



Lesions caused by anisakid and capillariid in *Cairina moschata* raised on Marajó island, state of Pará, Brazil

[Lesões por anisakídeos e capillariídeos em *Cairina moschata* criados na Ilha de Marajó, estado do Pará, Brasil]

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ABSTRACT

The Muscovy duck is a commercially important bird on the island of Marajó usually raised in a peculiar system that includes supplying fish viscera to the birds under semi-extensive farming conditions. This enables a risk of contamination and losses in the production of these birds, resulting from injuries caused by helminth infections, especially nematodes. The objective of this study was to evaluate the histopathological changes caused by nematodes of the genera: *Eucoleus*, *Anisakis* and *Contraecum*. Thirty-three ducks with lesions in the esophagus and ventricle were analyzed. Histopathological exams showed a mild inflammatory infiltrate in the submucosa of the esophagus caused by the fixation of *E. contortus* and third stage larvae of *Anisakis* sp., and we recorded third stage larvae of *Contraecum* sp. parasitizing the ventricle, this being the first record of this parasite in ducks in Brazil.

Keywords: histopathology, esophagus, birds, parasitism, helminths

RESUMO

O pato doméstico é uma ave amplamente comercializada na Ilha de Marajó, com um peculiar manejo que inclui a oferta de vísceras de peixes aos animais em criações semiextensivas, propiciando, assim, risco de contaminação e perdas na produção dessas aves decorrentes de lesões oriundas de infecções por helmintos, especialmente os nematódeos. Nesse sentido, objetivou-se avaliar as alterações histopatológicas causadas por nematódeos dos gêneros: *Eucoleus*, *Anisakis* e *Contraecum*. Foram analisados 33 patos, e três exemplares apresentaram lesões no esôfago e no ventrículo. Exames histopatológicos demonstraram discreto infiltrado inflamatório na submucosa do esôfago ocasionado pela fixação de *E. contortus* e larvas de terceiro estágio de *Anisakis* sp., bem como foram registradas larvas de terceiro estágio de *Contraecum* sp. parasitando o ventrículo, sendo esse o primeiro registro desse parasito em patos no Brasil.

Palavras-chave: histopatologia, esôfago, aves, parasitismo, helmintos

INTRODUCTION

Cairina moschata ducks (Linnaeus, 1758) are bred for the production of eggs and meat for both self-consumption and for sale (Meulen and

Dikken, 2003). Muscovy ducks are birds that have filtering habits and are not selective in terms of food, especially when raised extensively, where they absorb enough proteins in the environment, feeding on grass, small fish, crustaceans and insects (Sick, 1997; Meulen and Dikken, 2003). Livelihood creations are common

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in Brazil, and occur mainly among small producers, commercial houses and open markets, where the hygienic sanitary conditions of this type of creation are not clarified (Souza Almeida et al., 2016). In northern Brazil they are appreciated in the cuisine of Pará and have high commercial value mainly during festive seasons.

Breeding birds under extensive or free-range systems in the environment facilitates the occurrence of endoparasites. That is a point of concern in the different systems of duck farming as it leads to economic losses, and preventive measures are considered the most effective strategy (Rennó et al., 2008). The rate of helminth infection is worrisome, especially since ducks may show unspecific clinical signs of those infections (Cubas, 2007; Rosa and Shivaprasad, 2015). In addition, these helminthiasis are the main diseases that affect birds reared in an extensive regime, causing an increase in the mortality rate, as well as providing the dissemination of a wide variety of parasite species in the environment (Menezes, 1999; Gomes et al., 2009). Among the main changes in the host organism caused by the parasites are spoliation and the inflammatory process resulting from the process of migration, fixation or type of food performed by the parasite, which can vary with the degree of intensity of infection (Menezes et al., 2001; Neves, 2016).

Menezes et al. (2001) described macro and microscopic changes found in several organs, among them *Numida meleagris* Linnaeus, 1758 esophagus and crop parasitized by *Eucoleus perforans*, of the macroscopic changes the authors observed that the parasites caused petechiae and congestion, and microscopy showed the parasites inserted deep in the stratified squamous epithelium of the crop, with intense inflammatory reaction and distension of the mucous glands present in the crop's own tunic. These changes by the parasite were considered serious, even with low average intensity of infection. Data on helminths in ducks are scarce and little known, particularly about the spoliative action of the presence of parasites and their relationship with host tissue (Mattos Junior et al., 2008). The investigation of the biota of helminths of Muscovy ducks on the Island of Marajó, can help in the sanitary control and in the productivity of these animals. This study thus

aimed to describe the histopathological aspects of infection and lesions in the tubular digestive system of *Cairina moschata*, caused by *Eucoleus contortus* (Capillariidae), *Anisakis* sp. (Anisakidae) and *Contracaecum* sp. (Anisakidae), in order to contribute to the medical clinic and sanitary management of this species, of this bird, raised free on the Island of Marajó.

MATERIAL AND METHODS

Thirty-three specimens of *C. moschata* were purchased from rural properties in the municipality of Soure (00° 43' 00" S; 48° 31' 24" W), Marajó Island, State of Pará, under protocols of the Ethics Committee on the use of animals (CEUA) No. 030/2018 and the Federal Rural University of the Amazon (UFRA) No. 23084.014807 / 2018-80. They were necropsied in the laboratory to search for helminths, where each organ was carefully analyzed with the aid of the Leica ES2 stereomicroscope, and three specimens presented nematodes fixed to the esophagus and ventricles, from which fragments were removed and fixed in 10% formalin, and processed according to routine histological techniques (Tolosa et al., 2003). Photomicrographs of the slides were captured and analyzed using a Leica DM2500 microscope with an attached digital camera.

The nematodes collected were fixed in A.F.A (93 parts of 70% ethyl alcohol, 5 parts of formaldehyde and 2 parts of glacial acetic acid), overnight, transferred to a solution containing 70% ethanol. For taxonomic identification, the nematodes specimens were clarified with 20% Aman lactophenol and temporarily mounted between slides and coverslips for observation of morphological characters under a LEICA DM2500 light microscope with an imaging capture system. For the taxonomic classification of nematodes, the works of Vicente et al. (1995), Moravec (1998), De Ley and Blaxter (2002), Felizardo et al. (2009), Gibbons (2010) and Fonseca et al. (2016) were consulted. To determine the ecological indexes of parasitism, these helminths will be analyzed by means of prevalence (%), average intensity of infection (IMI) and average abundance, according to Bush et al. (1997).

RESULTS

The nematodes recovered were found inserted in the esophagus and ventricle of muscovy duck in Marajó Island and morphologically identified as third stage larvae *Anisakis* (Anisakidae) (Figure 1A), and adults from *Eucoleus contortus*

(Capillariidae) were also found parasitizing the esophagus with a prevalence of 9.1% and 75.8% respectively. Third stage larvae of *Contracaecum* (Anisakidae) were found inserted in the ventricle in 12.1% of the ducks. The parasitological indices of these nematodes in *Cairina moschata* are shown in Table 1.

Table 1. Parasitological indices of Capillariidae and Anisakidae in *Cairina moschata* (n = 33) from the eastern Amazon (Brazil)

SI	Parameters	<i>Eucoleus contortus</i>	<i>Anisakis</i> sp.	<i>Contracaecum</i> sp.
Esophagus	P (%)	75.8	9.1	3.0
	MI	11.2	95.7	3.0
	MA	85	8.7	0.1
	TNP	281	287	3
Gizzard	P (%)	9.1	9.1	0
	MI	10.7	0.3	0
	MA	1	0.03	0
	TNP	32	1	0
Proventriculus	P (%)	12.1	0	6.1
	MI	17.3	0	3.5
	MA	2.1	0	0.2
	TNP	69	0	7
Ventriculus	P (%)	0	0	12.1
	MI	0	0	2.3
	MA	0	0	0.3
	TNP	0	0	9
Intestine	P (%)	0	3.0	3.0
	MI	0	1.0	2.0
	MA	0	0.03	0.1
	TNP	0	1	2

SI: infection site, P: Prevalence, MI: Mean intensity, MA: Mean abundance, TNP: Total number of parasites.

