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Gastrointestinal and ectoparasites of plumbeous rail, *Pardirallus sanguinolentus* (Aves: Rallidae) in Central Chile

Gastrointestinais e ectoparasitas do saracura-do-banhado, *Pardirallus sanguinolentus* (Aves: Rallidae) do Chile central

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Abstract

With the aim to identify the parasite fauna of plumbeous rail, *Pardirallus sanguinolentus* (Aves: Rallidae) in Chile, 26 carcasses were parasitologically necropsied. The present study revealed the presence of 14 species of parasites (inverse Simpson index = 4.64; evenness = 0.332), including ectoparasites: feather mites: *Analloptes megnini*, *Grallobia* sp., *Grallolichus* sp., *Megniniella* sp., and *Metanalges* sp.; the feather lice *Pseudomenopon meinertzhageni*, *Rallicola andinus*, and *Fulicoffula* sp.; and six species of gastrointestinal helminths: *Heterakis psophiae*, *Porrocaecum ardeae*, *Tetrameres* sp., *Capillaria* sp., *Diorchis* sp., and *Plagiorhynchus* sp. The relatively high parasite richness that was found could be attributed to the highly favorable conditions of wetlands for parasite development. All parasites found, except feather lice, are new records for plumbeous rail. A checklist of parasites for plumbeous rail is presented.

Keywords: Parasites, helminths, diversity, wetlands, rallids.

Resumo

Com o objetivo de identificar a fauna parasitária do saracura-do-banhado, *Pardirallus sanguinolentus* (Aves: Rallidae) no Chile, 26 carcaças foram necropsiadas. O presente estudo revelou a presença de 14 espécies de parasitos (índice Simpson inverso = 4,64; equitatividade = 0,332), incluindo os ácaros de penas: *Analloptes megnini*, *Grallobia* sp., *Grallolichus* sp., *Megniniella* sp. e *Metanalges* sp.; os piolhos de penas *Pseudomenopon meinertzhageni*, *Rallicola andinus* e *Fulicoffula* sp.; e seis espécies de helmintos gastrointestinais: *Heterakis psophiae, Porrocaecum ardeae*, *Tetrameres* sp., *Capillaria* sp., *Diorchis* sp. e *Plagiorhynchus* sp. A riqueza parasitária relativa encontrada pode ser devido às condições altamente favoráveis das zonas úmidas para o desenvolvimento do parasita. Todos os parasitos encontrados, com exceção dos piolhos de pena, são novos registros para o saracura-do-banhado. Um checklist dos parasitos do saracura-do-banhado é apresentado.

Palavras-chave: Parasitos, helmintos, diversidade, zona úmida, ralídeos.

Introduction

Parasite-host associations reveal valuable information about the host that should always be considered for studies of biodiversity and conservation (PÉREZ-PONCE DE LEÓN & GARCÍA-PRIETO, 2001), particularly since parasites have been linked to important variations in biodiversity, population declines, and even species extinction (e.g., JOHNSON et al., 1999; CUNNINGHAM & DASZAK, 1998). The plumbeous rail, *Pardirallus sanguinolentus* (SWAINSON, 1838), is one of three members of the genus *Pardirallus* Bonaparte, 1856, in South America. Six subspecies are recognized, three of which are partially distributed in Chile. This bird inhabits all types of wetlands, including brackish and

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freshwaters, which offer ideal conditions for the high presentation of parasitism (KAMIYA et al., 2014; LEUNG & KOPRIVNIKAR, 2016). The previous records of parasites for plumbeous rail include both gastrointestinal and ectoparasites (see Table 1); however, these reports have been strongly biased toward taxonomic descriptions that either focus on specific parasite groups or species (e.g. CICCHINO, 2011; SKORACKI et al., 2014). The aim of this study was to identify the ecto and gastrointestinal parasites of plumbeous rail in Chile.

Materials and Methods

Between June 2001 and March 2015, the anatomic organs of 26 adult birds from the Ñuble Province, Biobío Region (36°37'S; 71°57'W), were analyzed. The organs corresponded to museum skins of three birds (which were part of the Ornithological Collection of Avian Carcasses of the Zoology Laboratory of the Faculty of Veterinary Sciences, University of Concepción), ten carcasses whose deaths were attributed to road kills and poaching (retrieved by the Wildlife Rehabilitation Center, University of Concepción), and 13 gastrointestinal tracts. Ectoparasites were collected through plumage inspection (15 minutes per bird), followed by immediate preservation in 70% ethanol. Feather lice were mounted using Canada balsam following the techniques described by Palma (1978) and Price et al. (2003). Feather mites were cleared in Nesbitt solution (40 g of chloral hydrate, 25 mL of distilled water, and 2.5 mL of hydrochloric acid) for 72 hours and were later mounted in Berlese solution (KRANTZ & WALTER, 2009). For the endoparasites, the dissection of birds and the collection and preservation of helminths followed the methods of Kinsella & Forrester (1972). The keys used for taxonomic identification

Table 1. Checklist of parasites found in plumbeous rail, *Pardirallus sanguinolentus*, to date.

Parasite	Location	Reference
Acari: Syringophilidae		
Rafapicobia melzeri	Santiago Province, Chile	Skoracki et al. (2014)
Acari: Pterolichidae		
Grallobia sp.	Biobío Region, Chile	This study
Grallolichus sp.	Biobío Region, Chile	This study
Acari: Xolalgidae		
Analloptes megnini	Biobío Region, Chile	This study
Acari: Analgidae		
Megniniella sp.	Biobío Region, Chile	This study
Metanalges sp.	Biobío Region, Chile	This study
Phthiraptera: Amblycera		
Pseudomenopon meinertzhageni	Brazil and Chile (location not specified); Buenos Aires and Neuquén Provinces, Argentina; Biobío Region, Chile	Price (1974); Cicchino (2011); this study
Phthiraptera: Ischnocera		
Rallicola andinus	Lake Junín, Perú; Brazil (location not specified), Buenos Aires and Tierra del Fuego Provinces, Argentina; Biobío Region, Chile	Carriker (1949); Emerson (1955); Cicchino (2011); this study
Rallicola pratti	Buenos Aires Province, Argentina	Cicchino (2011)
Fulicoffula sp.	Buenos Aires Province, Argentina; Biobío Region, Chile	Cicchino (2011); this study
Nematoda: Heterakidae		
Heterakis psophiae	Biobío Region, Chile	This study
Nematoda: Ascarididae		
Porrocaecum ardeae	Biobío Region, Chile	This study
Nematoda: Tetrameridae		
Tetrameres sp.	Biobío Region, Chile	This study
Nematoda: Capillariidae		
Capillaria sp.	Biobío Region, Chile	This study
Platyhelminthes: Cestoda		
Diorchis sp.	Biobío Region, Chile	This study
Platyhelminthes: Trematoda		
Microphallus szidati	Buenos Aires Province, Argentina	Martorelli (1986)
Echinostoma parcespinosum	Buenos Aires Province, Argentina	Martorelli (1987)
Acanthocephala: Plagiorhynchidae		
Plagiorhynchus sp.	Biobío Region, Chile	This study

adopted the approach of Carriker (1949), Emerson (1955), Price (1974), and Cicchino (2011) for feather lice; Trouessart (1885), Gaud (1958), and Gaud & Mouchet (1963) for feather mites; and Yamaguti (1961, 1963) and Khalil et al. (1994) for helminths.

