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Population Dynamics and Breeding Ecology of Grey Francolin (*Francolinus pondicerianus*) and Black Francolin (*Francolinus francolinus*) in Tehsil Nara, District Khairpur, Sindh, Pakistan

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Abstract

This study examined the population dynamics and breeding ecology of game birds as a basis for developing effective conservation frameworks and sustainable management strategies. The research focused on seasonal variation, habitat preferences, and reproductive traits of two sympatric species Grey francolin (*Francolinus pondicerianus*) and Black francolin (*Francolinus francolinus*) in Tehsil Nara, District, Khairpur Mir's, Sindh, Pakistan Field investigations were carried out from February to October 2023 using line transects, point counts, nest searching techniques, and habitat assesments across agricultural fields, scrublands, grasslands, and riverine vegetation. A total of 178 Grey francolins and 143 Black francolins were recorded during the survey period. The population densities of Grey francolins were more commonly observed in cultivated areas and grassy habitats, whereas, Black francolins showed a stronger association with water proximate areas and dense vegetation. Breading activity commenced in mid-march for the Grey francolins and in early april for Black francolins. The mean clutch size was found to be 7.2-1.1 and 6.4-1.3 in Grey and Black francolin respectively. Success rates were 68.3% and 61.5% respectively. Human activities such as habitat fragmentation, pesticides and uncontrolled hunting have been cited as the major threats. A comparison with previous research from Punjab and Khyber Pakhtunkhwa showed that there were some regional differences on the onset of breeding and in the size of the clutch, which could be due to climatic and ecological factors. Overall this study provides essential baseline information to support focused conservation initiatives aimed at sustaining francolin populations and maintaining ecological balance

in the region. It is suggested to have habitat restoration; community-level awareness campaign and have the incorporation of the francolin monitoring into provincial wildlife management plans.

Keywords: Grey francolin, Black francolin, Breeding ecology, Population dynamics, Tehsil Nara, Avian conservation, Sindh

Introduction

Francolinus is an ecologically important genus of game birds in Pakistan; its representatives play an active role in seed dispersal, eliminating insects, and signaling to people the condition of their habitats (Ahmad and Mian, 2013; Hussain and Rafiq, 2019). Some of them, including Grey francolin (*Francolinus pondicerianus*) and Black francolin (*Francolinus francolinus*), have a broad range of distribution throughout the Indus plains, but their ecological functions have been under reported in most regions and especially Interior Sindh (Javed & Khan, 2017; Younis & Baig, 2019).

Being adaptive to the landscapes changed by humans, the Grey francolin prefers dry scrublands and agricultural fields (Khalil et al., 2015; Iqbal and Hussain, 2019). On the contrary, the black francolin perfers more tropical vegetation particularly around the water bodies, and exhibits more secretive behaviour, making it less frequently sighted despite its wide distribution, (Mahmood and Shah, 2016; Malik and Jamil, 2018). Hunting pressure and habitat degradation affect both species, whereas, the variability of the population is not well measured in southern Pakistan (Ali et al., 2022; Farooq and Ahmed, 2021).

The previous research mainly concerned the use of these areas in Punjab and Khyber Pakhtunkhaw under protection. As an example, the abundance of francolin seasonally was reported by Khan and Javed (2015), in Mang Game reserve and breeding success was studied in the Lal Suhanra National Park by Ahmad and Mian (2013), Ullah et al. (2023) introduced the information about the dynamics of population in Totali game reserve with emphasis on habitats. Another area, however, is Tehsil Nara, a semi-arid agro-ecological environment with characteristic habitat mosaic and the growing anthropogenic encroachment that lacks published data (UNDP, 2021; Ali, Raza, and Qureshi, 2022).

