Some aspects of feeding ecology and behavior of House crow (Corvus splendens) in an urban habitat of city Prayagraj (U.P.), India

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ABSTRACT

The present article explains some aspects of feeding ecology and behavioral strategies adopted by house crow (Corvus splendens) in urban habitats. The house crow (C. splendens) is an omnivorous, scavenger, and highly opportunistic bird. Feeding ecology and behavior were observed in each study area following a suitable sampling method. House crow significantly feeds in unhygienic places and prefers food items from miscellaneous sources (human refuses, carcasses, etc.) over plant and animal sources during the day time. In the early morning, house crow mostly relied on plant and animal sources as food items. House crow significantly prefers to feed in the morning. Irrespective of the abundance of the various plant species house crow significantly prefers to feed products of five plant species, namely, Ficus religiosa, Azadirachta indica, Ficus racemosa, Ziziphus, Ficus indica, and Artocarpus lacucha. Other plants are only occasionally visited for feeding purposes. House crow significantly prefers to feed in the congregation; however, feeding solitary is not uncommon. House crow utilizes carcasses in congregation with the aid of feral dogs if otherwise unable to crack open carcasses alone. It also feeds on ticks present on the body surface of Sus scrofa. Instances of both inter and intraspecific competitions have been observed. Interspecific competitive events were significantly more common in comparison to intraspecific competitive events. Acridotheres tristis, Acridotheres ginnimmianus, Gracupica contra, Passer domesticus, Bubulcus ibis, Egretta garzetta, Columbia livia, and Milvus migrans are bird species, house crow showed aggressive behavior. Apart from this, house crow showed both aggressiveness and appeasement toward Macaca sp. and feral dogs. House crow significantly spends more time in search of food items than actual feeding time. Four types of feeding methods, namely, searching, stealing, specific and environmental, and economic damage [12-14]. Reports are available that mark house crow as the carrier of pathogens that cause diseases in human beings [13,15,16]. In India, the house crow is also associated with religious rituals. Feeding ecology of a bird is important aspect of the basic ecology of species concerned. Feeding behavior is the way, in which a bird exploits resources for feeding purpose. This explains how a bird species utilize their environment and help to identify the factors which are crucial for their survival and propagation [17]. The present study aims to describe some aspects of feeding ecology and behavior of house crow. Outcome definitely will help us to understand how population of this invasive bird species can be managed up to a sustainable level.

1. INTRODUCTION

House crow is a common bird of crow belonging to family Corvidae of order Passeriformes. House crow is omnivorous, scavenger bird. The food preference of house crow is highly opportunistic [1,2]. House crow also eat agricultural produce and stored food [3-8]. House crow is highly adaptive to the urban environment [9,10]. It is a strongly commensal, vocal, gregarious bird, generally unafraid of the public. Its abundance is closely associated with the human population up to the extent that non-dependent population may no longer exist [11]. Habitat abundance relationships suggest that house crows are highly dependent on anthropogenic food [1]. It is an invasive species, that is, negatively alters its new environment causing ecological, environmental, and economic damage [12-14]. Reports are available that mark house crow as the carrier of pathogens that cause diseases in human beings [13,15,16]. In India, the house crow is also associated with religious rituals. Feeding ecology of a bird is important aspect of the basic ecology of species concerned. Feeding behavior is the way, in which a bird exploits resources for feeding purpose. This explains how a bird species utilize their environment and help to identify the factors which are crucial for their survival and propagation [17]. The present study aims to describe some aspects of feeding ecology and behavior of house crow. Outcome definitely will help us to understand how population of this invasive bird species can be managed up to a sustainable level.

