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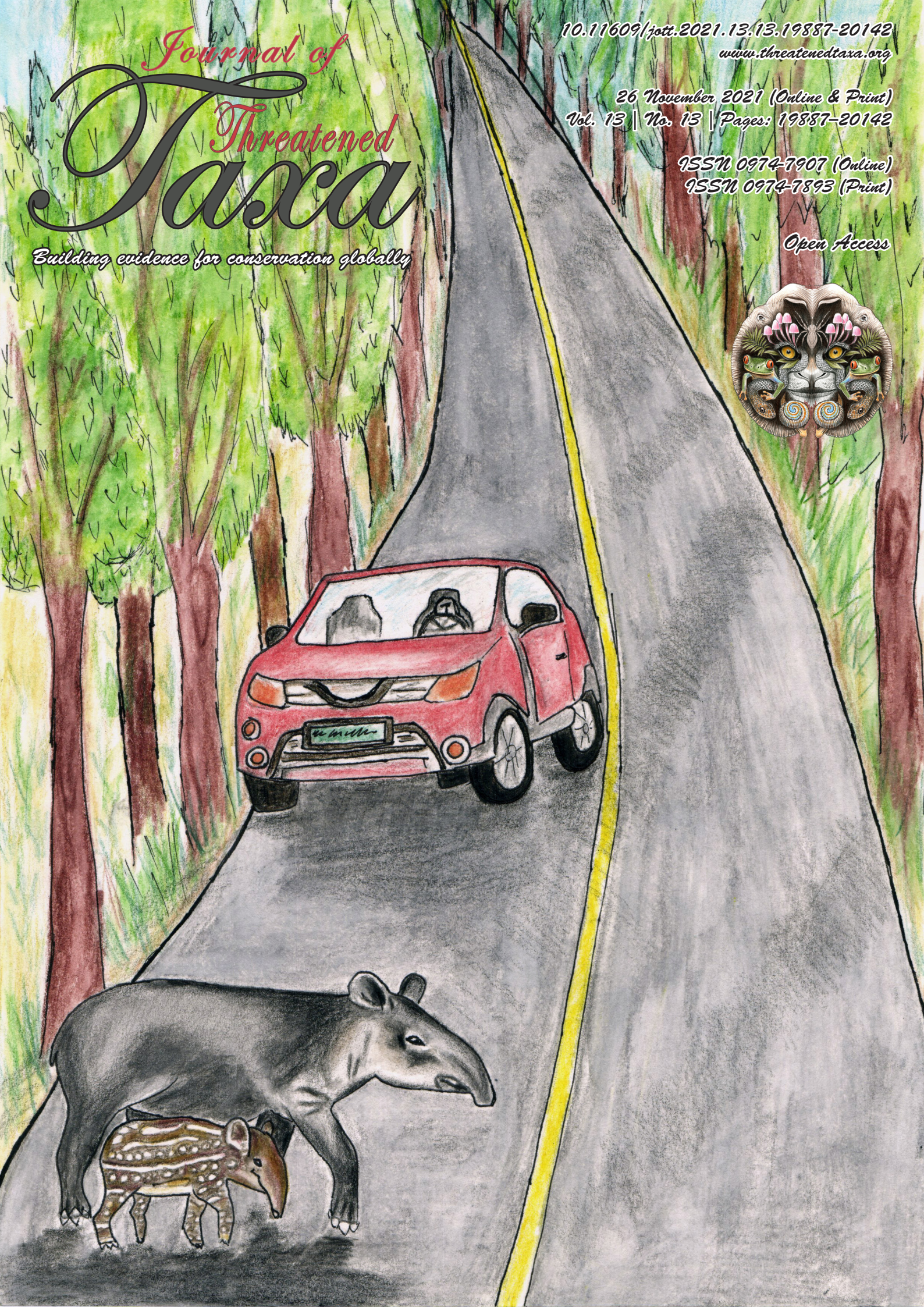
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Caption: Lowland Tapir *Tapirus terrestris* (Medium—watercolours on watercolour paper) © Aakanksha Komanduri.



