

## Exploration of Photo-Period Role on the Scavenging Behavior of Pied Crow (*Corvus Albus*) On Solid Waste Dumps in Bonaberi, Douala, Littoral Region, Cameroon

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### Abstract

Pied crow (*Corvus albus*) is a widespread scavenger in urban areas of Cameroon that plays an important role in the management of solid waste. However, little is known about the factors influencing its scavenging behavior. This study explored the role of photoperiod on the scavenging activity of pied crows on solid waste materials in Bonaberi. Observations were conducted over a 4-month period to document the scavenging behavior of these birds during different photoperiod conditions (morning, afternoon, and evening periods of the day). Data collection was done within the first 15 days of each month, from 7:00am – 6:00 pm. The study has shown that photo-period significantly associated with congregation behavior of birds  $X^2=17.737$   $df=8$   $P=0.023$ , birds' activity  $X^2=8.669$   $df=6$   $P<0.05$ , and food-type  $X^2=52.257$   $df=10$   $P=0.000$  respectively. The study also revealed a significant relation between photo-period and human activity at dumpsites  $r=0.100$   $P=0.021$ . More so, grouping behavior of birds significantly associated with automobile traffic intensity  $X^2=10.120$   $df=8$   $P<0.05$ . Pied crows (*Corvus albus*) in Cameroon exhibit a strong tendency to aggregate at the solid waste dumpsites, often forming large flocks numbering in the hundreds or even thousands of individuals. Furthermore, grouping behavior of birds significantly associated with human activity  $X^2=12.069$   $df=8$   $P<0.05$ . Pied crows are highly adaptable and opportunistic scavengers that have flourished in urban environments, particularly in the presence of dumpsites. By integrating an understanding of crow ecology into waste system design and operations, municipalities would leverage the valuable ecological services these birds provide while also mitigating any potential nuisance issues. Additionally, these findings acknowledge that photoperiod is an important environmental cue influencing the scavenging ecology of pied crows in urban Bonaberi. Understanding these patterns would inform strategies for managing solid waste and crow populations in growing cities. Further research is needed to explore other factors that may interact with photoperiod to shape crow scavenging behavior

**Keywords:** Pied crow; Scavenging behavior; Dumpsites; Large flocks; Human activity

### Introduction

Urban solid waste dumps provide a reliable and abundant source of food resources for opportunistic scavenger species, such as the pied crow (*Corvus albus*). As a dominant avian scavenger found in high densities at dump sites in littoral region of Cameroon, pied crow plays a crucial role in the cleanup and recycling of organic waste materials [1,2]. Understanding the factors that drive the feeding and aggregation patterns of pied crows on urban dumps is important for developing effective waste management strategies that balance environmental and public health concerns. One such key factor that may influence pied crow foraging behavior is the daily and seasonal variations in daylight hours, known as photoperiod. Photoperiod has been shown to act as an important environmental cue that synchronizes the circadian rhythms and activity patterns of many bird species [3]. For example, studies on urban corvids have found that their visitation and foraging activity at anthropogenic food sources, such as landfills, can fluctuate in relation to changes in daylight availability [4-6].

Pied crows are known to be prolific scavengers, readily consuming a wide variety of carrion, including the remains of dead livestock, wild animals, and even human refuse [7]. Studies have shown that carrion can make up a significant proportion of their diet, especially in areas with high levels of animal mortality or human activity [8,9]. Pied crows employ a variety of strategies to locate and exploit carrion resources. They have been observed actively searching for and investigating

potential food sources, as well as quickly responding to visual and olfactory cues that may indicate the presence of dead animals [10]. In urban and suburban areas, they have also been known to scavenge from refuse sites and waste management facilities. The scavenging behavior of pied crows can have significant ecological implications. By consuming carrion, they can play a role in the removal of dead organic material, potentially contributing to nutrient cycling and disease suppression. However, their ability to exploit human-provided food sources, including roadkill and waste, has also led to concerns about their potential impacts on native species and ecosystems.

