangladesh; China; India; Malaysia; Pakistan; Viet Nam (IUCN, 2015). *V. bengalensis* has been recorded in all geo-climatic zones of Sri lanka (Das and de Silva 2005). It is also found in Nepal (Ghimire and Phuyal, 2013) and in Thailand (Stanner, 2011). *V. bengalensis* is a wide-ranging species, occurring from South Asia and throughout Southeast Asia (Papenfuss and Portik, 2010).
It is found in all parts of Pakistan at less than 1218m elevation (Auffenberg, 1989). *V. bengalensis* was found in all parts of Sind province. It is very common in Thatta district of Sind (Hashmi *et al*., 2013). Also reported from Khyber Paktunkha province of Pakistan (Younas *et al*., 2017) and found in Cholistan desert, Bahawalpur (Baig *et al*., 2008). It is widespread and lives in all biotopes, ranging from evergreen forests to the desert fringes (Daniel, 2002). They are also human commensals, and flourish in anthropogenic habitats such as home gardens and homesteads, and can even occupy households and built-up urban environments (Koch *et al*., 2013). Varinid lizards are a diverse group of reptiles not only in regard to variation in size within their family, but also in their use of different habitats within their natural range and identified as arboreal, semi-aquatic, terrestrial and rock dwelling (Collar *et al*., 2010).
Most of the herpetological studies carried out in Pakistan are old and mainly limited to Sind and Baluchistan provinces. Herpetological studies are very rare in Pakistan as well as in Cholistan desert (Smith, 1935). Cholistan desert is wide spread having great diversity of flora and fauna comprising lizard, snakes and turtles but the research in the field of herpatofauna is not sufficient and bio-researchers interested in harpatufaunal studies are in less number. Number of Bioresearches is less and there is need to research on the total account and eco biology of various species of reptiles in Pakistan. The lizards are very eye-catching and important reptiles but this group is not giving special concern in research field and yet no studied properly (Akhter *et al*., 2006).
While the other reason to conduct this study was that all the lizards of family Varanidae including *V. bengalensis* are categorized as least concern in IUCN red list 2009, 2013. But according to (Koch *et al*., 2013) reported that Varanids of South Asia and South East expresses worries about their populations and he concludes that their status reach to vulnerable instead of least concern. He suggest that their conservation status need to be revise and stricter vigilant to be assigned. Predation of *V. bengalensis* by humans is worth mentioning. The human beings mishandling of *V. bengalensis* for food has been recorded as far back as 800 BC - 200 AD and still today both consumption and trade of monitor lizard by humans is continued (De Silva, 2006). This mis-handling results in the population declination of the concerned species hence it is the time to manage this defenseless species by conducting research on their ecology and behavior.

MATERIALS AND METHODS

Eight random sites within Cholistan desert Bahawalpur, Pakistan were selected to study the ecology and behavior of monitor lizard (Fig 1). The eight study sites were further divided into 8 microhabitats as; Agriculture croplands, canal side, deserted areas, forest areas, gardens and orchards, ponds and lakes, nurseries areas and human settlements (Table 1). For data collection, we spent 12 Months from May 2017 to April 2018 in the field. A total of 50 field visits conducted during whole research period. All visits were made on weekly basis during whole research duration. All research sites were visited twice or thrice to get repeated data and to observe variations in its habitat and its behavior. Visit time was selected early in the morning from 6:00 am to 10:00 am and in evening from 3:00 pm to 6:00 pm. The selection of this time range was based on higher activity rate of lizard in the early morning because this time lizard leaves its burrows for basking and for food searching. At noon lizard is highly active in search of food and other activities like breeding. Lizards hides themselves in burrow at Evening and never remains active after dark. Same time and time duration was used for all visits. Climatic data of Bahawalpur and especially Cholistan during overall research duration was obtained from the meteorological station (Fig 2).

