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Ectoparasites of *Coragyps atratus* (Bechstein, 1793) (Accipitriformes: Cathartidae) on Bucaramanga, Santander, Colombia*

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Abstract

Objective. To identify and to list ectoparasite species of black vulture in two locations in Bucaramanga, Colombia. **Scope.** To contribute to the knowledge of ectoparasites species found in black vultures in the metropolitan area of Bucaramanga, at the northeastern Andes. **Methodology.** The birds were captured in Guarin Marketplace and "El Carrasco" Solid Waste Disposal Center, both in the metropolitan area of Bucaramanga, Colombia. To obtain the ectoparasites, each black vulture were introduced into a fumigation chamber previously modified to preserve the life of the bird during the procedure. Moreover, some feathers were taken and preserved in ethanol 70%. **Main results.** In total, 1,696 ectoparasites were collected from 18 black vultures (*Coragyps atratus*) in two localities of Bucaramanga (Colombia). The parasites were identified as *Cathartacarus coragyps* (Gabuciniidae), *Dermanysus gallinae* (Dermanyssidae), *Cuculiphilus alternatus* (Menoponidae), *Falcolipeurus marginalis* (Philopteridae), *Laemobothrion glutinans* (Laemobothriidae) and *Olfesia bisulcata* (Hippoboscidae). The most abundant species were *Cuculiphilus alternatus* with 1,217 specimens and *Cathartacarus coragyps* with 295. **Conclusions.** Most of these records are new to the region and contribute to improving the knowledge concerning the ectoparasites distribution in the study area. Mann-Whitney tests and the calculated parasitological indexes show differences between the two sampling places.

Key words: Acari, Diptera, Phthiraptera, epidemiology, parasitological indexes.

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Ectoparásitos de *Coragyps atratus* (Bechstein, 1793) (Accipitriformes: Cathartidae) en Bucaramanga, Santander, Colombia

Resumen

Objetivo. Identificar y conformar una lista de especies de ectoparásitos en el gallinazo negro en dos localidades de la ciudad de Bucaramanga, Colombia. **Alcance.** Realizar un aporte al conocimiento sobre las especies de ectoparásitos encontrados en piel y plumaje del gallinazo negro en el área metropolitana de Bucaramanga, en el nororiente de los Andes. **Metodología.** Las aves fueron capturadas en la Plaza de Mercado Guarín y en el Centro de Disposición de Residuos Sólidos "El Carrasco", ambos en el área metropolitana de Bucaramanga, Colombia. Para obtener los ectoparásitos, los gallinazos se introdujeron uno por uno, en una cámara de fumigación previamente modificada para preservar la vida del ave durante el procedimiento. Adicionalmente, se tomaron algunas plumas y se preservaron en etanol 70%. **Principales resultados.** Se colectaron 1.696 ectoparásitos sobre 18 gallinazos negros (*Coragyps atratus*) en dos sitios de Bucaramanga (Colombia). Los parásitos fueron identificados como *Cathartacarus coragyps* (Gabuciniidae), *Dermanysus gallinae* (Dermanyssidae), *Cuculiphilus alternatus* (Menoponidae), *Falcolipeurus marginalis* (Philopteridae), *Laemobothrion glutinans* (Laemobothriidae) y *Olfesia bisulcata* (Hippoboscidae). Las especies más abundantes fueron *Cuculiphilus alternatus* con 1.217 individuos y *Cathartacarus coragyps* con 295. **Conclusiones.** La mayor parte de estos registros son nuevos para la región y amplían el conocimiento con respecto a la distribución de estos ectoparásitos. Tanto las pruebas de Mann-Whitney como los índices parasitológicos calculados permiten observar diferencias entre los dos sitios de muestreo.

Palabras clave: Acari, Diptera, Phthiraptera, epidemiología, índices parasitarios.

