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# ECOLOGY OF BENGAL FOX (*VULPES BENGALENSIS*) IN NORTHWEST BANGLADESH

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**ABSTRACT:** The northwest regions of Bangladesh belong to the global range of Bengal fox, *Vulpes bengalensis*. However, scientific information on this small canid in Bangladesh is scanty; it also remains out of any conservation initiatives, and it is widely perceived as a potential threat to local poultry. We conducted this premier study between September 2019 and December 2021. We investigated the feeding and breeding behaviour of this fox by using scat samples, direct field surveys and camera-trapping. An analysis of 67 scats yielded eight major categories of prey items consumed by the fox. Arthropods (29%) ranked top in the relative percentage of occurrence, followed by rodents (27%), plant parts (17%), and birds (13%), among the others. Ninety-two percent of scats contained multiple food items, with an average number of food items per scat of 3.50± *SE* 1.87. We recorded 17 den sites in and around human-dominated landscapes, of which nine den sites remained unoccupied during the entire study period. Dens used by Bengal foxes were complex, comprising interconnected tunnels and holes with an average of 23.66± *SD* 12.78 holes/den. We estimated a total of 37 individuals of the fox, with 62% pups in the recorded population. The average litter size was 3.36± *SE* 0.52 pups. We recommend further research to assess population status and delineate its range in Bangladesh.

***Key words***: Bangladesh, breeding behaviour, canid, dens, feeding behaviour, *Vulpes bengalensis*

## INTRODUCTION

The Bengal fox, *Vulpes bengalensis* is endemic to the Indian subcontinent, ranging from the foothills of the Himalayas in Nepal to the southern tip of the Indian peninsula, including Bangladesh and Pakistan (Johnson and Jhala 2008, Jhala 2016). Bangladesh is home to three species of canids – Golden jackal, *Canis aureus*, Dhole *Cuon alpinus* and Bengal fox – of which the former one is widespread whilst the latter two species have restricted distribution in the country. The Bengal fox is currently found in the western part of the country, mostly confined to the west side of the river Jamuna. It was reported to occur

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along the coastal areas in the southeast regions of Cumilla and Chattogram during the 1980s; however, there is no sighting afterward from these regions. We suspect that the range of the species might have been reduced greatly over decades; thereby IUCN-Bangladesh has categorised it as Vulnerable in its latest Red List (IUCN Bangladesh 2015).

This small canid inhabits semi-arid scrubs and grasslands, including agricultural fields and rural areas but avoids hilly terrains, wet forests, and deserts (Johnsingh 1978, Mankadan and Rahmani 2000, Johnsingh and Jhala 2004, Vanak 2005). In Bangladesh, it occurs in human-dominated agricultural landscapes and around human habitations.

The Bengal fox is known to be an opportunistic omnivore across its range (Home 2005, Johnsingh and Jhala 2004). Several studies were conducted on this canid in India and Nepal, which provided important information on their distribution, food habits, den characteristics as well as niche separation (Johnsingh 1978, Vanak and Gompper 2009, Dookia and Das 2012, Niraula *et al.* 2020).

This canid has received little attention from researchers and conservation authorities; thereby, scientific information, including the ecology and their occurrence, is scanty in Bangladesh. Importantly, its range in the country might have been contracted significantly over decades (IUCN Bangladesh 2015), perhaps due to traditional hunting as well as deliberate killing by communities considering the species to be a threat to local poultry (Aziz 2020). We carried out this premier investigation on its population status, feeding behaviour, and breeding behaviour in a landscape dominated by agricultural activities and human settlements in the northwestern districts of Bangladesh.

