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Ecological and Morphological Studies of Indian Peafowl (*Pavo Cristatus*) of Khar Centre, Khar Division at Khirthar National Park, Sindh, Pakistan

Original Article

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Abstract

In Pakistan, the blue peafowl is found in Narowal and Tharparkar, and is breeding in the natural habitat of Khar Centre, Kirthar National Park, which is the only national park in Sindh. The present research on Ecological and Morphological study is carried out in an 8 km radius of Khar Centre, Kirthar National Park, from July 2021 to June 2022. The estimated population of Indian peafowls was recorded as 250. Among them, about 30%. subadult 36% and 34% peachicks, male, female ratio is 34% to 66%. Thirty specimens of Indian peafowls were collected to measure their body parameters. Average body length from beak to cloaca was measured as 64cm and 52.8cm for adult males and females, respectively. While for sub-adults, males and females, it was 49.2cm and 44cm, respectively. While for peachicks, it was 38.4cm and 29.6cm, respectively. Average beak length was measured as 2.96cm to 1.5cm in adult, subadult, and peahen. Tail length varied from 146.8 cm to 29.2 cm in different categories. Wingspan length varied from 156cm to 54cm, while crest length varied from 8.2cm to 4cm in adults and in peahens, respectively. The temperature varies from 10C to 45C in the area. The water used by the Indian peafowl (*Pavo cristatus*) has a pH. Salinity, conductivity, and TDS are (pH: 8.60±0.59), (Salinity, 60±0.28ppt), (Conductivity:1609.33±300.57µs/cm), and (TDS:790.67±147.64mg/l). In this study, the estimated population of Indian peafowl (*Pavo cristatus*) was observed as 31individuals/km. The results indicate that the Khar Centre Kirthar National Park is a suitable place for the breeding and conservation of Indian peafowl. This study is of its first kind in Khar Centre, Kirthar National Park, Sindh.

Keywords: Breeding, Conservation, Peafowl, Ecological Study, Khirthar National Park.

Introduction

Bird fauna is an important part of vertebrate. It provides a great variety of services in the ecosystem. It has nutritional, commercial, and ornamental importance. There are many species of birds which are used for food and medicine, and some are used for ornamental purposes, so in the present study, I have selected Indian peafowl, Tail feathers of Indian peafowl (*Pavo cristatus*) are greatly used for decoration in homes, and its meat is also used for food. It is a very attractive bird, but there is no proper study of it, which is why it has been selected for the present study. Peafowls are members of the Pheasant family, a family of birds commonly known as Game Birds, e.g., Turkey, Quail, Sand Grouse, Partridges (Krell & Marshall, 2017). There are three species of peafowls, among them two are Asia variety navy otherwise Indian peafowl (*Pavo cristatus*), the Burmese or Green peafowl (*Pavo muticus*), and the Congo otherwise pasty peafowl (*Pavo cristatus)*(Darwin, 2008). Peafowl Blue or Indian (*Pavo cristatus*) is originally native to Pakistan, India, Sri Lanka, Nepal, and Bhutan. The green peafowl is native to Myanmar, Indochina, and Java. White peafowl native to the Congo basin only (Kane, Wang, Fang, Lu, & Dakin, 2019).
Blue or Indian peafowl (*Pavo cristatus*), Burmese or Green peafowl *(Pavo muticus*) and Congo or White peafowl (*Pavo cogenesis*) are three species of peafowl, two of them Asian species, Burmese or Green peafowl *(Pavo muticus*) and Blue /Indian peafowl (*Pavo cristatus*) locally breed in to Pakistan, India, Sri Lanka and Bangladesh, it is locally known as Mor and its breeding season starts from April to October (Wang *et al*., 2022). Indian peafowls mate with more than one female, so it is called polygynous (Bhawna, Rai, & Singh, 2024). Peahen lays eggs 4 to 8, and it incubates eggs for 28 to 30 days (McCarthy, 2006). Indian peafowl eats both plants and animals, such as seeds, crops, vegetables, fruits, snakes, and small rodents, which means omnivorous (Mushtaq-ul-Hassan, Ali, ARSHAD, Mahmood, & Mahmood-ul-Hassan, 2012). Khar Centre is the main wildlife conservation and captive breeding Centre. Provide real wilderness with full enjoyment of wildlife and good recreation and picnic resorts, with scenic views, Hub Dam, and a beautiful mountain with natural perennial spring water. Khar Centre is very close to Karachi, only 70 km or an hour's drive. Khar Centre is a unique area of Kirthar National Park for the scientific study of wild animals and especially for the students of Zoology, Botany, and Geology.

