Helminth communities of two populations of *Myotis chiloensis* (Chiroptera: Vespertilionidae) from Argentinean Patagonia

Antonella C. Falconaro*, Rocío M. Vega, Gustavo P. Viozzi

Laboratorio de Parasitología, INIBIOMA (CONICET-UNCo), Quintral 1250, 8400 Bariloche, Río Negro, Argentina

**A R T I C L E   I N F O**

**Keywords:**
- Bats
- Parasites
- South America

**A B S T R A C T**

Most of the studies on chiropteran endoparasites in Argentina come from the Central and Northeast regions of the country, and there is only one parasitological study of bats from the Argentinean Patagonia. The aim of this study is to describe the helminth fauna of 42 *Myotis chiloensis*, comparing the composition and the structure of the endoparasite communities between two populations, inhabiting different environments in Andean humid forest and the ectone between forest and Patagonian steppe. A total of 697 helminths were recovered from 33 bats: five species of trematodes, *Ochoterenatrema sp.*, *Paralecithodendrium sp.*, *Parabasculus limatulus*, *Parabasculus sp.*, and *Postorchigenes cf. joannae*, two species of cestodes, *Vampirolepis sp. 1* and *Vampirolepis sp. 2*, and three species of nematodes, *Allintoshius baudi*, *Physaloptera sp.*, and *Physophalus sp.* All the helminths, but *Physophalus sp.*, were recovered from the small and large intestine. This is the first survey of *M. chiloensis’* helminth fauna. All the species, but *A. baudi*, represent new records of helminths in Patagonian bats. There were differences of parasite species richness between localities and both bat populations share almost half of the endoparasite species. Different preferences for intestinal regions were found for three species of trematodes in the bats from the site in the humid forest. *Myotis chiloensis* serves as both a definitive and intermediate host for endoparasites in the Patagonian ecosystem.

1. Introduction

Studies on chiropteran endoparasites are limited around the world, which means that the diversity of bat’s parasites is probably underestimated (Lord et al., 2012; Portes Santos and Gibson, 2015). Most of the studies in Argentina come from the Central and Northeast regions of the country, where 17 species of nematodes, 12 of trematodes, and four of cestodes have been reported (Boero and Delpietro, 1970; Lunaschi, 2002a, 2002b, 2004, 2006; Lunaschi et al., 2003; Drago et al., 2007; Lunaschi and Drago, 2007; Ramallo et al., 2007; Lunaschi and Notarnicola, 2010; Oviedo et al., 2009, 2010, 2012, 2016; Fugassa, 2015; Portes Santos and Gibson, 2015; Milano, 2016) (Table 1). There is only one parasitological study of bats from Argentinean Patagonia, describing the trichostrongylid nematode, *Allintoshia baudi*, from *Myotis aelleni* collected in El Hoyo de Epuyén, Chubut province (Vacher and Durette-Desset, 1980).

*Myotis chiloensis*, known as “Murcielaguito de Chile (Chilean Little bat)” is an endemic vespertilionid bat from the Argentinean and Chilean Patagonia. These bats have been collected in the Argentinean provinces of Neuquén, Río Negro, Chubut, and Tierra del Fuego (Barquez and Díaz, 2009; Barquez et al., 2013; Díaz et al., 2011). They are small, insectivorous bats which feed mainly on insects of the orders Lepidoptera, Diptera, Coleoptera, and Trichoptera (Giménez and Giannini, 2013; Osa and Rodríguez San Pedro, 2015).

The aim of this study is to report for the first time the helminth fauna of *M. chiloensis* and to compare the composition and the structure of the endoparasite communities between two populations, inhabiting different environments in Andean Patagonia.

