DETERMINING THE RELATIVE ABUNDANCE OF, HABITAT PREFERENCES OF AND OCCURENCES OF GASTROINTESTINAL PARASITES IN COMMON CRANE AND DEMOISELLE CRANE INHABITING THREE DISTINCT HABITATS

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Abstract. Understanding the behavior of crane species is highly important for conservation and management activities. Unfortunately, cranes are facing deleterious threats due to human intervention, i.e., habitat loss and degradation, trapping and illegal hunting. This research's primary goals were to assess the relative quantity of cranes, the prevalence of gastrointestinal parasites, and their endangerment at three separate study sites; River Indus (S_1), River Kurram (S_2) and Zara Dagger (S_3). From 2019 to 2022, four years straight, the line transects surveys approach was used during the migratory season (November to March). In total, 1874 crane bird individuals, comprising 822 common cranes and 1052 demoiselle cranes were observed. The results about habitat preference indicated that demoiselle crane – *Grus virgo* and common crane *Grus grus* frequently utilized the River Indus (S_1 = 20.238%) and River Kurram (S_2 = 22.512%) especially grassland while in Zara Daggar (S_3) they heavily utilized the semi–sandy habitat (39.114%). The results of crane diversity analysis revealed that demoiselle crane – *G. grus* and common crane – *G. virgo* diversity indices varied among three distinct habitats. In Indus River the higher diversity index was determined for common crane (H' = 0.3524 and D = 1.252) and species richness and uniform distribution for demoiselle crane. In Kurram river, the prevalent diversity index (H' = 0.2363 and D = 1.136), species richness (R = 0.1879 and Mn = 0.1397) and species evenness (E_1 = 0.3323 and E_2 = 0.2092) was ascertained for common crane than demoiselle crane. Likewise, in Zara Daggar, the higher diversity indices were determined for common crane than demoiselle crane. Three parasite species, i.e., *Ascaridia* sp. (21.127%), *Fasciolopsis* sp. (18.309%) and *Echinochasmus* sp. (15.845%) were especially abundant in faeces of cranes. On the contrarily, the *Syngamus trachea* (0.352%) was the lowest parasite in the faeces of cranes. The highest parasite relative abundance was detected in Zara Daggar (S_3; 120 parasites; 42.253%) and the lowest one in River Indus (S_1; 28.169%). This demonstrated that both crane species were inflected by different parasite species. Additionally, people's perspectives suggested that habitat loss and degradation, illegal hunting, and poaching are the main sources of harmful risks to crane species.
Keywords: *habitat, cranes, threats, nematodes, Pakistan*

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Introduction

Cranes are large, elegant and attractive migrant bird species having long necks, legs, and lifespans. They often prefer diverse habitats, i.e., marshlands, grasslands, swamps, wetlands, waterlogged areas and paddy fields for foraging, loafing and breeding purposes. Determining and understanding the distribution, habitat preference, food consumption, conservation status, current population trend and threats are vitally important factors that helps in conservation and management (Morris, 2003). Habitat productivity, occurrence of food resources, and threats are vitally important factors that affect the survival and reproduction (Block and Brennan, 1993; Martin and Schwab, 2013). Detailed information about these factors helps in conservation and management activities to enhance the population and reduce external influence on bird assemblages across different habitats (Jones, 2001; Cañadas et al., 2005; Benhamou and Riotte-Lambert, 2012).

Cranes are among the most beautiful bird species, they often congregate in flocks and dance that uplift people's spirits (Landfried, 1991). It has been reported that around fifteen species of crane exist in the world, 8 species in Asia and 4 species in Pakistan (OBC, 2011). They species had occupied a wide range of different habitats except Antarctica (Harris and Mirande, 2013). According to Meine and Archibald (1996) out of 15 species, 13 utilized the wetland habitats to perform different activities. Cranes are most susceptible to wetland habitat loss and degradation. Hence, they can be used bioindicators to determine changes in wetland habitat productivity and suitability. Even fewer crane species, like the Blue Crane – *Anthropoides paradisea* and the Demoiselle Crane – *G. virgo*, are in danger due to land use conversion, such as agriculture expansion and deforestation for human settlements.

