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Population Estimates, Habitat Preference and the Diet of Small Indian Mongoose (*Herpestes javanicus*) in Potohar Plateau, Pakistan

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Abstract.- The small Indian mongoose (*Herpestes javanicus*) preys upon a variety of invertebrates, arthropods, small reptiles and mammalian species. In Potohar region, it is distributed in different habitats. The present study was undertaken to collect information regarding the population, habitat preference and the diet of the species at six different study sites covering wild areas of Chakwal and Rawalpindi Districts. The population was estimated using indirect method of burrows count and also by finding footprints in the activity areas. Analysis of the diet was carried out by faecal pellet analysis, while the habitat preference of the species was studied by a comparison of three different habitats in the study area. The results revealed a population density of 0.083 /ha in Chakwal region and 0.085 /ha in Gujar Khan region. Analysis of scat samples of the species revealed that the faecal matter on average (by volume) consisted of mammals (66.18%), other vertebrates (7.11%), insects (10.54 %), plant parts (3.15 %), seeds (5.54 %) and unidentified food items (6.98 %). The hair recovered from the faecal samples of the two regions matched with the hair samples of *Rattus rattus* collected from the study sites. The most preferred habitat of the species was the habitat located in the vicinity of human habituation, also having some poultry farms.

Keywords: *Herpestes javanicus*, Potohar Plateau, small Indian mongoose.

INTRODUCTION

There are two species of mongooses in Pakistan; the small Indian mongoose (*Herpestes javanicus*) and the common Indian mongoose (*H. edwardsi*), the former is well adapted to live near human habitations. Generally *H. javanicus* occurs in agricultural areas, coastland, desert, natural forests, planted forests, range/grasslands, riparian zones, disturbed scrub, shrub lands, urban areas and wetlands (Nellis, 1989). In Pakistan, the species is distributed in Southern Sindh, extending throughout Tharparkar, Thatta and Dadu Districts. In the province of Punjab, it is common around Lahore, Kasur and Sialkot Districts and also observed around Gujranwala. In the Potohar region, it is found around Jhelum and Salt range. It has been reported to be adapted to live in the outskirts of villages and towns (Roberts, 1997).

Potohar region (Jhelum, Rawalpindi, Chakwal and Attock Districts) of Punjab is an important area regarding the distribution of some diverse wildlife species like urial, chinkara, chakor, hare, porcupine, mongooses, wild boar, and yellow-throated martin. In the Potohar Plateau, two species of mongooses are reported, the small and large mongoose.

The small Indian mongoose prefers dry habitats. Its habitat preferences in the native range have not been investigated properly but it seems that the species prefers grassland, secondary growth as well as dense forests (Siddiqui *et al*., 2004). According to Taber *et al*. (1967), *H. auropunctatus (javanicus)* is a ground-foraging burrowing species that often lives near human dwellings. The species is well known throughout the irrigated parts of the region although its numbers appear low. They have also mentioned two individuals belonging to the other species of the *Herpestes*; *H. edwardsi*. It was just a kind of survey and did not focus the population estimates; however, important thing is that they mentioned the presence of the *H. auropunctatus* in the region. Moreover, they also pointed out that *H. auropunctatus* was present in more abundance than it was observed by the survey team and it was also more abundant than the *H. edwardsi* in the region.

The small Indian mongoose (*H. javanicus*) is an important carnivore in biological niche. It is omnivorous having a varied diet; normally

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consisting of small mammals, birds, herpetofauna, invertebrates and also plant material. Proportions of these dietary items vary according to the availability and location of the study area. Some populations are largely insectivorous; others may eat a diet largely consisting of fruit for part of the year (Seaman and Randall, 1962). Since it has a large diversity of prey in its diet from small arthropods to small mammals, so it plays a significant role in biological diversity and also controlling the insect population.

The Potohar plateau is an important region regarding the distribution of small Indian mongoose. However, no formal studies have been yet documented addressing its major ecological aspects; population status, habitat preference or diet. It is classified as "Least Concern" by IUCN Red List of Threatened Species (IUCN, 2009), but in actual terms there is no formal scientific study is available on the status of the species in Pakistan in general and in the Potohar region, in particular. With the human population growth, urbanization and change in agricultural practices, the state of ecosystem of the Potohar Plateau has changed over time. The present study, therefore, investigated the current status and habitat preference as well as the diet of this species.

