DOI: 10.2436/20.8100.01.36 Revista Catalana d'Ornitologia 38:18-29, 2022

Intra- and interspecific kleptoparasitism in the American Black Vulture *Coragyps atratus* (Aves: Cathartidae) in a garbage dump in Ecuador

Enrique Richard[1], Denise Ilcen Contreras Zapata[2] & Fabio Angeoletto[3]

Kleptoparasitism is recognized as an important ethological feeding strategy that enables many animals to feed on a limited resource. Research on avian scavengers is significant because their consumption of carrion and food discarded by humans helps reduce foci of infection due to animals that die from disease, thereby preventing the spread of infection through the ecosystem. Scavenging birds provide key environmental and hygienic services valued at billions of dollars and here we document, analyze, and discuss the first cases of inter- and intraspecific kleptoparasitism reported in the American Black Vulture *Coragyps atratus* within the context of Calceta garbage dump (Manabí, Ecuador). The sampling work was documented with photos and videos over a period of 69 hours. A total of 48 events of intraspecific kleptoparasitism and 19 of interspecific kleptoparasitism were recorded. The intraspecific kleptoparasitism was triggered by the discharge of large amounts of waste from trucks, while the interspecific kleptoparasitism occurred when the Black Vultures took advantage of domestic dogs and their olfactory abilities to accurately locate food and then steal it. The efficiency of interspecific kleptoparasitism indicates that cooperative groups with more vultures are more likely to succeed in obtaining food. The data suggest that there is an optimal size beyond which larger group sizes will begin to incur foraging costs. This acquired behavior shows a high tolerance to anthropogenic conditions and illustrates the great adaptive phenotypic plasticity of this species.

Key words: anthropogenic ecosystems, feeding behavior, trophic efficiency, plastic intake, dogs.

[1*] Carrera de Medicina, Universidad San Gregorio de Portoviejo, Manabí, Ecuador. Orcid: 0000-0002-0061-7807.

[2] Carrera de Medicina, Universidad San Gregorio de Portoviejo, Manabí, Ecuador. Candidata a Doctor en Ciencias Pedagógicas por la Universidad Andina Simón Bolívar, Bolivia. Email: dennycz@gmail.com. Orcid: 0000-0001-7912-7095.

[3] Maestría en Geografía, Universidad Federal de Mato Grosso, Mato Grosso. Brazil. Email: fabio_angeoletto@yahoo.es. Orcid: 0000-0002-3084-3928.

* Corresponding author: chelonos@gmail.com

Received: 19.01.21; Accepted: 29.09.22 / Edited by J. Quesada

Humans are exponentially producing large amounts of waste that is discarded as garbage, thereby generating anthropogenic ecosystems with their own identity (Moleón *et al.* 2014, de Araujo *et al.* 2018, Noreen & Sultan 2021). Part of this waste contains organic material originating from domestic food discarded by humans (Parfitt *et al.* 2010), although there is also a large proportion of inorganic elements such as metal, glass, ceramics, and crockery, and synthetic material including pieces of cloth, medicines, rubber, and hard and soft plastic (Barnes *et al.* 2009).

Various species of scavenging birds use garbage dumps around the world as a source of food (Moleón *et al.* 2014, Ballejo *et al.* 2021, Noreen & Sultan 2021, Richard *et al.* 2021). According to a number of authors (Parfitt *et al.*

2010, Oro *et al.* 2013, Moleón *et al.* 2014, Noreen & Sultan 2021), dumps have historically played an important role in the maintenance and flourishing of populations of scavenger species. However, in more recent times the change in the constitution of dumped waste, characterized today by an exponential increase in plastics and other anthropogenic materials (heavy metals, biocides, drug residues, etc.), is leading to increased mortality in scavenger species (Ogada *et al.* 2012, Moleón *et al.* 2014, Buechley & Şekercioğlu 2016, Plaza & Lambertucci 2017, Noreen & Sultan 2021).

Studies of the trophic ecology of Cathartidae at garbage dumps are relatively new in the literature (Íñigo 1987, Houston *et al.* 2007, Kelly *et al.* 2007, Lambertucci *et al.* 2009, Ballejo & De Santis 2013, Noreen & Sultan 2021, Richard *et al.* 2021) and less frequent still is work on the ethology of the species that frequent these sites (Sazima 2007, 2010).

Due to its great affinity and tolerance of humans in urban and rural ecosystems, the American Black Vulture *Coragyps atratus* (Aves: *Cathartidae*) (hereafter Black Vulture) is regarded as a scavenger species (Ridgely & Greenfield 2001, Ballejo & de Santis 2013). It is also opportunistic (Ballejo & de Santis 2013, Ballejo *et al.* 2021) and/or an exploiter of urban ecosystems, and has winning etho-ecological characteristics (Carrete *et al.* 2010, Gangoso *et al.* 2013, Luna *et al.* 2021). As a result, this species has a very wide trophic spectrum, which in anthropogenic environments can include non-biological materials generated by human activities (Íñigo 1987, Kelly *et al.* 2007, Ballejo & de Santis 2013, Ballejo *et al.* 2021, Carlin *et al.* 2020). In this context, kleptoparasitism, i.e. the deliberate theft by an animal of food previously captured or taken by another individual of the same or different species (Brockmann & Barnard 1979, Furness 1987, Iyengar 2008), is relatively uncommon in birds and has been documented above all in seabirds (Brockmann & Barnard 1979, Shealer *et al.* 2005, Morand-Ferron *et al.* 2007, García 2010, Noreen & Sultan 2021). Although it has been observed in African vultures (*Accipitridae*), Cattle Egrets *Bubulcus ibis* and other species (Brockmann & Barnard 1979, Morand-Ferron *et al.* 2007), to date it has not been documented in *C. atratus*.

