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Mastozoología Neotropical, vol. 16, núm. 1, enero-junio, 2009, pp. 121-133

Sociedad Argentina para el Estudio de los Mamíferos
Tucumán, Argentina

Available in: http://www.redalyc.org/articulo.oa?id=45712055011
ARTHROPODS AND HELMINTHS ASSEMBLAGE IN SIGMODOINTINE RODENTS FROM WETLANDS OF THE RIO DE LA PLATA, ARGENTINA

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ABSTRACT: The assemblage of arthropods and helminths, present in sigmodontine rodents (Cricetidae) from a broad wetland area of the Río de la Plata, Argentina, was studied. A total of 250 sigmodontines were captured during a two-year sampling period: Scapteromys aquaticus and Oxymycterus rufus were the most abundant hosts, followed by Oligoryzomys nigripes, Akodon azarae, Oligoryzomys flavescens, and Deltamys kemp. There were 33102 parasites collected, corresponding with Rhopalopsyllidae fleas (Siphonaptera), Hoplopleuridae lice (Phthiraptera), Laelapidae and Macronyssidae mites, Ixodidae ticks, and Trombiculidae chiggers (Acari), the trematodes Echinostomidae, Microphallidae, and Dicrocoelidae, the flatworm Ciclophyllidea, the nematodes Trichuridae, Spiruridae, Onchocercidae, Physalopteridae, Aspidoderidae, Oxyuridae, and Nippostrongylinae, and the thorny-headed worm Acanthocephala. A list of arthropods and helminths species associated with each rodent species was given, as well as the prevalence and mean abundance. New host and geographic records were provided. The phenogram of the relationships of the parasite assemblages showed a high value of similarity between both species of Oligoryzomys, and between S. aquaticus and O. rufus. Variation of the values observed in the prevalence and the mean abundance of the host-parasite association suggests that there could be environmental barriers between the rodent populations, or that differential behavior of the host species (i.e. use of microhabitats, tropics behaviors) may influence these indexes. This knowledge may be used to determine targets for biological conservation and ecological impact of parasitism in the area.

RESUMEN: Ensamble de artrópodos y helmintos parásitos en roedores sigmodontinos de los humedales del Río de la Plata, Argentina. Se estudió el ensamblaje parasitario de artrópodos y helmintos en roedores sigmodontinos (Cricetidae) en una franja de los humedales del Río de la Plata, Argentina. Se capturaron un total de 250 roedores sigmodontinos durante dos años consecutivos. Scapteromys aquaticus y Oxymycterus rufus fueron los más abundantes, seguidos por Oligoryzomys nigripes, Akodon azarae, Oligoryzomys flavescens, y Deltamys kemp. Se colectaron 33102 parásitos correspondientes a pulgas Rhopalopsyllidae (Siphonaptera), piojos Hoplopleuridae (Phthiraptera), ácaros Laelapidae y Macronyssidae, garrapatas Ixodidae, y bichos colorados Trombiculidae (Acari), trematodos Echinostomidae, Microphallidae y Dicrocoelidae, cestodos Ciclophyllidea, nematodos Trichuridae, Spiruridae, Onchocercidae, Physalopteridae, Aspidoderidae, Oxyuridae y Nippostrongylinae, y los gusanos espinosos Acanthocephala. Se detalla una lista de las asociaciones de artrópodos y helmintos con cada especie hospedadora y se dan las prevalencias y abundancias medias. Además, se mencionan nuevos registros geográficos y hospedatorios. Los fenogramas de similitud de los ensambles parasitarios mostraron altos valores entre ambas especies de Oligoryzomys y entre S. aquaticus y O. rufus. Variaciones en los valores de prevalencia y abundancia media observados en las asociaciones parásito-hospedador sugieren que podrían estar actuando barreras ambientales...
Colonization of a host species by a parasite species is a process that may take several generations. Its success depends on different factors, such as environmental conditions, age and sex of the host, or more complex ones, for example, the behavior and immune status of the hosts (Poulin and Morand, 2004). Once the host-parasite association is known, variations of them can be detected as the presence-absence of the above mentioned association or variation in the indexes—prevalence, mean abundance. Using the variability of these features, it is possible to predict what host harbors what parasite (Poulin and Morand, 2004). In terrestrial habitats, environmental factors can also cause variation in parasite species richness among populations of the same host species (Krasnov et al., 1997).

The wetlands of the Río de la Plata, Argentina, comprise a forest of complex structure with numerous species and strata (Menalled and Adamoli, 1995). This area is included in the Ecoregion of Delta and Paraná Island (Burkart et al., 1999). Wild rodents are the most representative mammals in the area, and at least 10 species are mentioned for the wetlands living in different microhabitats ranging from flooded to grassland habitats (Massoia, 1961; Ringuelet, 1962; 1981; Gomez Villafañe et al., 2005). Several host-parasites associations were reported from these rodents in the area. Among them, ticks, mites, fleas, nematodes, and flatworms are mentioned (Sutton, 1974; Castro et al., 1987; Sutton and Lunaschi, 1994; Lareschi, 1996; Suriano and Navone, 1996; Lareschi and Mauri, 1998; Notarnicola et al., 2000; Robles and Navone, 2006). However, most of these surveys in the wetland area deal with descriptions of new species and/or records of new hosts. Lareschi (2000) described some parasite associations between arthropods and hosts (i.e. sigmodontine rodents) from the Selva Marginal de Punta Lara, near the Río de la Plata. Moreover, Lareschi et al. (2004, 2007) showed the association between the arthropods Hoplopleura travassosi Werneck, Gigantolaelaps wolffsohni (Oudemans), and Ornithonyssus bacoti (Hirst) with the filarioid worms Litomosoides bonaerensis Notarnicola, Bain and Navone and L. oxymycteri Notarnicola, Bain and Navone, and suggested their potential role as natural vectors of the filarioids.