Following parameters relating to ecology and behavior of *V. bengalensis* were determined.
Morphological features such as color, Snout to Vent Length (SVL), Weight of specimens were observed. All parameters regarding to its SVL were measured by using measuring tape or by steel scale. Weight was measured by using weight balance (SK-5KModel) having range of 1g to 25kg. A digital Camera (101 Nikon) was used for photography and Bushnell binoculars were used to observe from distant places. Color, body shape was observed from visual observation while it's SVL and body weight was measured by capturing. Capturing was done by using cage of steel wire or by noose method.
All the data relating to its habitat likewise its topography, climate, vegetation cover and other faunal species living in its habitat were noted. The feeding behavior was observed keenly by direct visual observation by naked eye or by using binocular to observe at distant place in the field. All aspects of breeding were observed directly in field by direct observation in field like breeding season, breeding behavior of lizard, Breeding sites, Time of breed, Eggs & hatchling. Population density of each site was measured by calculating active burrows, footprints, dropping, visual count, and interviewing local residents or by counting the number of individual along line transect on repeating visit of that specific area.
Data was partially analyzed manually. Simple calculations were made by using scientific calculator. Arithmetic mean was calculated to find out average. Graphical representations of population sizes, habitat preference, prey group were made using Micro Graph.

Fig. 1: Google Map image showing selected study sites
https://www.google.com/maps/d/viewer?mid=1V63QWO6dnWKV4PgyQg3r0MsV3SqvvqK9&ll=29.0237654600323%2C71.98213836168168&z=9

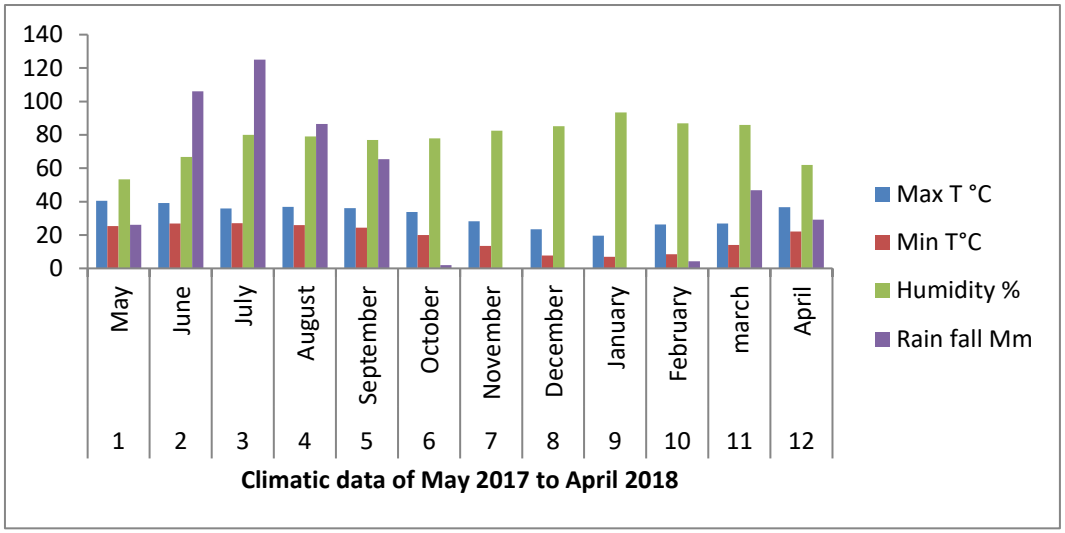

Fig. 2: Climatic data of study area from May 2017-April 2018

RESULTS AND DISCUSSION

Morphology

During study, it observed that there was variation in color, length and weight of *V. bengalensis* in each habitat.

Color: There was difference in color between adult and juvenile. The color of adult *V. bengalensis* ranges between from black, light brown or dark grey, both sexes adult male and female were similar in color, but the male is healthier and vigorous than female in its seeing. The hatchlings are dull orange and brown in color with yellow and black spotted bands on its back from face to tail. Yellow spots are round in its shape while black bands are elongated and scattered on whole body. Black bands were prominent on tail part of juvenile. These yellow spots and black bands vanish with the passage of time as the hatchling grows and adult have light grey spots on its body. With the growth of juvenile, the black color changes gradually into grey color. The *V. bengalensis* has a round compressed tail at posterior end and toothed crest on tail. Our observation resembles with the results of Smith (1935). The observed difference of coloration in our research between adults and juvenile resembled with that of Khan (1987), as he reported the color difference between adult and juvenile.

