

Avian assemblages in the waste landfills: observations from urban sites in West Bengal, India

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Abstract Urban dumpsites, often regarded as environmental eyesores, may play an unexpected ecological role by providing habitats for avian species. In this context, the present study was conducted to justify whether dumpsites can sustain bird populations and enhance urban biodiversity. We recorded the bird abundance and species richness through surveys at four well-known urban dumpsites in Kolkata and surrounding areas between February and June 2024. We encountered a variety of common and rare bird species that use the dumpsite for feeding, breeding, and roosting using established methods. The dumping area close to the agricultural fields had a higher bird species richness compared to the urbanized area. However, the urban dumping areas exhibited comparatively higher bird abundance. House Crow (*Corvus splendens*) and Cattle Egret (*Bubulcus ibis*) were the two most common species at the dumpsites. This work emphasizes the importance of studying the bird groups concerning landfill sites and management, as a significant influx of birds could lead to various environmental challenges in metropolitan areas.

Keywords: avian diversity, landfill, waste management, feeding guilds

Összefoglalás A városi szeméttelpek kevésbé ismert ökológiai szerepet játszhatnak, mivel élőhelyet biztosítanak a madárfajok számára. Egy tanulmányt végeztek annak igazolására, hogy a hulladéklerakók képesek-e fenntartani a madárpopulációkat, és ezáltal növelni a városi biodiverzitást. Négy jól ismert városi szeméttelpek felmérése során rögzítettük a jelenlévő madárfajokat és a madarak számát. Sztenderd ornitológiai eljárások segítségével számos olyan gyakori és ritka madárfajt jegyeztünk fel, amelyek táplálkozásra, költésre és pihenésre használják a szeméttelpeket. 2024 februárja és júniusa között blokkszámlálások segítségével madárszámlálásokat végeztünk két különböző hulladéklerakó helyen. Az erdőhöz közeli lerakási területen szignifikánsan több madár volt, mint a városi területen. Azonban utóbbi mutatta a magasabb avifaunisztikai diverzitást és gazdagságot. A két leggyakoribb faj az indiai varjú (*Corvus splendens*) és a pásztorgém (*Bubulcus ibis*) volt. Ez a munka hangsúlyozza a madársoportok hulladéklerakók területén történő tanulmányozásának és kezelésének fontosságát, mivel a madarak jelentős beáramlása különböző környezeti kihívásokhoz vezethet a nagyvárosi területeken.

Kulcsszavak: hulladékgazdálkodás, sokféleség, szeméttelrakó, táplálkozási guildek

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Introduction

Urban development often misses the proper management of dump areas, which become alternative homes for various bird species. As cities grow larger and natural spaces get smaller, several birds find food, shelter, and breed in these artificial yet polluted areas. A deeper analysis of this development deepens our understanding of human and wildlife interactions (Oro *et al.* 2013). Dump areas provide optimal bird habitats in towns and cities, where natural habitats are frequently fragmented or deteriorated. Numerous species are attracted to these locations, especially those adapted to take advantage of anthropogenic resources due to the high amount of food resources. Avian species diversity is influenced by the habitat variability seen in dumpsites, which includes open areas, garbage piles, and vegetated zones. Because of the diversity of microhabitats, several species can live and use diverse ecological niches found in the dumpsites. On the other side, environmental pollution evokes growing environmental concern, especially in developing countries, where rapid growth of the human population is being observed. Municipal solid waste results from human activities, causing significant levels of pollution and health problems. Food leftovers produced by people act as food subsidies for other species, vastly changing the ecosystem structure and function, especially for leftovers from farms and dumpsites (Oro *et al.* 2013). Municipal solid waste mainly comes from places where people live, including small businesses, hospitals, clinics, and other commercial activities. Mixing medical waste with regular trash brings health hazards and environmental challenges. Therefore, it is crucial to keep medical waste separate for safe disposal following the standard rules and regulations to reduce health and environmental hazards (Pattnaik & Reddy 2009, Sing *et al.* 2011, Hoornweg *et al.* 2013). Fast-developing countries often face tricky problems with solid waste management based on population size and wealth levels. When waste is not managed well, it damages the environment and public health, so we must find sustainable solutions (Flores-Tena *et al.* 2007, Houston *et al.* 2007, Matejczyk *et al.* 2011, Mane & Hingane 2012). Particularly in developing countries, managing solid waste becomes highly important since financial resources are limited and the risks from dumping increase (Hazra & Goel 2009, Monney *et al.* 2013). In this context, understanding the feeding ecology of the fauna present in the dumpsites may help with wildlife management.

