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EL ÚLTIMO NATURALISTA TIPÓLOGO:
CONTRIBUCIONES EN HONOR A ELIO MASSOIA (1936-2001)
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Artículo

LAELAPID MITES (MESOSTIGMATA) ECTOPARASITES OF *Oligoryzomys* (RODENTIA: CRICETIDAE) IN NORTH-EASTERN AND CENTRAL ARGENTINA

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ABSTRACT. Laelapidae mites are distributed throughout the world and include many species that are common parasites of cricetid rodents. Although knowledge of the host associations of laelapids is well recorded for the *Oligoryzomys* species in Buenos Aires province in Argentina, this information is scarce or null for other regions of the country and for some species of this genus. Here we report new records of laelapid mites associated with *Oligoryzomys flavescens*, *O. fornesi* and *O. nigripes*, obtained during collections carried out for more than a decade in north-eastern and central Argentina, covering a wide geographic range that includes sympatric sites for these rodents. Herein, laelapids associated with these rodents are reported for the first time in the provinces of Chaco and Formosa; and also for the first time records of laelapids in *O. fornesi*. All three rodent species are associated with the laelapids *Androlaelaps fahrenholzi*, *Gigantolaelaps wolffsohni*, *Mysolaelaps microspinosus* and *Mysolaelaps parvispinosus*. *Laelaps schatzi* is reported only for *O. flavescens* and *O. fornesi*, while *Laelaps paulistanensis* was exclusive to *O. nigripes*, regardless of locality. The results support the view that species reflect the distribution of each host, with the exception of *M. parvispinosus*. Information on the distribution of ectoparasites and their hosts is relevant to many biological questions, especially when the host and / or the ectoparasite play an important role in the transmission of pathogens of public health importance.

RESUMEN. Ácaros laelápidos (Mesostigmata) ectoparásitos de *Oligoryzomys* (Rodentia: Cricetidae) en el noreste y centro de la Argentina. Los ácaros Laelapidae están distribuidos en todo el mundo e incluyen muchas especies que son parásitos comunes de los roedores cricétidos. Si bien el conocimiento de las asociaciones hospedatorias de los lelápidos está bien registrado para las especies de *Oligoryzomys* en la Provincia de Buenos Aires de la Argentina, esta información es escasa o nula para otras regiones del país y para algunas especies de este género. Aquí reportamos nuevos registros de ácaros lelápidos asociados a *Oligoryzomys flavescens*, *O. fornesi* y *O. nigripes*, obtenidos durante colectas llevadas a cabo durante más de una década en el noreste y centro de la Argentina, cubriendo un amplio rango geográfico que incluye sitios de simpatría de estos roedores. Se mencionan por primera vez lelápidos asociados a estos roedores en las provincias del Chaco y Formosa, y también por primera vez registros de lelápidos en *O. fornesi*. Roedores de las tres especies se registran asociados a los lelápidos *Androlaelaps fahrenholzi*, *Gigantolaelaps wolffsohni*, *Mysolaelaps microspinosus* y *Mysolaelaps parvispinosus*. *Laelaps schatzi* solo se reporta para *O. flavescens* y *O.*

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fornesi, mientras que *Laelaps paulistanensis* fue exclusivo de *O. nigripes*, independientemente de la localidad. Los resultados apoyan que todas las especies reflejan la distribución de cada hospedador, con la excepción de *M. parvispinosus*. La información actualizada sobre la distribución de los ectoparásitos y de sus hospedadores es relevante para muchas cuestiones biológicas, especialmente cuando el hospedador y / o el ectoparásito juegan un papel importante en la transmisión de patógenos con importancia sanitaria.

Palabras clave: Acari, distribución geográfica, Neotrópico, Sigmodontinae.
Key words: Acari, geographic distribution, Neotropics, Sigmodontinae.

INTRODUCTION

Laelapidae mites (Mesostigmata, Dermanyssoidea) are distributed worldwide and are one of the most common ectoparasites of cricetid rodents (Strandtmann & Wharton 1958; Radovsky 1969). Knowledge of South American laelapids was primarily established by the pioneering work of Fonseca (1936, 1958), who described about 20 species, established the genera of some and defined the taxonomic limits of others. In South America, the study of laelapids was initiated by high rates of small mammal collecting due to a bubonic plague outbreak in north-eastern Brazil in the 1930s, and the creation of the National Plague Service (Servicio Nacional de Peste – SNP) (Fonseca 1958). Thousands of rodents were captured and the ectoparasites collected from the host pelage were systematically distributed among specialists for their study (Fonseca 1958). Laelapids were sent to the collections of the Museu de Zoologia da Universidade de Estado de São Paulo and Instituto Butantan in Brazil and were studied by Flavio Oliveira Ribeiro da Fonseca. This author reported (1958) that from the 4510 rodents captured in north-eastern Brazil, almost 60% were parasitized with mesostigmatid mites. Out of them, only 1500 rodents were identified to species level, and some of these species were reported in association with between 13-19 laelapid species such as *Oligoryzomys nigripes* (Olfers, 1818) (cited as *O. eliurus* in Fonseca (1958)).