Agricultural intensification, extensive pesticide application, and uncontrolled hunting are major factors contributing to the decline of avian biodiversity in Sindh (Khan and Aslam, 2017; Shahid and Farooq, 2020). UNESCO (2021) conservation report and the UNDP (2021) baseline survey emphasized the urgent need for localized monitoring of the avifauna in in the interior districts of sindh. Considering the ecological and cultural significance of francolins as game birds, along with their role in shaping the soundscapes, of rural landscapes, it is essentiat to understand their breeding ecology and population dynamics (Rauf and Tariq, 2020; Abbas and Raza, 2022).

Materials and Methods

Study Area

This study was conducted in the Nara region, the largest Tehsil of District Khairpur Mir's, Sindh, Pakistan. Geographically, it lies between 26º41′ to 53º N latitude and 68º to 53º45′ E longitude, covering an area of approximately 11,610 km² with a population of 160,985. The region experiences a dry subtropical climate, characterized by cool winters and extremely hot summers. Winter temperatures range from 10°C to 30°C, while summer temperatures may rise from 35°C to 50°C. The landscape encompasses a mixed ecosystem, including semi-evergreen subtropical forests, tropical

thorn forests, lakes, seasonal torrents, mountainous terrain, sand dunes, and cultivated farmlands. The habitats help generate various microhabitats which can support ground nesting birds, including francolins (UNDP, 2021).

Survey Design

The field survey will take place between February and October 2023 and in this entire breeding season. A sample size of three dominant habitat types was picked.

- Cultivated fields (wheat, cotton, fodder crops)
- Scrublands (acacia, mesquite patches)
- Riparian zones (vegetation along irrigation canals and seasonal streams)

Each type of habitat was provided with line transects (1.510 km) and fixed-point counts. Sampling was daily done twice a month, in the early mornings (05:3008:30) so that the birds were at their most active and the sampling produced the least amount of bias.

Population Estimation

The Distance Sampling was used to estimate population density. The observers noted the species name, group size, the perpendicular distance to the transect line, and the type of habitat that was associated. The analysis was carried out with the help of the DISTANCE 7.3 software that takes into consideration the detectability and the spatial distribution of data (Rehman and Shah, 2020).

Breeding Ecology

Nest searches were instigated by pursuing vocalizing males and monitoring the way they nest. Parameters that were recorded were type of nest, hatch size, period of incubation, hatch success and indicators of predation or disturbance. Monitoring of a nest was only done after every 3-4 days until the fledging or failure and it was done in order to maintain a minimum observer around the nest.

Statistical Analysis

Population densities were estimated using DISTANCE 7.3, with adjustments for detection probability. Descriptive statistics (mean ± SD) were calculated for clutch size, hatching success, and nest success. Differences in clutch size between species were assessed using independent t-tests, nest success rates with chi-square tests, and habitat-specific densities with one-way ANOVA followed by Tukey's post-hoc comparisons. All analyses were two-tailed, with significance defined at $p \leq 0.05$.

Results

Species Abundance and Habitat Distribution

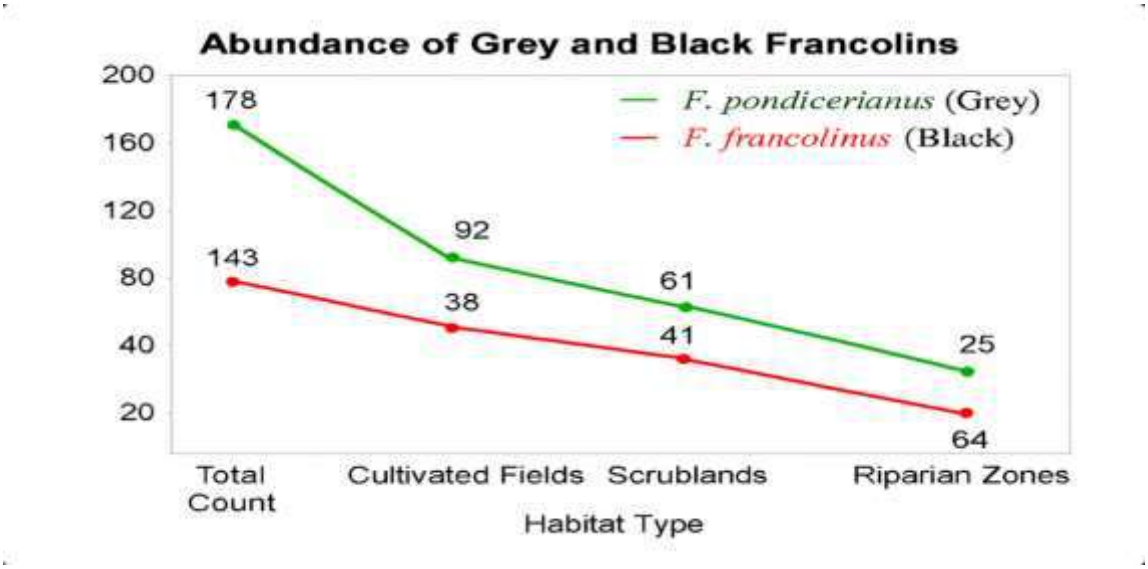
A total of 321 francolins were recorded during the study period, comprising 178 Grey francolins (*Francolinus pondicerianus*) and 143 Black francolins (*Francolinus francolinus*). Grey francolins

were predominantly observed in cultivated fields, whereas Black froncolin were more common in riparian habitats.

Table 1. ***Habitat-wise Abundance of Grey and Black francolins in Tehsil Nara (Feb2023-Oct2023).***

Species	Total Count	Cultivated Fields	Scrublands	Riparian Zones
F. pondicerianus (Grey)	178	92	61	25
F. francolinus (Black)	143	38	41	64

Figure 1: Habitat-wise Abundance



Interpretation: The Grey francolins were highly attracted to the cultivated fields whereas the Black francolins were concentrated in the riparian regions. This is an ecological response and separation of the niche by habitat.

Breeding Parameters

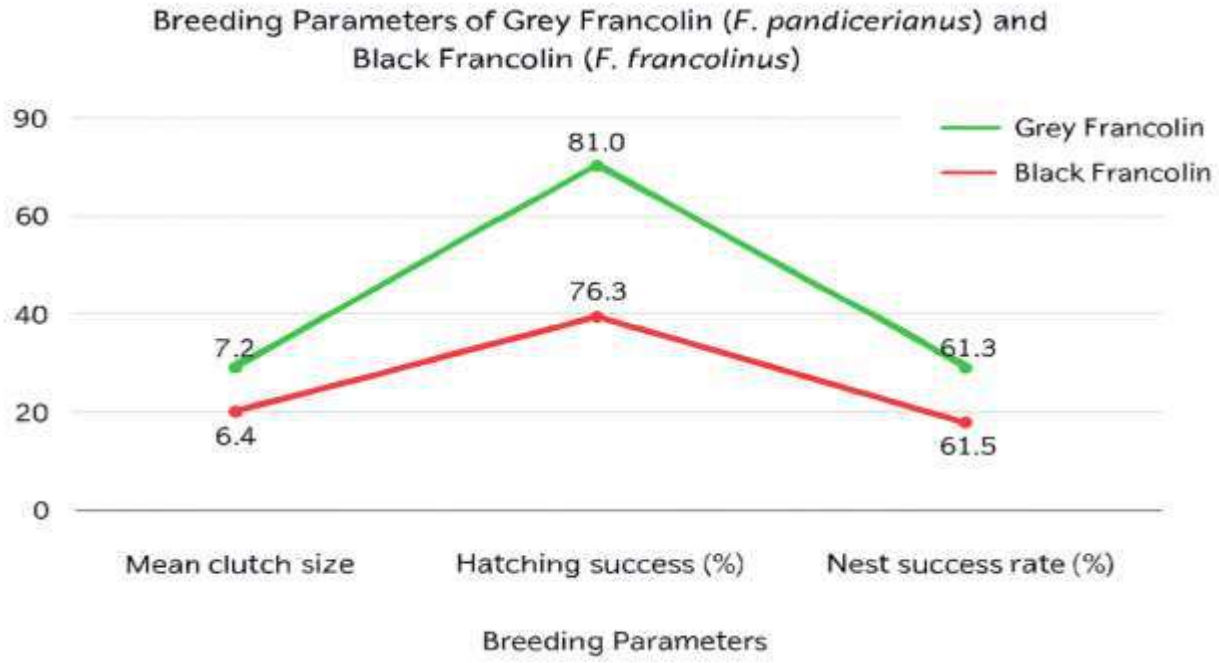
The activity was observed between March and August. Grey francolins nesting also started sooner and displayed a greater reproductive success than the Black francolins.