Kleptoparasitism is recognized as an important ethological feeding strategy by which many animals can obtain otherwise limited resources (Giraldeau & Caraco 2000, Morand-Ferron *et al.* 2007, García 2010). The individual that steals reduces the metabolic cost associated with foraging by using the energy invested by another (the same or different species) (Thompson 1986). This theft gives the thief a clear advantage since it obtains quality food (prey, carrion, etc.) relatively easily. This should motivate the development of skills either individually or specifically in kleptoparasites at the same time as the affected species will learn to avoid scavengers (Gochfeld & Burger 1981, Morand-Ferron *et al.* 2007, Yosef *et al.* 2012).

Studies of scavenging birds are important because, due to their consumption of carrion and food discarded by humans, they reduce the foci of infection originating from animals that die of disease, thereby preventing these infections from spreading through the ecosystem (Moleón *et al.* 2014, Plaza & Lambertucci 2018, Plaza *et al.* 2019, 2020, Noreen & Sultan 2021). As such they provide important environmental and hygienic services valued at billions of dollars (Markandya *et al.* 2008, Moleón *et al.* 2014).

Hence, a number of authors (Gangoso *et al.* 2012, Moleon *et al.* 2014, Plaza & Lambertucci 2017, Plaza *et al.* 2019; Noreen & Sultan 2021, Richard *et al.* in press) have highlighted the relevance (ecological, environmental, sanitation, etc.) of studies of the roles played by these species at waste dumps, above all in terms of their natural history and interactions with biodiversity.

This contribution documents, analyzes and discusses the first cases of inter- and intraspecific kleptoparasitism in *C. atratus* within the context of a garbage dump in Calceta, Ecuador.

Material and methods

The study area was the Calceta municipal waste dump located on the Tosagua-Calceta road, El Mirador area, Manabí Province, Bolívar Canton, Ecuador, 0°50'55.5"S 80°13'30.8"W. The site is owned by the municipality and covers a total area of 9.34 ha, although the area used as a waste dump only covers 4.2 ha (La Torre 2014).

The study area was visited four days a week (Tuesday to Friday) for two full months (15 January 2019 to 15 March 2019). A total of 69 hs. of accumulated observations was obtained.

For the focal sampling (Martín & Bateson 1993) of the individuals implicated in the group kleptoparasitism events, the number of individuals involved was counted. In the case of interspecific group kleptoparasitism, linear and a quadratic models were applied to estimate the best fit for the number of successful individuals as a function of group size (number of individuals in the entire group). For this, PAST software was used (Hammer *et al.* 2001).

The authors' main aim when studying this garbage dump was the incidental consumption of plastic by *C. atratus* (Richard *et al.* 2021) and the observations of kleptoparasitism were not the main focus. As such, given the hours dedicated to the observations included in this report and the time available to the authors (mostly in the mornings), we believe that the kleptoparasitism events documented and analyzed here in fact underestimate the frequency of occurrence of this practice.

For these reasons, it was not possible to mark the specimens involved in the interspecific group kleptoparasitism events. Therefore, the results expressed here refer to the efficiency of the *C. atratus* groups in terms only of the number of participating and successful individuals. We did not take into consideration whether groups were always made up of the same individuals or whether individuals also participate in other groups and other activities derived from these situations.

The monitoring of the vultures was carried out with Zenit 12 x 50 binoculars and documented with a Nikon S9700® camera with built-in satellite GPS.

Results

The garbage dump is home to a large number of Black Vultures that can be seen both in flight and on the ground in the dump in association with other birds such as the Cattle Egret, Smooth-

Figure 1. The arrival of the trucks unleashes a frenzy of Black Vultures that pounce on the recently unloaded bags and show a great tolerance to human beings. Photo: E.Richard.
L'arribada dels camions desferma el frenesí dels zopilots que es llancen sobre les bosses recentment descarregades i mostren gran tolerància a l'home. Foto E.Richard.

Figure 2. Intraspecific kleptoparasitism between two Black Vultures. Circle: the Black Vulture at the bottom finds food and the vulture at the top pounces and steals it from its beak. Photo: E.Richard.
Cleptoparasitisme intraespecífic entre dos zopilots. Cercle: l'exemplar de baix va trobar menjar i el de dalt de la imatge es va llançar per treure-li de la boca. Foto: E.Richard.

billed Ani *Crotophaga ani* and Domestic Pigeon *Columba livia*. On four occasions during the study period a few Turkey Vultures *Cathartes aura* were also seen but only ever in small numbers (1–3).

During the study period, a total of 48 intraspecific and 19 interspecific kleptoparasitism events were recorded. In the first type of kleptoparasitism, 68.75% of cases (n = 33) were triggered by the arrival and subsequent unloading of garbage trucks (Fig. 1). The Black Vultures would pounce on the unloaded bags and a frenzy of intraspecific aggression would be unleashed. The Black Vulture closest to the one that found the food would attack the finder and try to grab

Figure 3. Intraspecific kleptoparasitism between two Black Vultures (afterwards two more joined in the struggle). Circle: the bottom vulture finds food (apparently a gut) and another Black Vulture pounces on it from the air and steals it from its beak. Photo: E.Richard.
Cleptoparasitisme intraespecífic entre dos zopilots (després dos més es van afegir al forcejament). Cercle: l'exemplar de baix va trobar menjar,pel que sembla una tripa i un altre voltor s'hi va llançar des de l'aire per a treure-li de la boca. Foto: E.Richard.

Figure 4. Interspecific kleptoparasitism. Top left: Group of Black Vultures actively following a dog. Top right and bottom left: The dog seems to find food and the group of Black Vultures begins to circle around it. Bottom right: One of the Black Vultures about to snatch the food found by the dog. Photo: E.Richard.
Cleptoparasitisme interespecífic. Dalt a l'esquerra: Grup de zopilots en seguimient actiu a un gos. Dalt a la dreta i baix a l'esquerra: el gos pel que sembla troba menjar i el grup de zopilots tanca un cercle al seu voltant. Baix a la dreta: un dels zopilots preparat per robar-li el menjar acabat de trobar pel gos. Foto: E.Richard.

the bag, thereby releasing the food (n = 21, Fig. 2). Other birds would observe the forager from a distance and then attack swiftly from the air or along the ground (n = 12, Fig. 3).

