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HELMINTHS ASSEMBLAGE OF CHRYSMUS RUFICAPILLUS (VIEILLOT, 1819) (PASSERIFORMES: ICTERIDAE) IN SOUTHERN BRAZIL

ENSAMBLAJE DE HELMINTOS DE CHRYSMUS RUFICAPILLUS (VIEILLOT, 1819) (PASSERIFORMES: ICTERIDAE) DEL SUR DE BRASIL

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ABSTRACT

Chrysomus ruficapillus (Vieillot, 1819) is an abundant bird of the Pampa Biome, often found associated with Oryza spp. cultivation. One hundred twenty-two birds were collected in rice fields from southern Brazil to examine the presence of helminths. One hundred fourteen C. ruficapillus were positive for at least one parasitic species (P%=93.4). We identified 15 taxa: species of Trematoda (P%=75.4), two Cestodes (P%=20.5), four Nematodes (P%=57.4) and one acanthocephalan (P%=2.4). Results and parasitological indexes are new for C. ruficapillus contributing to parasitological knowledge of species and for the helminthology of Icteridae in South America.

Keywords: Acanthocephala – Cestoda – chestnut – Chrysomus ruficapillus – Nematoda – rice fields – Trematoda

RESUMEN

Chrysomus ruficapillus (Vieillot, 1819) es una ave abundante en Bioma Pampa frecuentemente asociada a arrozales. Se examinaron 122 especímenes recolectados en campos de arroz del extremo sur de Brasil para investigar la presencia de helmintos. Ciento y catorce C. ruficapillus fueron positivos para por lo menos una especie parásita (P%=93.4) y fueron identificados 15 taxa: ocho pertenecientes a Trematoda (P%=75.4), dos a Cestoda (P%=20.5), cuatro a Nematodes (P%=57.4) y uno a Acanthocephala (P%=2.4). Los resultados y índices parasitológicos son inéditos para C. ruficapillus contribuyendo al conocimiento parasitológico de la especie y para la helmintología de Icteridae en América del Sur.

Palabras clave: turpial de gorro castaño – arrozales – parasitos - Acanthocephala Cestoda - Nematoda - Trematoda
Parasites represent a significant part of biological diversity. According Price (1980), parasitism is one of the most successful lifestyles exhibited by several organisms. Estimates suggest that there are between 75,000 and 300,000 species of helminths parasitizing vertebrates (Dobson et al., 2008), however, this diversity will only be known when the hosts are studied (Windsor, 1998).

The southern region of Rio Grande do Sul is located in the Pampa Biome, which covers part of Argentina, all of Uruguay and most of the territory of Rio Grande do Sul (62.2%) (Boldrini et al., 2010). This biome presents high animal and vegetal diversity, being the richness of birds in Rio Grande do Sul composed by 480 species (Develey et al., 2008).

Chrysomus ruficapillus (Vieillot, 1819) (Passeriformes: Icteridae) internationally as known as chestnut-capped blackbird comprises a characteristic bird of the Pampa Biome. It is geographically restricted to the South American continent, occurs in French Guiana, Brazil, Bolivia, Paraguay, Argentina and Uruguay (IUCN, 2017). In Brazil, C. ruficapillus is distributed throughout the eastern territory, often found associated with Oryza spp. (rice fields) and it is appropriately established at these sites (Belton, 1994; Fallavena, 1988; Dias & Burger, 2005; Crozariol, 2008).

This species is swampy, has a gregarious habit and can be found in flocks ranging from a few to thousands (Belton, 1994). In the state of Rio Grande do Sul it is considered one of the most abundant bird (Fallavena, 1988; Belton, 1994; Silva, 2004), however, helminthological information about C. ruficapillus does not exist, in this sense, the study identified and quantified the helminth assemblage associated to C. ruficapillus in rice fields in southern Brazil.

**MATERIAL AND METHODS**

Collect of host's

One hundred twenty-two hosts were collect in period of 2013 at 2014 in rice fields of the propriety “Granjas Quatro Irmãos S.A.” in the city of Rio Grande, Rio Grande do Sul, Brazil (a.c. 32° 14'37.24” S; 52°29'38.71” W) through the trap (one cube with sized 2.5 m³ with metal edges, covered with screen and top opening, which allows the entry of the birds, but not the exit) was installed containing potable water and bird food ad libitum.

The identification of birds was performed according to Belton (1994). The capture, euthanasia, and transport of birds have been licensed by “Instituto Chico Mendes de Conservação da Biodiversidade” (ICMBio/41095-3) and approved by “Comissão de Ética e Experimentação Animal – UFPe” (CEEA/UFPe/nº1477). After euthanasia, the hosts (number 1 to 122) were packed individually in plastic bags and transported to Instituto de Biologia, Departamento de Microbiologia e Parasitologia at “Laboratório de Parasitologia de Animais Silvestres” (LAPASIL/UFPe), and frozen until processing.