The study of laelapids in Argentina began in the early 1960s with Ricardo A. Mauri from the Administración Nacional de Laboratorios e Institutos de Salud "Dr. Carlos G. Malbrán" (ANLIS) located in the Ciudad Autónoma de Buenos Aires in Argentina, when the mammologist Elio Massoia collected ectoparasites from their rodent hosts and delivered them to specialists for their study (Mauri 1965). It is worth noting that Massoia started to mention host-laelapid associations identified by Mauri in his publications, which was unusual for that period of time. The rodent *O. nigripes* was among the first to have parasitological information reported. Indeed, Massoia inaugurated by the term "eto-ecología" which seems self-evident nowadays and is also called "integrative-biology" (Massoia & Fornes 1964, 1972). Massoia himself did not emphasize the need for recognition of his work in epistemological terms (Contreras Roqué 2019). His comprehensive way of working (from collecting the remains of nests and excrements and identifying predators and parasites, to captive breeding of rodents at home for better biological observations) resulted in numerous and in many cases the only existent contributions of the ecology and ethology of small mammals (Pardiñas & Cirignoli 2000; Contreras Roqué 2019).

After the death of the mammalogist Abel Fornes in 1972, Massoia honored his memory with the description of a new species *O. fornesi* Massoia, 1973 from the genus *Oligoryzomys* Bangs, 1900. In fact, the genus *Oligoryzomys* deserves special interest in Massoia's agenda and is still of current interest. Taxonomic uncertainties remain due to its genetic diversity and low morphological variation, including cryptic species (Weksler & Bonvicino 2015; Hurtado & D'elía 2019).

Oligoryzomys nigripes is distributed in eastern Brazil, Paraguay, Uruguay and Argentina, and shares important areas of sympatry with *O. flavescens* (Waterhouse, 1837). In Argentina, *O. nigripes* reaches its southern limit at Reserva El Destino in Buenos Aires province (Udrizar et al. 2005), and *O. flavescens* extends southwards to the southwest of Buenos Aires province and the northern limit of Patagonia (Weksler & Bonvicino 2015). In addition, in the northeast of Argentina, *O. flavescens* shares geographical range in sympatry with *O. fornesi* and parapatry with *O. nigripes* concentrated in a sector of the Humid Chaco in Formosa and Chaco provinces (Weksler & Bonvicino 2015; Pardiñas 2017a).

From a parasitological point of view, the wide distribution of *O. nigripes* and *O. flavescens* and the sympatric and partly allopatric distribution of all three species constitute an interesting model to study

host-parasite associations across their geographical range. The last two rodents share four mite genera: *Androlaelaps*, *Gigantolaelaps*, *Mysolaelps* and *Laelaps* (Fonseca 1958; Lareschi & Mauri 1998; Saraiva et al. 2012). For some of these mite genera, the degree of host specificity is debated (Gettinger 1987, 1992; Martins-Hatano et al. 2012; Silva-de La Fuente et al. 2020). While some laelapids are considered host-generalist parasites (Tipton et al. 1966; Furman 1972), others exhibit high host preference (e.g., Gettinger 1987, 1992; Martins-Hatano et al. 2012), with some of them species-specific to its sympatric hosts (Gettinger 1992; Lareschi & Galliari 2014). Few studies have analysed factors structuring host association of laelapids and rodent hosts in the Neotropics (e.g., Lareschi & Krasnov 2010; Linardi & Krasnov 2012). However, a comprehensive knowledge of the distribution of both host and mite is needed, especially when factors and patterns of distribution are studied to evaluate variation in the composition and structure of biological communities across space and/or over time (Krasnov et al. 2019).

