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A STUDY ON DIET AND RELATIONSHIP OF INDUS VALLEY SPINY-TAILED LIZARD (*Saara hardwickii*) WITH VEGETATION

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ABSTRACT

The Spiny-tailed Lizard (*Saara hardwickii*) is widely recognized as a herbivore lizard inhabiting arid areas, but less is known about association of the lizard abundance with different vegetation type and lizard's diet using stomach content flushing method. We conducted the present study to see relationship of woody and non-woody vegetation with abundance of Spiny-tailed Lizard in Chakwal District, Punjab, Pakistan, and to see if proportions of food item species were similar in the samples of stomach contents and fecal samples. We found a weak significant relationship with woody vegetation cover (trees and shrubs) but relatively strong significant relationship with non-woody vegetation cover (herbs and grasses). Herbs such as *Chenopodium album* and *Peganum hermala* accounted for most of the volume and frequency in stomach content and fecal samples followed by grasses *Cynodon dactylon* and *Desmostachya bipinnata*. We found significant difference in the number of food item species recorded from the samples of stomach contents and fecal samples. We recorded *Acacia modesta* (tree) and *Eruca sativa* (herb) only from samples of stomach contents while *Ziziphus nummularia* (shrub) and *Cymbopogon jwarancusa* (grass) only from the fecal samples whereas the other food item species were the same. Of all the food items, only the proportion of *Peganum hermala* (herb) in the stomach content samples and fecal samples were different. We concluded that the lizard abundance was more related with non-woody vegetation than woody vegetation. The lizard did not selectively forage on the vegetation rather it fed on herbs and grasses common in its habitat and might have ingested insects incidentally. The stomach content flushing method is less tedious and yield similar result as that of a more robust fecal pellet analysis method. On contrary, fecal pellet analysis is relatively harmless while flushing the stomach contents may put the lizard under stress.

Key words: Uromastidae; Stomach content flushing; Fecal pellet analysis; linear regression; *Cynodon dactylon.*

INTRODUCTION

Lizards in Pakistan are represented by eight families: Agamidae, Chamaeleonidae, Eublepharidae, Gekkonidae, Lacertidae, Scincidae, Uromastycidae and Varanidae (Khan, 2006). The genus *Saara* (Family Uromastycidae) is represented by three species in the world (Wilms *et al*., 2009) of which two, Seistan Spiny-tailed Ground Lizard (*Saara asmussi*) and Indus Valley Spiny-tailed Ground Lizard (*Saara hardwickii*), occur in Pakistan. In Pakistan, Spiny-tailed Lizard is distributed throughout the Indus Valley extending up to Las Bela, southern Baluchistan. The lizard is facing a threat of illegal trapping in Chakwal District (Rais *et al*., 2012).

The lizard is known to occur in areas with slightly clayey to hard soil with sparse xerophytic vegetation (Ramesh and Sankaran, 2013; Sanjay *et al*., 2013). A few studies are available on the diet, using fecal pellet analysis and field observations on the foraging, of Uromastids from different parts of the world. The Arabian Spiny-tailed Lizard (*Uromastyx aegyptia microlepis*) feeds on plants and insects (Mansour, 2001) while occasional scavenging activity of different lizard species is also known (Castilla *et al*., 2011; Pérez-Cembranos, 2015; Baeckens, 2017; Perez-Cembranos *et al*., 2017). Spiny-tailed Lizard (*Saara hardwickii*) is primarily herbivorous (Dutta and Jhala, 2007; Sanjay *et al*., 2013) and may incidentally ingest insects and nematodes along with the vegetation (Sanjay *et al*., 2005). The information on association of the lizard abundance with different vegetation type and diet of the lizard using stomach content flushing method is scarce. We, therefore, carried out the present study to see relationship of woody and non-woody vegetation with abundance of Spiny-tailed Lizard in Chakwal District, Punjab, Pakistan, and to see if proportions of food item species were similar in the samples of stomach contents and fecal samples.