Collecting, preparing and identification of helminths

For helminths collection, the birds were necropsied. Were examined the eyes, mouth, esophagus, proventriculus, gizzard, small and large intestine, cecum, trachea, lungs, heart, liver, gallbladder, kidneys, reproductive system, cloaca and air sacs. These organs or systems were opened, washed with current water under sieve 150 µm. The washing resulting well as the cavities and mucous membranes were examined under stereomicroscope (Olympus’SZ61). The helminths were fixed and prepared for the identification respecting the taxa, according protocols of Amato & Amato (2010).

The identification was realized according to Faria (1912), Freitas (1951), Kohn & Fernandes (1972), Gibson et al. (2002), Jones et al. (2005), Bray et al. (2008) and Lunaschi et al. (2015) for Trematoda (Digenea); Saxena & Baugh (1978) and Khalil et al. (1994) for Cestoda; Vicente et al. (1983) and Anderson et al. (2009) for Nematoda and Schmidt & Kuntz (1977) for Acanthocephala. Vouchers were deposited in “Coleção Helmintológica do Instituto Oswaldo Cruz – CHIOC” (number 38586,a-b; 39084 at 39095 a-b) from Rio de Janeiro and “Coleção de Helmintos do Laboratório...”

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de Parasitologia de Animais Silvestres - CHALAPASIL" (number 644 at 679) in Departamento de Microbiologia e Parasitologia, Instituto de Biologia, Universidade Federal de Pelotas.

Parasitological analysis
The term assemblage was used in this research according to the concept to Fauth et al. (1996), because it represents the universe of species (taxonomic limits) and limits of distribution (geographic) according to the aim of the study. For the “assembly” of helminths was estimated: prevalence (P%), mean abundance of infection (MA), and mean intensity of infection (MII) according to Bush et al. (1997), and range of infection (R) according to Bush et al. (2001).

From the 122 C. ruficapillus examined, one hundred and fourteen were positive (P%=93.4) for at least one taxon parasite. Trematoda with P%=75.4 (n=92), Cestoda with P%=20.5 (n=25), Nematoda with P%=57.4 (n=70), and Acanthocephala with P=2.4% (n=3). The helminth assemblage was composed by 15 taxa, Trematoda (Digenea): Tanaisia valida Freitas, 1951 (Eucotylidae: Tanaisiinae) (n=328) (Fig.1-a), Prosthogonimus ovatus (Rudolphi, 1803) (Prosthogonimidae) (n=25) (Fig.1-b), Conspicuum conspicuum (Gomes de Faria, 1912) (Dicrocoelidae: Leipertrematinae) (n=32) (Fig. 1-c), Stomylotrema gratiosus Travassos, 1922 (Stomylotrematidae) (n=13) (Fig.1-d), Eumegacetes sp. (Eumegacetidae) (n=3) (Figural-g), Strigea sp. (Strigeidae) (n=2) (Fig.1-e) e dois Echinostoma spp. (Echinostomatidae) (n=4/1) (Fig. 1 e/f); Cestoda: Mathevotaenia sp. (Anoplocephalidae) (n=45) (Fig.2a-d); and Anochotaenia sp. (Paruterinidae) (n=1) (Fig. 2 e-h); Nematoda: Diplatraena bargusinica Skrjabin, 1917 (Diplotriaenidae) (580 males and 652 females) (n=1,232) (Fig.3a-f), Oxyspirura Drashe in Stossich, 1897 (Thelaziidae) (two females and one male) (n=3), one species of Aproctoidea (three females) and one species of Capillarinae (one female) (Fig.4a-h) and Acanthocephala: Mediorhynchus micranthus (Rudolphi, 1819) (Gigantorhynchidae) (8 males and 11 females) (n=19) (Fig.5 a-b). Pathological aspects of infections were not analyzed.

RESULTS

DISCUSSION

Helminths assemblage of C. ruficapillus, infection site and parasitological indexes (P%, MA, MII e R) are presented in Table 1. According to P%, T. valida, D. bargusinica and Mathevotaenia sp. were the taxa the showed highlighted values. T. valida the taxon with highlight in the P% and D. bargusinica the species with highlight in MA, MII and R (Table 1).

Helminths of C. ruficapillus were not recorded until the present study, although there are occurrences of parasites for other Icteridae in Brazil. Species of Tanaisia (Digenea) parasite renal tubules and kidneys of birds (Gibson et al., 2002). Tanaisia valida was described by Freitas, 1951 parasitizing kidneys of Himantopus melanurus Vieillot, 1817 (Charadriiformes: Recurvirostridae) in the state of Rio de Janeiro, Brazil. It resembles Tanaisia fedtschenkoi Skrjabin, 1924, differentiating them by the size (length and width) of the eggs, which are slightly larger than those of T. valida, in addition to the geographical distribution, as T. fedtschenkoi occurs in Asia and Europe, reported in Charadriiformes (Scolopacidae, Recurvirostridae, Charadriidae, Laridae) (Freitas, 1951).
Table 1. Assemblage of helminths of *Chrysomus ruficapillus* (Vieillot, 1819) (Passeriformes: Icteridae) from southern Brazil. Infection sites (IS), number of infected birds (NIB) and parasitological indexes: prevalence (P%), mean abundance of infection (MA), mean intensity of infection (MII) and range of infection (R).