## MATERIAL AND METHODS

*Study sites:* We conducted this study in the Dinajpur and Panchagarh districts — located in the northwest region of Bangladesh. Dinajpur district, with an area of 3,444 km$^2$ is bounded by Thakurgaon and Panchagarh districts on the north and Gaibandha and Joypurhat districts on the south, Nilphamari and Rangpur districts on the East and the state of west Bengal of India on the west. There are 13 upazilas (i.e., mid-level administrative unit), with an estimated human population of about 3,109,628. There are small and scattered deciduous forest patches, of which four are National parks. The district Panchagarh is bounded on the north by Darjeeling, District of West Bengal State of India, east by Jalpaiguri District and Coochbihar District of West Bengal State of India and Nilphamari District, south by Dinajpur District and Thakurgaon District and west by West Dinajpur District and Purnia District of West Bengal State of India

and Thakurgaon District (Fig. 1). The district consists of 5 upazilas, covering 1,404km$^2$ and has a population of 987,644 (BBS 2011).

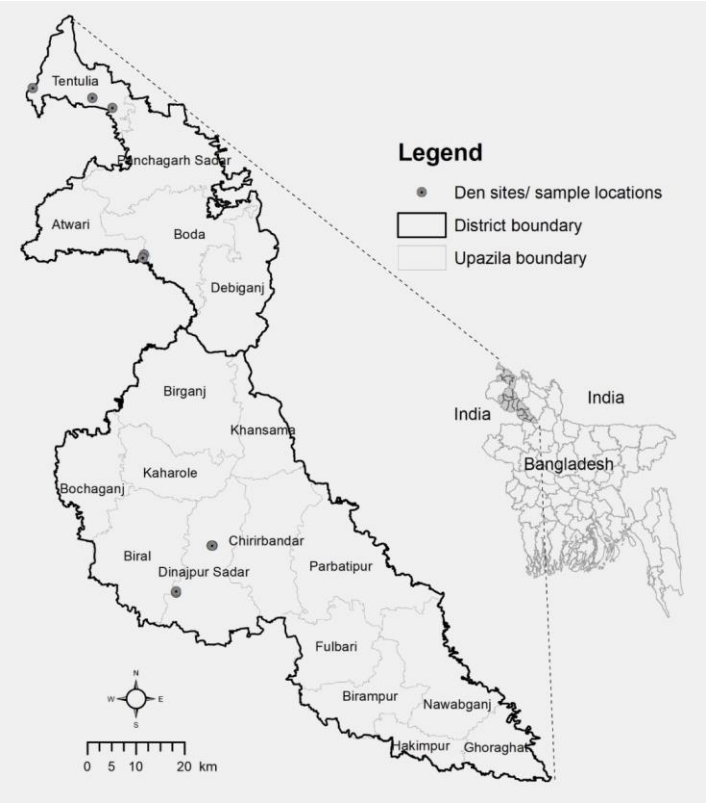


Fig. 1. Map showing the den sites and sample locations of Bengal fox in the northwest Bangladesh.

Agriculture is the mainstay of the people, with principal crops of rice, wheat and vegetables. Both districts are famous for producing good quality fruits, including lychees and mangoes. The deciduous forest patches in Dinajpur are dominated by sal *Shorea robusta*, along with Gamari *Gmelina arborea* and arjun *Terminalia arjuna*. The homestead orchards include fruit-trees such as lychee *Litchi chinensis*, mango *Mangifera indica*, jam *Syzygium cumini*, papaya *Carica* sp., tetul *Tamarindus indica* and marking nut *Semecarpus anacardium.* Trees such as segun (*Tectona grandis*), mahogani *Swietenia mahagoni* and neem *Azadirachta indica* are also common in the study sites. The major fauna found in the area includes golden jackal *Canis aureus*, jungle cat *Felis chaus*, blacknapped hare *Lepus nigricollis*, small indian mongoose *Herpestes auropunctatus*, Bengal monitor *Varanus bengalensis*, yellow monitor *Varanus salvator* and a range of rodent species (*Bandicota* sp., *Rattus* sp.).

