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Diseases of wild birds in southern Rio Grande do Sul, Brazil[1]

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ABSTRACT.- Echenique J.V.Z., Soares M.P., Albano A.P.N., Bandarra P.M. & Schild A.L. 2020. **Diseases of wild birds in southern Rio Grande do Sul, Brazil.** *Pesquisa Veterinária Brasileira 40(2):121-128.* Laboratório Regional de Diagnóstico, Faculdade de Veterinária, Universidade Federal de Pelotas, Campus Capão do Leão, Pelotas, RS 96010-900, Brazil. E-mail: alschild@terra.com.br

Necropsy protocols of the "Laboratório Regional de Diagnóstico" of "Faculdade de Veterinária" of the "Universidade Federal de Pelotas" were reviewed, ranging the period from 2000 to 2018. Three hundred eighty one necropsies, 25 refrigerated and/or formaline fixed organs, and seven biopsies were received, representing 413 samples. Most of these materials were sent by the "Núcleo de Reabilitação da Fauna Silvestre" of "Universidade Federal de Pelotas" (NURFS-CETAS-UFPel) and were from municipalities within the range area of LRD-UFPel influence. Of the 413 cases 55 (13.31%) corresponded to metabolic/nutritional diseases; 50 (12.10%) to trauma; 35 (8.47%) to bacterial diseases/toxi-infections; 30 (7.26%) to parasitic diseases; 28 (6.77%) to fungal diseases; four (0.97%) to viral diseases and 17 (4.11%) to other diseases. Cases where it was not possible to determine the etiology, were in severe autolysis or were inconclusive totaled 194 (46.97%). Metabolic/nutritional diseases and traumatic injuries were the main cause of death in wild birds', being Passeriformes the most affected order.

INDEX TERMS: Wild birds, spillover, wildlife animals, epidemiology.

RESUMO.- [**Doenças de aves silvestres no sul do Rio Grande do Sul.**] Foi realizado um estudo retrospectivo dos diagnósticos de causas de morte e de lesões em aves silvestres na região Sul do Rio Grande do Sul de 2000 a 2018. Foram revisados os protocolos de necropsia e materiais de aves silvestres encaminhados ao Laboratório Regional de Diagnóstico da Faculdade de Veterinária da Universidade Federal de Pelotas no período. Foram recebidos 381 cadáveres para necropsia, 25 órgãos refrigerados e/ou em formol e 7 biopsias, totalizando 413 materiais. A maioria desses materiais foi remetida pelo Núcleo de Reabilitação da Fauna Silvestre da Universidade Federal de Pelotas (NURFS-CETAS-UFPel) e provenientes de municípios da área de influência do LRD-UFPel. Dos 413 casos 55 (13,31%) corresponderam a doenças metabólicas/nutricionais; 50 (12,10%) a traumas; 35 (8,47%) a doenças bacterianas/toxi-infecções; 30 (7,26%) a doenças parasitárias; 28 (6,77%) doenças fúngicas; 4 (0,97%) doenças virais e 17(4,12%) outras doenças que não se encaixavam nas categorias. Ainda em nos casos em que não foi possível determinar a etiologia, apresentaram autólise acentuada ou foram inconclusivos somaram 194 (46,97%). As doenças metabólicas/nutricionais e lesões traumáticas foram as principais causas de morte de aves silvestres, sendo a ordem mais afetada a Passeriformes.

TERMOS DE INDEXAÇÃO: Aves silvestres, *spillover*, animais selvagens, epidemiologia.

INTRODUCTION

Brazil has the largest number of bird species in the world, many of which is endemic and threatened or in risk of extinction (Mittermeier et al. 2005, Marinha Militar 2016, Machado et al. 2008). In this scenario, Brazil is one of the

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main collection sites and leading routes of wildlife illegal trade (Oliveira 2003). This illegal trade moves around US $ 6 billion and extracts from nature more than four million birds, being one of the main threats to many species survival. In addition to illegal trade, habitat loss, illegal hunting and capture are other causes of bird population decline, causing an ecological imbalance in ecosystems (Redford 1992). This imbalance may facilitate pathogen transmission of an adapted population (reservoir) to a new host population (naïve) in an epidemiologic process called spill-over (Frölich et al. 2002). This phenomenon can be observed when wild birds approach urban centers and can be infected with agents that are not described for the species.