2. Materials and methods

A total of 42 specimens of *M. chiloensis* were captured in two rural localities in the Southwest region in the Patagonian province of Río Negro. The survey was part of the project “Estudio de fauna de pequeños vertebrados (anfibios, reptiles y mamíferos) en el Oeste de la provincia de Río Negro”, directed by Dr. Richard Sage, and it did not require any additional approval by an animal ethics committee. The first sample (N = 16) was captured in the site “Manso” (41°35′54″S, 71°45′0″W), located in the humid forest, on December 2011. The second sample (N = 26), was captured in the site “Luis Ruíz” (41°54′40″S, 71°25′23″W), located in the ectone between the forest and the steppe, on January 2014 (Fig. 1).

https://doi.org/10.1016/j.ijppaw.2017.12.004

Received 3 October 2017; Received in revised form 14 December 2017; Accepted 21 December 2017

© 2017 Published by Elsevier Ltd on behalf of Australian Society for Parasitology. This is an open access article under the CC-BY-NC-ND license (http://creativecommons.org/licenses/BY-NC-ND/4.0/).
2.1. Host and parasitological procedures

The bats were sacrificed by an overdose of sodic pentobarbital injectable and preserved and fixed in a 10% formaldehyde neutral solution. The bats’ abdominal and thoracic cavities and organs were examined with a stereoscopic microscope. The intestine was divided in three sections: 1) duodenum, 2) small intestine (jejunum and ileum), and 3) large intestine and rectum. The site of infection and the number of parasites found were registered and the specimens which were found detached from the host during the necropsy were not assigned to any particular intestinal section. Permanent and transitory slides were made in order to identify the helminths. The trematodes were dehydrated gradually in ethyl alcohol (70%, 96%), stained with Grenacher’s carmin, and mounted in Canada balsam. The cestodes and nematodes were cleared with Aman’s lactophenol. All parasites were photographed with a digital camera (Zeiss Axiocam ERc 5s). One specimen of each species was deposited in the Colección Nacional de Parasitología, Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Buenos Aires, Argentina (MACN-Pa).
2.2. Statistical procedures

The prevalence (P) and mean intensity (MI) was calculated for each species of endoparasite in order to characterize quantitatively the infections (Bush et al., 1997; Villarreal et al., 2006). The infracommunities species richness was quantified and a Mann-Whitney U test was used for comparing them between the two localities. In order to estimate the undetected species, the species richness was estimated using Chao and Jackknife (ChaoLocality ± SE, JackLocality ± SE) (these analyses were performed in R 3.4.2 using the vegan package). The Jaccard Index was used for comparing the similarity of presence/absence of species between the two localities (Krebs, 1989) and the Simpson’s Diversity Index (DLocality) and the Pielou’s Evenness Index (J’Locality) were used for evaluating the diversity and dominance of species in the two localities (Bush et al., 1997; Villarreal et al., 2006). The Fager’s Affinity Index was used for establishing the association rate between two species (Fager, 1957). In order to determine the preference for an intestinal region, a Kruskall-Wallis test was used, comparing the abundance of species among the sites of infection (Conover, 1980).

3. Results

3.1. Species composition

A total of 697 helminths was recovered from 33 bats: five species of trematodes, Ochoterenatrema sp. (Lecithodendriidae), Paralecithodendrium sp. (Lecithodendriidae), Parabascus limatulus (Braun, 1900) (Phaneropsolidae), Parabascus sp. (Phaneropsolidae), and Postorchigenes cf. joannae (Zdzitowiecki, 1967) (Phaneropsolidae), two species of cestodes, Vampirolepis sp. 1 and Vampirolepis sp. 2 (Hymenolepididae), and three species of nematodes, A. baudi (Trichostrongyloidea), Physocephalus sp. (Spiruroidea), and Physaloptera sp. (Physalopteroidea) (Fig. 2). All the species of helmints, but the larvae of Physalopterus sp., which was found encysted in the peritoneum, were recovered from the small and large intestine (Fig. 3). A total of 103 parasites were found detached from the host, and the site of infection could not be specified. The total number of worms, the abundance, the prevalence, and the mean intensity of each helminth species in both component communities are shown in Table 2.

Only two associations were significant: the association between the trematodes Parabascus limatulus and Parabascus sp., which showed the highest value of association (0.90, t = 3.05) in Manso, and the association between Ochoterenatrema sp. and P. limatulus (0.84, t = 2.45).
The nematode A. baudi also presented significant associations when paired with trematodes: with Ochoterenatrema sp. the Fager's index value was 0.76 ($t = 2.05$), with P. limatulus was 0.82 ($t = 2.56$) and with Parabascus sp. was 0.73 ($t = 1.72$).