*Scat collection:* We investigated the food habit of Bengal fox by identifying food remains in scat (Johnsingh and Jhala 2009). Prey remains in faeces have long been used to evaluate carnivore diets (Putman 1984, Home 2005). It is a straightforward, non-invasive approach with a wide range of applications and is used by many workers for carnivore diet analysis (Korschgen 1980, Home and Jhala 2009, Aziz *et al*. 2020).

We collected scat samples between September 2019 and November 2021. The study sites overlapped with ranges of jungle cat, *Felis chaus* and golden jackal, *Canis aureus*, so we collected scats only from the active den sites of Bengal fox. This allowed us to avoid any scats deposited by other sympatric carnivores in our samples. Each scat was preserved separately in ziplock polybag. Date of scat collection, GPS coordinates of each den site, habitat status (by observing vegetation, slope, soil structure, etc.) surrounding the den and distance from human habitation were recorded.

*Scat analysis:* All field-collected samples were analysed in the laboratory at the department of Zoology, Jahangirnagar University. Each sample was washed separately in normal tap water; dried and hard samples were soaked for around 24 hours before washing. A filter was used to keep any fragments of scat samples from being washed away and the samples were gently rippled in water. The unclean fluids were filtered again after washing to reabsorb the washed microscopic pieces of samples.

The washed samples were dried for three days in the sun to remove moisture content, ensuring that no bacterial or fungal infection occurred. In the laboratory, forceps and needles were used to separate indigestible components such as claws, scales, feathers, hairs, bones, insect chitin including any other materials. The prey remains, such as legs, wings, and antennae of insects, were identified using distinguishing qualities, but the small pieces, which were difficult to see with the naked eye, were examined using an optical microscope. The dental formula, hair, and bones of mammals, and rodents were identified by comparing with reference samples and guidebooks. We considered rodents and birds as broad taxa due to the difficulty in identifying the species level (Home and Jhala 2009).

There are several methods for analysing scat data; however, each of these methods has its own limitations (Loveridge and Macdonald 2003). We used frequency of occurrence expressed as the proportion of scats containing a prey item to provide a measure how often a fox feeds on a certain type of food (Corbett 1989, Reynolds and Aebischer 1991, Paltridge 2002, Loveridge and Macdonald 2003). This simple method was widely used for diet analysis; however, the technique tends to over-represent small prey items in the diet (Cobett 1989). Because there were no standard conversion factors available for

determining prey biomass from scats like other carnivores (Home and Jhala 2009, Aziz et al. 2020), we calculated relative percentage as the number of times a food type was encountered in a sample of scats as a percentage of total occurrence of all food types. This method provides a measure of the relative importance of food type in the diet (Loveridge and Macdonald 2003).

*Camera-trap and field surveys:* We conducted camera trapping in three den sites to document the breeding activities of Bengal fox with particular interest in documenting nocturnal activities. We used two sets of Bushnell Trophy Cam HD Trail Camera, deploying in one den site at a time. We deployed camera traps at sites facing the dens, potential to have the mating pair of the fox. Upon the initial detection of foxes in den sites, we kept the camera traps for longer period to record their activities.

We also made field surveys to document den structure, and breeding behaviour, including other activities of Bengal fox. We took position near the active dens as close as possible and observed foxes during the evening and early morning. We used a government dormitory close to one den site in Panchagarh and a community house for another site in Dinajpur as hideouts during observations so that the behaviours of foxes were not obstructed by our presence. Our observations were aided by binoculars and torch light when needed.

## RESULTS AND DISCUSSION

*Feeding behaviour:* We successfully analysed 67 samples sourced from the Bengal fox. Analysis of these samples yielded eight major categories of food items consumed by the Bengal fox. A variety of insects appeared as the most common prey item, occurring nearly 57 times in 67 scats. Other animal prey remains included rodents, birds, eggshells, reptiles, and fishes. Plant parts came from a variety of fruits, seeds, stems, and leaves (Fig. 2). Scats produced by pups exclusively contained remains of rodents and birds, with other items being negligible. We also detected some non-food items in scat which included parts of polythene, plastic, and kind of nylon threads.