Infectious or parasitic diseases affect wild birds often, mainly because of bare transport conditions of illegal trade. Consequently, 90% of captured birds do not reach their final destination (Redford 1992, RENCTAS 2001, Wilson-Wilde 2010). Cachexia and trauma injuries caused by this transportation can predispose the occurrence of infectious/parasitic diseases. In a study conducted in the state of São Paulo with apprehended birds from illegal trade, the main diseases were infectious and parasitic (Godoy & Matushima 2010).

The aims of this paper were to identify the main diseases that occur in wildlife birds in southernmost region of Rio Grande do Sul State, highlighting those diagnostics with zoonotic/spillover potential.

MATERIALS AND METHODS

A retrospective study of diseases of wild birds diagnosed in the "Laboratório Regional de Diagnóstico" of "Faculdade de Veterinária" of the "Universidade Federal de Pelotas" (LRD-UFPel) was carried out. The study period comprehended January 2000 until November 2018. Epidemiological data were retrieved from the necropsy protocols and information as species, sex and age were recorded. The birds were classified according to the age group in nestling, juvenile, and adult; and categorized into a higher taxon (Order) in order to group species with the same characteristics. The gross and microscopic changes observed in necropsies or biopsies/remitted organs, results of microbiological/mycological culture, and parasitology techniques were also reviewed. The diagnoses were grouped into different categories according to the nature of the etiological agent, in metabolic/nutritional diseases, traumas, parasitic diseases, bacterial diseases, fungal diseases, viral diseases, and other diseases. In cases which there were concomitant diseases, the disease responsible for the bird's death was considered. The cases that did not fit into any of the mentioned etiologies were classified as indeterminate etiology. The inconclusive diagnoses, samples in autolysis and without bacterial growth were also included in this study. In this study, domestic birds considered as pests (House Sparrows and Domestic Pigeons), non-traditional farmed species (Turkeys, Rheas and Quails), exotic or ornamental birds and/or kept as pets (Canaries, Cockatiels and Parakeets), and Penguins (Sphenisformes) were excluded.

RESULTS

From January 2000 to November 2018, 381 necropsy cadavers, 25 refrigerated and/or formalin fixed organs, and seven biopsies of wild birds, totaling 413 samples, were submitted to LRD. Most of these materials were sent by the "Núcleo de Reabilitação da Fauna Silvestre" of the "Universidade Federal de Pelotas" (NURFS-CETAS-UFPel) and was from the LRD's influence area municipalities.

Of the 413 cases, 55 (13.31%) corresponded to metabolic/nutritional diseases; 50 (12.10%) to trauma; 35 (8.47%) bacterial diseases/toxi-infections; 30 (7.26%) parasitic diseases; 28 (6.77%) fungal diseases; 4 (0.97%) to viral diseases, and 17 (4.11%) other diseases. The inconclusive or severe autolytic cases accounted for 194 (46.97%) individuals. The bird's species were informed in 413 cases and it was possible to group them in 21 orders, being 219 (53.02%) Passeriformes (song birds); 44 (10.65%) Psitassiformes (parrots and monk parakeet); 37 (8.95%) Strigiformes (owls); 25 (6.05%) Anseriformes (waterfowls); 14 (3.39%) Charadriiformes (scavenger birds); 11 (2.66%) Pelecaniformes (herons); 9 (2.18%) Columbiformes (wild pigeons); 9 (2.18%) Gruiformes (common gallinules); 7 (1.69%) Accipitriformes (hawks); 7 (1.69%) Piciformes (woodpeckers); 6 (1.45%) Falconiformes (falcons); 5 (1.21%) Suliformes (cormorants); 4 (0.97%) Coraciiformes (kingfishers); 4 (0.97%) Rheiformes (rheas); 3 (0.73%) Tinamiformes (tinamous); 2 (0.48%) Ciconiiformes (storks), 2 (0.48%) Procellariiformes (albatrosses and petrels); 2 (0.48%) Cuculiformes (cuckoos); 2 (0.48%) Podicipediformes (grebes); 1 (0.24%) Apodiformes (hummingbirds); 1 (0.24%) Caprimulgiformes (pauraques) and in one case (0.24%) it was not possible to determine the order.

In 243 (58.84%) cases the birds were classified as adults; 37 (8.95%) in juveniles, and 22 (5.32%) in nestlings. In 112 (27.11%) this information was not available in the necropsy protocols. The most frequent diseases of each etiology were distributed according to the order and age. This data is shown in Tables 1-3. The traumatism cases were classified according to the order and age group (Fig.1).

Less frequently, fungal diseases totaled 28 diagnoses, with 25 cases of aspergillosis. This disease was observed mainly in Anseriformes, Acipritiformes, Charadriiformes, Gruiformes, Podicipediformes, Strigiformes, Suliformes, and Passeriformes adult birds. The lesions were observed in air sacs and lungs,

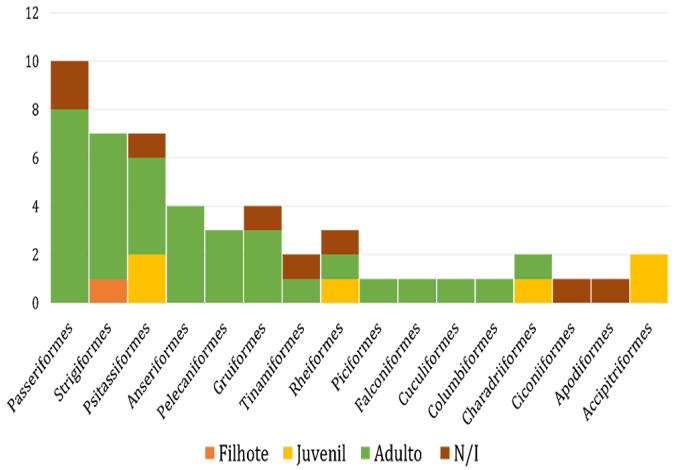

Fig.1. Distribution of traumatic lesions (n=50), according to order and category, diagnosed in wild birds at the "Laboratório Regional de Diagnóstico" of the "Faculdade de Veterinária" of the "Universidade Federal de Pelotas" from January 2000 to November 2018.

Table 1. Metabolic/nutritional diseases (n=55) distribution according to order and age category in wild birds submitted to the "Laboratório Regional de Diagnóstico" of the "Faculdade de Veterinária" of the "Universidade Federal de Pelotas" from January 2000 to November 2018

Order	Cachexia/ Age category	Hepatic steatosis/ Age category	Microvesicular cardiac degeneration*/ Age category	Capture myopathy/ Age category	Vitamin A deficiency/ Age category	Egg retention/ Age category
Anseriformes	5/1A, 3N, 1J	1/1F	-	-	-	-
Caprimulgiformes	1/A	-	-	-	-	-
Coraciiformes	1/1 Ni	-	-	-	-	-
Gruiformes	2/2A	-	-	-	-	-
Passeriformes	17/13 A, 1J,1N, 3Ni	9/7A, 1N, 1Ni	6/5A, 1 Ni	-	1/1 A	-
Podicipediformes	1/1 Ni	-	-	-	-	-
Psitassiformes	3/1A,1J, 1Ni	-	-	-	-	1/1 A
Strigiformes	3/2A, 1J	-	-	-	-	-
Charadriiformes	-	2/ 2F	-	-	-	-
Rheiformes	-	-	-	1/1A	-	-
Suliformes	-	-	-	1/1A	-	-
TOTAL	33 (60%)	12 (21.81%)	6 (10.90%)	2 (3.63%)	1(1.81%)	1(1.81%)

Category: N = nestling, J = juvenile, A = adult, Ni = not informed; * Lesions were observed only in cardiomiocytes, mainly in the papillary muscles of the left ventricle without skeletal muscle necrosis.