### 3.2. Comparison of the component communities

The richness of parasite species was higher in Manso (nine species) than in Luis Ruiz (five species), and was significantly different between localities ($U = 74$, $p = 0.0005$). The expected species richness in Manso was slightly higher than the observed in Manso ($Chao_{Manso} = 10.88 \pm 3.52$, $Jackk_{Luis Ruiz} = 10.88 \pm 1.33$). Meanwhile, the number of observed species richness and the expected were similar in Luis Ruiz ($Chao_{Manso} = 5.00 \pm 0.43$, $Jackk_{Luis Ruiz} = 5.96 \pm 0.96$). The Jaccard index showed that both bat populations share almost half of the endoparasite species (0.45). The diversity indexes indicated that none of the component communities was dominated by a particular species ($D_{Manso} = 0.19$, $J_{Manso} = 0.52$; $D_{Luis Ruiz} = 0.35$, $J_{Luis Ruiz} = 0.47$).

### 3.3. Distribution of the helminths within the hosts

Differences in the abundances among the intestinal regions were found in some species of trematodes in the bats from Manso. Three species of trematodes showed significantly different abundances: P. limatulus ($H[2] = 15.8315$, $p = 0.0004$), which infected mainly the duodenum (Fig. 3a), Ochoterenatrema sp. ($H[2] = 7.6357$, $p = 0.0220$) located mainly in the middle intestine (Fig. 3a), and Parabascus sp. ($H[2] = 10.7617$, $p = 0.0046$) in the large intestine. There were no differences in the abundances among the intestinal sections found for these species of trematodes in Luis Ruiz.

### 4. Discussion

#### 4.1. Species composition

This is the first survey of *M. chiloensis* helminth fauna. All the species, but A. baudi, represent new records of helminths in Patagonian bats.

##### 4.1.1. Trematodes

Two of the species of trematodes belong to the Lecithodendriidae family and three to the Phaneropodidae family. Specimens of the first family belong to the genus Ochoterenatrema and Paralecithodendrium. There are five species of the genus Ochoterenatrema parasitizing bats all around the world (Cain, 1966; Odening, 1969; Castiblanco and Vélez, 1982; Lotz and Font, 1983; Lunaschi, 2002a, 2002b; Milano, 2016) and Ochoterenatrema labda was the only species registered previously in Argentina (Lunaschi, 2002a, 2002b; Milano, 2016). The specimens found during this study were placed in this genus due to their ventral sucker slightly smaller than the oral sucker, the pseudogonotyl to the left of the ventral sucker, the testes at the level of the ventral sucker and the pseudocirrus-sac between the intestinal bifurcation and the ventral sucker (Lotz and Font, 2008a). However, the trematodes found in *M. chiloensis* have morphological differences with the other species of the genus. The main differences between Ochoterenatrema sp. from *M. chiloensis* and *O. labda* is the spinous tegument and the ovary, which is entire in our specimens. The combination of these characteristics suggests that Ochoterenatrema sp. would be a new species. There are two previous records of Paralecithodendrium species in Argentina: *Paralecithodendrium conturbatum* and *Paralecithodendrium arahai*, parasitizing bats from Buenos Aires province (Lunaschi and Drago, 2007;}

| Helminth Family | Helminth Species | Manso | Luis Ruiz |
|-----------------|------------------|-------|-----------|
| Trematoda       | Ochoterenatrema sp. | 9/16 103 | 56% 0.81 11.4 | 8/26 154 | 32% 0.34 |
|                 | Paralecithodendrium sp. | 3/16 12 | 19% 0.38 4.0 | – | – |
|                 | Parabascus limatulus | 10/16 159 | 63% 0.86 15.9 | 6/26 10 | 24% 0.40 |
| Cestoda         | Vampirolepis sp. 1 | 1/16 | 6% | – | – |
|                 | Vampirolepis sp. 2 | 1/16 | 6% | – | – |
| Nematoda        | Allinthisis baudi | 12/16 | 75% 0.96 4.0 | – | – |
|                 | Physaloptera sp. | – | – | – | – |
|                 | Physocephalus sp. | 7/16 | 44% 0.68 2.3 | 5/26 | 14 19% 0.34 |

* Immature proglottids were found in the host with the scolex.
the genus parasitizing bats of the genus *suckers* and the hook's morphology. This study reports two species of *Physocephalus* sp. (Spirocercidae). There are species of nematodes belonging to the *Ornithostrongylidae*, *Vampirolepis* species.