Introduction

The increasing population of black vulture *Coragyps atratus* (Bechstein, 1793), in the metropolitan area of Bucaramanga, Colombia, has been associated to zoonosis and avian risk (Vega-Rivero, 2006). For these reasons, the Cooperative University of Colombia (UCC by the initials in Spanish) carried out studies to understand some components of the population, and so, propose possible solutions to those problematic situations (Amaya-Espinel et al., 2005; Cala et al., 2006; Carvajal-Rodríguez, 2012). Activities were programmed by the student research group UCC, like marking, bird counting, blood chemistry analysis, etc. (AMB-UCC, 2009; Serrano-Novoa et al., 2009), it was first noticed the presence of ectoparasites when manipulating the birds. Samples, planning and organization of an interdisciplinary team were needed in the development of the current manuscript.

Black vulture, also known as *golero*, *zamuro* or *chulo*, is a scavenger and gregarious bird that is distributed from the south of the United States to north of Chile and Argentina, and from zero to more than 2,700 masl (Hilty & Brown, 1986). In the juvenile stage has white plumage throughout the body and no folds; in adulthood, they present black plumage, but the neck, head and legs are bared and with folds (Grossman & Hamlet, 1964). In Colombia, this bird is common and abundant, inhabits in open and semi-open places, around the cities near to garbage deposits (AMB-UCC, 2009). Few investigations on black vulture ectoparasites have been done, some are in Serafini et al. (2003), Valim et al. (2002, 2005) and Webb et al. (2005).

In general, the ectoparasites are living beings that at some moment in their life cycle inhabit the host skin or external parts, such as hairs, feathers or scales. Ectoparasites have the potential to transmit parasitic diseases to wild bird. Additionally, they can be a risk to domestic birds (Hopla et al., 1994). Some of the best-known ectoparasites belong to *Dermanyssus* Dugès, 1834, *Orthonyssus* Sambon, 1928, *Syringophilus* Heller, 1880 and *Knemidokoptes* Fürstenberg, 1870, which cause scabies in parrots, hens and canaries (Nelson & Murray, 1971). The study of ectoparasites requires the use of specialized equipment and specific processes to collect, identify, examine and preserve the specimens. Some methods used are: a) *visual examination*: it is the best to map microhabitat and distribution on the bird (Choe & Kim, 1989; Nelson & Murray, 1971); b) *washing*: the bird is shaken inside a container with soap 2% during 5-10 minutes (Watson & Emerson, 1967); and, c) *dissolution*: the skin of the host is divided into regions that are incubated and dissolved, so that data on microhabitat are obtained (Choe & Kim, 1989). However, the capture with anaesthetic chemicals gives a better approximation to the number of ectoparasites per bird (Walther & Clayton, 1997). Nevertheless, this requires care to preserve the life of the bird when it is exposed to anaesthetic substances, for which, a container must be adapted to ensure that the head of the bird is outside of the chamber (Fowler & Cohen, 1983; Marshall, 1981; Southwood, 1978; Williamson, 1954; Wolfensohn & Lloyd, 2003).

The objective of this manuscript is to identify and to list ectoparasite species of black vulture in two locations of Bucaramanga, Santander, Colombia, and to contribute to the knowledge of ectoparasites species found in black vultures. The captures of the black vultures were made in Guarin Marketplace and "El Carrasco" Solid Waste Disposal Centre, because in both places the waste management is very deficient and the black vulture populations are high.

Materials and methods

Study zone. The samplings were taken in Bucaramanga, capital of the department of Santander, northeast of Colombia. The captures of the black vultures were made (Fig. 1A) in Guarin Marketplace and "El Carrasco" Solid Waste Disposal Centre. Guarin

Marketplace is located in the northeast of the city of Bucaramanga (7°07′36.72”N; 73°06′45.16”W; 1,025 masl), and “El Carrasco” is located in the southwest of the city (7°04′30.0”N; 73°08′42.74”W; 810 masl). In both places, waste management is highly deficient, in such a way that the black vulture populations are high. In Guarin Marketplace, the presence of these birds is certain undesirable due to the proximity to food storage, handling and consumption; in “El Carrasco”, the presence is associated with a potential aviary risk given the proximity of Palonegro International Airport (Fig. 2).