Histopathological analysis of infection by *Anisakis* sp. in the esophagus of *Cairina moschata*, showed that the lesion is predominantly in the mucosa, and able to transpose the muscle of the mucosa and affect the internal muscular layer. The stratified squamous epithelium was found to be intact. However, in the parasite-host relationship, alterations are present in the mucous glands due to the location of the nematodes, which promotes glandular destruction and tissue reaction with accumulations of cellular debris at the tissue-parasite interface, bordered by a foreign body-type granulomatous reaction due to the presence of giant cells (Figure 1B). The lamina propria with prominent and variable infiltration of eosinophils in addition to lymphocytes and staining by Gomori Trichrome did not show fibroplasia associated with inflammation. The connective tissue adjacent to the compromised gland was looser, probably due to tissue edema.

In the cross section of the parasite *Anisakis*, it was possible to observe the epidermal cord in a “Y” shape (Figure 1C).

Histologically, the infection of the ventricle (gizzard) by *Contracaecum* sp. demonstrates that the nematode is fixed in the mucosa, below the glycoprotein secretion layer, where no tissue reaction due to the presence of the parasite was observed (Figure 1D). In the macroscopic image, we can observe the fixation of the parasite in the ventricle (Figure 1E). Esophageal infection by *Eucoleus contortus* showed pseudo-encapsulation of the parasite in the mucosal pavement epithelium, with mild compressive atrophy of keratinocytes. There was also mild exocytosis due to the presence of eosinophils among the keratinocytes and in the submucosa the inflammatory infiltrate of eosinophils is mild and variable (Figure 1F).

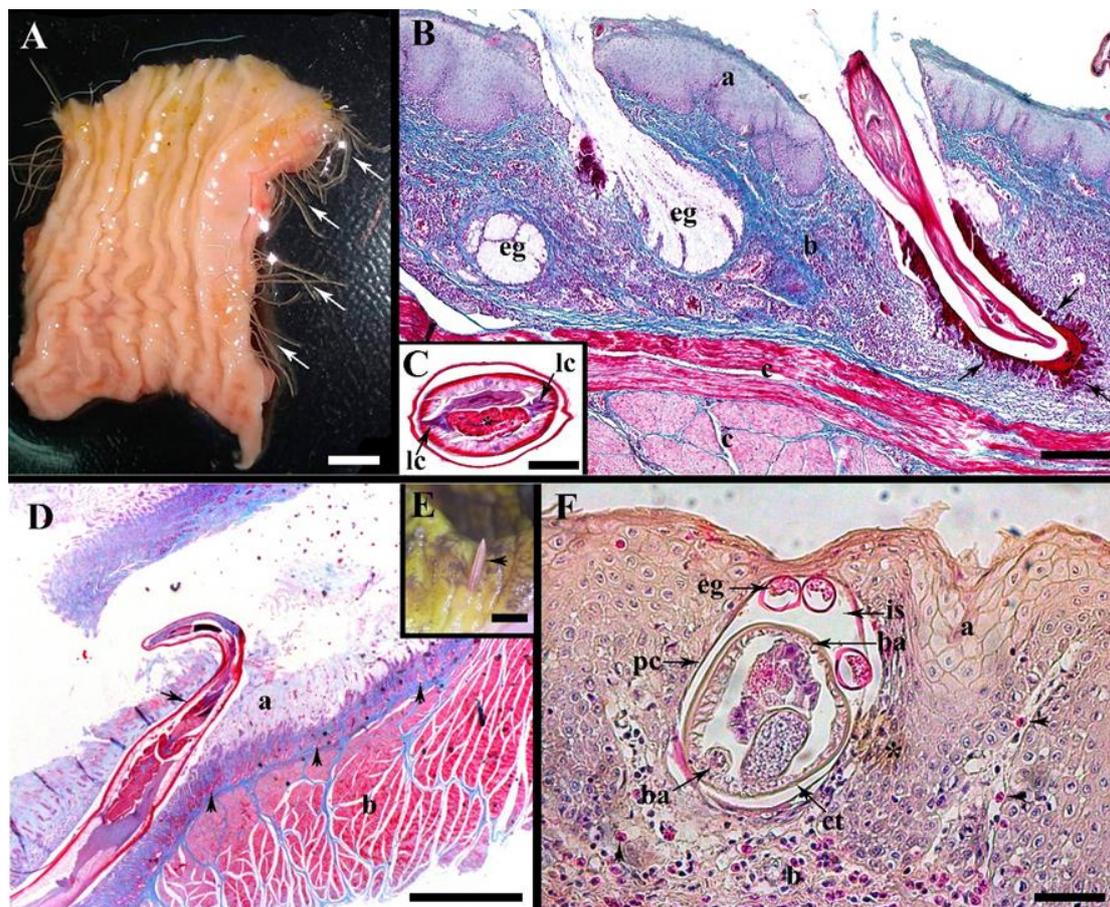


Figure 1. (A) Mesoscopic view of *Anisakis* sp. (arrowhead) inserted in the esophagus of a Muscovy duck on Marajó Island, State of Pará; (B) Photomicrographs of the esophagus parasitized by *Anisakis* sp. larvae (arrows) stained with Gomori Trichrome: a = stratified squamous epithelial tissue, of the esophageal lining, b = subepithelial connective tissue, c = smooth muscle tissue and eg = esophageal gland; (C) Detail of the cross section of an *Anisakis* sp. larva, showing lateral epidermal cord (arrow) and intestine (*). Gomori Trichrome; (D) Photomicrographs of the ventricle parasitized by *Contracaecum* sp. in Muscovy duck on Marajó Island stained with Gomori Trichrome: a = mucous layer of the ventricle, tubular glands of the ventricle (arrowhead) and b = muscular layer of the ventricle, showing the well-developed smooth muscle layer; (E) Mesoscopic view of a *Contracaecum* sp. (arrowhead) inserted in the Muscovy duck ventricle; (F) Photomicrographs of the esophagus parasitized by a female *Eucoleus contortus* in a Muscovy duck on Marajó Island stained with hematoxylin and eosin: a = stratified squamous epithelial tissue of the lining of the esophagus mucosa, b = loose connective tissue of the submucosa with abundant eosinophils (arrowhead), detail of the pseudo-capsule (pc) surrounding the parasite, forming an interstitial space (s) containing eggs (eg), and the nematode with the presence of a thick cuticle (ct) and the presence of bacillary bands (ba), compressive atrophy of keratinocytes (*) of the stratified squamous epithelial tissue of the esophagus. Scale bars: A = 2 cm, B = 200 μ m, C = 100 μ m, D = 1 mm, E = 2 cm; F: 50 μ m.

DISCUSSION

In Brazil, Mattos Junior *et al.* (2008), detected in *Cairina moschata* of Rio de Janeiro a parasitic biota of capillariids nematodes composed of 20% of *Capillaria phasianina* Kotlán, 1914 in esophagus and caecum; 30% of *Capillaria* sp. Pinto and Almeida, 1935 in esophagus, cecum and gallbladder, and 6.6% of *Eucoleus cairinae* (Freitas and Almeida, 1935) Lopez and Neyra,

1947 in esophagus, and histopathological studies of organs injured by parasitism have not yet been published. In our study, the major sites of infection were esophagus with *Eucoleus contortus* and *Anisakis* sp. and the ventricle with *Contracaecum* sp., these sites showed lesions by the parasites, and after histopathological processing it was possible to observe the changes caused by capillary and anisakid nematodes in the tissues.

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Histopathological changes caused by the presence of *Eucoleus contortus*, *Anisakis* sp., *Contracaecum* sp., are recorded herein for the first time in our research parasitizing the esophagus and ventricle of Muscovy duck in Brazil. These birds raised without confinement, look for food in areas of rivers or lakes, with no selectivity in feeding (Meulen and Dikken, 2003), which may justify the presence of these anisakid and capillary nematodes in birds (Carvalho *et al.*, 2019, 2020). Different studies have been carried out in order to characterize the parasitic fauna of ducks around the world. Among them Bano *et al.* (2005) recorded the presence of *Streptocara incognita* Gibson, 1968 in the esophagus of ducks in Italy. In the same host, Muhairwa *et al.* (2007) recorded *E. contortus*, *E. annulatus* (Molin, 1858) and *Capillaria anatis* (Schrank, 1790) parasitizing the intestinal caecum. Likewise, Yousuf *et al.* (2009), when assessing the fauna present in the gastrointestinal tract of ducks, registered the presence of *Amidostomum anseris* and *E. contortus*.

The presence of *E. contortus* and third stage larvae of *Anisakis* sp. inserted in the esophageal tissues of Muscovy ducks induced an inflammatory reaction in the tissue of this organ, as well as the migration of defense cells to this region, especially to the site of larval fixation, caused intense inflammatory infiltrate resulting from foreign body reaction and edema. Railliet and Lucet (1889) described the pathogenic effects by means of hispathological analysis in the gall bladder and esophagus of Galliformes and Anseriformes parasitized by *E. contortus*, thus demonstrating a major inflammatory process. According to Cram (1936), the Galliformes analyzed in his research were infected with *E. contortus* eggs and after death revealed necrosis of the esophageal epithelium, delicate connective tissue capsules that surrounded the areas containing the parasites and their eggs, tissue with lymphocytes and large mononuclear leukocytes, with some lesions extended to the submucosa. Pinto *et al.* (2004) observed lesions by the parasite *Eucoleus perforans* in the esophagus of *Phasianus colchicus*, where the parasites were deeply inserted in the stratified squamous epithelium, without inflammatory reaction, there was also thickening and papillary transformation of the mucosa.

Several third-stage larvae of *Anisakis* sp. were found strongly inserted in the esophagus of Muscovy ducks, causing an intense inflammatory infiltrate, resulting from a foreign body reaction and edema. According to Junqueira (2018), parasites that affect the crop and esophagus are especially harmful, as they can severely damage the mucosa of the affected organ, inducing edema and thickening of the mucous membranes, making eating difficult and even preventing birds from eating food. In cross section of the esophagus of the birds in our study, it was possible to observe the larvae of *Anisakis* sp. and their identifying structures. Murata *et al.* (2018) and Lauwers *et al.* (2017), who recorded the occurrence of anisakiasis in humans, was found as a definition of gender, found the shape of the lateral epidermal cord and the intestinal lumen in "Y" to be determinants for *Anisakis* spp. Kim *et al.* (2006) during histopathological analysis in humans recorded a lesion in the submucosa of the stomach that showed severe eosinophilic infiltrations and inflammation.

Anisakids, in their larval and adult forms frequently present important pathological lesions in the alimentary tract and associated organs in their natural host species (Smith, 1999). According to Lymbery and Cheah (2007), the larvae of these nematodes also promote a series of pathological effects in accidental hosts, such as humans. This reinforces the need for attention and care in proper management during the removal and disposal of the viscera of ducks infected with L3 larvae of anisakids, avoiding the migration of these larvae to the musculature of the bird in the postmortem and the possible risks to human health due to ingestion of contaminated meats (Carvalho *et al.*, 2020). In this study, the presence of *Contracaecum* sp. in the ventricle did not produce injuries in that organ. In contrast, Vicente *et al.* (1995) and Amato *et al.* (2006), registered the presence of different larval stages of *Contracaecum* sp. parasitizing the proventriculus and ventricles of birds of the orders Falconiformes, Accipitriformes, Pelecaniformes, Suliformes, Ciconiiformes, Sphenisciformes, inducing the formation ulcerated eosinophilic granulomas.