To quantify the parasite community, we determined the inverse Simpson diversity index, as follows:

$$D = 1/(\sum p_i^2) \quad (1)$$

where p is the proportional biomass of species i, species richness (*S*), and evenness (*D*/*S*) (WILSEY et al., 2005).

All parasite specimens were deposited in the Collection of Parasites of Chile, Zoology Laboratory, Faculty of Veterinary Science, University of Concepción, Chile, under the codes CDCA 132 to 136 for mites, UdeCPhsa 147 to 168 for lice and CDCA 180 to 182 for helminths.

Results and Discussion

Ectoparasites

Acari: All inspected birds were parasitized with at least one mite species (Table 2): *Analloptes megnini* Trouessart (1885), *Grallobia* sp., *Grallolichus* sp., *Megniniella* sp., or *Metanalges* sp.

Figure 1. Light microscopy of ventral view of male *Analloptes megnini*.

Table 2. Ecto and gastrointestinal parasites found in 26 plumbeous rails, *Pardirallus sanguinolentus*, between 2001-2015 in Central Chile.

Parasite	Prevalence (%)	Range	Mean intensity	Number of parasitized birds	Total of parasites
Acari: Pterolichidae					
Grallobia sp.*	80	0-22	7	8	56
Grallolichus sp.*	10	0-13	13	1	13
Acari: Xolalgidae					
*Analloptes megnini**	10	0-1	1	1	1
Acari: Analgidae					
Megniniella sp.*	30	0-1	1	3	3
Metanalges sp.*	80	0-4	2.1	8	17
Phthiraptera: Amblycera					
Pseudomenopon meinertzhageni	61.5	0-6	3.1	8	25
Phthiraptera: Ischnocera					
Rallicola andinus	100	2-22	10.9	13	142
Fulicoffula sp.	15.4	0-7	4	2	8
Nematoda: Heterakidae					
*Heterakis psophiae**	52.2	0-6	2.9	12	35
Nematoda: Ascarididae					
*Porrocaecum ardeae**	13	0-6	2.7	3	8
Nematoda: Tetrameridae					
Tetrameres sp.§	4.3	0-5	5	1	5
Nematoda: Capillariidae					
Capillaria sp.§	4.3	0-7	7	1	7
Platyhelminthes: Cestoda					
Diorchis sp.*	13	0-7	3	3	9
Acanthocephala: Plagiorhynchidae					
Plagiorhynchus sp.*	4.3	0-1	1	1	1

*New record for plumbeous rail and Chile; §New record for plumbeous rail.

A male individual of *A. megnini* (Astigmata: Xolalgidae) (Figure 1) was found on one bird. Despite the small number of individuals analyzed, low prevalence rates were frequently found among the *Analloptes* Trouessart, 1885 species. Miller et al. (1997) commented that this will likely underestimate the presence of this genus, as it generally occurs in small quantities. Furthermore, these mites inhabit downy and covert feathers, which may hinder the collection of this genus. The genus *Analloptes* includes 11 species that parasitize phylogenetically distant hosts, including Coraciiformes, Gruiformes, Pelecaniformes, Accipitriformes, and Passeriformes (GAUD, 1968; MIRONOV & HERNANDES, 2014).

Grallobia sp. (Astigmata: Pterolichidae) (Figure 2) presented with the highest prevalence rates in this study (80%). A similar result was found in american coot *Fulica americana* Gmelin, 1789, which was affected by *G. fulicae* Trouessart, 1885, with a prevalence of 82.4% (ROUAG-ZIANE et al., 2007). Conversely, *Grallolichus* sp. (Figure 3) had a prevalence of 10% and a mean intensity of 13.0. These mites were morphologically similar to the species *G. minutus* Gaud & Mouchet, 1963. Both genera, as well as all mites from the family Pterolichidae, inhabit the surface of feathers with large vanes, such as flight and covert feathers of the wings and tail (MIRONOV & DABERT, 2007). These mites affect a rather homogeneous group of birds; *Grallobia* Hull, 1932 is only associated with the avian family Rallidae, whereas *Grallolichus* Gaud, 1960 is associated with Rallidae, Jacanidae, and Heliornithidae (GAUD, 1968; GAUD & MOUCHET, 1963).

Both *Megniniella* sp. and *Metanalges* sp. (Astigmata: Analgidae) (Figures 4 and 5) were found in three (30%) and eight (80%) birds, respectively. Unlike most other genera from the subfamily Megniniinae, *Megniniella* Gaud & Mouchet, 1959 and *Metanalges* Truessart, 1919 occur almost exclusively on birds of the family Rallidae (GAUD, 1968; GAUD & ATYEO, 1982), and they are often found in downy and covert feathers. The genus *Megniniella* has seven species, six of which are described from New and Old World rallids (MIRONOV & GALLOWAY, 2002). Conversely, 11 species make up the genus *Metanalges*, which are allocated to the subgenera *Metanalges* and *Agrialges* Gaud & Mouchet, 1959, both of which are exclusive to rallids (GAUD & MOUCHET, 1959; MIRONOV & GALLOWAY, 2002). The individuals collected here could not be taxonomically identified beyond genus; nevertheless, they shared several similarities with *Megniniella gallinulae* Buchholz (1869), *Metanalges crexi* Mironov, 1985, and *M. rallorum* Trouessart (1885), respectively.

Lice: All birds were parasitized with at least one species of the feather lice *Pseudomenopon meinertzhageni* Price, 1974, *Rallicola andinus* Carriker, 1949, and *Fulicoffula* sp. (Table 2).

