Research Guru
Online Journal of Multidisciplinary Subjects (ISSN : 2349-266X)
UGC Approved Journal No. 63726
Impact Factor:3.021 website: www.researchguru.net
Volume-12, Issue-2, September-2018

# Foraging habitat, Feeding techniques and Foraging behavior of Black-headed Ibis *Threskiornis melanocephalus*

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**Abstract**

The present study emphasized of the foraging behaviour of Black-headed Ibis, emphasized on feeding techniques and foraging behaviour. Any living organism requires considerable 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. For the study of foraging habitat, feeding techniques and foraging behavior of Black-headed Ibis some parts of Mehsana district, Gujarat is selected. Mehsana district is situated in the North part of the Gujarat state. It lies between $23^0$ 02' to $24^0$ 06' N and the meridians of longitude $71^0$ 56' to $72^0$ 52' E. Direct observation method was applied to investigate food item during observing feeding techniques. Observations were made at least once a week using 10X50 binoculars to record number of ibises found in different microhabitat. The birds observed in aquatic and terrestrial habitats were separately recorded to avoid confusion due to diurnal foraging rhythm in which it occupied terrestrial habitats during foraging rhythm. Focal sampling method (Altman 1974) used to study various feeding and foraging behaviours found at different microhabitats. The Black-headed Ibis exhibited 11 types of feeding techniques in the 08 microhabitats. Probing and walking slowly are the most common feeding technique observed in varying frequencies at all selected microhabitats. Probing behaviour found as the chief technique with more than 50.00% time applied in the 08 microhabitats. Probing is very common in SE, SWSV, PU, CA, DS and AA.

**Key words:** Behaviour, Black-headed Ibis *Threskiornis melanocephalus*, Foraging, Probing, Food.

## Introduction

Any living organism requires considerable 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. Birds 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 of research.

In India, very little information is available at present on the food and feeding

habitat of the piscivorous birds. Kushlan (1978) summarized various aspects of feeding ecology of wading birds. Vast literature on foraging ecology of wading birds exists, but ibises are much less explored. Several studies on feeding ecology of Black-headed Ibis have been conducted at Bhavnagar (Gadhvi 2001) and at some parts of Mehsana district (Senma 2011). Ciconiiform groups of wading birds appear to specialize in one or two main foraging strategies, visual and non-visual tactile foraging (Kushlan 1978). Generally, ibises follow the non-visual tactile foraging and adapted mainly top probing. Use of various other feeding techniques by ibises reflects behavioural adaptation to capture various types of prey in different habitats (Kushlan 1978).

Seasonal variation in food abundance often influences habitat use pattern. Seasonal rainfall pattern changes availability of food in birds (Fogden 1972). For most of the wading birds, critical seasonality is created by wet and dry cycles of weather (Kushlan 1978). Many wading birds forage early in the morning and are more likely to forage in flocks. Although early morning feeding is explained in part by the preceding nightlong fast, early feeding may also be the result of a predictable and temporary increased availability of prey.

**Methodology**

For the study of foraging habitat, feeding techniques and foraging behavior of Black-headed Ibis some parts of Mehsana district, Gujarat is selected. Mehsana district is situated in the North part of the Gujarat state. It lies between $23^0$ 02' to $24^0$ 06' N and the meridians of longitude $71^0$ 56' to $72^0$ 52' E. Direct field observation of foraging individual is attractive and popular method to determine food of the birds. It is easy to approach and ideal for birds that eat large and conspicuous food items. Further, it does not require capture or killing of birds and it is unaffected by different digestion rate of various prey species.

Though varieties of methods are available, because of some surcumtancies little work was carry out on investigate of food items. In present work, direct observation method was applied to investigate food item during observing feeding techniques.

- **Diurnal foraging rhythm and habitat use**

Surveys conducted in the study area to locate feeding sites used by the Black-headed ibises. Observations were made at least once a week using 10X50 binoculars to record number of ibises found in different microhabitat. The birds observed in aquatic and terrestrial habitats were separately recorded to avoid confusion due to diurnal foraging rhythm in which it occupied terrestrial habitats during foraging rhythm. Such diurnal foraging rhythm studied at least, once a month and observations made throughout the day at an hourly interval covering all feeding sites. Observations intensified during critical time when it shifted habitat during morning between 0830 to 1200 hrs and afternoon between 1530 to 1700 hrs to determine time allocated by the birds at both the types of habitats.

- **Feeding techniques and foraging behaviors**

Focal sampling method (Altman 1974) used to study various feeding and foraging behaviors found at different microhabitats. Observations taken from eight microhabitats viz., sewage (SE), shallow water and sparse vegetation (SWSV), puddle

(PU), forest (FO), agriculture area (AA) (eg. wheat, millet, jowar, castor, mustard, cotton, tobacco, seasamum and rajko field), manure heap (MH), carcass (CA), and dumping station (DS).