4.1.3. Nematodes

Phyllostomidae and Vespertilionidae families (Boero and Delpietro, 1992). Despite the fact that the anatomy of the mature proglottids are different, single proglottids are described (Milano, 2016). The specimen found parasitizing *Tadarida brasiliensis* was recorded using the number of the rostellum's hooks.

1970; Milano, 2016). The two species found in this study due to their armed scolex with fraternoid hooks (Vaucher, 1900). This feature and the combination of other features such as the relation between the diameters of the suckers, the ovary and testes' position and the ventersucker (Lotz and Font, 2008b), As far as we know, there are six previously described species of the genus (Kochseder, 1968; Khotenovsky, 1972; Marshall and Miller, 1979; Lunaschi, 2004; Kirillov et al., 2012). Some specimens were identified as *Parabascus limatulus* (Braun, 1900). Some of the specimens found in this study resemble that of Lunaschi (2004), except in the length of the caeca, which is why we adopt the diagnosis of the *Parabacus* genus sensu Lotz and Font (2008b), who characterize the caeca as long. The rest of the specimens fit in the species *Parabacus* sensu Lotz and Font (2008b), but have a unique cirrus-sac.

This feature and the combination of other features such as the relation between the diameters of the suckers, the ovary and testes' position and the ventersucker (Lotz and Font, 2008b), recorded for the first time parasitizing *Tadarida brasiliensis* in the province of Buenos Aires by Lunaschi (2004), who described the caeca as short. Some of the specimens found in this study resemble that of Lunaschi (2004), except in the length of the caeca, which is why we adopt the diagnosis of the *Parabacus* genus sensu Lotz and Font (2008b), who characterize the caeca as long. The rest of the specimens fit in the species *Parabacus* sensu Lotz and Font (2008b), but have a unique cirrus-sac.

This feature and the combination of other features such as the relation between the diameters of the suckers, the ovary and testes' position and the ventersucker (Lotz and Font, 2008b), recorded for the first time parasitizing *Tadarida brasiliensis* in Poland (Zdzitowiecki, 1967). The species found in our survey were assigned to this genus due to the length of their caeca, posterior to the testes; the cirrus-sac oriented posteriorly and near to the ventral sucker, the submedian genital pore, the submedian ovary at the same level than the ventral sucker, and the ventillarium extending through the anterior region (Lotz and Font, 2008b). *Posthorchigenes cf. joannae* shows a cirrus-sac elongated, mostly posterior to the ventral sucker, and the genital pore is at the end of the cirrus-sac. The taxonomic results of this work represent the first record of *Parabacus* species infecting Patagonian bats, the first record of *P. limatulus* parasitizing a *Myotis* bat in Argentina, and the first record of a species of the genus *Posthorchigenes* in Argentina.

4.1.2. Cestodes

There are previous records of species of cestodes of the genus *Vampirolepis* infecting chiropterans belonging to the Molossididae, Phyllostomidae and Vespertilionidae families (Boero and Delpietro, 1970; Milano, 2016). The two species found in this study fit in *Vampirolepis* due to their armed scolex with fraternoid hooks (Vaucher, 1992). Despite the fact that the anatomy of the mature proglottids are needed in order to identify the species, a preliminary differentiation between other *Physocephalus* species and the ones found in this study was carried out using the number of the rostellum's hooks. *Vampirolepis* sp. 1 has the same number of hooks as *Vampirolepis* sp. 2, however, they differ in the shape and measurements of the scolex, the sizes of the suckers and the hook's morphology. This study reports two species of the genus parasitizing bats of the genus *Myotis* in Argentina for the first time, increasing the host range and the distribution range of the *Vampirolepis* species.