MATERIALS AND METHODS

Study Area: We conducted the present study at five randomly selected sampling sites (Fig. 1) in Chakwal District, Punjab, Pakistan. The sites were representatives of the habitat types of the district. The study area is located at about 498 meters elevation and comprises of approximately 6524 km^2 area. The area features typical arid landscape with annual average temperature of about

29.6°C and average annual rainfall of about 620 mm (Hanif and Ali, 2014). The area consists of cultivated flatlands, inter-spread with network of rivers and rain water stream, and thorn forests and few perennial and ephemeral wetlands (Mahmood *et al*., 2012).

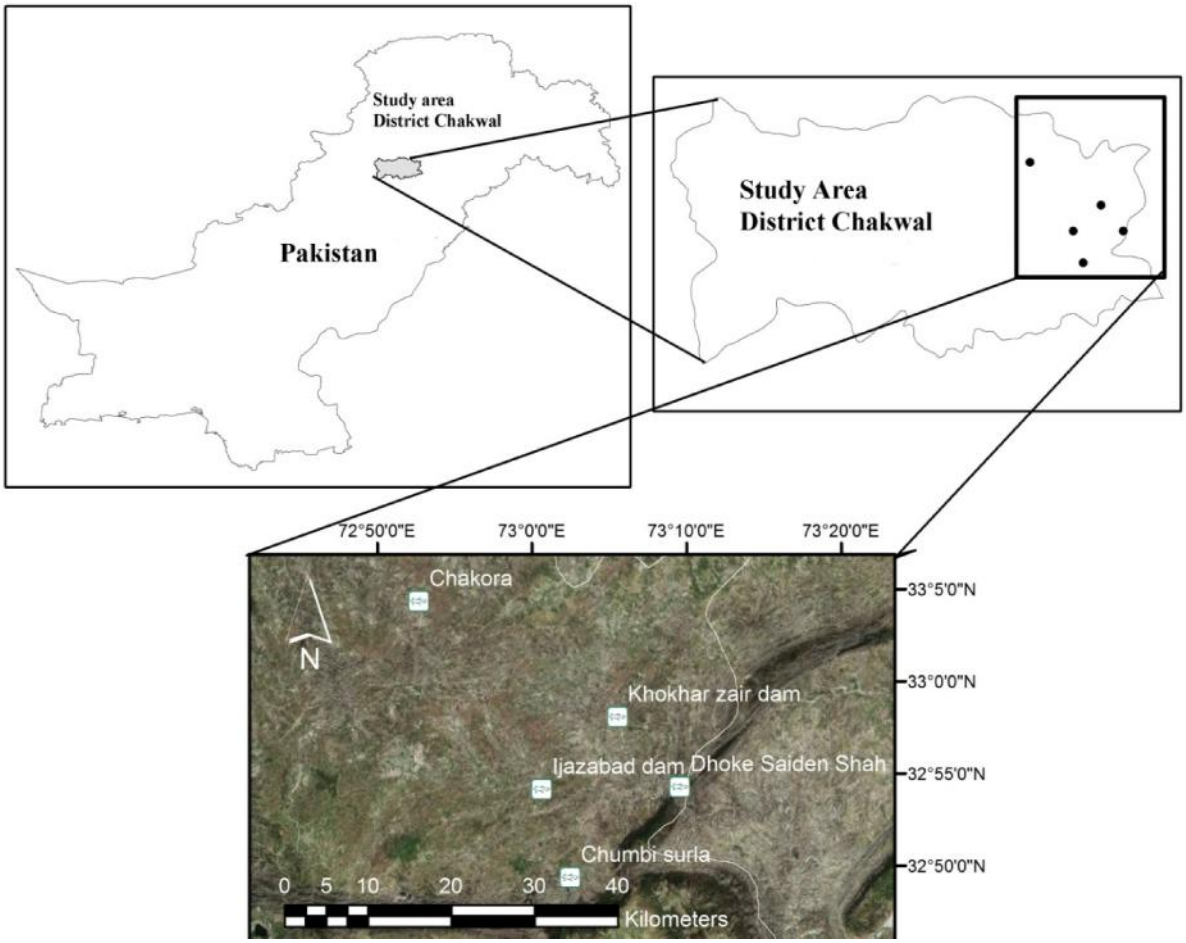

Fig. 1. Map showing locations of sampling sites in District Chakwal, Punjab, Pakistan.