The aim of this research is to study the parasite assemblage (arthropods and helminths) present in the most representative sigmodontine rodent species from a wetland area of the Río de la Plata, Buenos Aires Province, to provide the prevalence and mean abundance of the host-parasite associations, and to analyze the similarity of the parasite communities. New host-parasite associations are mentioned.

**MATERIALS AND METHODS**

**Studied area.**—Samples were carried out on an area besides the Río de la Plata, from Reserva Natural de Hudson (34° 45’ S, 58° 06’ W) to La Balandra (34° 56’ S, 57° 42’ W). The area is characterized by lowlands throughout the margin of the Río de la Plata intercalated with coastal strips emerging from water. It displays periods of floods originated mainly by the local rain, the dripping water from temporal creeks, and periodical southeast winds, plus the freshet of the Río de la Plata (Dascanio et al., 1994). A succession of vegetal communities are disposed from the margin to in-
ner lands as follows; rushes, riverside grasslands, riverside scrubland, «sauzales», wetland forest, straw grassland, and grass pseudo-steppe, producing heterogeneous microhabitats in the coast (Cabrera and Dawson, 1944; Barrios and Moschione, 1993).

Hosts.—Rodents were trapped from April 1995 to October 1996 during 30 trapping session. Captures were carried out by two of the authors (GN and ML) in accordance with regulations and policies of the Dirección de Administración y Difusión Conservacionista del Ministerio de Asuntos Agrarios, Buenos Aires. Live-traps were distributed along two transects; 30 to 40 traps stations were set three meters apart from each other. Traps were bait-loaded with oiled bread and activated for one night at each trapping session. A total of 2303 night traps were used. In positive captures, the rodents inside their traps were placed in individual plastic bags to avoid contamination with ectoparasites from another host species. Then, they were sacrificed with sulfuric ether and frozen. After collecting parasites, they were deposited at the Colección de Mastozoología, Museo de La Plata (CMMLP), and the Instituto de Limnología ILPLA, Buenos Aires, Argentina (see Appendix). U.F.J Pardiñas from the Centro Nacional Patagónico, Puerto Madryn, Argentina and CG identified the rodents. We followed Barquez et al. (2006) for the systematic of the species.

Parasites.—Arthropods were recovered by examining the furs under magnifying lens, preserved in 70º ethanol, and mounted on permanent slides. The body cavity and the viscera of hosts were examined for parasites. Helminths were fixed in 10% formalin, and preserved in 70% ethanol. Arthropods and helminths were identified following the conventional techniques and bibliography of the genera and species level, except the Acantocephala and nematode cysts. Voucher specimens were deposited in the Colección de Entomología (CEMLP), Colección de Helmintología (CHMLP) from Museo de La Plata, Argentina (see Appendix), and CEPAVE authors collection.

Data Analysis.—The relative abundance index (RAI) was estimated as follows: (number of trapped rodent / number of nights x number of traps) x 100 (Jones et al., 1996). Prevalence (P) and Mean Abundance (MA) with the standard deviation were calculated following Bush et al. (1997). Phenogram of the relationships of parasite assemblages among six host species was constructed using WPGMA on a similarity matrix (Morisita index) computed on the basis of the values of P and MA of 45 species or parasite species group (MVSP software).

RESULTS
A total of 250 rodents belonging to six species of Sigmodontinae were trapped in the area: Scapteromys aquaticus Thomas (n = 130), Oxymycterus rufus (Fischer) (n = 58), Oligoryzomys flavescens (Waterhouse) (n = 27), Akodon azarae (Fischer) (n = 23), Oligoryzomys nigripes (Olfers) (n = 8), and Deltamys kempi Thomas (n = 4). Nineteen traps captured other mammals such as marsupials and rats. The total RAI in the area was 11.7%. Scapteromys aquaticus and O. rufus were the most abundant hosts (RAI = 5.6%, and 2.5% respectively), followed by O. flavescens (RAI = 1.2), A. azarae (RAI = 1), O. nigripes (RAI = 0.3), and D. kempi (RAI = 0.2). About 33 102 parasites (9603 arthropods and 23 499 helminths) were recovered from these hosts and grouped in the taxa Siphonaptera, Phthiraptera, Acari, Digenea, Cestoda, Nematoda, and Acanthocephala.

Table 1 details a list of the collected parasites species (arthropods and helminths) from six sigmodontine rodent species. Table 2 summarizes P and MA of the collected parasites from the Río de la Plata’s wetlands.

Scapteromys aquaticus Thomas
This host species was the most frequently trapped in the area (RAI = 5.6%). Specimens were commonly captured in flooded trap-stations, where rushes were dominant. The parasite richness was 22 (10 arthropods species, 11 helminths species, and one helminth larva) (Tables 1, 2).