Notably, out of 15 species, four species namely, Demoiselle cranes – *G. virgo*, Sarus cranes – *G. antigone*, Siberian cranes – *G. leucogeranus*, and Common cranes – *G. grus* are regular winter visitor of Pakistan (Mehmood et al., 2011). The visiting of Pakistan during winter reason could be due to availability of one of seven major flyways, i.e., Indus Flyway (green route). This green route has been widely utilized by different migrant bird species, e.g., cranes, waders, flamingos, geese, ducks, falcons and eagles. These migratory birds passed and even also used the Hindu Kush mountains, Suleiman mountains, Karakorum mountains and Himalayan region during their journey to exploit different habitats (Ali and Khan, 2007).

Cranes utilized the Indus Flyway during winter for arrival to Pakistan and departure to their native country. They utilized the wide array of habitats of Pakistan during winter. The migrant crane species use the Indus, Kurram, Gambela, Kashew, and Gomal Zam rivers during the migration period, i.e. September to March, and then return to their origin (Farooq, 1992; Khan, 2004). Cranes are migrant species, i.e., navigate Pakistan on their migratory route (Indus Flyway) and spend most of their time foraging in wetlands and agricultural areas (Allen et al., 2006). According to IUCN Red List, the conservation status of Demoiselle cranes is 'Least Concern' according to Sarwar et al. (2021). In, Pakistan, this species faces a wide range of threats across Pakistan, such as; pesticides, illegal trapping for pet purposes and hunting for food, limited food resources, and habitat loss (Masaud et al., 2010; Perveen and Khan, 2010). However, in other regions of the world demoiselle cranes are shot or poisoned, because they caused damage to agriculture yields (Farooq, 1992). These detrimental factors posed great threats to the cranes; as a result, their populations declined globally (Horwich, 2001).

Ascertaining the relative abundance, habitat preferences, diversity indices, gastrointestinal tract parasites (indo-parasites), and endangerment are significant factors

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that provide detailed information about current conservation status, population trends, threats, and occurrence of parasites. This information helps to formulate a suitable conservation and management plan in the future. Hence, the objective of the present study was to determine the relative abundance, habitat preferences, diversity indices, gastrointestinal tract parasites, and endangerment of three crane species inhabiting three distinct habitats, i.e., grassland, semi-desert, and agriculture fields.

Materials and Methods

Study Area

The present study was conducted in three distinct habitats, i.e., grassland, semiarid, and agriculture fields. These habitats are within the deltaic areas of the Indus River, Kurram River, and Zara Daggar (*Figure 1*, *Table 1*).