Table 2. ***Breeding parameters of Grey and Black francolins***

Parameter	Grey Francolin (*F. pondicerianus*)	Black Francolin (*F. francolinus*)
Mean clutch size (± SD)	7.2 ± 1.1	6.4 ± 1.3
Incubation period (days)	18–20	19–21

Hatching success (%)	81.0	76.3
Nest success rate (%)	68.3	61.5
Nesting onset (first record)	3 March	14 April

Figure 2: ***Breeding Parameters***



Interpretation: Francolins of Grey breeds produced larger clutches and had better hatching and nest success, probably because they had nest earlier and better nest conditions in cultivated areas. The Black francolins were more preyed on and there was greater environmental pressure which led to poorer reproductive success.

Seasonal Abundance Trends

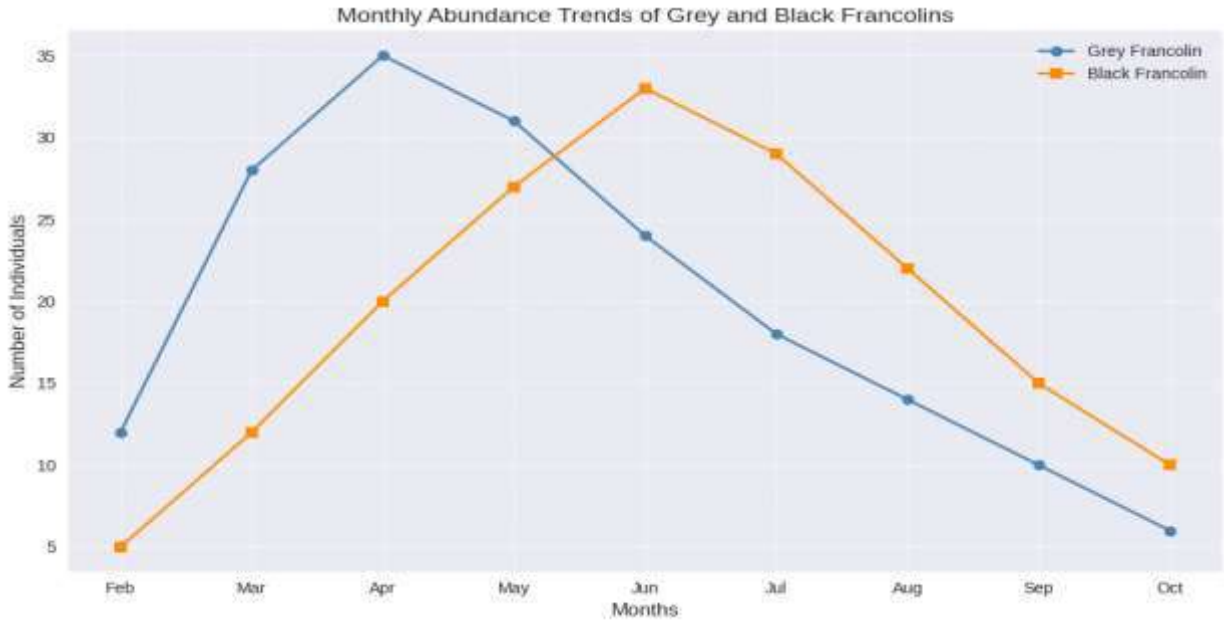
Seasonal trends showed different reports made each month. Grey francolins were most abundant in April and those of the Black francolin were most abundant in June.