Among mites, Laelaps manguinhosi Fonseca showed the highest P and MA (Table 2). The lice Hoplopleura scapteromysidis Ronderos, is specifically associated with S. aquaticus, and showed high value of P and MA. On the other hand, because ticks molt as well as eggs and immature stages of fleas occur out of the host’s bodies, flooded soils constitute a barrier for the development of these arthropods. Thus, with the exception of Polygenis (Neopolygenis)
Table 1
List of the species of parasites (arthropods and helminths; * = presence) collected from six species of sigmodontine rodents. Abbreviations: SA, Scapteromys aquaticus; OR, Oxymycterus rufus; OF, Oligoryzomys flavescens; ON, Oligoryzomys nigripes; AA, Akodon azarae; DK, Deltamys kempi.

<table>
<thead>
<tr>
<th>Parasite species</th>
<th>Host species</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arthropods</strong></td>
<td></td>
</tr>
<tr>
<td>Insecta</td>
<td></td>
</tr>
<tr>
<td>Siphonaptera, Rhopalopsyllidae</td>
<td></td>
</tr>
<tr>
<td><em>Polygenis (Neopolygenis) atopus</em> (Jordan and Rothschild, 1922)</td>
<td>* * * * *</td>
</tr>
<tr>
<td><em>Polygenis (Neopolygenis) massoiai</em> Del Ponte, 1967</td>
<td>* *</td>
</tr>
<tr>
<td><em>Polygenis (Neopolygenis) frustratus</em> Johnson, 1957</td>
<td>* *</td>
</tr>
<tr>
<td><em>Polygenis (Polygenis) rimatus</em> (Jordan, 1932)</td>
<td>*</td>
</tr>
<tr>
<td><em>Polygenis (Polygenis) axius axius</em> (Jordan and Rothschild, 1923)</td>
<td>* *</td>
</tr>
<tr>
<td><em>Polygenis (Polygenis) bohls bohls</em> (Wagner, 1901)</td>
<td>* *</td>
</tr>
<tr>
<td><em>Polygenis</em> sp.</td>
<td>*</td>
</tr>
<tr>
<td>Phthiraptera, Anoplura, Hoplopleuridae</td>
<td></td>
</tr>
<tr>
<td><em>Hoplopleura scapteromydis</em> Ronderos, 1965</td>
<td>*</td>
</tr>
<tr>
<td><em>Hoplopleura fonsecai</em> Werneck, 1934</td>
<td>*</td>
</tr>
<tr>
<td><em>Hoplopleura travassosi</em> Werneck, 1932</td>
<td>* *</td>
</tr>
<tr>
<td><em>Hoplopleura aiikeni</em> Jonson, 1972</td>
<td>*</td>
</tr>
<tr>
<td><strong>Acari</strong></td>
<td></td>
</tr>
<tr>
<td>Laelapidae</td>
<td></td>
</tr>
<tr>
<td><em>Androlaelaps fahrenholzi</em> (Berlese, 1911)</td>
<td>* * * *</td>
</tr>
<tr>
<td><em>Androlaelaps rotundus</em> (Fonseca, 1936)</td>
<td>*</td>
</tr>
<tr>
<td><em>Androlaelaps</em> sp. 1</td>
<td>*</td>
</tr>
</tbody>
</table>
| *Laelaps manguinhosi* Fonseca, 1936 | * * * *
| *Laelaps paulistanensis* Fonseca, 1936 | * * * *
| *Gigantolaelaps wolffsohni* (Oudemans, 1910) | * * *
| *Mysolaelaps microspinus* Fonseca 1936 | * * *
| Macronyssidae |              |
| *Ornithonyssus bacoti* (Hirst, 1913) | * * * *
| Ixodidae |              |
| *Isodes loricatus* Neumann, 1899 | * * * * *
| Trombiculidae |              |
| *Eutrombicula alfreddeugesi* (Oudemans, 1920) | * * * *
| Helminths |              |
| Digenea |              |
| Echinostomatidae |              |
| *Echinostoma plateatis* Sutton and Lunaschi, 1994 | * * * *
| *Echinoparyphium scapteromer (Sutton, 1983) | * * * * *
| Microphallidae |              |
| *Levinseniella (Monarrhenos) cruzi* Travassos, 1920 | * * * *
| Dicrocoeliidae |              |
| *Zoonorchiis oxymycterae* Sutton, 1983 | * * *
| Cestoda |              |
| Ciclophyllidea, Hymenolepididae |              |
| *Rodentolepis* sp. | * * *
| Nematoda |              |
| Trichuridae |              |
| *Tricharis laevitesti* Suriano and Navone, 1994 | * * *
| Echinomeles sp. |              |
| Pseudocapillaria sp. |              |
atopus (Jordan and Rothschild), low values of P and MA of these last groups of arthropods may be related to environmental conditions.

Concerning the helminths of S. aquaticus (Table 1), six of 12 species found (three trematodes, one cestode, one nematode, and one acanthocephala) have indirect life cycles, which include an intermediate host acquired through the food-web. Among the remaining worms, the nippostrongylines nematodes and Nematomyctes rodentiphilus Sutton, Chabaud and Durette-Desset have direct life cycles. Both nematodes displayed the highest P and MA (69 to 75%, and 36.9-47.2 respectively) (Table 2). These nematodes are small worms, parasitizing the small intestine and the caecum, respectively. In contrast, Trichuris laevitestis Suriano and Navone is a larger nematode and they frequently occurred with low P and MA (8.5% and 0.3, respectively). Cysts of nematodes containing larval stages of Physalopteridae were recovered either from the external intestine walls of the specimen or attached to mesenteries. The presence of these larval stages indicates that rodents are intermediate hosts. Adults Physalopteridae from Turgida turgida Rudolphi were found by Navone (unpublished data) in Didelphis albiventris Lund and Lutreolina crassicaudata (Desmarest) from this wetland area. This finding suggests that marsupials could possibly be the final hosts. Besides, S. aquaticus is a new host record for Rodentolepis sp., Echinocoleus sp., and the Physalopterinae cysts.