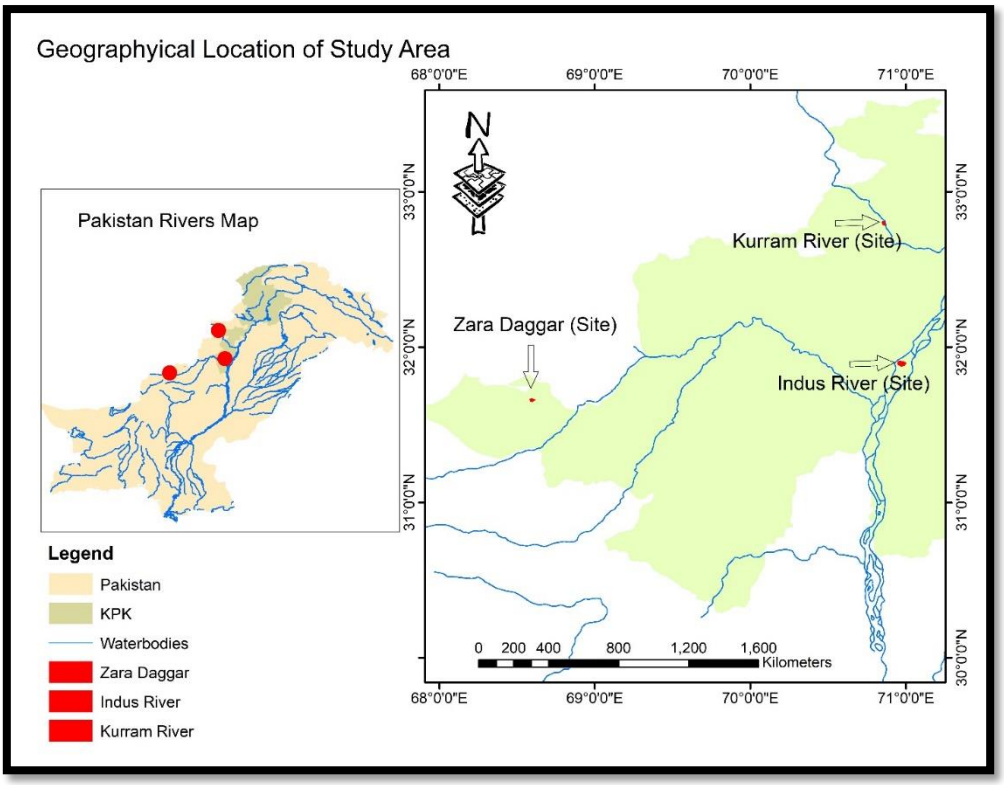

Figure 1. *Location map of three distinct study areas*

Table 1. *Showing the conducted work study areas*

Habitat Type	Vegetation	Area (ha)	Location	Elevation (M)
River Indus (S_1) Semiarid plains	Lack of vegetation due to constant flow of water	1740	31°54' 48" N 70° 57.4' 41"E	170 M asl
Kurram River (S_2) Grassland	Common reed – *Phragmites australis* Egyptian clover – *Trifolium alexandrinum*, Halfa grass – *Desmostachya* bipinnata	590	32° 47' 32" N, 70° 51' 31.02" E	274 M asl
Zara Daggar (S_3) Intermittent dry lake	*Astragalus species*, *Chrysopogon aucheri*, *Cymbopogon jwarancusa*	1725	31° 39' 42" N 68° 34' 37" E	1946 M asl

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Field Surveys

In this study, we used line transect surveys to document crane distributions and habitat use. This method is widely employed to determine the relative number and dispersion of wildlife species. Because, this technique assumed that all fauna species are detected at the initial locations (Buckland et al., 2010; Glennie et al., 2015; Owusu, 2019). Different strips were used to split up each habitat based on easy access and obtained reliable data while conducting the surveys. The data was collected from 08:00 and 19:00 hours from 2019 to 2022. From October through March, the surveys were carried out. These months were most suitable since cranes migrate and used these habitats for feeding and reproduction throughout these months. The survey was conducted in each habitat for one week each month. The polls were conducted on every other month basis. In all, 72 surveys were undertaken (each year, 6 surveys were conducted in each habitat; over the course of four succeeding years, 24 surveys were completed; three habitats served as study areas; 6 months per year x 4 years = 24 x 3 habitats = 72 total). In addition, Nikon D7200 digital camera having Sigma 150-600 mm lens was used to capture the crane flock and 10 x 42 binocular was also employed for closer view and crane identification. In order to get accurate detections, several investigations have been carried out using high resolution photographs captured by DSLR cameras (Chabot and Bird, 2015; Hodgson et al., 2018; Lyons et al., 2019). Through pictures, one may objectively determine the relative abundance of birds due to low biasness (Cruz et al., 2015).

Gastrointestinal Parasites Sampling: The feces samples from three study sites were collected early November and March from 2019 to 2022 employing a non-invasive sample approach. From the study sites, a total of, 292 fresh feces samples of the gastrointestinal system were collected. In addition, the digestive tracts of slaughtered cranes were obtained from hunters. In addition, around 45 samples (each year 15 samples) were collected from hunters to investigate the parasites. The digestive tract was dressed to obtain the fresh feces sample. The samples were put into clean and labeled polyethylene bags, which were subsequently delivered to the Department of Zoology at Government Girl's College No. 2 Dera Ismail Khan for immediate parasitology examination, or occasionally held at 4 °C.

Processing of Feces Samples and GI Tracts

Feces samples were processed using the simple flotation procedure in a saturated salt solution. The GI tracts were longitudinally opened with sterile scissor to examine the parasites. Flotation and sedimentation technique was applied to treat the samples. To determine the propagule size, shape, wall width, and internal components of the parasite's morphology were examined. One gram of fresh faces was mixed in saturated saline solution (1.195 g/l) and centrifuged for five minutes at speed of 3000 rpm. After that, the slides were prepared from the supernatant. After three minutes, the total number of parasite slides was counted using 100 or 200 folds amplification. The adult parasites that were extracted from the GI tracts were stored in 10% formalin for identification. The adult parasites were extracted from the GI tracts and stored in 10% formalin for identification. In addition, the direct wet mount technique was employed using microscope to identify the occurrence of helminthic eggs and *Eimeria oocysts* from gut contents. A test was done utilizing the direct wet mount approach and the basic flotation technique.