Methods: We conducted a one-day (8:00-17:00) visit to each sampling site monthly from March to July, 2014 to gather data on habitat (substrate and vegetation), lizard abundance and to mark the burrows. We collected fecal and stomach content samples when the lizards were most active viz. June-July, 2014, from the marked burrows. We laid out five transects each with a length and width of 300 and 25 meters, respectively in each sampling site. We counted total number of individuals, recorded data on substrate as sand: largest particles and gritty to feel, silt: medium-sized and soft and silky, clay: smallest sized particles and sticky and hard-compact soil and on vegetation. To obtain data on vegetation, we randomly selected 100 (m) line along the transect length. We then noted start and end points of each plant species intercepting the line. We calculated difference between start and end point intercept length. We calculated the percentage cover as the intercept lengths of plant species divided by total length of transect line multiplied by 100 (Cummings and Smith, 2000). The frequency of occurrence was calculated as number of transects where a plant species was present divided by the total number of transect lines and multiplied by 100. We performed a simple linear regression to see if number of lizard individuals was related with percentage cover of woody and percentage cover of non-woody vegetation.

We analyzed 23 stomach content samples using stomach content flushing technique (as described by Legler, 1977) without administrating anesthesia. We opened the jaws of the lizard using sterilized spatula. We then flushed out the stomach contents by pumping water through an infusion tube of soft material (silicon) connected with a syringe. We repeated the procedure until no more stomach contents appeared. We released the lizard at the capture site. We decanted the water containing stomach contents through a sieve. We picked up food items with forceps, fixed and preserved them in 70% ethanol and 10% formaldehyde, respectively. We identified the items under stereo-microscope to the lowest possible taxonomic level. We expressed the results as

volume (ml), relative volume (%), total number of plant species, total number of animal species and total number of food items (plant+ animal) (Windell and Bowen, 1978). We determined volume of each food item by water displacement using graduated cylinders to the nearest 0.01 ml. We calculated relative volume as volume of each food item divided by total volume of food items from each specimen multiplied by100.

We analyzed 23 composite fecal samples (each composite sample contained 10 fecal pellets) using micro-histological analysis following Sparks and Malecheck (1968). We calculated frequency of occurrence of plant species as number of specific plant species in sample slide divided by number of total plant species identified in sample slide multiplied by 100 (Sparks and Malechek, 1968; Alipayo *et al*., 1992). We calculated relative frequency of each food item as total number of fragments identified for a given food item divided by the total number of all counts made in the sample slide multiplied by 100. We calculated species richness estimators Jacknife 2 and Chao 2 using program Estimate S 9.1.0. and compared with our observed number of species (food item) richness recovered from the samples of fecal pellets and stomach contents. These estimators represent the statistical expectation of species number (obtained from species accumulation curves) based on the repeated re-sampling of all pooled samples (Gotelli and Colwell, 2001). We used paired *t*-test to compare number of species recovered from fecal and stomach content samples and Fisher's exact test to see if proportions of food item species were similar in the samples of stomach contents and fecal samples (α = 0.05).

RESULTS

Our sampling sites were characterized by hard compact soil. The sites had high richness of non-woody vegetation (11 herb and five grass species) followed by eight species of woody vegetation (five shrubs and three tree species) (Appendix 1). We recorded *Peganum hermala*, *Cynodon dactylon*, *Maytenus royleana* and *Acacia modesta* as the most frequent (frequency > 60%) herb, grass, shrub and tree, respectively, from the habitat (Appendix 1). We recorded a total of 70 individuals (3 lizards/ m^2) and 103 burrows (9 burrows/ m^2) of the lizard species from sites with woody cover, respectively, while 103 individuals (4 lizards/ m^2) and 225 burrows (9 burrows/ m^2) from sites with non-woody cover, respectively. We found a weak significant (R^2= 0.35; F = 12.43 $_{(1, 23);}$ P = 0.001) relationship between number of lizard individuals and woody vegetation cover such as shrubs and trees, but relatively strong significant (R^2= 0.50; F = 23.50 $_{(1, 23);}$ $P < 0.05$) relationship with non-woody vegetation cover such as herbs and grasses (Fig. 2).