In the other 31.25% cases (n = 15) numerous groups of individuals of the species perched on top of the garbage bags in the waste dump would undertake search behavior involving walking and pecking at bags, apparently at random, while others remained expectant and almost motionless observing the former. If the immobile individuals observed that one of the active birds had found something, they pounced on the active bird to steal the food, generally from its bill. This strategy was not always successful (33.3% success, n = 5).

A total of 19 events assignable to group and cooperative interspecific kleptoparasitism were also recorded. All of them (100%, n = 19) involved the domestic dogs *Canis lupus familiaris* that feed in this dump as the parasitized host species. In this case, groups of 9–17 (minimum and maximum observed) Black Vultures would actively accompany the dogs (walking behind them) and as soon as the dog stopped to smell a bag, the Black Vultures would surround it and begin to close in on the dog until they were almost touching it (Fig. 4). If the dog found food, the Black Vultures would pounce and try to grab it for all the individuals in the group, although not always successfully (Table 1, Fig. 5), as some dogs would respond aggressively and attack the vultures. In any case, the kleptoparasitism observed in all cases (n = 19, n = 17 complete observed events) can be divided into the times in which all individuals or only some individuals were successful. The results show a positive relationship between group size and the number of successful individuals (Fig. 5). There is a better fit in a quadratic relationship (R^2=0.69; $p<0.001$; AIC=19.09) than in a linear one (R^2=0.59; $p<0.001$; AIC=20.83), which suggests that there is a point at which the group size does not imply a greater number of successful individuals, the difference between models regarding the value of AIC<2. (Table 1, Fig. 5).

Table 1. Cooperative interspecific kleptoparasitism detailed by event showing the number of events, the date and time of each event, the number of individuals (No. of i) of Black Vultures involved, and the efficiency ratio of the number of individuals vs. their success (modified Furness Formula 1987). Finally, the percentage of successful individuals (GE) of the cooperative group is recorded (i.e. those who manage to obtain food from the dogs). Event = Focal sampling; No. of i = Number of Black Vultures participating in the group action**;** Efficiency Nr. i./Success i. (Eff/succ) No. individuals that forms the group/ No. of individuals who managed to obtain food; Group efficiency (%) = Percentage of individuals who managed to obtain food
Cleptoparasitisme interespecífic cooperatiu detallat per esdeveniment. Es consigna el número d'esdeveniment, la data i hora, el nombre d'individus (N⁰ of i) de zopilots participants i la relació eficiència del nombre d'individus vs l'èxit obtingut (Fórmula de Furness 1987 modificada). Finalment, es consigna el percentatge d'individus exitosos (EG) del grup cooperatiu (els que assoleixen l'objectiu d'obtenir menjar del gos). Event =Número de mostra; No. of i = Nombre de zopilots que participen en el grup; Efficiency Nr. i./Success i. (Eff/succ) Nombre d'individus que formen el grup/ Nombre d'individus que intenten obtenir menjar; Group efficiency (%) = Percentatge d'individus que intenten obtenir menjar.

Event No.	Date/hour	No. of i	Efficiency Nr. i./ Success i. (Eff/succ)	Group efficiency %
1	16/01/2019, 11:05	13	13/5 = 2.6	38 %
2	17/01/2019, 12:15	9	9/2 = 4.5	22 %
3	18/01/2019, 09:11	11	11/5 = 2.2	45 %
4	22/01/2019, 09:05	12	12/5 = 2.4	42 %
5	23/01/2019, 09:25	15	15/7 = 2.14	47 %
6	24/01/2019, 11:05	15	15/9 = 1.66	60 %
7	29/01/2019, 09:33	17	17/7 = 2.4	41 %
8	05/02/2019, 08:45	14	14/6 = 2.33	43 %
9	06/02/2019, 09:55	10	10/5 = 2	50 %
10	11/02/2019, 12:45	11	11/6 = 1.8	55 %
11	19/02/2019, 10:45	12	12/? (At least 3)	¿?
12	22/02/2019, 11:28	15	15/7 = 2.14	47 %
13	27/02/2019, 11:20	11	11/6 = 1.8	55 %
14	01/03/2019, 11:10	14	14/8 = 1.75	57 %
15	05/03/2019, 11:22	15	15/8 = 1.87	53 %
16	06/03/2019, 11:40	11	11/6 = 1.8	55 %
17	07/03/2019, 11:54	15	15/7 = 2.14	47 %
18	09/03/2019, 12:00	12	12/? (At least 3)	¿?
19	12/03/2019, 11:18	16	16/7 = 2.2	44 %
Average group efficiency (over 17 complete observed events)				
Mean		13.17	2.08	47.3%
Max-Min		9.00-16.00	1.66-4.50	22.0-60.0 %

Some of the dogs that responded less aggressively to the Black Vultures when attacked were followed by larger groups of vultures than others (E.R. pers. obs.).

Discussion

In the case of the recorded intraspecific kleptoparasitism events, in both the described strategies the attacker does not always succeed in stealing the food. However, due to the sheer number of Black Vultures that pounce on the unloaded waste, in many cases we were unable to observe the whole sequence and so verify whether the attack was successful or not. Therefore, these cases were not considered within the events described and are not analyzed herein. The Black Vulture is a gregarious species (Spina & Silveira 2019), probably due to the inherent