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Data Analysis

Each sample site's cranes and parasite species richness index; R_1 (the total number of parasite species), diversity index; H′ (variation and variability) and evenness index; E (dispersion in the numbers) of parasites at the taxa level were determined through applying Community Analysis Package (Version 4.5).

Relative Abundance (%): It is the total number of bird crane individuals per species that occupied particular habitat.

$$\text{Relative species abundance } (\%) = \frac{\text{Isi}}{\sum \text{Nsi}} \times 100 \quad \text{(Eq.1)}$$

where, ISi = the number of particular crane individuals, /∑Nsi = total number of crane species.

Species Diversity: The diversity is a variation and variability among crane species occupied the dwelling habitat. For example; *Shannon's Diversity Index* is calculated employing *Equation 2*;

$$H' = \sum[(\text{pi}) \times \ln(\text{pi})] \quad \text{(Eq.2)}$$

where, H' designates diversity, S indicates the number of crane species, *i* specifies the abundance of species, *N* is the total number of all crane individuals, p_i is the relative abundance of each species, and ln is the natural logarithm.

Simpson Diversity Index (Equation 3);

$$D = \sum(ni * (ni - 1)/(N - 1)) \quad \text{(Eq.3)}$$

where, Ni = Number of individuals in the *ith* species and N = total number of individuals in the community.

Species Richness Index: It is the number of different crane bird species in a particular habitat. Moreover, it provides the data on the homogeneity and irregularity of crane distribution and occurrence. For example; *Margalef's Richness Index (Equation 4);*

$$R1 = (S - 1)/\ln N \quad \text{(Eq.4)}$$

where, S is the total number of species and N is the total number of individuals in the sample.

Menhinick Index (Mn): It is an index based on the relationship between the number of species (S) and the square root of all the species (N). This index was compared the crane species occurs in three distinct habitat. It can be calculated through *Equation 5*;

$$Dn = S/\sqrt{N} \quad \text{(Eq.5)}$$

where, N = the total number of individuals in the habitat and S the species number.

Species Evenness Index: It is the degree of the relative abundance of crane bird species occurs in a particular habitat.

McIntosh Evenness Index ($E_{1,2}$): It uses the geometry to represent how heterogeneous a sample is? It takes the Euclidean distance of the sample's point from the origin and

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characterizes it as a point of an "S"-dimensional hyper volume. It can be determining using *Equation 6*;

$$D = \frac{N - U}{N - \sqrt{N}} \; E_1 \quad \text{(Eq.6)}$$

where, N = the total number of crane individuals in the habitat and U = given by expression;

$$U = \sum ni^2 \; E_2 \quad \text{(Eq.7)}$$

where, *n*(i) = the total number of individuals in the ith species, and all the species are added together. When represented in an S-dimensional hyper volume, U represents the community's Euclidean distance from the origin.

Menhinick's Evenness Index;

$$E_2 = HB / HB_{MAZ} \quad \text{(Eq.8)}$$

where, HB_{MAX} is calculated as;

$$HB_{MAZ} = 1/N \; 1n \frac{N!}{\{[N/S!\}s-r\,\{(N/S]+1)!\}r} \quad \text{(Eq.9)}$$

with [N/S] = the integer of N/S, and r = N – S[n/S].

Habitat Use and Preference: The Habitat use was calculated by the number of crane flocks occurring in each habitat type as a percentage of all crane flocks observed.

Parasite's Identification

By identifying parasite propagule in faeces droppings, the prevalence of parasite species was determined (eggs or oocysts). Eggs and oocysts per gram (EPG/OPG) in faeces samples were measured. The variety of parasites was described in terms of their richness, diversity, and evenness. Parasites were identified using Veterinary Parasitology (Taylor et al., 2015).

Results

Relative Abundance

The results of relative abundance revealed that throughout the migratory seasons from 2019 to 2022, only two species the Demoiselle crane – *G. grus* and Common crane – *G. virgo* used the three sites River Indus, Kurram River, and Zara Daggar, each of which had three distinct habitats (grassland, semi-sandy, and agriculture). Each crane species may have different habitat preferences. In total, 1874 crane bird individuals, comprising 822 common cranes and 1052 demoiselle cranes, were documented. The findings demonstrated that both cranes significantly used grassland habitats (20.238%) in the Indus River Indus (S_1) habitat, followed by agriculture habitats (1.654%). The demoiselle crane displayed a semi-sandy habitat less preferred, whereas the common crane entirely avoided utilizing it (*Table 2*).