Materials and Methods

This study was conducted from July 2021 to June 2022 at Khar Centre (KNP). The study area was selected based on the availability of peafowl, with Coordinates (Latitude of Khar Centre is 25º18 N. The Longitude of Khar Centre is $67^0$11 E).

During present observation to classify peacock plumage in to different categories, at least five feathers used for the measurement and measuring different parameters and also measured different body parameters of Indian peafowl like body length, tail length, wing span, beak length, crest length and leg length were with measuring scale such as Tape reader, Foot scale and used different materials during present research work like Binocular, Camera (Nikon Coolpix P900), Electronic device used for analyzing water quality and also used GPS (Graph Positioning System) and Thermometer for ecological parameters. For counting and detecting Sampling Distance transect line method was also used (Johnsingh & Murali, 1981). Present study, all individuals of peafowls were classified into three categories:
Adult male, female, sub-adult male, female, and a peahen male, female below one year, followed the age-classification method of Johnsgard (Johnsgard, 1986).

Research work we were conducted on water sampling at different locations in Khar Center, Kirthar National Park, Sindh, Pakistan, and analyzed water quality such as pH, Salinity, Conductivity, and TDS in Hitech Lab, University of Sindh, Jamshoro.

pH (potential of hydrogen or power of hydrogen): pH is a scale used to specify the acidity or basicity of an aqueous solution. Studies have found that birds can tolerate a wide range of pH water, being virtually unaffected by pH levels of 3,4, and 5, tolerating levels up to 8. A pH less than 5 corrodes metals and results in mineral leaching and shortens the lifespan of the system. Poultry prefers water with a pH of 6.0 to 6.8. Salinity: However, **to** survive, salt is an

essential mineral required by birds, as it is by all living animals. A shortage of salt can cause excessive fluid excretion, polyuria, weight loss, fatigue, and slow growth.

Conductivity: Conductivity is an indirect measure of the salinity of the water. Animals that drink freshwater cannot tolerate a large increase in the salinity of the water because they will not be able to keep water in their bodies.

Total Dissolved Solids (TDS): The TDS changes the mineral content of the water, which is important to the survival of many animals, and can be fatal. It can increase the temperature of the water, which many animals cannot survive in.

Figure1
Photograph during field work at Khar Centre, Khirthar National Park, Sindh, Pakistan.

Figure 2
Photographs: Taking measurements of different body parts of Indian peafowls (Pavo cristatus)

Results and Discussion

The present research work of the Ecological and Morphological studies of the Indian peafowl (*Pavo cristatus*) was carried out in an 8 km radius of Khar Centre, Kirthar National Park, from July 2021 to June 2022. The estimated population of Indian peafowls was recorded as 250. Among them, adults were 30%. Subadult 36% and 34% peachicks and male, female ratio is 34% and 66%. 30 specimens of Indian peafowl were collected, and different body parameters were measured. The average body length from beak to cloaca was measured as 64cm and 52.8cm for adult males and females, respectively. For subadults, male and female, it was 49.2cm and 44cm, respectively. And while for peachicks it was 38.4cm and 29.6cm, respectively. Average beak length was measured as 2.96cm to 1.5cm in adult, subadult, and peahen. Tail length varied from 146.8 cm to 29.2 cm in different categories of Indian peafowl. Wingspan length varied from 156cm to 54cm, while crest length varied from 8.2cm to 4cm in adults and in peahens, respectively. The temperature varies from 10^0C to 45^0C in the study area. Due to some threats from wild cats, jackals, and domestic dogs, mortality occurred, and the mortality ratio was observed to be 13.79% and 3.84% in males and females, respectively, during the study period and the survival ratio was observed in males and females as 86.20% and 96.15% respectively. In the present study, the estimated population of Indian peafowl (*Pavo cristatus*) was observed as 31 individuals/km. Though mortality occurs, the population is increasing, and the environment is encouraging the species ratio. The present study of ecology and morphology of Indian peafowl (*Pavo cristatus*) first time in Khar Centre, Kirthar National Park. The present study indicates that the Khar Centre Kirthar National Park is a suitable place for the breeding and conservation of Indian peafowl (*Pavo cristatus*).