Among the parasites that present risks to human health, nematodes of the Anisakidae family can be highlighted. Their intermediate hosts are fish cephalopod molluscs, and small crustaceans

(Adams *et al.*, 1997), all animals that can compose the diet of ducks raised free in the wild. In Brazil, investigations related to helminth-induced diseases have been described in other bird species such as *Phasianus colchicus* and *Meleagris gallopavo* by Pinto *et al.* (2004, 2008). In terms of pathogenesis, when there is a major infection it can be considered extremely harmful to birds (Pizarro *et al.*, 2000). The clinical signs presented by Muscovy ducks can be nonspecific (Rosa and Shivaprasad, 2015), meaning that helminthiasis can lead to an economic problem, as well as to the health of domestic poultry breeding systems (Cubas, 2007). Therefore, preventive health care such as good hygiene, deworming and vaccination of birds can reduce the rate of emergence of various parasites and other diseases (Meulen and Dikken, 2003).

CONCLUSION

The Muscovy duck is the new host of *Contracaecum* sp. in the state of Pará, being important, as there were still no studies on this parasite in this bird. And we also added the description of histopathological changes, such as intense inflammatory reactions in the esophagus caused by *Anisakis* sp. and *Eucoleus contortus*, and the presence of *Contracaecum* sp. in the ventricle, thus contributing to the knowledge of the pathogenicity of these parasites in *Cairina moschata* created and consumed by the island's population.

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REFERÊNCIAS

ADAMS, A.M.; MURRELL, K.D.; CROSS, J.H. Parasites of fish and risks to public health. *Rev. Sci. Tech.*, v.16, p.652-660, 1997.

AMATO, J.F.; MONTEIRO, C.M.; AMATO, S.B. *Contracaecum rudolphii* hartwich (nematoda, anisakidae) from the neotropical cormorant, *Phalacrocorax Brasiliensis* (Gmelin) (aves, Phalacrocoracidae) in southern Brazil. *Rev. Bras. Zool.*, v.23, p.1284-1289, 2006.

BANO, L.; NATALE, A.; VASCELLARI, M. *et al.* First report of parasitic esophagitis by *Streptocara incognita* in Muscovy ducks (*Cairina moschata domestica*) in Italy. *Avian Dis.*, v.49, p.298-300, 2005.

BUSH, A.O.; LAFFERTY, K.D.; LOTZ, J.M. *et al.* Parasitology meets ecology on its own terms: Margolis *et al.*, revisited. *J. Parasitol.*, v.83, p.575-583, 1997.

CARVALHO, E.L.; SANTANA, R.L.S.; GONÇALVES, E.C. *et al.* First report of *Anisakis* sp. (Nematoda: Anisakidae) parasitizing Muscovy duck in Marajó Island, state of Pará, Brazil. *Braz. J. Vet. Parasitol.*, v.29, p.e020319, 2020.

CARVALHO, E.L.; SANTANA, R.L.S.; PINHEIRO, R.H.D.S. *et al.* *Eucoleus contortus* (Nematoda: Capillariidae), a parasite of *Cairina moschata domestica* (Anseriformes: Anatidae) on Marajó Island, Pará State, in Brazilian Amazon. *Braz. J. Vet. Parasitol.*, v.28, p.692-699, 2019.

CRAM, E.B. *Species of Capillaria parasitic in the upper digestive tract of birds*. Washington: United States Department of Agriculture, 1936. p.13-15.