4.1.3. Nematodes

This study reports three species of nematodes: *A. baudii* (Ornithostrongylidae), *Physaloptera* sp. (Physalopteridae), and *Physocyclus* sp. (Spirocercidae). There are species of nematodes belonging to 12 genera recorded in Argentinean bats from the provinces of Misiones, Corrientes, Entre Ríos, Buenos Aires, Jujuy, Salta, Tucumán, and Chubut. Only three are found infecting *Myotis* bats (Vaucher and Durette-Desset, 1980; Ramallo et al., 2007; Oviedo et al., 2009). Our specimens of *A. baudii* resemble the specimens found by Vaucher and Durette-Desset (1980) parasitizing *M. aelens*. They belong to the genus due to the shape of the rays six and eight of the male's bursa and the size of the synlophe, being the ventral ridges bigger than the dorsal ones (Rossi and Vaucher, 2002). The genus *Physocyclus* was registered previously infecting the bat *Eptesicus furinalis* in the province of Entre Ríos (Oviedo et al., 2009). The species found in *M. chiloensis* was assigned to this genus due to the presence of a cephalic collarette. This is the second record of a juvenile stage of a *Physocyclus* nematode infecting Argentinean bats. The nematode larvae found encysted in the peritoneum resembles the species of the genus *Physocyclus* (Diesing, 1861). The L3 of this genus has an esophagus divided in a muscular and glandular region, which extends beyond the middle of the body and in the posterior end they present two concentric rings with digitiform processes (Alicata, 1935). Up to date, there were no records of larval stages of nematodes from bats in Argentina. The presence of *Physocyclus* L3 encysted in the peritoneum indicates that *M. chiloensis* can play the role of an intermediate host for this species. Owls (*Tyto alba*) and domestic cats were observed attacking and feeding on *T. brasiliensis* bats in the city of Rosario, Argentina (Romano et al., 1999). The life cycle of the *Physocyclus* L3 might continue in any of these animals in the Patagonia.

4.2. Community structure

4.2.1. Associations between species

The highest association value was between the two species belonging to the *Parabacus* genus. Despite the fact that the association values of *Ochoterenatrema* sp. with *P. limatulus* and *Parabacus* sp. were high in the bats from both localities, only the association between *Ochoterenatrema* sp. and *P. limatulus* was statistically significant. These values might indicate that these trematodes share a common intermediate host. The associations between gastrointestinal helminths from the definitive host could be reflecting the interactions between the species infecting the intermediate host (Poulin, 2001). *Metacercariae* (Marliuan et al., 2012) and larvae of cestode (Pers. Obs.) have been found in nymphs (Order Ephemeroptera, Plecoptera, Diptera, and Trichoptera) from Patagonian streams. In contrast to the trematodes, which have heteroxenous cycles, trychostrongyloid nematodes have monoxenous cycles, and the infection happens when the bat ingests the eggs (Anderson, 1988, 2000). Therefore, the high association values between *A. baudii* and the three species of trematodes could be explained by two factors. On one hand, the Fager's Index is sensitive to the number of infected hosts by the endoparasite species. *Allintosthias baudii* was found infecting most of the bats from Manso, which might explain the high association values with the trematodes. On the other hand, it might be due to facilitation processes. *Allintosthias baudii* could be inducing a bat's immunosuppression, benefitting the infection by other species of endoparasites (Poulin, 2001).
Insects intervene as intermediate hosts in the life cycles of many species of endoparasite infecting chiropterans (Hilton and Best, 2000). Due to the fact that Manso shows higher quantity of waterbodies than Luis Ruíz, and presents an heterogeneous bottom of inorganic and organic material, and therefore, a higher insect diversity, it is expected that the bats from this locality would have high values of species richness. Both species richness estimators suggest that the expected number of species is approximately 11 in Manso and five in Luis Ruíz. Two of the species found parasitizing the bats in Manso were rare species (Vampyroplois sp. 1 and sp. 2), represented by one individual each. It could be expected that the 11th species in this locality would be a rare species, too.

