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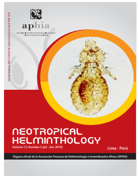

ORIGINAL ARTICLE / ARTÍCULO ORIGINAL

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

ENSAMBLAJE DE HELMINTOS DE *CHRYSOMUS 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 uma espécie parásita (P% = 93.4) y fueron identificados 15 *taxa*: ocho pertenecientes a Trematoda (P% = 75.4), dos a Cestoda (P% = 20.5), cuatro a Nematoda (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 espécie y para la helmintología de Icteridae en América del Sur.

Palabras clave: turpial de gorro castaño – arrozales – parasitos - Acathocephala Cestoda - Nematoda - Trematoda

INTRODUCTION

Parasites represent a significant part of biological diversity. According Price (1980), parasitism is one of 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. 32º 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 – UFPel" (CEEA/UFPel/nº1477). After euthanasia, the hosts (number 1 at 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/UFPel), 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 150µm. The washing resulting well as the cavities and mucous membranes were examined tunder 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 Schimidt & 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 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).

RESULTS

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) (Dicrocoellidae: Leipertrematinae) (n=32) (Fig. 1-c), *Stomylotrema gratiosus* Travassos, 1922 (Stomylotrematidae) (n=13) (Fig.1-d), *Eumegacetes* sp. (Eumegacetidae) (n=3) (Figura1-g), *Strigea* sp. (Strigeidae) (n=2) (Fig.1-h) e dois *Echinostoma* spp. (Echinostomatidae) (n=4/1) (Fig. 1 e/f); Cestoda: *Mathevotaenia* sp. (Anoplocephalidae) (n=45) (Fig.2a-d); and *Anonchotaenia* sp. (Paruterinidae) (n=1) (Fig. 2 e-h); Nematoda: *Diplotriaena 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 Capillariinae (one female) (Fig.4a-h) and Acanthochephala: *Mediorhynchus micranthus* (Rudolphi, 1819) (Gigantorhynchidae) (8 males and 11 females) (n=19) (Fig.5 a-b). Pathological aspects of infections were not analyzed.

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).

DISCUSSION

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).

The specimens of *T. valida* found in *C. ruficapillus* presented small variations in the morphology of the testis lobes, possibly related to the maturation of the trematodes, also verified by Freitas (1951). It was possible to observe the insertions of the spines in the integument in most of the digenetics, whereas spines were visualized only in parasites of two hosts. These birds did not undergo the freezing process after euthanasia, a fact that may explain the conservation of the spines, corroborating Monteiro *et al.* (2007) and Mascarenhas *et al.* (2016) that attributed the absence of spines in Trematoda (Digenea) due to the freezing or the state of conservation of the hosts (*P. ovatus* of aquatic birds and *Telorchis* spp. Of freshwater turtles,

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).

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

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. oviaspera* 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. valida* 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) (Dicrocoeliidae) BAR=460μm; **d.** *Stomylotrema gratiosus* Travassos, 1922 (Stomylotrematidae) BAR=430μm; **e.** *Echinostoma* morphotype 1 BAR=600μm; **f.** *Echinostoma* morphotype 2 BAR= 560μm (Echinostomatidae) **g.** *Eumegacetes* Looss, 1900 (Eumegacetidae) BAR=320μm; **h.** Strigeidae BAR=175μm. OS=oral sucker; P= pharynx; C=cecum; VS=ventral sucker; O=ovary; T=testes; CS=cirrus sac; U-EG=uterus with eggs.