MATERIALS AND METHODS

Study area

The current study was conducted at six different representative sites of Chakwal and Rawalpindi Districts of Potohar region (Fig. 1). In Chakwal District, "Dhudial" area which is located at a distance of about 70 km in south east of Islamabad city, whereas in Rawalpindi District, Gujar Khan area which is located at a distance of about 50 kilometers in the east of Islamabad, were selected for the study.

Study design

In each study area of the two districts, three different ecosystems were selected. In Chakwal District, the selected study site in "Dhudial" included three different habitats: 1) cultivated tracts / croplands; situated at "Koont farm" (33°06'969"N and 073°00'700"E), on the way to Chakwal city. 2) non-cultivated tracts such as open, wild area, situated at about two kilometers in the east of the village "Panjgraan Kalaan".3) vicinity of villages, having poultry farms; an area located at 33°08'681"N and 073°02'178"E, situated in the surroundings of the village "Panjgraan Kalaan".

Fig. 1. A map of Punjab Province, Pakistan, showing Potohar Plateau consisting of four Districts; Rawalpindi, Chakwal, Jhelum and Attock.

Similarly, Gujar Khan area representing Rawalpindi District, was selected as potential study site for the species. Three different ecosystems as mentioned above were selected here as well: 1) cultivated tracts or cropland ecosystem; located at 33°11'152"N and 073°10'577"E, midway between the village "UsmanZada Adra" and Daultala town road, near village "Naban". 2) non-cultivated tracts located 33°11'638"N and 073°12' 422"E, situated near Village Usmanzada Adra, about 15 km in the south from Gujar Khan city.3) premises of village level poultry farms; a study site located 33°11'735"N and 73°16'249"E in the surrounding of the village Gulyana located at about nine kilometers in the south of Gujar Khan city, was selected.

Each study site at both Dhudial and Gujar Khan regions was, in turn, divided into three plots, each plot having an area of about 500m^2. Thus each site had a total study area of 1.5 km^2. Regular visits to each study site were conducted every month from July 2008 to June 2009. The selected plots were

Fig. 2. A) Photograph of freshly laid foot prints (arrow) of the small Indian mongoose at morning time.B) Photograph of faecal pellets of the species (arrow) found around an active burrow.

Table I.- Three different kinds of habitats and details of number of direct sightings, reported sightings, foot prints and faecal pellet samples collected from three sites each of Chakwal and Gujar Khan Regions.

Habi-tat No.	Type of habitat	GPS location	Direct sightings	Reported sightings	No. of faecal pellets collected	No. of foot prints	Water source
Chakwal region							
I	Cultivated tracts / croplands;	33°6.969'N and 073° 0.700'E.	01	4 -5	10	03	-
II	Wild Area/Non-cultivated tracts	33°N and 073°E	Nil	01	-	-	-
III	Vicinities of villages having poultry farms	33°8.681'N and 073° 2.178'E	02	5-7	05	-	01
	Total		**03**	**10-13**	**15**	**03**	**01**
Gujar Khan region							
I	Cultivated tracts / croplands;	33°11.152'N and 073°10.577'E	2	4 -5	5-6	03	01
II	Wild Area / Non-cultivated tracts	33°11.638'N and 073°12.422'E	1	2 -3	5	-	-
III	Vicinities of villages having poultry farms	33° 11.735' N and 73°16.249'E	2	5 -7	4-5	-	01
	Total		**05**	**11-15**	**14-16**	**03**	**02**

regularly surveyed for location and identification of burrows of the species. The burrows in the field were identified on the basis of size and other characteristics and were also counted in each plot.

The plots in the study sites were extensively searched and surveyed for the presence of foot prints of the species, especially around the burrows (Fig. 2), where they were identified. The selected study areas were also searched for the collection of scat samples of the species (Fig. 3), especially around the burrows, to analyse the diet of the species. The scats were identified in the field on the basis of combination of size, shape, smell, composition and locality. The scats were confirmed to be belonging to the *H. javanicus* based on the fact that many of them were especially collected from near or around the opening of its burrows, where the direct observations of the species were also made. Moreover, it was ensured that the same study area was not having other species of the mongoose; large mongoose, whose faecal samples may overlap with it. In addition, local people were contacted for their trivial knowledge regarding this species.

Fig. 3. Photographs of the food items recovered from the faecal samples of small Indian mongoose collected from the study sites of two districts of Potohar Plateau.
A, Shows the structure of faecal samples collected from various study sites; B, Tufts of hairs recovered from faecal sample S11; C, Bone pieces of recovered from faecal sample S10; D, Parts of insects recovered from scat sample S12; E, Plant parts recovered from sample S10; F, Plant seeds recovered from faecal sample S12.