INTRODUCTION

The Grey Francolin *Francolinus pondicerianus* (J.F.Gmelin, 1789) (Aves: Galliformes: Phasianidae) is native to India, Pakistan, Sri Lanka, Nepal, and Iran, and has been introduced into Bahrain, British Indian Ocean Territories, Mauritius, Oman, Qatar, Seychelles, United Arab Emirates, United States (BirdLife International 2018), and the Andaman & Chagos islands (Rasmussen & Anderton 2005; Loustace-Lalanne 1962). Fuller et al. (2000) stated that this species occurs worldwide except in the Sahara desert, the Arctic and colder regions. It occurs throughout India except in the high Himalaya, with few records in the northeastern parts (India Biodiversity Portal 2021). The birds are largely greyish-brown, rufous, and chestnut above, mottled, barred, and vermiculated with buff and black galliform (Sathyakumar & Kalsi 2007). They are omnivorous (Chaudhry & Bhatti 1992) and prefer seeds, grains, ants, and termites (Hussain et al. 2012). Sexes are alike, but males are slightly larger and have sharp spurs (Islam 1999). During non-breeding seasons, they move in groups (Rasmussen & Anderton 2005), each group consisting of 4–8 birds (Grimmett et al. 1998; Wijeyamohan et al. 2003). Breeding occurs between April–September in India (Rasmussen & Anderton 2005), and March–October in Pakistan (Roberts 1991). Ali (1945) and Sharma (1983) observed nests of *F. pondicerianus* in grasslands, ploughed fields, and dry scrub, while Bro et al. (2004) noted nests in standing crops in France. The clutch size varies from six to eight eggs (Jerdan 1864; Edwards 1933; Tiwari 1999). The female alone incubates eggs for 18–19 days (Ali & Ripley 1983; Roberts 1991). Studies and observations have been carried out on Grey Francolin populations in Coimbatore wetlands (Pramod 2011), Vaduvor Bird Sanctuary (Gokula & Raj 2011), Sirumalai (Santharam et al. 2014), and Anaikatty hills of Tamil Nadu (Divyapriya & Pramod 2019).

The populations of Grey Francolin have been declined due to various causes. Based on the agent-based model (ABM) study, Topping et al. (2010) stated that landscape modifications and climate change are causing population decline. Habitat destruction, intensive farming, use of pesticides, hunting, and nest predation were stated reasons for population decline in the U.K. (Potts 1986; Roberts 1991; Aesbischer & Potts 1995; Southerton et al. 2010), western Europe (Bro et al. 2004), Pakistan (Khalil et al. 2015), and India (Whistler 1949). The global population size of this species has not been quantified, but it is reported to occur in most parts of its range (DelHoyo et al. 1994). The IUCN Red List considers it as 'Least Concern' (BirdLife International 2018).

The population size of Grey Francolin has not been quantified (BirdLife International 2018). Studies have, however, been conducted on the habitats and behaviours of this species but no literature is available about these aspects of this species in the northern districts of Tamil Nadu. Hence, the present study was carried out to fill these gaps by studying the habitats and foraging habits of this species, size of flocks and roosting patterns in five villages each in Ranipet, Tiruvallur, Tiruvannamalai, and Villupuram districts of Tamil Nadu in India, with the following objectives: (1) assess numbers of individuals in the rural landscape of the study area; (2) identify preferred habitat types with key plant species used for shelter; (3) assess human impact on bird habitats; and (4) identify key local threats.

MATERIALS AND METHODS

Study Area

The current study was carried out in 20 villages, five each in Tiruvallur (13.083°N, 79.543°E), Ranipet (12.948°N, 79.319°E), Tiruvannamalai (12.491°N, 79.1097°E), and Villupuram (11.940°N, 79.486°E) districts of northeastern Tamil Nadu (Figure 1). These districts spread over 15,560 km², with a human population of c. 94,80,000. Agriculture is the primary occupation of the residents, and the major crops are paddy *Oryza sativa* L., jowar *Sorghum bicolor* (L. Moench.), pearl millet *Pennisetum glaucum* (L.)R.Br., finger millet *Eleusine coracana* Gaertn., sugarcane *Saccharum officinarum* L., groundnut *Arachis hypogaea* L., and green gram *Vigna radiata* (L.)R.Wilczek. Vegetables, ornamental flowers, and fruits are also commonly cultivated in the study area. The maximum and minimum temperatures are 36 °C and 20 °C, respectively, and the average annual rainfall is 1,060 mm (www.tn.gov.in).

METHODS

With help from three farmers, potential habitats for the Grey Francolin were identified in 20 villages surveyed during the non-breeding season from November 2019 to March 2020. Birds are usually active in the morning and evening from 0600–0900 h and 1500–1800 h (Gould 1966; Mahmood et al. 2010), thus field investigations were focused during these times. Based on information on the habitats of birds, each village was monitored for three days consecutively. Population size, including juveniles/chicks, was determined using the total count method (Bibby et al. 2000). Movements of birds were observed using binoculars without causing disturbance. Data were