Table 2. Bacterial diseases (n=35) distribution according to order and age category in wild birds submitted to the "Laboratório Regional de Diagnóstico" of the "Faculdade de Veterinária" of the "Universidade Federal de Pelotas" from January 2000 to November 2018

	Colibacilosis/ Age category	Sepsis/ Age category	Botulism/ Age category	Pododermatitis/ Age category	Salmonellosis/ Age category	Micobacteriosis/ Age category
Accipitriformes	-	1/1N	-	-	-	-
Anseriformes	1/1Ni	1/1Ni	2/2Ni	-	-	-
Charadriiformes	-	1/1Ni	1/1A	-	-	-
Coraciiformes	2/1N, 1Ni	-	-	-	-	-
Passeriformes	4/2A, Ni	7/1A, 1N, 4Ni	-	1/1 A	-	-
Psitassiformes	8/2A, 1J, 5Ni	3/2N, 1J	-	-	1/1 Ni	-
Strigiformes	1/1A	-	-	-	-	1/1 Ni
TOTAL	16 (45.71%)	13 (27.14%)	2 (5.71%)	1 (2.94%)	1(2.94%)	1(2.94%)

Category: N = nestling, J = juvenile, A = adult, Ni = not informed.

Table 3. Parasitic diseases (n=30) distribution according to order and age category in wild birds submitted to the "Laboratório Regional de Diagnóstico" of the "Faculdade de Veterinária" of the "Universidade Federal de Pelotas" from January 2000 to November 2018

	Trichomoniasis/ Age category	Coccidiosis/ Age category	Singamosis/ Age category	Trematode hepatitis/ Age category	*Hytrichis* sp. parasitism/ Age category	gastrintestinal parasitosis/ Age category	Filariosis/ Age category	Nematode Hepatitis/ Age category	Trichomoniasis Aspergillosis/ Age category
Passeriformes	-	8/7A, 1 Ni	3/3 A	-	-	1/1 Ni	1/1 Ni	1/1 Ni	-
Strigiformes	5/4A, 1J	-	-	2/2A	-	-	-	-	-
Falconiformes	3/1N, 2J	-	-	-	-	-	-	-	1/1J
Columbiformes	2/1A, 1J	-	-	-	-	-	-	-	-
Pelecaniformes	-	-	-	-	2/2A	-	-	-	-
Accipitriformes	-	-	-	-	-	-	-	-	-
Psitassiformes	-	-	-	-	-	1/1A	-	-	-
TOTAL	10 (33.33%)	8 (26.66%)	3 (10%)	2(6,45%)	2(6.66%)	2 (6.66%)	1(3.33%)	1(3.33%)	1(3.33%)

Category: N = nestling, J = juvenile, A = adult, Ni= not informed.

and in one case, the bird also presented avian pox skin lesions. Another important fungal disease observed in that period was oral candidiasis, being diagnosed in three cases.

Regarding the viral diseases the poxvirus was observed in four opportunities and in all cases only the integument was affected. This disease was observed in Psitaciformes (1), Passeriformes (1), and Strigiformes (2). The age category were adult (2), juvenile (1) and in one case was not informed. The diagnostics that did not fit in any category included: avian leucosis (4) captive maladaptation (1), deforming arthritis (1), xhantoma (1), skin squamous cell carcinoma (1), hepatic cirrhosis (1), non-specific granuloma (1), congenital malformation (1), and others (6). These cases summed up 17 individuals of different avian Orders.

DISCUSSION

Metabolic diseases were the main cause of death in wild birds from southernmost Brazil and Passeriformes being the most frequent Order. Song birds are very addressed by wildlife trade due to its high commercial value and high profit rate (RENCTAS 2001). Additionally, this reflects the reality of rehabilitation centers where this is the main Order submitted in these facilities (De Freitas et al. 2015).

Cachexia was the most frequent diagnostic with the widest Orders range. The majority of birds were from NURFS, which suggests an inability of those animals to adapt in captivity after their illegal capture in nature. The second major metabolic cause of death was hepatic steatosis. This disease can also be related to illegal trafficking and poor housing conditions. The main affected order was Passeriformes, mainly *Paroaria coronate* (red crested cardinal) (Fig.2). Those birds when submitted to NURFS were seized from illegal trade and were in poor sanitary conditions without an appropriated diet (diet rich in sunflower seeds and often with mold) during its previous captivity. Despite offering the proper diet, the animals came to death. This framework suggests that those birds may have been in prolonged fasting. In domestic felids, food deprivation can cause severe hepatic steatosis (Valtolina & Favier 2017) and it is believed that the same disease onset could have happened in these cases.