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Table 2. *Comparison of relative abundance and habitat preference of demoiselle cranes and common cranes in three different sites and distinct habitats*

Name of Site	Name of Habitat	Name of Species		Total Detections	%	Area (Hectare)
		Common crane	Demoiselle crane			
Indus River (S_1)	Grassland	173	210	383	20.438%	32 ha
	Semi-sandy	0	12	12	0.640%	1037 ha
	Agriculture	22	9	31	1.654%	671 ha
	Sub–Total	**195**	**231**	**426**	**22.732%**	**1740 ha**
Kurram River (S_2)	Grassland	192	230	422	22.519%	244 ha
	Semi-sandy	13	6	19	1.014%	267 ha
	Agriculture	0	0	0	0	79 ha
	Sub–Total	**205**	**236**	**441**	**23.533%**	**590 ha**
Zara Daggar (S_3)	Grassland	44	68	112	5.976%	90 ha
	Semi-sandy	310	423	733	39.114%	1495 ha
	Agriculture	68	94	162	8.645%	140 ha
	Sub–Total	**422**	**585**	**1007**	**53.735%**	**1725 ha**
	Grand Total	**822**	**1052**	**1874**		

The Kurram River (S_2) site's findings were also quite intriguing. Both crane species, including the Demoiselle crane – *G. grus* and Common crane – *G. virgo*, were more prevalent exploiters of grassland habitat (22.512%) than of semi-sandy habitat (1.014%). However, neither Demoiselle crane – *G. grus* nor Common crane – *G. virgo* used the agricultural habitat at all (*Table 2*).

Additionally, the relative abundance of Zara Daggar (S_3) was very different from that of the Kuram River (S_2) and the Indus River (S_1) For instance; the Demoiselle crane – *G. grus* and Common crane – *G. virgo* utilized each of the three habitat types. However, the relative abundance of each species and habitat preference may vary. For instance, the semi-sandy habitat was foremost frequently used by both species (39.114%), followed by agriculture (8.645%) and grassland (5.976%), respectively (*Table 2*).

Comparison of Crane Diversity Indices among Three Distinct Habitats

The community analysis results demonstrated that demoiselle crane – *G. grus* and common crane – *G. virgo* diversity indices varied among three distinct habitats. Indus River harbored the predominant diversity of common crane (H' = 0.3524 and D = 1.252). However, the highest crane species richness and uniform distribution was detected for demoiselle crane in Indus river habitat. The finding indicated that Kurram river habitat attracted the higher diversity index (H’ = 0.2363 and D = 1.136), species richness (R = 0.1879 and Mn = 0.1397) and species evenness (E_1 = 0.3323 and E_2 = 0.2092) than demoiselle crane. Moreover, results also showed that common crane species have higher species richness (R1 = 0.1879 and Mn = 0.1397), species diversity (H' = 0.2363 and D = 1.136), and species evenness (E1 = 0.3323 and E2 = 0.2092) in Zara Daggar habitat than other habitat (*Table 3*).

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Table 3. *Comparison of crane diversity indices among three distinct habitats*

Habitat	Shannon's Index (H')	Simpson's Index (D)	Margalef's Index (R_1)	Menhinick Index (Mn)	Brillouin Index (E_1)	McIntosh's Index (E_2)
Indus River **(S_1)**						
Common crane	0.3524	1.252	0.1896	0.1432	0.5012	0.5084
Demoiselle crane	0.3667	1.205	0.3675	0.1974	0.3247	0.3338
Overall	0.3869	1.229	0.3303	0.1454	0.3466	0.2308
Jackknife Standard Error	0.0017	0.0091	0.0138	0.0178	0.0009	0.0016
Kurram River **(S_2)**						
Common crane	0.2363	1.136	0.1879	0.1397	0.3323	0.2092
Demoiselle crane	0.1185	1.052	0.1830	0.1302	0.1627	0.0856
Overall	0.1776	1.0900	0.1642	0.09524	0.2512	0.1438
Jackknife Standard Error	0.0225	0.0158	0.0068	0.0116	0.0325	0.0237
Zara Daggar **(S_3)**						
Common crane	0.7565	1.738	0.3309	0.146	0.6855	0.5696
Demoiselle crane	0.7784	1.781	0.3139	0.1240	0.7063	0.592
Overall	0.7694	1.762	0.2892	0.0945	0.6989	0.5827
Jackknife Standard Error	0.0041	0.0082	0.0108	0.0117	0.0038	0.0042