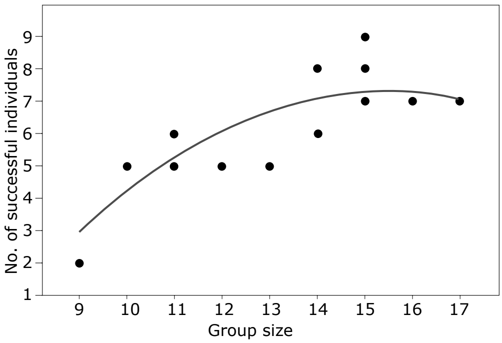

Figure 5. Efficiency ratio of the number of individuals in the group vs. their success. Values 11 and 18 (Table 1) were excluded from the graph due to lack of certainty regarding the number of successful individuals. *Relació d'eficiencia del nombre d'individus que formen el grup vs l'éxit obtingut. La gráfica només inclou els 17 valors corresponents a seqüències d'observació completes. Els valors 11 i 18 (Taula 1) es van excloure per falta de certesa en el nombre d'individus exitosos.*

vulnerability of consuming prey on the ground for relatively long periods of time. Therefore, being part of a group is an adaptive advantage against predators and/or competitors (Carrete *et al.* 2010, Richard *et al.* in press). Against possible predators, the effect of dissolution and confusion gives the individual greater chances of survival (Senar 1994), although in the case of the Black Vulture no natural predators are known (Spina & Silveira 2019). Likewise, participation in monospecific and heterospecific flocks (together with *C. aura* and *Fregata magnificens* in the study area; E.R. per. obs.) also affords Black Vultures an advantage when searching food, among other benefits.

Other studies (Caraco 1979, Senar 1994) of gregarious birds suggest that the size of the group influences the efficiency of the food search. Although the amount of food ingested on a daily basis does not vary due to living in groups, the variance in the amount of food eaten between days does, and from the point of view of the economy of the individual bird this is much more important than the average. In this sense, the average is affected by the fact that animals in a group fight more and waste more time interacting with other individuals (Senar 1994). Agonistic behavior is thus an emerging characteristic of group coexistence and well known to occur in the Black Vulture (Spina & Silveira 2019). Such behavior is supposed to be a drawback to gregarious lifestyles since the time devoted to aggression is time wasted that cannot be used to search for food (Senar 1994). However, the intraspecific kleptoparasitism observed here could be considered as an expression of agonistic behavior that is also consistent with gregariousness. Thus, aggression would optimize the efficiency in obtaining food within the group.

The effect of gregariousness and its costs is more clearly observed in interspecific kleptoparasitism. Our results show that beyond a certain group size, foraging efficiency is negatively affected, probably due to the costs of group size. From ~15 individuals, the data suggest that the number of individuals stabilizes and as the group grows in size its efficiency decreases in line with optimal foraging models (Caraco 1979, Giraldeau & Caraco 2018). Unfortunately, our data did not capture this part of the variance, which indicates the need for more study of this question.

The differential tracking of some dogs to the detriment of others by the Black Vultures due to their aggressiveness suggests the existence of acquired/learned group phenotypic behavior in this avian scavenger that has emerged from this particular anthropogenic context. Thus, the groups of Black Vultures that are able to recognize the meekest or the most permissive dogs will have an advantage in the efficiency of kleptoparasitism, although this aspect still requires experimental validity.

However, we were unable to mark individuals and so underlying questions remain: do the groups participating in cooperative kleptoparasitism contain the same individuals? Do the groups form randomly based on the possibilities of success of the kleptoparasitism? What kinds of ties in addition to kleptoparasitism exist between individuals? Are there individuals in the population with a tendency to form kleptoparasitic groups and others that feed on a more individual basis? Do members who join a group for one event join another group for another event? Is there a kind of natural selection favoring kleptoparasitism in this ecosystem? Many more questions remain, which will undoubtedly motivate future experiments aimed at clarifying the issues they raise.

The Black Vulture is apparently not attracted to (or does not perceive) the smell of carrion and will not approach carrion in the absence of visual cues (Grigg *et al.* 2017). Sazima (2007) showed that this species is attracted to garbage or market bags as part of behavior that associates these bags with food (even if they do not contain food). The specimens of Black Vultures observed by Sazima (2007) approach and break open the bags, even though there is only newspaper inside, thereby demonstrating that it is not smell that guides them towards the food; rather, there is clear associative learning in relation to food and plastic bags. All this contributes to explain the behavior of interspecific kleptoparasitism observed here. Although the garbage dump is literally a great island of food for these birds, it is no less true that not all bags in this ocean of bags contain food. In this study, at least part of the population of the vultures from the dump used dogs to find food and therefore practice cooperative interspecific kleptoparasitism to achieve greater food-finding efficiency.

Therefore, it makes sense to follow dogs to find new food sources given their highly developed sense of smell (Lord 2012). Black Vultures use dogs to locate food and then steal it from them. This tracking and use of other species by these vultures to locate food sources has precedents. Groups of Black Vultures have been observed following groups of Turkey Vulture (sympatric in much of its distribution) at higher altitudes, the latter a species whose sense of smell allows it to detect prey even when buried (Stager 1964, Buckley 1996, Grigg *et al.* 2017). When carrion is located by Turkey Vultures, individuals of Black Vultures descend and when the group is large enough they displace the Turkeys (Grigg *et al.* 2017). Similarly, Carrete *et al.* (2010) indicate that in areas of sympatry with the Andean Condor *Vultur gryphus* in Patagonia (Argentina), Black Vultures access a higher proportion of carrion on flat terrain when they occur in large groups and compete successfully with the condor at corpses. This form of competition could also be considered a subtle form of cooperative group kleptoparasitism (Brockmann & Barnard 1979, Morand-Ferron *et al* 2007) and illustrates the great adaptive plasticity of Black Vultures in different contexts, ecosystems and situations.

All this suggests that, in the absence of a developed sense of smell, the monitoring of other species that can smell helps locate new food sources and that the accumulation of individuals also helps to deter the species that follow and/or steal their food.

In this study, apart from the kleptoparasitism of Black Vultures with dogs as hosts, no other interaction was observed between these two species. However, Sazima (2010) reports for this species grooming behavior towards a dog on the beaches of São Paulo (Brazil), the second such report of this behavior in Black Vultures with mammals (Sazima 2010). In our study, even despite the relative abundance of dogs in the garbage dump, this interesting behavior was not observed. This was probably due to the context of the waste dump in which Black Vultures would prioritize the use of dogs' sense of smell to find food to the detriment of grooming, a much less profitable trophic activity in terms of energy and nutrition.

Additionally, we believe that kleptoparasitism influences the incidental ingestion of plastic and other anthropogenic materials due to the speed required for the theft of foodstuffs. This prevents these vultures from carefully separating the stolen food from the material that covers, surrounds, impregnates or is adhered to or associated with it (mostly plastic), as verified in all (n=112) the pellets collected in the study area (Richard *et al.* 2021). This is particularly important given that plastics, among other anthropogenic materials, constitute one of the most important causes of vulture decline globally (Ogada *et al.* 2012, Buechley & Şekercioğlu 2016). The ingestion of this type of material causes physical and mechanical damages to the digestive system of these species and, due to their behavior, also helps vectorize the toxic substances including persistent organic compounds, heavy metals and drug residues such as diclofenac that they release (Borges-Ramirez *et al.* 2021, Richard *et al.* 2021). All this leads to lethal or sublethal processes of bioaccumulation and biomagnification (Moleón *et al.* 2014, Noreen & Sultán 2021, Borges-Ramirez *et al.* 2021).

This brief analysis indicates that the development of new behavioral schemes seems to be commonplace in this species, which coincides with the observations of acquired behavior made by Sazima (2007, 2010). According to Morand-Ferron *et al.* (2007), open habitats are positively associated with kleptoparasitic behavior in birds and our observations in this sense would provide support for this affirmation. Similarly, our study agrees with García *et al.*

(2010) who suggest that animals with specialized feeding methods – be it in terms of quantity or energy content, or the need to handle large or cumbersome prey – are the most likely to indulge in kleptoparasitism.

On the other hand, Morand-Ferron *et al.* (2007) in their work reviewing and testing hypotheses on the motivation behind and/or evolution of interspecific kleptoparasitic behavior in birds conclude that the main predictive factor is a relatively larger brain (brain hypothesis) in the species who practice this type of behaviour (as opposed to the so-called brawn hypothesis). However, these authors also underline the fact that their results do not invalidate other examples associated with factors such as social dominance or the importance of open habitats (Paulson 1985). Likewise, they indicate that these other factors do not provide a general explanation that contributes to understanding why certain taxa practice interspecific kleptoparasitism to the detriment of other types of behavior. As a response to this latter issue, we should question whether the taxa included in the group that do not practice kleptoparasitism really do not practice it or whether this behavioral pattern has simply never been documented.

Although, the study by Morand-Ferron *et al.* (2007) of the brain hypothesis refers to interspecific kleptoparasitism in birds, the truth is that the observations made here involve a kleptoparasitic bird (*C. atratus*) and a mammal that, as a host, is recognized for its intelligence and skills (Udell & Wynne 2008). Dogs are larger hosts and have a much larger brain than Black Vultures, which raises at least reasonable doubt regarding the brain hypothesis of Morand-Ferron *et al.* (2007) and so highlights questions that need to be answered.

Brockmann & Barnard (1979) classified kleptoparasite modalities as either specialist or opportunistic. Specialists are species that possess a set of adaptations such as the development of high-speed flight and maneuverability that favor kleptoparasitism. They only steal food from other species as occurs commonly in the families Fregatidae (Frigatebirds) and Stercorariidae (Skuas, Jaegers). On the other hand, the latter – the opportunists – are those that only occasionally steal food and take advantage of particular situations, generally when food is visible in the beak of the host. Opportunistic kleptoparasitism is very well documented at inter- and intraspecific level and is very common in the Laridae (gulls and terns). Thus, the behavior we describe here fits into the category of inter- and intraspecific kleptoparasitism of the opportunistic type, although with certain limitations since we believe that this form of kleptoparasitism in the local population of Black Vulture is not infrequent given the (underestimated) number of times it was observed during the study period. On the other hand, it could be locally restricted as part of learned behavior in the context of this particular garbage dump. In our study and, especially in the interspecific modality observed, Black Vulture individuals apparently do not need to see the food in the dogs' mouth to recognize it as such. Everything indicates that it is enough for the dog to identify a bag for the Black Vultures to pounce, and so it would be important to check whether or not the ethological patterns reported here appear elsewhere and under other anthropogenic and/or natural contexts.

Currently, kleptoparasitism (Brockmann & Barnard 1979) is widely recognized as an important feeding strategy that enables many animals to obtain limited resources (Giraldeau & Caraco 2000, García 2010). However, we agree with other authors (García 2010, Sazima 2010, Gangoso *et al.* 2012, Plaza & Lambertucci 2017, Noreen & Sultan 2021) and, in light of the questions raised by our study, believe that there is still much to investigate on this subject. For example, as García (2010) has pointed out, in recent decades a significant amount of published work on birds has emphasized the associated and/or triggering factors of kleptoparasitism.

The tolerance (McKinney 2002) shown by Black Vultures to human activities in the dump and the described behavior demonstrate the great phenotypic plasticity expressed when acquiring new forms of behavior, In this case, they have allowed this winning species (McKinney & Lockwood 1999) to expand its area of distribution notably, favored by the development of anthropogenic ecosystems (Carrete *et al.* 2010).

These studies provide vital information for understanding the natural history of this scavenger species in anthropogenic contexts and, above all, for the design of management, conservation and education policies aimed at the harmonious integration and coexistence of Black Vultures with humans in anthropogenic ecosystems. Recent studies also reveal the large gaps in our knowledge of the subject and probably raise more questions than they answer.

Acknowledgements

The authors express their sincere gratitude to the anonymous reviewers and associate editor Dr. Javier Quesada for their hard work, suggestions, and valuable contributions that greatly contributed to improving this work. Likewise, we would to thank Lic. Mariana E. Quintero Cevallos and Dayane M. Proaño Zambrano, respectively, Director of the Language Center and Delegate Teacher of the Language Center of the San Gregorio de Portoviejo University for the translation into English of this work and Dr. Ignacio W. Loor Colamarco and Lic. Adrián E. Reyna García from the Research Department of the Universidad San Gregorio de Portoviejo for the steps taken and support for the research work.