Table 1

Total estimated population of Indian peafowl (Pavo cristatus)

Individual	Male	Female	Total
Adult	25	50	75
Sub adult	30	60	90
Peachick	30	55	85
Total Estimated Population			**250**

Figure 3

Total Estimated Population of Indian Peafowl in Percent

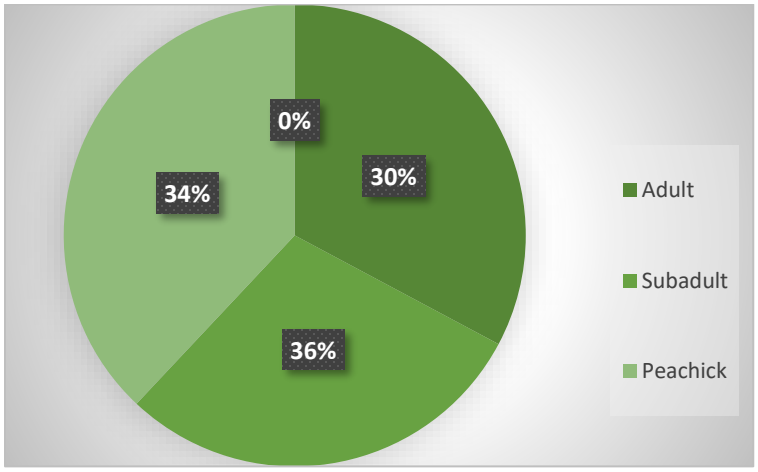

Table 2

Monthly Population Density Data of Indian peafowl (Pavo cristatus) in the study area from July 2021 to June 2022

Month	Adult		Subadult		Peachick		Estimated Population month-wise
	Male	Female	Male	Female	Male	Female	
July	21	40	15	30	12	23	141
August	17	37	19	35	15	25	148
September	19	39	16	32	20	30	156
October	21	35	17	39	21	35	168
November	20	37	21	42	23	38	181
December	23	40	25	50	19	37	194
January	25	43	27	51	21	40	207
February	27	45	29	55	21	39	216
March	25	50	30	57	23	42	227
April	21	45	27	60	26	53	232
May	23	47	25	62	27	56	240
June	25	50	30	60	30	55	250
Mean	**22.25**	**42.33**	**23.42**	**47.75**	**21.50**	**39.42**	**196.67**
Standard Deviation	**22.25±2.93**	**42.33±5.10**	**23.42±5.57**	**47.75±11.65**	**21.50±4.95**	**39.42±10.88**	**196.67±37.62**

Table3

Mortality and Survival Ratio in Adult Male and Female Indian Peafowl (Pavo cristatus)

Individual	Mortality ratio in adult Males & Females in %	Survival Ratio in Adult Male & Female in %
Male	13.79%	86.20%
Female	3.84%	96.15%

Table 4

Measurement of different body parts (Largest and Smallest Length) of adult peacock of Indian peafowl (Pavo cristatus)