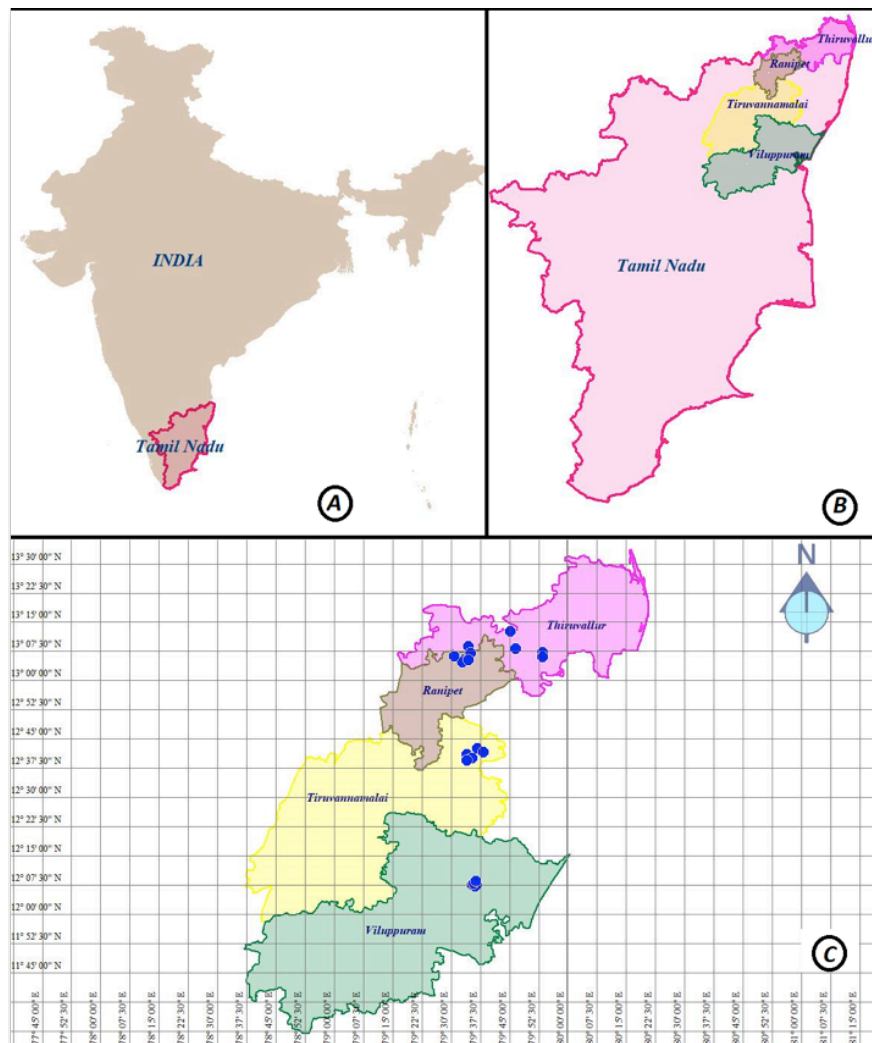


Figure 1. Study area map: A—India map showing Tamil Nadu | B—Tamil Nadu map showing the four selected districts | C—Map of the four districts indicating villages.

collected on group size, foraging behaviour, call bouts, fighting between males, roosting, vegetation types, type of habitats, and probable local conservation threats. GPS coordinates were recorded where birds appeared in agricultural fields, near water bodies, residential areas, and temples/buildings. Trees and tall grasses providing shelter to the birds were identified using Gamble (1915, 1921, 1928) and Nair & Henry (1989). Pearson Chi-square analysis was used to test the significance between different types of habitats and behaviours of Grey Francolin. Collected data were tabulated, analyzed and shown as graphical representation. Photographs and videos were taken using Nikon P1000 digital camera.

RESULTS AND DISCUSSION

A total of 252 Grey Francolin individuals, including 16 juveniles/chicks, were observed in 20 villages covering four districts. A maximum of 93 birds were enumerated in Tiruvallur district, followed by 70 birds in Ranipet, 54 in Villupuram, and 35 in Tiruvannamalai district. Of the 252 birds counted, 16 were juveniles/chicks found along with adult birds in five villages (Table 1). Availability of fallow lands, bushes, and less threat from hunters may be responsible for the existence of considerable populations of this species in the study area. In the present study the enumerated birds were found in small groups of 2–6 individuals. This observation matches the findings of Rasmussen & Anderton (2005), Grimmett et al. (1998), and Wijeyamohan et al. (2003).

Table 1. Details of *Francolinus pondicerianus* individuals counted in the study area.

District	Name of the villages	No. of adult birds counted	No. of juveniles/chicks counted	Total no. of birds counted	District wise no. of birds counted
Tiruvallur	Periyakadambur	18	6	24	93
	Thiruvalangadu	14	3	17	
	K.K. Chatram	12	0	12	
	Selai	28	0	28	
	Ekattur	12	0	12	
Ranipet	Minnal	9	0	9	70
	Narasingapuram	16	3	19	
	Gudalur	12	0	12	
	G.R. Pet	21	0	21	
	Salai-Vedal	7	2	9	
Tiruvannamalai	Valarpuram	8	0	8	35
	Velianallur	11	0	11	
	Kaazhiyur	7	0	7	
	Irumanthangal	4	0	4	
	Pandiyambakkam	5	0	5	
Villupuram	Mayilam	20	0	20	54
	Sendur	13	2	15	
	Pathiripuliyur	6	0	6	
	Vilangampadi	5	0	5	
	Edapalayam	8	0	8	
Total	20	236	16	252	252

Type of habitats

One-hundred-and-forty-three foraging birds were observed in grasslands (Figures E, F), followed by 61 in fallow agricultural lands, 37 in dry lakes/canals, and 11 in harvested fields (Table 2). Grey Francolins live in bushes consisting of stunted trees, shrubs/herbs/grasses, and adjoining sites such as grasslands, fallow agricultural lands, lakes/canals, and harvested fields for foraging. Chi-square analysis to test the significance between type of habitats and behaviours of bird yielded a p value of 0.503, hence we conclude that no significant association exists between the type of habitats and behaviors of bird such as foraging, fighting, and roosting in the study area. There was no variation in the number of birds observed roosting and the number observed fighting in lakes and canals. Based on row percentage, 87% of foraging birds were found in grasslands, indicating this habitat provides ideal shelter (Table 3).