Relative Abundance of Parasites in Three Distinct Study Sites

In total, 292 faeces samples of Demoiselle crane – *G. grus* and Common crane – *G. virgo* were collected from three distinct sites to determine the occurrence of parasites. Out of 292 samples, the parasites were founded in 284 samples. This reflected that *G. grus* and *G. virgo* crane species are infected by a wide range of parasites. The parasite species that were most prevalent in our study were *Ascaridia* sp. (21.127%), *Fasciolopsis* sp. (18.309%), and *Echinochasmus* sp. (15.845%). On the other hand, the *Syngamus trachea* (0.352%) was the least common parasite found in crane faeces. A higher relative abundance of parasites was detected in the Zara Daggar study site (i.e., 120 parasites; 42.253%) while the occurrence of parasites in the rest two study sites was quite similar, i.e. River Indus (S_1; 28.169% and Kurram River site (S_2; 29.577%. Moreover, the faeces test findings demonstrated that the relative abundance of parasite species varied from species to species and site to site. For example; in the River Indus study site, *Capillaria* sp. was the prevalent parasite (6.690%) and *Syngamus trachea* (0.352%) was the rarest parasite. Similarly, at the River Kurram (S_2), the parasite *Fasciolopsis* sp. was more prevalent in the faeces samples than in *Syngamus trachea* and tapeworms (6.690%). Likewise, at Zara Daggar (S_3), the *Ascaridia* sp. (21.127%) and *Fasciolopsis* sp. (19.014%) were the most prevalent parasites, whereas no Hymenolepis sp. or Syngamus trachea individuals were found in the faeces samples (*Table 4 and Figures 2, 3*).

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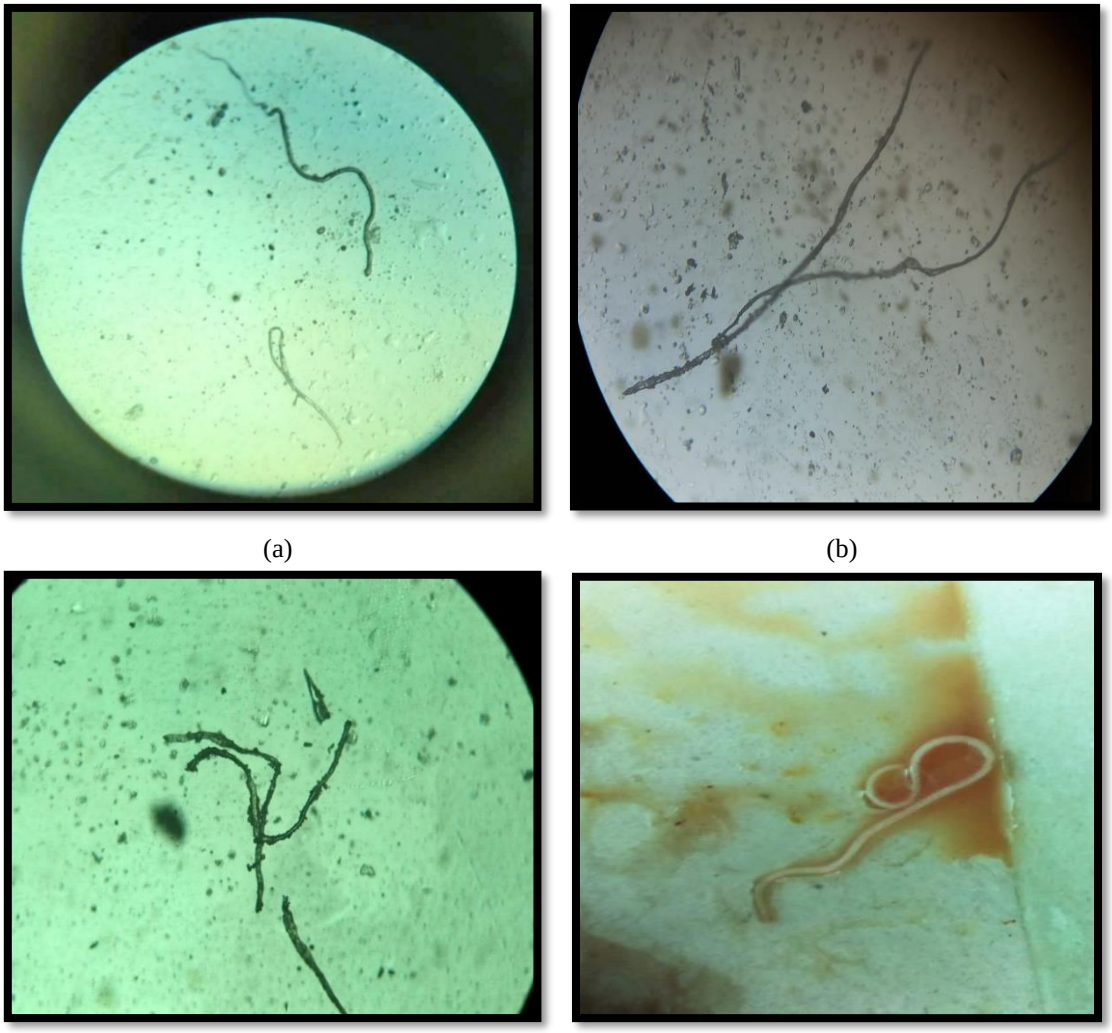

