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Comparative Study on the Diet Composition of Selected Birds in Okara and Bahawalnagar Districts, Pakistan

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Abstract. This study investigated the dietary composition of wader and terrestrial birds in Pakistan, collecting approximately 30 bird samples. The study sites were Okara and Bahawalnagar Districts. The collected birds were dissected to get the stomach food contents. Gut samples were analyzed to determine food preferences between the two groups. The Common Redshank fed on plant seeds, grasses, weeds, invertebrates and insects. The Night Heron primarily consumed invertebrates, including bivalves, snails, worms, nematodes, beetles, as well as vertebrates like fish and various vegetation. The Common Sandpiper's diet included amphibians, insects, worms, crustaceans, grasses, weeds and seeds. The Laughing Dove mainly ate wheat, seeds, termites and small stones. House Sparrows consumed grasses, seeds, beetles and livestock larvae, while the Red-vented Bulbul ate fruit seeds, mulberry grains, insects, dipteran larvae and corn. Overall, non-waders typically ate grains, grasses and seeds, while waders preferred polychaetes, mollusks, bivalves, snails and worms. The study concluded that wader birds favored animal-based diets, whereas non-wader birds predominantly consumed plant-based foods.

Keywords: wader birds, non-wader birds, food preference, vertebrates, invertebrate, Pakistan

Introduction

The distribution of bird species is typically limited by the availability of essential resources, with food being among the most crucial. A fundamental step in understanding the relationship between birds and their food sources is identifying their dietary intake. This can be achieved through various methods, ranging from direct observation of foraging behavior in the wild to more invasive approaches, such as gut content analysis. Foraging studies are most straightforward in bird species inhabiting open, accessible environments, where the prey species are few, large enough to be observed during ingestion and where both prey abundance and availability are easily quantifiable. Waders are commonly recognized as fitting this description, which likely accounts for their prominence in the foraging literature (Swennen *et al*., 1989; Leopold *et al*., 1989; Meire, 1987; Piersma, 1987; Sutherland, 1982; Zwarts, 1980; Goss-Custard, 1977 and Goss-Custard, 1970). Wading birds belong to the taxonomic order Charadriiformes, which includes many important species recognized as wading birds, totaling around 13 families worldwide. Moreover, shorebirds often exhibit a preference for specific habitats when engaging in foraging activities.

Research into the feeding behavior of water birds, particularly wading birds, suggests they are highly effective at foraging even in challenging conditions Krebs (1978). During aerial surveys at Grays Harbor in the fall of 1993 and 1994, 265 and 210 medium-sized sandpipers, respectively, were recorded and subsequently classified as dowitchers, based on the predominance of dowitchers observed in the fall 1992 survey. In the spring of 1993, 28,690 medium-sized sandpipers recorded during aerial counts were allocated to Red Knots and dowitchers, proportionally aligned with ground counts conducted before and after the aerial survey, which identified 110 Red Knots and 5,965 dowitchers Page, Stenzel *et al*. (1999). Highly migratory waders are typically located in Arctic and temperate regions, demonstrating significant migratory patterns, whereas tropical residents often travel mainly during the rainy season. Smaller species, such as calidrids or "sandpipers", are primarily found in coastal areas, although the term "sandpipers" can be misleading, as exemplified by the plateau sandpiper, which inhabits grasslands. Wading birds, including sandpipers, have

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a varied diet consisting of small fish, crustaceans, mollusks and additional food sources, extending to insects and small reptiles found on land. Overall, these birds exhibit a broad dietary range, foraging from both wetland and terrestrial sources, unlike non-wading birds that do not inhabit areas near water bodies Stroud *et al.* (2006). This study aims to enhance our understanding of critical factors such as foraging patterns and ecological interactions, which are vital for their prey relationships. The research is particularly significant given the limited studies on wading birds in this region and their connections to prey behavior. The scarcity of comprehensive morphological data highlights the importance of this ongoing research in Larkana, which seeks to delve into the complexities of wading bird characteristics and improve our understanding of their foraging ecology and feeding habits Hicklin and Smith (1984). The main goal of this study was to evaluate and compare the feeding composition and preferences of migrating wader birds and terrestrial birds during the winter season in Pakistan.