Oxymycterus rufus (Fischer)

Oxymycterus rufus was the second species in abundance captured in the wetland area (RAI = 2.5). The parasite species richness reached 19 (11 species of arthropods and eight of helminths) (Tables 1, 2).
Table 2

Prevalence (P) and Mean Abundance (MA) ± the standard deviation of the parasites collected from six species of sigmodontines rodents from the wetlands of the Río de la Plata, Buenos Aires.

<table>
<thead>
<tr>
<th>Parasites species</th>
<th>Host species</th>
<th>S. aquaticus</th>
<th>O. rufus</th>
<th>O. flavescens</th>
<th>O. nigripes</th>
<th>A. azarae</th>
<th>D. kempi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>P (%)</td>
<td>MA (±)</td>
<td>P (%)</td>
<td>MA (±)</td>
<td>P (%)</td>
<td>MA (±)</td>
</tr>
<tr>
<td>Polygenis (N.) atopus</td>
<td></td>
<td>21.5</td>
<td>0.4 ± 1</td>
<td>3.4</td>
<td>0.1 ± 0.4</td>
<td>23.1</td>
<td>0.3 ± 0.5</td>
</tr>
<tr>
<td>Polygenis (N.) massoiai</td>
<td></td>
<td>0.7</td>
<td>0 ± 0.1</td>
<td>17.2</td>
<td>0.5 ± 1.8</td>
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</tr>
<tr>
<td>Polygenis (N.) frustratus</td>
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<td>-</td>
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<tr>
<td>Polygenis (P.) rimatus</td>
<td></td>
<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>Polygenis (P.) a. axius</td>
<td></td>
<td>3</td>
<td>0 ± 1.2</td>
<td>8.6</td>
<td>0.2 ± 0.6</td>
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<tr>
<td>Polygenis (P.) b. bohlsi</td>
<td></td>
<td>0.7</td>
<td>0 ± 0.1</td>
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<tr>
<td>Polygenis sp.</td>
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<tr>
<td>Hoplopleura scapteromydis</td>
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<td>50.7</td>
<td>19 ± 41</td>
<td>-</td>
<td>-</td>
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<td>13.1 ± 30</td>
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<tr>
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<tr>
<td>Hoplopleura aitkeni</td>
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<tr>
<td>Androlaelaps fahrenholzi</td>
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<td>28.5</td>
<td>1.2 ± 3.6</td>
<td>46.5</td>
<td>1.9 ± 3.6</td>
<td>7.7</td>
<td>0.1 ± 0.3</td>
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<td>Androlaelaps rotundus</td>
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<tr>
<td>Androlaelaps sp. 1</td>
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<tr>
<td>Laelaps mugunthinosi</td>
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<td>75.3</td>
<td>18.3 ± 25.6</td>
<td>1.7</td>
<td>0 ± 0.1</td>
<td>26.9</td>
<td>0.3 ± 0.5</td>
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<td>17.0</td>
<td>0 ± 0.1</td>
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<tr>
<td>Gigantolaelaps wolfschoi</td>
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<td>-</td>
<td>76.9</td>
<td>2 ± 2</td>
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<tr>
<td>Myxolaelaps microspinosis</td>
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<td>-</td>
<td>-</td>
<td>65.4</td>
<td>2.1 ± 2</td>
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<tr>
<td>Ornithonyssus bacoti</td>
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<td>16.9</td>
<td>0.5 ± 2</td>
<td>41.4</td>
<td>3 ± 8.4</td>
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<td>Ixodes loricatus</td>
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<td>3.1</td>
<td>0 ± 0.2</td>
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<td>0 ± 0.3</td>
<td>7.7</td>
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<td>19.2 ± 62.3</td>
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<td>2.8 ± 10.8</td>
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<td>6.4 ± 29</td>
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<td>Zoonorchis asyncterae</td>
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<td>-</td>
<td>8.6</td>
<td>1.6 ± 6.8</td>
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<td>Rodenilepis sp.</td>
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<td>0.3 ± 1.1</td>
<td>15.5</td>
<td>0.4 ± 1.5</td>
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<tr>
<td>Trichurus laurentissus</td>
<td></td>
<td>8.5</td>
<td>0.3 ± 1.7</td>
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<td>-</td>
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<tr>
<td>Echinoleucus sp.</td>
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<td>14.6</td>
<td>0.56 ± 1.6</td>
<td>-</td>
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<tr>
<td>Pseudocapillaria sp.</td>
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<td>-</td>
<td>13.8</td>
<td>0.5 ± 1.8</td>
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<tr>
<td>Protospiro n. cricetica</td>
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<td>0.2 ± 1.4</td>
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<td>-</td>
<td>7.4</td>
<td>0.3 ± 1.3</td>
</tr>
</tbody>
</table>