Pseudomenopon meinertzhageni (Phthiraptera: Amblycera) (Figure 6) was found in eight birds (61.5%). Lice from this genus can be found in the hosts Gruiformes, Podicipediformes, and Charadriiformes, and they essentially feed on contour feather barbs and are occasionally recorded with hematophagous behavior (CICCHINO, 2011). According to Lakshminarayana (1977), lice from this genus are widely distributed in birds from the family Rallidae. *Pseudomenopon meinertzhageni* was exclusively recorded in plumbeous rail in Brazil, Chile, and Argentina (PRICE, 1974; CICCHINO & CASTRO, 1998a; CICCHINO, 2011).

Rallicola andinus (Phthiraptera: Ischnocera) (Figure 7) was found in all analyzed birds. *Rallicola* Johnston & Harrison, 1911 is composed of 55 species, all of which are parasites of Guiformes and Chardriiformes birds (CICCHINO & CASTRO, 1998b). Since the first description of *Rallicola andinus* in plumbeous rail in Peru (CARRIKER, 1949), this parasite has been recorded in Brazil, Argentina, and Chile (EMERSON, 1955; CICCHINO & EMERSON, 1983; CICCHINO, 2011).

Two birds (15.4%) presented with *Fulicoffula* sp. (Phthiraptera: Ischnocera) (Figure 8). This genus was originally erected to allocate all Ischnocera Kellogg, 1896 species with an elongated shape found on rallid birds (EMERSON & PRICE, 1967). The specimens found shared similarities with *F. americana* Emerson, 1960, but with notable differences in size. Equally, Cicchino (2011) recently found a similar *Fulicofulla* Clay & Meinertzhagen, 1938 species on plumbeous rail that likely corresponded to a new species.

Gastrointestinal parasites

In 23 birds, six helminth species were found (Table 2) to be distributed in the phylum Nematoda: *Heterakis psophiae* Travassos, 1913, *Porrocaecum ardeae* Frölich (1812), *Tetrameres* sp., and *Capillaria* sp.; Platyhelminthes: *Diorchis* sp.; and Acanthocephala: *Plagiorhynchus* sp.

Nematoda: *Heterakis psophiae* (Ascaridida) (Figure 9) was a helminth with a higher prevalence rate (52.2%) and mean intensity (2.9). This parasite was found in the cecal lumen of 12 birds, as usually reported for members of this genus (ATKINSON et al., 2008). These parasites present a direct life cycle and worldwide distribution (ATKINSON et al., 2008), and they have been recorded on two previous occasions in Chile: *H. gallinarum* (Shrank, 1788) in eared dove *Zenaida auriculata* (Des Murs, 1847) in Ñuble, as well as *H. dispar* (Shrank, 1790) in upland goose *Chloephaga picta* (Gmelin, 1789) in the Magallanes region (GONZÁLEZ et al., 2004; GONZÁLEZ et al., 2005). *Heterakis psophiae* was described by Travassos (1913) from green-winged trumpeter *Psophia viridis* Spix, 1825 in Brazil; thus far, this parasite corresponds to the only known *Heterakis* species from South American Gruiformes.

Porrocaecum ardeae (Ascaridida) (Figure 10) was found in three birds (13%). One bird presented this parasite underneath the parietal peritoneum and mesentery of its body cavity (coelom), as well as in the lumen of the small intestine, which was perforated. This does not seem to be an isolated incident given that Fanke et al. (2011) reported the death of three common crane, *Grus grus* Linnaeus (1758), due to intestinal perforation caused by severe infestation with this parasite. Species of the genus *Porrocaecum* Railliet & Henry, 1912 are cosmopolitan and present indirect life cycles; invertebrates serve as an intermediate host (ATKINSON et al., 2008; DZIEKONSKA-RYNKO et al., 2015). There are several records of *P. ardeae* regularly affecting birds of the families Gruidae and Ardeidae in Europe and Central America (SCHMIDT & NEILAND, 1973; HARTWICH, 1979; FANKE et al., 2011;

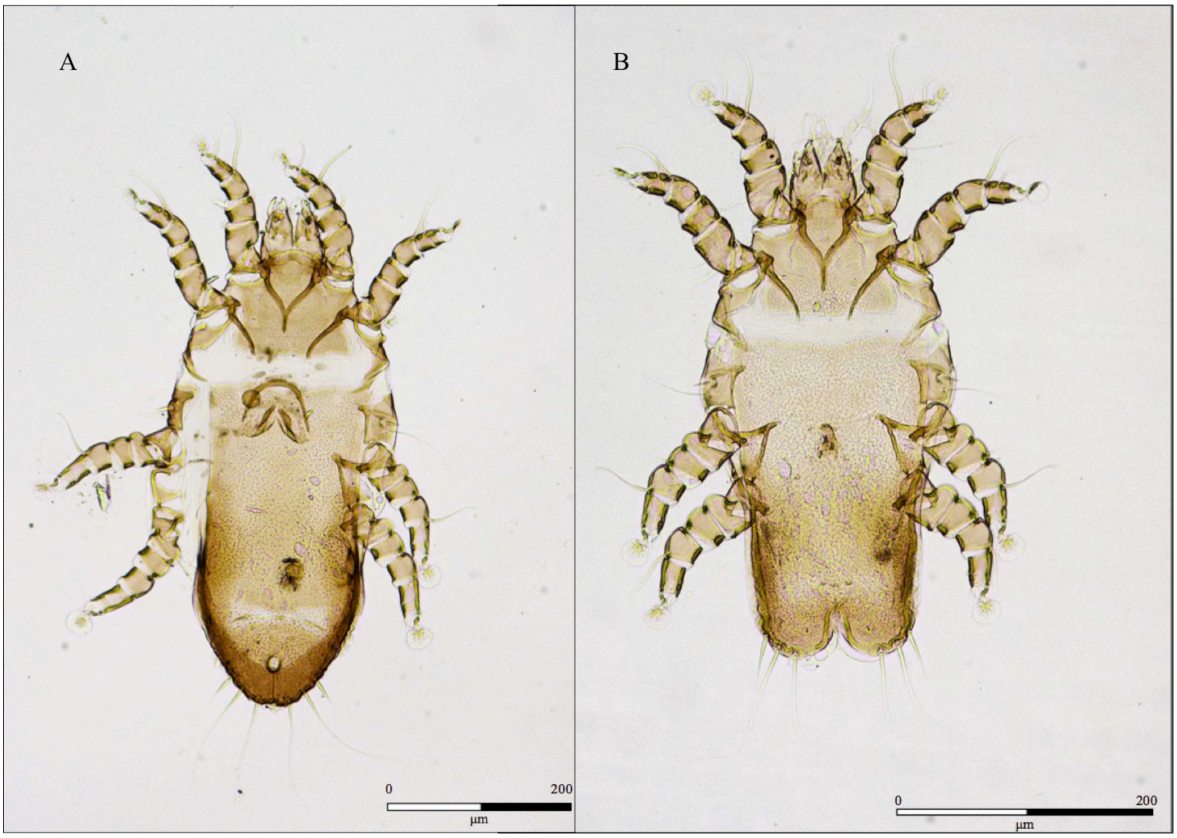

Figure 2. Light microscopy of ventral view of female (A) and male (B) *Grallobia* sp.