The sudden death without cachexia occurred exclusively in Passeriformes. All these cases presented a history of stress episodes (apprehension by the ambiental patrol) consisting with capture (exertional) myopathy. In these cases, microscopically there was severe microvesicular cardiac degeneration, more marked within the papillary muscles in the left ventricle. This lesion can be observed in some cases of capture myopathy (Friend & Thomas 1999). However, in classic cases it is noted segmented muscular necrosis of muscular fibers in great skeletal muscle masses (mainly pectoral and inferior limbs) (Friend & Thomas 1999). In the present cases, skeletal muscle and renal lesions were not observed, which leads to believe that Passeriformes cases had an extremely acute clinical course. All those animals underwent a stressful event what can release endogenous catecholamines by sympathetic nerve endings and adrenal medulla. The prolonged exposure to high concentrations may result in coronary spasm, arrhythmias, contractile dysfunction, and cell damage which lead to myocardial necrosis (Dhalla et al. 1992). Based on this mechanism, it can produce solely cardiac lesions in these songbirds without the skeletal lesions commonly seen in other species (Spraker et al. 1987, Tully Junior et al. 1996).

The second major cause of death was trauma, unlike shown in other surveys (Sharma et al. 2014, Montesdeoca et al. 2017). This may have happened because trauma diagnosis is not difficult to the clinician and the cadavers are not submitted to diagnostic laboratories. It is also necessary to consider the high number of Passeriformes presented with trauma, which is related to poor transport conditions of illegal trade (RENCTAS 2001). In cases involving Strigiformes (owls)(Fig.3), the trauma injuries were probably results of accidental run over by vehicles that transited at night. In southernmost Brazil, human depredation is also a reality due to the superstitious feature (bad luck) that owls have amongst rural populations. In the Psitaciformes (parrots and monk parakeets) cases of this study, the traumas occurred mainly in nestlings and could be related to the collection of these specimens being sold and used as pet birds.

Fig.2. *Paroaria coronata* (red crested cardinal) adults, pectoral muscle. Marked atrophy of pectoral muscles of both cardinals, severe onichogriphosis and feces accumulation around the cloaca.

Fig.3. *Bubo virginianus* (great horned owl), adult, humerus. Body of humerus exposed oblique fracture in its medial third associated with edema and hemorrhage.

Regarding the bacterial diseases, avian colibacilosis was the most frequent disease. The diagnosis was based on macroscopic and histological lesions with bacterial isolation. Colibacillosis is caused by avian pathogenic *Escherichia coli* (APEC) and it has a wide range of systemic and localized lesions (Barnes & Gross 1997). In this study, this disease occurred more in adult Psitaciformes and Passeriformes. This is an opportunistic disease and can affect a large number of animals in rehabilitation centers, mainly because the high density of birds, which can lead to immunosuppression by stress. (Valtolina & Favier 2017). As well as colibacillosis, different opportunistic microorganisms can cause sepsis (Chadfield et al. 2005, Seymour et al. 2016). Bacterial diseases were the second most frequent cause of death in wild birds and were observed predominantly in nestlings. This age group is more exposed to ruthless weather condition when they are away of parental care. This can predispose to bacterial infections and consequent septicemia (Benskin et al. 2009). Furthermore, some authors have observed that the high concentration of organochlorines (OGC) in tissues of northern Baltic Sea nestlings seagulls found dead can enhance the septicemia risk (Hario et al. 2004). OGCs decrease the ability of the immune system to respond correctly to infections (Hario et al. 2004, Morrissey et al. 2014). It should be emphasized that the southernmost region of RS, where most of those birds of this work came from, is a well-developed agricultural region with large rice and soybeans crops. Various pesticides are often used in these plantations, including organochlorines, which remain in the environment and birds can bioaccumulate these substances in their bodies over the years (Flores et al. 2004). The sepsis in adult birds was associated with trauma. These lesions may permit the entry of pathogenic microorganisms such as *Staphylococcus* sp. (Huckabee 2000).

Two cases of botulism were observed in birds with aquatic and scavenger habits (Rocke & Bollinger 2008). The diagnosis was based on the clinical signs, absence of gross and histologic lesions, and bioassay in mice. These birds could work as sentinels for botulism, since the high unusual mortality indicates contamination sources for other domestic species.