No	Beak Cloaca LEN Cm	Tail/Train Length Cm	Beak-LEN cm	CREST-LEN cm	WINGSPAN LEN cm	LEG-LEN cm	FEET-LEN cm
1	65	150	2.7	9	160	44	9
2	65	150	2.8	9	160	44	9
3	64	145	2.9	8	155	43	8
4	64	145	3.1	8	155	43	8
5	62	144	3.3	7	150	42	9

Figure 4

Measurement of different body parts of adult peacock of Indian peafowl (Pavo cristatus)

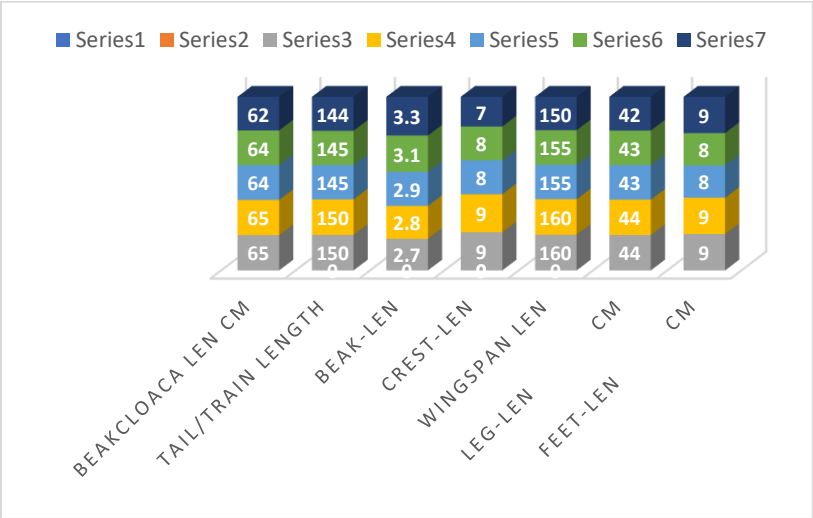

Table 5

Measurement of different body parts (Largest and Smallest Length) of adult peahens of Indian peafowl (Pavo cristatus).

No	Beak-Cloaca Len (cm)	Tail-Len (cm)	Beak-Len (cm)	Crest-Len (cm)	Wingspan-Len(cm)	Leg-Len(cm)	Feet-Len(cm)
1	55	40	2.5	6	80	42	8
2	55	40	2.6	6	80	42	7
3	52	38	2.7	5	78	40	8
4	52	38	2.8	5	78	40	8
5	50	36	2.9	5	76	38	7

Figure 5

Measurement of different body parts of adult peahens of Indian peafowl (Pavo cristatus)

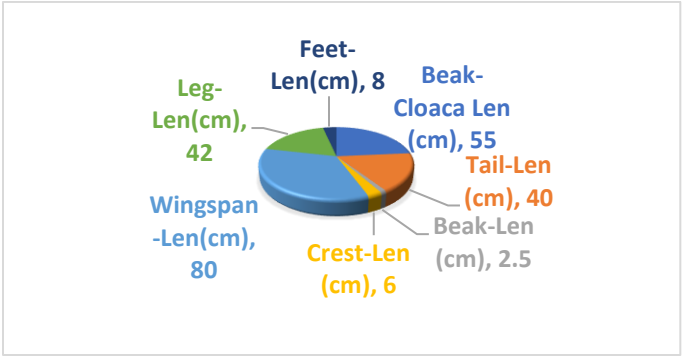

Table 6

Measurement of different body parts of a Subadult peacock of Indian peafowl (Pavo cristatus)

No	Beak-Cloaca Len (cm)	Tail-Len (cm)	Beak-Len (cm)	Crest-Len (cm)	Wingspan-Len (cm)	Leg-Len (cm)	Feet-Len (cm)
1	50	90	1.9	5	120	40	7
2	50	90	2.1	5	120	40	6
3	50	88	2.3	5	115	38	7
4	48	86	2.4	5	115	38	6
5	48	86	2.5	5	110	36	7

Figure 6

Measurement of different body parts of a Subadult peacock of Indian peafowl (Pavo cristatus)