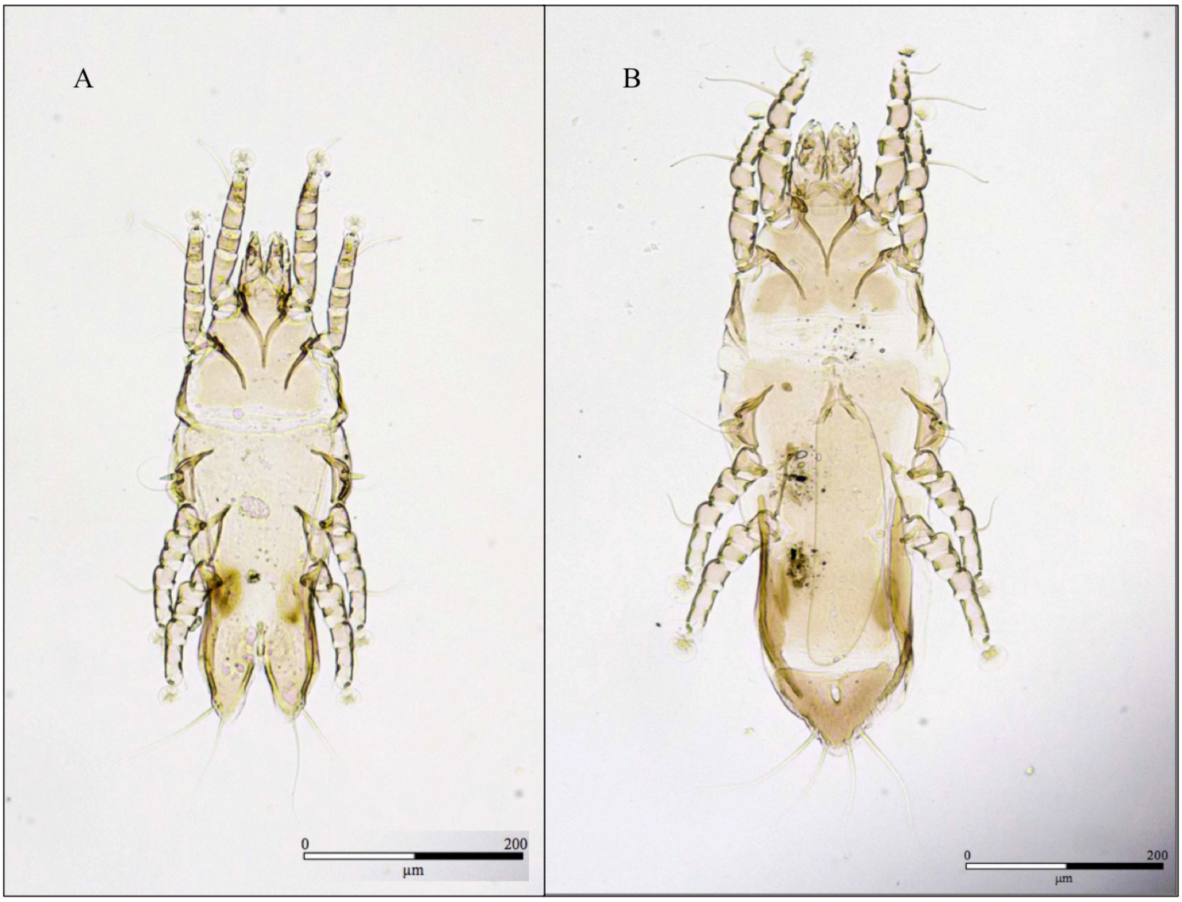

Figure 3. Light microscopy of ventral view of male (A) and female with egg (B) *Grallolichus* sp.