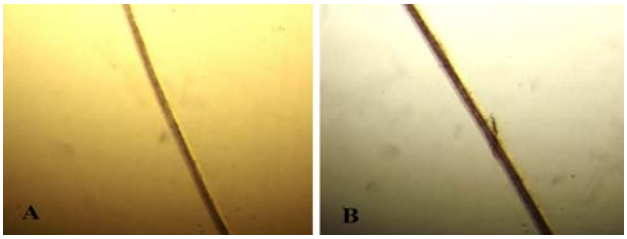

Fig. 4. Photomicrographs of whole mounts of rodent hairs. A, structure of hair recovered from the faecal samples (X 20); B, Structure of reference hair of *Rattus rattus* (X 20) collected from the fields.

Population density

Walking transects were developed in both the study regions for counting the number of burrows of the species and also for direct observation of the animal in the field. Three transects, each of 500m^2 size, were established in each of the three selected study sites.

Table II.- Mean number of burrows and estimates of population density of small Indian mongoose per hectare (ha) at study sites in Chakwal and Gujar Khan regions. Values expressed as Mean±SEM.

Habitat type (1.5 km^2 each)	Mean number of burrows	No. of active burrows	Population density /ha	Average population density /ha
Chakwal region				
I	21.42±0.64	15.28±0.83	0.101	
II	07.00±0.43	05.14±0.45	0.034	**0.083**
III	30.42±0.61	17.28±0.99	0.115	
Total (4.5 km^2)	**58.84±1.68**	**37.70±2.27**	**0.250**	
Gujar Khan region				
I	18.14±0.93	12.28±0.71	0.081	
II	16.14±0.73	10.14±0.40	0.067	**0.085**
III	27.42±0.48	16.14±0.73	0.107	
Total (4.5 Km^2)	**61.70±2.14**	**38.56 ± 1.84**	**0.255**	

Burrows count

The population density of small Indian mongoose was estimated by applying burrows count method, while also taking into account the direct sightings as well as establishing the foot tracks in all the transects (Tables I and II) of selected sites of the study regions (Chakwal and Gujar Khan). Methodology used for burrow counting consisted of walking predetermined transect lines during the survey period and counting the number of occupied burrows by the mongoose species. Occupancy of burrows was determined using a combination of scat deposition and noting recent tracks as described by Blaum *et al*. (2007). Newly deposited faeces (dark brown) were indicative of an active burrow in mongoose species as described by Cavallini and Nel (1995). Moreover, active burrows were confirmed in such a way that in each plot the openings of the burrows are closed by placing clay and vegetation at late evening time. The same burrows were then observed next morning. The burrows which were

found open were indicative of the active burrows.

The number of burrows per transect (each plot) in the study sites were counted and regularly monitored. The numbers of active burrows, far less than the total number of burrows in the area, were identified in each plot. A burrow becomes inactive because the animal might abandon it due to any reason some time later. The population density of the animal per site (3 plots = 1.5 km^2) per hectare area of the two study regions was then estimated through the count of active burrows considering the fact that each burrow harbored only one animal species.

Direct sightings

The established transects were surveyed regularly, at different times of the day during the study period from July 2008 to June 2009, for the direct sightings of the small Indian mongoose. Moreover, local people were approached for their knowledge about the sighting and population of the mongoose in the study area.

Foot tracks

Ground patches were established in each transect, especially around the burrows of the species in the activity area for the estimation of number of animals around in the area under study (Fig.2).

Diet

The diet of the species was investigated by analysis of the scat samples as described by Dawson *et al.* (2007) and Schemnitz (1980). The scats were identified in the field on the basis of combination of size, shape, smell, composition and locality. The scat samples were collected in polythene sample bags, labeled during the field visits and brought to the food habits investigation laboratory of the Department of Wildlife Management for detailed analysis. Briefly, stored, oven dried scat samples were soaked in warm water for 2 to 3 hours, to loosen the hair and other materials that bind the scats. Each scat was disintegrated and examined to sort out the fragments of bones, hair, insect parts, plant materials and soil using a magnifying glass and binocular microscope. The materials recovered from the faecal samples were identified, weighed and photographed. The animal hair were identified and matched by preparing the whole mounts slides of the sample hairs and those of known rodents obtained from the fields. Similarly the body parts of insects recovered from the faecal samples were identified in the Entomology Department of the Arid Agriculture University, Rawalpindi.

