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Cover: Pseudo-flying animals and wind-dependent seed & spore dispersers – made with digital painting in Krita. © Melito Prinson Pinto

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COMMUNICATION

Differential kleptoparasitic interactions of Himalayan Vulture *Gyps himalayensis* with conspecifics and heterospecifics during various stages of breeding

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Abstract: Reports of kleptoparasitic events involving *Gyps himalayensis* (Himalayan Vulture) are limited. In this article we document intraspecific and interspecific kleptoparasitic interactions at nesting sites, and analyse factors influencing this behaviour. The study was carried out at Hirpora Wildlife Sanctuary of Kashmir Himalaya, at an elevation of about 2,546 m. We observed 61 instances of food theft involving conspecifics (n = 12) and heterospecifics (n = 49). The highest number of incidents were observed during the chick rearing period (n=40), followed by incubation (n = 10) and pre-laying periods (n = 5). We observed the highest number of attacks at nesting sites (n = 30) and the lowest in flight (n = 9).

Keywords: Himalaya, Hirpora Wildlife Sanctuary, Kashmir, Kleptoparasitism, nest, vulture.

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INTRODUCTION

Kleptoparasitism is the acquisition of resources by theft (Brockmann & Barnard 1979; Hadjichrysanthou et al. 2018) such as prey or other materials that require time and effort to obtain. The practice is not without risk, since a kleptoparasite might be injured by its victim if it defends its prey (Iyengar 2008; Hadjichrysanthou et al. 2018). This behaviour is relatively widespread among birds, particularly sea birds. Kleptoparasitic interactions involving vultures, for example the Lammergeier *Gypaetus barbatus* and Black Vulture *Aegypius monachus,* have been reported in the literature (Margalida & Heredia 2002). Data on this behaviour at nesting zones, however, is limited. This may be due to the fact that while vultures congregate at carcasses (Mundy et al. 1992) they carry food in their crop to the nest where chicks are fed via regurgitation (Mushtaq 2020), making theft by other birds difficult.

Himalayan Vultures feed on carcasses of dead animals (Image 2) (Wani et al. 2021) along with other scavengers including large billed crows and raven (Navaneethan et al. 2015). The availability of carrion can vary spatially and seasonally, thereby playing an important part in movement and distribution of species feeding on it (Wani et al. 2020). Himalayan vultures show intensive parental care during chick rearing periods. In this article, we documented intraspecific and interspecific kleptoparasitic interactions of Himalayan vulture at nesting sites, and analysed the factors influencing this behaviour.

MATERIALS AND METHODS

Study area

Hirpora Wildlife Sanctuary spreads over an area of 341 km^2 in Shopian District, Kashmir. At an altitude of 2,546 m, the sanctuary is located between 33.3955 °N & 74.3940 °E. It has forests, pastures, scrub land, waste land water bodies. To the north, the sanctuary is bounded by Lake Gumsar, to the east by Rupri, to the south by Saransar, to the west by the Pir Panjal pass and to northeast by Hirpora village (Wani et al. 2020) (Image 1). The area is renowned for its rich floral and faunal diversity. The main faunal elements of the sanctuary include- Pir Panjal Markhor *Capra falconeri*, Himalayan Musk Deer *Moschus leucogaster*, Himalayan Black Bear *Ursus thibetanus*, Himalayan Brown Bear *Ursus arctos*, Leopard *Panthera pardus*, Red Fox *Vulpes vulpes*, and Tibetan Wolf *Canis lupus*. The vegetation of the sanctuary is divided into mixed coniferous forests, deciduous subalpine scrub forests and subalpine pastures. The coniferous forests are dominated by Kail pine, the sub alpine forests are dominated by fir while the deciduous subalpine scrub forests are dominated by Himalayan Birch *Betula utilis* and Juniper *Juniperus communis* (Wani et al. 2021).

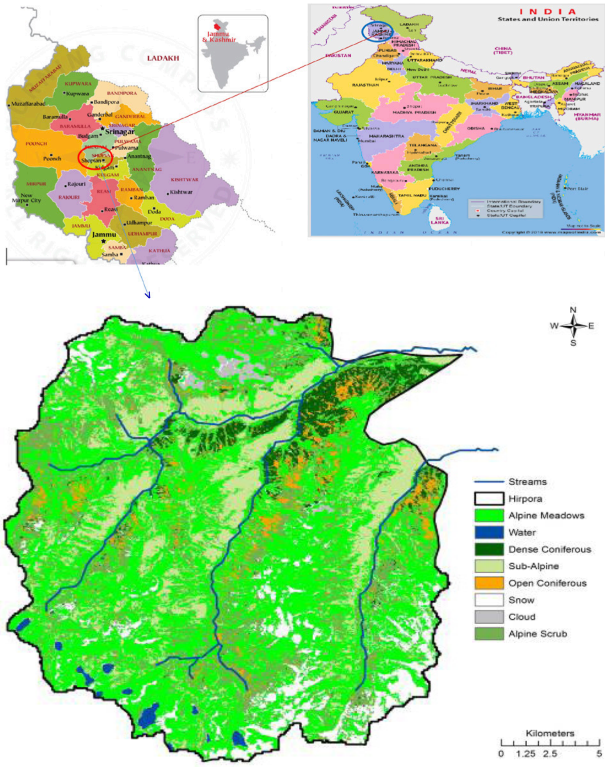

Image 1. Hirpora Wildlife Sanctuary.

Methods

Field work was undertaken in Hirpora Wildlife Sanctuary from June 2019 to May 2020. Observations on food stolen, species involved and situation in which they occurred (in flight, at nest and on feeding site) were made during pre-laying, incubation and chick rearing period with the help of 10X binocular. Observations were made from vantage points (at a distance of about 300–400 m) that allowed a good view of nesting and feeding sites. In all intraspecific interactions observed, we recorded the individuals' age which was determined by Grimmett et al. (2016).

Data analysis

Basic statistics such as, mean and standard deviation were calculated for all the variables and were given as X±SD. Statistical analysis were performed by using Windows based statistical packages- Micorsoft Excel and MINITAB (Ryan et al. 1992). A non-parametric test, Kruskal-Wallis one way ANOVA was used for testing the null hypothesis at p <0.05.

RESULTS

We observed 61 Himalayan Vulture interactions of food theft, 12 with conspecifics and 49 with heterospecifics. These interactions varied among different sites and seasons (Table 4, Table 5). The various heterospecifics involved in these interactions included Bearded Vulture *Gypaetus barbatus* (n = 7), Common Raven *Corvus corax* (n = 22), Large-billed Crow *Corvus macrorhynchos* (n = 15), and House Crow *Corvus splendens* (n = 5).

Interactions with conspecifics

We observed a total of 12 interactions of Himalayan Vulture with conspecifics (Table 2). In eight interactions adult Himalayan vultures acted as kleptoparasites, and in four interactions sub-adult vultures acted as kleptoparasites. During the former case, four sub-adults and two adults acted as hosts whereas in the latter case, one adult and one sub-adult acted as hosts. All these interactions with conspecifics were statistically significant (H = 7.89; DF = 01; P <0.05) (Table 2).

Interactions with heterospecifics

We observed a total of 49 interactions of Himalayan Vulture with heterospecifics. All these interactions were statistically significant (H = 7.32; DF = 03; P <0.05). In 07 of these interactions, *Gypaetus barbatus* acted as kleptoparasite with 05 such interactions in which sub-adult Himalayan vulture acted as host. In rest of the two interactions, adult Himalayan vulture acted as host. Rest of the interactions involved different corvid species including- Common Raven *Corvus corax* (n = 22), Large-billed Crow *Corvus macrorhynchos* (n = 15), and House Crow *Corvus splendens* (n = 05). In 15 interactions with Common Raven, sub-adult Himalayan vulture individuals acted as hosts and in seven such interactions, adult Himalayan Vulture individuals acted as hosts. Similarly, in eight interactions with *Corvus macrorhynchos*, sub-adult Himalayan Vulture and in seven such interactions, adult Himalayan vulture acted as hosts. Among interactions with *Corvus splendens,* three interactions involve sub-adult Himalayan Vulture, and two interactions involve adult individuals as hosts (Table 1).

Table 1. Kleptoparasitic interactions of *Gyps himalayensis* with heterospecifics in Hirpora Wildlife Sanctuary.

Kleptoparasite	**Host**	
	Gyps himalayensis (Subadult)	*Gyps himalayensis* (Adult)
Gypaetus barbatus	05	02
Corvus corax	15	07
Corvus macrorhynchos	08	07
Corvus splendens	03	02
Kruskal-Wallis one way ANOVA	H = 7.32; DF = 03; P <0.05	

Table2. Kleptoparasitic interactions of *Gyps himalayensis* with conspecifics in Hirpora Wildlife Sanctuary.

	Host	**Kleptoparasite**	
	Gyps himalayensis	Subadult	Adult
Kleptoparasite	Sub-adult (04)	02	02
	Adult (08)	06	02
Kruskal-Wallis ANOVA	H = 7.89; DF = 01; P <0.05		

Table 3. Percentage of Kleptoparasitic attacks defended and not defended by *Gyps himalayensis* during Pre-laying, Incubation and Chick rearing period in Hirpora Wildlife Sanctuary.

Period	**No. of attacks**	**Percentage of attacks**	
		Defended (%)	**Non-defended (%)**
Pre-laying	**05**	5(100)	0(0.0)
Incubation	**16**	10(62.5)	6(37.5)
Chick rearing	**40**	36(90)	4(10.0)
Kruskal-Wallis one way ANOVA		H = 8.16; DF = 02; P <0.05	

Interactions during different periods

Highest number of attacks from both conspecifics and heterospecifics were observed during chick rearing period (n = 40) followed by incubation period (n = 10) and pre-laying period (n = 5). In chick rearing period, 90% attacks were defended successfully whereas in incubation period, only 62.5% of the attacks were defended successfully. However, during pre-laying period, all attacks from conspecifics and heterospecifics were defended successfully. The percentage of defended and non-defended attacks were statistically significant (H = 8.16; DF = 02; P <0.05) (Table 3).

Interactions at different sites

The number of interactions of Himalayan Vulture with its conspecifics and heterospecifics at different

Table 4. Kleptoparasitic interactions of *Gyps himalayensis* with conspecifics and heterospecifics in flight, at nest and at feeding site.

Place/Site	Thefts	Defended	Non-defended
Flight	09	07	02
Nest	30	29	01
Feeding site	22	15	07
Kruskal-Wallis one way ANOVA	H = 8.14; DF = 02; P <0.05		

Table 5. Kleptoparasitic interactions of *Gyps himalayensis* with conspecifics and heterospecifics during different seasons.

Season	Attacks	Attacks defended (%)	Attacks not defended (%)
Winter	28	92.85	7.15
Spring	12	83.33	16.67
Summer	14	57.14	42.86
Autumn	07	71.42	28.58

sites were statistically significant (H = 8.14; DF = 02; P <0.05). We observed highest number of attacks at nesting site (n = 30) and lowest number of attacks in flight (n = 09). A total of 22 attacks were observed at feeding sites. Among 30 attacks, at nest site, 29 were defended successfully. On the other hand, among 22 attacks at feeding sites, only 15 were defended and rest (31.81%) were not defended (Image 2). Out of nine attacks in flight, seven were defended and in two attacks, kleptoparasite remained successful in taking away the food from Himalayan Vulture (Table 4).

DISCUSSION

Kleptoparasitism occurs when there is an association between species. However, it is equally obvious, that kleptoparasitism does not always occur when two species are found together. Rather, there are various ecological and behavioural conditions that make kleptoparasitism particularly likely. These include- large concentration of host (John & Lee 2019), large quantities of food (Mullers & Amar 2015) large and high quality food items (Iyengar 2008), predictable food supply (Dekker et al. 2012), visibility to food items (John & Lee 2019), food shortage behaviour of parasite (Mullers & Amar 2015), behaviour and habitat of host (Hamilton 2002).

Our results suggested that the *Corvus corax, C. macrorhynchos* and *C. splendens* due to their little chance for foraging at carcass as compared to vultures, are making use of the spatial and temporal predictability of food resources by becoming kleptoparasites (Fisher 1985). Most of the thefts suffered at the nest by kleptoparasites took place during chick rearing, a period when food items often accumulate at the nest sites. Thefts in flight occurred during pre-laying and incubation period, a time when food availability is reduced and when weather may greatly limit the activities of foraging and locating food. For those age groups (principally <3 years, i.e., sub-adults) that are more dependent on predictable food sources such as feeding stations (Heredia 1991), this might be a foraging strategy used much more regularly. These results are in agreement with the idea that immature or inexperienced birds may compensate for their less effective foraging abilities by kleptoparasitism (Margalida & Bertran 2003). To the contrary, kleptoparasitism by adults could be an opportunistic foraging behaviour. Our observations were done in flight, in addition to nests and feeding sites. This accounts for the fact that breeding adults were the host bird in 79% of all observed events.

As a result of the cost/benefit rate, two factors would determine that the species that attempted stealing would resort to this indirect strategy: the territorial behaviour of the host species (Margalida & Bertran 2000) and the accumulation of food resources in nesting area.

Dominance of adults over immature is a well-documented phenomenon in raptors (Moreno-Opo et al. 2020), but a reverse dominance pattern also has been observed (Rodríguez-Estrella & Rivera-Rodriguez 1992). In the case of conspecifics, plumage colouration of Himalayan vulture adults could act as a status signal (Negro et al. 1999). This signal could be used by territorial adults to displace other immature Himalayan Vultures not by attacking them, but simply by signalling their status while approaching them (Bautista et al. 1998).

On the other hand, the Himalayan Vulture having low wing loading and its large wingspan give this species great dominance in flight (Donázar et al. 1993) and make it difficult for an opponent to steal food successfully. In the case of conspecifics, the fact that younger birds are less skilful in flight would mean that they would be less successful in actions of direct piracy, so that the energetic cost of those attempts might be greater than the likely benefits obtained from those actions (Fisher 1985; Moreno-Opo et al. 2020).

The Himalayan Vulture's attacks of intruders in the vicinity of the nest throughout the breeding season (Margalida & Bertran 2000) would act as deterrent

Image 2. Himalayan Vulture feeding on carcass of a buffalo.

and would make food at nest the least convenient for stealing. The success in aggressive encounters appears determined by the body size and condition, and the previous possession of the disputed resource (Bautista et al. 1998). In contrast, those species with higher aerial maneuverability but with smaller size, such as ravens, would have to focus their actions at the nest, where prey remains also accumulate. Obtaining prey remains there may be less costly for those birds: (1) adults are gradually less often present at the nest as the breeding season progress (Margalida & Bertran 2000) and (2) prey items present in the nest have a higher meat content as consequence of differential requirements in nutrients for the chick (Margalida & Bertran 2001).

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