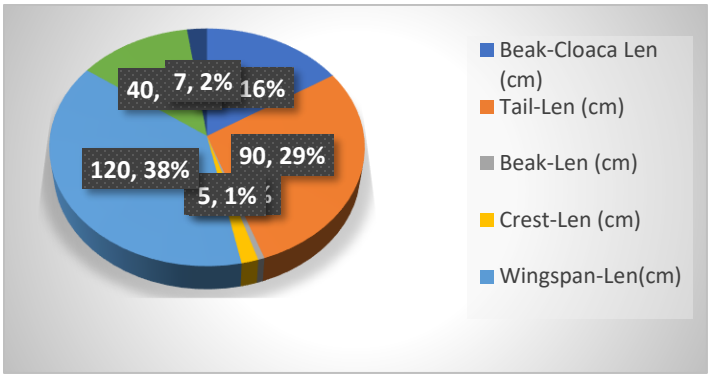

Table 7

Measurement of different body parts (Largest and Smallest Length) of Subadult peahens of Indian peafowl (Pavo cristatus)

No	Beak-Cloaca Len (cm)	Tail-Len (cm)	Beak-Len (cm)	Crest-Len (cm)	Wingspan-Len (cm)	Leg-Len (cm)	Feet-Len (cm)
1	45	35	1.8	5	70	34	7
2	45	35	1.9	5	70	34	6
3	44	34	2.1	5	70	34	7
4	43	34	2.3	5	68	32	6
5	43	34	2.4	5	68	32	6

Figure 7

Average Length of Different Body Parameters in Subadult Peahen (cm)

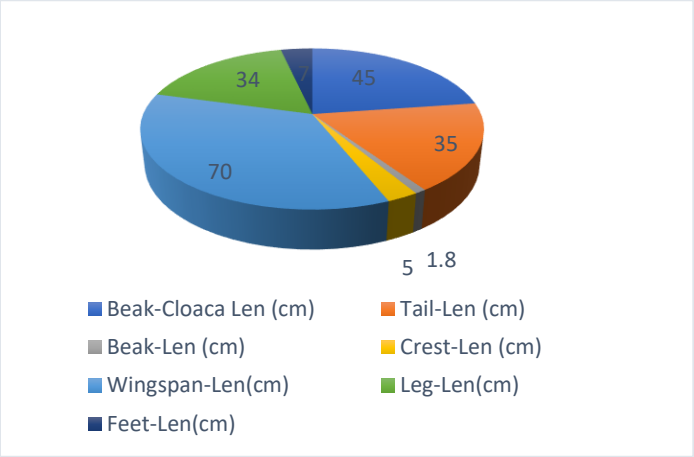

Table 8

Measurement of different body parts (Largest and Smallest Length) of male Peachick of Indian peafowl (Pavo cristatus)

No	Beak-Cloaca Len (cm)	Tail-Len (cm)	Beak-Len (cm)	Crest-Len (cm)	Wingspan-Len (cm)	Leg-Len (cm)	Feet-Len (cm)
1	40	40	1.3	4	65	25	5
2	40	40	1.5	4	65	25	5
3	38	38	1.7	4	64	24	4
4	38	38	1.9	4	64	24	5
5	36	36	2.1	4	62	23	4

Figure 8

Average Length of Different Body Parameters in Male Peachick (cm)

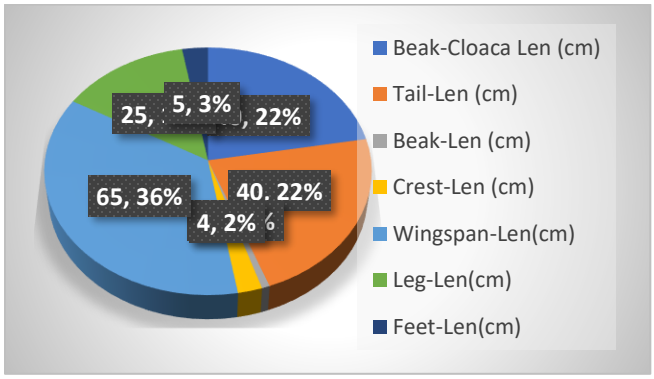

Table 9

Measurement of different body parts (Largest and Smallest Length) of a female peacock of Indian peafowl (Pavo cristatus)