Materials and Methods

Study area and duration. This research was carried out in the districts of Okara and Bahawalnagar, located in the province of Punjab, Pakistan. This site was selected because many of birds were accessed easily. The study spanned a period of 12 months, from March 2021 and concluding in February 2022. This can be seen in Fig. 1.

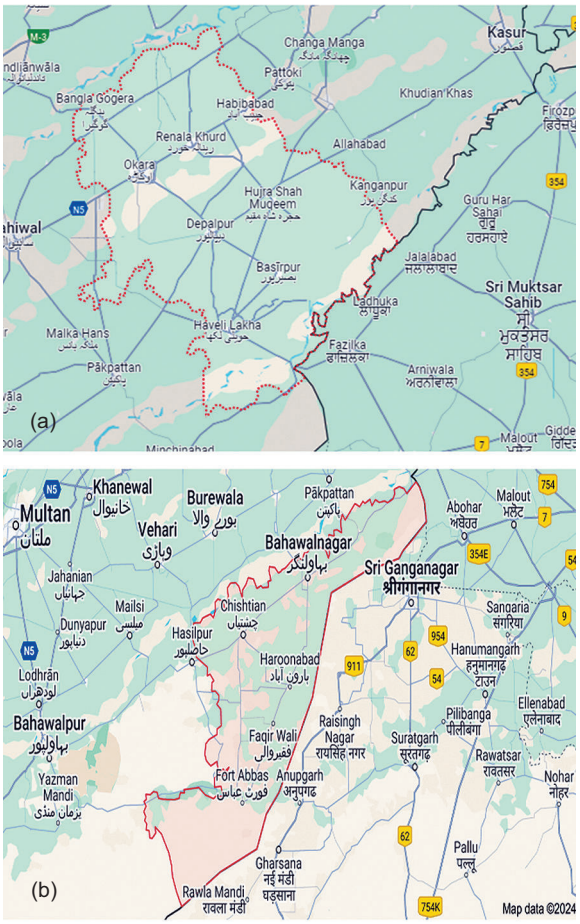

Fig. 1. The maps of study site.

Study species. The food composition of four wader birds, including the Common Red Shank (*Tringa totanus*), Night Heron (*Nycticorax nycticorax*) and Common Sandpiper (*Actitis hypoleucos*), along with four non-wader birds such as Laughing Dove (*Streptopelia senegalensis*), House Sparrow (*Passer domesticus*), House Crow (*Corvus splendens*) and Red Vented Bulbul (*Pycnonotus cafer*) was analyzed during the work Tsipoura and Burger (1999).

Field visit. A field visit was executed every weekend to gather samples, with designated areas allocated for each month. The animals were promptly shot and frozen using dry ice, maintaining their frozen state until dissection of the alimentary tract. The stomach and proventricular contents of each bird were preserved in 95% alcohol Reeder (1951). Two visits were carried out at sites in Okara and two visits were conducted at sites in Bahawalnagar. This process resulted in a total of 48 visits to the field for data assessment. It is worth noting that on certain occasions *i.e.*, either foraging for food and during resting period, no samples were encountered during the visits. The study comprised of both waders and non-wader birds.

Diet assessment and samples collection. To gather data, 30 samples of each bird type were collected with the assistance of local hunters in the designated areas.

Following dissection, gut samples from both waders and non-wader birds were meticulously separated, aiming to uncover and analyze their respective food preferences.

Local hunters assisted in collecting 30 gut samples from each sampled bird to examine and analyze the feeding preferences of both waders and non-wader birds. The hunters from market was called and asked them to hunt the specific birds for sampling. The samples were

collected individually in separate containers and were stored.

Sample placement and dissection. Birds captured in the field underwent immediate dissection after reaching in the laboratory to extract their gastrointestinal tracts. The extracted gastrointestinal tracts of each sampled bird were carefully packed in individual polythene bags. Subsequently, each bag was labeled with the respective field number and the date of collection. These labeled samples were then placed in an icebox for transportation to the laboratory, where further processing and detailed analysis were conducted Duffy and Jackson (1986).

Dietary composition. In the university laboratory, additional processing of the samples was undertaken to discern the dietary composition of birds throughout their life. The compound microscope played a pivotal role in identifying the specific food consumed by the birds.

Statistical analysis. The data collected underwent analysis utilizing standard statistical methods, including the calculation of positive frequency with samples. IBM SPSS software (version 21) was employed for these statistical analyses Fernandez *et al*. (1997).

Results and Discussion

The objective of the current study was to analyze the food habits of wader birds, specifically the Common Red Shank, Night Heron, Cattle Egret and Common Sandpiper, along with non-wader birds such as Laughing Dove, House Sparrow, House Crow and Red Vented Bulbul.

Wader birds. ***Common Redshank, Night Heron and Sandpiper.*** The Table 1 presents a comparative analysis of the dietary preferences of three bird species: Common RedShank, Night Heron and Common Sandpiper, each with 30 samples.

Common Redshank primarily consumes both plant materials and invertebrates. Grass is the most frequently consumed item (97%), followed by polychaetes (93%) and molluscs (87%). Weeds, nuts and nematodes are also significant components of their diet, with frequencies ranging from 53% to 63%. Fish is a minor part of their diet (7%). Night Heron shows a preference for vertebrates, particularly fish (87%), with limited consumption of invertebrates such as polychaetes (23%) and isopods (13%). It consumes fewer plant materials, with no presence of grass, weeds, or other plant items. Common Sandpiper demonstrates a balanced diet between plant materials and invertebrates. Suaeda/grains (97%) and weeds (93%) are prominent plant materials, while invertebrates like insects (80%), worms (63%) and crustaceans (73%) form the bulk of their non-plant diet. Amphibians are consumed occasionally (30%).

Terrestrial birds. ***Laughing Dove and House Sparrow.*** Laughing Dove primarily feeds on seeds (53%) and termites (40%), indicating a preference for both plant and invertebrate materials. It also consumes grasses (43%), wheat (23%) and occasionally ingests stones (33%) to aid digestion. House Sparrow has a mixed diet that includes grains (27%), seeds (23%) and livestock feed (20%). Digested food is also significant (27%), while wheat (10%), beetles/dipteran larvae (10%) and sorghum (7%) are consumed to a lesser extent. This is shown in Table 2.

Red Vented Bulbul and House Crow. Red Vented Bulbul shows a strong preference for seeds (60%) and corn grains (50%), while grains (43%) and digested food (53%) form a substantial part of its diet. In addition, beetles and dipteran larvae (30%) are also consumed, making it reliant on both plant materials and invertebrates. House Crow primarily consumes grains (50%) and livestock feed (40%), with feathers (33%) making up a notable part of its diet. Unlike the other species, it shows no consumption of seeds, termites, or plant materials like grasses as detailed in Table 2.

The research was carried out in the districts of Okara and Bahawalnagar to examine and compare the dietary components of wader birds and terrestrial birds. Various species of wader birds, including the Common Red Shank, Night Heron and Common Sandpiper, were chosen for the study. Additionally, terrestrial birds such as the Laughing Dove, House Sparrow, House Crow and Red-vented Bulbul were included in the investigation. This study builds upon previous research efforts in the Goss-Custard and Jones (1976). Researchers closely observed the feeding ecology of Redshank birds, documenting their consumption of a variety of items such as worms, large silvery objects, shrimps, Crangon species and small fishes from aquatic environments.

Certain Redshanks were noted to feed on marshes at the beach's top, consistently consuming bivalve mollusks and worms. Recognizable substances, including hard slices resembling pellets, were also identified in their diet. Some Redshanks were observed feeding on the