Of the 252 birds enumerated, 87% were observed foraging in various habitats (Figure 2). They come out of the bushes in the morning between 0545 and 0600 h, complete foraging and take shelter in the bushes before 0900 h. On spotting anthropogenic disturbances such as agricultural workers, general public or vehicular movements in the vicinity of foraging sites, they ran swiftly and hid in the tall grasses or bushes. Their foraging activities were found to extend between 0600 and 0900 h and 1600 and 1800 h. No birds were found in open places between these two time segments. Study of foraging behaviours reveals that birds dig the soil using beak and claws to find seeds, worms, and insects (Image

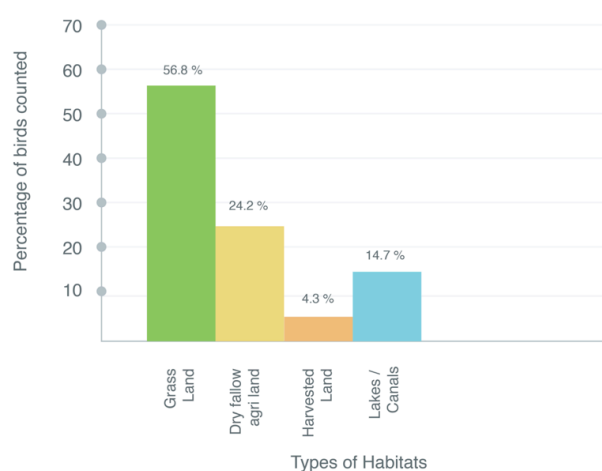
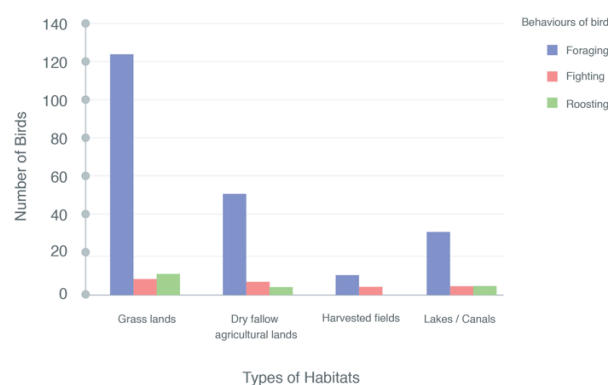
Figure 2. Percentage of *Francolinus pondicerianus* individuals observed on various habitats.

Figure 3. Type of habitats and number of birds found foraging, fighting, and roosting.

Table 2. Details of observance of *Francolinus pondicerianus* populations in various habitats in the study area.

	Type of habitat	Total no. of birds		Foraging		Fighting		Roosting	
		Count	%	Count	%	Count	%	Count	%
1	Grasslands	143	56.8	124	56.7	8	44.5	11	73.4
2	Fallow fallow agricultural lands	61	24.2	53	24.2	6	33.3	2	13.3
3	Harvested fields	11	4.3	9	4.1	2	11.1	-	-
4	Lakes/Canals	37	14.7	33	15.0	2	11.1	2	13.3
	Total	252	100	219	100	18	100	15	100

Table 3. Chi-Square test for association between type of habitats and observed behaviours of *Francolinus pondicerianus* in the study area. The values within () and [] refer to row and column percentages, respectively.

Type of habitats	Behaviours of bird			Total	Chi-Square Value	p-Value
	Foraging	Fighting	Roosting			
Grasslands	124 (86.7) [56.6]	8 (5.6) [44.4]	11 (7.7) [73.3]	143 (100.0) [56.7]	5.321	0.503
Dry fallow agricultural lands	53 (86.9) [24.2]	6 (9.8) [33.3]	2 (3.3) [13.3]	61 (100.0) [24.2]		
Harvested fields	9 (81.8) [4.1]	2 (18.2) [11.1]	0 (0.0) [0]	11 (100.0) [4.4]		
Lakes/Canals	33 (89.2) [15.1]	2 (5.4) [11.1]	2 (5.4) [13.3]	37 (100.0) [14.7]		
Total	219 (86.9) [100.0]	18 (7.1) [100.0]	15 (6.0) [100.0]	252 (100.0) [100.0]		

1b,c,d). Grey Francolin individuals preferred seeds, grains, worms, ants and termites in India (Jerdon 1864) and in Pothwar region of Pakistan (Hussain et al. 2012). In the current study, the foraging sites (6) in Mayilam and Selai villages were examined between 0600 and 0800 h when the birds were found active at the foraging sites. The study revealed that there were termite nests on the dead plant materials covered with thin layer of wet soil. In Pathiripuliur village Grey Francolin individuals were found foraging on spillover paddy grains in the harvested paddy fields. Hence, observation of foraging on termites and paddy grains in the present study matches with the findings of Jerdon (1864) and Hussain et al. (2012). The details of other prey of this bird warrant further elaborate study.

Among the 252 Grey Francolin individuals studied, nine pairs of males were found fighting in open land in the early morning. For 21 fights observed, the duration ranged from 5 to 15 minutes, and the number of fights per pair varied from 1 to 4. No fights were observed in the evening during the study period. When they noticed humans in the vicinity males stopped fighting

temporarily and took cover in the bushes, then later emerged to make loud calls and continue fighting until further disturbances occurred in the vehicular traffic or other human activities (Image 1f). The maximum of such fighting by male individuals were observed in grasslands (four pairs), followed by dry fallow agricultural lands (three pairs) and two pairs each in harvested fields and dry lakes/canals, respectively. All such fights were observed in open places and the reason could be either territorial or breeding or both, and this aspect requires further study. Study on the call sounds reveal that the males have repeatedly produced calls in a sequence of calling bouts ranging from four to seven bouts at a time by stretching their neck. Males call more frequently at sunrise and sunset (Ali & Rilpey 1983; Johnsgard 1988). In the present study also males were found making such loud calls both during their morning and evening forages and hence it matches with the observations of the above authors. Rana et al. (2007) had stated that the dawn calling by these birds in Haryana (India) might have been linked to the transmission of messages for marking their territorial jurisdiction. The pattern of maintaining

territorial jurisdiction and the pattern of dawn calls of males in the present habitat requires further study (Image 1a).

Only 15 birds were found roosting during the afternoon between 1600 and 1800 h. Fourteen birds were found on the stunted *Prosopis juliflora* (Sw.) DC. trees and one bird was on liana *Tinospora cordifolia* (Thunb.) Miers. Except during foraging and fighting, it was difficult to spot the birds in their habitats because they hide/take cover in the tall grasses and bushes (Image 1).

Plants providing habitat

Trees with stunted growth interspersed with tall, thick grasses forming dense vegetation in the study area becomes a suitable habitat for this bird. The study reveals that thick growth of tall grasses such as *Cymbopogon coloratus* (L.) Speng., *Chrysopogon zizanioides* (L.) Roberty, *Chloris inflata* (L.) Sw., and *Aristida setacea* L. were found in the study area. In between grasses, small and stunted tree species such as *Prosopis juliflora* (Sw.) DC., *Azadirachta indica* A.Juss., *Canthium coromandelicum* L., *Lantana camera* L., *Vitex negundo* L., *Vachellia nilotica* (L.) P.J.H.Hurter & Mabb., *Ziziphus jujuba* Mill., and *Capparis sepiaria* L. were identified. High density of Grey Partridge *Perdix perdix* were found in the herbaceous and farmland habitats in Prague of the Czech Republic (Salek et al. 2004). Husain et al. (2012) have stated that these birds preferred to live in scrub vegetation in Pothwar plateau in Pakistan. In Sri Lanka, they occur in the habitats with dwarf bush and thorn scrub vegetation (Wijeyamohan et al. 2003). It was observed that Grey Francolin individuals roost on short trees and shrubs in India (Sangha (1987) and in Pakistan (Roberts 1991). Hence, in the present study the occurrence of sizeable populations of Grey Francolin in the grassland habitats with bushes containing short trees and shrubs corroborates the findings of Sangha (1987), Roberts (1991), Salek et al. (2003), and Wijeyamohan et al. (2003). These bushes might have protected the birds from predators such as dogs and raptors and also protected their chicks from house crows, and hunting by local villagers. Hence, four species of tall grasses such as *C. coloratus*, *C. zizanioides*, *C. Inflata*, and *A. setacea*, six species of trees and two species of shrubs provide suitable habitat for this species. In addition tall grasses in the habitats afford camouflage to the birds.

When analysing the relationship between the sites of observance of birds and the nearest human residences, it was observed that a maximum of 117 birds (46%) were found more than 1,000 m away from human settlements. Seventy-six birds (30%) were found between 751 and 1,000m, 21 birds (8.3%) between 501 and 750 m, 26 birds

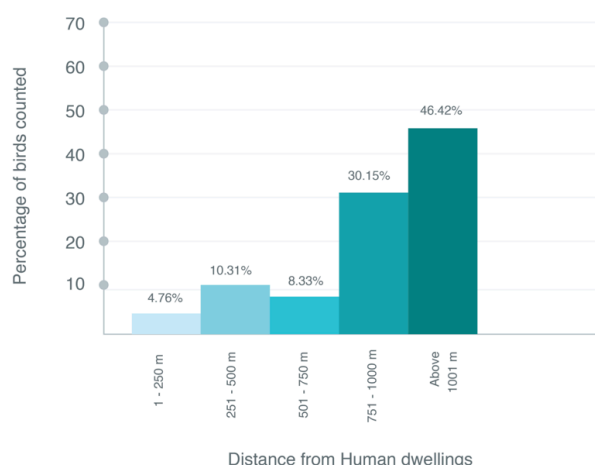


Figure 4. Relationship between distance from nearest human dwellings and number of birds enumerated.

(10%) between 251 and 500 m, and 12 birds between 1 and 250 m from human settlements as observed in the study. The existence of 77% of birds (n= 193) located 750 m away from human dwellings reveals that they preferred the rural landscape (Figure 4). The study also reveals that the average flush distance of this bird from human beings is 80 m.

Conservation issues

Two incidents of dogs chasing Grey Francolin were noted in Narasingapuram, and one each in Mayilam and G.R. Pet villages, between 1700 and 1800 h. A trap net placed by hunters in the grassland of Mayilam village was found on 10 March 2020; no trapped birds were found and traps were not observed in other habitats/villages during the study period. Habitat destruction, intensification of agriculture, and indiscriminate use of pesticides have been linked to francolin population decline in Pakistan (Roberts 1991), and Khalil et al. (2015) stated that hunting, predation and increasing agricultural activities caused population decline in Salt range, Pakistan. Hunting, nest predation and agricultural practices have been linked to declining populations in the United Kingdom (Potts 1980, 1986; Aesbischer & Potts 1995; Southerton et al. 2010) and in western Europe (Bro et al. 2004), while landscape modifications, climate change and predation have reduced populations worldwide (Topping et al. 2010). In India, Grey Francolin continue to be hunted for food (Long 1981), with use of low nets being prevalent (Whistler 1949). Observation of hunting/trap nest in the habitat and the impact of urbanization and intensification of agriculture on the populations of this species in Tamil Nadu warrants further study.