2. MATERIALS AND METHODS

The present investigation was carried out in certain parts of the city Prayagraj (Allahabad; 25°45’ N to 81° 85’ E) located in the southernmost part of the state Uttar Pradesh, India. Average elevation
is over 90 m above sea level. Prayagraj has three seasons. Summer
expand from March to June with temperature up to 48°C. Monsoon
starts in June and lasts up to August and even up to mid-September
having annual rainfall of 1027 mm. Winter runs from November to
February, with average minimum temperature of about 9°C. Annual
mean temperature is around 26°C. Recorded average relative humidity
is about 53%. Prayagraj is the seventh most populous city of the state
concerned and 36th in country. Huge quantities of food scrap/human
left over, animal remains, are produced in the city every day. City also
covers considerable vegetation and river bank areas. Thus, studied city
is right choice for the study of feeding ecology of house crow in an
urban habitat.

Direct observations were made to record the food habits, feeding
behavior, inter- and intraspecific struggles, and some other aspects
of feeding ecology of the house crow. Focal animal sampling with
5 min interval was used to record individual feeding behavior. For
group observation, all animal sampling together with ad-libitum
were considered. All sampling methods were applied with procedure
described by Altman [18] and Lehner [19]. We observed group
feeding up to the time participating species disintegrated or it was
not possible to continue observation otherwise. Food stealing events
were observed until house crow disappears or was beyond to tackle.
We approximated food hoarding if captured/stolen food item was
avoided to consume immediately and house crow flew away along
with it up the untraceable extent. Each study area has been visited
5 times in a month during period of April 2019 to April 2021. The
observation started following sunrise and ended up to 09.00 AM and
in evening 04.00 PM to 06.00 PM. Occasional visits were also made
during day time whenever required. Identification of flora and fauna
has been made using most preferred references. Bird’s counts were
made at each study area using point count method [20]. Stopwatch
and binocular (Olympus 10 × 50) have been used to observe feeding
activity and bird’s counting whenever required with observation free
of possible human interference. Photographs and videos were taken
with the help of Cannon power shot digital camera with ×40 zoom (model
no. SX430IS) with 20 mega pixel capacity. Suitable graphical
presentation and statistical treatment have been made using Microsoft
Excel 2007 version.

3. RESULTS AND DISCUSSION

Total 41 feeding grounds have been visited, of which only eight sites
were located in neat clean places; rest resides in grubby/garbage
collecting sites. House crow thus significantly feeds in unhygienic
condition (calculated $\chi^2$ value 9.01 > critical $\chi^2$ value 3.84; $P < 0.002$).
Feeding sites were almost full of human refuges, cooked left over,
wastes from food stall, wastes recovered from vegetable/meat/fish
market, animal remains, and other organic/inorganic constituents.
It was perceived that roosting sites of house crow coincide with feeding
sites. Principle diet consists of caterpillars, beetles, weevils, bugs,
wasps, various other insects and small fishes, amphibians, reptiles, and
fledglings. Kitchen leftover, human refuges, and various other edible
organic/inorganic substances contribute a lot in its menu. Flowers and
fruits of various plant species are also part of its diet. House crow
frequently spotted to eat carrion and rotten meat [Table 1].

Food preference to above categorized items [Table 1] has been
estimated by number of house crows spotted to feeding on it. House
crows were found to significantly feed on human refuges and other
miscellaneous food item (calculated $\chi^2$ value 183.39 > critical $\chi^2$ value
5.99; $P < 0.0001$) [Figure 1i]. Similar results were obtained when we
consider feeding states (calculated $\chi^2$ value 357.03 > critical $\chi^2$ value
5.99; $P < 0.0001$) clearly indicating that house crow very unlike to
feed on plant products [Figure 1ii]. In the early morning, house crows
significantly feed on plant and animal source (calculated $\chi^2$ value
4.79 > critical $\chi^2$ value 3.84; $P = 0.028$) [Figure 1iii]. Rest of the day
they mostly relied on miscellaneous food items (calculated $\chi^2$ value
49.14 > critical $\chi^2$ value 3.84; $P = 0.001$) [Figure 1iv]. In addition to
this, house crow significantly like to feed in the morning (calculated $\chi^2$
value 37.33 > critical $\chi^2$ value 3.84; $P < 0.0001$) [Figure 1v].

Koul and Sahi [17] in their study on feeding ecology of house crow
in open agricultural fields listed the food items under three categories,
namely, plant, animal, and other food items. House crow spends much
time in searching for food on the ground and occasionally feeds on
trees. The food preference of house crow is very broad and highly
opportunistic; it includes seeds, fruit, grain, nectar, berries, bird’s eggs,
nestlings, fledglings, reptiles, amphibians, fish, insects, carrion, and
food scraps [1,2]. Alam and Nooralam [21] studied the feeding habit
in urban habitat of Kolkata and reported that maximum count of house
crow was made in residential area followed by commercial and public
parks. They suggested that house crow prefers to feed significantly on
residential wastes followed by food available at commercial places.
Anjum et al. [22] reported feeding of house crow at a dumping site
full of organic (fruit residues, vegetables remains, meat/chicken
pieces, corn, and eggs) and inorganic (bulbs, plastic spoons, different
packaging materials, cloths, pampers, animal dung, etc.) substances.
Khan et al. [23] recorded foraging rhythms of house crow on some
crops and found enhanced foraging activity in the early morning and
late afternoon. Similarly, maximum feeding activity was observed in
the early morning and in evening [14,22]. Minimum feeding activity
was observed in the evening and middle of the day [14]. In the present
study, we observed similar feeding characteristics.

Irrespective of the abundance of the various plant species, house
crow significantly feed on five species, namely, Ficus religiosa,
Azadirachta indica, Ficus racemosa, Ziziphus, Ficus indica, and
Artocarpus lacucha (calculated $\chi^2$ value 44.07 > critical $\chi^2$ value
3.84; $P < 0.0001$) [Figure 1vi]. Plant species whose products were
observed to frequently use as food source have been recognized as
major plant feeder. Minor plant feeders were those occasionally visited
by house crow for feeding purpose. Similar plant species preference
has been calculated by considering occurrences of feeding states.
About 72% of the total 432 feeding states were found to be associated
with major plant feeder, that is, significantly more than 28% occurred
on minor plant feeder species (calculated $\chi^2$ value 35.65 > critical
$\chi^2$ value 3.84; $P < 0.0001$) [Figure 1vii]. Plants such as citrus,
sunflower, guava, unripe zizyphus, and jaman were frequently visited
for feeding purpose by house crow [23]. Behrouzi-Rad [24] observed
that most preferred trees for roosting and nesting purpose by house
crow were Ficus bengalensis, Eucalyptus, and Ziziphus aucheri. Kaur
and Sahi [25], during their study on community ecology of cattle
egret, found vegetation consists of Acacia nilotica (babul), Dalbergia
sissou (sheesham), Eucalyptus, Ziziphus mauritiana, F. bengalensis,
F. religiosa, and other plant species. House crow was one of important
bird species of this community. Kaur and Kumar [26] found that six
trees, namely, banyan (F. bengalensis), Jamun (Syzygium cumini),
Mulberry (Morus alba), Neem (A. indica), Peepal (F. religiosa),
and Sheesham (D. sissoo) harbor most of the bird diversity including
house crow. We found similar pattern of vegetation with regional
variation used by house crow for feeding and roosting purpose [3].
House crow significantly prefers to feed in congregation (calculated
$\chi^2$ value 96.31 > critical $\chi^2$ value 3.84; $P < 0.0001$) [Figure 1viii].
Feeding observed to occur in group of 3/4 to more than 30 individuals
Figure 1: Pie chart showing various feeding aspects of *Corvus splendens*. (i) Number and percentage feeding on different food sources; (ii) number of feeding states under different feeding sources; (iii) number of feeding states at different feeding sources in the morning; (iv) number of feeding states during rest of the day at different feeding sources; (v) number of feeding states during morning and rest of the day; (vi) number of house crows feeding on major and minor plant feeder; (vii) number of feeding states at major and minor plant feeder; (viii) number of feeding states during rest of the day at different feeding sources; (ix) number of feeding states during rest of the day at different feeding sources; (x) number and percentage of different feeding methods utilized.