<table>
<thead>
<tr>
<th>Helminths</th>
<th>IS</th>
<th>P% (NIB)</th>
<th>MA</th>
<th>MII</th>
<th>R</th>
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<tr>
<td><strong>Trematoda (Digenea)</strong></td>
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<tr>
<td><em>Tanaisia valida</em></td>
<td>kidney ducts</td>
<td>58.2 (71)</td>
<td>2.7</td>
<td>4.62</td>
<td>1-12</td>
</tr>
<tr>
<td><em>Prosthogonimus ovatus</em></td>
<td>cloaca</td>
<td>14.75 (18)</td>
<td>0.2</td>
<td>1.38</td>
<td>1-5</td>
</tr>
<tr>
<td><em>Conspicuum conspicuum</em></td>
<td>small bladder</td>
<td>8.20 (10)</td>
<td>0.26</td>
<td>3.2</td>
<td>1-7</td>
</tr>
<tr>
<td><em>Stomylotrema gratiosus</em></td>
<td>cloaca</td>
<td>7.37 (9)</td>
<td>0.1</td>
<td>1.4</td>
<td>1-3</td>
</tr>
<tr>
<td><em>Echinostoma</em> morphotype 1</td>
<td>small intestine</td>
<td>2.45 (3)</td>
<td>0.244</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><em>Echinostoma</em> morphotype 2</td>
<td>small intestine</td>
<td>0.82 (1)</td>
<td>0.0082</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><em>Eumegacetes</em> sp.</td>
<td>cloaca</td>
<td>0.82 (1)</td>
<td>0.02</td>
<td>3</td>
<td>3</td>
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<tr>
<td><em>Strigea</em> sp.</td>
<td>small intestine</td>
<td>1.64 (2)</td>
<td>0.01</td>
<td>1</td>
<td>1</td>
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<tr>
<td><strong>Cestoda</strong></td>
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<tr>
<td><em>Mathevotaenia</em> sp.</td>
<td>small intestine</td>
<td>19.67 (24)</td>
<td>0.36</td>
<td>1.87</td>
<td>1-5</td>
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<tr>
<td><em>Anonchotaenia</em> sp.</td>
<td>small intestine</td>
<td>0.82 (1)</td>
<td>0.008</td>
<td>1</td>
<td>1</td>
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<td><strong>Nematoda</strong></td>
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<tr>
<td><em>Diplostriaena bargusinica</em></td>
<td>air sacs, washing of</td>
<td>53.30 (65)</td>
<td>10.9</td>
<td>19.1</td>
<td>1-106</td>
</tr>
<tr>
<td></td>
<td>external surface of the</td>
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<td></td>
<td>body</td>
<td></td>
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<tr>
<td><em>Oxyspirura</em> sp.</td>
<td>washing of external</td>
<td>1.64 (2)</td>
<td>0.016</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>surface of the body</td>
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<td><strong>Aproctoidea</strong></td>
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<td></td>
<td>cavity washing</td>
<td>1.64 (2)</td>
<td>0.024</td>
<td>1.5</td>
<td>1-2</td>
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<tr>
<td></td>
<td>abdominal</td>
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<td><strong>Capillariinae</strong></td>
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<td></td>
<td>cavity washing</td>
<td>0.82 (1)</td>
<td>0.008</td>
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<td>1</td>
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<tr>
<td></td>
<td>abdominal</td>
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<tr>
<td><strong>Acanthocephala</strong></td>
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<tr>
<td><em>Mediorhynchus micracanthus</em></td>
<td>small intestine</td>
<td>2.46 (3)</td>
<td>0.15</td>
<td>6.33</td>
<td>1-9</td>
</tr>
<tr>
<td><strong>Total number of infected birds</strong></td>
<td></td>
<td><strong>114</strong></td>
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</table>

respectively). In this way, it is evident that the freezing, state of conservation of the hosts as well as the preparation of the specimens influences the quality of the digenetics for taxonomic identification.

In Brazil for Icteridae were registered *Tanaisia inopina* Freitas, 1951 in *Icterus chrysocephalus* (Linnaeus, 1766), *T. ovispera* in *Icterus pyrrhopterus* (Vieillot, 1819)(Freitas, 1951) and *T. valida* in *Molothrus bonariensis* (Gmelin, 1789) (Passeriformes: Icteridae) (n=5) (P%=40, MA=4.0 and MII=10) in the state of Rio Grande do Sul (Bernardon et al., 2016). The values of the *T. valida* indexes in *C. ruficapillus* (Table 1) were higher than those presented by Bernardon et al. (2016).