CUBAS, Z.S. Piciformes (tucanos, araçaris, pica-paus). In: CUBAS, Z.S.; SILVA, J.C.R.; CATÃO-DIAS, J.L. *Tratado de animais selvagens: medicina veterinária*. São Paulo: Roca, 2007. 1376p.

DE LEY, P.; BLAXTER, M.L. Systematic position and phylogeny. In: LEE, D.L. *The biology of nematodes*. London: Taylor and Francis, 2002. 648p.

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- FELIZARDO, N.N.; KNOFF, M.; PINTO, R.M.; GOMES, D.C. Larval anisakid nematodes of the flounder *Paralichthys isosceles* Jordan, 1890 (Pisces:Teleostei) from Brazil. *Neotrop. Helminthol.*, v.3, p.57-64, 2009.
- FONSECA, M.C.G.; KNOFF, M.; FELIZARDO, N.N. *et al.* Integrative taxonomy of Anisakidae and Raphidascarididae (Nematoda) in *Paralichthys patagonicus* and *Xystreureys rasile* (Pisces: Teleostei) from Brazil. *Int. J. Food. Microbiol.*, v.235, p.113-124, 2016.
- GIBBONS, L.M. *Keys to the nematode parasites of vertebrates: supplementary volume.* Oxon, Wallingford: Cabi Publishing, 2010. 416p.
- GOMES, F.F.; MACHADO, H.H.S.; SILVA LEMOS, L. *et al.* Principais parasitos intestinais diagnosticados em galinhas domésticas criadas em regime extensivo na municipalidade de Campos dos Goytacazes, RJ. *Ciênc. Anim. Bras.*, v.10, p.818-822, 2009.
- JUNQUEIRA, P. *Capillaria* spp, gusanos nematodos parásitos de aves (gallinas, pavos, faisanes etc.). Parasitipedia.net, 2018. Available in: https://parasitipedia.net/index.php?option=com_content&view=article&id=2145&Itemid=230. Accessed in: 19 May 2019.
- KIM, S.G.; JO, Y.J.; PARK, Y.S. *et al.* Four cases of gastric submucosal mass suspected as anisakiasis. *Korean J. Parasitol.*, v.44, p.81, 2006.
- LAUWERS, G.Y.; MINO-KENUDSON, M.; KRADIN, R.L. Infections of the gastrointestinal Tract. In: KRADIN, R.L. *Diagnostic pathology of infectious disease.* 2.ed. Amsterdam: Elsevier Health Sciences, 2017. p.232-271.
- LYMBERG, A.J.; CHEAH, F.Y. Anisakid nematodes and anisakiasis. In: MURRELL K.D.; FRIED, B. (Eds.). *Food-borne parasitic zoonoses.* World Class Parasites. Boston: Springer: 2007. v.11, p.191-193.
- MATTOS JUNIOR, D.G.; COSTA, D.A.; MENEZES, R.C.; MESQUITA, E.M. Prevalência de helmintos em patos domésticos *Cairina moschata dom.* (Linné) (Anseriformes, Anatidae, Cairinini, *Cairina*) provenientes de criações extensivas no estado do Rio de Janeiro, Brasil. *Rev. Bras. Cienc. Vet.*, v.15, p.140-142, 2008.
- MENEZES, R.C. *Helmintoses de galinhas d'angola (Numida meleagris Linnaeus, 1758) criadas extensivamente no Estado do Rio de Janeiro, Brasil.* 1999. 106f. Dissertação (Mestrado em Patologia Veterinária) - Universidade Federal Fluminense, RJ.
- MENEZES, R.C.; MATTOS JUNIOR, D.G.; TORTELLY, R. Frequência e patologia das infecções causadas por nematóides e cestóides em galinhas-d'angola (*Numida meleagris* Linnaeus, 1758) criadas extensivamente no estado do Rio de Janeiro, Brasil. *Rev. Bras. Ciênc. Vet.*, v.8, p.35-39, 2001.
- MEULEN, C.J.; DIKKEN, G. *Criação de patos nas regiões tropicais.* Wageningen: Fundação Agromisa, 2003. 96p.
- MORAVEC, F. *Nematodes of freshwater fishes of the Neotropical Region.* Praha: House of the Academy of Sciences of the Czech Republic, 1998. 464p.
- MUHAIRWA, A.P.; MSOFFE, P.L.; RAMADHANI, S. *et al.* Prevalence of gastrointestinal helminths in free-range ducks in Morogoro Municipality, Tanzania. *Livest. Rev. Rural Develop.*, v.19, p.1-5, 2007.
- MURATA, Y.; ANDO, K.; USUI, M. *et al.* A case of hepatic anisakiasis caused by *Pseudoterranova decipiens* mimicking metastatic liver cancer. *BMC Infect. Dis.*, v.18, p.619, 2018.
- NEVES, D.P. Parasitologia humana. In: *Parasitologia humana.* 13.ed. São Paulo: Atheneu, 2016. 587p.
- PINTO, R.M.; BRENER, B.; TORTELLY, R. *et al.* Capillariid nematodes in Brazilian turkeys, *Meleagris gallopavo* (Galliformes, Phasianidae): pathology induced by *Baruscapillaria obsignata* and *Eucoleus annulatus* (Trichinelloidea, Capillariidae). *Mem. Inst. Oswaldo Cruz*, v.103, p.295-297, 2008.
- PINTO, R.M.; TORTELLY, R.; MENEZES, R.C.; GOMES, D.C. Trichurid nematodes in ring-necked pheasants from backyard flocks of the State of Rio de Janeiro, Brazil: frequency and pathology. *Mem. Inst. Oswaldo Cruz*, v.99, p.721-726, 2004.