We recorded 11 food items from stomach contents of Spiny-tailed Lizard of which nine were of plant (five herbs, two grasses, one shrub and one tree species) origin and two were of animal (a bug and an ant species) origin (Table 1). The Jacknife 2 and Chao 2 estimators predicted 12.25 and 11.48 species, respectively, which showed that our sample size was sufficient enough to document the species (food item) richness of stomach contents of the lizard. Herbs such as *Chenopodium album* and *Peganum hermala* accounted for most of the volume of the stomach contents followed by the grass *Cynodon dactylon* while the insects accounted for negligible volume (Table 1).

We recorded 11 food items from fecal pellets of the lizard of which nine were of plant (four herbs, three grasses and two shrub species) origin and two were of animal (a bug and an ant species) origin (Table 2). The Jacknife 2 and Chao 2 estimators predicted 13 and 12 species, respectively, which showed that our sample size was sufficient enough.

Table 1. Volume (ml) and relative volume (%), in parenthesis, of food items recovered from stomach contents of Indus Valley Spiny-tailed Lizard (*Saara hardwickii*) from the sampling sites of study area (District Chakwal).

Volume/Relative volume values show means of the samples collected from sampling sites I: Chakora; II: Dhoke Saiden Shah; III: Chumbi Surla; IV: Khokharzair Dam; V: Ijazabad Dam.

	I	II	III	IV	V	Study Area
Number of samples	**6**	**4**	**4**	**5**	**4**	**23**
Food item						
Plant material						
Herbs						
Aerva javanica				0.02 (4.05)		0.02 (4.05)
Amaranthus oleraceus	0.12 (54.54)					0.12 (54.54)
Chenopodium album	0.34 (62.96)					0.34 (62.96)
Eruca sativa	0.21 (18.26)					0.21 (18.26)
Peganum hermala	0.28 (66.08)					0.28 (66.08)
Grasses						

Desmostachya bipinnata				0.06 (11.73)		0.06 (11.73)
Cynodon dactylon	0.26 (64.33)	0.51 (76.85)	0.38 (81.05)	0.52 (91.93)	0.3 (100)	0.33 (82.83)
Shrubs						
Maytenus royleana			0.15 (64.7)	0.06 (7.59)		0.10(36.14)
Trees						
Acacia modesta		0.3 (73.14)				0.3 (73.14)
Total plant species	**5**	**2**	**2**	**3**	**1**	**9**
Animal material						
Bagrada hilaris (bug)	0.03 (5.18)			0.03 (3.79)		0.03 (4.48)
Camponotus confucii (ant)			0.01 (1.69)	0.1 (20.83)		0.05 (11.26)
Total animal species	**1**		**1**	**2**		**2**
Total number of food items (Plant+ Animal)	**6**	**2**	**3**	**4**	**1**	**11**

Table 2. Frequency of occurrence and relative frequency (in parenthesis) of food items recorded from the fecal pellets of Indus Valley Spiny-tailed Lizard (*Saara hardwickii*) collected from the sampling sites of study area (District Chakwal).

Frequency/Relative frequency values show means of the samples collected from sampling sites I: Chakora; II: Dhoke Saiden Shah; III: Chumbi Surla; IV: Khokharzair Dam; V: Ijazabad Dam.