The life cycle of *T. valida* is unknown, however, according to Lunaschi et al. (2015) the biology of Tanaisiinae involves the ingestion of molluscs containing metacercariae (intermediate hosts). Pathological aspects caused by *T. bragai* are not known, however, researches with wild birds and mainly with breeding birds parasitized by *T. bragai* were realized in state of Rio de Janeiro, Brazil (Menezes et al., 2001; Pinto et al., 2004; Gomes et
Figure 1. Trematoda (Digenea) of *Chrysomus ruficapillus* (Vieillot, 1819) (Passeriformes: Icteridae) from southern Brazil. a. *Tanaisia valida* Freitas, 1951 (Eucotylidae) BAR=410µm; b. *Prosthogonimus ovatus* (Rudolphi, 1803) (Lühe, 1899) (Prosthogonimidae) BAR=580µm; c. *Conspicuum conspicuum* (Gomes de Faria, 1912) (Dicrocoelidae) BAR=460µm; d. *Stomylotrema gratiosus* Travassos, 1922 (Stomylotremaidae) BAR=430µm; e. *Echinostoma* morphotype 1 BAR=600µm; f. *Echinostoma* morphotype 2 BAR=560µm (Echinostomatidae) g. *Eumegacetes* Looss, 1900 (Eumegacetidae) BAR=320µm; h. Strigeida BAR=175µm. OS=oral sucker; P= pharynx; C=cecum; VS=ventral sucker; O=ovary; T=testes; CS=cirrus sac; U-EG=uterus with eggs.
Figure 2. Cestoda of *Chrysomus ruficapillus* (Vieillot, 1819) (Passeriformes: Icteridae) from southern Brazil. a-d. *Mathevotaenia* sp. (Anoplocephalidae); a. scolex BAR=190µm; b. mature proglottides BAR=625µm; c. gravid proglottides BAR=750µm; d. gravid proglottides with cirrus sac and cirrus BAR=150µm; e-h. *Anonchotaenia* sp. (Paruterinidae); e. scolex BAR=250µm; f. mature proglottides BAR=92µm; g. mature proglottides in highlight BAR=340µm; h. gravid proglottides and paruterine organ with eggs BAR=42µm. S=suckers; IP= immature proglottides; CB=cirrus bag; O=ovary; C=cirrus; T=testes; PO= paruterine organ; LCE=longitudinal excretory canal.
Figure 3. *Diplotriaena bargusinica* Skrjabin, 1917 (Nematoda: Diplotriaenidae) of *Chrysomus ruficapillus* (Vieillot, 1819) (Passeriformes: Icteridae) from southern Brazil. a. Body cavity of the bird, arrow head indicates the nematodes in air sacs BAR=1000µm; b. Nematodes inside air sacs BAR=1000µm; c. Anterior extremity of nematode, arrow head indicates the smooth trident with tapered apex BAR=30µm; d. Arrow head indicates the genital pore of female BAR=100µm; e. Posterior region of female rounded BAR=400µm; f. Posterior region of male, right and left spicules arrow head pointing the papillae BAR=350µm. LI=lips; E=esophagus AS=air sacs; N=nematode; TR=trident; PRF=posterior region of female; LS=left spicule; RIS=right spicule.
Figure 4. Nematode of *Chrysolus ruficapillus* (Vieillot, 1819) (Passeriformes: Icteridae) from southern Brazil. a-e. *Oxyspirura* sp. (Thelaziidae); a. anterior region, arrow head indicates the papillae *BAR*=62µm; b. medium region of female *BAR*=45µm; c. posterior region of female *BAR*=77µm; d. posterior region of male *BAR*=157µm; e. spicules of male, arrow head indicates the papillae *BAR*=157µm; f. Capilariinae eggs *BAR*=65µm; g. anterior region *BAR*=6µm; g-h. Aproctoidea g. anterior region *BAR*=6µm h. posterior region of female *BAR*=6µm. OC=oral capsule; E= esophagus; S= spicules; RIS= right spicule; LS=left spicule. EG= eggs.
Figure 5. *Mediorhynchus micracanthus* (Rudolphi, 1819) (Acanthocephala: Gigantorhynchidae) of *Chrysomus ruficapillus* (Vietillot, 1819) (Passeriformes: Icteridae) from southern Brazil. a. female BAR=600 µm. b. male BAR=950 µm. PRO=proboscis; LE=lemniscus; EG=eggs; T=testes; CG=cement gland; CB=copulatory bursa.

Although *T. bragai* is considered to be poorly pathogenic to birds, it can cause clinical complications such as apathy, weight loss, diarrhea and death in high parasite loads (Costa *et al.*, 2015). Microscopic lesions such as dilatation of the collecting ducts, nephritis, fibrosis, destruction, and calcification points have been reported (Menezes *et al.*, 2001; Pinto *et al.*, 2004).

