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DIETARY PATTERNS OF GREY FRANCOLIN (*FRANCOLINUS PONDICERIANUS*) IN TEHSIL NARA, DISTRICT KHAIRPUR MIR'S SINDH, PAKISTAN

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ABSTRACT

This study examined the diet of the Grey Francolin (*Francolinus pondicerianus*) in Tehsil Nara, District Khairpur Mir's, Sindh, Pakistan. Twenty-eight samples of gizzards and crops were collected in the four seasons; spring (n = 6), summer (n = 4), autumn (n = 7), and winter (n = 11). Specimens were obtained from local hunters during morning and evening hours. Through analysis, 12 plant-based food items were identified, *Brassica campestris*, *Pennisetum typhoideum*, *Carthamus oxycantha*, *Eruca sativa*, *Triticuma estivum*, *Vigna radiata*, *Oxalis corniculata*, and *Sorghum bicolor*. Furthermore, there were eight items of animal origin, which included three insect orders. *Formica rufa* (Hymenoptera), *Coptotermes formosanus* (Isoptera), and *Tribolium castaneum* (Coleoptera). The mean intestinal mass of the Grey Francolin was 147.1 g, and the mean fecal content was 10.50 g, ranging between 1.26 g. The average weight of the intestines and food content was 115.86 g and 8.27 ± 0.53 g during morning and evening hours, respectively, which showed that there was a difference in the feeding intensity between day and night. Seasonal differences were evident in plant intake, which was lowest in summer (2.59 ± 0.67 g), followed by winter (1.47 ± 0.65 g) and autumn (1.23 ± 0.48 g), and highest in spring (2.33 ± 0.89 g). Insect consumption also varied seasonally, with mean values of 1.56 ± 0.88 g in spring, 2.38 ± 1.03 g, in autumn, 4.15 ± 1.93 g, in summer, and 2.5 ± 1.44 g in winter. These observations imply that the dietary habits of GFP are flexible and depend on seasonal food resources. This research also offers great details on the feeding ecology of this species that can be applied in the future by conservation efforts and habitat management in arid and semi-arid areas of Pakistan.

Keywords: Grey Francolin (*Francolinus pondicerianus*), dietary composition, seasonal variation, crop and gizzard analysis, feeding ecology.

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INTRODUCTION

Grey Francolin (*Francolinus pondicerianus*) is a native Pakistani game bird that is characterized by the ecological importance as well as cultural factor, basically because of its popularity among the hunters (Roberts, 1991; Ali and Ripley, 1983; Islam, 1999). It is a highly accommodating species and has appealing dissimilar movements that may reach to 81 km. Seasonally, locally and the average length of the body is between 33 and 35 cm (Roberts, 1991; Islam, 1999). Though, both males and females have the same clothing traits, males are recognized by having the metatarsal spurs and a relatively higher body mass (Islam,

1999). Grey Francolins are generally found in uncultivated agricultural fields and highly sparsely forested spaces consisting of mostly shrubs. They also occupy a huge geographical area of around 10 million square kilometers with a unique call known in the area as Teeter (BirdLife International, 2012; IUCN, 2013). Its introduction in other areas beyond its native distribution includes, with considerable measure of success, to the Oman region during the early 20th century and to the United Arab Emirates during the 1970s, where it has become stable in population, to a large degree due to its great reproductive potential (Khan et al., 2009; Gallagher and Woodcock, 1980).

In Pakistan the habitable areas of the Grey Francolin range as far west to the Indus valley and as far as south to the Himalayan foothills (Roberts 1991). It can never be found at places of more than 1200 m and mostly feeds in alluvial scrublands that have less vegetation cover (Rasmussen and Anderton, 2005). Dietary research in Nara area has demonstrated that they followed an omnivorous feeding ecology and gizzard content analysis has shown that they preferred weather, food and beetle larvae, various vegetables, locust hopper, and ants legalists (Bhatti and Chaudhry, 1992; Mian and Wajid, 1994). According to seasonal dietary measurements of the Lal Suhanra National Park, the species feeds on about 70 per cent of plant-based things and 30 per cent of things of insect origin (Khan and Mian, 2012). The insects are also important part of diet of the Grey Francolin, making it an important species of the French biological pest control in terms of bio-ecosystem in agricultural environments (Wajid, 1994; Faruqi, 1960).