RESULTS

Population density

Chakwal region

In Chakwal region, the total numbers of burrows in the three representative habitats of the region were estimated to be 58.84 ± 1.68 while the population density of the species was estimated to be 0.083 /ha. The direct sightings of the species were rare and during the whole study period spanning about one year, only three animals were observed directly running (Tables I, II).

Gujar Khan region

In Gujar Khan region, the total numbers of burrows in all the three representative habitats were found to be 61.70±2.14, while the population density of the species was estimated to be 0.085 /ha, (Table IV). The direct sightings were rare in this region also and during the whole study period only 5 animals were directly observed running (Tables I, II).

Habitat preference

The least numbers of active burrows of the species were located in habitat type-II in both the study regions; that consisted of purely wild areas, and as a result, this kind of habitat supported least population density of the species (0.034 /ha and 0.067 /ha respectively for Chakwal and Gujar Khan regions). In contrast, habitats in the vicinity of villages and poultry farms, supported maximum population density of the species (0.115 /ha and 0.107 /ha, respectively for Chakwal and Gujar Khan regions. Whereas habitat type I harbored moderate populations of the species (Tables I, II).

Diet

The analysis of the scats of the species collected from the selected study sites revealed hairs

(of mammals), bone pieces (of other vertebrates), parts of insects, plants parts, seeds and also some unidentified matter as main food remains.

The samples from Chakwal region showed the percent frequency of occurrence (%F) of mammalian hair as 86.66 %, vertebrates bones 66.66 %, insect body parts 93.33%, plant material 53.33%, seeds 73.33% and unidentified materials 93.33% (Table V). The individual food components recovered from the faecal samples were weighed and their mean percent volume occurrence (%V) was calculated; mammalian hair constituted 66.59%, vertebrates bones 6.05%, insects 9.81%, plant materials 3.75%, seeds 6.47% and some unidentified matter 7.30% (Table III, Fig.3).

Table III.- Mean percent frequency of occurrence (% F) and percent volume (%V) of various food items in the scat samples of small Indian mongoose collected from Chakwal and Gujar Khan regions.

Food item	Chakwal region		Gujar Khan region	
	% F	% V	% F	% V
Mammals (hairs)	86.66 (13)	66.59	93.33 (14)	65.78
Other Vertebrates (bones)	66.66 (10)	6.05	66.66 (10)	8.17
Insects	93.33 (14)	9.81	86.66 (13)	11.28
Plant material (leaves, stems)	53.33 (8)	3.75	60.00 (9)	2.55
Plant seeds	73.33 (11)	6.47	46.66 (07)	4.61
Unidentified matter	93.33 (14)	7.3	100.00 (15)	6.66

Similarly, the analysis of the faecal samples collected from the study sites of Gujar Khan region showed the percent frequency of occurrence (%F) of mammalian hair in the faecal samples as 93.33%, other vertebrates bones 66.66%, insects parts 86.66%, plant materials 60.0%, seeds 46.66 % and unidentified matter 100% (Table V). While their mean percent volume occurrence (%V) showed mammalian hair (65.78%), other vertebrates bones (8.17%), insects (11.28%), plant materials (2.55%), seeds (4.61%) and some unidentified matter (6.66%) (Table III).

The average %V composition of the food items recovered from the faecal samples from both the study regions have been shown in Figure 5. According to the results, the most frequently consumed food items on average were mammals (66.18%), then the species preferred insects (10.55%). The bones recovered from the faecal samples constituted 7.11%, along with small percentages of seeds (5.54%) and other plants parts (3.15%).

The hair recovered from the faecal samples analysis were processed for light microscopic examination by preparing whole mounts slides. These were compared with those of the reference hair slides of *Rattus rattus*, *R. norvegicus* and *Mus muculus*. The sample hair recovered from the faecal samples matched only with those of *R. rattus* (Fig. 5). Some of the hair samples could not be matched to any prey species and these indicate that mongoose species also feeds on some other unidentified prey species.