Both of the endoparasite communities from the M. chiloensis populations share approximately half of the species, being trematodes the majority. This could be explained by the presence of common intermediate hosts in both sites. On the other hand, the ecological indexes calculated suggest that there is no dominant endoparasite species. However, it should be noted that the highest abundance and prevalence values belong to three species of trematodes (Ochoterenatrema sp., P. limatulus, and Parabascus sp.), in contrast to the other helminths.

4.4. Preferences for intestinal regions

Intestinal helminths may show a preference for the site of attachment in the host's gut. However, interactions among species may result in an alteration of the site of attachment (Poulin, 2001). Ochoterenatrema sp., P. limatulus, and Parabascus sp. were found parasitizing the three intestinal regions in Manso. Nevertheless, different preferences appeared for each trematode: Ochoterenatrema sp. occupied preferably the small intestine, P. limatulus the duodenum, and Parabascus sp. the large intestine. There are different factors that could be affecting the distribution of the endoparasites along the intestine, such as specialization, reproductive efficiency and competition. Due to negative interactions between species, one species of parasite may alter their distribution in order to minimize the spatial overlap with the others (Poulin, 2001). Interspecific competition is one of the main factors delimiting the fundamental niche of one parasite species (Holmes, 1990). On the other hand, none of the trematodes species showed a preference for the intestinal regions in Luis Ruíz, probably because the trematodes' abundance and intensity were lower than in Manso. Interspecific competition depends on the intensities of the species that are interacting, which means that in small endoparasite infra-populations this kind of competition would not be significant (Dobson, 1985). It should be noted that Ochoterenatrema sp. was the most abundant species in both the duodenum and the small intestine, unlike in Manso. This could be explained by the low quantity of P. limatulus in the duodenum. When the numbers are high for P. limatulus, these species could be interacting negatively, as seen in Manso.

The role of insectivorous bats in the ecosystem is highly important, due to their role as both definitive and, more rarely, intermediate host, seen in the large number of parasite species found infecting bat populations (Boero and Delpietro, 1970; Saoud and Ramadan, 1976; Esteban et al., 2001; Lunaschi and Drago, 2007; Fugassa, 2015; Portes Santos and Gibson, 2015; Milano, 2016; Clarke-Crespo et al., 2017; Esteban et al., 1999, 2001; Shimalov et al., 2002), and M. chiloensis is not the exception to this. Due to their endoparasites, these bats could be acting as a link between the aquatic and terrestrial environments, allowing the exchange of matter and energy. Nevertheless, little is known about the diversity of endoparasites in Neotropical bats, and about a third of the known bats have been studied in this matter in South America (Portes Santos and Gibson, 2015). The species reported in this study provide useful information and contribute to the actual knowledge on bat's helminth fauna, by reporting for the first time the parasite diversity in a poorly studied bat species, M. chiloensis, and extending the distributions of several known endoparasite genus to the South of the continent.

Acknowledgements

Funds were provided by the Project B-187 of the Universidad Nacional del Comahue. We thank Dr. Richard Sage for providing the material for this study, for the critical reading, and the idiotic corrections of the manuscript. The permissions for the project “Estudio de fauna de pequeños vertebrados (anfibios, reptiles y mamíferos) en el Oeste de la provincia de Río Negro”, were provided by Dirección de Fauna Silvestre – Ministerio de Producción (Provincia de Río Negro) N° 134275 –DFES- 2006. We also thank Prof. Norma Brugni, for the help in the determination of the nematodes of this study, and Dr. Gilda Garibotti, for the help with the statistics.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.ijppaw.2017.12.004.