The birds are usually found roosting in coveys of two or three usually on low thorny skinny breeds. Their plumage offers effective camouflage, aiding predator avoidance within sparsely vegetated habitats (Sharma, 1983; Roberts, 1991). Grey Francolins are monogamous, with females primarily responsible for incubation duties. The main breeding season occurs during spring, particularly in March and April, although secondary nesting activity is often observed after the monsoon season in September and October. Eggs are pale brown to buff in color, glossy, pointed at one end, and unmarked, requiring an incubation period of approximately 18–19 days. Both parents participate in post-hatching care (Roberts 1991).

Although Grey Francolins play a crucial role in their ecosystems, they are increasingly endangered due to shrinking habitats, aggressive agricultural development, and unsustainable harvesting of scrub forests for resources such as fodder, timber, and firewood (Islam, 1999; Bhatti, 1992; Roberts, 1991). In the last ten years, their population across Pakistan has notably diminished. As a result, the International Union for Conservation of Nature (IUCN) has classified the species as endangered in its Red Data Book (BirdLife International, 2012). Due to the scarcity of scientific studies in the Nara region a key habitat for Grey Francolin research was conducted to examine the dietary habits and seasonal shifts in food selection of (*Francolinus pondicerianus*), within, Tehsil Nara, District Khairpur Mir's. The study placed particular focus on analyzing the proportion of plant-based versus animal-based consumption to gain deeper insights into the species, ecological function and support future conservation efforts.

MATERIAL AND METHODS

Study Area

The study was conducted in the Nara district, the largest administrative, Tehsil area in the District Khairpur Mir's, located in Sindh, Pakistan. Geographically, it lies between latitudes 26° 41' to 53° North and longitudes 68° 00' to 53° 45'. Covering approximately 11,610 sq. km, it has a population of about 160,985 people. The climate is characterized as dry subtropical, with relatively mild winters and extremely hot summers. In winter, temperatures range from 10°C to 30°C, while in summer, they can soar to between 35°C and 50°C.

In the ecological perspective, the area exhibits huge diversity of ecosystems, comprising of semi-evergreen subtropical forest, tropical thorn woodlands, freshwater ponds, ephemeral streams, hilly terrain, dune sand and marginately cultivated agricultural terrain. This diversified land sustains a vast variety of plant and animal life forming good environment to many of the species such as birds using it in their habitat, including the Grey Francolin (*Francolinus pondicerianus*).

Methodology

In the study of the feeding behavior of the Grey Francolin, 28 samples of gizzards and crops were collected from adult birds found within the Nara region. Sampling was conducted across four distinct seasons spring (March to May), summer (June to August), autumn (September to November), and winter (December to February), to assess seasonal changes in food habits. Ethical trading was observed, and specimens were collected during designated hunting time, with local hunters assisting in the process, which took place in the mornings and evenings.

All the samples were carefully stored and then brought to entomology lab where they were to be categorized further and thoroughly examined. Crop and gizzards were analyzed in order to recognize and quantify the percentage food items which are plant-based and animal-based. It was identified by reference to available taxonomic guides and reference materials, emphasis being given to distinctions of seeds, plant remains and insect remains. To compare dietary intakes in the seasons, comparisons with seasons made it possible to examine changes in the flexibility of the species and their feeding habits.

Each crop as well as gizzard in the field was measured in a digital balance (model SF-820) which provided a range of measurement between 0.1 mg and 300 g. The weighed samples were placed in labeled plastic bags where all the necessary information concerning collections such as date, time, and location was recorded. Such specimen was then

shipped to the Zoology department in the Shah Abdul latif university, Khairpur, to enhance laboratory analysis.

They were preserved either in 10% formalin solution in order to preserve integrity of the specimens or they were frozen. There were dissection processes of isolating and classifying the contents of each crop and gizzard. To know the net weight of ingest material, the organs were emptied, and weighed again, finding the difference in weight of material distributed at the beginning and after dissection.

The retrieved contents were placed in petri dishes and inspected under a magnifying lens at 10× magnification. Seeds were separated and affixed to cardboard sheets for identification purposes. Plant materials were classified with support from the Weed Control Program at the National Agricultural Research Center, while insect specimens were identified in collaboration with the Entomology Laboratory at Shah Abdul Latif University. All biological samples were preserved for future verification and reference.

Each dietary element was air-dried at ambient temperature for 24 hours and subsequently weighed using the same digital scale. Statistical analyses were done with the aim of detecting seasonal variations in type of diet. Mass and proportional representation of different food stuffs contained in the crop and gizzard samples were calculated. To compare the food content of the morning and evening collection, Student t-test was performed with the help of QI Macros-2014 software.

The percentage occurrence of each food item was calculated using the formula below:

$$\text{Percentage} = \frac{\text{Number of birds with specific food content}}{\text{Total number of birds}} \times 100$$

RESULTS

There were 28 crop and gizzard samples of an adult Grey

Francolins gathered to be examined in four seasons namely spring (n = 6), summer (n = 4), autumn (n = 7), and winter (n = 11). The weight of the digestive tract holding food in the morning collected specimens was of an average weight of 147.10 g with a mean standard error (SE) of 10.50-1.26. The weight of the empty gizzard was then noted as 86.65 g (mean $\pm$ SE: 6.18 $\pm$ 0.89 g) and the mass of the net food was obtained as 59.88 g (4.27 $\pm$ 0.57 g). The gut weight in evening samples, on the contrary, was 115.86 g (8.27 $\pm$ 0.53 g), and the empty gizzard weighed 68.25 g (4.87 $\pm$ 0.38 g), therefore the net content of the food was 46.87 g (3.34 $\pm$ 0.28 g).

Morning Specimens

Table 1 pools the weight of gut and gizzard, of, Grey Francolin (*Francolinus pondicerianus*), taken in the morning. The calculated net food content included the difference between total gutted weight and weight of empty gizzards. Samples of the feeding patterns are compared by presenting mean, SE, and SD of both morning and evening samples.

Evening Specimens

In the 14 specimens, in the evening (Specimen No, 15-28), the total weight of the gut was 115.86 g, and the total weight of the empty gizzard was 68.25 g. This gave a net food content of 46.87 g. The evening sample statistical summary is the following one:

Gut with food: 8.27 $\pm$ 0.53 g (SD: 1.99 g)

Empty gizzard: 4.87 $\pm$ 0.38 g (SD: 1.45 g)

Food content: 3.34 $\pm$ 0.28 g (SD: 1.07 g)

The findings indicate that there is a significant decrease of food content in the evening time as compared to morning samples indicating that there may be diurnal difference in feeding behaviour or digestive processes of the Grey Francolins.

Table 1: Mean gut with food and food content (g) in Gizzard Samples of the Grey Francolin (*Francolinus pondicerianus*) in the Nara Region.

Specimen No.	Sex	Time of Hunt	Gut with Food (g)	Empty Gizzard (g)	Food Content (g)
1	Male	Morning	7.42	5.39	2.03
2	Female	Morning	4.05	2.56	1.37
3	Male	Morning	6.65	4.42	2.23
4	Male	Morning	8.15	5.08	3.05
5	Female	Morning	9.97	3.00	6.97
6	Male	Morning	10.97	3.76	7.21
7	Female	Morning	6.88	2.54	4.34
8	Female	Morning	8.13	1.50	6.63
9	Male	Morning	17.97	11.44	6.50
10	Male	Morning	17.97	11.69	5.98
11	Female	Morning	8.00	5.21	2.69

12	Male	Morning	7.64	5.20	2.31
13	Female	Morning	15.08	9.21	5.87
14	Female	Morning	8.42	5.68	2.70
Total			147.10	86.65	59.88
Mean $\pm$ SE			10.50 $\pm$ 1.26	6.18 $\pm$ 0.89	4.27 $\pm$ 0.57
SD			4.71	3.33	2.14

Table 2: Mean Stable Season and Weight (g $\pm$ SE) of Crop and Gizzard of Food in Crop and Gizzard Samples of the Grey Francolin (*Francolinus pondicerianus*) in the Nara Region.