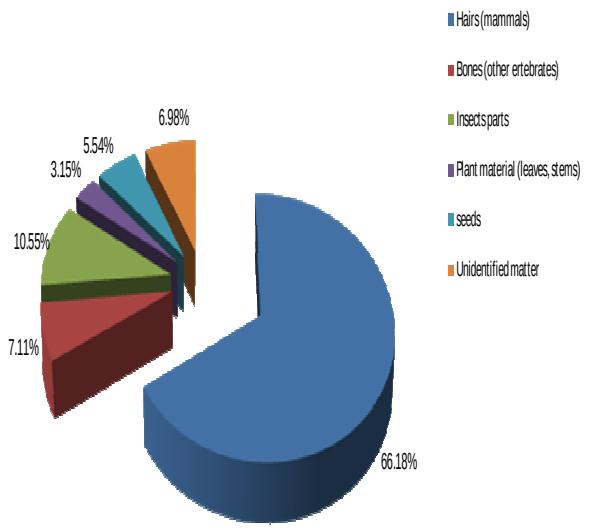

Fig. 5. Average percent volume (%V) of prey items recovered from the scat samples of small Indian mongoose collected from the study sites of both Chakwal and Gujar Khan Regions.

DISCUSSION

It is an established fact that mongooses are mostly solitary, although males can, sometimes, form small social groups and even share burrows,

especially during breeding season. However, in the current study there was found no evidence of their existance in the form of pairs or groups and neither their young ones were recorded. In this respect, the results of estimates of population density are quite logical by considering that each active burrow was occupied by only one mongoose. A careful comparison of the selected study regions of Chakwal and Rawalpindi Districts (Gujar Khan) has indicated almost similar population density of 0.083 /ha and 0.085 /ha, respectively in the two regions. But as far as the earlier published records of this species are concerned, no formal studies have yet been documented in this very region, addressing the population estimates and habitat preference of this species. However, one research paper is available by Taber *et al.* (1967) who studied the abundance, ecology and reproduction of mammals of the Lyallpur region (at present Faisalabad region) of West Pakistan. They conducted a seven month survey on mammals of the region from October 1963 to April 1964, during which they observed only 6 animals belonging to the species *H. javanicus*. They reported two species of mongooses in the region; one was *H. auropunctatus (javanicus)* and the other was *H. edwardsi.*

According to Roberts (1997) *H. javanicus* is well adapted to live in the vicinity of the villages but avoids mountainous areas as it is absent from the Himalayan regions. It is plentiful in Southern Sind but occurs sparsely in Bahawalpur Division. It is commonly found around Lahore, Kasur, and Sialkot Districts. Moreover, Roberts (1997) also observed its wild specimens around Jhelum, which is included in the Potohar Plateau. He also states the chance sightings of small Indian mongoose in the Salt Range of the Punjab. This indicates that Chakwal District is more likely to be having mongooses' populations. Although Roberts (1997) has not separately mentioned the occurrence of this species in the Gujar Khan area, a part of Rawalpindi District, but as this region lies on the northern boundary of Jhelum and towards the eastern side of Chakwal, so Gujar Khan region is also more likely to sustain the mongooses' populations. But as far the population estimates are concerned; Roberts gave no idea or explanation about it.

During the present study, the authors personally observed (and also trapped a few) wild specimens of this species in Islamabad and Rawalpindi, especially in the open fields of the main Campus of PMAS Arid Agriculture University, Rawalpindi, in the Campus of Divisional Public School, Rawalpindi, at poultry farms located at 20 km area around Rawalpindi city and also one specimen found feeding on the litter or garbage thrown by the visitors on the southern side of the Kallar Kahar lake (Chakwal) in the late evening time at about 18:45, on 2nd of May 2009, which support the earlier observations by Roberts (1997).

The investigation of the preference of habitat by small Indian mongoose in the Potohar region has indicated that it prefers habitat type III rather than habitats type I and II. The habitat type-III in both the study areas was the kind of habitat that was located in the surroundings of villages and also comprised of some poultry farms around. The importance of the poultry farms in the mongoose habitat preference lies most probably for the availability of different species of rodents which it uses as its main food item in both the study regions. According to Siddiqui *et al.* (2004) *H. javanicus* is well adapted to live near human habitations and is a common small carnivore in Pakistan. However, Nellis (1989) demonstrated that *H. javanicus* has a wide range of distribution and the species occurs in agricultural areas, coastland, desert, natural forests, planted forests, range/grasslands, riparian zones, ruderal/disturbed scrub/shrub lands, urban areas and also wetlands.