Table 1. The frequency of different diet contents in wader birds

	Common Redshank (n=30)		Night Heron (n=30)		Common SandPiper (n=30)		
Type of food	Positive samples	Frequency	Positive samples	Frequency	Positive samples	Frequency	No of bird species consumed
Plant materials							
Grass	29	97	9	30	26	87	3
Weeds	16	54	-	-	28	93	2
Suaeda/grains	2	7	-	-	29	97	2
Unidentified/nuts	19	63	-	-	25	83	2
Invertebrates							
Polychaetes	28	93	7	23	-	-	2
Isopods	12	40	4	13	-	-	2
Molluscs	26	87	6	20	-	-	2
Chironomids	1	3	2	7	-	-	2
Nematodes	16	53	-	-	-	-	1
Insects	1	3	-	-	24	80	2
Worms	-	-	-	-	19	63	1
Beetles	-	-	3	10	-	-	1
Crustaceans	-	-	-	-	22	73	1
Terrestrial insects	-	-	-	-	20	67	1
Vertebrates							
Fish	2	7	26	87	-	-	2
Amphibians	-	-	-	-	9	30	1
Other items							
Grit	26	87	-	-	-	-	1

Table 2. Gives the frequency of food in different terrestrial birds

	Terrestrial birds							
	Laughing Dove		House Sparrow		Red Vented Bulbul		House Crow	
Type of Food	Positive samples	Frequency	Positive samples	Frequency	Positive samples	Frequency	Positive samples	Frequency
Wheat	7	23	3	10	-	-	-	-
Seeds	16	53	7	23	18	60	-	-
Termites	12	40			-	-	-	-
Stones	10	33	8	2	-	-	-	-
Grasses	13	43			-	-	-	-
Grains	-	-	8	27	13	43	15	50
Beetles/ Dipteran larvae	-	-	3	10	9	30	-	-
Livestock Feed	-	-	6	20	-	-	12	40
Un identified plant material	-	-	6	20	-	-	-	-
Digested food	-	-	8	27	16	53	-	-
Sorghum	-	-	2	7	-	-	-	-
Dipteran larvae	-	-	-	-	-	-	-	-
Corn grains	-	-	-	-	15	50	-	-
Feathers	-	-	-	-	-	-	10	33

meat of cockles either released by other birds or spoiled by cockle fishermen. At times, they even seized Lanice from Curlews. The investigation involved the dissection and analysis of different types of food in the gut and stomach of Common Redshank birds. The analysis revealed five main categories: plant leaves, plant seeds, invertebrates, vertebrates and non-living materials like pebbles. Plant leaves, particularly grasses and weeds, were prevalent, with 96.67% of the sampled birds showing traces of these in their gut and stomach, indicating a significant consumption of grasses. Invertebrates, including polycheates, isopods, mollusks, chironomids, nematodes and insects, were prominently present, with chironomids and nematodes specifically noted. These materials collectively comprised the invertebrate type of food. Additionally, fish material and grit were also identified in the gut. The Japanese Night Heron, an endangered bird species breeding in Japan, was highlighted in the researchers' reports (Kawakami *et al*., 2005; Hancock *et al*., 1978; Kiyosu, 1978), the bird's diet encompasses earthworms, crustaceans, fishes and insects; however, there is a variation in the identified key food substances among different authors.

Others Kiyosu (1978) and Yamashina (1980) found earthworms and freshwater crabs as chief food objects, while Hancock *et al*. (1978) claimed that crustaceans, tiny fishes and insects were the key food. Pellets were also observed but millipedes were not seen Kawakami *et al*. (2005). Throughout the course of this study, I observed the feeding habits of the Night Heron, noting its diverse dietary preferences encompassing invertebrates, vertebrates and vegetation. Among the invertebrates, the bird's diet included bivalves, snails, worms, nematodes and beetles. In the sampled group of 30 birds, Common Redshank primarily consumes both plant materials and invertebrates. Grass is the most frequently consumed item (97%), followed by polychaetes (93%) and molluscs (87%). Weeds, nuts and nematodes are also significant components of their diet, with frequencies ranging from 53% to 63%. Fish is a minor part of their diet (7%). Night Heron shows a preference for vertebrates, particularly fish (87%), with limited consumption of invertebrates such as polychaetes (23%) and isopods (13%). It consumes fewer plant materials, with no presence of grass, weeds, or other plant items.