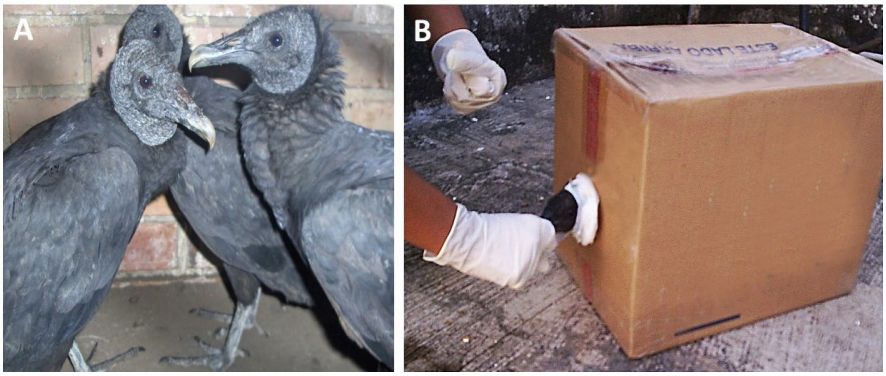

Figure 1. A: Specimens of *Coragyps atratus*. **B:** Fumigation chamber.

Obtaining ectoparasites. In total, 18 black vultures were captured using a metal cage with bait inside and a sliding door. The bait was a piece of decaying beef. Each bird was introduced, for 5 minutes, into a fumigation chamber made with a cardboard box that had a lateral hole through which the head of the bird was taken out to preserve its life (Fig. 1B). Inside the box there was installed a white cardboard to facilitate the collection of the ectoparasites. Inside there was also installed a metal container with a cotton impregnated with ether, although it could also use carbon dioxide, chloroform or ethyl acetate (Fowler & Cohen, 1983; Marshall, 1981; Silva et al., 2014; Southwood, 1978; Visnav & Dumbacher, 1999; Walther & Moore, 2005; Williamson, 1954). Essentially, the method used is a modification of Kilner’s ornithological instrument (Fowler & Cohen, 1983), which was improved and described by Bear (1995). An advantage of this method is that a single person can take several samples at same time, with the disadvantage that it only removes 80% of the ectoparasites (Fowler & Cohen, 1983). Additionally, and as a complement to the sampling, five feathers from the ventral region and five from the cloacal area were taken and immersed in ethanol 70% for further study to stereoscope. The collected material was separated and they were conserved in ethanol 70%, for the taking of photographs and the identification using keys and descriptions of Bequaert (1933), Bochkov & Mironov (1998), Clay (1970), González & Carrejo (1992), Guimarães (1942), Nelson & Price (1965),

Pedroso et al., (2015), Scharf & Price (1965) and Tandan & Dhanda (1963). Ethics Committee for Animal Experimentation of the Cooperative University of Colombia – UCC, previously authorized all procedures.

Figure 2. Satellite photography of the city of Bucaramanga, Colombia (adapted from Google Earth Pro) and detail of the sampling places.

Analysis of inventory quality. A sampling effort analysis examined the degree of knowledge reached during fieldwork, referred to the richness of species and, thus, with the aim of predicting the potential richness of the sampling zone. The effort-sampling unit (ESU) was the summation of all data of each sampling bird. Using the EstimateS program (Colwell, 2000), data entry was randomized (1,000 iterations) to avoid bias

in the estimation of observed richness randomized. To predict the potential richness, we used the nonparametric statistic Chao1 (based in abundances) because it is a robust estimator of the minimum richness and offers better results than other estimators (Gotelli & Colwell, 2001; Walther & Moore, 2005). With the CurveExpert program (Hyams, 2009), the estimates were adjusted to an asymptotic curve of Clench, and thus, to calculate the different parameters of the curve (Jiménez-Valverde & Hortal, 2003).

Comparison between sampling areas. To make the comparison between the sampling areas, Guarin Marketplace and "El Carrasco" Solid Waste Disposal Centre, we use the *Statistica 10* program (StatSoft, 2011) and we made a comparison of both groups using the sampling data for each species. The Z adjusted and *p* values were calculated through the non-parametric test of Mann-Whitney (significant for $p<0.05$).

Additionally, in order to establish differences between the sampling zones, statistical analyses to determine possible differences between each bird collected in the both places were carried out. We use the nonparametric test of Wilcoxon (*Z* tests) for comparison between the variables using the *Statistica 10* program (StatSoft, 2011). The abundance data by bird were treated by converting them into their log (x+1), then, a distance matrix based on the Euclidean distance was obtained. An amalgamation strategy of Group Average was applied and a Simprof test (1,000 iterations) to construct the respective phenogram. All this was done using the program Primer 6 v6.1.6 (Primer-E Ltd., 2006), thus estimating the similarity between "El Carrasco" y Guarin Marketplace.

Parasitological parameters. We calculate the following values with a parasitic and epidemiological interest (Bush et al., 1997; Muñoz et al., 2003).

- Medium abundance (MA): Total parasites of one species/examined hosts.
- Prevalence (Pr): Infested birds/analysed birds *100.
- Parasitic intensity (PI): Total parasites/parasitized individuals.
- Parasitic dominance (PD): Total parasites of one species *100.
- Frequency (Fr): Minimum and maximum number of parasites collected by bird.

Results and discussion

We collect 1,696 parasites belonging to the orders Acari (325), Phthiraptera (1,359) and Diptera (12) (Fig. 3). Of the order Acari, *Cathartacarus coragyps* Pedroso,

Hernandes & Mironov, 2015 (Astigmata: Gabuciniidae) and *Dermanyssus gallinae* De Geer, 1778 (Mesostigmata: Dermanyssidae) were identified. In the order Phthiraptera, *Cuculiphilus alternatus* (Osborn, 1902) (Amblycera: Menoponidae), *Laemobothrion glutinans* Nitzsch [en Giebel], 1861 (Amblycera: Laemobothriidae) and *Falcolipeurus marginalis* (Osborn, 1902) (Ischnocera: Philopteridae) were identified. Regarding the order Diptera, *Olfersia bisulcata* Macquart, 1847 (Brachycera: Hippoboscidae) was identified. The frequency varied from one to 272 ectoparasites by bird. The most abundant species were *C. alternatus* with 72.5%, *C. coragyps* (17.2%), *F. marginalis* (4.5%) and *L. glutinans* (3.4%). The most dominant species were *C. alternatus* (71.76%) and *C. coragyps* (17.39%) (Table 1).

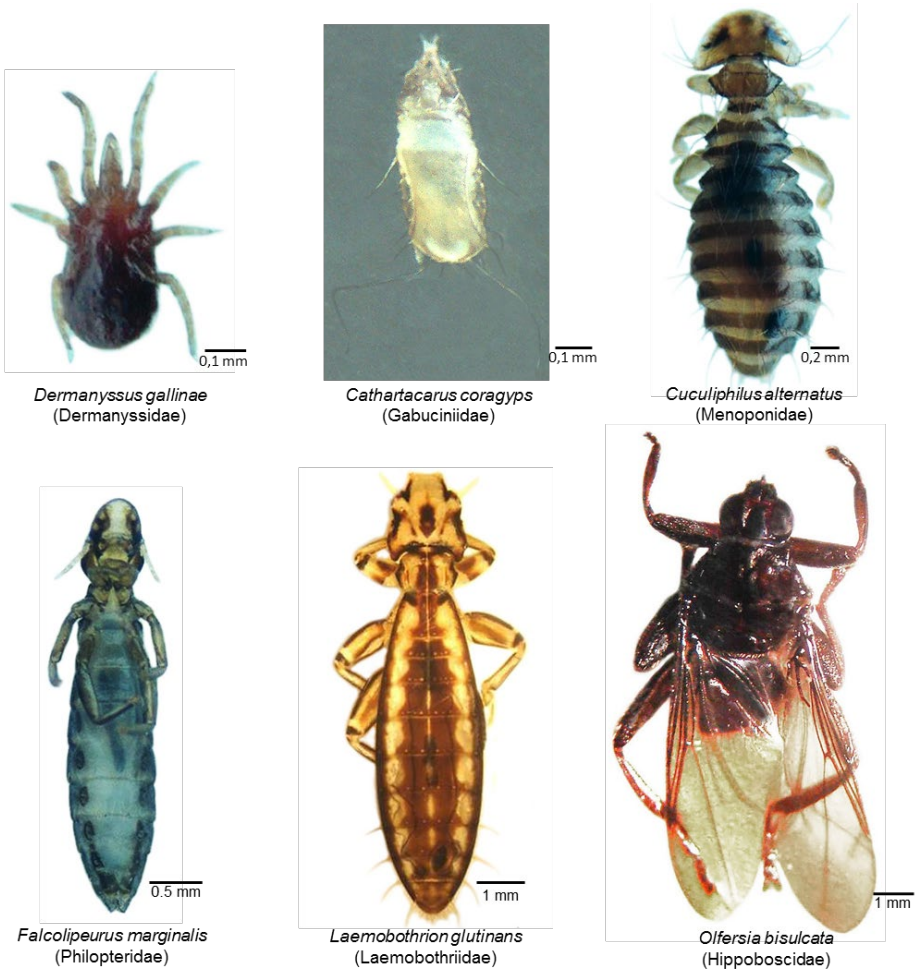

Figure 3. Species of ectoparasites collected.

Table 1. Frequency of ectoparasites in *Coragyps atratus* in two sampling areas in the city of Bucaramanga, Colombia. N: studied birds.

Places	N	*Dermanysus gallinae*	*Cathartacarus coragyps*	*Laemobothrion glutinans*	*Cuculiphilus alternatus*	*Falcolipeurus marginalis*	*Olfesia bisulcata*
El Carrasco	1	2	0	1	19	2	0
	2	0	4	3	89	0	2
	3	1	6	4	56	0	0
	4	2	3	8	31	0	1
	5	2	34	7	141	9	4
	6	0	80	10	272	5	0
	7	11	16	0	94	28	1
	8	9	109	4	24	2	2
	9	2	27	7	136	27	0
Guarín	1	1	3	0	40	0	0
	2	0	0	8	63	2	0
	3	0	8	2	79	1	2
	4	0	0	0	17	0	0
	5	0	3	0	16	0	0
	6	0	0	3	42	1	0
	7	0	0	1	6	0	0
	8	0	0	1	11	0	0
	9	0	2	6	81	0	0

Analysis of inventory quality. The sampling methods used in this investigation were highly efficient to establish the diversity of ectoparasites on *C. atratus*. The potential richness, estimated according to adjustment of the Clench curve, reached 6.34 species (asymptote of the function) (Fig. 4). The slope of the curve was 0.01 (reliable for <0.1), the proportion of observed species was 94.67%, and the estimated sampling effort was 96.95%. These data allow us to consider that the inventory presented an

adequate quality and, at the most, one more species could be collected, which would not have been observed in this investigation.

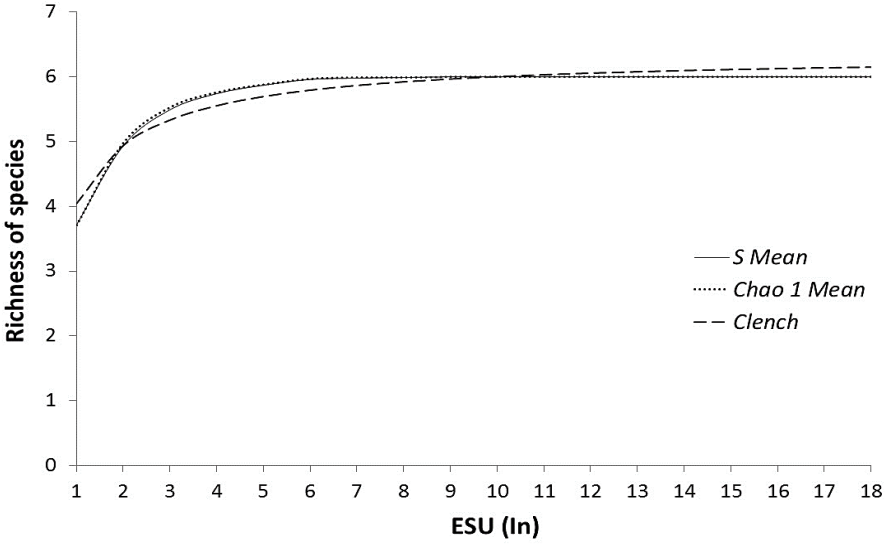

Figure 4. Check of sampling effort. *S Mean*: curve of observed richness randomized; *Chao 1 Mean*: curve of potential richness obtained using the nonparametric estimator Chao1; *Clench*: curve adjusted to Clench asymptote ($y = (11{,}18 \cdot x)/(1 + 1{,}76 \cdot x)$; standard error: 0.152; correlation coefficient: 0.967.

The sampling effort analysis was also calculated separately: the potential richness for "El Carrasco" reached 6.29 species, the slope of curve was 0.02, the proportion of observed species was 95.32% and the estimated sampling effort was 97.14% (Standard error = 0.136; correlation coefficient = 0.947). The potential richness for "Guarin" reached 7.02 species, the slope of curve was 0.11, the proportion of observed species was 85.46% and the estimated sampling effort was 83.88% (Standard error = 0.059; correlation coefficient = 0.999). These data, except for the slope of curve in "Guarin" that was 0.11 and it is reliable for <0.1, allow us to consider that the inventory in both places presented an adequate quality.

Comparison between sampling areas. Based on Z adjusted values obtained through the non-parametric test of Mann-Whitney (significant for p <0.05), we observed that all the p values were low, although the differences were non-significant for three species *C. alternatus*, *L. glutinans* and *O. bisulcata*. Regarding *O. bisulcata*, the differences could be explained by the high mobility of this insect, which makes it difficult to capture. In general, we can conclude that there are some differences between the two sampling areas (Table 2). It is possible that the differences between the two sampling

zones are related to the high density of black vulture in "El Carrasco" that increases the exchange of ectoparasites between the birds.

Table 2. Values of *Z* adjusted and *p* (significant for $p < 0.05$) in the comparison between two sampling areas in Bucaramanga, Colombia.

Ectoparasites	N	*Z* adjusted	*p*	Difference
C. coragyps	18	2.659	0.008	Significant
D. gallinae	18	2.880	0.004	Significant
C. alternatus	18	1.943	0.052	No significant
L. glutinans	18	1.649	0.099	No significant
F. marginalis	18	1.987	0.047	Significant
O. bisulcata	18	1.795	0.073	No significant

The similarity analysis for collected birds in each sampling area, provided a dendrogram where the conformation of some groups is appreciated, showing some differences between the two sampling locations. The groups were formed by the birds 5-9 collected in "El Carrasco" and by the birds 1, 4, 5, 7 and 8 collected in Guarin Marketplace. On the other hand, there were no important differences among the other birds (Fig. 5).