Actively feeding individual was selected as a focal bird and attempts were made to cover different individuals found in various feeding sites. Focal bird constantly watched for 05 min from a distance of 10 to 30m. Observation on feeding behaviors such as; number of steps, probes, food items taken, scanning for predator (vigilance) and other activities (i.e., preening, hopping, encounters etc.) recorded by handycam and data analyzed in computer. Time allocated in various foraging activities including steps, probing, handling time of food items, vigilance and other behavior derived from the recorded data to formulate time budget of the BHIs foraging in eight microhabitats. From the recorded data four variables; step/min, probes/min, steps/probe, probing success (%) were also calculated.

Nomenclature to describe various feeding techniques of the BHIs followed as per Kushlan (1976, 1977, 1978):

1. Probing (PR): The placing of the slightly open bill into the substrate and closing the tip on encounter of the prey.

Several types of probing have been distinguished by accompanying depth and direction of probing and locomotors movements:

(a) Shallow probing: Less than quarter deep insertion of the bill into the substrate.
(b) Deep probing: More than quarter deep insertion of the bill into the substrate.
(c) Step probing: The bird probes while stepping.
(d) Multi probing: The bird probes at the same spot from shallow to deep.
(e) Stationary probing: Applying shallow, deep or multiple probing around the body while standing at one location.

2. Pecking (PE): Picks up food item from surface of the substrate.
3. Walking slowly (WS): Here a bird walks at slow speed of ≤ 1 step/sec (Rodgers 1983).
4. Hopping (HO): Flies short distance and alight.
5. Head swaying (HSa): Moves head side to side out of water.
6. Head swinging (HSi): Moves bill from side to side in the water.
7. Groping (GR): The bird holds open bill into the water/sewage and lift it up.
8. Flipping (FL): Turns over object (e.g. stone, cattle dung etc.) to feed underneath.
9. Running (RU): Moving quickly, or in this study, chasing a moving or flying insect.
10. Standing (ST): The bird stands in one place.
11. Standing fly catching (SF): While standing catches airborne prey.

- **Foraging behaviour**

(1) Steps: Bird walks slowly to fast from one feeding spot to another.
(2) Neck shake: Bird shakes its neck to remove unwanted adhesive material, or to get rid of flying insects.
(3) Body shake: The bird fluffles feathers and shake itself.
(4)Vigilance: The bird's attention is drawn by someone in the neighborhood. Its neck is been straighten and its bill is lifted a little upwards (Draulans *et al*. 1986).
(5) Preening: The bird arranges its feathers on the feeding ground.
(6)Resting: The bird stops feeding. It stands on its one foot or sits on the substratum.

**Results and discussion**

- **Foraging habitat use**

Black-headed Ibis found to forage in 08 microhabitats. Number of microhabitats occupied by Black-headed Ibis is fluctuating. Maximum number of the Black-headed Ibis uses the aquatic foraging microhabitats. As the Black-headed Ibis is a wetland bird, it remains on the feeding site throughout the daytime. The BHIs arrived half-an-hour after the sunrise and leave the site half-an-hour after the sunset. The duration allocation by the Black-headed Ibis increased with the day length. During foraging, the Black-headed Ibis is engaged in various activities; mainly feeding, resting, preening and scanning for predator (vigilance).

Bird species that face seasonal fluctuation in availability of food have two alternatives, (1) they may shift to feeding on other food resources, or (2) may move to other area where original food resource is available (Karr 1976). The ibises seem to follow former pattern. Rainfall pattern and environmental changes associated with it has shown to influence seasonality in many bird species (Beals 1970; Fogden 1972; Karr 1976). Rainfall pattern affects phenological conditions of seasonal crops and thus food availability. Hence, seasonal changes in availability of food play a dominant role in habitat use pattern in the ibises. Seasonal variation in the number of ibises in various microhabitats appeared largely attributed to seasonal condition of the feeding grounds and its impact on the availability of food. Kushlan (1978) recorded similar observations on wading birds feeding in aggregation due to patchily distribution of food. In DS, food is available to the Black-headed Ibis throughout the year, which allows them to forage in different seasons. Feeding in a group on the restricted resources may render benefit to individuals (Turner 1964). SE also exploited regularly by the ibises except during the rich rainy days, which drain the settled water with the bounty of insects. Whereas microhabitat such as; AA in rainy season flourishes with several insects and allow the ibises to feed upon insects. The OL lush-full during the monsoon and allow the ibises to prey upon its meso-fauna.

Seasonal variation in resource availability plays dominating role in evolution of species and communities (Fogden 1972, Beals 1970). Apparently, this could be correlated to the Black-headed Ibis, which is secondarily a waterfowl species but for-mostly found to forage in the man-made terrestrial microhabitats.

- **Feeding techniques and behaviour**

The Black-headed Ibis exhibited 11 types of feeding techniques in the 08 microhabitats. Probing and walking slowly are the most common feeding technique observed in varying frequencies at all selected microhabitats. Probing behaviour found as the chief technique with more than 50.00% time applied in the 08 microhabitats. Probing is very common in SE, SWSV, PU, CA, DS and AA. FO and MH are the only habitat where probing is exercised as low as 23.33% and 24.00% time in relation to the other applied behaviours respectively. However, probing found to employ more or less with its subtle in all the 08 microhabitats. Except step probing, all the probing behaviors considered as a stationary application.

Walking slowly employed most frequently in FO (60.00%). However, it recorded in decreasing frequency in PU (28.64%), AA (27.27%), SWSV (22.25%), DS (15.67%), CA (11.54%), SE (8.24%) and MH (8.00%). Probing showed reverse trend, with lowest frequency in FO (23.33%). It is recorded increasing frequency in

MH (24.00%), AA (29.55%), DS (45.26%) and CA (57.69%). Higher frequencies of probing recorded in PU (67.73%), SWSV (74.50%) and SE (87.61%) (Table 2).

Standing observed in all habitats, but it used always in association with active foraging such as, probing, groping and head swinging when density of food was relatively high in a patch. Pecking, a visual feeding technique applied with little percent in SE (1.16%), DS (1.34%) and FO (3.33%). It observed mostly in MH (16.00%) and AA (11.36%) (Table 2). However, its frequency of use could not be determined because it is not always distinguishable from probing from the distance as observation often impeded by furrows in the fields. Hopping employed along with short flight by the Black-headed Ibis to move for short distance. A higher frequency of flipping recorded in MH (52.00%). In very few instances only in AA (6.81%) and SE (00.53%), the Black-headed Ibis chased or run to capture a flying insect. Standing fly catching is uncommon and applied in a microhabitat, which had a considerable amount of flies. It mainly used in DS (24.24%) and CA (7.69%). Head swaying observed in SE (1.52%), SWSV (00.73%) and PU (00.45%) and Head swinging in PU (2.55%), SWSV (1.55%) and SE (00.09%). Groping and Head swaying is associated with wetland habitats. Groping rarely observed in wetland habitats i.e. SWSV (00.77%), PU (00.36%) and SE (00.01%) (Table 2).

Shallow probing applied in all microhabitats but success rate is greater in DS and CA, whereas deep probing mainly applied in all the microhabitats while it occasionally occurs in the CA and MH. Step probing also found to use commonly with a little preference in DS. Another frequently exercised subtle is multiple probing.

A non-visual tactile forager characterized by the primary feeding techniques to capture its prey present underneath the any type of substratum. Its selection for the particular eight microhabitats and thirteen feeding techniques apparently inherited from the generations living in the semi-arid zone of Gujarat, which were exploiting the available eight microhabitats. The ibises used various feeding behaviours in different microhabitats. However, it is primarily non-visual tactile forager, feeds mainly by walking slowly and probing into substrate. Almost all Ibises, use probing as a principal technique to capture prey (Hancock *et al*. 1992). Walking slowly is very common feeding behaviour used by most wading bird species (Kushlan 1978). In the ibises, it was mainly associated with probing. The ibis applies various probing techniques which depend upon the type of prey, type of hard or soft substratum, depth at prey was available, and mobility and density of prey. But abundant density of prey on the surface of the substratum in the CA results visual feeding niche, which could play a beneficiary role in adapting various foraging grounds (Kahl 1964; Kushlan and Kushlan 1975). They 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 ibises to apply universal techniques; stand and feed (Kushlan 1978). Given a repertoire of potential feeding behaviour, the ibises probably choose any behaviour based on success rate or net energy return to fit its current need. Though feeding repertoire of the ibises restricted mainly to probing and walking slowly, subtle variations recorded in frequency occurrence of behaviour in different foraging habitats. The variations probably attributed to different degree of food dispersion in various habitats. The ibises use walking slowly less often and

probing more frequently in habitats such as SE, SWSV, PU, MH, CA, DS and AA where success rate was relatively higher due to abundant food in discrete patches. The reverse phenomenon observed in that habitats like; FO and OL where food items found widely dispersed in low density. Such variation in frequency, use of feeding behaviours allows the ibises to explore various microhabitats energetically in efficient way.

Feeding techniques such as standing fly catching and groping restricted to some microhabitats and used in any one situation. Standing fly catching seems to be a passive feeding technique in which the bird wants to avoid the disturbance of an airborne prey. Looking at overall applications of grabbing air born, it considered a secondary behaviour of feeding. Whereas application of groping seen rare in the water due to its niche selection preference, and may be because the bird not dependent on water such as White ibis (Ali and Ripley 1983).

A special use of feet in foraging sighted as common among waders (McLlhenny 1936; White 1947; Haverschmidt 1948; Rand 1956; Hobbs 1957; Meyerriecks 1959, 1962, 1971; Recher and Recher 1972; Kushlan 1978; Baird *et al*. 1984). However, foot racking employed in a particular situation by the ibis to capture moving prey like spiders, hidden underneath the loose substratum. Further, habit of feeding on slow ground dwelling insects may dissuade to run after relatively fast moving insects. According to Kushlan (1978), bird is more likely to choose behaviour based on its success rate or on the time between successes. Application of packing instead principally used non-visual tactile method by the Black-headed Ibis and Black Ibis in the DS, CA and MH showed relevancy towards successful attempts due to abundance of the prey items around the carcasses rather underneath the substratum. Whereas well scattered prey underneath the soft mud in the SE and SWSV reinforces the chances of escaping one shallow or deep probing. Hence, multiple probing employed cardinally adapting to that ecosystem. In other microhabitats with the relatively lower prey density, the bird takes more steps in search of a better feeding spot by declining its feeding rate on the cost of a higher searching time. Likewise, depending upon the situation, foraging tactics may change from habitat to habitat and minute to minute.

**Table 1: Frequency occurrence (%) of various feeding behaviours in various microhabitats**

| Feeding techniques | Microhabitats | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fresh water bodies | Sewage | Grazing field | Agriculture Field | Forest area | Garbage | Manure heaps | Carcasses | Dumping station |
| Probing | 71.68 | 87.61 | 39.60 | 29.55 | -- | 52.38 | -- | 57.69 | 38.14 |
| Pecking | -- | 01.16 | 10.89 | 11.36 | -- | -- | -- | -- | 02.67 |
| Walking slowly | 23.97 | 08.24 | 31.68 | 27.27 | -- | 23.81 | -- | 11.54 | 07.53 |
| Hopping | 00.20 | 00.27 | -- | -- | -- | -- | -- | -- | 00.52 |
| Head swaying | 00.82 | 01.52 | -- | -- | -- | -- | -- | -- | -- |
| Head swinging | 02.45 | 00.09 | -- | -- | -- | -- | -- | -- | -- |
| Groping | 00.88 | 00.01 | -- | -- | -- | -- | -- | -- | -- |
| Flipping | -- | 00.57 | 08.91 | 25.00 | -- | 23.81 | -- | 23.08 | 02.67 |
| Running | -- | 00.53 | 05.94 | 06.81 | -- | -- | -- | -- | -- |
| Standing | ** | ** | ** | ** | -- | ** | -- | ** | ** |
| Standing fly catching | -- | -- | 02.97 | -- | -- | -- | -- | 07.69 | 48.48 |
| **No. of observations** | 9234 | 9760 | 101 | 44 | -- | 21 | -- | 26 | 4237 |

**Table 2 : Frequency occurrence (%) of various feeding techniques in various microhabitats**

| **Feeding techniques** | **Microhabitats** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Sewage** | **SWSW** | **Puddle** | **Forest** | **Agri. area** | **Manure heap** | **Carcass** | **Dumping station** |
| Probing | 87.61 | 74.50 | 67.73 | 23.33 | 29.55 | 24.00 | 57.69 | 45.26 |
| Pecking | 01.16 | -- | -- | 03.33 | 11.36 | 16.00 | -- | 01.34 |
| Walking slowly | 08.24 | 22.25 | 28.64 | 60.00 | 27.27 | 08.00 | 11.54 | 15.67 |
| Hopping | 00.27 | 00.20 | 00.27 | -- | -- | -- | -- | 00.26 |
| Head swaying | 01.52 | 00.73 | 00.45 | -- | -- | -- | -- | -- |
| Head swinging | 00.09 | 01.55 | 02.55 | -- | -- | -- | -- | -- |
| Groping | 00.01 | 00.77 | 00.36 | -- | -- | -- | -- | -- |
| Flipping | 00.57 | -- | -- | 13.33 | 25.00 | 52.00 | 23.08 | 13.24 |
| Running | 00.53 | -- | -- | -- | 06.81 | -- | -- | -- |
| Standing | ** | ** | ** | ** | ** | ** | ** | ** |
| Standing fly catching | -- | -- | -- | -- | -- | -- | 07.69 | 24.24 |
| Sweeping | -- | -- | -- | -- | -- | -- | -- | -- |
| **No. of observations** | **9760** | **8134** | **1100** | **30** | **44** | **25** | **26** | **2129** |

** = Behaviour observed, but not quantified

-- = Not observed

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