Human-modified habitats like landfills become crucial for avian species as natural habitats decline. As birds adapt, social behaviour and demography may change, leading to stable dominance hierarchies in anthropogenic food-dependent species (Saalfeld *et al.* 2013). Although birds in landfills provide essential ecological services (Devault 2016), abnormally high populations of a few bird species with poor species richness might negatively affect the overall proportions of other species (Mills *et al.* 1989, Cam *et al.* 2000). It is vital to know how bird species adjust to their environments as well as how they help to keep ecosystems balanced and diverse (Sekercioglu 2012). With this knowledge, we can generate better conservation efforts and strategies for protecting bird populations and their homes (Maurice *et al.* 2020). Food subsidies from the dumpsites have multiple effects on bird communities, including behaviour changes and health impacts (Robb *et al.* 2008, Oro *et al.* 2013). Birds feed on organic foods like meat, fish, fruits, and eggs,

available in the dumpsites, which may give essential nutrients along the food chain (Parfitt *et al.* 2010). However, these foods can also carry toxins or harmful materials that might risk bird health and human safety.

Waste management includes physical destruction, chemical cleaning, and getting rid of trash in the environment. Since early human history, waste management has worked well with bones and shells because they decompose quickly (Steffo 1991). Birds do important jobs – they are bioindicators of pollution that help reduce waste while controlling pests in natural and modified spaces (Sekercioglu 2006). This study aims to fill a significant information gap about how Indian bird populations are affected by landfills and focuses explicitly on assessing the variety and quantity of bird species in the south-eastern part of West Bengal. The trash landfills are important food sources for local birds, and this study aims to ascertain this by examining the feeding guild structures of these bird populations. This study is anticipated to shed light on how landfills affect nearby avian populations, improving our comprehension of the ecological significance of these birds in this particular location.

Materials and Methods

Study area

This study was conducted in four randomly selected sites, i.e. Duttapukur Station Road market (22.768° N, 88.540° E) (transect I) and its associated dump area, Basirhat dumping ground (22.651° N, 88.872° E) (transect II), Barasat dumping ground (22.653° N, 88.873° E) (transect III) under the district of North 24 Parganas, and Bara Bazar station road and its associated dumpsites (22.589° N, 88.350° E) (transect IV) under the district of Kolkata. These places are used as waste disposal sites with regular dumping for various wastes, such as household garbage, sludge, market wastes, and biomedical wastes, which generate a variety of food sources for the birds. The average temperature and relative humidity of these areas varied between 20–42 °C and 60–80%, respectively, with an average annual rainfall of 150 mm.

Data collection

The field observations were conducted between February 2024 and June 2024. From each of the surveyed sites, the birds were observed using a modified point count survey method (Buckland *et al.* 1993, Bibby *et al.* 2000). Each site was surveyed at least twice a week, and the data on the bird abundance and richness were collected and noted. Olympus binoculars were used to observe birds, and digital photographs were taken using a Nikon B700 camera for the species identification to the smallest taxonomic class (Ali & Ripley 1995, Grimmett *et al.* 2011). The observations at the dumpsites were conducted mainly in the morning hours, and the activities of the birds were recorded. We noted direct sighting records for each site and identified various species at that time using the standard method

(Bibby *et al.* 1998). Alongside these observations, we also documented different types of foods available in the dumpsites and the feeding behaviours of birds. Additionally, we recorded the major dump materials, distinguishing between biodegradable and non-biodegradable items.