(a) (b)

(c) (d)

Figure 2. *Showing the (a) Capillaria spp, (b) Heterakis gallinarum (Cecal worm), (c) Ascaridia galli (Roundworm), and (d) Tapeworm*

(a) (b)

Figure 3. *Showing the (a) Flock of Demoiselle cranes, (b) Pair of Common cranes*

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Table 4. *Comparison of parasites in feces of crane species in three distinct study sites*

Parasite	Scientific Name	River Indus (S_1)	River Kurram (S_2)	Zara Daggar (S_3)	Total Number of Individuals	Percentage
		No of Individuals	No of Individuals	No of Individuals		
Cestode	*Hymenolepis*	3	1	0	4	1.408%
Nematode	*Ancylostomatidae*	5	6	12	23	8.098%
	Ascaridia sp.	11	13	36	60	21.127%
	Capillaria	19	17	3	39	13.732%
	Heterakis gallinarum	7	3	4	14	4.929%
	Syngamus trachea	1	0	0	1	0.352%
Protozoan	*Eimeria gruis*	11	9	21	41	14.437%
Tapeworm		2	0	3	5	1.760%
Trematode	*Echinochasmus sp.*	12	16	17	45	15.845%
	Fasciolopsis sp.	9	19	24	52	18.309%
Grand Total		**80**	**84**	**120**	**284**	

Discussions

The majority of crane species are now vulnerable or endangered, making knowledge of their population size critical. Utilizing a variety of approaches, the bird species has frequently been identified (Zhao et al., 2016; Sebastian-Gonzalez and Green, 2016; Hagy et al., 2017; Firth et al., 2020). Monitoring current conservation status and population trends is made easier by accurately quantifying bird assemblages (Seavy and Reynolds, 2007; Zimmerman et al., 2012). On the status and distribution of common cranes and demoiselle cranes in Pakistan, there is a significant knowledge vacuum. The current study has concentrated on long-term monitoring of the species to close this information gap and provide a detailed picture of the species' general condition and range in Pakistan. Indus and Kurram rivers were rarely crossed by more than four flocks at a time during migration. Each flock had nine to fifteen members.

Around the Kurram and Kashoo Rivers, a variety of crane species are also seen, according to (Farooq, 1992). Additionally, this study discovered that the demoiselle crane was seriously endangered by pollution in the Kurram and Kashoo Rivers. According to Tariq et al. (2015), domestic and industrial untreated sewage is highly polluting cranes' environment and routes. Over the past 15-20 years, crane migratory flocks have decreased by 95%. Five to nine flocks infrequently utilized the path during migratory seasons. Compared to earlier times when each flock included between 30 and 50 birds (Rehman et al., 2021). Crane populations have decreased recently because of the destruction of watershed regions, which provide habitat for them, claims (Liu et al., 2003).

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In our study, the black-necked and common cranes largely avoided grassland due to the scarcity of food, but in another studies by Dong et al. (2016) and Wu et al. (2020), both species did the same. In contrast to earlier studies, where farmland and marshland were preferred habitats whenever black-necked cranes were absent, for example, in Beijing Yeyahu Wetlands, black-necked crane flocks were most frequently found in farmland, similar to other European and Asian studies (Aviles et al., 2002).