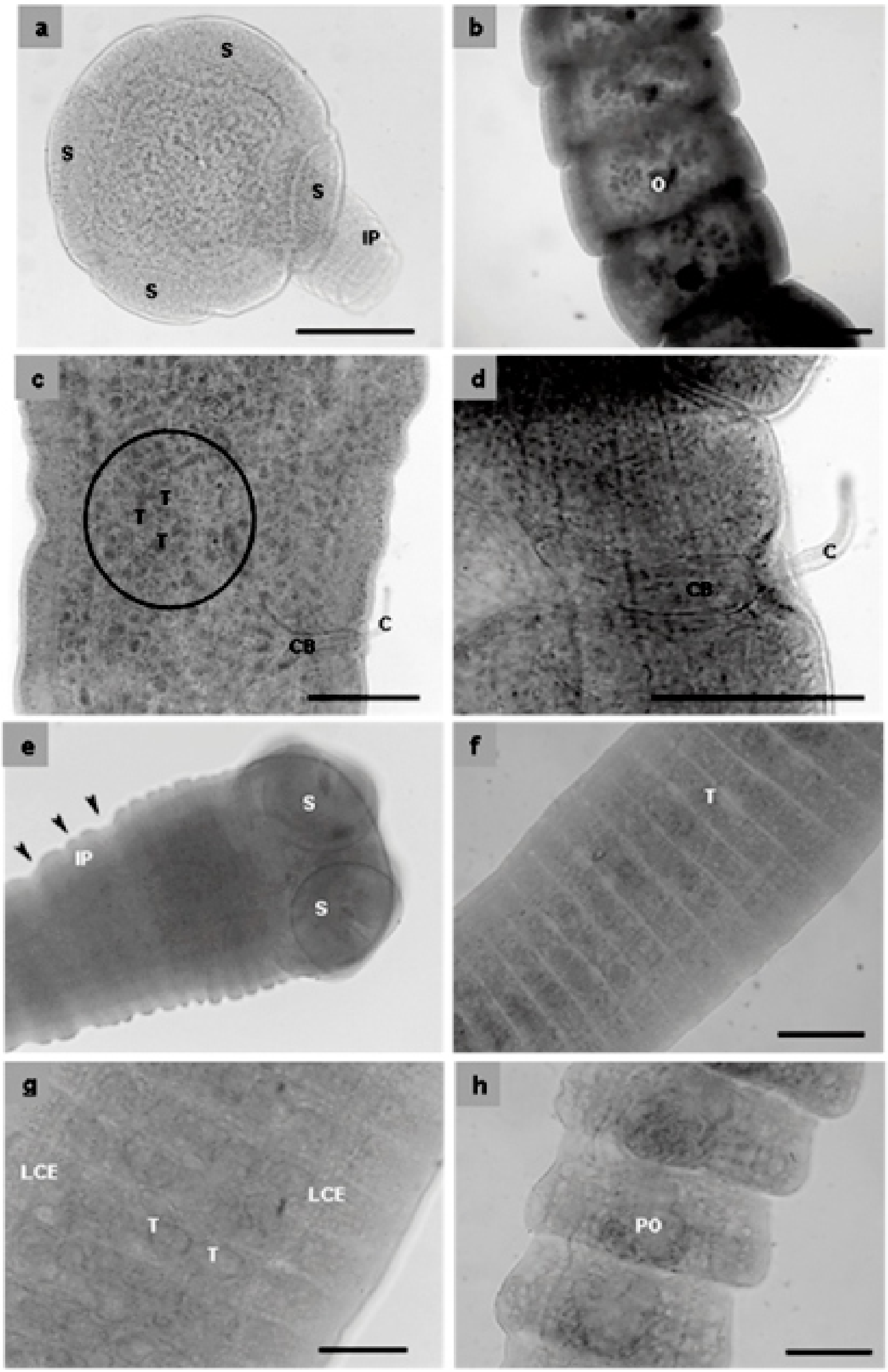

Figure 2. Cestoda of *Chrysomus ruficapillus* (Vieillot, 1819) (Passeriformes: Icteridae) from southern Brazil. **a-d.** *Mathevotaenia* sp. (Anoplocephalidae); **a.** scolex BAR=190μm; **b.** mature proglottides BAR=625μm; **c.** gravid proglottides BAR=750μm; **d.** gravid proglottides with cirrus 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.

