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REVIEW

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PARASITIC INFECTIONS IN WILD BIRDS OF THE FAMILY PSITTACIDAE: THE RELATIONSHIP BETWEEN ZOONOSIS AND THE ONE HEALTH

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ABSTRACT

Birds belonging to the Psittaciformes order have a wide distribution worldwide, emphasizing the Brazilian biomes, and are characterized by their colors and shapes. Due to their vast diversity, these wild animals are targets for trafficking and illegal confinement in captivity. The stress and self-mutilation of capture are one of the main clinical signs these animals show, leaving them immunologically vulnerable to infections. Thus, endoparasite infections caused by zoonotic parasites are recurrent in this group of birds. Therefore, this study aimed to evaluate the most recurrent parasitic infections that affect the Psittacidae family of wild birds, highlighting the relationship between parasitic zoonoses and the concept of One Health. The work consisted of a literature review of articles related to the incidence of parasites in wild Psittacidae published from 2010, the data the till when extracted and computed in table form. The most prevalent diseases in the study were capillariasis, ascariasis, eimeriosis, cryptosporidiosis, strongyloidiasis, and giardiasis, and three of the six diseases cited to have the potential for transmissibility between animals and humans. Thus, the measures of approach to these zoonotic diseases are of interest to One Health, making it necessary for the joint action of veterinarians and other health professionals.

KEYWORDS: One health, Parasites, Psittacidae, Uses of Epidemiology.

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INTRODUCTION

The birds of the family Psittacidae have a cosmopolitan distribution. Despite the wide variety of colors and shapes, the Psittacidae constitute a very homogeneous group belonging to the order Psittaciformes, which currently consists of 398 species, gathered in four families: Strigopidae, Cacatuidae, Psittaculidae e Psittacidae (BEJČEK and ŠTASTNÝ, 2002). In Brazil, there is a great diversity of recorded psittacine, with approximately 88 species described throughout the Brazilian territory, which represent about 22.3% of the world's psittacines birds, and more than 15% of these native species are classified as endangered (GRESPAN and RASO, 2014; MMA, 2018; IUCN, 2021). However, due to this vast diversity, these wild birds are one of the country's main targets of illegal trade (GOGLIATH et al., 2010).

Many Psittacidae species have high longevity (YOUNG et al., 2012), and birds bred and kept in captivity develop a set of diseases that may or may not differ from those that occur in their natural habitats (RICKLEFS, 2000). After capture and confined in captivity, these animals are subject to some harmful effects on birds, such as stress, self-mutilation, and depression, factors that compromise their well-being, leaving them immunologically vulnerable to infections (BRADSHAW and ENGEBRETSON, 2013).

In connection with this, factors inherent to confinement promote the maintenance and dissemination of pathogens because they are treated in areas with low ventilation, protected from luminosity, and with an accumulation of waste from other animals (MARINHO et al., 2010). Thus, parasitic infections caused by zoonotic endoparasites stand out as one of the most recurrent problems in these species, leading to a subclinical infection, which prevents the animal from being released into the wild environment again, may lead to death (MARQUES et al., 2019).

The epidemiological study of parasitic infections of the psittacines, considering the parasite-host relationship in wild birds, is essential because these relationships reflect on the reproductive performance of these captive birds, their general well-being, and the fact that they act as reservoirs and hosts of etiological agents impacting on human, animal, and ecosystem health (SOUSA et al., 2018; SNAK et al., 2014). These impacts generate health challenges and demand the development of integrated solutions proposed by One Health (OIE, 2019). In this sense, due to the high biodiversity of the country and the risks that affect fauna, the implementation and support for studies investigating the occurrence of pathogens and the consequent disease in animals are urgent (CATÃO-DIAS, 2003).

DEVELOPMENT

The present study was developed in the form of a literature review. The theme of the research and the possible inclusion and exclusion criteria of the articles that

would make up this work were defined. The following guide question was formulated: "What are the main species of parasites found in birds of the family Psittacidae, and what is the impact of these infections on the health conditions of these animals?". The survey also sought to investigate links between such parasitic infections and human, animal, and environmental health within the context of One Health.

