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Feeding behaviour of Indian black kite (*Milvus migrans*) inhabiting the arid zone of Rajasthan

[1] SK Sharma, [2] KC Soni
[1] Research Scholar, Maharaja Ganga Singh University, Rajasthan, India
[2] Laboratory of raptor research, Department of Zoology, Govt. Lohia P. G. College, Churu, Rajasthan, India

Abstract
The feeding behaviour of the Black kite (*Milvus migrans*) was studied during the 2012-2014 in twelve microhabitats in and around Churu city (28º 15' N and 74º 55' E, 286 msl) of Rajasthan, India. Focal sampling method was used to study various feeding and foraging behaviours of the Black kite found in different microhabitats. Observations were taken in twelve viz. waste water body (WWB), municipal garbage dumping station (MGDS), animal dead body dumping station (ADBDS), agriculture field (AF), sand dune (SD), forest area (FA), slaughter house (SH), grazing field (GF), out skirts area of highways (OSH), human inhabitation (HI), graveyard area (GYA) and garden area (GF). Actively feeding individual was selected as a focal bird and attempts were made to cover different individuals found in various feeding sites. From the recorded seven variables; standing on ground, snatching, hovering, perch hunting, gliding and hovering, intraspecific cleptoparasitism and interspecific cleptoparasitism were also calculated. Snatching behaviours mostly applied in the eleven microhabitats. But success rate was more in SH and less in AFH, GYA and GA with 90.94%, 22.22%, 25.00% and 25.00%. This behaviour depends upon the situation and type of behaviour. In sand dunes (SD), the Black kite used perch hunting behaviour many times in a day to dig out the beetles and lizards.

Keywords: feeding behavior, Indian black kite, Rajasthan

Introduction
Any living organism requires considerable amount of energy for the survival and reproduction. Because, birds do not accumulate enough reserve food in their body as compared to high daily energy expenditure; constant food intake is essential on day to day basis to fulfill energy demand. Bird living in mosaic of natural habitat patches may face space and time constraints while securing their energy requirements. Therefore, foraging strategies adapted by birds are one of the major interesting fields. In the terrestrial ecosystems predators, the raptors among the birds play the apex role. Occupying a position at high tropic level they play important role by regulating prey species. Raptor species is usually classified as a scavenger due to a frequent consumption of livestock carrion (Cramp and Simmons 1980) [5]. The concept recorded by Lack (1946) as "density of raptor is limited because of its food supply". Therefore studying the food habits of raptors is essential for the understanding of raptor biology and its community dynamics.

The Black kites are most often seen gliding and soaring on thermals as they search for food. The flight is buoyant and the bird glides with ease, changing directions easily. They will swoop down with their legs lowered to snatch small live prey, fish, household refuse and carrion, for this behaviour they are known in British military slang as the shite hawk. They are opportunist hunters and have been known to take birds, bats and rodents (Narayanan 1989) [17]. They are attracted to smoke and fires, where they seek escaping prey (Hollands 1984) [11]. This behaviour has led to Australian native beliefs that kites spread fires by picking up burning twigs and dropping them on dry grass (Chisholm 1971) [3]. The Indian populations are well adapted to living in cities and are found in densely populated areas. Large numbers may be seen soaring in thermals over cities. In some places, they will readily swoop and snatch food held by humans (Ali and Ripley 1978) [1]. Kites have also been seen to tear and carry away the nests of Baya (Wesely *et al.* 1991). The needs to study feeding behaviour of birds gain prominence when their activities come into conflict with human interest; fish eating birds are obvious target (Draulans 1988) [8]. Another target group of birds is those foraging in crop fields that either feed on damaging crops or feeds on the pests and rodents.

Materials and Methods
In Churu city (28º 15' N, 74º 55' E) inhabiting arid zone of Rajasthan, India, kites were observed feeding at several places from 2012-2014. The study area was surveyed before starting actual research to classify various foraging grounds (microhabitats and microclimates). All the microhabitats were visited once a week during 2012-2014, and number of foraging birds counted to decide preference for habitats in summer, monsoon and winter seasons. Focal sampling method (Altman 1974) [2] was used to study various feeding and foraging behaviours of the Black kite found in different microhabitats. Observations were made by using Olympus binoculars (10 X 50) and Nikon P 510 camera to record number of Black kite found in different microhabitats. Observations were intensified during critical time when it shifted habitat during morning between 8:30-12:00 hr and afternoon between 15:30-17:00 hr to determine time allocated by the Black kite at both types of habitats.