Data analysis

Following the field surveys, the abundance of birds and species richness was measured. The species diversity indices (i.e. the Dominance index, Simpson's diversity index, Shannon's diversity index, Evenness, Margalef's index, and Fisher's alpha) were determined using PAST software (version 4.03) (Hammer *et al.* 2001). Pie chart showing the proportional representation of different orders of birds and relative abundance of feeding guilds were prepared using the *ggplot2* package in R software (version 4.3.0) (Wickham 2016, R Core Team 2021).

Table 1. The list of the birds observed in the urban dumpsites, West Bengal, India, during the study period

1. táblázat A városi személtlerakókon feljegyzett madárfajok listája a vizsgálati időszakban, Nyugat-Bengálban (India)

Sl no.	Order	Family	Species Name	Scientific Name	Guild	Acronym
1	Cuculiformes	Cuculidae	Asian Koel	<i>Eudynamis scolopaceus</i>	Omnivore	ESC
2	Columbiformes	Cuculidae	Spotted Dove	<i>Spilopelia chinensis</i>	Granivore	SCH
3	Suliformes	Phalacrocoracidae	Little Cormorant	<i>Microcarbo niger</i>	Carnivore	MNI
4	Pelecaniformes	Ardeidae	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	Carnivore	NNY
5	Pelecaniformes	Ardeidae	Mallard	<i>Anas platyrhynchos</i>	Omnivore	APL
6	Pelecaniformes	Ardeidae	Pond Heron	<i>Ardeola grayii</i>	Carnivore	AGR
7	Pelecaniformes	Ardeidae	Cattle Egret	<i>Bubulcus ibis</i>	Carnivore	BIB
8	Pelecaniformes	Ardeidae	Intermediate Egret	<i>Mesophoyx intermedia</i>	Carnivore	AIN
9	Accipitriformes	Accipitridae	Black Kite	<i>Milvus migrans</i>	Carnivore	MMI
10	Coraciiformes	Alcedinidae	White-breasted Kingfisher	<i>Halcyon smyrnensis</i>	Carnivore	HSM
11	Passeriformes	Sturnidae	Jungle Myna	<i>Acridotheres fuscus</i>	Omnivore	AFU
12	Passeriformes	Sturnidae	Common Myna	<i>Acridotheres tristis</i>	Omnivore	ATR
13	Passeriformes	Corvidae	Jungle Crow	<i>Corvus culminatus</i>	Omnivore	CCU
14	Passeriformes	Corvidae	House Crow	<i>Corvus splendens</i>	Omnivore	CSP
15	Passeriformes	Dicruridae	Black Drongo	<i>Dicrurus macrocercus</i>	Aerial insectivore	DMA
16	Passeriformes	Sturnidae	Pied Starling	<i>Gracupica contra</i>	Omnivore	GCO
17	Passeriformes	Motacillidae	White Wagtail	<i>Motacilla alba</i>	Insectivore	MAL
18	Passeriformes	Passeridae	House Sparrow	<i>Passer domesticus</i>	Ground granivore	PDO

Results

During the study period, a comprehensive survey recorded a total of 18 bird species across 10 families and 7 orders (*Table 1*). House Crows (*Corvus splendens*) are quite uncommon in the Basirhat region, but they predominate in landfills in Barasat, Duttapukur and Kolkata. In the Basirhat region, Cattle Egrets (*Bubulcus ibis*) were predominate, but are non-existent elsewhere. Unexpectedly, the Basirhat region has a higher prevalence of Jungle Myna (*Acridotheres fuscus*) than Common Myna (*Acridotheres tristis*). Among the 7 orders identified, Passeriformes emerged as the most dominant order, accounting for 50.2% of the species observed. This order includes a significant number of species, showcasing its prevalence in the study area. Following Passeriformes, Pelecaniformes represented 28.7% of the species. The remaining orders were less diverse, each represented by only a few species (*Figure 1*). Among the families of birds encountered, the Ardeidae family was the most dominant, represented by five species, followed by Sturnidae with three species, indicating a moderate presence. Cuculidae and Corvidae, each represented by two species, contributed to a relatively small but notable diversity. The remaining six families were each represented by a single species, highlighting a broad yet uneven distribution of species among the various families.