Then search strategies were carried out in Medline (PubMed), Scielo, e Google Scholar databases. The descriptors were used "Psitacídeos/ Psittacids" e "Parasitas/ Parasites", combined with the Boolean operator "AND", whose search has been limited to articles in Portuguese and English and published since 2010. This stage was performed in pairs by two independent reviewers. After the systematization of the information collected from the articles, starting with the information extracted from them, it was possible to identify the infections with the highest prevalence in psittacines, which will be explained below.

CAPILLARIASIS

Of the most recurrent parasitic infections in psittacines is parasitism by specimens of the genus Capillaria (MELO et al., 2020). The parasite of this genus belongs to the class Nematoda and is filamentous and whitish (BOWMAN, 2006). Females of this genus reach from 10 to 80 mm, while males are 10 to 25 mm in length, differing from females by the presence of only one spicule (BOWMAN, 2006). This infection is often reported in captive psittacines and kept in zoos due to the high population density in captivity and the low sanitary condition of the environment in which these birds live (AYRES et al., 2016).

The life cycle of parasites is usually direct (monoxenic), but some species of Capillaria spp. need an intermediate host, indirect cycle (heteroxenous) (ZUCCA and DELOGU, 2010). The monoxenic cycle begins with the ingestion by a healthy bird of larval eggs released into the feces of infected birds, possibly contaminating the water and food of these animals. In the small intestine of the newly parasitized bird, the larvae take about 3 to 4 weeks to develop in egg-producing males and females after penetrating the cecal mucosa (TAYLOR, COOP and WALL, 2017; ZUCCA and DELOGU, 2010). When they become adults, the females lay bi-operculated eggs, having a barrel-like shape and a thick casing in the intestinal lumen of the birds, which will be eliminated together with the feces in the environment (TAYLOR, COOP and WALL, 2017).

For the species C. caudinflata the heteroxenous cycle is required, as the eggs of these parasites need to be ingested by an intermediate host of the genus Lumbricinas (earthworms) to become infective within approximately 3 to 4 weeks (MARTINS, 2019; TAYLOR, COOP and WALL, 2017; YABSLEY, 2008).

Regarding the epidemiology of the disease, the prevalence of Capillaria spp. in psittacines Amazona aestiva, Nymphicus

hollandicus, Psittacula krameria, Brotogeris pyrrhoptera, Melopsittacus undulates, Agapornis fischeris, Eclectus roratus, Aratinga cactorum, Anodorhynchus hyacinthinus, Ara ararauna, Ara macao, Ara chloropterus, Cyanoliseus patagonus, Amazona spp. Ochrocephala, Ara ambígua (MARQUES et al., 2019; SPRENGER et al., 2017; LIMA et al., 2017; AYRES et al., 2016; SANTOS et al., 2015; SIERRA, RAMIREZ and OSORIO, 2013; FARRET et al., 2010), showing this parasite can affect domestic and wild birds. It was possible to identify in the literature the infection of psittacines of the species Enicognathus ferrugineus e Enicognathus leptorhynchus, species of the species-specific species Capillaria genus for birds of the family Psittacidae such as Capillaria plagiaticia (VALDEBENITO et al., 2015).

Capillary is usually a low pathogenic. Birds with low parasitic load present an asymptomatic picture of the infection or nonspecific signs of infection (YABSLEY, 2008; TAYLOR, COOP and WALL, 2017). However, in birds that have a high parasitic load, the disease promotes clinical signs such as diarrhea, decreased thirst, mucoid feces, cachexia, polyphagia, and secondary infections, due to severe diarrhea due to the destruction of intestinal tissue integument and dehydration of the animal (GRESPAN and RASO, 2014; YABSLEY, 2008; SPRENGER et al., 2017). It is also common for birds to have mixed parasitic infections, with an association of Capillaria sp. with parasites of the genus Eimeria, Ascaridia, and Strongyloides (MARQUES et al., 2019; SPRENGER et al., 2017; LIMA et al., 2017; AYRES et al., 2016; SANTOS et al., 2015; FARRET et al., 2010).

Even though it is not very pathogenic, capillariasis is a zoonotic disease, as it is known Capillaria spp. infects mammals and birds of a different genus that have direct contact with the feces of infected birds or indirect if there is contamination of water or food sources (MARTINS, 2019). Species such as Capillaria philippinensis are anthropozoonotic because bird feces containing the larval eggs of the species can contaminate water sources and food sources that will be served to humans, mammals, and other birds. This infection will promote other serious enteropathies, with anorexia preceded by intermittent diarrhea (TAYLOR, COOP and WALL, 2017).

Although it is an intestinal pathogen, there are rare reports of respiratory tract infections in humans leading to hemorrhagic and pulmonary necrosis (SOARES et al., 2011; MEDENICA and MEDENICA, 2014). Thus, concerning this disease and other zoonoses, it is understood there is an inherent between human, animal, and environmental health, as described by One Health.

ASCARIASIS

Ascariasis is a common parasitic infection in almost all wild and domestic birds. However, nematodes of the genus Ascaridia cause more severe and generally fatal infections in captive birds due to immunodeficiency generated by captive stress (MELO et

al., 2020; AYRES et al., 2016). The phylum Nematoda parasites are robust and have a whitish tint; females measure from 70 to 120 mm, and males, 50 to 75mm. Thus, these worms are considered one of the largest nematodes of parasite birds, the most recurrent species of ascariasis in psittacines Heterakis spp. and Ascaridia hermaphrodite (TAYLOR, COOP and WALL, 2017).

- HETERAKIS SPP.

Nematodes of this genus are usually parasite-production birds; however, they show a negative impact when reported in birds of free and captive life (MELO et al., 2020; TAYLOR, COOP and WALL, 2017). This genus was found in more than 107 wild bird species, including Brazilian birds, recorded on all continents except Antarctica (ATKINSON, THOMAS and HUNTER, 2008). Adult parasites of Heterakis spp. measure up to 1.5 cm and usually parasite the cecum of the definitive host. Males have two spurious of different sizes with a pre-cloacal suction cup at the posterior end and the presence of papillae (MARTINS, 2019; ROBERTS, JANOVY and NADLER, 2013; MONTEIRO, 2007).

The biological cycle of these parasites is monoxenic and begins by eliminating the eggs next to the feces of the infected bird, promoting the development of L1 inside the egg. The definitive host is infected with the ingestion of eggs, and later a part of the larvae penetrates deeply into the mucosa of the cecum, and another part, is in the epithelial crypt of the cecum, where they make the seedlings from L2 to L4, passing through the stages of young to adult, ending the cycle with oviposition in the cecal lumen. This infection has a pre-patent period of approximately 4 weeks (MARTINS, 2019; MONTEIRO, 2007).

Some authors have recorded infection by nematodes of the genus Heterakis in the species of psittacines Myiopsitta monachus, Nymphicus hollandicus, Amazona spp., Aratinga cactorum, Psittacula krameri (BOLL, MARQUES, and ALIEVI, 2017; LIMA et al., 2017; AYRES et al., 2016; BERNARDI et al., 2013). Three, among the five species of Psittacidae parasitized by Heterakis spp. reported, are species of birds commonly created as pets in Brazil; therefore, the possibility of cross-infection with urban birds stands out, evidencing a public health problem.

The pathogenesis of parasitic worm infection Heterakis is mild. Larvae might cause minor inflammations in the cecal mucosa (MARTINS, 2019; MONTEIRO, 2007). Clinical signs of infection are nonspecific, such as weakness, diarrhea, dyspnea, emaciation, and terminal panting (ATKINSON, THOMAS and HUNTER, 2008; LIMA et al., 2017). But in more severe cases of infection, congestion of the cecum, thickening and mucosal petechiae, abscesses in the cecum, and intussusception (MENEZES et al., 2003).

It is known synanthropic animals are the main sources of cross-infection with captive animals due to contact with food sources and enclosures. Thus, it is vital to perform the tests and stool examination analyses periodically in the squads and avoid contact with the synanthropic ani-

mals with the captives (AYRES et al., 2016; SNAK et al., 2014).

- ASCARIDIA HERMAPHRODITE AND OTHER SPECIES OF THIS GENUS

Parasites of this genus are frequently reported in captive psittacines, such as parakeets and macaws, being considered the most important parasites of parrots kept in captivity (HOFSTATTER and GUARALDO, 2015). According to Claudino et al., (2017), Valdebenito et al., (2015), Bernardi et al., (2013), Melo et al., (2013), and González-Hein et al., (2012), the most recurrent species of the genus Ascaridia in psittacids were Ascaridia hermaphrodite, Ascaridia platyceri and Ascaridia columbae. These nematodes have a trilled mouth and eggs, like those of the genus Heterakis, are intensely white and females measure up to 12 cm in length (TAYLOR, COOP and WALL, 2017; MONTEIRO, 2007).

The eggs of these parasites become infective (L3) in the environment at ideal temperatures and may be ingested by earthworms, acting as transport hosts. The parasitic phase is not migratory, starting with a phase of transition in the intestinal mucosa, and afterwards, the adult parasites settle in the intestinal lumen, where the females lay the eggs that will be eliminated together with the feces in the environment (MARTINS, 2019; ATKINSON, THOMAS and HUNTER, 2008). Inside the eggs, with humidity and adequate temperatures, there is the formation of larvae L1 and L2, making them infect the species that may accidentally ingest them (MONTEIRO, 2007).

Infection by worms of the genus Ascaridia, such as A. hermafrodita, A. platyceri e A. columbae, mainly affects the following species of Psittacidae: Amazona spp., Ara spp., Aratinga spp., Nymphicus hollandicus, Agapornis fischeris, Anodorhynchus hyancintynus, Eclectus roratus, Enicognathus leptorhynchus, Platycercus spp., Barnadius zonarius barnadii e Psephotus haematogaster (FIGUEIREDO, MANRIQUE and NOGUEIRA, 2018; CLAUDINO et al., 2017; LIMA et al., 2017; AYRES et al., 2016; SANTOS et al., 2015; VALDEBENITO et al., 2015; SNAK et al., 2014; BERNARDI et al., 2013; MELO et al., 2013; GONZÁLEZ-HEIN et al., 2012). Usually, the typical host of A. columbae are birds of the order Columbiformes. However, in recent decades studies have pointed to the parasitism A. columbae in birds of the order Psittaciformes (TAYLOR, COOP and WALL, 2017; ATKINSON, THOMAS and HUNTER, 2008).

Melo et al., (2013) describe ascariasis as one of the psittacines' most common gastrointestinal parasitic infections. It is associated with clinical signs of severe anorexia and sudden weight loss, and with parasitic load in the intestine, an obstruction may occur, causing the animal's death. Usually, ascariasis is more severe in young animals, causing intestinal hemorrhages associated with obstruction (MARTINS, 2019). The pathogenesis of this infection is mild, presenting nonspecific signs such as diarrhea, dyspnea, and irritation of the cecal mucosa, which leads to ede-

mas, hyperemia, hemorrhage, and destruction of epithelial villi (ROBERTS, JANOVY and NADLER, 2013; ATKINSON, THOMAS and HUNTER, 2008).

Because it is a moderate infection, wild bird management agencies do not actively seek parasitological control in the plants; thus, ascarids establish constant cycles in captive birds (ATKINSON, THOMAS and HUNTER, 2008). Even the species of the genus Ascaridia that infect birds are not able to parasitize man, it is essential parasite control strategies be disseminated in places of captivity once these nematodes are monoxenics and offer a health risk to animals.

EIMERIOSIS OR COCCIDIOSIS

Eimeriosis or coccidiosis is one of the most diagnosed parasitic diseases in wild and exotic birds. The disease is caused by protozoa class Coccidia and the genus Eimeria, which develops more quickly in humid environments and is favored by the high stocking rate (LIMA et al., 2017; GRESPAN and RASO, 2014). Among the species of these birds, the parasite rarely completes its cycle in more than one genus of the host bird (MARTINS, 2019; MONTEIRO, 2007). According to Yabsley (2008), the epidemiological distribution of these protozoa in birds is concentrated in the order of the Galliformes. However, parasitism by Eimeria spp. is reported in most orders of birds and other animals.

The evolutionary cycle of these protozoa is composed of different stages: sporulation, infection, schizogony, and the formation of oocysts in gametogony (TAYLOR, COOP and WALL, 2017). Transmission occurs by ingesting sporulating oocysts, and in the animal's intestine, sporocysts emerge and penetrate the mucosa, becoming trophozoites. Then begins asexual reproduction (schizogony), and after several mitoses' nuclei and cytoplasm are formed to originate schizonts with merozoites. The cell breaks down, releasing the merozoites which perform a new asexual reproduction forming a second generation or going to the sexual phase forming macro and microgametocyte. The fertilized microgametocyte will form the oocysts that will be released into the feces (TAYLOR, COOP and WALL, 2017; MARTINS, 2019; MONTEIRO, 2007).