Resum

Cleptoparasitisme intra i interespecífic en el zopilot negre *Coragyps atratus* (Aves: Cathartidae) en un abocador de residus d'Equador

El cleptoparasitisme està reconegut com una important estratègia etològica alimentària per mitjà de la qual molts animals obtenen recursos limitants. Els estudis d'aus carronyeres resulten importants pel fet que amb el consum de carronya i aliments rebutjats per l'ésser humà disminueixen els focus d'infecció d'animals que moren per malaltia evitant-ne la propagació a l'ecosistema. Amb això presten importants serveis ambientals i higiènics valorats en bilions de dòlars. Per això la rellevància d'aquests estudis. Aquí, documentem, analitzem i discutim els primers casos de cleptoparasitisme inter i intraespecífic per al zopilot negre *Coragyps atratus* contextualitzats a l'abocador d'escombraries de Calceta, (Manabí, Equador). Es van fer 69 hs. d'observació focal documentant fotos i vídeos. Es reporta per primera vegada el cleptoparasitisme individual i grupal cooperatiu en el zopilot negre com a espècie i associat al context d'un abocador de residus. Es van registrar 48 esdeveniments de cleptoparasitisme intraespecífic i 19 de cleptoparasitisme interespecífic. L'intraespecífic, pel que sembla, passa desencadenat per la descàrrega de grans quantitats de residus des de camions recollectors. El cleptoparasitisme interespecífic va ser observat sobre gossos domèstics (hoste) que el zopilot aprofitaria per les seves aptituds olfactives per ubicar encertadament els aliments que després li roba. L'eficiència del cleptoparasitisme interespecífic indica que els grups cooperatius amb més individus de zopilot negre tenen més possibilitats d'èxit per obtenir l'aliment, si bé les dades suggereixen una mida òptima, on majors mides de grup començarien a tenir costos de cerca. Aquest comportament adquirit mostraria una gran tolerància a condicions antropogèniques i una gran plasticitat fenotípica adaptativa de l'espècie.

Resumen

Cleptoparasitismo intra e interespecífico en el zopilote negro *Coragyps atratus* (Aves: Cathartidae) en un vertedero de residuos de Ecuador

El cleptoparasitismo está reconocido como una importante estrategia etológica alimentaria por medio de la cual muchos animales obtienen recursos limitantes. Los estudios de aves carroñeras resultan importantes debido a que con el consumo de carroña y alimentos desechados por el ser humano disminuyen los focos de infección de animales que murieron por enfermedad evitando la propagación de las mismas en el ecosistema. Con ello prestan importantes servicios ambientales e higiénicos valorados en billones de dólares. De ahí la relevancia de estos estudios. Aquí, documentamos, analizamos y discutimos los primeros casos de cleptoparasitismo inter e intraespecífico para el zopilote o gallinazo negro *Coragyps atratus* contextualizados en el vertedero de basura de Calceta, (Manabí, Ecuador). Se realizaron 69 hs. de observación focal documentando con fotos y videos. Se reporta por primera vez el cleptoparasitismo individual y grupal cooperativo en el zopilote negro como especie y asociado al contexto de un vertedero de residuos. Se registraron 48 eventos de cleptoparasitismo intraespecífico y 19 de cleptoparasitismo interespecífico. El intraespecífico, al parecer, ocurre desencadenado por la descarga de grandes cantidades de residuos desde camiones recolectores. El cleptoparasitismo interespecífico fue observado sobre perros domésticos (hospedero) que el zopilote aprovecharía por sus aptitudes olfativas para ubicar certeramente los alimentos que luego le roba. La eficiencia del cleptoparasitismo interespecífico indica que los grupos cooperativos con mayor número de zopilotes tienen más posibilidades de éxito para obtener el alimento, si bien los datos sugieren un tamaño óptimo, donde mayores tamaños de grupo comenzarían a tener costes de forrajeo. Este comportamiento adquirido mostraría una gran tolerancia a condiciones antropogénicas y una gran plasticidad fenotípica adaptativa de la especie.

References

Ballejo, F. & de Santis, L.J.M. 2013. Dieta estacional del jote cabeza negra (*Coragyps atratus*) en un área rural y una urbana. *El Hornero* 28: 7–14.

Ballejo, F., Plaza P., Speziale, K.L., Lambertucci, A.P. & Lambertucci, S.A. 2021. Plastic ingestion and dispersion by vultures may produce plastic islands in natural areas. *Sci. Total Environ.* 755 (142421). https://doi.org/10.1016/j.scitotenv.2020.142421

Barnes, D.K., Galgani, F., Thompson, R.C. & Barlaz, M. 2009. Accumulation and fragmentation of plastic debris in global environments. *Philos. Trans. R. Soc. B Biol. Sci*. 364, 1985–1998. https://doi.org/10.1098/rstb.2008.0205

Borges-Ramírez, M.M., G. Escalona-Segura, E., Huerta-Lwanga, E., Iñigo-Elias, J. & Rendón-von, O. 2021. Organochlorine pesticides, polycyclic aromatic hydrocarbons, metals and metalloids in microplastics found in regurgitated pellets of black vulture from Campeche, Mexico. *Sci. Total Environ.* 801, 149674. https://doi.org/10.1016/j.scitotenv.2021.149674

Brockmann, H. & Barnard, C. 1979. Kleptoparasitism in birds. *Anim. Behav.* 27: 487–514. https://doi.org/10.1016/0003-3472(79)90185-4

Buckley, N. 1996. Food finding and the influence of information, local enhancement, and communal roosting on foraging success of North American vultures. *Auk* 113 (2): 473–488. https://doi.org/10.2307/4088913

Buechley, E.R. & Şekercioğlu, Ç.H. 2016. The avian scavenger crisis: Looming extinctions, trophic cascades, and loss of critical ecosystem functions. *Biol. Conserv.* 198: 220–228. https://10.1016/j.biocon.2016.04.001

Carlin, J., Craig, C., Little, S., Donnelly, M., Fox, D., Zhai, L. & Walters, L. 2020. Microplastic accumulation in the gastrointestinal tracts in birds of prey in central Florida, USA. *Environ Pollut.* 2020 Sep; 264:114633. https://doi.org/10.1016/j.envpol.2020.114633