- PIZARRO, M.; VILLEGAS, P.; RODRIGUEZ, A. et al. *Capillaria contorta* parasitism in red-legged partridge under farm conditions in Spain: histopathology of the upper digestive system. *World Poult. Sci. J.*, v.56, p.159-166, 2000.
- RAILLIET, A.; LUCET, A. Sur la presence eu *Trichosoma Contortum* Creplin chez le canard domestique. *Bull. Soc. Zool.*, v.14, p.382-383, 1889.
- RENNÓ, P.P.; QUEIROZ, F.M.; GARCIA, B.P. et al. Endoparasitose em aves-revisão de literatura. *Rev. Cient. Eletr. Med. Vet.*, v.6, p.1-6, 2008.
- ROSA, M.; SHIVAPRASAD, H.L. Capillariasis in a vulture guinea fowl. *Avian Dis.*, v.43, p.131-135, 2015.
- SICK, H. *Ornitologia brasileira*. 2.ed. Rio de Janeiro: Nova Fronteira, 1997. 912p.
- SMITH, J.W. Ascaridoid nematodes and pathology of the alimentary tract and its associated organs in vertebrates, including man: a literature review. *Helminthol. Abstr.*, v.68, p.49-96, 1999.
- SOUZA ALMEIDA, A.M.; LEONÍDIO, A.R.A.; ANDRADE, M.A. Principais doenças em anseriformes. *Rev. Vet. Foco*, v.14, p.10-33, 2016.
- TOLOSA, E.M.C.D.; RODRIGUES, C.J.; BEHMER, A.O.; FREITAS NETO, A.G.D. *Manual de técnicas para histologia: normal e patológica*. 2.ed. São Paulo: Manole, 2003. 331p.
- VICENTE, J.J.; RODRIGUES, H.D.; GOMES, D.C.; PINTO, R.M. Nematóides do Brasil. Parte 4. Nematóides de aves. *Rev. Bras. Zool.*, v.12, Supl.1, p.1-273, 1995.
- YOUSUF, M.A.; DAS, P.M.; ANISUZZAMAN, M.; BANOWARY, B. Gastro-intestinal helminths of ducks: some epidemiologic and pathologic aspects. *J. Bangladesh Agril. Univ.*, v.7, p.91-97, 2009.