The species of Eimeria amazonae, E. ochrocephalae, E. ararae, E. purpureicephali, and E. haematodi are the main ones responsible for the infection of psittacines, three of them species-specific. Furthermore, the prevalence of this infection is described in birds of the species Amazona spp., Psittacula krameri, Nymphicus hollandicus, Brotogeris pyrrhoptera, Purpureicephalus spurius, Ara spp., Trichoglossus haematodus, and Cyanoliseus patagonus (MARQUES et al., 2019; SPRENGER et al., 2017; SANTOS et al., 2015; YANG, BRICE and RYAN, 2015; BOMFIM-LOPES et al., 2014; SNAK et al., 2014; HOLSBACK et al., 2013; HOFSTATTER and KAWAZOE, 2011).

Usually, infection by protozoa of the genus Eimeria manifests itself asymptomatically, and the clinical signs of the disease are inappetence, diarrhea, intussusception,

cachexia, apathy, prostration, and death (MARQUES et al., 2019; GRESPAN and RASO, 2014). The intensity of the infection varies according to the parasitic load of the animal, in addition to the fact that each species of Eimeria has a specific site of the intestine for parasitizing. In the host organism, it causes lysis of the intestinal epithelium, and when in high amounts, it leads the animal to starvation, hemorrhages, and intense diarrhea (YABSLEY, 2008; TAYLOR, COOP and WALL, 2017). In addition, the resistance to reinfection obtained with one species does not protect against others, and the infection is self-limiting in the absence of reinfections (TAYLOR, COOP and WALL, 2017).

Isopora and Eimeria have been described as parasitizing birds of different orders. In this context, coccidiosis is recognized as a parasitic disease with the most significant economic impact on the poultry market due to the high mortality of birds (MARQUES et al., 2019; CARNEIRO, JÚNIOR and MARTINS, 2011). Coccidiosis by Eimeria spp. is believed to be a recurrent problem in animal clinics since there are more than one hundred species of Eimeria reported in several animals of various taxonomic classes (TAYLOR, COOP and WALL, 2017).

CRYPTOSPORIDIOSIS

Cryptosporidiosis is a parasitic disease prevalent in domestic and wild birds and is considered an emerging problem in the world poultry industry and public health (CARNEIRO, JÚNIOR and MARTINS, 2011). This disease is caused by protozoa of the genus Cryptosporidium of the family Cryptosporidiidae, which usually affect mammals, birds, reptiles, and fish, lodging the epithelial cells of the gastrointestinal tract of these animals (TAYLOR, COOP and WALL, 2017). The oocysts of these protozoa measure approximately 5 µm and have four sporozoites without sporocysts (MONTEIRO, 2007).

The cycle of protozoa of this genus is monoxenic, where schizogony occurs on the surface of intestinal cells, presenting two generations of schizonts and one of the gametogony, forming micro and macrogametocytes. Microgametocytes fertilize macrogametocytes giving rise to oocysts with four sporozoites which are eliminated in feces as an infecting form. Sporulation occurs within the host, and schizogony and gametogony in intestinal microvilli. Generally, some oocysts break within the host, promoting self-infection, while others are released along the sporulated feces (MONTEIRO, 2007; TAYLOR, COOP and WALL, 2017; ATKINSON, THOMAS and HUNTER, 2008).

The disease transmissibility occurs by ingestion of water and food contaminated with sporulated oocysts of Cryptosporidium, and water is the most likely means of transmission between different species (ATKINSON, THOMAS and HUNTER, 2008). The concentration of captive birds in the urban perimeter is a fact that predisposes a potential source of transmissibility of infection to other animals and humans who have direct or indirect contact with these infected birds (VASCONCELOS et al., 2018; BERNARDI

et al., 2013; HOLSBACK et al., 2013; FARRET et al., 2010).

Studies have estimated the prevalence of Cryptosporidium spp. in the following species of psittacines: Aratinga jandaia, Diopsittaca nobilis, Pionus menstruus, Myiopsitta monachus, Agapornis roseicollis, Ara chloroptera, Brotogeris tirica, Pionus maximiliani, Aratinga leucophthalma and Anodorhynchus hyacinthinus (VASCONCELOS et al., 2018; BRICEÑO et al., 2017; BERNARDI et al., 2013; HOLSBACK et al., 2013; SEVÁ et al., 2011; FARRET et al., 2010).

Infection by these parasites is usually mild and rarely causes clinical signs in psittacines. However, in immunosuppressed patients, the manifestation of infection becomes more severe (GRESPAN and RASO, 2014). Clinical signs of cryptosporidiosis in birds range from enteritis to respiratory problems and even back problems. Diarrhea usually occurs with blood, coughs, sneezing, and dyspnea; occasionally, the disease may affect the pancreas, eye conjunctive, and the middle ear (VASCONCELOS et al., 2018; SEVÁ et al., 2011; ATKINSON, THOMAS and HUNTER, 2008).

Cryptosporidiosis is a reemerging protozoal disease in humans, especially those immunodeficient (HOLSBACK et al., 2013). Even though it may cause severe disease, serious infections caused by protozoa of the genus Cryptosporidium have been reported in patients with compromised immune health. In 1993, in the city of Milwaukee in the United States of America, an epidemic of cryptosporidiosis was reported, affecting more than 400,000 people (ROBERTS, JANOVY and NADLER, 2013). According to Vasconcelos et al., (2018), the presence of infected animals in captivity in the urban environment assumes a potential reservoir of the disease, putting into check the health of handlers and other animals directly and indirectly.

STRONGYLOIDIASIS

The parasites causing strongyloidiasis are nematodes of the Strongyloididae family. Usually, these versatile parasitize the small intestine of animals, are colorless, thin, like hair strands, and less than 10 mm long (TAYLOR, COOP and WALL, 2017). Females are parthenogenetic, with a trilled mouth and claviform esophagus. They may promote infection optionally and survive without a host (MONTEIRO, 2007; MARTINS, 2019; ROBERTS, JANOVY and NADLER, 2013).

Females of the genus Strongyloides penetrate the mucosa of the small intestine and may also be found in the respiratory, pancreatic, or biliary tract. In sequence, females form their eggs by parthenogenesis and deposit them in the intestinal lumen, where the feces will be associated. Some eggs hatch during the path in the intestine and are released into the environment next to the feces and may develop into a free life. Self-infection occurs when the vermin penetrate the bloodstream or lymphatic vessels and move to the lung, in addition to the accidental ingestion of the young parasites orally or by integumentary penetration, making hosts of Strongyloides (ROBERTS,

JANOVY and NADLER, 2013; TAYLOR, COOP and WALL, 2017).

Some studies have described infection with Strongyloides in psittacines of the species Nymphicus hollandicus, Brotogeris pyrrhoptera, Ara ararauna, Cyanoliseus patagonus, Ara chloroptera, Amazona aestiva, Agapornis roseicollis, Psittacula krameri, Amazona amazonica and Trichoglossus haematodus (SPRENGER et al., 2017; SNAK et al., 2014; BERNARDI et al., 2013; HOLSBACK et al., 2013). Among these species, the N. hollandicus and A. roseicollis are raised as exotic pets in Brazil, creating a possibility of zooanthropozonotic risk for tutors and other birds kept in captivity (SPRENGER et al., 2017; SNAK et al., 2014; BERNARDI et al., 2013; HOLSBACK et al., 2013).

The pathogenesis of strongyloidiasis manifests itself according to the bird's environment. In free-living birds, infection is usually asymptomatic, while in captive animals, it manifests more severely, becoming a significant health problem (SPRENGER et al., 2017). Due to the penetration of the larvae, it is typical for the site of penetration to present hemorrhages and edemas. In addition, the larvae can be associated with bacteria and generate dermatitis which may be purulent (ROBERTS JANOVY and NADLER, 2013; MARTINS, 2019). Another important factor related to pathogenesis is parasitic load, which may lead to severe respiratory problems (MONTEIRO, 2007). Common clinical signs are related to diarrhea, dietary malabsorption, dehydration, and cachexia (MARTINS, 2019).

Some genera of these parasites are commonly found in birds, reptiles, and mammals. Thus, due to a broader range of hosts, the disease has high transmissibility (ROBERTS, JANOVY and NADLER, 2013). Thus, according to Holsback et al., (2013), the intensity of anthropic action in wild environments may favor the transmissibility of pathogens cross-sections between men and animals (HOLSBACK et al., 2013). Thus, the infection is characterized as a zooanthropozonotic problem, and specific control measures are necessary for this parasitic infection.

GIARDIASIS

Another parasitic infection of great importance is giardiasis, caused by a gastrointestinal protozoan of the genus Giardia. Giardia sp. is a flagellate, monoxenic protozoan belonging to the family Hexamitidae (BOWMAN, 2006), infecting several different hosts, including mammals, birds, reptiles, and amphibians (FERNANDES, GRESPAN and KNÖBL, 2014; CARNEIRO, JÚNIOR and MARTINS, 2011; FARRET et al., 2010; ACHA and SZYFRES, 2003). Although relatively common in Psittacidae, giardiasis is rare in other captive birds (ZUCCA and DELOGU, 2010).

Protozoa of this genus present two morphologically distinct forms during their life cycle: trophozoite and cyst. The cyst is the infecting form for humans and animals, presenting resistance in the environment, being transmitted to birds by direct contact and ingestion of contaminated water or food, es-

pecially in captivity situations with high population density (IVANOV, 2010; BOWMAN, 2006). Although the cyst is the infecting form of Giardia spp., it is based on the morphology of the trophozoite the different species that affect birds as Giardia duodenalis, Giardia psittaci, and Giardia ardeae are classified by optical microscopy, taking into account their differentiation in terms of other intestinal flagellate trophozoites by presenting 4 pairs of flagella, 2 nuclei, without undulating membrane or axostyle, with size between 10 and 20 μm (IVANOV, 2010; MONIS, CACCIO and THOMPSON, 2008).

This disease is common in poultry and wild birds and may be associated with other intestinal parasitic infections (FARRET et al., 2010). The main species already described as hostesses of Giardia spp. are Agapornis spp., Amazona spp., Anodorhynchus hyancintynus, Ara spp., Aratinga spp., Brotogeris versicolurus chiriri, Cacatua spp., Nymphicus hollandicus, Pionites leucogaster, Eos bornea, Guaruba guarouba, Melopsittacus undulatus. Poicephalus senegalus, Psittacula spp., and Anodorhynchus hyacinthinus (FERNANDES, GRESPAN and KNÖBL, 2014; CARNEIRO, JÚNIOR and MARTINS, 2011; FARRET et al., 2010).

Giardiasis may occur asymptomatically, acutely, or chronically in the hosts (MONIS, CACCIO and THOMPSON, 2008; BOWMAN, 2006). However, in birds subjected to stress, malnutrition, immunosuppression, and other parasitic diseases or not, the development of giardiasis may be exacerbated (OMBUGADU et al., 2019; IVANOV, 2010; ZUCCA and DELOGU, 2010). Diarrhea is the most evident clinical sign of giardiasis. In addition, clinical manifestations such as weight loss, chronic diarrhea of variable coloration, depression, anorexia, skin dryness, and feather pecking in the carpal-metacarpal region are described (OMBUGADU et al., 2019; FERNANDES, GRESPAN and KNÖBL, 2014; CARNEIRO, JÚNIOR and MARTINS, 2011; FARRET et al., 2010; IVANOV, 2010; ZUCCA and DELOGU, 2010; BOWMAN, 2006).

The inflammatory bowel process promoted by Giardia spp. promote hyperplasia of intestinal crypts, intense infiltration of immune cells such as lymphocytes and polymorphonuclear leukocytes, and cellular apoptosis (OLSON and BURET, 2001; IVANOV, 2010). With this, the birds present a functional deficit in the absorption of fats and fat-soluble vitamins (A, D, E, K), vitamin B12, and iron, causing osmotic diarrhea with the formation of gases resulting from bacterial degradation (OLSON and BURET, 2001; IVANOV, 2010).

Giardiasis is considered a global zoonotic disease of possible epidemic character as the environmental sanitary conditions to which men and animals are subjected (IVANOV, 2010; ACHA and SZYFRES, 2003). The first reports relating giardiasis to zoonosis date back to 1991, when there was an outbreak of human diarrhea in Egypt and an outbreak of mortality in crows in the region. When performing the necropsy of the animals, Giardia sp. parasites were found in the intestines of the birds, incriminating the environmental

contamination by the dissemination of cysts by the crows and consequently the increase in the number of cases of diarrhea in the population (Al-SALLAMI, 1991).