Length: The average maximum length was found in agriculture land that was recorded as 125.73 cm and minimum length was recorded in ponds lake area that was 95.99 cm. More length was observed in agriculture land, as there was presence of surplus food, like insects, rats, grasshoppers and water. Individual does not travel more in search of food and water. Hence, grow faster and could obtain maximum length and weight. Table 1, shows the different length value of *V. bengalensis* in different habitats.

Weight: The highest average weight was 3.25 kg while we capture 2 to 3 individuals those were bulky and weighed 4 to 5 kg in agriculture areas. Our results of weight resembles with that of Jasmi (1988), who recorded weight from 3 kg to 10 kg (Table 1).

Table 1: Description of selected study sites within Cholistan Desert with Sighting, Percentage, Average SVL and Weight of *Varanus bengalensis* in each habitat

Sr. No.	Study Sites	Habitat Type	Coordinates	Sighting	%	SVL (cm)	Weight (Kg)
1	Qilla Mojgarh	Agriculture land	29°32 59 N 72°92 06 E	16	13.3	125.73	3.25
2	Bahawal Canal	Canal side	29°15 96 N 71°30 25E	13	10.8	112.76	2.15

3	Derawar Fort	Dry land /Desert	29°21 46 N 71°03 85E	27	22.5	103.34	2.04
4	Yazman	Human settlement	29°12 07 N 71°7445 E	09	7.5	108.50	2.12
5	Lal Sohanra NP	Forest area	29°31 70 N 71°9046 E	24	20.0	106.68	2.09
6	IUB	Nurseries	29° 37 49 N 71°75 43 E	05	4.1	105.11	1.99
7	BWP city area	Orchard	29°35 44 N 71°69 11 E	07	5.8	99.50	1.90
8	Patisar Lake	Ponds/lake	29°32 76 N 71°9974 E	19	15.8	95.99	1.87

Habitat

Habitat preference was determined based on number of individual. Where more number of individuals was observed, we considered that habitat, most preferred habitat. Results show that more preferred habitat is Dry land or a deserted land that is having 27 individuals, Forest areas =24, Ponds & Lakes= 19, Agriculture lands= 16, Canal side= 13, Human settlements= 9, Orchards & Gardens= 7, Nurseries= 5 (Fig. 3). The *V. bengalensis* is found from desert fringes to rainforests, but is most common in farmlands and dry, open forests, banks of ponds and houses (Jaman *et al*. 2007). It can also inhabit agricultural areas (Auffenberg, 1994). *V. bengalensis* was also reported in Lal Sohanra National Park by (Khan *et al*., 2018). *V. bengalensis* mostly makes its burrow in *Cynodon dectylon*, as it spread rapidly and so dense, the lizard find more shelter and camouflage under this grass. These were commonly found mammals' species we encountered within the habitat of *V. bengalensis* and these were commonly found in each of its habitat. In present research, it was observed that the Dog (*Canis lupus* familiaris) predates on it and kill it wherever it encounters with this lizard. The dog is considered as it enemy in village reported from local villagers during field visit. Cat (*Felis catus*) also eats its juveniles. Wild boar and jackal also make its adults and juvenile their prey. *V. bengalensis* mostly found where the cattle grazed in open grasses ground like in Patisar Lake, we closely observed the affiliation of *V. bengalensis* and cattle. Farmer that its main reason is the killing of lizard correlated the reason of decline in the number of its population in villages by (*Canis lupus* familiaris). *Hemiechinus auritus*, *Hystrix indica*, *Herpestes adwardsi*, *Saara hardwickii*, *Funambulas pennantii*, *Naja naja* are the most common reptiles species that live in close relationship and inhabit the same habitat in which the *V. bengalensis* lived.

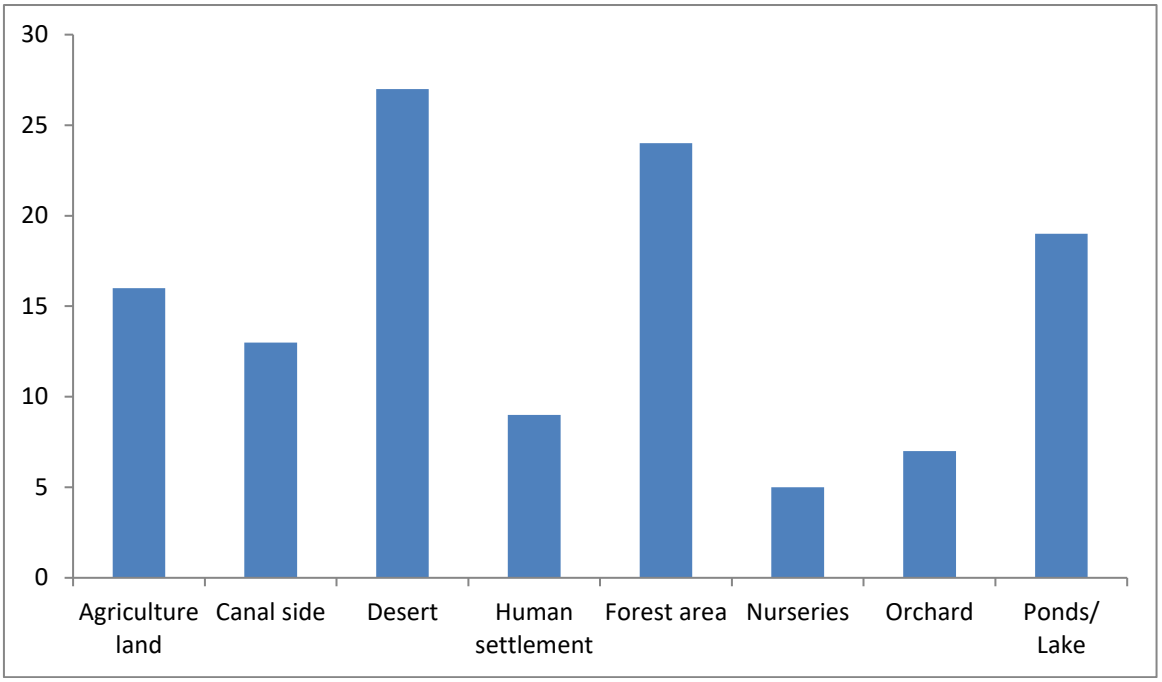

Fig. 3: Graphical representation of Habitat Preferences

During our field excursion and review of literature reported that *Naja naja* could eat and prey on juvenile and on its egg. *Herpestes adwardsi* is more common its habitat sharing partner and a fight is also reported by a local villager in which the lizard was killed by mongoose. *V. bengalensis* sometime occupied the burrow of mongoose or spiny-tailed lizard. As *V. bengalensis* is semi aquatic and can swim and dive in water, in one of our research site named Bahawal canal Bahawalpur, we observed the presence of *V. bengalensis* and then its jumps into standing water and then came out eating a small fish. We could not observe that which species of fish it was eating as we are on great distant but from review of literature, it became clear that it preys on fishes and toad in running as well as in static water.

Feeding behavior

V. bengalensis is a generalist species and can be found in a variety of habitat. It is generally categorize as carnivorous as it major diet portion is comprised of insects, mollusks, crustaceans, arthropods and some vertebrate species like birds and smaller animals. We observed these 11 groups of its feeding habits and we labeled these groups as “Prey group” in our study. This feeding behavior was determined based on field observation. These observations were made visually by visiting different study site. It is diurnal in its dietary habit. It consumed both invertebrate and vertebrate species (Table 2; Fig 4). Our observations are similar to (Akond *et al*., 1982; Auffenberg, 1994). Rahman *et al*. (2015) reported eating of fruits and vegetables by *Bengal moniter*. *V. bengalensis* leave it burrow and travels to find food. Its home range in search of food depends upon the area in which it inhabits. According to Auffenburg (1994) it can move large distances to find food from 3 hectare to 40 hectare. Its leaves its burrow in the morning and enter in burrow in the evening.