The Bengal fox took a variety of foods comprising insects, rodents, birds, eggs, reptiles, and plant materials. About 93% scat contains more than one prey items, suggesting its opportunistic as well as generalist feeding habit. Our results confirm the findings of Home and Jhala (2009) in Gujarat of India where arthropods were most common, followed by rodents, fruits, and reptiles.

Arthropods (29%) ranked top in the relative percentage of occurrence, followed by rodents (27%), plant parts (17%) and birds (13%), among the others (Table 1). Ninety-two percent of scats contained multiple food items, with an average number of food items per scat was 3.50 ± *SE* 1.87. Regarding the proportion of different food items in scat samples, 35.82% of scats had three items, 34.33% two items, 17.91% four items, 2.98% five items, and 1.49% six items. The remaining 7.46% of scats had only one prey species.

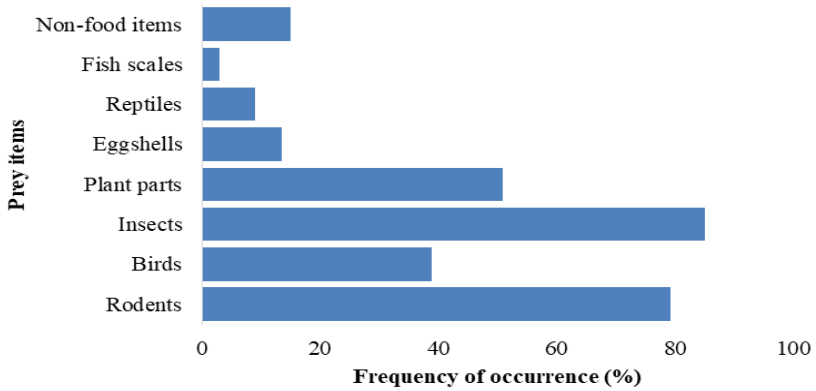


Fig. 2. Major prey items and their frequency of occurrence in scats of Bengal fox in Dinajpur and Panchagarh Districts of Bangladesh.

The Orthoptera, Coleoptera, and Hymenoptera (particularly ants) were common, accounting for 60% of arthropods eaten. Mole crickets (*Gryllotalpidae*), field crickets (*Gryllinae*), beetles (*Carabidae*), black and red ants were frequently consumed by foxes. Paddy (*Oryza* sp.) was the most common plant parts in the scat along with rice seeds, leaves, and young stems. Fruits of *Ziziphus* sp., *lychee* sp., and Solanaceae seeds appeared in scats. Fox also fed grasses with preference of *Narenga* sp. and *Cyperus* sp. A few scats also contained *Allium* sp.

Among Arthropods, Coleoptera and Orthoptera constituted the larger proportions of diet in Gujarat as well (Home and Jhala 2009). We did not find any remains of livestock in the scats, despite having all kinds of livestock being reared by communities in the study sites. In Gujarat of India, remains of livestock (remains of sheep, goat, and cattle) were found, which could be from scavenging of carcasses or predated by large carnivores. Together with this finding, our result suggests that Bengal fox is unlikely to predate on any livestock. We could not detect any remains of hare, *Lepus nigricollis* in fox scat, which was reported in Andhra Pradesh (Manakandan and Rahmani 2000).

*Population and breeding behaviour:* We report a total of 37 individuals from five study sites of Dinajpur (Hossainpur) and Panchagarh (Boda, Buraburi, Vojonpur and Tentulia). The pups constituted almost 62% of the population, suggesting reasonable breeding performance at study sites. This estimate came from our direct sightings only, so the accurate population size across the study areas would certainly be larger.