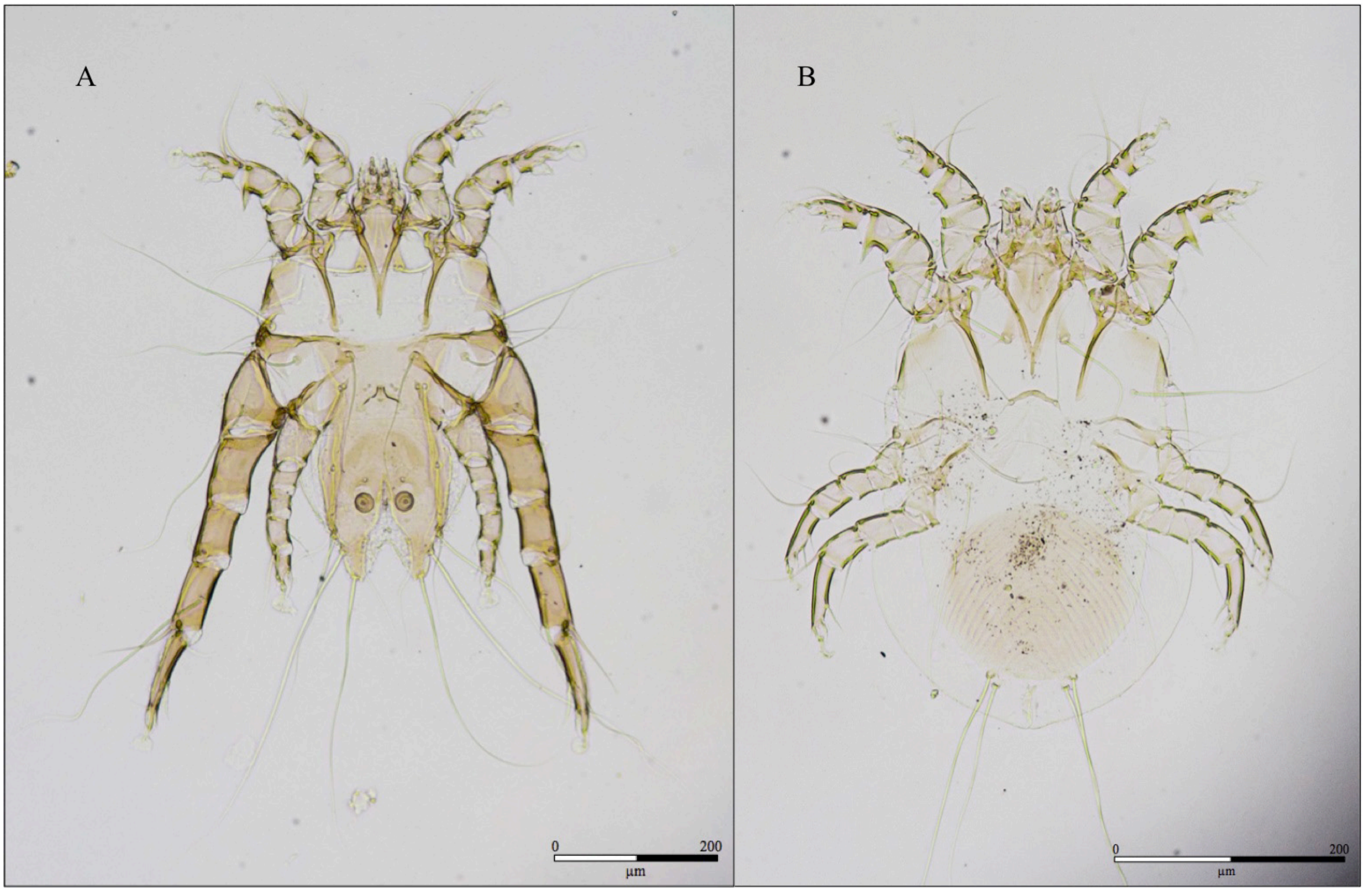

Figure 4. Light microscopy of ventral view of male (A) and female (B) *Megniniella* sp.

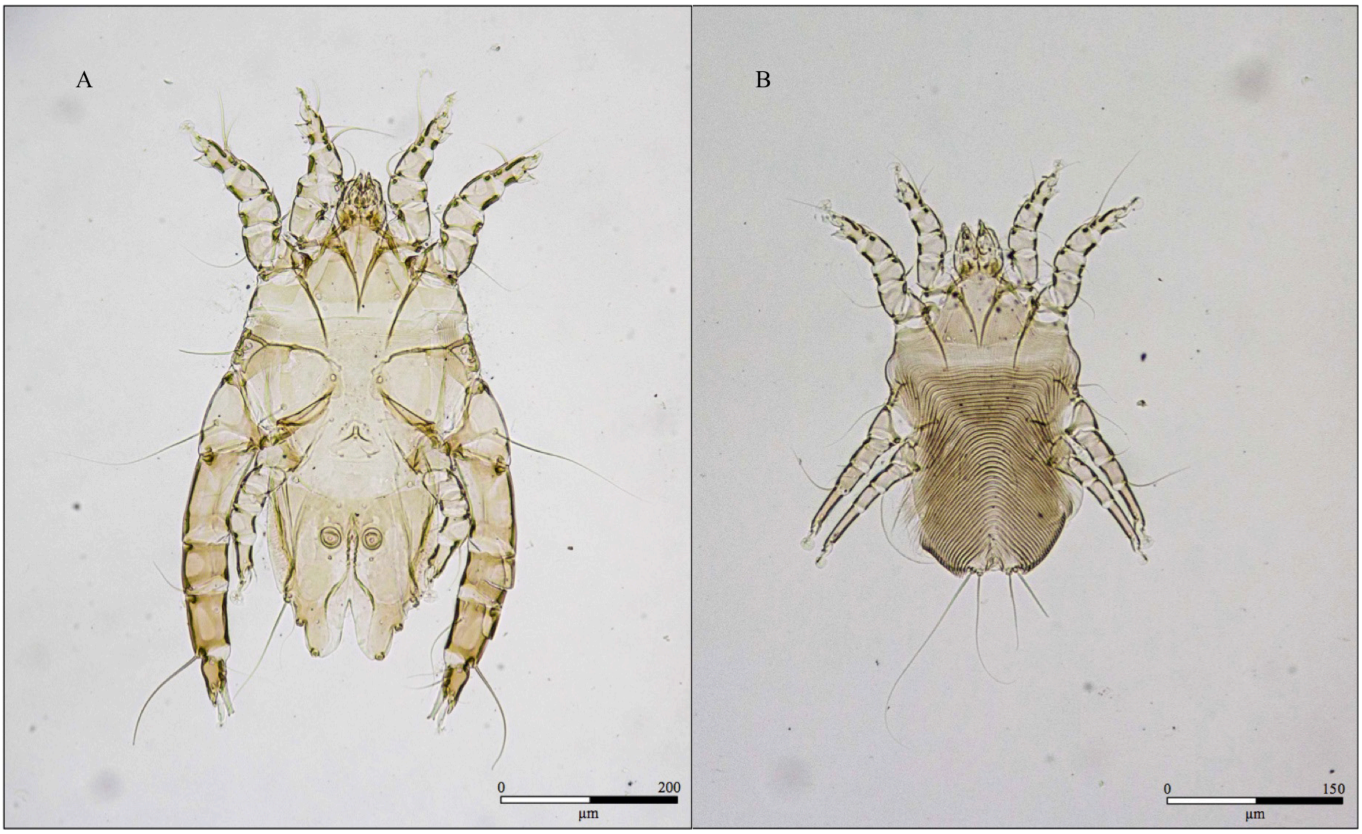

Figure 5. Light microscopy of *Metanalges* sp. showing ventral view of male (A) and female (B).

DZIEKONSKA-RYNKO et al., 2015; SITKO & HENEBERG, 2015).

In one bird (4.3%), seven individuals from the genus *Capillaria* Zeder, 1800 (Capillariidae) were found (Figure 11). The parasites were in the final portion of the small intestine and a few were identified in the caecum. These parasites have a worldwide distribution and there are several records of its existence in Chile (e.g., HINOJOSA-SÁEZ & GONZÁLEZ-ACUÑA, 2005; GONZÁLEZ-ACUÑA et al., 2010; VALDEBENITO et al., 2015). Among all members of this genus, *Capillaria fulicae* Pavlov & Borgarenko (1959) is often found in rallid birds from North America (KINSELLA, 1973; KINSELLA et al., 1973). In addition to its distinctive morphological features, there are no *Capillaria* species described for South American rallids; therefore, this parasite is a good fit as a possible new species. Further studies need to be conducted to verify whether this does, in fact, represent a new species.

Five females from the genus *Tetrameres* Creplin, 1846 (Tetrameridae) were found in one bird (4.3%). These nematodes are widely distributed and can affect captive and wild birds. Female *Tetrameres* are typically attached to the proventriculus of the definitive host, while males tend to move more freely and are more likely to be found on the mucosa or lumen (ANDERSON, 2000). On certain occasions, *Tetrameres* species were recorded to affect terrestrial birds (e.g., Passeriformes and Galliformes); however, their main hosts are aquatic birds like Anseriformes, Pelecaniformes, Charadriiformes, and Gruiformes (MOLLHAGEN, 1976; ATKINSON et al., 2008), where *T. fissispina* Diesing, 1861, *T. globosa* Linstow (1879), and *Tetrameres* sp. were found to affect several species around the world (KINSELLA et al., 1973; MOLLHAGEN, 1976; AL-AWADI et al., 2010; BIRMANI et al., 2011).

Platyhelminthes: In the lumen of the small intestine of three birds (13%), nine parasites were found in poor condition;

Figure 6. Light microscopy of *Pseudomenopon meinertzhageni* showing ventral view of female.

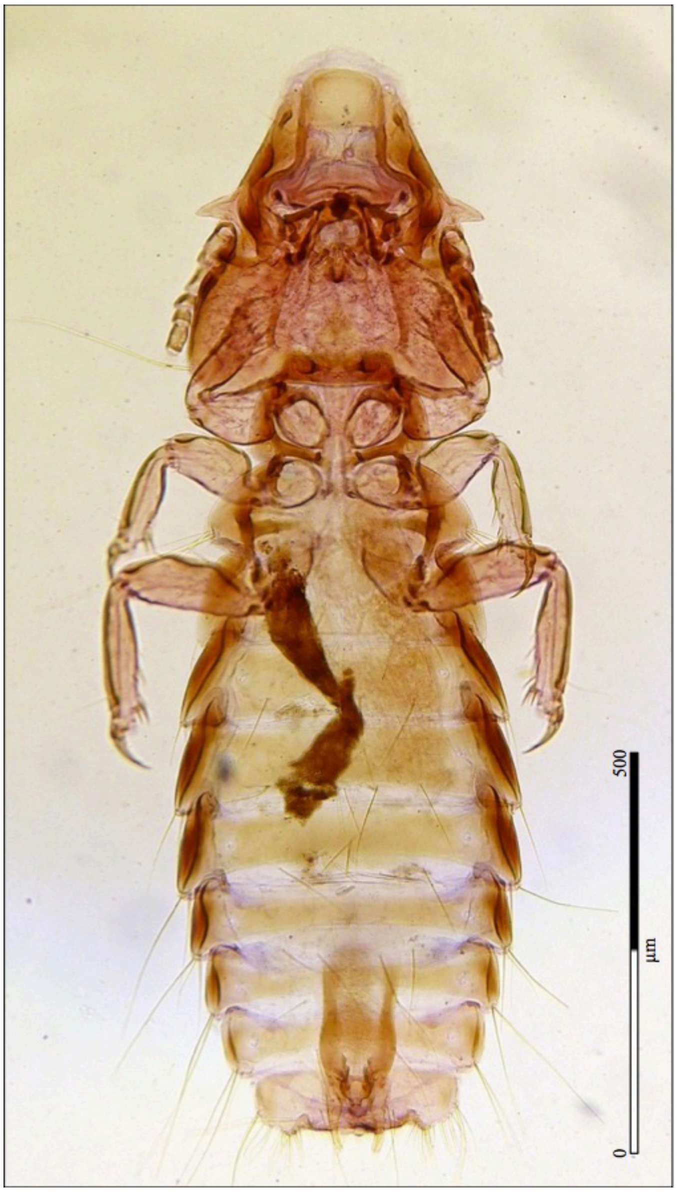

Figure 7. Light microscopy of *Rallicola andinus* showing ventral view of male.

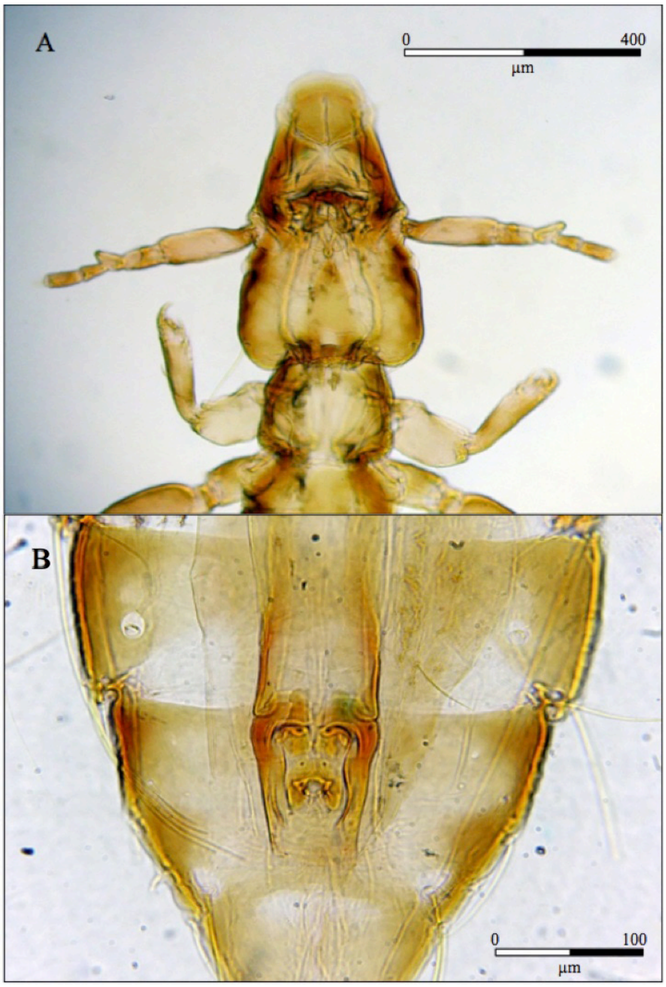

Figure 8. Light microscopy of *Fulicoffula* sp. showing head (A) and geniatalia (B) of male.

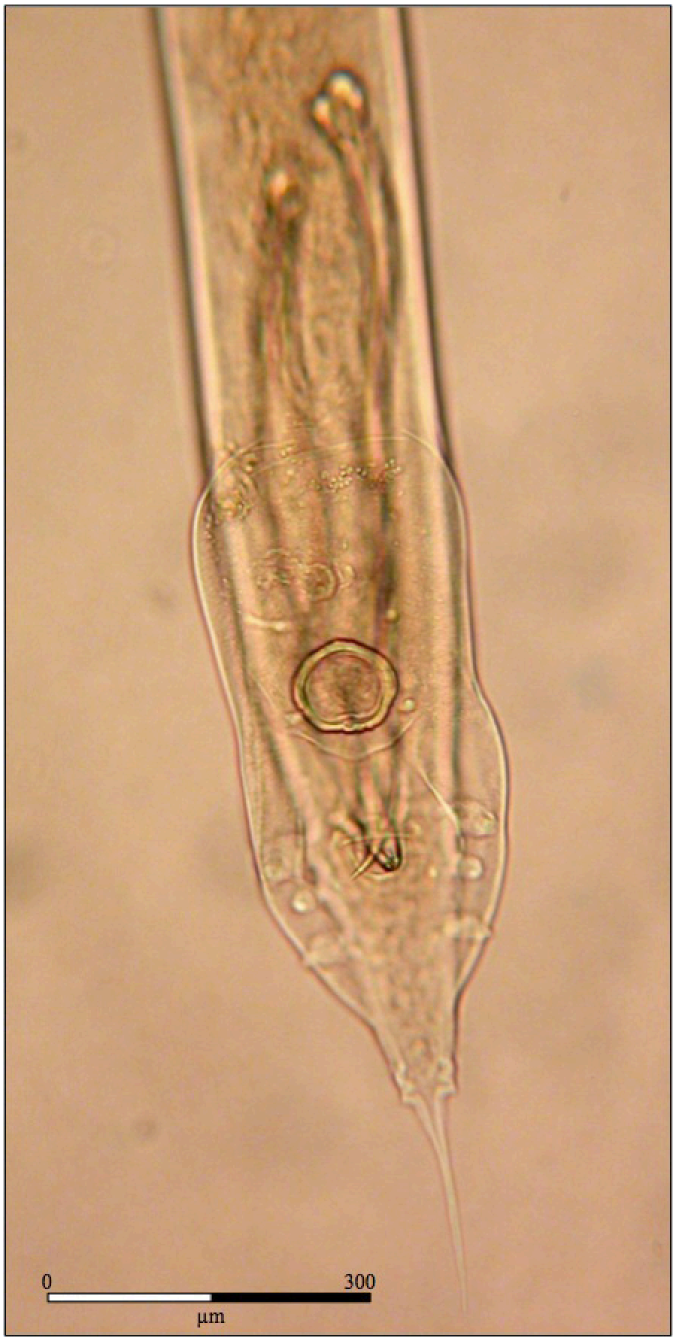

Figure 9. Light microscopy of *Heterakis psophiae* showing posterior end of male.

however, given their rostellum (Figure 12) with 8 hooks 80 µm in length, they were placed in the genus *Diorchis* Clerc, 1903 (Cestoda: Hymenolepididae). This genus appears to commonly affect the avian families Anatidae, Rallidae and, occasionally, Charadriiformes (MARINOVA et al., 2015). While several *Diorchis* species have been collected from *Fulica* Linnaeus, 1758 birds (e.g., MCLAUGHLIN, 1986; GUILLÉN & MORALES, 2003; LUNASCHI et al., 2012), only *D. ralli* Jones, 1944 was found in rallids, affecting king rail, *Rallus elegans* Audubon, 1834, in North America (JONES, 1944).

Acanthocephala: In one bird (4.3%), one individual from the genus *Plagiorhynchus* Lühe (1911) (Plagiorhynchidae) was found. These parasites have a global distribution and were recorded in several bird orders (YAMAGUTI, 1963), including rallids (YOSHINO et al., 2009; ONUMA et al., 2011). All members of this phylum present an indirect life cycle, and invertebrates serve as intermediate host and occur exclusively in the small intestine of the definitive host (ATKINSON et al., 2008).

The overall parasite diversity and evenness was 4.64 and 0.332, respectively. Both ectoparasites and helminths had a similar species diversity index (inverse Simpson index: ectoparasites, 2.91; helminths, 2.92), whereas evenness was higher in helminths (0.487) when compared to ectoparasites (0.364). High parasite diversity is generally attributed to numerous factors including, for example, high latitude, large body size, and various habitat characteristics (KAMIYA et al., 2014). For plumbeous rail, habitat seems to be the primary contributing factor for the relatively high degree of diversity found. Wetlands have been shown to be advantageous for parasite communities, as there is a greater opportunity for contact with the various stages of parasite infection and/or the consumption of infected hosts (LEUNG & KOPRIVNIKAR, 2016). These ecosystems also serve as stopover point for many