Table 2: The feeding behavior of *Varanus bengalensis*

Sr. No.	Prey group	Part eaten	Frequency	Proportion (%)
1	Crustaceans	All body parts	12	12
2	Insects	All body parts	23	23
3	Frog & toad	All body parts	04	04
4	Earthworm	All body parts	08	08
5	Water bugs	All body parts	07	07

6	Birds	Juvenile and egg	10	10
7	Mouse	All body parts	06	06
8	Mollusks	Fleshy part	15	15
9	Fish	All body parts	03	03
10	Fruits	Damped fruits	05	05
11	Vegetables	Ruined vegetables	07	07

* Feeding behavior of *Varanus bengalensis* (n=130)

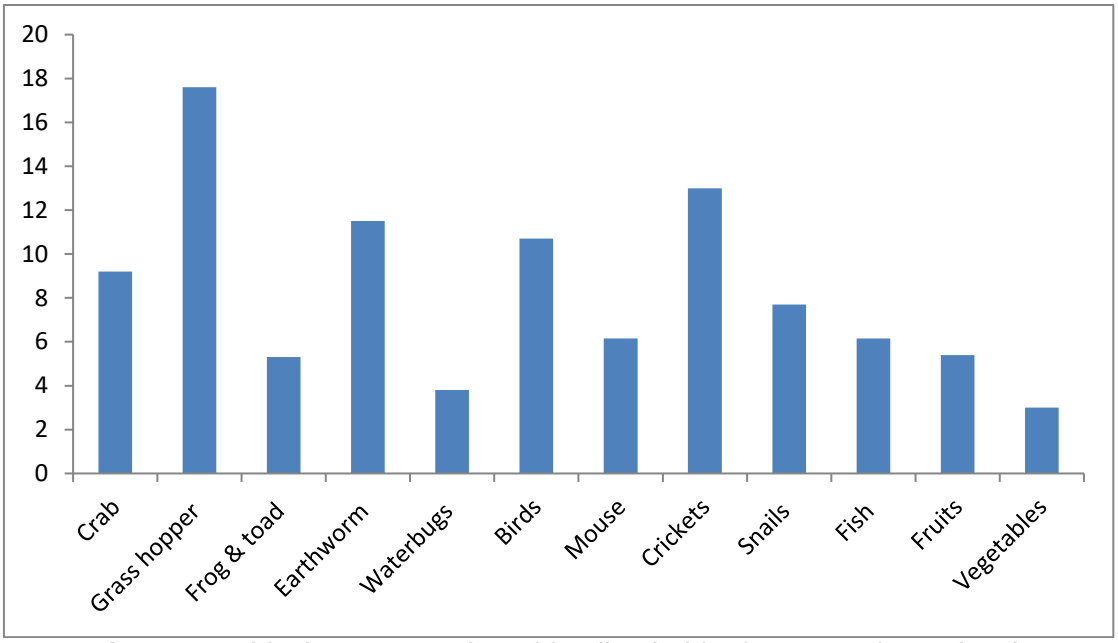

Fig. 4: Graphical representation of feeding habit of *Varanus bengalensis*

Fig. 5: Direct and indirect sighting of *Varanus bengalensis*

Breeding biology

As it is exothermic in its nature and all of its processes are directly affected by external environment temperature. In the same way, the breeding process of the species was seen influenced by external temperature.

Breeding period

Breeding period starts in this semi-arid region from March and lasts to May. In the month of February to May, found sexually active and mating occurs in these three months. No literature review is found about the breeding period of *V. bengalensis*.