Characteristics of Parasitic Infection

It is thought that high population densities increase the risk of infection (Honma et al., 2011). Due to the decreased host density in our investigation, we discovered a lower incidence of Eimeria coccidia infection than that previously reported for hooded cranes wintering in Japan. In addition to worms, intestinal parasites are another risk factor for migrating cranes (Varela et al., 2001; Mowlavi et al., 2006; Fanke et al., 2011).

Threats to the Cranes

This study found that hunting, habitat degradation, and pesticide usage are the three main hazards facing cranes in the study region (Tariq and Aziz, 2015; Rehman et al., 2021). When compared to other causes in the research region, hunting is determined to be the primary cause of cranes degrading, as it is in other southern parts of KP. Crane hunting is considered to be a local custom. The same risk that overexploitation of crane species is causing population reduction was raised by a different researcher (Horwich, 2001; Perveen, 2012). During hunting season, a formal camp is set up close to the crane species' resting places.

Crane hunting drew traditional hunters from the whole area. Similar activities in Lakki Marwat and Bannu were recorded by another investigation (Farooq, 1992; Horwich, 2001). It was discovered that the primary motivation for hunting and capturing cranes was only a form of amusement for the hunters. The majority of hunters kept cranes as pets because they believed they were a symbol of pride and respect. The area's only domestic usage of the crane species was its sporadic use as food. The economic benefits of commercial commerce and hunting were insignificant.

Water Diversion due to Construction of Dams

Over the past century, changes in hydrology have had an impact on all crane species, whether it is an impoundment behind dams, decreased water availability owing to diversions, or adjustments to seasonal flow levels and timing (Liu et al., 2003; Harris and Mirande, 2013).

Agricultural Development

Landscapes in the majority of locations have seen a significant transformation as a result of the expansion and intensity of agricultural activities during the past. Changes in agriculture have advantages and disadvantages for cranes and their habitats. Working with farmers and agricultural organizations to find and put into practice environmentally sound and financially viable techniques can aid cranes (Harris and Mirande, 2013).

Crane Trade

Cranes with crowns stand for grace, riches, life, and fortune. Despite being revered in Pakistan and across the world for their exceptional beauty, they have ironically fallen out

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of favor. The unlawful capture of both cranes poses a severe danger, and over the past 20 years, population loss has been considerable and quick. To get money, people capture these animals in a variety of methods (Kumar et al., 2002).

Climate Change

When temperatures rise owing to climate change, birds may invest more energy to regulate their body temperatures, which might affect how they are dispersed. The migratory patterns and routes of migratory cranes in Pakistan are impacted by global warming as well. Cranes that are migrating regularly change, shorten, or abandon their migration routes as a result of the changing temperatures (Harris and Mirande, 2013).

Use of Pesticides

The majority of farmers today utilize various pesticides on their farms. Pesticides also have an indirect impact on cranes by reducing the amount of food that is available or by changing their habitat. When pesticides reduce the amount of insect food available, cranes that consume insects are literally at a loss, especially if they have young to feed (Harris and Mirande, 2013; Rehman et al., 2021).

Habitat Loss and Degradation

Major risks to the persistence of bird populations include habitat loss and fragmentation (Smith et al., 2011; Carrara et al., 2015; Winiarski et al., 2017). It was assessed that land use change posed the biggest substantial threat to habitat. Changes in habitat may result in the loss of vegetation, as well as decreasing production and suitability for bird usage. Changes in habitat may result in the loss of vegetation, as well as decreasing production and suitability for bird usage. For instance, in agricultural settings, where they are both the object of local hunting and easily preyed upon by predators. Additionally, the use of pesticides may cause some bird species to die or become less active (Archibald et al., 2013; Rehman et al., 2021).

Conclusions

Cranes mostly move along these routes to Pakistan throughout the winter, according to the findings of the most current study. In contrast to other species, they frequently inhabit grasslands. However, the use of different pesticides influences the number of cranes residing in certain areas. Crane poaching and illegal killing were also mentioned as issues. Zara Daggar was a more secure area for the birds than other places. The gastrointestinal parasites of the cranes vary across individuals and between geographical locations. The range of parasites varies between research sites and as wintering habits alters.

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