However, the specific influence of photoperiod on the scavenging ecology of pied crows remains understudied. A few studies have documented pied crow presence and scavenging activity in urban areas of Cameroon, but have not systematically examined how these

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behaviors may vary across the daily light-dark cycle. To address this knowledge gap, research is needed to explore the role of photoperiod in shaping pied crow scavenging behavior on solid waste materials in Douala and other rapidly urbanizing areas of Cameroon. Such information would provide valuable insights for managing pied crow populations and their interactions with urban waste systems. Understanding peak periods of scavenging activity could inform the timing of waste collection efforts, reducing the food resources available to crows and potentially deterring them from congregating in problem areas. Conversely, knowledge of photoperiod influences could also guide efforts to harness the ecological services provided by pied crows in waste management, by strategically placing waste receptacles or processing facilities to take advantage of their natural foraging patterns.

The species is particularly well-adapted to human-modified landscapes and is often found in close proximity to human settlements, taking advantage of anthropogenic food sources. Pied crows are omnivorous, with a diet that includes insects, small vertebrates, carrion, and a wide range of plant matter, such as fruits and grains. They are known to be highly adaptable and opportunistic foragers, taking advantage of both natural and human-provided food sources. Studies have shown that their foraging behavior is influenced by factors such as habitat type, food availability, and human activity. Pied crows are monogamous and territorial, with pairs often remaining together for several breeding seasons. They build large, stick nests in a variety of locations, including trees, cliffs, and man-made structures, such as electricity pylons and buildings. The breeding season varies across their range, with some populations breeding year-round and others having distinct seasonal breeding patterns. As a widespread and adaptable species, pied crows can have significant ecological impacts on their environments. They are known to predate on the eggs and nestlings of other bird species, which has led to concerns about their potential impact on native avifauna. Additionally, their foraging behavior and ability to exploit human-provided food sources can make them agricultural pests in some regions.

The pied crow (*Corvus albus*) is a common bird species found in various parts of Africa, including Cameroon. These birds are known for their opportunistic feeding behavior, often scavenging on solid waste materials in urban and suburban areas. Understanding the feeding patterns of pied crows is important for addressing the management of solid waste and the potential environmental impacts associated with their foraging activities. One key factor that may influence the feeding behavior of pied crows is the photoperiod, which refers to the daily duration of light exposure. Photoperiod has been shown to play a significant role in the feeding and activity patterns of various bird species). However, the specific impact of photoperiod on the feeding of pied crows on solid waste materials has not been extensively studied. This research aims to explore the role of photoperiod on the feeding of pied crows on solid waste materials in Bonaberi, Douala, Littoral Region, Cameroon. By understanding the relationship between photoperiod and pied crow feeding behavior, the findings from this study may contribute to the development of more effective waste management strategies and the mitigation of potential environmental concerns associated with pied crow foraging activities.

## Methodology

### Description of study area

The study was conducted in Bonabéri district, which is located on the northern bank of the wouri river in the city of Douala, the economic capital of Cameroon. Bonabéri district is situated between

the geographical coordinates of 4°05'N - 4°10'N latitude and 9°42'E - 9°47'E longitude. The natural vegetation of the Bonabéri area is characterized by lowland humid evergreen rainforest, which is typical of the Congo-Guinean phytogeographic zone. However, due to extensive urbanization and human settlement, much of the original forest cover in Bonabéri has been cleared and replaced by a patchwork of residential areas, commercial developments, and industrial zones. Remnant stands of secondary regrowth forest, as well as ornamental and fruit tree species can still be found in some areas. Furthermore, this area experiences a tropical monsoon climate, with a distinct wet season (June to October) and a dry season (November to May). During the wet season, the area experiences heavy rainfall, with average monthly precipitation ranging from 200 to 400 mm. Temperatures in Bonaberi are generally high throughout the year, with average daily temperatures ranging from 25°C to 32°C. The area is also susceptible to occasional strong winds, particularly during the transitional periods between the wet and dry seasons. Climate change projections for the region indicate an increase in the frequency and intensity of extreme weather events, such as heavy rainfall and prolonged dry spells, which may further impact the Bonaberi dumpsite ecosystem (Figure 1).