<p>| Zoonorchis (M.) cruzi      |                    | 21.5  | 17.8 ± 52.2 | 10.3 | 6.4 ± 29 | -     | -     | -     | -     | 25   | 1 ± 2    | -   | -   |
| Zoonorchis asyncterae        |                    | -     | -     | 8.6   | 1.6 ± 6.8 | -     | -     | -     | -     | 4.3  | 0.3 ± 0.9 | -   | -   |
| Rodenilepis sp.              |                    | 13    | 0.3 ± 1.1 | 15.5  | 0.4 ± 1.5 | -     | -     | -     | -     | -   | 50    | 0.5 ± 0.6 | -   | -   |
| Trichurus laurentissus       |                    | 8.5   | 0.3 ± 1.7 | -     | -     | -     | -     | -     | -     | 13   | 0.3 ± 0.4 | -   | -   |
| Echinoleucus sp.             |                    | 14.6  | 0.56 ± 1.6 | -     | -     | -     | -     | -     | -     | -   | -   | -     | -   | -   |
| Pseudocapillaria sp.         |                    | -     | -     | 13.8  | 0.5 ± 1.8 | -     | -     | -     | -     | -   | -   | -     | -   | -   |
| Protospiro n. cricetica      |                    | 6.1   | 0.2 ± 1.4 | -     | -     | 7.4   | 0.3 ± 1.3 | -     | -     | -   | -   | -   | -     |</p>
<table>
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<tr>
<th>Parasites species</th>
<th>O. aquaticus</th>
<th>O. rufus</th>
<th>O. flavescens</th>
<th>O. nigripes</th>
<th>A. azarae</th>
<th>D. kempi</th>
<th>D. australis</th>
<th>O. flavescens</th>
<th>O. nigripes</th>
<th>O. rufus</th>
<th>O. rufus</th>
<th>O. flavescens</th>
<th>O. nigripes</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>P (%)</td>
<td>MA</td>
<td>P (%)</td>
<td>MA</td>
<td>P (%)</td>
<td>MA</td>
<td>P (%)</td>
<td>MA</td>
<td>P (%)</td>
<td>MA</td>
<td>P (%)</td>
<td>MA</td>
<td>P (%)</td>
</tr>
<tr>
<td>Litomosoides oxymycteri</td>
<td>-</td>
<td>-</td>
<td>43.1 ± 27</td>
<td>4.8 ± 27</td>
<td>-</td>
<td>-</td>
<td>6.2 ± 5</td>
<td>4.3 ± 6.5</td>
<td>9.5 ± 1.6</td>
<td>100</td>
<td>75.4</td>
<td>28.7 ± 4.7</td>
<td>126.7 ± 168.6</td>
</tr>
<tr>
<td>Cysts of Physalopteridae</td>
<td>20 ± 11.3</td>
<td>1.7</td>
<td>3.8 ± 6.5</td>
<td>0.3 ± 0.3</td>
<td>100</td>
<td>75.4</td>
<td>18 ± 7.8</td>
<td>100 ± 12.6</td>
<td>100 ± 12.6</td>
<td>100</td>
<td>100</td>
<td>100 ± 12.6</td>
<td>100 ± 12.6</td>
</tr>
<tr>
<td>Nematomystes rodentiphilus</td>
<td>75.4 ± 77.5</td>
<td>11.1</td>
<td>128 ± 66.6</td>
<td>100 ± 12.6</td>
<td>100</td>
<td>75.4</td>
<td>128 ± 66.6</td>
<td>100 ± 12.6</td>
<td>100 ± 12.6</td>
<td>100</td>
<td>75.4</td>
<td>128 ± 66.6</td>
<td>100 ± 12.6</td>
</tr>
<tr>
<td>Syphacia sp.</td>
<td>1</td>
<td>-</td>
<td>11.1 ± 6.3</td>
<td>0.6 ± 0.3</td>
<td>100</td>
<td>75.4</td>
<td>11.1 ± 6.3</td>
<td>100 ± 12.6</td>
<td>100 ± 12.6</td>
<td>100</td>
<td>75.4</td>
<td>11.1 ± 6.3</td>
<td>100 ± 12.6</td>
</tr>
<tr>
<td>Syphacia carlitosi</td>
<td>-</td>
<td>-</td>
<td>11.1 ± 6.3</td>
<td>0.6 ± 0.3</td>
<td>100</td>
<td>75.4</td>
<td>11.1 ± 6.3</td>
<td>100 ± 12.6</td>
<td>100 ± 12.6</td>
<td>100</td>
<td>75.4</td>
<td>11.1 ± 6.3</td>
<td>100 ± 12.6</td>
</tr>
<tr>
<td>Stilestrongylus sp. 1</td>
<td>20 ± 11.3</td>
<td>1.7</td>
<td>3.8 ± 6.5</td>
<td>0.3 ± 0.3</td>
<td>100</td>
<td>75.4</td>
<td>18 ± 7.8</td>
<td>100 ± 12.6</td>
<td>100 ± 12.6</td>
<td>100</td>
<td>75.4</td>
<td>18 ± 7.8</td>
<td>100 ± 12.6</td>
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<tr>
<td>Stilestrongylus sp. 2</td>
<td>36.9 ± 63</td>
<td>1.7</td>
<td>3.8 ± 6.5</td>
<td>0.3 ± 0.3</td>
<td>100</td>
<td>75.4</td>
<td>18 ± 7.8</td>
<td>100 ± 12.6</td>
<td>100 ± 12.6</td>
<td>100</td>
<td>75.4</td>
<td>18 ± 7.8</td>
<td>100 ± 12.6</td>
</tr>
<tr>
<td>Stilestrongylus sp. 3</td>
<td>6.1 ± 2.4</td>
<td>1.7</td>
<td>3.8 ± 6.5</td>
<td>0.3 ± 0.3</td>
<td>100</td>
<td>75.4</td>
<td>18 ± 7.8</td>
<td>100 ± 12.6</td>
<td>100 ± 12.6</td>
<td>100</td>
<td>75.4</td>
<td>18 ± 7.8</td>
<td>100 ± 12.6</td>
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<td>Malvinema spp.</td>
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<td>1.7</td>
<td>3.8 ± 6.5</td>
<td>0.3 ± 0.3</td>
<td>100</td>
<td>75.4</td>
<td>18 ± 7.8</td>
<td>100 ± 12.6</td>
<td>100 ± 12.6</td>
<td>100</td>
<td>75.4</td>
<td>18 ± 7.8</td>
<td>100 ± 12.6</td>
</tr>
<tr>
<td>Suttonema spp.</td>
<td>6.9 ± 2.4</td>
<td>1.7</td>
<td>3.8 ± 6.5</td>
<td>0.3 ± 0.3</td>
<td>100</td>
<td>75.4</td>
<td>18 ± 7.8</td>
<td>100 ± 12.6</td>
<td>100 ± 12.6</td>
<td>100</td>
<td>75.4</td>
<td>18 ± 7.8</td>
<td>100 ± 12.6</td>
</tr>
</tbody>
</table>