References

Alicata, J.E., 1935. Early developmental stages of Nematos occurring in swine. Tech. Bull. 489, 1-96.
Anderson, R.C., 1988. Nematoide transmission patterns. J. Parasitol. 74, 30-45.
Anderson, R.C., 2000. Nematoide Parasites of Vertebrates. Their Development and Transmission, 2° Ed. CAB Publishing, Wallingford, Oxon, Reino Unido.
Barquez, R.M., Carbajal, M.N., Failla, M., Diaz, M.M., 2013. New distributional records for bats of the Argentine Patagonia and the southeastern most known record for a mothoid bat in the world. Mamm 77, 119-126.
Barquez, R.M., Diaz, M.M., 2009. Los murciélagos de Argentina. Clave de identificación (Key to the Bats of Argentina). PCMA Publicaciones especiales. Magna. Turcán, Boero, J.J., Delpietro, H., 1970. El parasitismo de la fauna autóctona. VII. Los parásitos de los murciélagos argentinos. Jornadas Internas de la Facultad de Ciencias Veterinarias. La Plata, Argentina. pp. 76-82.
Braun, M., 1900. Trematoden der Chiroptera 15. pp. 217-237 Annalen des K.K. Naturhist. Hofmuseums.
Bush, A.O., Laifferty, K.D., Lotz, J.M., Shostak, A.W., 1997. Parasitology meets ecology on its own terms: margolis et al. revisited. J. Parasitol. 83, 575-583.
Cain, G.D., 1966. Helminth parasites of bats from Carlsbad caverns, New Mexico. J. Parasitol. 52, 351–357.
Cáliblanco, F., Vélez, I., 1982. Observación de trematodos digeneos en murciélagos del Valle de Aburra y alrededores. Actual. Biol. 11, 129-141.
Clarke-Crespo, E., de León, G.P., Montiel-Ortega, S., Rubio-Godoy, M., 2017. Helminth fauna associated with three Neotropical bat species (Chiroptera: mormoopid) in Veracruz, México. J. Parasitol. 103, 338-342.
Conover, W.J., 1980. Practical Nonparametric Statistics, 2° Ed. Texas Tech University, Estados Unidos.
Díaz, M.M., Aguirre, L.F., Barquez, R.M., 2011. Clave de identificación de los murciélagos del Cono Sur de Sudamérica. Centro de Estudios en Biología Teórica y Aplicada, Bolivia.
Dieing, K.M., 1861. Kaiserl. Revision der Nematoden 42. Academie der Wissenschaften in Wien, pp. 595-763.
Drago, P.B., Lunaschi, L.I., Delgado, L., Robles, R., 2007. Helminthofauna de quirópteros de la Reserva Natural Punta Lara, Provincia de Buenos Aires. Resúmenes XXI Jornadas de Mastozoología. Turcán, Argentina. pp. 255.
Dobson, A.P., 1985. The population dynamics of competition between parasites. Parasitology 91, 317-347.
Esteban, J.G., Amengual, B., Serra Cobo, J., 2001. Composition and structure of helminth communities in two populations of Pipistrellus pipistrellus (Chiroptera: Vespertilionidae) from Spain. Folia Parasitol. 48, 143-148.
Esteban, J.G., Botella, P., Toledo, R., Oltra, A., 1999. Helminthofauna of bats in the Iberian Peninsula. IV. Parasites of Schreber’s bat (chiroptera: rhinolophidae). Res. Rev. Parasitol. 59, 57-68.
Fager, E.W., 1957. Determination and analysis of recurrent groups. Ecology 38, 586-595.
Fugassa, M.H., 2015. Checklist of helminths found in Patagonian wild mammals. Zootaxa 134275-82. 
Giménez, P., Springer, M., Ramirez, A., 2010. Introducción a los grupos de macro-invertebrados acuáticos. Rev. Biol. Trop. 58, 3-37.
Hilton, C.D., Best, T.L., 2000. Gastrointestinal Helminth Parasites of Bats in Alabama. Occasional papers of the North Carolina Museum of Natural Sciences and North Carolina Biological Survey. pp. 57-66.
Holmes, J.C., 1990. Competition, contacts, and other factors restricting niches of parasitic helminths. Ann. Parasitol. Hum. Comp. 65, 69-72.
Khotenovsky, L.A., 1972. On the evolution of trematodes from bats. Parazitologiya 6, 79-82.
Kirillov, A.A., Kirillova, N.Y., Vehnik, V.P., 2012. Trematodes (trematoda) of bats