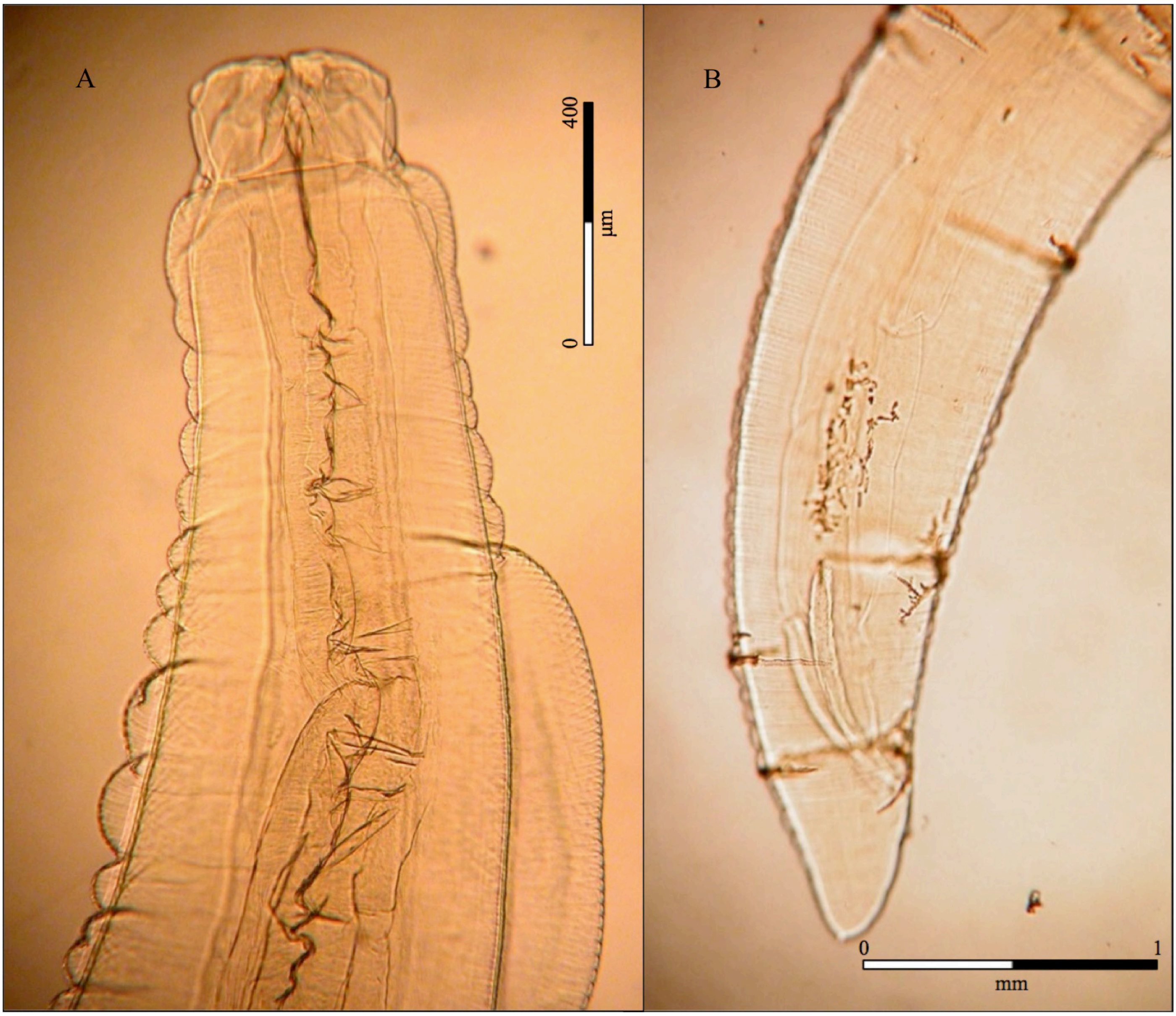

Figure 10. Light microscopy of *Porrocaecum ardeae* showing anterior end of female (A) and posterior end of male (B).

migrant bird species usually presenting elevated parasite diversity (LEUNG & KOPRIVNIKAR, 2016). Additionally, studies on sympatric species, including various birds from the family Ardeidae (NAVARRO et al., 2005) and *F. americana* (CANARIS & WALDMANN, 2017), have shown similar species richness and diversity.

Although Skoracki et al. (2014) did not report information on the prevalence of *Rafapicobia melzeri* (Table 1), we speculate that this absence was due to the relatively small numbers of birds examined. Cicchino (2011) found the louse *Rallicola pratti* on birds from Buenos Aires Province, Argentina (Table 1), which were located close to the area where the hosts blackish rail *P. nigricans* Vieillot, 1819 and plumbeous rail overlap in terms of their distribution. Therefore, this louse could likely only occur on plumbeous rail in areas where there is a close relationship between these two rallids. On the other hand, the absence of the trematodes *Microphallus szidati* and *Echinostoma parcespinosum* (Table 1) recorded in Argentina (MARTORELLI, 1986; MARTORELLI, 1987) were likely due to the absence of their intermediate hosts, which are needed to complete their life cycle. However, must be noted that the snail *Pomacea canaliculata* Lamarck (1828), an intermediate host of *E. parcespinosum,* was recently introduced to Chile and first reported by Jackson & Jackson (2009) in the Coquimbo Region. Additionally, *E. parcespinosum* can abbreviate its life cycle in this snail by using it as a primary and secondary intermediate host (MARTORELLI, 1987), enabling the possibility of future presentation of this parasite in Chile.

The present study contributes to the understanding of parasite communities by supporting the current findings on the associations between habitat type and parasite richness and diversity (LEUNG

Figure 11. Light microscopy of *Capillaria* sp. showing posterior end of male.

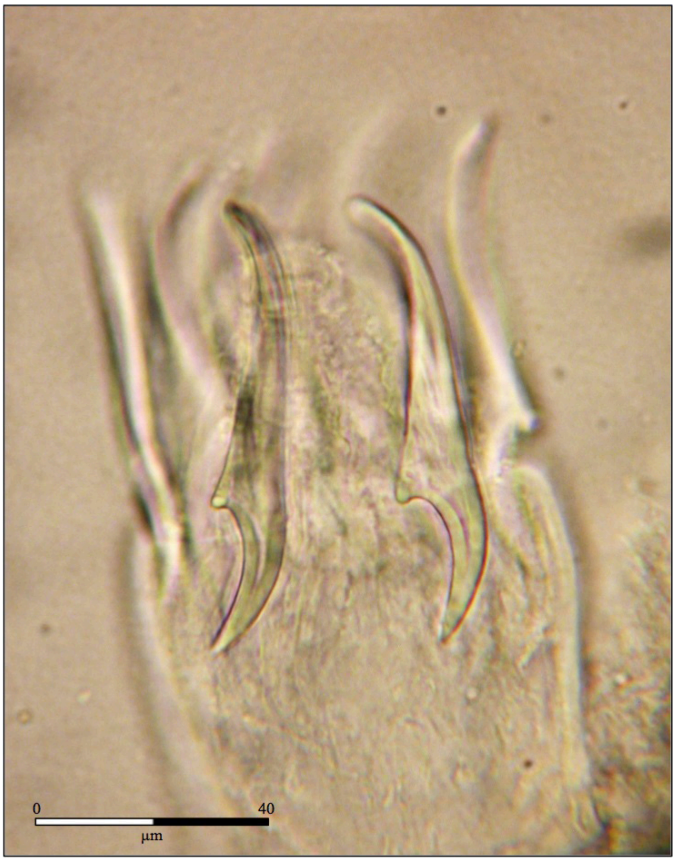

Figure 12. Light microscopy of *Diorchis* sp. showing hooks of rostellum.

& KOPRIVNIKAR, 2016; GUTIÉRREZ et al., 2017). Plumbeous rail presented a high degree of parasite diversity, 14 species, including ecto and gastrointestinal parasites; these species featured 11 species that were not previously recorded in this host and nine not previously reported in Chile.

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