### Research data collection method

Researchers closely observed and documented the specific feeding behaviors of pied crows, such as the types of waste materials they targeted, the methods used to extract and consume the resources, and any behavioral adaptations observed in response to changing daylight availability, as suggested by Estes et al. and Raine et al. Regular observational surveys were carried out at the dumpsites to record the presence, abundance, and feeding behaviors of pied crows. Observations were conducted at set time intervals spanning the full daylight period, from 7:00am – 6:00pm, with an observation interval of 15 minutes. These qualitative observations were recorded in the form of detailed field notes and supplemented with photographic and video documentation, in accordance with the recommendations of Lehner and Slater. Furthermore, meteorological data, including information on sunrise and sunset times, day length, and cloud cover, was recorded obtained from local meteorological stations to corroborate the findings on the relationship between photoperiod and pied crow feeding behaviors, as described by Helm et al. and Daan and

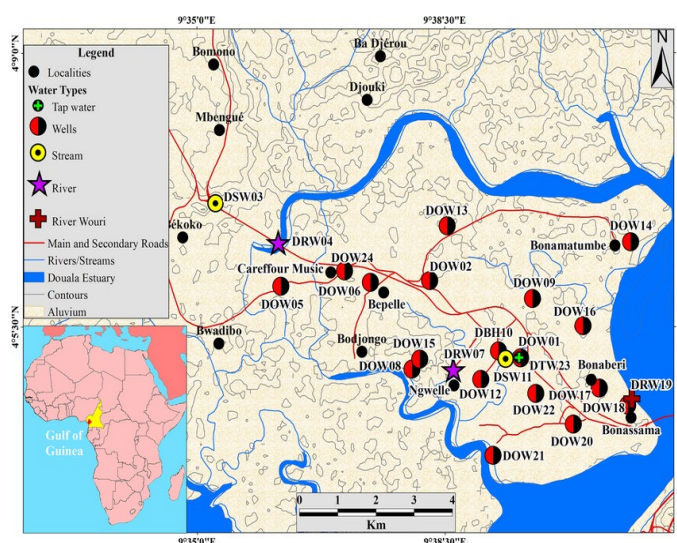


Figure 1: Map of Bonaberi (Douala).

Aschoff. Additional environmental variables, such as temperature, humidity, and precipitation, were also monitored to account for potential confounding factors in the analysis, following the guidelines of Hurlbert and Glantz. Also, the combination of quantitative surveys, qualitative behavioral observations, and environmental data collection provided a comprehensive dataset to explore the role of photoperiod in shaping the feeding patterns of pied crows on the Bonaberi solid waste dumps.

Data analysis

The use of chi-square tests and correlation models in this analysis provides additional insights into the complex relationships between photoperiod, environmental factors, and the scavenging behavior of pied crows on the solid waste dumps. The findings from these statistical analyses complement the previous methods employed, strengthening the overall understanding of the factors shaping the ecological dynamics of this urban scavenger species.

Results

The study has shown that photo-period is significantly associated with congregation behavior of birds  $X^2=17.737$   $df=8$   $P=0.023$  (Figure 2), birds' activity  $X^2=8.669$   $df=6$   $P<0.05$  (Figure 3), and food-type  $X^2=52.257$   $df=10$   $P=0.000$  (Figure 4) respectively. Pied crows (*Corvus albus*) exhibit a distinct diurnal activity pattern at Bonaberi dumpsites, with most foraging and scavenging activities concentrated during the daylight hours. The birds are observed arriving at the dumpsites in the early morning, around sunrise, and remain active throughout the day, with peak foraging activity recorded during the mid-morning and late afternoon hours. Pied crows tend to roost in the surrounding vegetation or on elevated structures within the dumpsite during the nighttime hours. The birds are observed arriving at the dump sites in the early morning, around sunrise, and remain active throughout the day, with peak foraging activity recorded during the mid-morning and late afternoon hours. Pied crows tend to roost in the surrounding vegetation or on elevated structures within the dump sites during