*Prosthogonimus* spp. are found in the oviduct, Fabricius bursa, cloaca and accidentally in the intestine and eggs (Olsen, 1974), distribution is cosmopolitan (Bray *et al.*, 2008). *Prosthogonimus ovatus* has a low parasitic specificity, recorded in Brazil for the first time in *Gallus gallus* (Linnaeus, 1758) (Galliformes: Phasianidae) (n=17) (P%=17.6), however, the authors did not cite origin and MII (Travassos, 1928; Travassos *et al.*, 1969).

According to Kohn & Fernandes (1972), after examining 84 *P. ovatus* specimens 22 hosts of 10 orders, verified that the digenetic presents significant intraspecific morphological variations (=phenotypic plasticity), and these variations may be greater in the specimens of the same host than
when observed in parasites of zoologically far away hosts (Kohn & Fernandes, 1972; Monteiro et al., 2007). According to Boddeke (1960a) apud Monteiro et al. (2007) differences in morphology may be linked to different sites of infection and low specificity. However, P. ovatus of C. ruficapillus did not present relevant morphological differences between the specimens and all specimens were found in the cloaca of the hosts.

Boddeke (1960b) elucidated the biological cycle of P. ovatus in Europe (Holland) presented a participation of Bithynia tentaculata (Linnaeus, 1758) (Mollusca: Gastropoda) as primary host and adults or young adults of Odonata Cordulia aenea (Linnaeus, 1758) (Corduliidae), Orthetrum cancellatus Linnaeus, 1758 (Libellulidae), Leucorrhinia caudalis (Charpentier, 1840) (Libellulidae) and Aeshna cyanea (Muller, 1764) (Aeshnidae) as secondary host of trematode. The author comments that the primary intermediate host and larval stages of the parasite were not identified for the Americas. It is evident the lack of work in relation to the biology of P. ovatus in Brazil. The effects of Prosthogonimus parasitism on egg-laying birds, affecting egg production, causing decline or non-formation (economic losses in domestic poultry) (Olsen, 1974).

Prosthogonimus ovatus was recorded in Icteridae in Sturnella superciliaris (Bonaparte, 1850) in the state of Minas Gerais (Kohn & Fernandes, 1972) without indexes, and in M. bonariensis (n=5) in the state of Rio Grande do Sul (P%=20; MA=1; MII=5) (Bernardon et al., 2016). The P% value of P. ovatus in M. bonariensis was higher than in C. ruficapillus (Table 1), however, it is necessary to consider that the sample number of hosts in the present study was high to that presented by Bernardon et al. (2016).

Conspicuum spp. (Leipertrematinae) parasite the gallbladder of birds, rarely mammals. Its distribution comprises Europe, Asia, Africa, North America, Central America and South America (Bray et al., 2008). Conspicuum conspicuum was described as Dicrocoelium conspicuum by Faria (1912), from three specimens collected from Mimus gilvus (Passeriformes: Mimidae) (n = 1) in the state of Rio de Janeiro, Brazil. For Icteridae, C. conspicuum was recorded in Cacicus haemorrhous (Linnaeus, 1766) no recorded origin, number of birds sampled and parasitological indexes (Travassos et al., 1969; Fernandes et al., 2015).

Biology of C. conspicuum is not known, Patten (1952) elucidated the cycle of Conspicuum icteridorum Denton & Byrd, 1951 and identified Zonitoides arboreus (Say, 1816) (Gastropoda: Mollusca) as the primary intermediate host and Armandillidium quadrirrons Stoll, 1902 (Isopoda: Armadillidiidae) as secondary. Menezes et al. (2001), identified C. conspicuum in Numida meleagris Linnaeus, 1764 (Galliformes: Numididae) (n=36) (P%=2.8; MII=1), in the state of Rio de Janeiro, birds were raised in the air free and had no clinical signs. However, macroscopic and microscopic lesions were observed: enlarged liver lobes (hepatomegaly) and yellowish (jaundice), and hepatic degenerative process (hepatolysis). These is the first record of C. conspicuum in C. ruficapillus in Brazil.

Species of Stomylotrema Looss, 1900 are found in the posterior alimentary tract, especially in the cecum, rectum, Fabriciuc Bursa or cloaca of birds, with cosmopolitan distribution (Bray et al., 2008). Brenes et al. (1966) elaborated the identification key for Stomylotrema spp. from Costa Rica. In this study the authors described Stomylotrema ucremium from two specimens collected from Icterus galbula Linnaeus, 1758 (Passeriformes: Icteridae), differentiated from S. gratiosus due differences in genital pore position, shape and extent of vitellaria fields, and egg size. According to Pinto et al. (2015) these differences may be the result of intraspecific variation or preparation of specimens, suggesting that S. ucremium is S. gratiosus synonym. That the low number of specimens and possibly the preparation of the specimens compromises the description of Brenes et al. (1966).