Food item consumed	**I**	**II**	**III**	**IV**	**V**	**Study Area**
Number of composite samples	**6**	**4**	**5**	**4**	**4**	**23**
Plant material						
Herbs						
Peganum hermala	15 (13.26)	0	0	0	0	15 (13.26)
Chenopodium album	18.75 (13.94)	0	0	0	0	18.75 (13.94)
Amaranthus oleraceus	15 (13.49)	0	0	0	0	15 (13.49)
Aerva javanica	0	0	0	15 (14.28)	0	15 (14.28)
Grasses						
Cynodon dactylon	91.87 (80.95)	98 (91.91)	86 (81.79)	87.5 (84.83)	100 (98.09)	92.67 (87.51)
Desmostachya bipinnata	0	0	21.66 (19.65)	0	0	21.66 (19.65)
Cymbopogon jwarancusa	0	0	0	5 (4.76)	0	5 (4.74)
Shrubs						
Ziziphus nummularia	0	0	19 (8.69)	20 (21.05)	0	19.5 (14.87)
Maytenus royleana	0	5 (5)	12.5 (11.68)	10 (9.52)	0	9.16 (8.73)
Seeds						
Cynodon dactylon	0	11.66 (9.9)	0	0	0	11.66 (9.9)
Total plant species	**4**	**2**	**4**	**5**	**1**	**9**
Animal material						
Insects						
Bagrada hilaris	5 (4.31)	0	0	0	0	5 (4.31)
Camponotus confucii	5 (4.5)	5 (4.73)	0	5(4.68)	5(4.76)	5 (4.66)
Total animal species	**2**	**1**	**0**	**1**	**1**	**2**
Total number of food items	**6**	**3**	**4**	**6**	**2**	**11**

Grasses such as *Cynodon dactylon* and *Desmostachya bipinnata* were most frequent. Further, seeds of *Cynodon dactylon* were also recorded from fecal pellets (Table 2).

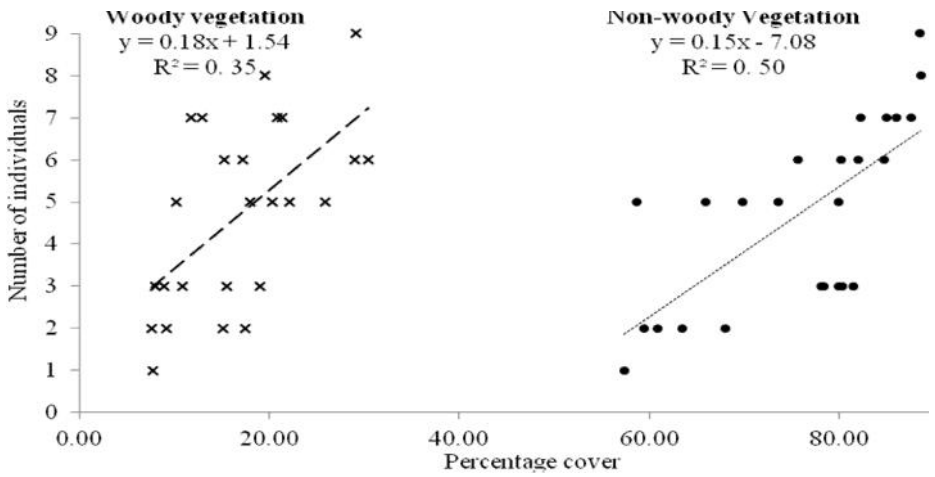

Fig. 2. Relationship between abundance of Indus Valley Spiny-tailed Lizard (*Saara hardwickii*) (number of individuals) and vegetation types in District Chakwal, Punjab, Pakistan.

We found significant difference (t = - 6.70; df = 45; P < 0.05) in the number of food item species recorded from the samples of stomach contents and fecal samples. We recorded *Acacia modesta* (tree) and *Eruca sativa* (herb) only from samples of stomach contents while *Ziziphus nummularia* (shrub) and *Cymbopogon jwarancusa* (grass) only from the fecal samples whereas the other food item species were the same. Of all the food items (Table 1&2), only the proportion of *Peganum hermala* (herb) in the stomach content samples and fecal samples were different (P < 0.05).

DISCUSSION

Our findings on habitat of the lizard are consistent with the published studies. The lizard's habitat was dominated by herbs: *Chenopodium album, Fagonia cretica, Peganum hermala* and grasses: *Cynodon dactylon, Desmostachya bipinnata* and *Cymbopogon jwarancusa* (Appendix 1). Available published studies also report that the species inhabits firm ground with moderate to sparse xerophytic vegetation such as *Neurada procumbens, Dectyloctenium spp., Cynodon dactylon, Desmostachya bipinnata*, *Cenchrus biflorus*, *Cyperus rotundus*, *Haloxylon salicornicum, Lasiurus sindicus* and *Capparis decidua* (Husain, 2012; Khan, 2006; Ramesh and Sankaran, 2013; Sanjay *et al*., 2013). These studies did not investigate if the lizard was more related to any vegetation type. However, we found relatively strong significant relationship between number of lizard individuals and non-woody vegetation cover (herbs and grasses) than woody vegetation cover (Fig. 2). This might be due to the fact that the lizard is a ground-dwelling species and prefers to forage on non-woody vegetation in proximity of its burrows.