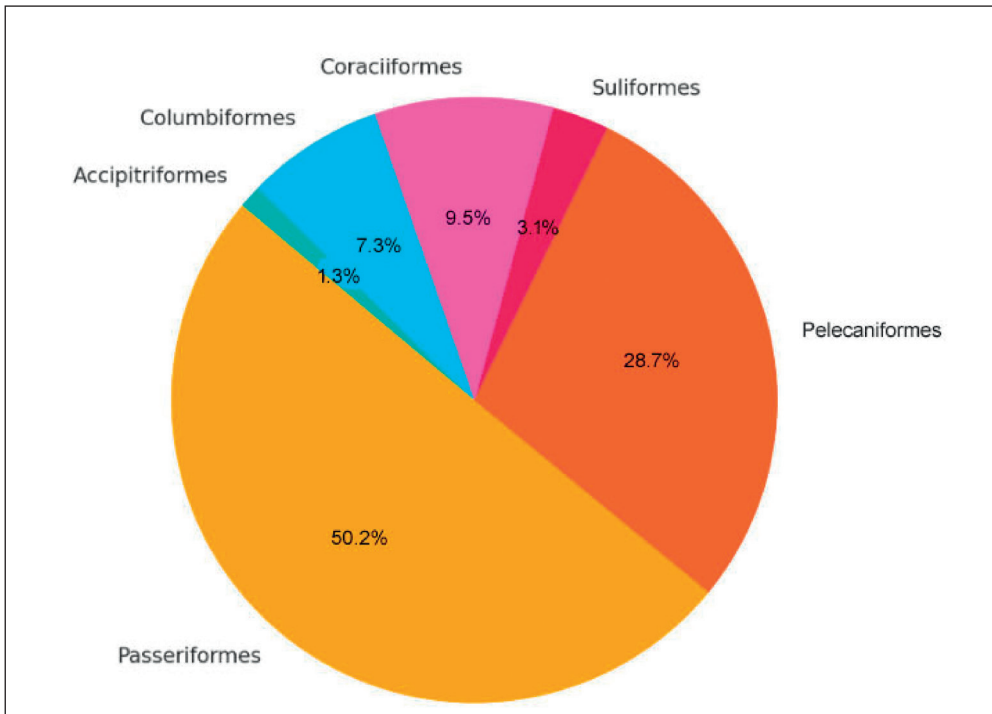


Figure 1. Pie chart showing proportional representation of different orders of birds observed in the waste landfill sites in West Bengal, India

1. ábra Nyugat-Bengál (India) területén felmért szemétklerakók madárrendjeinek arányát szemléltető kördiagram

The diversity indices, such as Simpson’s diversity index showed evenness, Shannon’s diversity index reflected community with many taxa, Margalef’s index revealed transects 1 and 2 are richer than the rest, and Fisher’s alpha confirmed this (Table 2). At the dumpsites, the bird census revealed four feeding guilds, i.e. carnivore, omnivore, granivore and insectivore (Figure 2). Of all the feeding guilds at the dumpsites, omnivores were the most prevalent, followed by carnivores, insectivores, and graminivores.

Table 2. Bird species diversity in the waste landfills in the 4 different transects (urban sites) of West Bengal, India

2. táblázat A szemétklerakók 4 transzektjének faji sokféleségét leíró mérőszámok

Diversity indices	Transect I (Duttapukur Station Road market area)	Transect II (Basirhat dumping ground)	Transect III (Barasat dumping ground)	Transect IV (Bara Bazar Station Road area)
Number of taxa	13	13	11	8
Number of individuals	461	369	345	812
Dominance index	0.168	0.2087	0.186	0.1851
Simpson’s diversity index	0.832	0.7913	0.814	0.8149
Shannon’s diversity index	2.076	1.79	1.902	1.829
Evenness	0.6131	0.4605	0.6092	0.7785
Margalef’s index	1.957	2.03	1.711	1.045
Fisher’s alpha	2.487	2.625	2.167	1.232