We recorded 17 den sites in and around human-dominated landscapes during this study. Nine den sites were found unoccupied during the entire study period. The recorded dens were distributed in backyard orchards (n=3), graveyards (n=3), cropfields (n=3), pond banks (n=3), roadside slopes (2), grassy

riverbanks (n=2), and open lands (n=1). No dens were recorded in forests or well-vegetative areas, despite having deciduous forest patches around. We estimated a total of 37 individuals of fox, comprising 14 adults and 23 pups (Table 2). The highest number of foxes was found in Boda upazila whilst none were found in Biral despite having active dens.

Dens used by Bengal fox were complex, comprising interconnected tunnels and holes with an average of 23.66 ± *SD* 12.78 holes/den (range: 2 - 40). The number of holes appeared to be related to the number of foxes (Fig. 3). The same den sites were used for years if disturbance remained low or den sites were not destroyed by human activities. Most of the new or rebuilt dens (n=11) were

**Table 1: Prey items, frequency of occurrence (FO) and relative occurrence (RO) in scats of Bengal fox in Dinajpur and Panchagarh Districts of Bangladesh**

| Prey type | No. of prey/food items | FO | RO |
|---|---|---|---|
| Rodents | 53 | 79.1 | 26.9 |
| Birds | 26 | 38.8 | 13.18 |
| Eggshells | 9 | 13.43 | 4.56 |
| Reptiles | 6 | 8.95 | 3.05 |
| Fish scales | 2 | 2.98 | 1.02 |
| Insects | 57 | 85.07 | 28.94 |
| *Coleoptera* | 14 | 20.89 | 24.25 |
| *Hymenoptera* | 9 | 13.43 | 15.78 |
| *Orthoptera* | 17 | 25.37 | 29.82 |
| *Blattodea* | 6 | 8.95 | 10.52 |
| *Lepidoptera* | 3 | 4.47 | 5.26 |
| *Odonata* | 1 | 1.49 | 1.75 |
| *Unidentified* | 7 | 10.45 | 12.28 |
| Plants | 34 | 50.74 | 17.26 |
| *Paddy* | 11 | 16.41 | 32.35 |
| *Grassess* | 6 | 8.95 | 17.64 |
| *Litchi fruits & leaves* | 4 | 5.97 | 11.76 |
| *Potatoes* | 4 | 5.97 | 11.76 |
| *Dicot leaves* | 3 | 4.47 | 8.82 |
| *Sugarcanes* | 2 | 2.98 | 5.88 |
| *Sedges* | 2 | 2.98 | 5.88 |
| *Garlics* | 2 | 2.98 | 5.88 |
| Non-food items | 10 | 14.92 | 5.08 |

**Table 2: Recorded dens and populations of Bengal fox in 6 upazilas in the northwest Bangladesh**

| Name of upazila | No. of holes | | No. of individuals | |
|---|---|---|---|---|
| | Active | Inactive | Adults | Pups |
| Boda | 40 | 11 | 4 | 7 |
| Buraburi | 26 | 0 | 2 | 3 |
| Tentulia | 24 | 3 | 4 | 6 |
| Vojonpur | 34 | 0 | 2 | 4 |
| Hossainpur | 11 | 9 | 2 | 3 |
| Biral | 7 | 2 | 0 | 0 |

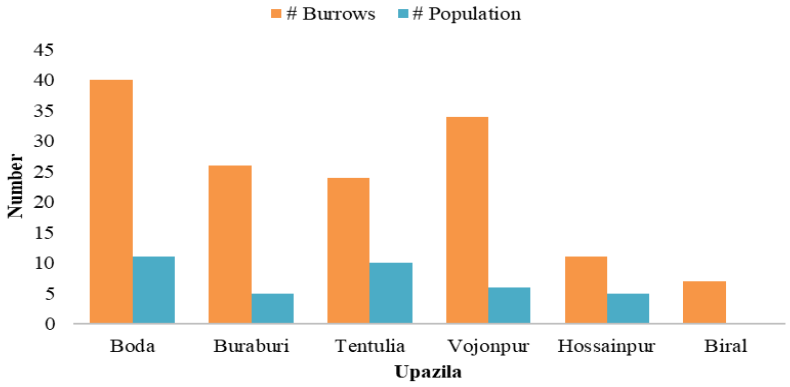


Fig. 3. Number of dens and fox population in six sites in Dinajpur and Panchagarh districts of Bangladesh.