Time allocated in various foraging activities including steps,

snatching, hovering, g From the recorded seven variables; standing on ground, snatching, hovering, perch hunting, gliding and hovering, intraspecific cleptoparasitism and interspecific cleptoparasitism were also calculated.

Results

Feeding behaviours of Black kite showing in arid zone of Rajasthan

1. **Standing on ground:** Black kites are often seen observing its prey either standing still on ground or walking and also same times feeding while walking.
2. **Snatching:** Black kite often seen catching flying insects, small birds in the air.
3. **Hovering:** This is the exercise done by kites or birds of prey for locating their food. In it the birds fly in a circular movement over the expected areas of prey.
4. **Perch hunting:** The birds alight or roosts typically a branch or horizontal bar and hunt their prey.
5. **Gliding and soaring:** This is a kind of hovering in which birds freely float in air at a great height.
6. **Intraspecific cleptoparasitism:** Feeding habit by the theft among birds of same species.
7. **Interspecific cleptoparasitism:** Feeding habit by the theft among birds of different species.

The Black kite exhibited 7 kinds of feeding behaviours in 12 microhabitats (Table: 1). Snatching behaviour was found as the chief technique with more than 80.00% time applied in the 12 microhabitats (Table: 2). Snatching was very common in WWB, MGDS, SH, and HI. GA was the only ground where snatching was exercised as low 14.11% time in relation to the other applied behaviours. However, snatching was found to be employed more or less with its subtle in all 12 microhabitats (Table: 2). Perch hunting was uncommon and applied in a microhabitat which had a considerable amount of flies. It was mainly used in the GA, GYA, OSH but success rate was more in WWB and AFH with 67.02% and 60.03% respectively. Standing on ground and gliding and soaring behaviour was applied in all the microhabitats with relatively less in GYA and GA. Snatching behaviours mostly applied in the eleven microhabitats. But success rate was more in SH and less in AFH, GYA and GA with 90.94%, 22.22%, 25.00% and 25.00%. This behaviour depends upon the situation and type of food. In sand dunes (SD), the Black kite used perch hunting behaviour many times in a day to dig out the beetles and lizards. Intraspecific cleptoparasitism was applied in all microhabitats but success rate was greater in SH and AFH and lowest rate also noted in SD and GYA. Interspecific cleptoparasitism behaviour applied in all microhabitats but success rate was greater in MGDS and WWB with 68.93% and 68.79%. Lowest rate also noted in GA and SD with 17.58% and 20.63%. Hovering behaviour mostly applied in the twelve microhabitats but success rate was more in AFH, WWB and less in MGDS with 62.61%, 58.32% and 17.61%.

Below are 10 minute recordings from my field observation at SH and recorded in Nikon P 510 camera.

At Slaughter House Observation

Sitting on tree, hovering, hovering, gliding, gliding, gliding, soaring, attacking on prey, snatch with beak and claws, intraspecific cleptoparasitism, sitting on trees or pylon or other man-made objects, tearing the piece of meat, interspecific cleptoparasitism with crow, tearing, resting and body shake.

Discussion

The diet of the Black kite is one of the best examples, among raptors, within species plasticity in foraging behaviour and food consumption. Although the species classified as a scavenger of consume of livestock carrion (Cramp and Simmons 1980) [5]. It has been defined as an adaptable and opportunistic feeder (Geroudet 1965, Delibes 1975) [9, 7].

A non-visual tactile forager was characterized by the primary feeding techniques to capture its prey present underneath any type of substratum. Its selection for the particular twelve microhabitats and seven feeding techniques were apparently inherited from the generations living in the arid zone of Rajasthan, which were exploiting the available twelve microhabitats, because there is no evidence of any single general theory which explains habitat selection. The Black kite used various feeding behaviorus in different microhabitats. However, it is primarily non visual tactile forager, feeds mainly by walking slowly and food snatching into substrate. Kites searched for food while directly standing on the feeding area or, more often while flying low over the ground. Almost all Black kites use snatching as a principle technique to capture prey (Collopy 1983, Marti 1987) [4, 16]. Cleptoparasitism is a widespread aggressive strategy among birds, especially among predators and has been frequently observed in Black kite (Kabouche and Ventroux 1999) [12]. The Black kite applies various feeding techniques which depend upon the type of prey, type of hard or soft substratum, depth at which prey was available, and mobility and density of prey. But abundant density of prey on the surface of the substratum in the ADBDS, SH and HI results visuals feeding niche, which could play a beneficiary role in adapting various foraging grounds (Kahl 1966, Kumar *et al.* 2014) [13, 14]. It exhibits several feeding behaviours demonstrates its flexibility in its activity level with response to the nature of the habitat, morphological and physiological features of prey and availability of prey, such as feeding ground with relatively higher prey density allow the Black kite to apply universal techniques; stand and cleptorasitism (Davies and Cowlichaw 1996) [6]. Given a repertoire of potential feeding behavior, the Black kite probably chooses any behaviour based on success rate or net energy return to fit its current need.

Though feeding repertoire of the Black kite was restricted mainly to standing or walking slowly and snatching, subtle variations were recorded in frequently occurrence of behaviour in different foraging habitats. The variations were probably attributed to different degree of food dispersion in various habitats. Snatching and soaring more frequently in habitats such as SH, HI, WWB where food items were found widely dispersed in high density. Such variation in frequency use of feeding behaviorus allows the Black kite to explore various microhabitats energetically in efficient way.

Feeding techniques such as hovering and perch hunting were restricted to some microhabitats. Hovering is used by kites for locating their food. In it the birds fly in a circular movement over the expected area of prey. The Black kite use hovering mostly in all microhabitats but maximum use is in AFH. White tailed kite use the hovering during the feeding time and

kites feed principally on rodents, and they are readily seen patrolling or hovering over grassland (Ragusa-Netto 2000) [18]. During perch hunting, most prey of raptors is killed by the talons of the contracting foot being driven into their bodies; if required, the hooked bill is used to give a coup-de-grace. Sometime Black kite kill by biting into the neck of victims in mid-air. Wesley *et al.* (1991) [19] reported the Black kite catch the Rock pigeons (*Columba livia*) from building lodges and crevices with occasional success, and they also take small injured birds.

The Black kite use standing and slow walking more frequently in MGDS where success rate was relatively higher due to abundant food in large scale. Food collection from the ground was observed only in the late morning. Searching for food on the ground was the technique used more often when the number of other birds and animals was low and the opportunities for cleptorasitism more limited (Table: 2). Same behaviour was observed by (Giacomo and Guerrieri 2008) [10].

Conclusion

Snatching behaviour was found as the chief technique with more than 80.00% time applied in the 12 microhabitats. The Black kites snatch the rodents, lizards, insects, small mammals; chapatti and small meat piece near slaughter house most. We should increase the biodiversity of these animals. Black kites snatched food from dumping station also, so we can make legal small dumping stations for conservation in urban area. The Muslim people of the area have a tradition of giving meat piece to Black kites. They call it "Sadka". In this practice they feed the birds by throwing small piece of meat in the air and shouting "Chillo" (The common hindi name for Black kite being cheel). The birds are thus attracted and they catch their food in the air itself.

Table 1: Application of various feeding behaviours of the Black kite in the twelve microhabitats.

Microhabitat Behaviour	WWB	MGDS	ADBDS	AFH	SD	FA	GF	SH	OSH	HI	GYA	GA
Standing on ground	*	*	*	*	*	*	*	*	*	*	*	*
Snatching	*	*	-	+	*	+	*	*	*	*	*	*
Hovering	*	*	*	*	+	*	+	*	+	*	*	-
Perch hunting	*	+	-	*	*	*	*	-	+	+	*	+
Gliding and soaring	*	*	*	*	*	*	*	*	*	*	*	*
Intraspecific cleptoparasitism	*	*	*	+	*	*	-	*	*	*	*	-
Interspecific cleptoparasitism	+	*	*	-	-	-	+	-	+	+	+	+

* =Occurs, += Occasionally occurs, - =Does not occurs

WWB= WASTE WATER BODY, MGDS= MUNCIPAL GARBAGE DUMPING STATION, ADBDS= ANIMAL DEAD BODY DUMPING STATION, AFH= AGRICULTURE FARM HOUSE, SD= SAND DUNES, FA= FOREST AREA, GH= GRAZING FIELD, SH= SLAUGHTER HOUSE, OSH= OUT SKRIT OF HIGHWAYS, HI= HUMAN INHABITATION, GYA=GRAVEYARD AREA, GA= GARDEN AREA.