Carrete, M., Lambertucci, S.A., Speziale, K., Ceballos, O., Travaini, A., Delibes, M., Hiraldo, F. & Donázar, J.A. 2010. Winners and losers in human-made habitats: interspecific competition outcomes in two Neotropical vultures. *Anim. Conserv.* 13: 1–9. https://doi.org/10.1111/j.1469-1795.2010.00352.x

Caraco, T. 1979. Time budgeting and group size a theory (and a test of a theory). *Ecology* 60: 611–627. https://doi.org/10.2307/1936082

de Araujo, G.M., Peres, C.A., Baccaro, F.B. & Guerta, R.S. 2018. Urban waste disposal explains the distribution of Black Vultures (*Coragyps atratus*) in an Amazonian metropolis: Management implications for birdstrikes and urban planning. *PeerJ* 2018, 6, e5491. https://doi.org/10.7717/peerj.5491

Furness, R.W. 1987. Kleptoparasitism in seabirds. Pp. 77-99. In Croxall J.P. (ed.): *Seabirds, feeding biology and role in marine ecosystem*. Cambridge: Cambridge University Press.

Gangoso, L., Agudo, R., Anadón, J.D., de la Riva, M., Suleyman, A.S., Porter, R. & Donázar, J.A. 2013. Reinventing mutualism between humans and wild fauna: insights from vultures as ecosystem services providers. *Conserv. Lett.* 6: 172–179. https://doi.org/10.1111/j.1755-263X.2012.00289.x

García, G.O. 2010. *Cleptoparasitismo en aves como una estrategia trófica oportunista: costos y beneficios para parásitos y hospedadores*. Tesis Doctoral, Universidad Nacional de Mar del Plata, Argentina. 166 p.

García, G.O., Favero, M. & Vassallo, A. 2010. Factors affecting kleptoparasitism by gulls in a multi-species seabird colony. *Condor* 112 (3): 521–529. https://doi:10.1525/cond.2010.090117

Giraldeau, L.A. & Caraco, T. 2018. *Social Foraging Theory*. Princeton: Princeton University Press.

Grigg, N.P., Krilow, J.M., Gutierrez-Ibanez, C., Wylie, D.R., Graves, G.R. & Iwaniuk, A.N. 2017. Anatomical evidence for scent guided foraging in the turkey vulture. *Sci. Rep.* 7, 17408 (2017). https://doi.org/10.1038/s41598-017-17794-0

Gochfeld, M. & Burger, J. 1981. Age-related differences in piracy of frigatebirds from laughing gulls. *The Condor, 83*(1), 79-82. https://doi:10.2307/1367608

Hammer, Ø., Harper, D.A. & Ryan, P.D. 2001. PAST: Paleontological statistics software package for education and data analysis. *Paleontología electrónica* 4 (1): 9.

Houston, D.C, Mee, A. & McGrady, M. 2007. Why do condors and vultures eat junk? The implications for conservation. *J. Raptor Res.* 41 (3): 235–238. https://doi.org/10.3356/0892-1016(2007)41[235:WDCAVE]2.0.CO;2

Iñigo, E. 1987. Feeding habits and ingestion of synthetic products in a Black Vulture population from Chiapas, Mexico. *Acta Zool. Mex*. 9: 1–15. https://doi.org/10.21829/azm.1987.19222040

Iyengar, E.V. 2008. Kleptoparasitic interactions throughout the animal kingdom and a reevaluation, based on participant mobility, of the conditions promoting the evolution of kleptoparasitism. *Biol. J. Linn. Soc.* 93: 745–762. https://doi.org/10.1111/j.1095-8312.2008.00954.x

Johnston, R.F. 2001. Synanthropic birds of North America. In Marzluff, J.M., Bowman, R. & Donnelly, R. (eds.): *Avian ecology in an urbanizing world*. Kluwer Academic Publishers, Norwell, MA, pp. 49–67. https://doi.org/10.1007/978-1-4615-1531-9_3

Kelly, N.E., Sparks, D.W., DeVault, T.L. & Rhodes, O.E. 2007. Diet of Black and Turkey Vultures in a Forested Landscape. *Wilson J. Ornithol.* 119: 267–270. https://doi:10.1676/05- 095.1

Lambertucci, S.A., Trejo, A., Di Martino, S., Sánchez-Zapata, J.A., Donázar, J.A. & Hiraldo, F. 2009. Spatial and temporal patterns in the diet of the Andean condor: ecological replacement of native fauna by exotic species. *Anim. Conserv*. 12 (4): 338–345. https://doi.org/10.1111/j.1469-1795.2009.00258.x

La Torre, F. 2014. *Informe para cierre técnico del Botadero y diseño de celda emergente del cantón Bolívar*. PROYECTO: LCC-MAE- 003 – 2013. Ministerio de Medio Ambiente de Ecuador. 132 p. Disponible en https://bit.ly/3sKECla

Lord, K. 2012. *A* Comparison of the Sensory Development of Wolves *(Canis lupus lupus)* and Dogs *(Canis lupus familiaris). Ethology* 119 (2): 110–120. https://doi.org10.1111/eth.12044

Luna, Á., Romero-Vidal, P. & Arrondo, E. 2021. Predation and scavenging in the city: a review of spatio-temporal trends in research. *Diversity* (13): 46. https://doi.org/10.3390/d13020046

Markandya, A., Taylor, T., Longo, A., Murty, M.N., Murty, S. & Dhavala, K. 2008. Counting the cost of vulture decline: An appraisal of the human health and other benefits of vultures in India. *Ecol. Econ.* 67: 194–204. https://doi.org/10.1016/j.ecolecon.2008.04.020

Martin, P. & Bateson, P. 1993. *Measuring Behaviour: An Introductory Guide* (pp. 84-100). Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9781139168342.009

McKinney, M.L. 2002. Urbanization, biodiversity and conservation. *BioScience* 52 (10): 883 – 890. https://doi.org/10.1641/0006-3568(2002)052[0883:UBAC]2.0.CO;2