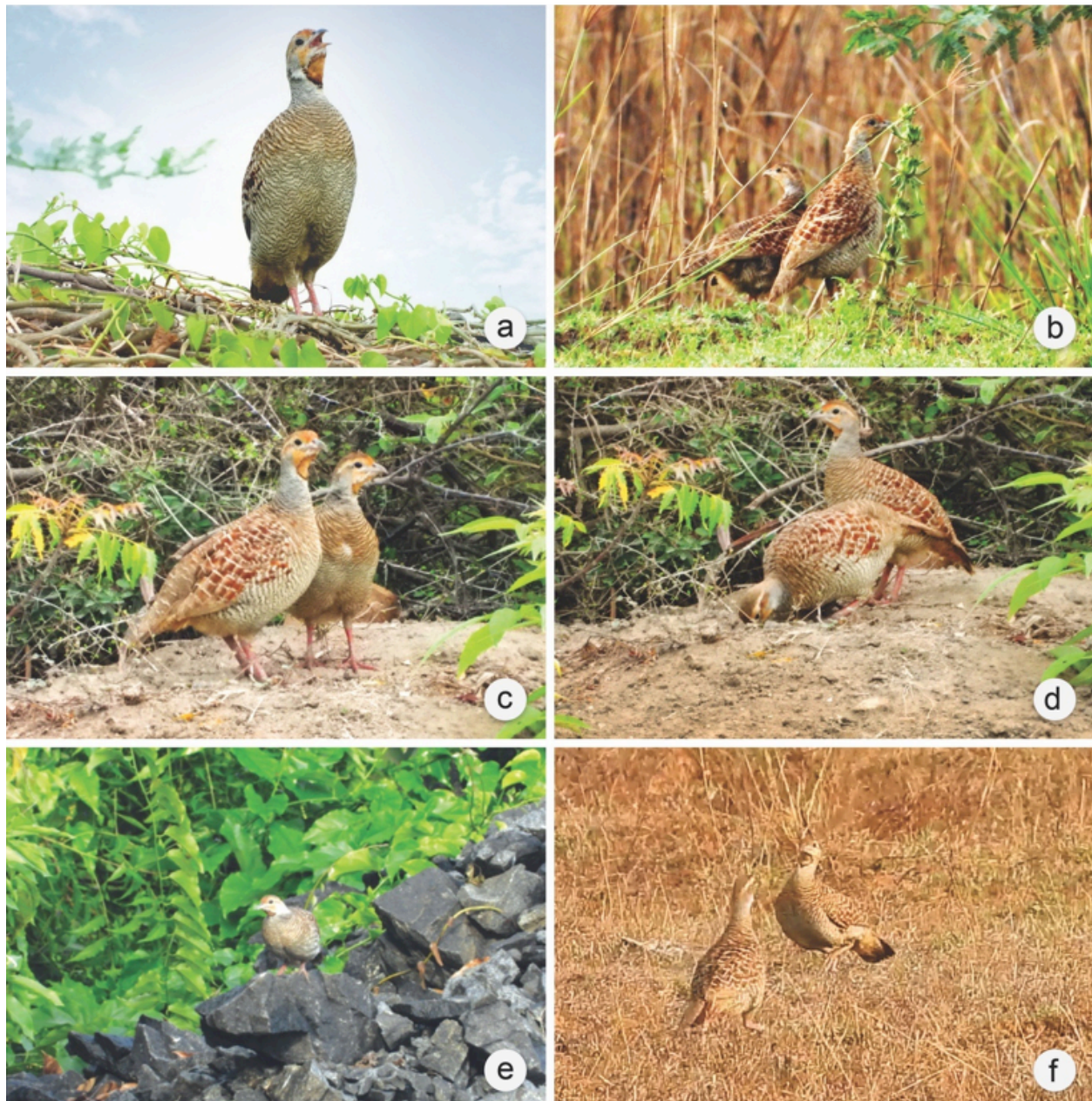


Image 1. Behaviours of *Francolinus pondicerianus* individuals: a—Male calling | b—Pair foraging near dried lake | c, d—A foraging pair | e—An individual observed in an abandoned stone quarry in grassland | f—Males fighting with each other. © M. Pandian.

CONCLUSION

The present investigation of 20 villages in four districts of northern Tamil Nadu enumerated 252 Grey Francolin in habitats that by order of preference included grasslands, dry fallow agricultural lands, dry lakes/canals and harvested crop fields, with birds showing a preference for areas distant from human dwellings. Males made calling bouts in the morning and evening forages, probably to mark their territories via fighting. Hunting and dogs may pose threats to populations in the study area. Further

study on the population dynamics, geospatial analysis of nests, and their breeding biology at various habitats covering larger areas in the state may throw more light on the exact population status of this bird. This will require sustained surveys and monitoring of populations during the breeding and non-breeding seasons. Efforts should also be taken to protect existing habitats from widening of roads, urbanization, industrialization, and hunting by villagers. A management plan could be devised for the area, considering the anthropogenic and natural stresses that bird habitats are currently subjected to.



Local community, particularly traditional hunters, should be sensitized to understand the importance of this bird species and their need to preserve the populations of Grey Francolin. A detailed and systematic survey on the population dynamics, foraging behaviours and anthropogenic impact on their populations covering the entire state may be carried out to help in drafting an action plan to conserve the declining populations of this native species.

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Article

An inventory of geometrid moths (Lepidoptera: Geometroidea: Geometridae) of Kalakad-Mundanthurai Tiger Reserve, India

– Geetha Iyer, Dieter Stüning & Sanjay Sondhi, Pp. 19887–19920

Communications

Roadkills of Lowland Tapir *Tapirus terrestris* (Mammalia: Perissodactyla: Tapiridae) in one of its last refuges in the Atlantic Forest

– Aureo Banhos, Andressa Gatti, Marcelo Renan de Deus Santos, Leonardo Merçon, Ilka Westermeyer, Natália Carneiro Ardente, Luis Francisco Oliveira Pereira Gonzaga, Lucas Mendes Barreto, Lucas Damásio, Tomas Lima Rocha, Vitor Roberto Schettino, Renata Valls, Helena Godoy Bergallo, Marcos Vinicius Freitas Silva, Athelson Stefanon Bittencourt, Danielle de Oliveira Moreira & Ana Carolina Srbek-Araujo, Pp. 19921–19929

Scientific contributions and learning experiences of citizen volunteers with a small cat project in Sanjay Gandhi National Park, Mumbai, India

– Shomita Mukherjee, R. Nandini, P.V. Karunakaran & Nayan Khanolkar, Pp. 19930–19936

Seasonal food preferences and group activity pattern of Blackbuck *Antelope cervicapra* (L., 1758) (Mammalia: Cetartiodactyla: Bovidae) in a semi-arid region of western Haryana, India

– Vikram Delu, Dharambir Singh, Sumit Dookia, Priya & Kiran, Pp. 19937–19947

Studies on the habitats of Grey Francolin *Francolinus pondicerianus* (J.F. Gmelin, 1789) (Galliformes: Phasianidae) in northern districts of Tamil Nadu, India

– M. Pandian, Pp. 19948–19955

Recovery of vulture population in roosting and scavenging areas of Bastar and Bijapur, Chhattisgarh, India

– Sushil Kumar Dutta, Muntaz Khan, P.R.S. Nagi, Santosh Durgam & Surabhi Dutta, Pp. 19956–19963

A geographical assessment of Chariganga and Arpara Beel (wetlands) of Nadia, West Bengal as a habitat of wetland birds

– Mehedi Hasan Mandal, Arindam Roy & Giasuddin Siddique, Pp. 19964–19975

Phenotypic plasticity in *Barilius vagra* (Hamilton, 1822) (Teleostei: Danionidae) from two geographically distinct river basins of Indian Himalaya

– Sumit Kumar, Sharali Sharma & Deepak Singh, Pp. 19976–19984

Taxonomic notes, a new species, and a key to Indian species of the click beetle genus *Cryptalaus* Ôhira, 1967 (Coleoptera: Elateridae: Agrypninae)