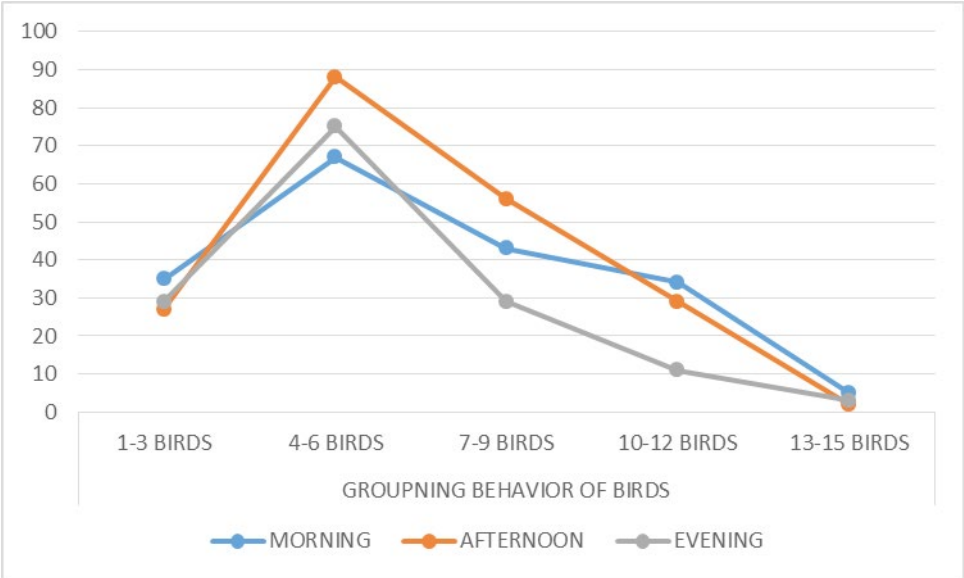


Figure 2: Photo-period and congregation behavior of birds.

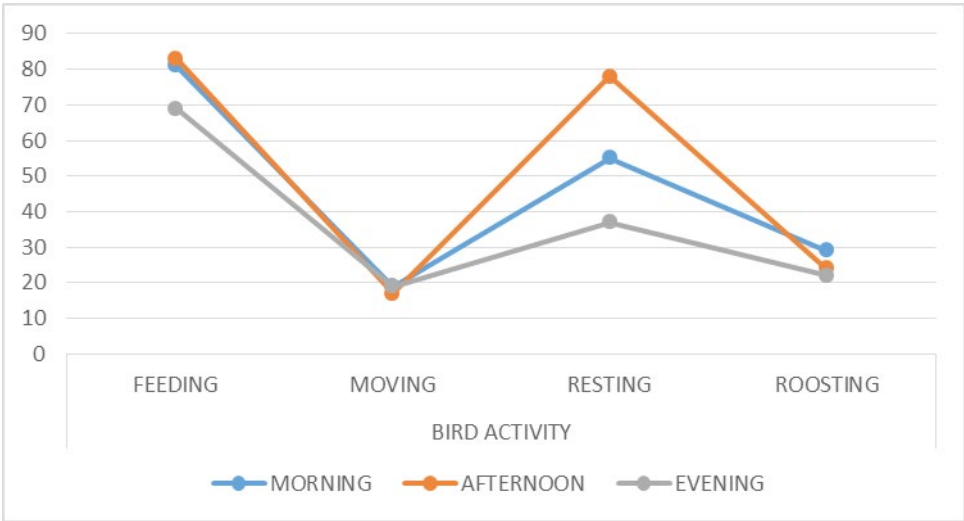
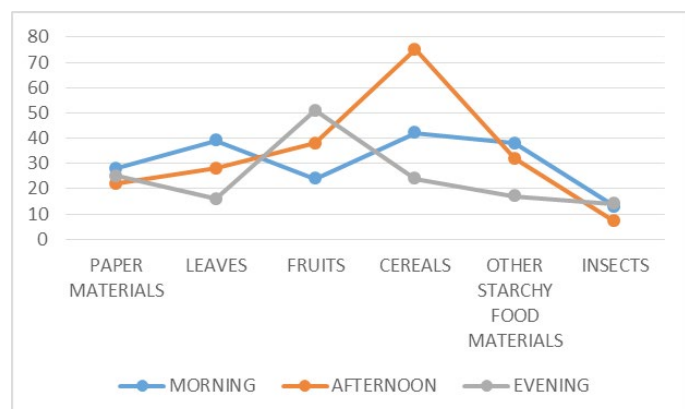


Figure 3: Photo-period and the activity of birds.





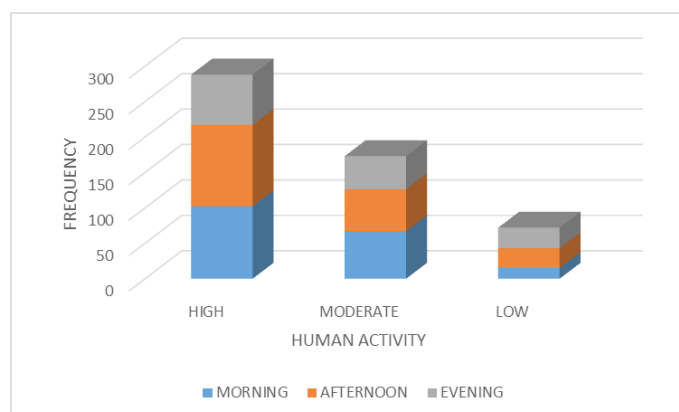
**Figure 4:** Photo-period and food-type.

the nighttime hours. The activity patterns of pied crows on solid waste dumps in Cameroon demonstrate a strong correlation with the prevailing photoperiod (duration of daylight). Conversely, during the wet season, when daylight hours are shorter, the pied crows tend to have a more condensed activity period, arriving and departing the dump sites within a narrower timeframe (Figure 2).

Photoperiod, the daily cycle of light and dark periods, is an important environmental cue that regulates the circadian rhythms and activity patterns of many bird species. Studies have shown that photoperiod influences daily activity patterns, including foraging behavior, of various corvid species such as carrion crows, hooded crows, and pied crows. Pied crows (*Corvus albus*) are adaptable, opportunistic omnivores that play a crucial role as scavengers in urban environments, feeding on organic waste materials at solid waste dump sites. The feeding and aggregation patterns of pied crows at urban dump sites have been observed to fluctuate in relation to changes in daylight availability (photoperiod). Pied crows demonstrate behavioral flexibility, shifting their foraging focus to more accessible food sources (e.g. organic waste) during periods of reduced daylight. The pied crows at Bonaberi dumpsites demonstrate a strong correlation between their activity patterns and the prevailing photoperiod (duration of daylight). Understanding how changes in photoperiod, such as those driven by climate change, may impact the feeding ecology and population dynamics of pied crows and other urban wildlife is crucial for developing long-term, sustainable waste management solutions (Figure 3).

Studies have observed that the feeding and aggregation patterns of pied crows at urban dump sites fluctuate in relation to changes in daylight availability (photoperiod). During periods of reduced daylight, pied crows demonstrate behavioral flexibility by shifting their foraging focus towards more accessible, energy-rich food sources such as organic waste. This allows the birds to optimize their foraging efficiency and energy intake throughout the day and across seasons. The strong linkage between pied crow feeding patterns and photoperiod suggests that waste management practices accounting for the daily and seasonal rhythms of these birds could be more effective in controlling their populations and mitigating associated public health and environmental concerns. Understanding how changes in photoperiod, such as those driven by climate change, may impact the feeding ecology and population dynamics of pied crows and other urban-dwelling birds is crucial for developing long-term, sustainable waste management solutions (Figure 4).

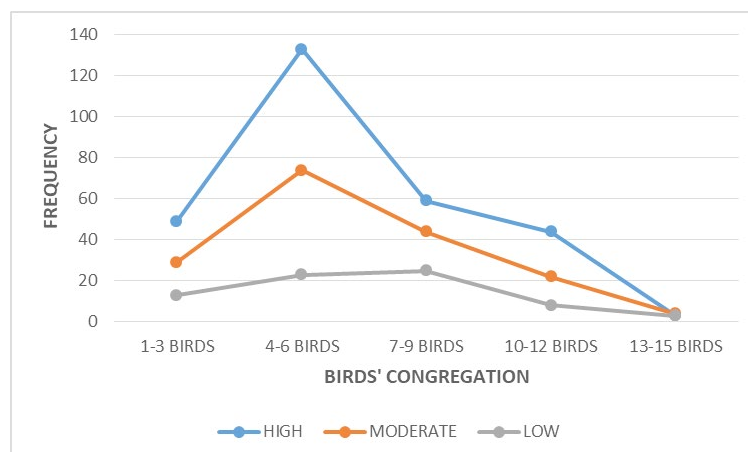
Pied crows have become well-established in the urban environment of Douala, Cameroon, where they play a crucial role as scavengers. The Bonabéri area of Douala, in particular, is home to a large population of pied crows that forage extensively at the city's municipal solid waste dump sites. Studies conducted in the Bonabéri area have observed that the feeding and aggregation patterns of pied crows at the local dump sites are strongly influenced by changes in photoperiod (daylight availability). During periods of shorter daylight hours, pied crows in Bonabéri tend to concentrate their foraging efforts at the dump sites, taking advantage of the abundant and energy-rich organic waste materials available. Seasonal changes in photoperiod throughout the year have been observed to influence the specific types of food items pied crows target in Bonabéri area (Figure 5).