McKinney, M.L. & Lockwood, J.L. 1999. Biotic homogenization: a few winners replacing many losers in the next mass extinction. *Trends Ecol. Evol*. 14 (11): 450–453. http://dx.doi.org/10.1016/S0169-5347(99)01679-1

Moleón, M., Sánchez-Zapata, J.A., Margalida, A., Carrete, M., Owen-Smith, N. & Donázar, J.A. 2014. Humans and Scavengers: The evolution of interactions and ecosystem services. *BioScience* 64 (5): 394–403, https://doi.org/10.1093/biosci/biu034

Morand-Ferron, J., Sol, D. & Lefebvre, L. 2007. Food stealing in bird: brain or brawn? *Anim. Behav.* 74: 1725-1734. https://doi.org/10.1016/j.anbehav.2007.04.031

Noreen, Z. & Sultan, K. 2021. A global modification in avifaunal behavior by use of waste disposal sites (waste dumps/rubbish dumps): A review paper. *Pure Appl. Biol*. (10) 3: 603–616. http://dx.doi.org/10.19045/bspab.2021.100062

Ogada, D.L., Keesing, F. & Virani, M.Z. 2012. Dropping dead: causes and consequences of vulture population declines worldwide. *Annals of the New York Academy of Sciences* 1249: 57–71. https://doi.org/10.1111/j.1749-6632.2011.06293.x

Parfitt J., Barthel, M. & Macnaughton, S. 2010. Food waste within food supply chains: quantification and potential for change to 2050. *Philos. T. Roy. Soc. B* 365 (1554): 3065–3081 https://doi.org/10.1098/rstb.2010.0126

Paulson, D.R. 1985. The importance of open habitat to the occurrence of kleptoparasitism. *Auk* 102: 637–639. https://doi.org/10.1093/auk/102.3.637

Plaza, P. & Lambertucci, S.A. 2017. How are garbage dumps impacting vertebrate demography, health, and conservation? *Global Ecology and Conservation* 12: 9–20. https://doi.org/10.1016/j.gecco.2017.08.002

Plaza, P.I., Blanco, G., Madariaga, M.J., Boeri, M.L., Bianco, T.G. & Lambertucci, S.A. 2019. Scavenger birds exploiting rubbish dumps: Pathogens at the gates. *Transbound Emerg. Dis*. 66: 873–881. https://doi.org/10.1111/tbed.13097

Plaza, P.I., Blanco, G. & Lambertucci, S.A. 2020. Implications of bacterial, viral and mycotic microorganisms in vultures for wildlife conservation, ecosystem services and public health. *Ibis* 162: 1109–1124. https://doi.org/10.1111/ibi.12865

Richard, E., Contreras Zapata, D.I. & Angeoletto, F. 2021. Consumo incidental de plásticos y otros materiales antropogénicos por parte de *Coragyps atratus* (Bechstein, 1793) en un vertedero de basura de Calceta, Ecuador, *Revista Peruana de Biología* 28 (4): e21627. http://dx.doi.org/10.15381/rpb.v28i4.21627

Richard, E., Contreras Zapata, D.I. & Angeoletto, F. (in press). Birds of prey from high-altitude cities (Bolivia): Between extreme limitations and adaptations, winning? In Angeoletto, F., Tryjanowski, P., Carmona, D. & Fellowes, M. (eds.): *Ecology of Tropical Cities: Natural and Social Sciences Applied to the Conservation of Urban Biodiversity*. Springer Nature Publishing House.

Ridgely, R.S. & Greenfield, P.J. 2001. *The Birds of Ecuador*. Ithaca, NY: Cornell University Press.

Sazima, I. 2007. From carrion-eaters to bathers' bags plunderers: how Black Vultures (*Coragyps atratus*) could have found that plastic bags may contain food. *Rev. Bras. Ornitol.* 15 (2): 617–620.

Sazima, I. 2010. Black Vultures (*Coragyps atratus*) pick organic debris from the hair of a domestic dog in southeastern Brazil. *Rev. Bras. Ornitol.* 18 (1): 45–48.

Senar, J.C. 1994. Vivir y convivir: La vida en grupos sociales. In Carranza, J. (ed.): *Etología: Introducción a la Ciencia del Comportamiento*. Pp. 204–232. Cáceres: Publicaciones de la Universidad de Extremadura. Disponible en: https://bit.ly/3Czjx3W

Shealer, D.A., Spendelow, J.A., Harfield, J.S. & Nisbet, I.C.T. 2005. The adaptive significance of stealing in a marine bird and its relationship to parental quality. *Behav. Ecol.* 16: 371–376. https://doi.org/10.1093/beheco/ari008

Spina, M.A. & Silveira, L.F. 2019. First record of death-feigning in Black Vultures (*Coragyps atratus*) (Cathartidae). *Rev. Bras. Ornitol.* 27: 242–244. https://doi.org/10.1007/BF03546069

Stager, K.E. 1964. The role of olfaction in food location by the Turkey Vulture (*Cathartes aura*). *Los Angeles County Mus., Contrib. Sci*. No. 81. Disponible en https://bit.ly/3kfSiRw

Thompson, D.B.A. 1986. The economics of kleptoparasitism: optimal foraging, host and prey selection by gulls. *Anim. Behav.* 34: 1189–1205. https://doi.org/10.1016/S0003-3472(86)80179-8

Udell, M.A. & Wynne, C.D. 2008. A review of domestic dogs (*Canis familiaris*) human-like behaviors: or why behavior analysts should stop worrying and love their dogs. *J. Exp. Anal. Behav. 89* (2): 247–261. https://doi.org/10.1901/jeab.2008.89-247

Yosef, R., Zvuloni, A. & Yosef-Sukenik, N. 2012. House crow (*Corvus splendens*) attempt to cooperatively kleptoparasitize western Osprey (*Pandion haliaetus*). *Wilson J. Orn.* 124: 406–408. http://dx.doi.org/10.2307/41480765