Currently, authors have found the genetic and structural similarity of Giardia spp. isolated in samples from different hosts suggests a potential risk of transmission between species (THOMPSON and MONIS, 2004; MONIS, CACCIO and THOMPSON, 2008), corroborating the hypothesis of risk to the human, animal, and environmental public health, according to the One Health. Colli et al., (2013) and Valverde et al., (2011) stated the presence of animals infected by Giardia sp. in the home environment doubles and triples, respectively, the chance of infection of the guardians. In addition, Johnston et al., (2010) proved that Giardia spp. infection is frequently observed in humans and their pets when they live near areas with infected primates.

STRATEGIES FOR INFECTION CONTROL

Most of the parasitic diseases described in this study are transmitted by contamination, directly or indirectly, of water and food served by birds. Based on this knowledge, the prophylactic and mitigating measures indicated for controlling these infections are the correct and frequent hygiene of enclosures and their accessories, mainly drinking fountains and feeders. The food and water available must be in strategic locations, preventing contact with the feces or secretions of these animals, stopping the spread of infection or even the possibility of self-infections. In addition, it is essential to carry out periodic examinations on the animals of the plants, adequate worming, and veterinary follow-up (AYRES et al., 2016; SNAK et al., 2014; MONTEIRO, 2007).

AVIAN ZOONOSES AND ONE HEALTH

The creation of the term "Veterinary Public Health" was only recognized by the World Health Organization (WHO) in 1950, employing veterinarians in contexts which concern zoonotic diseases, the protection of lives, disease prevention, and the promotion of human well-being. However, recently the term "One Health" was consolidated, addressing animal, human, and environmental health on a single professional front, including the veterinarian in areas that directly practice public health. Thus, the context of zoonosis is closely linked to One Health, thus breaking the artificial barriers between veterinary medicine and human medicine (AVILA-PIRES, 2015).

Thus, this concept of single health is faithfully related in the present study, and of the parasitic diseases described, some have the potential for transmissibility between animals and humans. In addition, the infectious diseases which most affect humans are of animal origin, representing 60% of diseases and 70% of emerging infectious diseases (GOMES et al., 2016). Thus, the measures of approach to these diseases are of interest to Only Health, with the

joint action of veterinarians and other health professionals (MIRANDA, 2018).

FINAL CONSIDERATIONS

From the selected studies, the authors identified parasitosis with the highest prevalence in psittacines. They have zoonotic potential once they can be transmitted between animals and humans. Thus, individuals assume a safe posture in care and the relationship between men-animals-environment, as recommended by One Health. Care while managing these birds is one of the main factors affecting this transmissibility, so the authors call attention to asepsis techniques and proper management of birds kept in captivity or as domestic animals.

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INFECÇÕES PARASITÁRIAS EM AVES SILVESTRES DA FAMÍLIA PSITTACIDAE: RELAÇÃO ENTRE ZOONOSES E O *ONE HEALTH*

RESUMO

As aves pertencentes à ordem Psittaciformes têm ampla distribuição no mundo, com ênfase nos biomas brasileiros, e se caracterizam por suas cores e formas. Devido à sua vasta diversidade, esses animais selvagens são alvos de tráfico e confinamento ilegal em cativeiro. O estresse e a automutilação da captura são um dos principais sinais clínicos que esses animais apresentam, deixando-os imunologicamente vulneráveis a infecções. Assim, infecções endoparasitas causadas por parasitas zoonóticos são recorrentes nesse grupo de aves. Por isso, este estudo teve como objetivo avaliar as infecções parasitárias mais recorrentes que afetam aves silvestres da família Psittacidae, destacando a relação entre zoonoses parasitas e o conceito de One Health. O trabalho consistiu em revisão bibliográfica da literatura de artigos relacionados à incidência de parasitas em psitacídeos silvestres publicados a partir de 2010, os dados foram extraídos e computados em forma de tabela. As doenças mais prevalentes no estudo foram capilariose, ascaridíase, eimeriose, criptosporidíase, estrongiloidíase e giardíase, e três das seis doenças citadas têm potencial de transmissibilidade entre animais e seres humanos. Assim, as medidas de abordagem dessas doenças zoonóticas são de interesse da One Health, tornando necessária a ação conjunta de veterinários associados a outros profissionais de saúde.

PALAVRAS-CHAVE: One health, Parasitos, Psittacidae, Usos da Epidemiologia.

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