Salmonellosis and mycobacteriosis, despite being diagnosed only in one case each, highlighted the spillover risk in southernmost Brazil. It has been mentioned that the proximity between species can facilitate the transmission of these diseases (Converse 2008, Daoust & Prescott 2007). In cases of salmonellosis (Turquoise-fronted amazon - *Amazonaa estiva*) and mycobacteriosis (great horned owl - *Bubo virginianus*), the animals had close contact with people and other domestic birds.

In relation to parasitic diseases, trichomoniasis was more frequently observed affecting mainly birds of prey and less frequently wild pigeons (Fig.4A). This disease is a great limitation for conservation of wild birds (Bunbury et al. 2007, Forzán et al. 2010), since domestic pigeons are the main reservoirs of *Trichomonas gallinae* (Amin et al.2014.). Birds of prey can be contaminated by domestic dove predation. In addition, those birds can contaminate waterer and grains in feeders, which can lead to transmission to wild birds (Purple & Gerhold 2015). Regarding this, it is suggested that wild-doves sharing waterers with domestic pigeons (*Columbia livia*) can be contaminated and transmit the disease to their predators who are extremely sensitive to trichomoniasis. In this context, birds of prey could contaminate themselves as they approached urban centers to prey domestic doves.

Coccidiosis affected exclusively adult red crested cardinals, suggesting a susceptibility of this species. Godoy & Matushima (2010) analyzed birds from illegal trafficking in São Paulo state and observed that coccidiosis was one of the main causes of death in that population. Passeriformes of this present study were from illegal trafficking, which may have caused a stressful condition and triggered the disease. This disease has declined over the years following the adoption of deworming protocols upon birds' arrival at NURFS.

Singamosis (Fig.4B) was diagnosed only in song birds that stayed at the "Núcleo de Reabilitação da Fauna Silvestre" (NURFS-CETAS-UFPel) and were in a soft release enclosure (Clarke et al.2002). This disease is mainly diagnosed in Galliformes (Pheasants) (Gethings 2018) and is not commonly observed in Passeriformes. Other parasitic diseases were diagnosed in only in a few cases.

Regarding fungal diseases, aspergillosis was the main diagnosis in this etiology (Fig.5). The disease was observed in adult birds and was generally associated with other conditions or trauma injuries. Immunosuppressive factors are determinants for the disease occurrence (Carrasco et al. 2001) and it has been observed that aspergillosis cases, and other mycoses, are limiting factors for wild birds conservation (Pitarch et al. 2017). In addition, cases of oral candidiasis were observed only in Passeriformes and Columbiformes, both adult and nestling. In nestlings of scavenger birds in Spain, oral candidiasis is related to the accidental ingestion of residual antibiotics in bovine carcasses (Pitarch et al. 2017). It has been mentioned that in adults, candidiasis is usually associated with other diseases (Hubbard et al. 1985). In this survey, this condition was not observed in any of the adult bird's cases.

The most important viral disease was avian pox and it was observed in juvenile birds of three different orders. Avian pox summed four cases only, being of minor importance for wild birds' conservation in southern Brazil. On the other hand, this disease was very frequent in songbirds from São Paulo state (Godoy & Matushima 2010) and the most important skin disease in wild turkeys of the United States (Elsmo et al. 2016). The leukosis cases happened in adult Passeriformes and did not have epidemiological importance. This fact is supported by a five years survey held in England. One-thousand-two-hundred-thirty-four cadavers from a zoo were examined and the disease was observed only in six occasions (Wadsworth et al. 1981).

Fig.4. (**A**) *Carcara plancus* (southern crested caracara), juvenile, oral cavity, oral trichomoniasis. Multiple coalescent yellow tan nodules affecting 1/3 of oral cavity. There is also velvet green plaques covering the tongue. (**B**) *Saltator similis* (green saltator), adult, trachea, singamiasis. Multiple reddened areas when opened revealed parasites.