[Figure 2a]. However, feeding solitary is not uncommon in house crow. It was observed that, in populated area they prefer to feed solitary, but in open field communal feeding is more common. House crow seen to utilize carcasses in congregation. Some individuals lie at the periphery of carcass waiting for their turn and rest feed untroubled. It seemed that waiting ones were probably act as sentries. It was important to note that when carcasses were intact they feed mutually along with feral dogs [2] possibly due to dependency to crack open the carcasses by them. Feral dogs rags the dead body that was subsequently utilized by the house crow. House crow was unafraid of any harm to be made by feral dogs [Figure 2b]. However, in case of cut open carcasses, house crow observed to have independent assess and showed aggression toward *Sus scrofa* that were feeding along [Figure 2c]. It was also seen that house crow feeds on ticks present on the body surface of *S. scrofa* and domestic buffalo (*Bubalus* sp). Whether the association of ticks to their host was beneficial/harmful, carriers never found tried to get rid of house crow. Probably tick’s feeding by house crow was a pleasant act. House crow seen to steal fish and rotten meat without any hesitation in places even with human interference. The instances of intraspecific competition were seen in feeding of carcasses and specific food offered to them. We have taken clawing, pecking, flapping of wings, and chasing as part of aggressive behavior. Interspecific competition was quite common. *Acridotheres tristis, Acridotheres ginginianus, Gracupica contra, Passer domesticus, Bubulcus ibis, Egretta garzetta,*
Columbia livia, and Milvus migrans were bird species, house crow showed aggressive behavior. Interspecific competitive events were significantly more common in comparison to intraspecific competitive events (calculated $\chi^2$ value 72.26 > critical $\chi^2$ value 3.84; $P < 0.0001$) [Figure 1b]. Interspecific competition of house crow has been observed with other birds and mammals [Table 2]. Competition with M. migrans was quite interesting. It was seen that out number of house crows and their unique strategy to occupy food item made them to surpass M. migrans. Food item was stolen by few individuals of a flock, while others involved in entangling the other party. In the meantime stealer hoarded the item at the nearby hoarding site. The incidences of food hoardings were also noticed to be associated with other feeding methods. Besides, house crow showed both aggressive and appeasement towards Macaca sp. and feral dogs [Figure 1d].

Feeding separately and becoming content with what got to eat were recognized as appeasement policy. In a 5 min of observation, significantly more time was spent in searching of food items and other unrecognized activities to actual feeding event (Calculated t-value 5.66 > critical t-value 2.04; $P < 0.0001$) [Figure 3]. House crow spends much time in searching for food [15]. Communal feeding is common in case of house crow. Communal feeding of house crow is well documented in case of valuable agricultural crops such as Wheat, Maize, Jowar, Groundnut, ripe fruits of fig, Mulberry, Chili, sunflower, and Grape which are some of the important crops on which losses caused by house crow depredation [3-8,23] as well as in case of carcasses [13]. Gobi et al. [27] observed that two house crows on either side of the food item were acting as sentries to alert the conspecifics while feeding. Sign of individual feeding can be traced in reports of stealing and food caching [28-30]. House crow dives into the water to catch stranded fish and forage on insects on the surface [31]. Interspecific competition has been noted in case of jungle crow (Corvus macrorhynchos culminatus) with aggressiveness toward house crow during food scarcity [32,33]. Kaur and Sahi [25], in their study on community ecology of cattle egret, listed the name of birds those share same feeding locality. Phalacrocorax nigerr, Ardeola grayii, Egretta garzetta, Vanellus indicus, Porphyrio porphyrio, A. tristis, Acridotheres ginguianus, C. splendens, and Dicrurus adsimilis are such bird species. Similar observation has been made by Kaul and Sahi [14], Gobi et al. [27] found that Corvus splendens, Corvus culminatus, A. tristis [34], Turdoides caudatus, Funambulus palmarum, and Herpestes javanicus

Table 1: List of food items observed to feed by house crow.