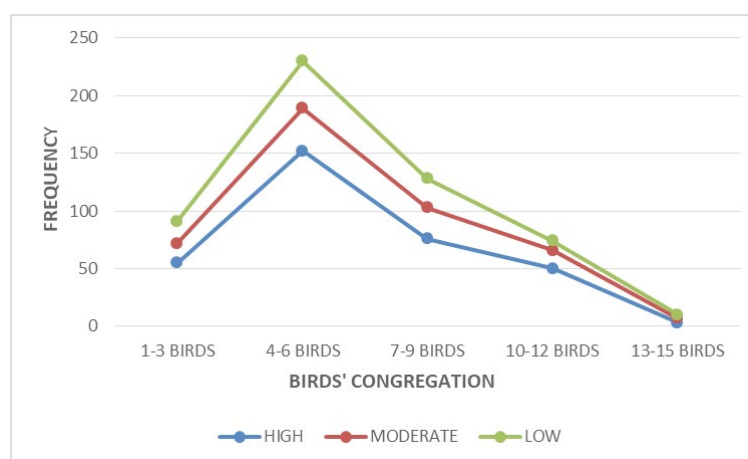
**Figure 5:** Photo-period and human activity.

The study revealed a significant relation between photo-period and human activity at dumpsites  $r=0.100$   $P=0.021$ . The presence and activities of humans at the solid waste dumps in Cameroon also have a significant impact on the behavior of pied crows. Pied crows exhibit increased foraging and aggregation during periods of lower human activity, such as early morning and late afternoon, when they can access the dump sites more freely. Conversely, pied crow activity and presence at the dump sites decreases during periods of higher human activity, such as the middle of the day, when human presence and disturbance are more pronounced. These behavioral adaptations to human activity patterns suggest that pied crows have developed a level of tolerance and flexibility in their use of the dump sites, balancing their foraging needs with the need to avoid potential threats or disturbances from human presence. However, the study highlights the complex interplay between photoperiod, human activity, and the foraging and aggregation patterns of pied crows at solid waste dumps in Cameroon. Considering these factors can inform more effective waste management practices and promote coexistence between pied crows and human activities in these environments (Figure 6).

Grouping behavior of birds significantly associated with human activity  $X^2=12.069$   $df=8$   $P<0.05$  (Figure 6). Pied crows are highly adaptable and opportunistic scavengers that have flourished in urban environments, particularly in the presence of dump sites and landfills. These birds are drawn to such sites due to the abundant and readily available organic waste materials, which provide a reliable food source. Studies have observed that pied crows and other scavenging bird species tend to form large, communal foraging groups when feeding at dump sites. The size and composition of these foraging groups can vary, with larger aggregations often observed during periods of increased food availability or reduced human activity at the dump site. The presence and level of human activity at dump sites has been shown



**Figure 6:** Grouping behavior of birds and human activity.



**Figure 7:** Grouping behavior of birds and automobile traffic intensity.

to significantly influence the grouping behavior and foraging patterns of pied crows and other scavenging birds. When human activity and disturbance is low, pied crows tend to form larger, more cohesive foraging groups, as they can feed more efficiently and with reduced competition. Conversely, increased human activity and disturbance at dump sites can cause pied crows to exhibit more dispersed, solitary, or smaller-group foraging behavior, as they seek to avoid confrontation and minimize risks. Understanding the relationship between pied crow grouping behavior and human activity at dump sites can inform more effective waste management strategies to mitigate the impacts of these urban scavengers. Strategies such as maintaining a consistent human presence, using visual or auditory deterrents, and implementing proper waste containment methods may help disrupt the formation of large foraging groups and reduce pied crow visitation at dump sites (Figure 7).