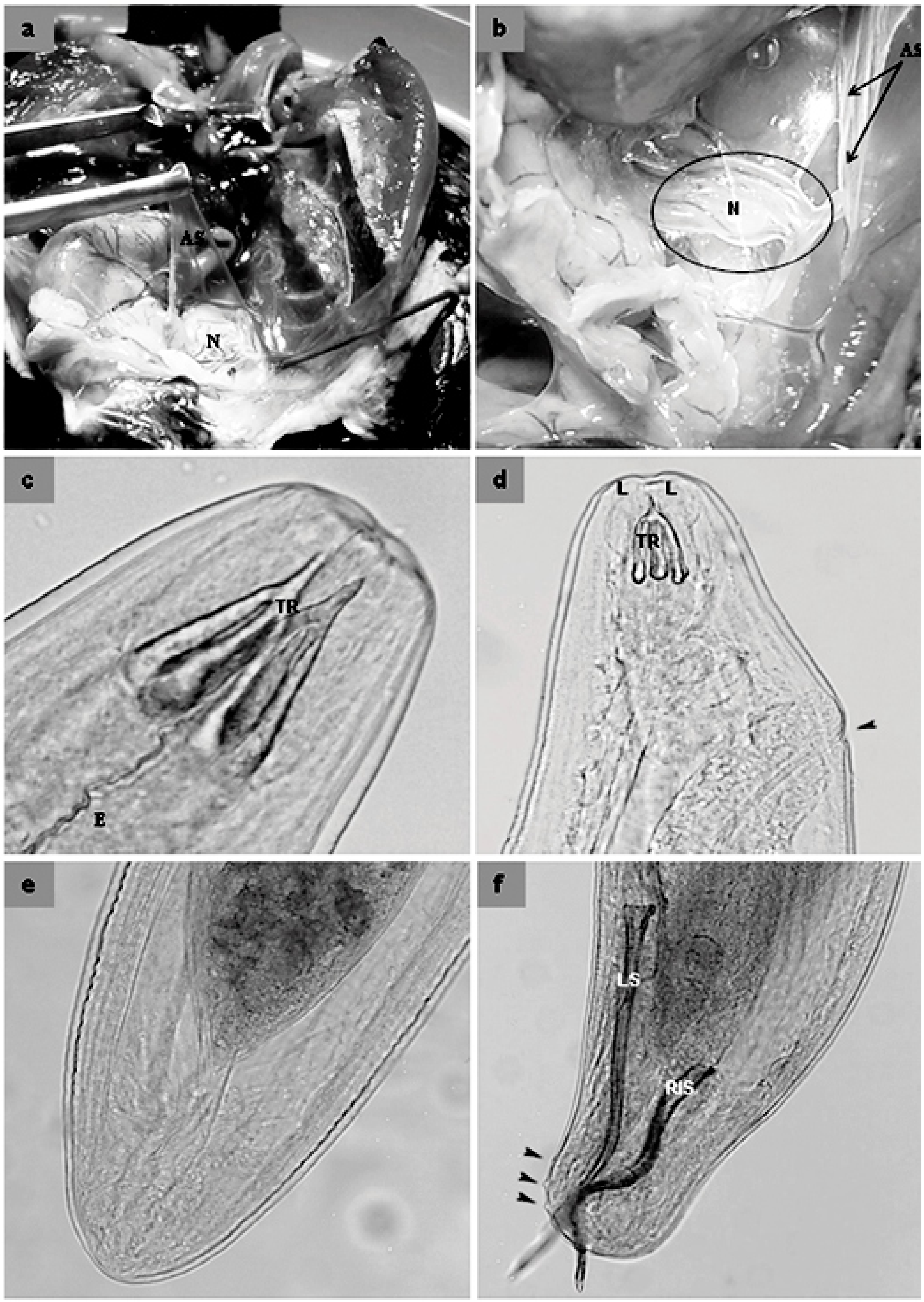

Figure 3. *Diplotriaena bargusinica* Skrjabin, 1917 (Nematoda: Diplotriaenidae) of *Chrysomus ruficapillus* (Vieillot, 1819) (Passeriformes: Icteridae) from southern Brazil. **a.** Body cavity of the bird, arrow head indicates the nematodes in air sacs BAR=1000μm; **b.** Nematodes inside air sacs BAR= 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.