Breeding sites

Different breeding sites were observed in different habitats but the main site was ground level. One observation was made in stony type habitat where it was observed that *V. bengalensis* was used a large stone piece for mating purpose. No literature was found about the breeding site of concerned lizard.

Clutch size

Different numbers of eggs were observed in each site. We concluded that clutch size was not same and there was variation in clutch size of every female. We then take a mean clutch size that was 21 eggs. Hence average clutch size in our study was 21. Review of literature states that clutch size depends upon the age and size of female older female lays more eggs than younger one in the same way longer females lays more eggs than smaller one (Farid *et al*., 2004). Khan (1987), reported 20-30 while Daniel (2002) reported between 8-30 in India.

Incubation period

The incubation period was 160-180 in days and 5-6 month. First emergence was recorded between 150-155 days. Dated 14-07-2018 and last egg hatchling was observed dated 28-08-2018 Earlier reports showed the incubation period of *V. bengalensis* ranges between 180-240 days according to Akond *et al*. (1982), 210-240 days according to Khan (1987) and Whitaker and Hidika (1981) reported that incubation period was between 6-8 month. Our result of incubation period were close to Whitaker and Hidika (1981), but smaller than reported by khan 1987. According to Whitaker and Hidika (1981) eggs hatched in the month of July, Akond *et al*. (1982) reported June-July as hatchling period, but in our observation, we observed hatchling month was July-August the difference in incubation period is due to climate change and high temperature value in our study site.

Hatchling

We determine the hatchling success on the basis of total number of hatchling emerged from eggs. Hatchling success was determined by dividing the total number of eggs hatched divided by total number of counted eggs. Out of total 126 eggs total eggs hatched were 39. Other eggs were

rotten and excluded from our result. The hatchling success was measured 30.90 %. This hatchling success was very low. It was concluded that low hatchling success was due to varying temperature and rains happening during incubation period.

We captured total 12 hatchling to determine its snout vent length (SVL), tail length (TL), total body length (BL) and body weight. Total length, mean the length from its snout tip to its tail end that was 18.50 ± 1.50. The weight of newly emerged hatchling was observed as 15.60 ± 2.75. Length and weight were calculated by arithmetic mean and standard deviation of different point; implied for certainty and accuracy.

Population density

Population density was randomly determined in each of its habitat and study site. Total number of active burrows along with direct sighting of individuals counted in each month and vice versa for all observation. According to our calculation, there were ~50-70 individual in each of eight study sites and approximately total 700 number of individual of *V. bengalensis* found in the area of Cholistan desert, according to our estimated population density value (Table 3). According to Kour and Sharma (2016), the population of *V. bengalensis* was also on declines due to over hunting.

Table 3: Population density of *Varanus bengalensis* from May 2017-April 2018

Sr. No.	Active Burrows	Foot prints	Droppings	Visual counts	Questioner	Total No
May	20	08	04	08	30	70±10
June	10	06	04	08	20	48±5
July	07	03	02	05	15	32±08
August	12	08	03	07	18	48±07
September	10	04	03	08	15	44±04
October	16	06	02	11	25	60±13
November	06	04	01	04	28	43±10
December	03	01	00	03	35	49±15
January	02	00	00	00	12	37±5
February	16	11	06	11	25	75±7
March	18	10	03	05	18	63±8
April	28	13	07	12	22	82±8

CONCLUSION

Ecobiology of *V. bengalensis* was thoroughly studied. The result showed that the lizard found in all types of habitats but preferred habitat was dry lands/desert. There was change in coloration, SVL and weight of lizards in different habitat of study area. We conclude that this difference is due to changing environmental factor, availability of food and travel done by each individual in search of food and mating. This species is used for food by some Non-Muslim tribes and used by "hakeem" in making certain traditional medicines. So illegal hunting and poaching was the major threats observed during research. Due to habitat fragmentation, harsh climatic condition, and illegal hunting the population of this specie is on decline. Special concern should be given to this important species otherwise; it would be endangered in status.

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