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Antipredator Behaviour Towards Human in Birds of Southern Rajasthan, India

Agrawal Avinash, Yadav Rahul, Bhagora Abhilasha, Gupta Sahil and Saxena Kanan*

Government Meera Girls College, Department of Zoology, Mohanlal Sukhadia University, Udaipur, Rajasthan 313001, India

**Corresponding Author*

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Abstract: There are many anti-predatory escape strategies in animals. An established method for assessing escape behavior is the flight initiation distance (FID), which is the distance between prey and predator at which an animal flees. The ecological factors affecting avian FID have received much attention over the past few decades, and meta-analysis and comparative analysis have shown that FID is related to body mass and flock size and varies along rural to urban gradients. In our analyses, we determined the relation between FID with two important factor flock size and body mass of birds. Group or herd size can either impact FID negatively (i.e. the dilution effect caused by the presence of many individuals) or positively (i.e. increased alertness as more eyes search for predators).

Keywords: Escape behaviour, Birds, Human disturbance, Urban, Rural, Flight initiation distance

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Introduction

According to life history theory, anti-predation behavior has a significant impact on reproductive success (Caro, 2005). Animals must therefore change their behavior and adapt to the environment in order to increase (future) reproductive success.When faced with a predatory threat, prey may employ one of three possible defense strategies: camouflage to evade detection, evade capture, or attempt to dissuade the predator(Kalb and Randler, 2019). However, when a predatory threat is present, a prey's most typical response is to flee (Lima and Dill, 1990). Early escape may reduce foraging efficiency or increase physiological costs, while, on the other hand, delayed escape may increase the risk of mortality from predation (Ydenberg and Dill, 1986). When a human approaches a given bird under controlled conditions, flight initiation distance (FID) is often used to quantify fear and risk-taking in birds. In all species, FID is typically positively correlated with body size, possibly because larger species that live longer and delay reproduction minimize mortality from predation by taking fewer risks (Wasser and Sherman, 2010; Virkkala and Lehikoinen, 2014), and they take a longer time to get airborne and thus avoid capture (Hemmingsen, 1951; Fernández-Juricic *et al*., 2006; Møller *et al*., 2007; Weston *et al*., 2012). Finally, the number of birds in a flock can have a positive effect on FID, likely due to multi-eyed scanning and increased vigilance (Pulliam *et al*., 1982; Morelli *et al*., 2019). The flock size seems to be related to FID rather than distance traveled during the flight (Tätte *et al*., 2018).

Animals in larger groups or large flock size usually flee at a longer distance (Stankowich and Blumstein, 2005) (flock-size hypothesis) because large flocks may be able to detect an approaching predator earlier (Boland *et al*., 2003) and therefore earlier the take flight. On the other hand, some species are more tolerant of approaching threats when in a large group, as animals may feel safer in groups (dilution effect) (Cresswell, 1994), which can result in decreased FID. As the black redstart does not live in permanent flocks, we expect our findings to be in line with Stankowich and Blumstein (2005); that is, birds in flocks have a higher FID than single birds or birds in smaller flocks.

Rajasthan is the northwestern state of India. Although this state is poor in water resources, it supports rich bird life. About 40% of India's bird life (1224 species) occurs in the state, which occupies only 10% of the country's land area. The reason for its high diversity is the appearance of different habitats and the geographical location of the state, which falls in the flight path of migratory birds. About 510 bird species can be seen in the state of Rajasthan (Grimmett and Inskipp, 2003); while Devarshi (2004) has recorded a total of 496 bird species from Rajasthan, representing about 40% of India's bird life.

The southern part of Rajasthan includes six Districts -- Chittorgarh, Udaipur, Pratapgarh, Banswara, Rajsamand and Dungarpur. Southern Rajasthan covers an area between 23°1'11'' to 26°1'15''N latitude and 73°1'10'' to 75°43'30'E longitude. It is located in the western zone of India in general and in the southwestern part of the Aravalli Mountains in particular. It covers an area of about 47397 km^2, it stretches almost 210 km from north to south and 240 km from east to west. The region is bounded to the east by Bundi and Kota districts. The districts of Mandsor, Ratlam and Jabua in Madhya Pradesh in the south-east and the districts of Banaskanta, Sabarkanta and Panchmahal in Gujarat in the south. Tropic of Cancer runs through its southern tip in Banswara District.