No	Beak-Cloaca Len (cm)	Tail-Len (cm)	Beak-Len (cm)	Crest-Len (cm)	Wingspan-Len (cm)	Leg-Len (cm)	Feet-Len (cm)
1	30	30	1.1	4	55	23	5
2	30	30	1.3	4	55	23	4
3	30	30	1.5	4	54	23	5
4	30	30	1.7	4	54	23	4
5	28	28	1.9	4	52	22	5

Figure 9

Average Length of Different Body Parameters in Female Peachick (cm)

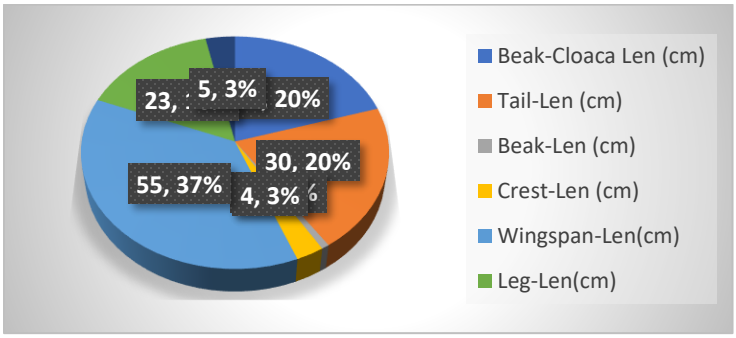

Table 10

Temperature of Khar Centre, Kirthar National Park from July 2021 to December 2021

Year-2021	July	August	September	October	November	December
High	36^0CHigh	40^0C High	37^0C High	41^0C High	35^0C High	31^0C High
Low	26^0C Low	24^0C Low	23^0C Low	19^0C Low	11^0C Low	9 ^{0}C Low
Average	**30^0C**	**30^0C**	**29^0C**	**29^0C**	**24^0C**	**20^0C**

Table 11

Temperature of Khar Centre, Kirthar National Park from January 2022 to June 2022

Year 2022	January	February	March	April	May	June
High	30^0C High	34^0C High	41^0C High	40^0C High	45^0C High	40^0C High
Low	10^0C Low	10^0C Low	17^0C Low	20^0C Low	25^0C Low	27^0C Low
Average	**20^0C**	**23^0C**	**27^0C**	**30^0C**	**33^0C**	**31^0C**

Water Quality Parameters

For the analysis of water quality following parameters were taken into consideration like hydrogen ion concentration (pH), Salinity (ppt), Conductivity (µs/cm), and Total Dissolved Solids (mg/l) were recorded every month throughout the study period. Water quality parameters were analyzed, pH (8.60±0.59), Salinity (0.60±0.28ppt), Conductivity (1609±300.57 µs/cm), and TDS (790.67±147.64 mg/l), respectively. According to the literature, birds have a tolerance of 8 pH, but the present result shows that Indian peafowl (*Pavo cristatus*) can survive more than 8 pH.

Table 12

Water Quality Parameters

Month	pH	Salinity (ppt)	Conductivity (µs/Cm)	TDS (Mg/L)	Salinity (ppt)	Conductivity (µs/cm)
July	8.13	0.1	1964	962	0.1	1964
August	7.6	0.5	1126	550	0.5	1126
September	8.94	0.6	1883	923	0.6	1883
October	8.97	0.7	1482	726	0.7	1482
November	8.98	0.8	1609	789	0.8	1609
December	8.99	0.9	1592	794	0.9	1592
Mean	**8.60**	**0.60**	**1609.33**	**790.67**	**0.60**	**1609.33**
Standard Deviation	**8.60±0.59**	**0.60±0.28**	**1609.33±300.57**	**790.67±147.64**	**0.60±0.28**	**1609.33±300.57**