Our findings on lizard's diet are in accordance with published literature that had documented this lizard as mainly herbivorous (Sanjay *et al*., 2005; Dutta and Jhala 2007; Pérez-Cembranos, 2015; Baeckens, 2017; Pérez-Cembranos, 2017). We recorded herbs such as *Chenopodium album* and *Peganum hermala* and grasses such as *Cynodon dactylon* and *Desmostachya bipinnata* as major food item species. We also recorded these plant species as most frequent along the sampled transects (Appendix 1). Ramesh and Sankaran (2013) reported that the lizard fed on flowers and fruits of *Capparis aphylla* (tree/shrub) and *Salvadora persica* (tree) and herbs *Neurada procumbens* and *Barleria acanthoides* in Thar Desert, India. We attributed this difference of vegetation species in the diet of the lizard due to difference of vegetation in the study areas. Based on published literature and our data, we believed that the lizard did not selectively forage on the vegetation rather it fed on common vegetation species, particularly herbs and grasses, found in the habitat. We recorded only two insect species viz. *Bagrada hilaris* (bug) and *Camponotus confucii* (ant) from diet analysis of Spiny-tailed Lizard. Other studies have reported that the lizard also eat insects besides vegetation (Pradhan, 1971; Bhanotar *et al*., 1972; Bhanotar and Bhatnagar, 1973; Pradhan *et al*., 1973; Sanjay *et al*., 2013). Since we did not find a high frequency or volume of insects in fecal pellets and stomach content samples, respectively, we found that the lizard was not a specialized insect eater and might have ingested insects incidentally.

We concluded that the lizard abundance was more related with non-woody vegetation than woody vegetation. The lizard did not selectively forage on the vegetation rather it fed on herbs and grasses common in its habitat and might have ingested insects incidentally. The stomach content flushing method is less tedious and yield similar result as that of a more robust fecal pellet analysis method.

REFERENCES

Alipayo, D., R. Valdez, J.L. Holechek and M. Cardenas (1992). Evaluation of microhistological analysis for determining ruminant diet botanical composition. J. Range. Manage. 45: 148-152.

Baeckens, S., R. Garcia-Roa, J. Martin, and R.V. Damme (2017). The Role of Diet in Shaping the Chemical Signal Design of Lacertid Lizards. J. Chem. Ecol. 43: 1-9.

Bhanotar, R.K. and R.K. Bhatnagar (1972). Desert locust upsurve vis-a-vis predatory fauna. Entomol. News Letter, 2(8): 53.

Bhanotar, R.K., R.K. Bhatnagar, Y.N. Srivastav and Y. Mahto (1973). Preliminary studies on locust hopper predation by *Uromastix hardwickii*. Entomol. News Letter, 3 (3): 19-20.

Castilla, A.M., R. Richer, A. Herrel, A.A.T. Conkey, J. Tribuna and M. Al-Thani (2011). First evidence of scavenging behavior in the herbivorous lizard *Uromastyx aegyptia microlepis*. J. Arid. Environ. 75: 671-673.

Cummings, J. and D. Smith (2000). The line-intercept method: A tool for introductory plant ecology laboratories. Tested studies for laboratory teaching, 22: 234-246.

Dutta, S. and Y. Jhala (2007). Ecological aspects of Indian spiny-tailed lizard *Uromastyx hardwickii* in Kutch. J. Bombay. Nat. Hist. Soc. 104 (3): 255-265.

Gotelli, N.J. and R.K. Colwell (2001). Quantifying biodiversity: procedures and pitfalls in the measurement and comparison of species richness. Ecol. Lett., 4: 379–39.