<table>
<thead>
<tr>
<th>Plant source</th>
<th>Animal source</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berries of peepul (Ficus religiosa)</td>
<td>Caterpillars</td>
<td>Kitchen leftover</td>
</tr>
<tr>
<td>Berries of banyan (Ficus indica)</td>
<td>Beetles</td>
<td>Human refuses</td>
</tr>
<tr>
<td>Berries of Wild fig (Ficus cunia)</td>
<td>Weevils</td>
<td>Pulses</td>
</tr>
<tr>
<td>Fruit of neem (Azadirachta indica)</td>
<td>Bugs</td>
<td>Uncooked rice grain</td>
</tr>
<tr>
<td>Fruit of jujube (Zizyphus mauritiana)</td>
<td>Wasps</td>
<td>Wheat grain</td>
</tr>
<tr>
<td>Fruit of gular (Ficus racemosa)</td>
<td>Small fishes</td>
<td>Millets</td>
</tr>
<tr>
<td>Fruit of babul (Vachellia nilotica)</td>
<td>Amphibians</td>
<td>Corn</td>
</tr>
<tr>
<td>Fruit of jungle jalebi (Pithecellobium dulce)</td>
<td>Small reptiles</td>
<td>Shops</td>
</tr>
<tr>
<td>Fruit of chilbil (Holoptelea integrifolia)</td>
<td>Fledglings</td>
<td>Candles/Wax</td>
</tr>
<tr>
<td>Fruit of chinaberry (Melia azedarach)</td>
<td>Mites of body</td>
<td>Milk products</td>
</tr>
<tr>
<td>Fruit of barhal (Artocarpus lacucha)</td>
<td>Eggs of birds</td>
<td>Plastic pieces</td>
</tr>
<tr>
<td>Fruit and flower of sagnaun (Tectona grandis)</td>
<td></td>
<td>Cow dung</td>
</tr>
<tr>
<td>Flower of gulmohar (Delonix regia)</td>
<td></td>
<td>Clothes</td>
</tr>
<tr>
<td>Flower of eucalyptus (Eucalyptus globules)</td>
<td></td>
<td>Carcases/offal</td>
</tr>
<tr>
<td>Flower of golden shower (Cassia fistula)</td>
<td></td>
<td>Remains of meat/fish</td>
</tr>
<tr>
<td>Flower of seabam (Dalbergia siso)</td>
<td></td>
<td>Feathers of chicks</td>
</tr>
</tbody>
</table>

Figure 2: Photographs showing intra- and interspecific interactions.
(a) Intraspecific interaction, (b-d) interspecific interaction with different animal species.
feed communally. Mishra et al. [35] found that four of the most common commensally and socially feeding species with Egyptian vulture are Milvus migrans, C. splendens, Bubulcus ibis, and Canis sp. They also observed that population of Egyptian vulture was positively correlated with those of house crow and feral dogs. We found similar communal structure at feeding sites in the present study.

Four types of feeding methods could be recognized, namely, searching, stealing, specific food offering, and food retrieved from cached sites. It was assumed that what house crow cached, retrieved completely later on. Searching was significantly most preferred feeding method followed by stealing. Specific food offering by men was also common, while food retrieval from cached side was little scare (calculated $\chi^2$ value 277.33 > critical $\chi^2$ value 7.81; $P < 0.0001$) [Figure 1x]. Stealing of food items is a common observation that we found to see or read in newspapers [13]. Food storing in corvids is well documented from centuries. Neuronal specialization of house crow with concern to food storing behavior has been studied in some detail by Srivastava et al. [30,36]. Specific food offerings to house crow has been reported by Sayyad et al. [37] and Kumar and Ojha [38]. The present finding is in agreement with these previous reports.