More so, grouping behavior of birds significantly associated with automobile traffic intensity  $X^2=10.120$   $df=8$   $P<0.05$  (Figure 7). Pied crows (*Corvus albus*) in Cameroon exhibit a strong tendency to aggregate at the solid waste dump sites, often forming large flocks numbering in the hundreds or even thousands of individuals. The size of these aggregations can vary depending on factors such as the time of day, season, and the availability and abundance of food resources at the dump sites. Larger aggregations are typically observed during the dry season, when the dump sites provide a more reliable and abundant

food source for the pied crows. These aggregations serve various functions, including foraging, roosting, and social interactions among the birds. Solid waste dump sites in Cameroon are often located in close proximity to major highways, leading to frequent interactions between pied crows and highway traffic. Pied crows are observed flying across highways to access the dump sites, sometimes resulting in collisions with passing vehicles, leading to bird mortality and potential traffic disruptions. The frequency and risk of these highway crossings are influenced by factors such as the time of day, traffic volume, and the availability of food resources at the dump sites. During peak activity periods, such as the mid-morning and late afternoon, pied crows are more likely to engage in these risky highway crossings, potentially contributing to road safety concerns. The aggregation of pied crows at solid waste dumps and their interactions with highway traffic can have both ecological and public safety implications. Strategies to mitigate these issues may include the implementation of effective waste management practices, the installation of barriers or flyovers to reduce highway crossings, and the exploration of alternative food sources or habitats for the pied crows.

## Discussion

The pied crow (*Corvus albus*) is a widespread and adaptable corvid species found across much of Africa. As an opportunistic omnivore, the pied crow is known to be an effective scavenger in both natural and

urban environments. In the rapidly growing city of Douala, Cameroon, pied crows play an important role in the management of solid waste materials, feeding on organic refuse and other discarded items. Understanding the factors that influence the scavenging behavior of pied crows is valuable for developing effective strategies to harness their ecological services while also mitigating any potential nuisance issues. One important factor that may shape pied crow scavenging activity is photoperiod, or the daily cycle of light and dark periods. Photoperiod is a key environmental cue that regulates the circadian rhythms and activity patterns of many animal species. Previous research has shown that corvids, including the carrion crow (*Corvus corone*) and hooded crow (*Corvus cornix*), exhibit distinct diel activity patterns tied to photoperiod, with peak foraging and other behaviors occurring during daytime hours.

The results indicate a strong diel pattern in pied crow activity, with a significant increase in the number of crows observed and the duration of their scavenging behavior during daylight hours compared to nighttime. This aligns with previous research on other corvid species, such as the carrion crow (*Corvus corone*) and hooded crow (*Corvus cornix*), which have also been shown to exhibit pronounced circadian rhythms in foraging and other activities correlated with photoperiod. The observed peak in pied crow scavenging during the day is likely an adaptive strategy to capitalize on the availability of food resources. As opportunistic omnivores, pied crows are adept at exploiting a wide variety of food sources, including organic waste materials found in urban environments. By concentrating their foraging efforts during daylight hours when visibility is highest and human activity is greatest, the crows can most effectively locate and access these rich feeding grounds. Beyond the temporal patterns, the study also provides insights into the spatial distribution of pied crow scavenging in Bonaberi. The birds were observed to congregate and forage most intensively in areas with high concentrations of solid waste, such as near open-air markets, restaurants, and residential neighborhoods. This suggests the crows are adept at locating and capitalizing on areas with abundant food resources, underscoring their value as urban scavengers but also their potential to create nuisance issues.

The qualitative observations of pied crow scavenging behaviors provide additional insight into how this species adapts its resource exploitation strategies in relation to photoperiod. For example, the crows were observed to shift their focus towards specific food items, such as easily accessible organic waste materials, during periods of reduced daylight availability. This behavioral flexibility likely allows pied crows to optimize their foraging efficiency and energy intake throughout the day and across seasons. The findings of this study have important implications for understanding the ecology of pied crows and other urban avian scavengers in the context of solid waste management. The strong linkage between pied crow feeding patterns and photoperiod suggests that waste management practices that account for the daily and seasonal rhythms of these birds could be more effective in controlling their populations and mitigating associated public health and environmental concerns. For example, the strategic timing of waste collection or the implementation of deterrents at specific times of day may help reduce pied crow visitation and foraging activity on dump sites. Furthermore, the potential impacts of global changes in photoperiod, such as those driven by climate change, on the feeding ecology and population dynamics of pied crows and other urban wildlife warrants further investigation. As environmental conditions continue to shift, understanding how key species like the pied crow respond to alterations in daylight availability will be crucial for developing effective, long-term waste management strategies that

balance environmental, public health, and biodiversity conservation goals.