– Harshad Parekar & Amol Patwardhan, Pp. 19985–19999

Niche overlap of benthic macrofauna in a tropical estuary: diurnal variation

– Mário Herculano de Oliveira, Lidiane Gomes de Lima, Caroline Stefani da Silva Lima, Jéssica de Oliveira Lima Gomes, Francieli Ferreira Paiva, Graciele de Barros, Carlinda Raily Medeiros & Joseline Molozzi, Pp. 20000–20010

Diversity of aquatic insects and biomonitoring of water quality in the upper Ganga River, a Ramsar site: a preliminary assessment

– Kritish De, Arkojyoti Sarkar, Kritika Singh, Virendra Prasad Uniyal, Jeyaraj Antony Johnson & Syed Ainul Hussain, Pp. 20011–20018

Patterns of forest cover loss in the terrestrial Key Biodiversity Areas in the Philippines: critical habitat conservation priorities

– Bernard Peter O. Daipan, Pp. 20019–20032

The woody flora of Shettihalli Wildlife Sanctuary, central Western Ghats of Karnataka, India - A checklist

– Kanda Naveen Babu, Kurian Ayushi, Vincy K. Wilson, Narayanan Ayyappan & Narayanaswamy Parthasarathy, Pp. 20033–20055

Reproductive biology of *Ophiorrhiza caudata* C.E.C. Fisch. (Rubiaceae), an endemic and endangered creeping perennial herb of the Western Ghats, India

– Maria Theresa, Appukuttan Kamalabai Sreekala & Jayalakshmi Mohanlal, Pp. 20056–20065

Short Communications

Successful rescue, medical management, rehabilitation, and translocation of a Red Panda *Ailurus fulgens* (Mammalia: Carnivora: Ailuridae) in Arunachal Pradesh, India

– Jahan Ahmed, Sorang Tadap, Millo Tasser, Koj Rinya, Nekibuddin Ahmed & Sunil Kyarong, Pp. 20066–20071

A rare photographic record of Eurasian Otter *Lutra lutra* with a note on its habitat from the Bhagirathi Basin, western Himalaya, India

– Ranjana Pal, Aashna Sharma, Vineet Kumar Dubey, Tapajit Bhattacharya, Jeyaraj Antony Johnson, Kuppusamy Sivakumar & Sambandam Sathyakumar, Pp. 20072–20077

The first record of Medog Gliding Frog *Rhacophorus translineatus* Wu, 1977 (Anura: Rhacophoridae) from Chhukha District, Bhutan

– Sonam Lhendup & Bal Krishna Koirala, Pp. 20078–20083

First record of a freshwater crab, *Maydelliathelphusa masoniana* (Henderson, 1893) (Decapoda: Brachyura: Gecarcinucidae) from West Bengal, India

– Ram Krishna Das, Pp. 20084–20089

Butterflies of Amrabad Tiger Reserve, Telangana, India

– Deepa Jaiswal, B. Bharath, M. Karuthapandi, Shrikant Jadhav, S. Prabakaran & S. Rehanuma Sulthana, Pp. 20090–20097

An enumeration of the flowering plants of Kyongnosla Alpine Sanctuary in eastern Sikkim, India

– Sudhansu Sekhar Dash, Subhajit Lahiri & Ashiho Asoshii Mao, Pp. 20098–20117

A new record of psychrotrophic *Paecilomyces formosus* (Eurotiales: Ascomycota) from India: morphological and molecular characterization

– Skarma Nonzom & Geeta Sumbali, Pp. 20118–20123

Notes

Study on incidence and pathology of gastrointestinal parasitic infections in Nilgai *Boselaphus tragocamelus* in Hisar, Haryana, India

– Maneesh Sharma, B.L. Jangir, D. Lather, G.A. Chandratre, V. Nehra, K.K. Jakhar & G. Narang, Pp. 20124–20127

An unusual vocalization of Brown Hawk-Owl *Ninox scutulata* (Raffles, 1822) (Aves: Strigiformes: Strigidae) recorded from Kerala, India

– Riju P. Nair & Shine Raj Tholkudiyil, Pp. 20128–20129

New distribution data on the genus *Maripanthus* Maddison, 2020 (Araneae: Salticidae) from southern India

– A. Asima, John T.D. Caleb, Dhruv A. Prajapati & G. Prasad, Pp. 20130–20132

On the IUCN status of *Boesenbergia albolutea* and *B. rubrolutea* (Zingiberaceae) and typification of *B. rubrolutea*

– K. Aishwarya & M. Sabu, Pp. 20133–20135

New records of mass seeding *Cephalostachyum latifolium* Munro (Poaceae) along the mid-elevation broadleaved forest of Sarpang district, Bhutan

– Jigme Tenzin, Sangay Nidup & Dago Dorji, Pp. 20136–20139

Response

If habitat heterogeneity is effective for conservation of butterflies in urban landscapes of Delhi, India? Unethical publication based on data manipulation

– Sanjay Keshari Das & Rita Singh, Pp. 20140–20142

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