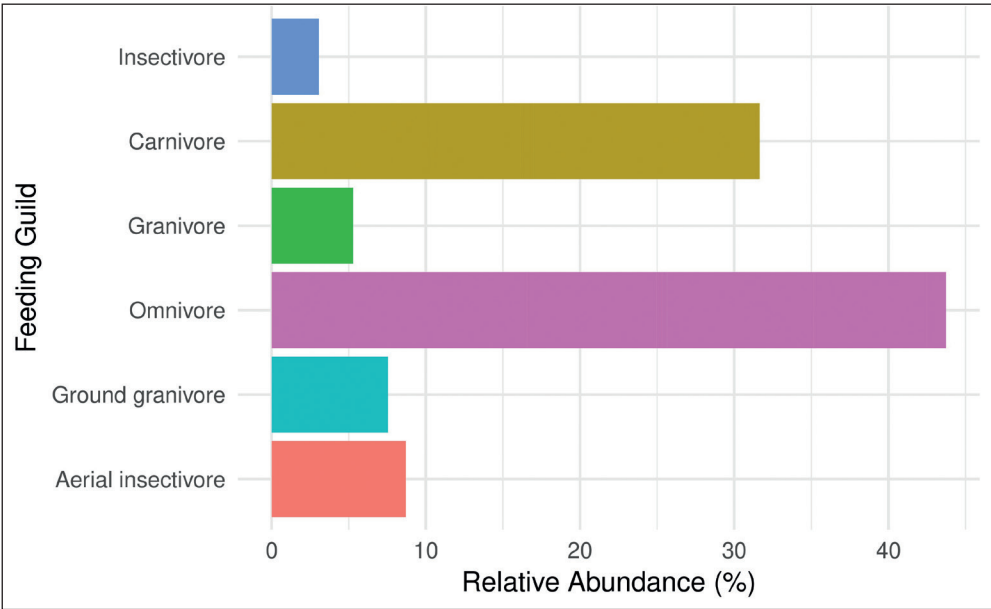


Figure 2. Relative abundance of feeding guilds in all the waste landfill sites observed in the selected urban regions of West Bengal, India

2. ábra Nyugat-Bengál (India) területén felmért szemétklerakókban megfigyelhető madarak táplálkozási guildjeinek relatív abundanciája

Discussion

The common perception of dumpsites as nothing more than environmental wastelands is a matter of debate following the earlier research on faunal diversity in these places. Instead, they highlight the intricate ecological dynamics at work, where a variety of bird species, especially scavengers and opportunists, find food and refuge. The implications of these discoveries for urban ecology, the advantages and disadvantages of using landfills as bird homes, and the larger picture of preserving urban biodiversity are covered in this regard. The present study centres on distinct species and their abundance at different dumpsites in and around Kolkata, West Bengal. The House Crow is the dominating species at two sites, while the Cattle Egret is the dominant species at two other sites. This opportunistic species can drive out other bird species from the area and is violent towards them. The research aims to examine how dominant species affect ecosystem dynamics and total biodiversity in these particular locations. Gaining knowledge about these dominating species' interactions and behaviour can be beneficial in determining the general stability and well-being of the local bird populations. The transect (II), where an agricultural area was closer, was predominated by Cattle Egrets, while House Sparrows (*Passer domesticus*) were prevalent across all sites. The results of the study demonstrate a diverse and rich avian community, with some orders and families demonstrating notable dominance. The results showed how dumpsites function as bird reservoirs, even though the dumpsites contain a variety of domestic hazardous wastes which may negatively affect the survival and conservation of several bird species. Food remains of all kinds can be found at dumpsites, including bread, fish, food grains, leftover meat, flowers, fruits, and packet meals, which draw different bird species. Matejczyk *et al.* (2011) and Abeba *et al.* (2020) found that non-biodegradable materials like metals, plastics, and paints in dumpsites lead to low bird species diversity and abundance. Plastic wastes and debris negatively impact aquatic and terrestrial bird species, affecting survival, growth, development, reproductive output, and physiology. The study recorded 18 bird species from dumpsites, which was much in line with the findings of Dutta *et al.* (2022), who identified 26 different bird species from the dumpsites of Kolkata. Variations in bird species richness may be due to food sources, human disturbances, climatic conditions, altitude, vegetation cover, water availability, urbanization, and habitat fragmentation.