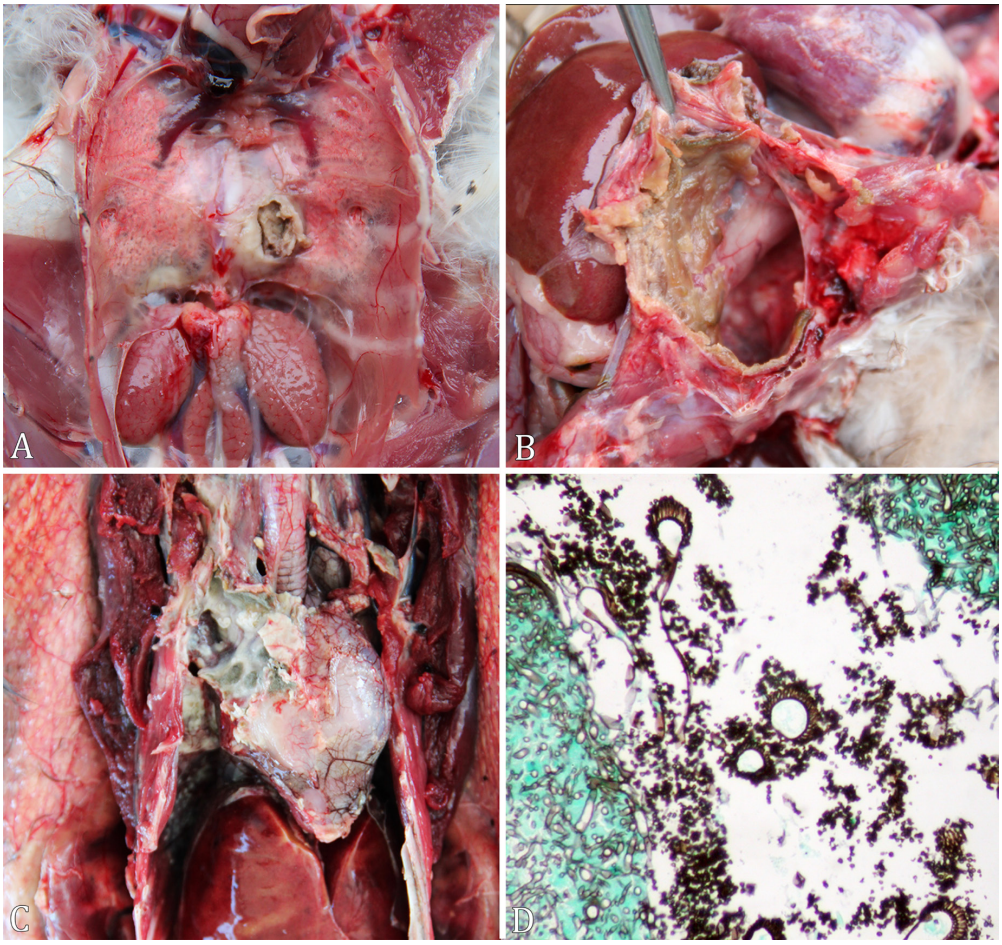

Fig.5. (**A**) *Tyto furcata* (common barn owl), juvenile, lung, pulmonary aspergillosis. Two tan nodules within the pulmonary parenchyma. (**B**) *Buteo gallusmeridionalis* (savanna hawk), juvenile, abdominal air sac, aspergillosis. Marked left abdominal air sac with wall thickening of yellowish caseous material. (**C**) *Phalacrocorax brasilianus* (neotropical cormorant), adult, cervical air sac, aspergillosis. Presence of velvet white to green fungal *Aspergillus* spp. colonies. (**D**) *Phalacrocorax brasilianus* (neotropical cormorant), adult, cervical air sac, aspergillosis. Gomori Methenamine-Silver (GMS) reveals septate hyphae with dichotomous branching, conidiophores and multiple free conidia. GMS, obj.40x.

CONCLUSIONS

This study demonstrated that metabolic diseases and trauma lesions are the main cause of death of wild birds in southernmost region of Brazil and Passeriformes were the most affected order.

Infectious and parasitic diseases are also important causes of wild bird mortality. Spillover in wild birds within this area may have a limited importance, since diseases caused by shared agents both by domestic and wild animals were diagnosed at low frequency.

Another important fact highlighted by this survey was that illegal trafficking was a determinant factor for a wide range of disease manifestations.

More studies are needed in the area in other wild animals' classes to better understand the possibilities of spillover occurrence.

Conflict of interest statement.- The authors have no competing interests.

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