The research findings indicate that Common Sandpipers exhibit a diverse feeding behavior, primarily foraging on rocks, pebbles, shells, sand and clay. Their feeding habitats extend beyond areas devoid of plant flora, as they are known to navigate mangrove and rainforest environments, frequently found near borderline regions Swennen (1977). In this study, the feeding ecology of Common Sandpipers were explored, a balanced diet between plant materials and invertebrates. Suaeda/grains (97%) and weeds (93%) are prominent plant materials, while invertebrates like insects (80%), worms (63%) and crustaceans (73%) form the bulk of their non-plant diet. Amphibians are consumed occasionally (30%). These findings shed light on the versatile and adaptive feeding habits of Common Sandpipers across various ecological niches.

The Laughing Dove, predominantly found in India, has been extensively observed, particularly in Lucknow, Uttar Pradesh. A study conducted between July 2005 and June 2006 documented its dietary habits, revealing a diverse array of food sources. Laughing Doves were observed consuming millet, wheat and rice, along with seeds from various grasses, roses and sunflowers. Notably, the study identified 11 species of weeds as a significant food source for the Laughing Dove. In addition to plant-based materials, the bird's diet included animal components such as ants, termites, spiders and dipteran larvae. These findings provide valuable insights into the Laughing Dove's dietary preferences and contribute to our understanding of its ecological role in the specified region Mazumdar and Kumar (2008). In the course of this study, Laughing Dove primarily feeds on seeds (53%) and termites (40%), indicating a preference for both plant and invertebrate materials. It also consumes grasses (43%), wheat (23%) and occasionally ingests stones (33%) to aid digestion. These observations contribute valuable data to our understanding of the feeding habits and dietary preferences of the sampled bird population.

Sparrows are predominantly found in areas with thick vegetation, including trees and shrubs such as Babul, Kaner, Ber, lemon trees, Guava, pomegranate, Custard apple, bottlebrush, chandni, Chameli and Mehendi. Additionally, they exhibit a preference for plants like Bougainvillea and *Combretum indicum*. Home-based gardens, with their diverse plant life, often serve as rich sources of food for sparrows, especially when artificial feeding options are made available. Despite this, it is noted that currently, only a limited number of people are actively providing supplementary feed for these birds Shaw, Chamberlain *et al*. (2011). This study

involved house Sparrow has a mixed diet that includes grains (27%), seeds (23%) and livestock feed (20%). Digested food is also significant (27%), while wheat (10%), beetles/dipteran larvae (10%) and sorghum (7%) are consumed to a lesser extent. These findings provide valuable insights into the diverse feeding habits of the sampled bird population, contributing to our understanding of their dietary preferences.

During the reproductive period of the Red Vented Bulbul, researchers observed its diet and identified insects, grasshoppers, aphids, spiders, cockroaches, honey bees and dragonflies as the primary food supplements. Notably, these food items were chosen for their higher protein content. The study recorded instances of two pairs of Red Vented Bulbuls feeding on junk food, indicating that this alternative food source was deemed more suitable than other supplements during the reproductive phase. These findings shed light on the specific dietary preferences and adaptations of the Red Vented Bulbul during crucial periods of its reproductive cycle Chishty *et al*. (2021). During this study, Red Vented Bulbul shows a strong preference for seeds (60%) and corn grains (50%), while grains (43%) and digested food (53%) form a substantial part of its diet. In addition, beetles and dipteran larvae (30%) are also consumed, making it reliant on both plant materials and invertebrates. These findings contribute valuable insights into the diverse food preferences and foraging habits of the sampled bird population, enhancing our understanding of their dietary ecology.

Conclusions

To conclude, the study revealed that there were distinct feeding patterns between non-wader and terrestrial birds. Terrestrial birds were primarily observed feeding on grains, grasses and various seeds and weeds. In contrast, wader birds showed a preference for invertebrates, such as polychaetes, molluscs, bivalves, snails and worms. The gut analysis from the study indicated that wader birds mostly consumed animal-based food, whereas non-wader birds relied mainly on plant-based food. This highlighted the dietary diversity among avian species and contributed to a better understanding of the ecological roles played by different bird groups.

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Conflict of Interest. The authors declare that they have no conflict of interest.

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