Dumpsites in Barasat and Duttapukur have the highest species diversity indices, while the Basirhat transect has the highest species evenness. Variations in food availability, roosting locations, and human disturbances influence species diversity and evenness (Megersa *et al.* 2016, Haider *et al.* 2022). The type of food subsidy (Bertellotti *et al.* 2001), shelter (Burger 2001, Dementieieva *et al.* 2023), and mating season (Pons & Migot 1995, Tortosa *et al.* 2002) are some of the variables that affect the number of birds on landfills. Numerous endangered species, such as vultures, have also been observed to inhabit landfills (Houston *et al.* 2007), where they use food resources. Although more research is needed, the food subsidy is most likely the reason for the large number of birds at the garbage site. This study conducted at a landfill site highlighted the presence of several dominant bird species, offering new insights into avian ecology in such

unique habitats. Omnivores dominated all feeding guilds at the dumping locations, with carnivores, insectivores, and granivores following closely behind. The feeding guild distribution points to a wide variety of species using the resources at the waste site. The existence of omnivores, in particular, suggests that the bird populations in this habitat are highly adaptive and opportunistic (Pohajdak 1998).

The most dominant species observed at the landfill was the House Crow. This adaptable bird was frequently seen foraging across the landfill, utilizing different areas for feeding, perching, and flying. This bird's ability to thrive in such environments underscores its versatility and opportunistic behaviour in exploiting food resources provided by human activities. Cattle Egret was identified as the second most dominant species at the site. The prevalence of Cattle Egret at landfills has been well-documented globally, with studies by Plaza and Lambertucci (2017) confirming their widespread presence in similar environments. These birds are known for their scavenging habits and have become a common sight at waste disposal sites worldwide. The third most abundant species recorded was the Jungle Myna and Black Drongo (*Dicrurus macrocercus*). Unlike the Jungle Myna and House Crow, the Black Drongo is an insectivorous bird. Large numbers of drongos were observed mainly in the evening when they were drawn to the landfill by the swarms of flies that blanketed the site. The presence of this species in such high numbers at a landfill site is a notable finding, as their primary diet consists of insects, indicating that landfills can also support insectivorous birds (Annorbah & Holbech 2012). House Crows are quite uncommon in the Basirhat region, but they predominate in landfills in Barasat, Duttapukur, and Kolkata (Vuorisalo *et al.* 2003, Noreen & Sultan 2021). In the Basirhat region, Cattle Egrets predominate (Marasinghe *et al.* 2018), but they are non-existent in other urban dumpsites. Unexpectedly, the Basirhat region has a higher prevalence of Jungle Myna than Common Myna, which might be because the location is closer to the Sundarbans National Park (Dutta *et al.* 2022). Both biodegradable and non-biodegradable waste were present in the dumpsites. Crows, White Wagtails (*Motacilla alba*), and House Sparrows are found in the areas dominated by non-biodegradable wastes, while Jungle Myna, Pied Starling (*Gracupica contra*), and Black Drongo are prevalent in the organic dumps. These observations suggest that certain bird species are more adaptable to specific waste materials. Further research is needed to understand the behaviour of urban birds foraging in dump areas and their interactions with other co-existing species, which may provide insights into urban ecosystems and inform conservation efforts.

Conclusion

Birds in waste landfill areas face high risks of ingesting harmful materials like plastics, heavy metals, and other chemicals, which can lead to poisoning, organ damage, and long-term health issues, affecting the population. Further, their dependency on human-provided food can make them more vulnerable if natural food sources are scarce or removed or the dump is closed. Dumpsites also attract large numbers of birds, leading to increased competition for resources. Apparently, organic waste and discarded food items are abundant

in the waste dumps, allowing birds to sustain themselves in urban environments. However, the foraging bird community at waste landfill sites is characterized by low species diversity and dominance of a few species, such as Cattle Egrets and House Crows. Waste landfills are an emergent environmental problem requiring effective management, waste formation, and solutions to waste isolation.

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