4. CONCLUSION

It is, therefore, concluded that house crow is omnivorous, highly opportunistic, and scavenger bird utilize urban resources to its best. It is possible due to its various ecological and behavioral adaptations in relation to act of feeding. It prefers to eat such items that are almost discarded by the others. It forages mostly in unhygienic places and thus trying to avoid unnecessary conflict. Furthermore, house crow roost communally close to the feeding source. So for behavior is concern, it is highly dramatic and plastic. Various feeding habits and strategies applied during community interactions specifically at the time of feeding make this bird far beyond others. Present work put forward some details to these things. It will be helpful to manage and utilize this amazing creature for human’s ecological and economic perspective.

5. ACKNOWLEDGMENTS

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6. AUTHORS’ CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

7. FUNDING

None funding agency provided any financial support in any form. Authors bear all expenses their own pertaining to this research work.

8. CONFLICTS OF INTEREST

Authors declared that they do not have any conflicts of interest.

9. ETHICAL APPROVALS

There is no bird ecological observation specific information in the guidelines of CPCSEA (Committee for the Purpose of Control and Supervision of Experiments on Animals, Ministry of Environment, Forest and Climate Change, Government of India), and it is not mandatory to get ethical clearance for bird observation in India. However, the guidelines for the care and use of animals followed for the maintenance, handling and conducting this experimentation in bird and no any hurdle created by the observer for the ethological observation during study.

Table 2: Some important animal species observed to share same feeding sites with house crow.

<table>
<thead>
<tr>
<th>Birds</th>
<th>Mammals</th>
</tr>
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<tbody>
<tr>
<td>Jungle crow (Corvus macrorhynchos)</td>
<td>Boar (Sus scrofa)</td>
</tr>
<tr>
<td>Common myna (Acridotheres tristis)</td>
<td>Domastic pig (Sus domesticus)</td>
</tr>
<tr>
<td>Bank myna (Acridotheres gingeinianus)</td>
<td>Feral dog (Canis sps.)</td>
</tr>
<tr>
<td>Indian pied myna (Gracupica contra)</td>
<td>Monkey (Macaca sps.)</td>
</tr>
<tr>
<td>House Sparrow (Passer domesticus)</td>
<td>Domastic buffalo (Bubalus sps.)</td>
</tr>
<tr>
<td>Black drongo (Dicrurus macrocerus)</td>
<td>Cattle (Bos sps.)</td>
</tr>
<tr>
<td>Rose ringed parakeet (Psitacula krameri)</td>
<td>Three striped palm squirrel (Funambulus palmarus)</td>
</tr>
<tr>
<td>Blue rock pigeon (Columbia livia)</td>
<td>Five striped palm squirrel (Funambulus pennantii)</td>
</tr>
<tr>
<td>Indian ring dove (Streptopelia decaoacta)</td>
<td>Indian grey mongoose (Urva edwardsii)</td>
</tr>
<tr>
<td>Little brown dove (Streptopelia senegalensis)</td>
<td>Lasser bandicoot rat (Bandicota bengalensis)</td>
</tr>
<tr>
<td>Red wattled lapwig (Vanellus indicus)</td>
<td>Greater bandicoot rat (Bandicota indica)</td>
</tr>
<tr>
<td>Yellow wattled lapwig (Vanellus malabaricus)</td>
<td>House rat (Rattus rattus)</td>
</tr>
<tr>
<td>Cattle egrets (Bubulcus ibis)</td>
<td></td>
</tr>
<tr>
<td>Little egret (Egretta garzetta)</td>
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</tr>
<tr>
<td>Intermediate egret (Ardea intermedia)</td>
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<tr>
<td>Indian pond heron (Ardeola grayi)</td>
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<tr>
<td>Black winged stilt (Himantopus himantopus)</td>
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</tr>
<tr>
<td>Large pied wagtail (Motecilla maderaspatensis)</td>
<td></td>
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<tr>
<td>Pariah kite (Milvus migrans)</td>
<td></td>
</tr>
<tr>
<td>Common babbler (Argya caudata)</td>
<td></td>
</tr>
<tr>
<td>Jungle babbler (Argya striata)</td>
<td></td>
</tr>
</tbody>
</table>
10. DATA AVAILABILITY

All data generated and analyzed are included within this research article.

11. PUBLISHER’S NOTE

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