About life cycle of S. gratiosus, Pinto et al. (2015) identified Pomacea maculata Perry, 1810 (Gastropoda) naturally infected in the state of Maranhaô, Brazil. Studies on the pathology caused by S. gratiosus don't exist, although Stomylotrema spp. have been recorded in several species of birds in Brazil (Travassos et al., 1969). This is the first report in Icteridae showing the parasitological indexes (Tab. 1).

Species of Echinostomatidae Looss, 1899 are
hematophagous, parasitize birds, mammals, fish and reptiles and have cosmopolitan distribution (Lutz, 1924; Jones et al., 2005). The taxonomy is complex, characterized by the presence of an uninterrupted cephalic collar armed with one or two crowns of thorns. The family belongs to 10 subfamilies, among them, Echinostomatidae. Looss, 1899 with 19 genera including Echinostoma Rudolfi, 1899 (Jones et al., 2005). About the biological cycle of Echinostoma, in Brazil, Lutz (1924) observed molluscs, tadpoles and fish as intermediate hosts. According to Esteban & Muñoz-Antoli (2009) apud Pinto & Melo (2012) biology involves three hosts (Gastropoda and Mollusca). Pinto & Melo (2012) identified Physa marmorata and Physidae as a natural intermediate host of E. exile Lutz, 1924 in the state of Minas Gerais. It is known that E. revolutum causes slimming and catarhhal enteritis, which may lead to the death of young Anseriformes (Yousuf et al., 2009 apud Saijuntha et al. 2013).

In Brazil, Echinostoma spp. were recorded for several birds, including Icteridae: E. discinctum Dietz, 1909 in Procaccius solitarius (Vieillot, 1816) and E. revolutum in M. bonariensis (Travassos et al., 1969; Fernandes et al., 2015). Parasitism in humans has been reported especially in South Asia, since some species of Echinostomatidae have zoonotic potential (Sohn et al., 2011a, 2011b; Chai et al., 2012). This is the first record of Echinostoma spp. for C. ruficapillus in Brazil. In C. ruficapillus there was a low P%% (Table 1), however, two morphologically distinct species were identified (Fig. 1 e-f). It is important to emphasize that due to the current complexity and taxonomy, a revision of Echinostomatidae from Brazil is necessary, besides studies involving the biological cycle and pathology of the species.

Eumegacetes spp. (Eumegacetidae) has a cosmopolitan distribution and they are parasites of the intestinal tract, especially the rectum, cloaca and renal system of birds (Bray et al., 2008). Although species are widely distributed, there are few records of Eumegacetes spp. in Brazil, constituted by a single species E. medioximus Braun, 1901. In the state of Rio de Janeiro, Brasil & Amato (1992) reported E. medioximus on two P. domesticus (Passeriformes: Passeridae) (n=142) (P%%=0.13 and MII=0.013) and in state of Rio Grande do Sul, Callegaro-Marques & Amato (2010) identified Eumegacetes sp. (n=1) in P. domesticus (n=160) (P%%=0.6 MA=0.01, MII=1 and R=1). The low values of parasitological indexes in C. ruficapillus (Table 1) corroborate the previously mentioned authors. And for the first time, Eumegacetes sp. was recorded for Icteridae in Brazil.

The biological cycle of Eumegacetes Looss, 1900 involves dragonflies (Odonata) (Bray et al., 2008). In Brazil, Pinto & Melo (2012) identified and characterized morphologically metacercariae of E. medioximus in Orthemis discolor (Burmeister, 1839) and Perithemis mooma Kirby, 1889 (Odonata: Libellulidae) in the state of Minas Gerais. However, the primary intermediate host of E. medioximus remains unknown as well as information about the pathology in the definitive host’s.

Strigeidae Railliet, 1919 are parasites of birds characterized by the anterior cup-shaped region and the presence of holdfast, composed of Duboisellinae Baer, 1938 and Strigeinae Railliet, 1919. Strigeinae Railliet, 1919 houses 12 genera among them, Strigea Abildgaard, 1970, which has vitellarias distributed evenly throughout the body and presence of pharynx (Gigson et al., 2002). In Brazil, according to Travassos et al. (1969) Strigea spp. were recorded in several birds, for Icteridae Strigea sphaerocephala (Westrumb, 1823) in Psarocolius decumanus (Pallas, 1769). For the first time, Strigea sp. is recorded in C. ruficapillus as well as parasitological indexes (Table 1).