Hanif, M. and J. Ali (2014). Climate Scenarios 2011-2040: Districts Haripur, Swabi, Attock and Chakwal Pakistan. Study conducted by Climate Change Centre, The University of Agriculture Peshawar.

Husain, A. (2012). Distributional pattern of genus *Uromastyx* Merrem, 1820 (Reptilia: Squamata: Agamidae: Uromastycinae) in India, Arabia and Africa. Biological Forum. 4 (1): 114-122.

Khan, M.S. (2006). Amphibians and Reptiles of Pakistan. Krieger Publishing Company, Malabar, Florida. p. 311.

Legler, J.M. (1977). Stomach flushing: a technique for chelonian dietary studies. Herpetologica, 33: 281-284.

Mahmood, T., R. Hussain, M. Rais, I. Hussain and M.S. Nadeem (2012). Habitat Analysis and Population Estimates of three falcon species, Red-headed Merlin (*Falco chicquera*), Common Kestrel (*Falco tinnunculus*) and Saker Falcon (*Falco cherrug*), inhabiting district Chakwal, Pakistan. Pakistan J. Zool. 44 (3): 787-798.

Mansour, A.L. (2001). Feeding Behaviour and Food Selection of Dhab *Uromastyx microlepis* from Wild Vegetation. Qatar Univ. Sci. J. 21: 65-73.

Pradhan, S. (1971). A voracious locust predator. Entomol. News Letter, 1 (1): 5 pp.

Pradhan, S., K.M. Singh, H.S. Sangwan, R.N. Singh and R.P. Singh (1973). Exploration of vertebrate predators for crop pests-1: food and feeding habits of spiny-tailed lizard, *Uromastix* sp. Ind. J. Entomol. 35 (2): 148-149.

Pérez-Cembranos A, V. Pérez-Mellado, 2015. Local enhancement and social foraging in a non-social insular lizard. Anim. Cogn. 18: 629–637.

Pérez-Cembranos, A. León and V. Pérez-Mellado, 2017. Omnivory of an Insular Lizard: Sources of Variation in the Diet of Podarcis lilfordi (*Squamata, Lacertidae*), Plos One, 11(2): 1-32.

Rais, M., S. Baloch, J. Rehman, M. Anwar, I. Hussain and T. Mahmood (2012). Diversity and conservation of amphibians and reptiles in North Punjab, Pakistan. Herpetol. Bulletin, 122: 16–25.

Ramesh, M. and R. Sankaran (2013). Natural history observation on the Indian Spiny- tailed Lizard *Uromastyx hardwickii* in Thar Desert. In: Faunal heritage of Rajasthan, India (eds. Sharma, B. K., S. Kulshreshtha and A. R. Rahmani). Springer, New York. 295–310.

Sanjay, K.D. and V. Pandy (2005). Food, Feeding, Behavior and Habitat preferences of spiny tailed lizard (*Uromastyx hardiwickii*) in the Thar desert of Rajahastan, 32 (4): 30-32.

Sanjay, K.D., S. Dookia, K. Das and S.K. Dutta (2013). Ecological observations on the Indian Spiny-tailed Lizard *Saara hardwickii* (Reptilia: Squamata: Agamidae) in Tal Chhapar Wildlife Sanctuary, Rajasthan. JoTT. 5 (1): 3516–3526.

Sparks, D.R. and J.C. Malechek (1968). Estimating percentage dry weight in diets using a microscope technique. J. Range. Manage. 21: 264-265.

Wilms, T.M., W. Bhome, P. Wagner, N. Lutzmann and A. Schmitz (2009). On the phylogeny and taxonomy of the genus *Uromastyx* MERREM, (1820). (Reptilia: Squamata: Agamidae: Uromastycinae): Resurrection of the Genus *Saara* Gray, 1845. Bonner Zoologische Beiträge, 56 (1/2): 55–99.

Windell, J.T. and S.H. Bowen (1978). Methods for study of fish diets based on analysis of stomach contents. In Methods for the Assessment of Fish Production in Fresh Waters, (3rd ed). p. 219-226.