The diet of the small Indian mongoose in Potohar region was investigated by analysis of the scat samples collected from the two regions. The results have revealed a diversity of food remains in its diet including hair of mammals, and bones of other vertebrates, and wings, antennae, legs and heads of insects. The mean percent frequency of the food items recovered from the faecal pellets has shown that the major food component (more than 65%) of the diet of the small Indian mongoose consisted of hairs supposedly belonged to rodents' species, also occurring in the same habitat. The insect parts recovered from the faecal analysis were identified and found to be belonging to cockroaches and grasshoppers, indicating that these invertebrates are also an important component of the mongoose

diet. The seeds recovered from the faecal pellets are most probably of the wild berries, also present in the same area. The earlier studies conducted by Feldhamer *et al.* (1999) have shown that most *Herpestes* are predators, feeding on a wide range of animals including small mammals and birds (including bird eggs), reptiles (especially snakes), a wide variety of insects and crabs. Some species of genus *Herpestes* also include vegetable materials in their diets, feeding on tubers, fruits, and berries.

The current results of the scats analysis also reveal that the bulk food component of the mongoose diet in the Potohar region consists of mammals (66%), and other vertebrates which may be amphibians and reptiles as past literature also gives some information about it (Pimental, 1955). The mammalian diet of the mongoose in the study region may largely comprise of rodents since faecal hair samples matched with those of *R. rattus*. Moreover, it may also be in large part, due to the presence of a large number of rodent species in the study region, owing to the presence of extensive number of poultry farms around. The insects found in this region constitute only about 10% of the mongoose diet. However, Siddiqui *et al.* (2004) studied the diet of the small Indian mongoose in Faisalabad region (Central Punjab) and obtained somewhat different results. They showed that most common remains in the scats were insects (23%) followed by soil (18%), feathers (16%), plant material (15%), bones (11%) and hairs (7%). Insects, feathers, plant material and soil were the main four items of the mongoose scats in their study while surprisingly they reported no rodent prey species of the small Indian mongoose. However, in the current study mammalian hair were found to be the dominant component of food which matched with those of rodents, indicating that mammals such as rodents are the most preferred food of the species in this study region. Insects were consumed as the second preferred food item, while no feathers were recovered from the faecal samples. According to Cavallini and Nel (1995) small Indian mongoose is primarily an insectivore, though it also feeds opportunistically on small vertebrates. Seaman and Randall (1962) had stated that small Indian mongoose mostly eats insects but is opportunistic feeder and also feeds on crabs, frogs, spiders, scorpions, snakes and birds. It also eats seeds, grains, nuts and fruit. Members of this species have also been known to catch mammals many times their size, up to the size of hares and even the young of white-tailed deer. Pimental (1955) had reported 315 food items that were recovered from the scats of mongoose and that consisted of 88.9% animals and 11.1% plant material. Insects made up to 56.4% of the animals and the remainder included 17.1% reptiles, 12.1% myriapods, 7.9% arachnids, 2.9% mammals, 1.4% crustaceans, 1.1% asteroids and amphibians, each, from 56 stomachs in Puerto Rico. So the findings in the literature confirm the results of the present study that the species has a varied diet. However, the presence of quite a large percentage of mammalian hair in its faecal samples indicates a shift of its food habits from insects to the mammals, especially rodents in the Potohar region.

Since the results of the current study demonstrate that rodents form most common component of the diet of small Indian mongoose in the Potohar region, *H. javanicus* must be playing a very vital role in controlling the populations of rodents in the croplands. Seaman and Randall (1962) had reported that the stomach contents of *H. javanicus* consisted of lizards (Anolis) 0.5%, toads 13.9%, mice *(M. musculus*) 13.9%, rats (*R. rattus)* 13.9%, birds 2.8%, poultry 2.8%, insects 83.0%, crabs and fruit each 11.1%; and vegetable materials 5.5%. However, the predators with wide feeding niche are known to change their diet according to the availability of food as Southern and Watson (1941) and Coman (1973) had reported for red fox. In the present study also more than 65 % of the percentage volume of the diet of *H. javanicus* has been found to be consisted of mammalian species (and maybe small mammals) while insects constituted only around 10 %. Since it consumes rodents and insects as main food items, the small Indian mongoose seems to be a farmer's friend and it is playing a positive role in ridding the cropland of these pests.

The comparison of faecal hairs and those of reference hairs of various rodent species matched with hairs of *R. rattus* only but not with those of *M. musculus or R. norvegicus*, indicating that *R. rattus* is the main prey species of small Indian mongoose in this region. However, those faecal hairs, which

did not match with any of those of *M. musculus* or *Rattus norvegicus*, indicate that these may be of any other unidentified prey. However, it needs further investigation that what else could be the mammalian prey of small Indian mongoose.

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