According to the IUCN (International Union for Conservation of Nature), Indian peafowl (*Pavo cristatus*) belongs to the Least Concern category for its growing and sustaining population. The results of the present study mentioned in previous topics are discussed here. The detection and counting of birds were easier through the Line Transect Method. Previous studies advised us that the Line Transect Method gives us more exact results than the point count method (Ramesh & McGowan, 2009). In Gir National Park, researchers mostly used the Line Transect Method for estimating estimated population richness of Indian peafowl (*Pavo cristatus*) (Sathyanarana, 2005). During the study period, we counted an estimated population141 Indian Peafowl individual with a density of 18/ km in July 2021 and 250 Indian peafowls with a density of 31/km in June 2022 in an 8 km radius area of Khar Centre Kirthar National Park, Sindh, Pakistan. Density was higher in June 2018 present research told us that the population of peahens (females) is more than peacocks (males) in the study area; females were 66% and males were 34%. Recent research showed that the peafowl rest under the shade most of the time, and in open areas, they relax in the evening. Peafowls choose those trees for resting that are in the day. The omnivorous nature of peafowl makes it a devious bird feeder. Sathyanarayana (2005a, b) (Anderson, 1976), and Chakravarthy & Thyagaraj (2005) revealed that peafowl eat seeds, so it is a granivore in nature and especially feeds on paddy and other crop seeds in agricultural lands (Burnham, Anderson, & Laake, 1980). The current study showed that the main diets of peafowl are bajra and other grain seeds in agricultural fields. The plumage pattern of peafowl enables it to survive in any environmental condition. The shape of plumage modifies its measurement and sustains its physical variations. Amongst bird's peacocks grow complicated feathers shape. The multifaceted shape is well-thought-out as an authentic communal indicator. Even though the tail plumages of the Indian peacock are exported for numerous causes, despite the trading of tail feathers is not considered in the Convention on International Trade of Endangered Species (CITES) may be thought that these plumages are unsurprisingly fall after every breeding season, and their trade worldwide is still understood (Sprent, Buckland, Anderson, Burnham, & Laake, 1994). A mature peacock contains 200 colorful tail feathers, molts in August, and is fully developed in February (Sankar, Qureshi, Shah, Mukherjee, & Dave, 2004). Subadult peacocks do not have large tails but have colorful feathers like adult peacocks, mostly detected near adult peacocks by means of cleaning. The fall down plumages of Mature peacocks are composed and traded in common marketplaces, and it is still being done, and the birds are also being slayed, raising income. There are several threats to Indian peafowl, such as habitat destruction, use of pesticides in agricultural fields, retaliatory killing, egg collection for medicinal

use, feathers collection for decoration purposes, and other threats from wild animals like wild cats, Jackals, and domestic dogs. Wild forest-dwelling peafowl in India forage and drink most actively at dawn and dusk (Chakravarthy & Thyagaraj, 2005). They tend to move about in flocks, as flocking allows for greater foraging due to shared vigilance for threats (Yasmin & Yahya, 2000). In our present study area, there are no major threats to Indian peafowl (*Pavo cristatus*), so the population is growing so good. The specimens of Indian peafowl (*Pavo cristatus*) under study were collected from the study area, measured, and analyzed. The water sample was amassed from the 6 research areas and analyzed in the Laboratory, finding its pH, Salinity, Conductivity, and TDS. This investigation was first studied in the Khar center of Kirthar National Park, Sindh, Pakistan. We observed ecological and morphological studies on the member of the order Galliformes, family Phasianidae, Blue/Indian peafowl (*Pavo cristatus*), making a new record in Sindh, Pakistan.