Paruterinidae Fuhrmann, 1907 are cestodes that present the paruterine organ (= structure in which the eggs are surrounded by layers of membranes) that gives name to the family (Georgiev & Kornyushin, 1994). Paruterinidae is composed by 21 genera, including Anonchotaenia Cohn, 1900 with cosmopolitan distribution (Phillips et al. 2014). According to Phillips et al. (2012) when reviewing the family in South America, eight species of Anonchotaenia Cohn, 1900 were recorded for Passeriformes and Apodiformes. In Icteridae, A. brasiliensis Fuhrmann, 1908 was reported in Cacicus haemorrhous (Linnaeus, 1766) (Passeriformes: Icteridae) in Brazil. The intermediate hosts of Paruterinidae are unknown as well as the pathological aspects; however, Phillips.
et al. (2014) suggest the involvement of terrestrial insects in the cycle.

*Mathevotaenia* Akhunyan, 1946 belongs to the Anoplocephalidae: Anoplocephalinae. It includes 28 parasitic species of mammals (rodents, marsupials, primates, mustelids, edentados,lemurs) and birds (Yamaguti, 1959; Schmidt, 1986). According to Spasskii (1951) *apud* Lunaschi et al. (2012) the life cycle of *Mathevotaenia* spp. involves Blattaria and Lepidoptera as intermediate hosts. Pathological aspects not known for definitive hosts. Saxena & Baugh (1978) report that the occurrence of *Mathevotaenia* spp. is rarer in birds than in mammals. This authors hey described *Mathevotaenia ornithis* Saxena & Baugh (1978) (P%=100, MII =2) parasitizing *P. domesticus* (n=1) in India (Saxena & Baugh, 1978). In Brazil, *Mathevotaenia* is first recorded for Icteridae, presenting the parasitological indexes (Table 1).

Diplotriaenoidea Anderson, 1958 (Nematoda) are respiratory tract parasites of reptiles and birds (Anderson, 2000). Diplotriaenidae (Anderson, 1962) includes 27 valid species with cosmopolitan distribution (Atkinson et al., 2009). *Diplotriaena* Railliet & Henry, 1909 is a nematode from the air bags of birds, reflecting its specificity for this host group, moreover this parasite group shows wide geographic distribution (Vicente et al., 1983; Atkinson et al., 2009).

*Diplotriaena bargusinica* was registered in different regions in Brazil in a several Passeriformes (Vicente et al., 1983; Pinto et al., 1997; Carvalho et al., 2007). For Icteridae in: *C. cela* (Linnaeus, 1758), *C. haemorrhous* (Linnaeus, 1766), *Gnorimopsar chopi* (Vieillot, 1819), *Icterus croconotus* (Wagler, 1829), *Icterus* sp. Brisson, 1760, *Psacolius decumanus maculosus* (Chapman, 1920), *Molothrus bonariensis* (Gmelin, 1789) in the states of Mato Grosso do Sul, São Paulo and Pará (Vicente et al., 1983). In *P. bifasciatus* (Spix, 1824) (n=3) from Manaus, state of Amazonas, without presenting indexes (Goantalves et al., 2002). In *M. bonariensis* (n=5) (P%=60; MA=7.4; MII=12.3; A=1-18) in the state of Rio Grande do Sul (Bernardon et al., 2016). The value of P% in *C. ruficapillus* was lower than that reported by Bernardon et al. (2016), although the sample number is higher in the present study (n=122), with emphasis on the R value (Table 1).

The biological cycle of *D. bargusinica* was detailed by Anderson in 1962 through experimental infection with wild birds (Turdidae and Icteridae). It is heteroxenous, involving grasshoppers (Orthoptera) as intermediate hosts (Anderson, 1962, 2000). The common clinical signs in parasitized birds are: lethargy, difficult respiration due to the presence of nematodes in the respiratory tract that causes inflammatory reaction with airway congestion in high infections (Atkinson et al., 2009).

According to Anderson (2000) Aproctoidea, 1945 Skrjabin & Shikhalovalova includes nematodes of bird found in air sacs, nasal cavity, nictitating membranes, subcutaneous tissue of the head and neck. To the superfamily belong Aproctidae Skrjabin & Shikhalovalova, 1945 that occur in terrestrial birds and Desmidocercidae Cram, 1927 in piscivorous birds. Knowledge about the transmission of these nematodes is scarce, for *Aprocta* Linstow, 1883 eggs containing the first-stage larvae are known to be eliminated by birds and ingested by arthropods (intermediate hosts) (Anderson, 2009). According to Anderson (2009), for morphological identification male specimens are required, however, in *C. ruficapillus* only females were found, making it impossible to identify at lower taxonomic level. For the first time, it is recorded Aproctoidea in Icteridae in Brazil.

Thelaziidae Skrjabin, 1915 (Nematoda) composed by Thelaziinae Skrjabin, 1915 and Oxyspirurinae Skrjabin, 1916 has cosmopolitan distribution. *Oxyspirura* Drasche in Stossich, 1897 belongs to Oxyspirurinae, a parasite found under the nictitating membranes of eyes of domestic and wild and occasionally in mammalian (Anderson et al., 2009). Eighty-four species have been reported in birds for at least 43 host's families (Anderson, 2000). In Brazil were registered *O.* spp. for a several birds, for Icteridae: *O. cassici* Rodrigues, 1963 in *C. haemorrhous* (Linnaeus, 1766); *O. cephaloptera* (Molin, 1860) Stossich, 1897 in *I. croconotus* (Wagler, 1825); *O. matogrossensis* Rodrigues, 1963 in: *P. decumanus* (Pallas, 1769), *I. croconotus* and *G. chopi chopi* (Vieillot, 1819). *Oxyspirura* sp. in *P. decumanus* (Vicente et al., 1995). According to Table 1, *Oxyspirura* and Aproctoidea occurred only in two *C. ruficapillus*. 

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**C. ruficapillus**
In the biological cycle of O. mansonii (Cobbolt, 1879) the adult nematodes located in the membrane of the eyes deposit the eggs, which together with lacrimal secretions follow the tear ducts to the mouth where they are swallowed and eliminated by the feces. These eggs are ingested by roaches such as Pycnoselus surinamensis (Linnaeus, 1758) (Blattodea) that act as intermediate hosts (Anderson, 2000). In definitive hosts clinical sings of this parasitosis depend on parasite load, being common, eye irritation, conjunctivitis and loss of vision. As a consequence, there is the compromise of foraging, loss of appetite and decrease in weight and death (Dunham et al., 2016).

According to Anderson (2000) the classification of the Capillarinae is one of the most difficult in the Nematoda. Were identified approximately 300 species of Capillaria (Zeder, 1800) parasitizing a wide range of fish and mammals. The life cycle of Capillarinae can be monoxenous or heteroxenous, eggs are released to the environment through feces, urine or predation, depending on the location of the parasite in the host (Anderson, 2000). In relation to pathology, they cause weight loss and diarrhea (Weher, 1939). This study records for the first time in Brazil Capillarinae in Icteridae, parasitizing C. ruficapillus.


In South America, Petrochenko (1971) reported M. vaginatus (Diesing, 1851) in Dolichonyx oryzivorus (Linnaeus, 1758) and M. emberizae (Rudolphi, 1819) in C. haemorrhous (Linnaeus, 1766), M. bonariensis and P. decumanus (Pallas, 1769) in Icteridae. In Brazil, Machado Filho (1941) recorded M. micracanthus (Rudolphi, 1819) in Procacicus solitarius (Vieillot, 1816) (Passeriformes: Icteridae) in the state of Mato Grosso. The biological cycle of Mediorhynchus involves Blattodea, Orthoptera and Coleoptera as intermediate hosts (Nickol, 1977). Pathological aspects were addressed by Nickol (1977), commenting that the deep penetration of the proboscis produces nodules (granulomas) in the intestine of the host. For the first time M. micracanthus is reported in C. ruficapillus with parasitological indexes.

According to the literature, the complex life cycles of the parasites provide information on trophic ecology, food webs, food preferences and host foraging mode (Marcogliese & Cone, 1997; Overstreet, 1997; Marcogliese, 2003). Thus, suggesting the diet of C. ruficapillus composed of arthropods (larvae and adults) (Coleoptera, Hemiptera, Odonata, Collembola and Diptera) (Fallavena, 1988, Belton, 2004, Silva, 2004) is relating to the observed infections. It was evidenced of parasite infections with heteroxenous life cycles: Trematoda (P% = 75.4), Nematoda (P% = 57.4) and Cestoda (P% = 20.5), C. ruficapillus is the definitive host of T. valida, D. bargusinica and Mathevotaenia sp..

In Brazil, were realized other studies with helminths with Icteridae (Freitas, 1951; Travassos et al., 1969; Kohn & Fernandes, 1972; Vicente et al., 1995; Bernardon et al., 2016), however, the small sample size, the absence of host numbers and information on the locality of the birds in the publications, made it difficult to compare the populations of Icteridae helminths. Nevertheless, it was possible to observe similarity in the composition of helmintofauna between M. bonariensis (Bernardon et al., 2016) and C. ruficapillus, since both icterids share the environment and food items. It can be noticed, after the research with C. ruficapillus and bibliographical review, that efforts beyond the taxonomy of parasites are necessary, mainly in relation to the biology and pathology of helminth species.

The taxa S. gratiosus, Eumegacetes, Mathevotaenia, Aproctoidea and Capillarinae were reported for the first time for Icteridae in Brazil. Tanaisia valida, Conspicuum conspicuum, Prosthogonimus ovatus, Stomylotrema gratiosus, Eumegacetes sp., Strigea sp., two species of Echinostoma (Trematoda); Mathevotaenia sp. and Anonchotaenia sp. (Cestoda); Diplotriaena bargusinica, Oxyspirura sp., one species of Aproctoidea and to Capillarinae (Nematoda), and Mediorhynchus micracanthus (Acanthocephala) are
unprecedented for *Chrysomus ruficapillus* in South America.

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