Only one specimen of *O. rufus* was parasitized with the lice *Hoplopleura fonsecai* Wernerck. Previous studies reported the absence of these arthropods parasitizing *O. rufus* during a monthly study in Punta Lara (Lareschi, 1996). However, in a northern locality (i.e. Otamendi-Buenos Aires), also in a monthly study, it was registered a prevalence of 40% (Lareschi and Sánchez López, 1999). Lice are obligatory parasites and all the stages of their life cycle occur on the host, so the colonization of a new host takes place by frequent physical contact among them. The differences of the P observed in *H. fonsecai* may suggest the presence of environmental barriers between the northern populations of *O. rufus* (Otamendi) and the southern in the wetland localities. Larvae of *Eutrombicula alfreddugesi* Oudemans are generalist parasites of amphibians, reptiles, birds, mammals, and also humans (Daniel and Stekol’nikov, 2004). These chiggers were collected from four out of the six host species trapped in this study (Table 2). However, it was mainly associated with *S. aquaticus* and *O. rufus*, the more abundant hosts in the area. The remarkable seasonality of this chigger, with a preference toward spring and summer and absence in winter (Lareschi, 2000), may affect values of total P and MA, which are lower when each season is independently considered. Among the mites, *Androlaelaps fahrenholzi* (Berlese) and *O. bacoti* showed the highest values of P and MA (Table 2).

Regarding to helminths, *O. rufus* harbored three species of trematodes and one cestode species with indirect life cycles. These parasites are acquired with the diet indicating that their main food consists in larval insects, mollusks, and small vertebrates, which are the usual intermediate hosts. Three of four species of nematodes collected from this host displayed direct life cycles. The fourth, the filarioid *L. oxymycteri*, is transmitted by a vector, probably either the mite *O. bacoti* or another arthropod ectoparasite as stated in Lareschi et al. (2003, 2007). Most helminths showed low P and MA with the exception of the filarioid (43.1% and 4.7 respectively)
(Table 2). Zoonorchis oxymycterae Sutton was originally described parasitizing O. rufus from Otamendi. In the present study, it was also found widening its known geographical distribution. Moreover, Echinoparyphium scapteromae (Sutton), Levinseniella (Monarrhenos) cruzi Travassos, Rodentolepis sp., and Pseudocapillaria sp. are new host records.

Oligoryzomys flavescens (Waterhouse)

Oligoryzomys flavescens is a common species in wetlands from Buenos Aires to Misiones provinces (Massoia, 1973). It was the third species in abundance in the area (RAI = 1.2). The total species richness was 16 (11 arthropod species and five helminths) (Tables 1, 2).

The arthropod richness was as high as that from O. rufus. The mites G. wolffsohni and Mysolaelaps microspinus Fonseca were collected with high P (76.9% and 65.4%, respectively) and MA (2 and 2.1, respectively). The louse H. travassosi was also collected in high number of hosts (P = 61.5%, MA = 3.1). In contrast, ticks, chiggers, and fleas—with the exception of P. (N.) atopus—and the mites G. wolffsohni, Laelaps paulistanensis, and M. microspinus, showed high values of P (62.5-100%) and low to high MA (1.7-19.8) (Table 2).

Three helminths species were recovered from Ol. nigripes, in contrast to the five species found in O. flavescens. Filarioïds and nippostrongyliines showed the highest P (Table 2). The filarioïd L. bonaerensis corresponds to the same species found in O. flavescens from wetlands but differs from that recovered from O. nigripes in Misiones Province (Notarnicola and Navone, 2002).

Akodon azarae (Fischer)

The relative abundance of A. azarae in the area was slightly lower than that from O. flavescens (RAI = 1 vs. 1.2). Akodon azarae harbored six arthropod species and five helminth species (Tables 1, 2).

Hoplopleura aitkeni Johnson, I. loricatus, and the mite Androlaelaps rotundus (Fonseca) parasitized A. azarae with higher value of P than those observed for each of these arthropods in the remaining host species trapped in the current study (Table 2). Ixodes loricatus was collected from five out of the six species of sigmodontines trapped in this study except D. kempi (Table 1). However, immature stages of this tick were frequently found parasitizing A. azarae confirming that immature stages are associated with this host. This result agrees with previous findings where the immature stages are mainly associated with Akodon species and adults with marsupials (Lareschi, 1996; Nava et al., 2004; Beldomenico et al., 2005).