In the present study, the anthropogenic antipredator response of terrestrial bird species in the southern part of the state of Rajasthan in India was investigated.

Materials and Methods

Rapid and extensive preliminary field surveys were carried out within southern Rajasthan, during the study period for selection of study points. All the above-mentioned places of southern districts of Rajasthan were surveyed to gather information regarding the presence and absence of the avian species as well as antipredator behavior. On the basis of preliminary survey data, some places and lake area were selected. The main criteria for selection of the places were number of birds sighted and anthropogenic disturbance level of that area. Data on the flight initiation distance (FID) of birds were collected in urban and rural areas in six districts of southern Rajasthan (Udaipur, Chittorgarh, Rajsamand, Pratapgarh, Dungarpur and Banswara during 2017 and 2018.

We used a study design that collected data in urban and rural areas (habitat type) at each study site, as a large body of literature highlights the main differences between urban and rural settings in terms of bird responses to predation risk (Møller *et al*., 2012; Samia *et al*., 2017).

The data were mainly collected during the first 4 h after sunrise (6:00–10:00) on weekdays when it was not raining or excessively windy. FID was measured as the distance between the observer and the point where the bird started to escape

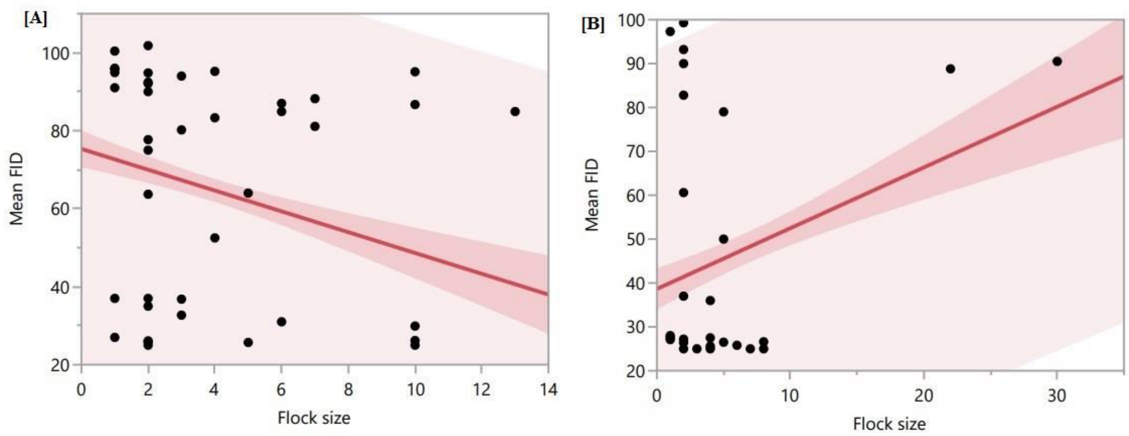

Fig. 1: Relation between mean flight initiation distance (FID) and flock size of terrestrial bird's species recorded in present study in six different districts of Rajasthan, India. [A] Rural, [B] Urban. Envelopes around lines are 95% confidence intervals.

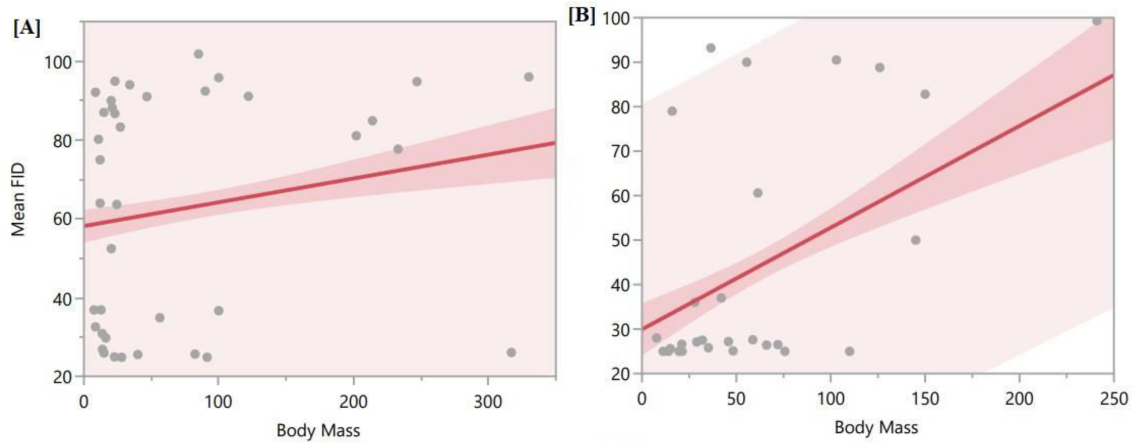

Fig. 2: Relation between mean flight initiation distance (FID) and Body mass (g) of terrestrial bird's species recorded in present study in six different districts of Rajasthan, India. [A] Rural, [B] Urban. Envelopes around lines are 95% confidence intervals.

(fleeing or running). Only bird species detected on the ground were considered. Flock size was defined as the number of aggregated individuals of the same species, implying that individuals in flocks are closer to each other than individuals that are not in flocks. Body mass for each species was obtained from the CRC Handbook of Avian Body Masses (Dunning Jr, 2007).

Statistical analyses:

All data presented in this paper were processed using JMP 16.2.0 (SAS Institute Inc.) statistics package software. General linear mixed models were used to study the relationships among dependent variables (FID) and predictor variables (Start distance, Alert distance, Body mass, Noise level and Flock size).

Results

From a total of 600 observations from six different districts, all observations of FID for the 73 terrestrial birds were collected with various sample size. In the exploration of data, FID was positively correlated with body mass and flock size (Figs. 1, 2). The FID for terrestrial bird species ranged from a minimum of close to 25 m to a maximum of 101 m, with a mean value = 65.76 with SD = 28.95 m in rural habitat and 45.76 with SD = 28.46 m in urban habitats. For the majority of the terrestrial birds that were the subject of this study, a preliminary graphical analysis indicated that the FID was shorter in urban settings than in

Table 1: A multiple linear regression was calculated to predict FID based on flock size and body mass of terrestrial birds from rural and urban habitat of six different districts of Rajasthan, India

Effect	Mean	Estimate	SE	t	p
Flock size (Rural)	65.01	-2.66	0.48	-5.55	< 0.0001
Flock size (Urban)	47.61	1.38	0.24	5.73	< 0.0001
Body mass (Rural)	63.45	0.06	0.01	3.75	< 0.0002
Body mass (Urban)	44.49	0.22	0.03	5.96	< 0.0001

rural areas. The results of this study showed that the mean FID of terrestrial birds was increased with increasing body size while an opposite scenario was found regarding flock size. With increasing flock size of terrestrial birds in rural habitat, FID tended to decrease. If excluded some exceptions, Birds with higher body size such as *Aquila nipalensis, Aquila rapax, Pavo cristatus, Sarcogyps calvus* and *Gyps indicus* showed longer FID while birds with lower reduced body size such as *Orthotomus sutorius, Culicicapa ceylonensis, Pericrocotus cinnamomeus, Zosterops palpebrosus, Pericrocotus erythropygius, Rhipidura aureola, Aegithina tiphia, Euodice malabarica, Cercomela fusca* and *Lonchura punctulate* showed shorter FID.

Discussion

The major finding of the present study was the FID of urban terrestrial birds increased with flock size but decreased in rural birds exceptionally. Terrestrial birds in urban habitat may be more susceptible to human disturbance as compared to birds of rural habitat (Weston *et al*., 2012). Our statistical model also confirmed the positive association of FID to flock size in urban habitat while negative relation in rural habitat (Table 1) (Møller, 2012; Weston *et al*., 2012; Díaz *et al*., 2013; Samia *et al*., 2017). In urban habitat birds showed many eyes effect hypothesis which state that more individual are available to screening for predator in large flock size while rural habitat birds with large flock size also showed dilution effect hypothesis which state that the risk of mortality is lower in large group of birds (Stankowich and Blumstein, 2005; Hingee and Magrath, 2009). In this study of terrestrial bird's body size was also significantly associated with relative FID and increased with increasing body size in both rural and urban habitats (Fig. 2). We believe that this association between body size/ flock size and escape behavior of birds deserves further study, as suggested also in a previous study (Blumstein, 2006).

Conclusion

In conclusion, relative FID increased with body size in terrestrial bird species, independently of the rural versus urban areas. Our results support the role of sociality for risk-taking behavior and hence for social organization. These conclusions have broad biological implications, especially considering the role of sociality as possible factor facilitating colonization of urban environments and adaptation to such human-impacted environments.

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