Table 3. Monthly abundance of grey and black francolins (Feb–Oct 2023)

Month	Grey Francolin	Black Francolin
February	12	5
March	28	12
April	35	20

May	31	27
June	24	33
July	18	29
August	14	22
September	10	15
October	6	10

Figure. 3 ***Trends of Abundance of grey and black francolin monthly. It exhibits a significantly variable seasonal change between February to October 2023.***



Interpretation: Grey francolins earlier in the season (April) and black francolins later in the season (June) were at different breeding points and used their habitats seasonally, thus species-specific breeding patterns. There was a decrease in both species following the monsoon showing reduced activity in reproduction and dispersal.

Discussion

The results of the present study bring up new information on the ecology of Grey and Black francolins in the area of Tehsil Nara, which has never been studied in the bird literature (Yousei and Baig, 2019; Javed and Khan, 2017). The increased population density of Grey francolins is in accordance with their sexual plasticity towards landscapes produced by humans (Khalil et al., 2015; Iqbal and Hussain, 2019), and the preference of the Black francolin to riparian habitats is consistent with the Totali Game Reserve (Ullah et al., 2023).

Grey francolins started to breed (mid March) than the Salt Range, which could be due to warmer pre-monsoon climate of Sindh (Khan and Malik, 2016). The sizes of clutches were relatively bigger than those mentioned by Tariq and Bukhari (2020) in Punjab, indicating that the nestings were

favorable in the mixed agro-scrub habitat of Tehsil Nara. But, the success rates of nesting are lower when compared to those of the protected areas, probably because of heightened predation as well as human interference (Akram & Saleem, 2021; Shah and Iqbal, 2021).

There is overlap in the number of habitats of both species, which implies overlapping of their niche; nevertheless, they prefer a different microhabitat, so their niche overlap is mitigated (Ahmad and Mian, 2013; Malik and Jamil, 2018). The comparative profitability of hatching in cultivated sites indicates that the agricultural landscapes with control measures are capable of ensuring viable population of francolin (Hussain and Rafiq, 2019; Saeed and Khan, 2022).

The Anthropogenic pressure is another major issue. The interviews with the local farmers showed that there is often extensive usage of pesticides and unmanaged hunting which supported the findings of Ali et al. (2022) and Khan and Aslam (2017). These dangers were confirmed by the absence of formal security in Tehsil Nara. Hence, the conservation plans should incorporate community-wide approaches, rehabilitation of the habitat, and incorporating the francolin-based monitoring actions into the wildlife arrangements at the district level (Farooq and Ahmed, 2021; Khan and Javed, 2015).

Baseline data can be applied as the basis of future research and policy. Monitoring is needed in the long run to identify population tendencies, and measure the effect of climate variability (Haider and Khan, 2020; Latif and Shahid, 2018). Comparison between the Sindh agro-ecological areas would also clarify the agro-ecological adaptations and conservation requirements (Rauf and Tariq, 2020; Abbas and Raza, 2022).

Conclusion

The findings of this study indicate that the breeding behaviour and population trends of the Grey and Black francolins have been systematically documented for Tehsil Nara, District Khairpur. Grey francolins were also more and breed earlier and black francolins liked tighter denser environments that were more wet. The anthropogenic pressure posed a very huge threat to the reproductive success of both species which had moderate success. These results highlight environmental importance of the semi-arid environments of Sindh and the necessity of a specific conservation policies. The future study needs to be extended to the surrounding districts and to include climate and land-use modeling to assist in the long-term preservation of avian species.

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