Scientific Name	Common Name	Spring (n=6)	Summer (n=4)	Autumn (n=7)	Winter (n=11)	Total (g $\pm$ SE)	% Occurrence
<i>Vigna radiata</i>	Mung Bean	1.00 $\pm$ 0.33	1.02 $\pm$ 0.55	0.76 $\pm$ 0.19	1.50 $\pm$ 0.50	3.04 $\pm$ 0.43	12.18
<i>Brassica campestris</i>	Mustard	1.34 $\pm$ 0.23	1.09 $\pm$ 0.09	1.39 $\pm$ 0.60	1.58 $\pm$ 0.55	3.78 $\pm$ 0.76	11.16
<i>Pennisetum typhoideum</i>	Millet	2.33 $\pm$ 0.33	1.91 $\pm$ 0.08	0.66 $\pm$ 0.22	1.50 $\pm$ 0.50	3.96 $\pm$ 1.08	10.13
<i>Triticum aestivum</i>	Wheat	0.50 $\pm$ 0.27	1.36 $\pm$ 0.35	0.50 $\pm$ 0.16	0.85 $\pm$ 0.15	2.19 $\pm$ 0.66	9.15
<i>Carthamus oxyacantha</i>	Pholi	0.13 $\pm$ 0.13	0.11 $\pm$ 0.11	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.25 $\pm$ 0.15	7.12
<i>Eruca sativa</i>	Taramera	0.00 $\pm$ 0.00	0.43 $\pm$ 0.36	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.22 $\pm$ 0.22	1.01
<i>Oxalis corniculata</i>	Wood Sorrel	0.36 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.08 $\pm$ 0.08	1.01
<i>Sorghum bicolor</i>	Jowar	1.68 $\pm$ 0.00	0.00 $\pm$ 0.00	1.22 $\pm$ 0.47	1.47 $\pm$ 0.64	4.37 $\pm$ 0.42	1.01
Mean (Plants)		2.33 $\pm$ 0.89	2.59 $\pm$ 0.67	1.51 $\pm$ 1.17	2.50 $\pm$ 1.44	6.90 $\pm$ 2.38	11.14
<i>Coptotermes formosanus</i>	Termite	0.50 $\pm$ 0.15	2.50 $\pm$ 1.44	1.26 $\pm$ 0.99	1.25 $\pm$ 1.25	4.07 $\pm$ 0.53	7.10
<i>Formica rufa</i>	Black Ant	0.51 $\pm$ 0.47	2.30 $\pm$ 0.33	0.36 $\pm$ 0.00	0.00 $\pm$ 0.00	3.58 $\pm$ 1.26	3.04
<i>Tribolium castaneum</i>	Flour Beetle	0.36 $\pm$ 0.00	0.45 $\pm$ 0.00	2.38 $\pm$ 1.03	2.50 $\pm$ 1.43	5.69 $\pm$ 0.09	17.25
Mean (Insects)		0.56 $\pm$ 0.88	4.15 $\pm$ 1.93	2.35 $\pm$ 1.03	1.15 $\pm$ 0.44	10.06 $\pm$ 4.74	9.13
	Grit (Stone)	0.62 $\pm$ 0.17	1.16 $\pm$ 0.55	0.98 $\pm$ 0.34	1.10 $\pm$ 1.10	4.22 $\pm$ 0.68	6.04
	Unidentified Mix	0.17 $\pm$ 0.06	0.12 $\pm$ 0.02	0.35 $\pm$ 0.46	0.32 $\pm$ 0.04	0.55 $\pm$ 0.20	2.11

Values show $\pm$ standard error (SE) of weights of food items in seasons. Percentage occurrence illustrates the percentage of the samples on which an item has been observed. Grit was found in 60.7% samples whereas unidentified organic was found in 32.1%.

Analysis of Variance

One-way ANOVA was done to determine seasonal difference in dietary intake of *F. pondicerianus*. There was a significant seasonal difference in the amount of insect

consumed ($F = 4.62$, $df = 3$, $P < 0.05$) with highest consumed being in summer (4.15 ± 1.93 g), then winter (2.50 ± 1.44 g), autumn (2.35 ± 1.03 g), and spring (0.56 ± 0.88 g). These findings suggest seasonal changes to the

availability of insects and foraging habit of the birds.

On the other hand, the plants-based food items did not significantly change between seasons ($F = 1.27$, $df = 3$, $P \geq 0.05$), meaning that vegetation-based food resources did not significantly change between seasons. All the statistical operations were done in SPSS (version 25) with a check of data normality and homogeneity of variance. The level of significance (P) of all tests was taken as $P < 0.05$.

DISCUSSION

The current study confirms the omnivorous and monogamous feeding behaviour of the Grey Francolin (*Francolinus pondicerianus*) as reflected in its consumption of both plant and animal food sources in cultivated landscapes of Tahsil Nara. Field observations revealed that the species foraged on millet cones (*Pennisetum typhoideum*), mustard leaves (*Brassica campestris*) as well as various insects, including termites (*Coptotermes formosanus*) and black ants (*Formica rufa*). These findings are consistent with previous reports describing the Grey Francolin as generalist feeder with diverse dietary preferences (Roberts, 1991; Ali and Ripley, 1983). Notably, individuals were observed feeding on both fresh and decomposed cow dung, likely as a behavioral adaptation to access termite colonies, particularly to meet the nutritional demands of chicks during early development, as suggested by Ullah (1991) and Sharma (1983).

A total of eleven dietary components were documented, including eight plant species and three insect groups, reflecting a moderate level of dietary diversity among the studied population. These findings are consistent with those reported by Hussain et al. (2012) in the Pothwar Plateau, where nine distinct food items were identified. However, the diversity observed in the current study is notably lower than that recorded by Khan and Mian (2012) in Lal Suhanra National Park, where the diet comprised 35 plant species and 16 animal taxa. Previous studies by Faruqi et al., (1960), Chaudhry and Bhatti, (1992) and Mian and Wajid, (1994) also produced more detailed dietary profiles as determined by habitat complexity, vegetation diversity as well as regional ecological conditions to foraging strategies. The current discovery based on predominantly agricultural environment is that simplified distributive patterns and situational variation of habitats may be restrictive to the diet of *F. pondicerianus* in the area.

There were differences on dietary intake according to season. Plantation was more prevalent in spring, summer and insect activity was highest in summer and winter. These trends are contrasting with the ones observed in the Lal

Suhanra National park where the highest seed feed was in autumn and winter and insect feed was more evident in spring and summer (Khan and Mian, 2012). These differences could be representing regional variation in the time of cropping, prey density and the structure of microhabitat. The uniformity of grit in the gizzard samples also gives it a necessary role in the mechanical digestion, especially in hard seeds and insect exoskeletons as observed by Kobriger (1977) and Hupp (1980) in research done on the partridge species. The positive association of without positivity outcome amid the grit consumption and the seed consumption plus the negative association of without positivity to the soft food items carry with them an adaptive manner of dealing with the digestion resulting in enhanced nutrient reclamation.

The reason is that findings will give more insight into the feeding ecology of *F. pondicerianus*, and will carry weight in drawing into the fact that heterogeneity of habitat is required to support such a species not only seasonally but also across sites. Future studies should expand the geographical scope of research so that they can provide comparison in different geographical areas to determine how these different geographical areas impact the diet contents. Seasonal variations in food eaten can be elaborated by the profiling of consumed food and its implications on the aptitude of attaining reproductive success. This is a long-term research that can be adapted to breeding behaviour and chicken development so as to find out the efficacy of insect protein on early growth stage. It is furthermore necessary to assess the impacts of agricultural intensification and pesticide use, as well as assess protection origins fragmentation on food supply in order to establish proper conservation programs within the area. GPS tracking and remote sensing can be further used to be integrated in order to understand patterns of movement and habitat use which can add to management strategies. The conservation aspects should also take into consideration the culture of the communities around the areas of conservation whose references undertaken through observations and native words as expressed in this paper gives some nice insights into the behavior of the spy as well as their way with the habitat.

CONCLUSION

This study demonstrates the omnivorous feeding behavior of the Gray Francolin (*Francolinus pondicerianus*), which is a highly adaptive trait, feeding independently both plant and animal matter throughout the year. There were changes in the dieting consumption over seasons as the presence of

plant and insect diet were prominent during the spring and winter, and summer respectively. Such patterns emphasize ecological versatility of the species, and its ability to be changed in response to changes in the habitat and resources. The moderate agroecosystem has been represented by the moderate dietary diversity of the, Nara region, which is not so extensive on the comparatively richer ecological setting such as the Lal Suhanra, National Park, and has represented how the local agroecosystem impacts foraging behavior. The combination of grit that is repeatedly contained in gizzard samples also serves to explain the physiological changes that enable hard-seeds and insect skeletons to be digested.

Comprehensively, the results greatly aid in the ecology of feeding of *F. pondicerianus* and in the need to obtain the heterogeneity in the habitat that can sustain the nutritional requirements of this given species in the across seasons. These are useful findings which form an appropriate starting point in which to control conservation activities, habitat management policies, and ecological initiatives concerned the sustainability of viable populations of the economically and culturally valuable native game bird of Pakistan.

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