Two species of trematodes were recovered with low P and MA (Table 2), indicating that these rodents probably include mollusks or
small vertebrates in their diet occasionally. In contrast, nippostrongylines were the most prevalent and registered the highest MA (P = 95.6%, and MA = 81.6). The remaining nematodes found in this area either registered low P and MA or they were absent (Table 2). Both trematodes, *E. scapteromae* and *Z. oxymycterae* are reported in *A. azarae* for the first time.

**Deltamys kempi** Thomas

Only four specimens of *D. kempi* were captured in the area (RAI = 0.2). They harbored three arthropods and three helminths species (Tables 1, 2).

Individuals were parasitized with fleas and one species of *Androlaelaps*. The morphology of this mite differs from the other known species of *Androlaelaps* but resembles *A. rotundus* found frequently in the area (ML unpublished data). However, *A. rotundus* is known to be a complex of species as stated Gettinger and Owen (2000) in Paraguay. This is the first time reporting helminths parasitizing *D. kempi*. The finding of the trematode *L. (M.) cruzi* and the flatworm *Rodentophilus* sp. indicates a diet constituted by mollusks and arthropod larval stages. The nematode *Stilestrongylus* sp. 3 appeared with high P (75%), similarly to the other sigmodontine rodents in the area.

**Data Analysis**

The phenograms obtained using P and MA values showed similar relationships of the principal nodes, however *D. kempi* changed the position (Figs. 1A, B). The parasite assemblages between both species of *Oligoryzomys*, and between *O. rufus* and *S. aquaticus* are more similar. *Akodon azarae* unites to this last node, while the assemblage of *D. kempi* presented the lowest similarity regarding the other host species (Fig. 1A) or conformed a cluster of low similarity values with *O. rufus*, *S. aquaticus*, and *A. azarae* (Fig. 1B).

**DISCUSSION**

The assemblage of parasites of the sigmodontine rodents reported in this study is characteristic of the Río de la Plata wetlands, in agreement with previous findings from pellets of *Tyto alba* (Strigiforme, Aves) in the area (Udrizar Sauthier et al., 2005). Concerning ectoparasites, previous studies listed these arthropod species associated with a variety of hosts (Castro et al., 1987; Lareschi and Mauri, 1998) suggesting that they are generalists. In the present study, most of the arthropods were collected from two or more host species. However, as stated Poulin et al. (2008), differences in the values of MA allow
to identify principal versus auxiliary hosts. Then, among others, in the present study *S. aquaticus* was identified as the principal host of *L. manguinhosi*, while *A. azarae* was of *A. rotundus*.

Among helminths, nipotrongylines, and filarioïds are host-specific. The former group was collected from all host species harboring a specific complex (Table 1). In contrast, species of filarioïds were found parasitizing only *O. rufus* and *Oligoryzomys* spp. in the study area. These findings agree with those from the northern locality Otamendi (Notarnicola, 2004). Thus, *S. aquaticus*, *A. azarae*, and *D. kempi* were not susceptible to acquire filarioïds in the wetlands.

Because wetlands exhibit periods of flood, the frequency and timing of floods determine either the absence or low abundance of ticks, fleas, and trichurids. Fleas and trichurids are dominant in arid areas (Lareschi et al., 2004; Robles et al., 2006). Although parasite communities retain their components along host distribution, characteristics of microhabitats such as the hydroperiod and presence of other mammals may produce some changes in the composition of communities.

From another point of view, it can be inferred the compound microhabitat and the diet of a host by knowing the arthropod and helminths infracommunity. For example, the presence of immature stages of *I. loricatus* parasitizing the sigmodontines indicates that marsupials are frequent in the area, as mentioned Nava et al. (2004), and Beldomenico et al. (2005). Moreover, cysts of the nematodes Physalopteridae, whose adults are parasites of the marsupials, were also recovered from these rodents. Relating to the diet, larval infective stages of trematodes as well as some nematodes develop in mollusks and coleopterans respectively. The finding of these parasites in *S. aquaticus* and *O. rufus* with intermediate P and MA suggest that they might include important quantities of invertebrates on their diets. *Akodon azarae*, *Oligoryzomys* spp., and *D. kempi* showed low P and MA of these parasites indicating they occasionally include invertebrates. Moreover, pieces of invertebrates, mainly coleopterans were observed in the stomach of these rodents during the dissections. This observation also agrees with the behavior of *S. aquaticus* and *O. rufus*, which are frequently trapped near rushes and meadow strands while *A. azarae*, *Oligoryzomys* spp. and *D. kempi* were trapped on graminoid grassland.

The parasite assemblages from both species of *Oligoryzomys* are the more similar, constituting the same node in both, P and MA phenograms (Figs 1A, B). This finding could be explained as a result of their phylogenetic affinity or by sharing the same microhabitats—arboreal and tall grass climbers. The nodes conformed by *S. aquaticus* and *O. rufus* are present in the P and MA phenograms with a lower similarity than those from *Oligoryzomys* spp. This similarity probably is a result of the convergence of their use of microhabitats in this area, such as wet grasslands and borders of flooding areas. The remaining species, *A. azarae* and *D. kempi*, showed a different position in the phenogram depending on the data matrix used (P or MA data). However, the similarity was much lower compared with the other nodes. The parasite assemblages of *A. azarae* and *D. kempi* are different from those of *S. aquaticus-O. rufus*. This result indicates that these rodent species use different microhabitats, even though they are sympatric species. The topologic instability of *D. kempi* observed in the phenograms could be related to the small sample size.