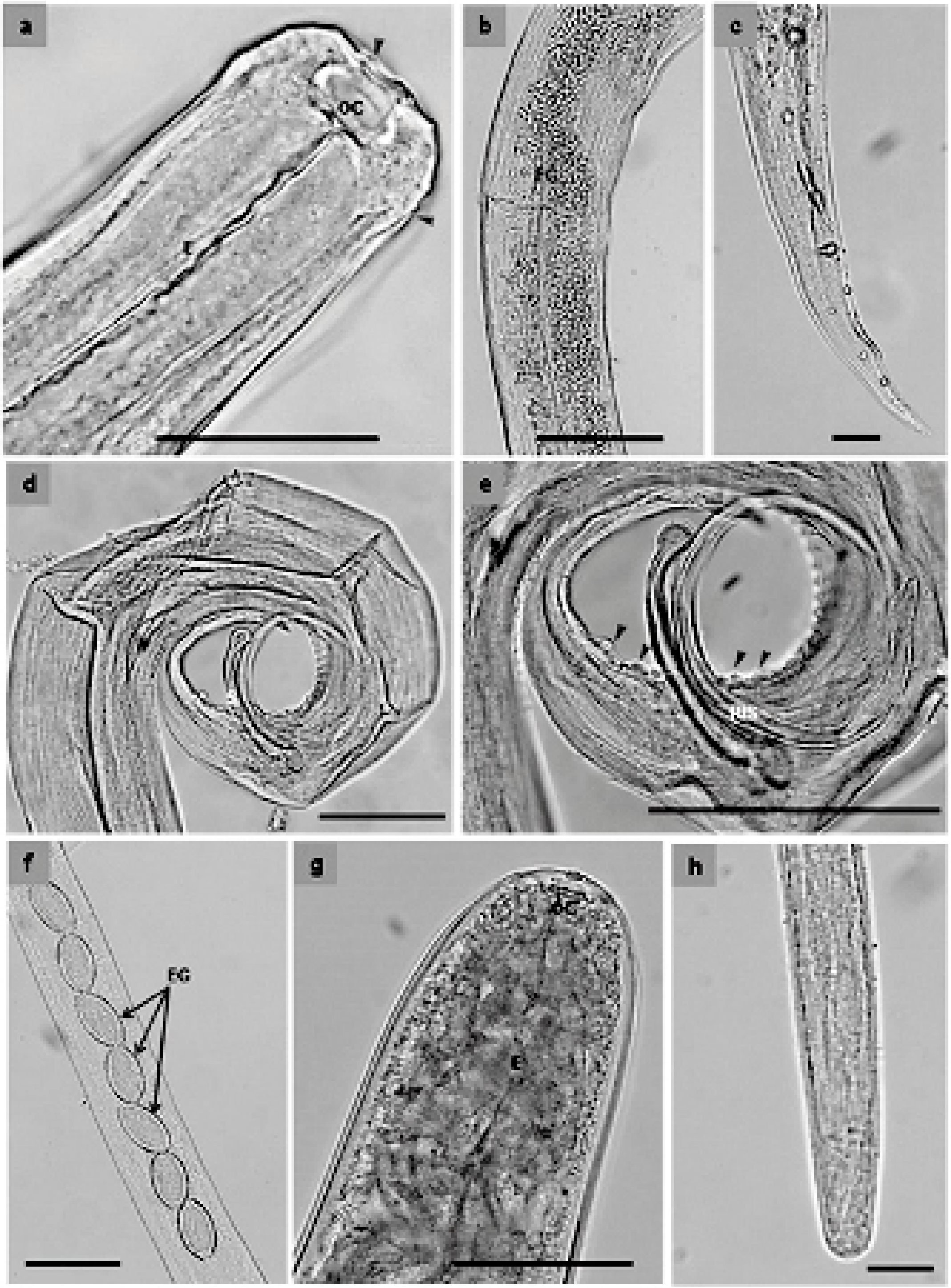

Figure 4. Nematode of *Chrysomus ruficapillus* (Vieillot, 1819) (Passeriformes: Icteridae) from southern Brazil. **a-e.** *Oxyspirura* sp. (Thelaziidae); **a.** anterior region, arrow head indicates the papillae BAR=62μm; **b.** medium region of female BAR =45μm; **c.** posterior region of female BAR =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* (Vieillot, 1819) (Passeriformes: Icteridae) from southern Brazil. **a.** female BAR=600μm. **b.** male BAR=950μm. PRO=proboscis; LE= lemniscus; EG=eggs; T=testes; CG=cement gland; CB=copulatory bursa.

al., 2005; Silva *et al.,* 2005; Costa *et al.,* 2015). 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 quadrifrons* Stoller, 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, Fabricius 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 compromised 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 Maranhão, 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, Echinostomatinae Looss, 1899 with 19 genera including *Echinostoma* Rudolphi, 1809 (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* Guilding, 1828 (Mollusca: 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 catarrhal 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 *Procacicus 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* including parasitological indexes. 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 Duboisiellinae Baer, 1938 and Strigeinae Railliet, 1919. Strigeinae Railliet, 1919 houses 12 genera among them, *Strigea* Abildgaard, 1790, 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 brids, reflecting its specificity for this host group, moreover this parasite group shows wide geograpgic 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, *Psarocolius 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 (Gonçalves *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 & Shikhobalova 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 & Shikhobalova, 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*.

In the biological cycle of *O. mansoni* (Cobbold, 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 Capillariinae in Icteridae, parasitizing *C. ruficapillus*.

Giganthorhynchidea Southwell & Mache, 1925 (Acanthocephala) are bird parasites composed of five families, among them Giganthorhynchidae Hamann, 1892 with five genera: *Gigantorhynchus* Hamann, 1892, *Empodisma* Travassos, 1916, *Heteracanthorhynchus* Lundström, 1942 and *Mediorhynchus* Van Cleave, 1916 (Yamaguti, 1963).

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. bonarienses* 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 Capillariinae 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 Capillariinae (Nematoda), and *Mediorhynchus micranthus* (Acanthocephala) are unprecedent for *Chrysomus ruficapillus* in South America.

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