Conclusion

The present research work of the Ecological and Morphological studies of the Indian peafowl (*Pavo cristatus*) was carried out in an 8 km radius of Khar Centre, Kirthar National Park, from July 2021 to June 2022. The estimated population of Indian peafowls was recorded as 250. Among them, adults were 30%. Subadult 36% and 34% peachicks and male, female ratio is 34% and 66%. 30 specimens of Indian peafowl were collected, and different body parameters were measured. The average body length from beak to cloaca was measured as 64cm and 52.8cm for adult males and females, respectively. For subadults, male and female, it was 49.2cm and 44cm, respectively. And while for peachicks it was 38.4cm and 29.6cm, respectively. Average beak length was measured as 2.96cm to 1.5cm in adult, subadult, and peahen. Tail length varied from 146.8 cm to 29.2 cm in different categories of Indian peafowl. Wingspan length varied from 156cm to 54cm, while crest length varied from 8.2cm to 4cm in adults and in peahens, respectively. The temperature varies from 10^0C to 45^0C in the study area. Due to some threats from wild cats, jackals, and domestic dogs, mortality occurred, and the mortality ratio was observed to be 13.79% and 3.84% in males and females, respectively, during the study period, and the survival ratio was observed in males and females as 86.20% and 96.15% respectively. In the present study, the estimated population of Indian peafowl (*Pavo cristatus*) was observed as 31 individuals/km. Though mortality occurs, the population is increasing, and the environment is encouraging the species ratio. The present study of ecology and morphology of Indian peafowl (*Pavo cristatus*) first time in Khar Centre, Kirthar National Park. The present study indicates that the Khar Centre Kirthar National Park is a suitable place for the breeding and conservation of Indian peafowl (*Pavo cristatus*).

Conclusion

The present study concludes an abundant population of Indian peafowl (*Pavo cristatus*) in Khar Centre, Kirthar National Park. A total estimated population of Indian Blue Peafowls, 250 individuals, with 34% male and 66% female, was counted. The feathers study reveals a great plumage pattern, and it is reasonable that the Indian peafowl *(Pavo cristatus)* is ideal for ornamental purposes. Peafowls possess diverse colors, including blue and green. However, the present study observed many threats to peafowl from wild cats, jackals, dogs, and other carnivorous animals. The study reveals that Khar Centre Kirthar National Park is suitable for the breeding of Indian peafowls (*Pavo cristatus*). Moreover, Khar Centre Kirthar National Park is a unique natural laboratory for scientific discourse regarding Zoological, Botanical, and Geological Sciences.

Recommendations

Seasonal and long-term studies need to be run to gain insights into ecological patterns and morphological changes during the year. Part of Khirthar National Park should be studied in the future to allow comparisons between ecological conditions and the morphology of species in various habitats. The integration of global positioning system (GPS) collars or drone monitoring would help improve the knowledge of movement, habitat preference, and territorial behavior of Indian Peafowls. Community-based and educational conservation programs ought to be implemented so that the involvement of local people in preserving peafowl habitats against poaching and destruction takes place.

Limitations and Future Directions for Research

It has conducted the research in a short frame of time that fails to demonstrate seasonal variations and variations in ecological and morphological aspects of Indian Peafowls comprehensively. Only the Khar Centre of Khirthar National Park was used to collect data. This localized area of space may not reflect the entire space distribution and morphological variation of the species throughout the whole park or region. There was a relatively small sample due to a lack of accessibility and logistical issues, and this aspect can lower the statistical potency and significance of the result. In the future, researchers can use a larger sample size for further analysis to find the factual position and suggest ways for improvement of the conditions.

Declarations

Ethical Approval and Consent to Participate: This study strictly adhered to the Declaration of Helsinki and relevant national and institutional ethical guidelines. Informed consent was not required, as secondary data available on websites was obtained for analysis. All procedures performed in this study were by the ethical standards of the Helsinki Declaration.

Consent for Publication: Not Applicable.

Availability of Data and Materials: Research Data could be provided upon request from the corresponding author.

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Authors' Contribution: Conceptualization and write-up [BMA, SS, BKH], data collection and analysis [BMA, ZM, MRN].

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