Table 2: Applied (A) and successful (s) feeding attempts made by the Black kite in 12 microhabitat (% in parenthesis).

Microhabitat Behaviour	WWB	MGDS	ADBDS	AFH	SD	FA	GF	SH	OSH	HI	GYA	GA
Standing on ground	2265 (78.97) 1396 (61.63)	3268 (91.28) 2754 (84.27)	1253 (55.93) 840 (67.03)	459 (24.67) 169 (36.81)	140 (21.53) 12 (8.57)	1163 (50.12) 269 (23.12)	1065 (38.17) 369 (34.64)	1869 (75.51) 1322 (70.73)	45 (20.17) 12 (26.60)	3560 (92.70) 2953 (82.94)	123 (12.36) 19 (15.44)	23 (7.66) 6 (26.08)
Snatching	789 (41.39) 563 (71.35)	945 (34.12) 696 (73.65)	423 (55.4) 169 (39.95)	45 (27.10) 10 (22.22)	89 (27.81) 14 (15.73)	42 (21.42) 9 (21.42)	71 (29.47) 21 (29.57)	3569 (87.00) 3246 (90.94)	19 (20.00) 4 (21.05)	2863 (77.57) 2236 (78.09)	8(26.66) 2(25.00)	12 (14.11) 3 (25.00)
Hovering	787 (65.85) 459 (58.32)	823 (41.64) 145 (17.61)	166 (57.24) 52 (31.00)	1359 (79.47) 851 (62.61)	423 (48.67) 102 (24.11)	159 (20.00) 69 (43.39)	632 (71.01) 324 (51.26)	198 (63.87) 101 (51.01)	40 (41.23) 12 (30.00)	1752 (78.95) 9529 (54.33)	321 (46.72) 126 (39.25)	35 (39.32) 8 (22.85)
Perch hunting	2963 (74.97) 1986 (67.02)	45 (17.17) 16 (35.55)	00(00) 00(00)	1964 (57.09) 1179 (60.03)	633 (65.73) 355 (56.08)	639 (55.95) 323 (50.54)	00(00) 00(00)	00(00) 00(00)	88 (63.30) 41 (46.89)	00(00) 00(00)	489 (40.88) 232 (47.44)	233 (41.38) 79 (34.10)
Gliding and soaring	3596 (87.53) 2185 (60.76)	2364 (60.53) 1879 (79.48)	855 (64.96) 465 (54.38)	3000 (66.38) 2112 (70.4)	733 (72.64) 236 (32.19)	834 (49.05) 312 (37.41)	1962 (69.84) 1006 (51.27)	3216 (78.15) 2102 (65.36)	65 (27.08) 19 (29.23)	2700 (74.66) 2145 (79.44)	170 (32.69) 45 (26.47)	12 (24.48) 3 (25.00)
Intraspecific clepto parasitism	423 (66.50) 211 (50.00)	196 (45.90) 101 (51.53)	233 (26.59) 92 (39.48)	38 (55.88) 40 (58.82)	00(00) 00(00)	213 (58.19) 78 (36.61)	266 (43.53) 87 (32.70)	623 (69.60) 455 (73.03)	129 (31.09) 45 (35.00)	482 (60.62) 233 (48.34)	269 (41.70) 59 (16.00)	96 (30.86) 19 (19.79)
Interspecific	923	1001	616	123	63	200	129	265	163	639	134	91

Microhabitat Behaviour	WWB	MGDS	ADBDS	AFH	SD	FA	GF	SH	OSH	HI	GYA	GA
clepto parasitism	(51.67) 635 (68.79)	(69.85) 690 (68.93)	(71.13) 369 (59.90)	(25.10) 45 (36.58)	(57.27) 13 (20.63)	(29.15) 45 (22.51)	(29.25) 23 (17.82)	(44.16) 163 (61.50)	(62.21) 78 (47.85)	(51.53) 333 (52.11)	(24.54) 44 (32.83)	(30.84) 16 (17.58)

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