Many cricetid rodent species and their laelapid associations have been identified and reported in Argentina, mainly for Buenos Aires province, while research in other areas of the country such as the northeast is scarce (see Lareschi & Mauri 1998). This is also the case for the genus *Oligoryzomys*, in particular because the previous surveys were conducted to explore the host-mite associations for all collected rodents rather than emphasizing a certain rodent genus. Consequently, this shows an uneven distribution of records for laelapid species associated with *Oligoryzomys* spp. In comparison with well-studied Buenos Aires province for the rodents *O. nigripes* and *O. flavescens* (Lareschi & Mauri 1998; Lareschi et al. 2003), only one locality record exists for the Entre Ríos province (Abba et al. 2001) and for Corrientes province (Lareschi et al. 2006b). There are scarce or no data of host-mite associations available where both rodents occur in sympatry, including Formosa and Chaco provinces. For other *Oligoryzomys* species from the same area, for example *O. fornesi*, the host-mite associations are yet unreported.

In this study we take the opportunity to honor Massoia's academic legacy by presenting an updated account of laelapid mites associated with *O. nigripes*, *O. fornesi* and *O. flavescens* from samples collected over a wide geographical range in north-eastern and central Argentina over a decade.

MATERIAL AND METHODS

Mites were collected between 2007 and 2019 from *O. nigripes*, *O. flavescens* and *O. fornesi* from in 35 localities situated in Pampas, Espinal, Esteros del Iberá, Campos y Malezales, Chaco Húmedo, and Selva Parananense ecoregions (Burkart et al. 1999) located in six political provinces as detailed in **Table** 1 and in **Fig**. 1.

Rodents were identified by Ulyses Pardiñas (IDEAus) and Carlos Galliari (CEPAVE) and are housed at the Colección de Mamíferos del Centro Nacional Patagónico (CNP; Puerto Madryn, Chubut province, Argentina). Several specimens were used in genetic studies and their specific identifications were confirmed by molecular markers (Raúl González-Ittig, IDEA, unpublished data). We followed Teta et al. (2013); Pardiñas (2017a,b); Rivera et al. (2018), among others, for *Oligoryzomys* spp. distributed in north-western Argentina. Rodents from Jujuy, Tucumán and La Rioja provinces mentioned in the literature and reported as *O. longicaudatus* Bennett, 1832 and *O. destructor* Tschudi, 1844 (Autino et al. 2003) or *O. f. occidentalis* (López Berrizbeitia et al. 2013) are here recognized as *O. brendae* Massoia, 1998. We also followed Rivera et al. (2018) for the *O. flavescens* populations distributed in western Argentina and refer to them as *O. f. occidentalis* Contreras & Rosi, 1980. This was the case for species reported in Tucumán, La Rioja and Jujuy provinces (e.g., Mauri 1965).

Mites preserved in vials with 96% ethanol were cleared in lactophenol and mounted individually in Hoyers medium for their identification in accordance with the original descriptions and drawings (Fonseca 1936, 1958) and keys provided by Tipton et al. (1966) and Furman (1971, 1972). Representative mites collected from every host species in each locality will be deposited at the Colección de Entomología del Museo de La Plata, Argentina (MLP). Laelapids have a holding number, which consists of the same field (e.g., CG, LTU, UP) or deposition acronym (e.g., CNP) as the hosts; for each individual mite of a single host a number was added and the letter M for mite, separated by a hyphen and MLP for Museo de la Plata (e.g., MLP-CNP6314/M3). A list of laelapid species is presented below with data about host species in each locality and number of specimens, all of them females. A brief report is also included with comments on the previous known geographical distribution and host associations with the emphasis on the genus *Oligoryzomys*.

RESULTS AND DISCUSSION

Subclass Acari
Order Mesostigmata
Family Laelapidae Berlese, 1892
Subfamily Laelapinae Berlese, 1892
Genus *Androlaelaps* Berlese, 1903
Androlaelaps fahrenholzi (Berlese, 1911)
Type host: Unidentified host described as "Wild rat"
Type-locality: Urbana, Illinois, USA
Material examined: 45 specimens.
Oligoryzomys flavescens: 12 specimens collected from BS1 (MLP-ROB128/M1, MLP-ROB130/M1), BS3 (MLP-CG/931/M1, MLP-CG930/M1), BS4

Table 1

Thirty five localities abbreviated and numbered consecutively corresponding to six political provinces in Argentina, indicated as: BS= Buenos Aires, ER= Entre Ríos, CH= del Chaco; CO= Corrientes, FO= Formosa, MI= Misiones and the corresponding ecoregion. Each locality name is abbreviated according to the province. Further abbreviations are used as: RP = Ruta Provincial, RN = Ruta Nacional, Aº = Arroyo, