

Investigating bird strikes in Brazil through DNA barcoding

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Abstract

Background: Bird-aircraft collisions, or bird strikes, are frequent worldwide, causing huge material losses and endangering the lives of crews and passengers. Identification of birds involved in such events can be important for many reasons, including the assistance of accident investigations and supporting management plans to reduce risks in critical areas. Bird strike remains are frequently fragmented or restricted to blood stains, which makes morphological identification impossible. In these situations, DNA barcoding can be used to associate unknown samples to reference samples by comparing cytochrome c oxidase I gene (COI) sequences. The Barcode of Life Data Systems (BOLD) provides a reference database with authenticated sequences and a searching tool suitable for species identification. **Results:** Between 2014 and 2016 the Brazilian Federal Police DNA Laboratory received for analysis 53 unidentified bird strike samples sent by CENIPA, the Brazilian Air Force unit responsible for the investigation of aeronautical accidents in Brazil. Using BOLD and species occurrence data was possible to identify 49 samples (92.5%), all but three to species level. Unsuccessful identifications were due to the lack of DNA in the samples or degradation. Thirteen bird species or genera were identified. The Black Vulture (30.2%), the Southern Caracara (22.6%), the Magnificent Frigatebird (9.4%) and the Southern Lapwing (7.5%) represented most identifications. One sample was associated to two different species, possibly a result of two independent impacts in the same part of the aircraft. **Significance:** Although a more extensive study is necessary to corroborate the results presented here, apparently a few species are more frequently involved in bird strikes. In order to be more cost effective, management plans should prioritize these species. As showed, the use of DNA barcoding associated to species occurrence is an efficient and sometimes the only way to identify bird strike remains, helping to improve flight safety in Brazil.

Introduction

Bird strikes are frequent worldwide, causing huge material losses and endangering lives of crews and passengers¹. In Brazil, 1.733 bird strikes were registered in 2015², and civil aviation companies estimated expenses of 21 million dollars caused by this kind of event in 2009³.

Identification of bird strikes can be used to assist with accident investigations and support management plans to reduce risks in critical areas, such as airports^{1,4}. Removing some species and/or the resources used by them from airport sites (e.g. food, water) and the strict control of land use and economic activities in nearby areas may reduce the frequency of bird strikes.

When biological remains from bird strikes are not suitable for morphological identification, genetic methods can be used to associate unknown samples to a reference sample by comparing DNA sequences that differ between species⁵. DNA barcoding was designed to be a universal system for cataloging and identifying animal species based on standard sequences of the COI gene. The system comprises a reference database with authenticated sequences and a searching tool used for species identification (BOLD)^{6,7}. DNA barcoding has already been used successfully to identify evidence from bird strikes⁸.

In 2014, the Brazilian Federal Police DNA Laboratory initiated a cooperative action with CENIPA, a unit of the Brazilian Air Force responsible for the investigation and prevention of aeronautical accidents in Brazil. Since then, unidentified bird strike remains from all over the country are submitted to the Laboratory for identification. The first results of this cooperative action are presented here.

Material and Methods

From April 2014 to December 2016, the laboratory received 53 samples from 50 different bird strikes (three events with two impacts). Samples consisted of dried or ethanol preserved fragments of feathers, viscera, muscular tissue or swabs with biological fluids.

DNA from sub-samples was extracted with PrepFiler Express™ Forensic DNA Extraction kit in the AutoMate Express™ DNA Extraction System (Applied Biosystems). Fragments of 650 bp from the 5' region of the COI gene were amplified using FishF1/FishR1⁹ or LCO1490/HCO2198¹⁰ primers. PCR conditions and sequencing procedures are described elsewhere¹¹. Consensus sequences were searched in BOLD Species Level Barcode Records database.

Identification of samples was based on BOLD similarity results and representativeness of the group in the database, associated with species occurrence data. Taxonomic information and species occurrence data followed IOC World Bird List¹² and Sigris (2009)¹³. A species level identification was provided when: (1) a query sequence presented >99% similarity to a single BOLD species and all the known congeneric species were represented in the database; and (2) query sequence presented >99% similarity to more than one BOLD species and/or congeneric species are not represented in the database, but these candidate species do not occur at the bird strike site. Considering situation (2), a genus level identification was provided if these species do occur at the bird strike site.