found during November and December. Preferable den sites were chosen by fox having soft or sandy soils, which might have facilitated ease of den excavation. Most of the inactive dens were used by mongooses (n=3) and rodents (n=4). Our detected den sites represent different types of habitats — the slope of railway, roadside, and riverbank, flat ground, the mound of a pond, graveyard, and orchard of local trees. Manakadan and Rahamani (2000) recorded dens in grassland and in light scrub habitats but none in dense grasslands; the fox avoided dense forests, steep terrain, tall grasslands, and true deserts for making their dens (Johnsingh and Jhala 2004). Our field surveys indicate that foxes are likely to avoid locations for den excavation with a good hold of golden jackals, appeared from the absence of dens where jackals are common. In central Indian landscape, Bengal fox was found to avoid sympatric canids such as Indian wolf *Canis lupus* and golden jackals (Punjabi *et al.* 2013). We found small Indian mongoose and rodents to appropriate abandoned dens of the fox. Similar observations were made by Manakadan and Rahmani (2000) in Andhra Pradesh

of India where Bengal monitor, golden jackals or wolves *Canis lupus* took shelter in fox dens.

A maximum of 43 holes (Manakadan and Rahmani 2000), and 23 holes (Johnsingh 1978) was reported from India, whereas we found maximum 42 holes in one site. Excavation of dens and pup sighting data suggest that mating might have taken place between November and December, concurrently with the preparation of dens. However, we found cubs with parents (*n*=2) in the last weeks of February, suggesting that breeding may last until January. We observed that pups emerged from their dens for the morning sun accompanied by parents in winter months when human presence remains low. Camera trap data also suggest that pups exercise a series of foraging attempts across bushes at short distances from dens while parents remained extremely vigilant sitting next to dens.

Camera trap data from a mating pair of fox showed that the pair heavily engaged in digging out dens during night, starting from around 19:00 – 20:00 hrs and continued until 00:50 – 00:60 hrs in mid-December. In the last week of January, 5 pups emerged from dens with their parents. Along with this finding including direct observations on four mating pairs, we estimated an average litter size of 3.36 pups (n=5) for Bengal fox (Table 2).

The Bengal fox is relatively common in areas with low rainfall, and where vegetation is typically scrub, thorn or dry deciduous forests or short grasslands (Rodgers 2000). The northwest region of Bangladesh is characterised by human-dominated landscapes, low rainfall and a semi-arid climate (Dey *et al.* 2011) and have a few patches of deciduous forests in the region (Aziz 2020). This condition might have influenced its occurrence in NW regions, but none in NE and SE tropical forest habitats of Bangladesh (IUCN Bangladesh 2015).

Hunting as well as deliberate killing and destruction of dens are two critical threats to Bengal fox in the study areas. For instance, four den sites recorded in the earlier time study were demolished by building human settlements, and due to the land being brought under cultivation. The landowner of one site in Dinajpur killed all four cubs in January who claimed that the tree roots of his orchards become very fragile when foxes excavate dens nearby. One pup from the same litter was taken away by an ethnic hunter for consumption.

Bengal fox is losing their habitats due to the increasing use of agricultural lands in Bangladesh. The scientific information on its role in controlling agricultural pests (e.g., rodents, insects, etc.) can potentially change the perceived threat of foxes to poultry and crops. Because the range of this species completely overlaps with human-dominated landscapes, its conservation largely relies on the support from local inhabitants across its range in the country. We recommend community-based awareness campaigns so that local inhabitants

across its range would understand the role of this canid in controlling the agricultural pests. The finding of this study is likely to bring the species into focus for further investigation, and to initiate conservation actions to arrest any future population decline in the country.

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