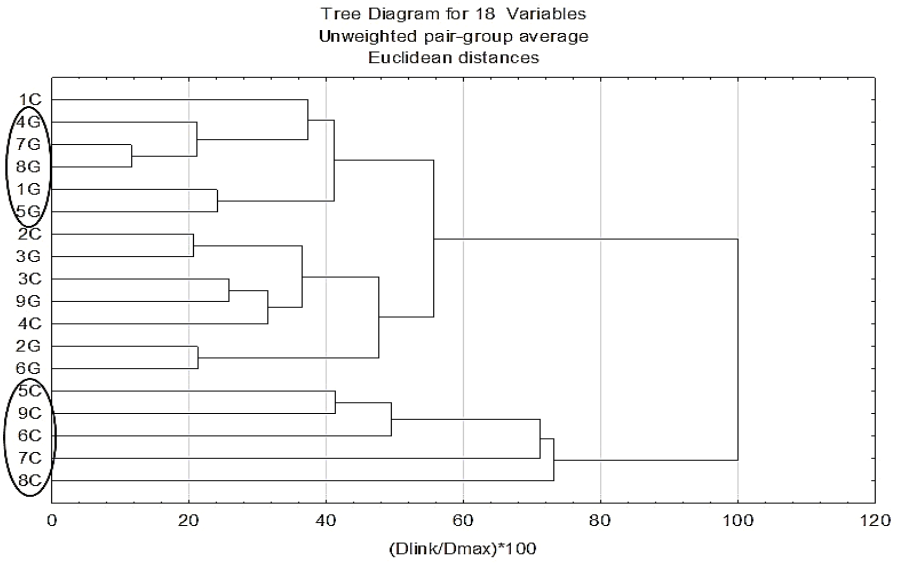

Figure 5. Similarity analysis for the collected birds in two sampling areas in Bucaramanga. C= Carrasco; G= Guarin.

Parasitic parameters. In Table 3, it is observed that in the Guarin Marketplace all parasitic values were lower than in "El Carrasco", except the parasitic dominance of *L. glutinans* (5.26%). The prevalence (Pr) of *C. alternatus* was 100% in both sampling areas, and in the same way, the parasitic intensity (PI) of *O. bisulcata* was 2.0 in both places. The values of the prevalence (Pr) of all species of ectoparasites in "El Carrasco" are highlighted, possibly due to the high density of black vulture in this area. It is observed that *C. alternatus* is the species with the higher parasitic values, followed by *C. coragyps* but with a lower value. In general, the species with the lower values was *O. bisulcata*, which could be explained by its high mobility and fast flight, which allows the insect to escape from the sampling system. The high density of birds in "El Carrasco" could explain the differences of parasitic parameters between the two sampling areas. Close to "El Carrasco", we can observe nests, juvenile specimens, perching, refuge areas, and abundant food, something that does not happen in "Guarin" because this place is only a feeding area.

Table 3. Epidemiologic values for the two sampling areas (CA: Carrasco; GU: Guarín). N: Total individuals collected; MA: Medium abundance; Pr: Prevalence; PI: Parasitic intensity; PD: Parasitic dominance; Fr: Frequency.

Ectoparasites	N		MA		Pr (%)		PI		PD (%)		Fr	
	CA	GU	CA	GU	CA	GU	CA	GU	CA	GU	CA	GU
C. coragyps	279	16	31.0	1.78	88.9	44.4	34.9	4.0	21.51	4.01	3-109	2-8
D. gallinae	29	1	3.2	0.11	77.8	11.1	4.1	1.0	2.24	0.25	1-11	1-1
C. alternatus	862	355	95.8	39.4	**100.0**	**100.0**	95.8	39.4	66.46	88.97	19-272	6-81
L. glutinans	**44**	**44**	4.9	2.3	88.9	66.7	5.5	3.5	3.39	5.26	1-10	1-8
F. marginalis	73	4	8.1	0.4	66.7	33.3	12.2	1.3	5.63	1.00	2-28	1-2
O. bisulcata	10	2	1.1	0.22	55.6	11.1	**2.0**	**2.0**	0.77	0.50	1-4	2-2

Conclusions

Most species are new reports to the region, expanding thus, their known distribution. The finding of the genus *Cathartacarus* on black vulture is highlighted, considering that it becomes the first record for the genus and for the family in Colombia. For the time of sampling, it was the first record on black vulture (S. V. Mironov, pers. com.).

The sampling effort analysis, for the investigation and for both places separately, allow us to consider that the inventory presented an adequate quality and, at the most,

one more species could be collected, which would not have been observed in this investigation. Regarding the comparison between the sampling areas, both evidences, the Mann-Whitney test and the parasitic values, allow observing differences between the two sampling areas. In general, "El Carrasco" Waste Deposit Centre presents higher values in almost all parasitic parameters, explained, possibly, by the high density of black vulture in this sampling area (Fig. 2). It is unknown how these ectoparasites can affect the health of the bird, so more studies are required, in order to establish the ecoepidemiological relationship between the parasites and the bird.

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