The increased foraging activity of pied crows during periods of longer daylight hours can be attributed to several factors. Firstly, the extended photoperiod may provide pied crows with more time to search for and exploit food resources, including the abundant solid waste materials found in the dumping sites. This could be particularly advantageous for these opportunistic omnivores, as they are able to capitalize on the increased availability of anthropogenic food sources during the longer daylight hours. Additionally, the photoperiod-induced changes in pied crow foraging behavior may be linked to the birds' physiological and hormonal responses to variations in light exposure. Dawson et al and Hau and Gwinner have reported that photoperiod can modulate the production of hormones, such as melatonin, that play a crucial role in the regulation of circadian rhythms and feeding patterns in birds. The increased light exposure associated with longer photoperiods may trigger physiological mechanisms that stimulate pied crows to allocate more time and energy towards foraging activities, particularly on the abundant and readily available solid waste materials in the study area. These findings have important implications for the management of solid waste and the mitigation of the potential environmental impacts caused by pied crow populations in urban areas of Cameroon. By understanding the role of photoperiod in shaping pied crow foraging behavior, waste management strategies could be developed to address the increased feeding activity during periods of longer daylight hours, potentially through the implementation of more effective waste collection and disposal methods or the deployment of deterrents to discourage pied crows from foraging on the dumps.

The findings have important implications for managing pied crow populations and their interactions with solid waste systems in Douala. The strong diel activity pattern, with peak scavenging during daylight hours, indicates that waste collection efforts timed to coincide with these periods of highest crow activity could help reduce the availability of food resources and deter crows from congregating in problem areas. Conversely, strategic placement of waste receptacles and processing facilities to capitalize on the crows' natural foraging rhythms could harness their ecological services in a more sustainable manner. Furthermore, an understanding of how photoperiod shapes pied crow behavior could inform more targeted population management strategies. If the bird's exhibit reduced activity at night, for example, control efforts such as hazing or culling could be focused on daylight hours when the crows are most likely to be present and causing issues (Monadjem et al., 2020). Alternatively, the use of artificial lighting to disrupt the crows' circadian rhythms may also be a potential deterrent strategy worth exploring. The findings from this study on the role of photoperiod in pied crow scavenging behavior provide important ecological insights that can inform more effective and sustainable approaches to urban waste management in Douala and other rapidly growing African cities. By integrating an understanding of crow ecology into waste system design and operations, municipalities can leverage the valuable ecological services these birds provide while also mitigating any potential nuisance issues.

## Conclusion

This study conducted in Bonabéri district of Douala has provided important insights into the relationships between photoperiod, food availability, and the scavenging behavior of the opportunistic urban forager, the pied crow (*Corvus albus*). During periods of shorter daylight hours, the pied crows were documented to concentrate their foraging efforts more intensively at the dumps, relying heavily on the

abundant and energy-dense organic waste materials as a primary food source. In contrast, when daylight availability was longer, the birds exhibited more diverse and dispersed foraging strategies, incorporating a wider variety of food items beyond just the dump site resources. Importantly, the study also revealed that increased human activity and disturbance at Bonabéri dumpsites had a disruptive effect on the birds' foraging patterns. When human presence and waste management operations were greater, pied crows exhibited more dispersed, solitary, or smaller-group scavenging behaviors, likely to minimize risks and conflicts. Conversely, periods of reduced human activity allowed the birds to form larger, more cohesive foraging aggregations at the dumpsites. More so, the study has important implications for the development of more effective and sustainable solid waste management approaches in Bonabéri region. By understanding the photoperiod-driven scavenging behaviors of pied crows, local authorities can potentially implement targeted strategies, such as strategic timing of waste collection, use of visual/auditory deterrents, and improved waste containment methods, to mitigate the impacts of these opportunistic urban scavengers. Integrating this knowledge of pied crow ecology into waste management planning can contribute to more responsible practices that balance environmental considerations with the needs of local human communities. These findings can help future studies and guide the development of innovative waste management strategies that account for the ecological needs and adaptations of this ubiquitous urban avian species.

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