Not only wetlands are main resources of water, they also constitute important reservoirs of biodiversity due to a variety of microhabitats (Schnack, 2001). In this study, wetlands from the Río de la Plata display a high biodiversity of parasites associated with sigmodontine rodents. Despite the complexity of the area studied, it was possible to establish the host-parasite associations and to explain the variability observed between the populations of the sigmodontines. This knowledge can be used as target for biological conservation and ecological impact of parasitism in the area (Schnack, 2001; Hugot et al., 2001).
AKNOWLEDGEMENTS

We thank Cecilia Ezquiaga that helped in the prospecting; to Ulyses Pardiñas and Julia Diaz for the critical reading of the manuscript; to Lucas Garbin for the English language revision. This investigation was financed by the CONICET (PIP 3000) and the UNLP (N363).

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Editor asociado: UFJ Pardiñas
APPENDIX

Host species

Material deposited in the Colección de Mastozoología, Museo de La Plata (CMMLP), with number of collection (MLP) and field numbers corresponding to the localities (B: La Balandra; H: Hudson, PB: Palo Blanco, PL: Punta Lara, and T: Los Talas); and Instituto de Limnología de La Plata (ILPLA).

**Akodon azarae**: B 014, 047, 050, 053, 056, 064; H 006, 007, 008, 016, 024, 035, 047; PL 334, 335, 336, 340, 341; T 055; ILPLA 181, 182, 185, 190.

**Deltamys kempi**: H 064; T050; ILPLA 179, 180.

**Oligoryzomys flavescens**: MLP 08.IV.97.52, 10.VIII.00.10, 10.VIII.00.09, 05.XII.01.33, 01.X.01.11, 02.X.01.01, 01.VIII.00.29, 01.VIII.00.35, 01.VIII.00.37, 08.X.97.51, 01.VIII.00.33, 01.VIII.00.28, 01.VIII.00.36, 08.X.97.53; B 010, 046, 055, 067, 073, 080; H 063; PB 018, 002, 010; PL 310, 323, 338.

**Oligoryzomys nigripes**: MLP 08.VIII.00.10, 08.IV.97.59, 08.IV.97.58, 01.VIII.00.31, 01.VIII.00.34, 01.VIII.00.30, 01.VIII.00.27; H 044.

**Oxymycterus rufus**: MLP 20.XII.00.22, 20.XII.00.23, 20.XII.00.21, 08.IV.97.36, 25.IV.01.02, 20.XII.00.20, 08.IV.97.43, 08.IV.97.41, 05.XII.01.32, 08.VIII.00.04, 08.IV.97.25, 08.IV.97.26, 08.IV.97.38, 08.IV.97.26, 08.IV.97.33, 08.IV.97.28, 08.IV.97.39, 08.IV.97.24, 26.V.99.08, 08.IV.97.31, 08.IV.97.29, 08.IV.97.34, 08.VIII.00.03, 08.IV.97.27, 08.IV.97.23, 08.IV.97.37, 08.IV.97.32, 08.IV.97.44, 08.IV.97.72, 17.XIII.01.03, 17.XII.01.05, 17.XIII.01.02, 17.XII.01.06, 08.IV.97.35; B 048, 058, 061, 063, 068; H 028, 036; PB 000, 007, 015, 016, 017, 026, 027, 028, 029, 030, 031, 032, 033, 038, 039, 040, 041, 042, 043, 052, 057, 059, 062, 069, 070, 071, 072, 074, 075, 077, 078; H 033, 053, 055, 021, 023; PB 000, 007, 007, 015, 016, 019, 020, 022, 023, 024, 025, 026, 027, 028, 029, 030, 031, 033, 034, 035, 036, 037, 038, 039, 040, 041, 042, 043, 044, 045, 046, 053, 056; ILPLA 163, 164, 165, 166, 170.

**Scapteromys aquaticus**: MLP 08.IV.97.05, 08.IV.97.10, 08.IV.97.12, 08.IV.97.11, 08.IV.97.13, 08.IV.97.03, 08.IV.97.04, 08.IV.97.17, 08.IV.97.19, 08.IV.97.15, 08.IV.97.01, 08.IV.97.02, 08.IV.97.18, 08.IV.97.20, 08.IV.97.16, 08.IV.97.14, 08.IV.97.07, 08.IV.97.22, 08.IV.97.06, 08.IV.97.08, 08.IV.97.21; B 001, 003, 004, 005, 006, 007, 008, 009, 016, 017, 026, 027, 028, 029, 030, 031, 032, 033, 038, 039, 040, 041, 042, 043, 052, 057, 059, 062, 069, 070, 071, 072, 074, 075, 077, 078; H 033, 053, 055, 021, 023; PB 000, 007, 007, 015, 016, 019, 020, 022, 023, 024, 025, 026, 027, 028, 029, 030, 031, 033, 034, 035, 036, 037, 038, 039, 040, 041, 042, 043, 044, 045, 046, 053, 056; ILPLA 188, 189.

Parasite species

Material deposited in the Colección de Helmintología Museo de La Plata (CHMLP) with the following numbers:

**Litomosoides bonaerensis**—CHMLP 4610

**Litomosoides oxymycteri**—CHMLP 4611

**Trichuris laevitestis**—CHMLP 5625-5629.

**Syphacia carlitosi**—CHMLP 5545-5551.

Note: For revision of the specimens deposited in the Colección de Entomología Museo de La Plata (CEMLP) contact Dr. Norma Diaz with the numbers of the host collection above mentioned.