Results

Good quality sequences were obtained from 49 samples (unsuccessful results were usually due to the lack of DNA). All sequences presented more than 99% similarity with at least one bird species from BOLD. Based on the methodology, 49 samples (92.5%) were identified, all but three to species level. BOLD alone allowed a species level identification for 18 samples (Figure 1). Thirteen different bird species or genus were identified. Interestingly, one sample was associated to two different species (Table 01).

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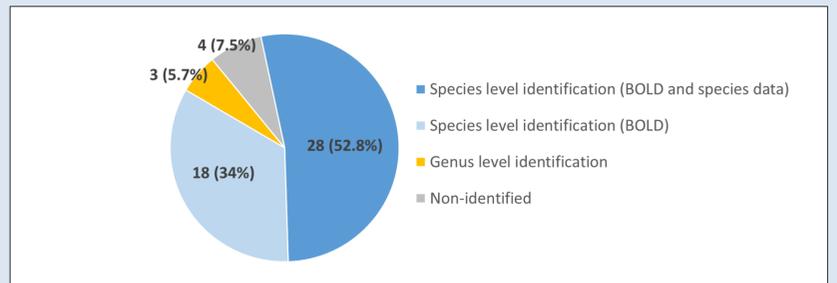


Figure 01. Identification of bird strike samples (n = 53).

Table 01. Identification of bird species or genus associated with bird strike samples and events.

Latin name	Common name	# Samples (%)	# bird strikes (%)
<i>Coragyps atratus</i>	Black Vulture	16 (30.2)	16 (32.0)
<i>Caracara plancus</i>	Southern Caracara	12 (22.6)	11 (22.0)
<i>Fregata magnificens</i>	Magnificent Frigatebird	5 (9.4)	5 (10.0)
<i>Vannellus chilensis</i>	Southern Lapwing	4 (7.5)	4 (8.0)
<i>Columba livia</i>	Rock Pigeon	2 (3.8)	2 (4.0)
<i>Cypseloides</i>	Swift	2 (3.8)	1 (2.0)
<i>Athene cunicularia</i>	Burrowing Owl	1 (1.9)	1 (2.0)
<i>Vannellus chilensis</i> and <i>Coturnix coturnix</i> *	Southern Lapwing and Japanese Quail	1 (1.9)	1 (2.0)
<i>Gallus gallus</i>	Red Junglefowl	1 (1.9)	1 (2.0)
<i>Hydropsalis torquata</i>	Scissor-tailed Nightjar	1 (1.9)	1 (2.0)
<i>Numida meleagris</i>	Helmeted Guineafowl	1 (1.9)	1 (2.0)
<i>Tachycineta albiventer</i>	White-winged Swallow	1 (1.9)	1 (2.0)
<i>Tyrannus melancholicus</i>	Tropical Kingbird	1 (1.9)	1 (2.0)
<i>Caracara</i>	Caracara	1 (1.9)	1 (2.0)
Non-identified	-	4 (7.5)	3 (6.0)
Total		53	50

*Both species were associated to the same sample, and thus the same bird strike event.

Discussion and Conclusions

BOLD with species occurrence data allowed the association of most samples to a single species or genus. The only case in which two different species were associated to one sample is possibly a result of two independent bird strikes on the same part of the aircraft.

Coragyps atratus and *Caracara plancus*, associated to the majority of bird strikes, are opportunistic species regularly found in urban areas. They use dumps as food sources and prey on small animals commonly found in open areas such as airport sites. To reduce incidents involving these species is necessary to eliminate areas where trash is not treated properly from the proximities of the airports. Additionally, measures to repel these animals from the airport sites, including habitat management techniques and the use of scare tactics, are frequently necessary.

Fregata magnificens is a seabird very common in Rio de Janeiro coast, where all the samples associated to this species came from. The two main airports in Rio de Janeiro are located close to the shore, and thus avoiding bird strikes involving this species is a complex problem. Monitoring the local populations to prevent their overgrown and keeping fishing boats away from the airport areas are possible actions.

Vannellus chilensis prey on insects and nests in lawns and short grassland, a kind of environment very common in airport sites. Reducing the risks of impacts with this species demands the removal of local populations and habitat management strategies. Keeping the vegetation higher than the usual is a technique used to make airport sites unattractive to short-grass foraging species¹⁴.

Although a more extensive study is necessary to corroborate the results presented here, apparently, few species are involved in most bird strikes and therefore management plans and risk analysis should prioritize them. As showed here, the use of DNA barcoding associated to species occurrence is an efficient and sometimes the only way to identify these species, helping to improve flight safety in Brazil.

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Support:

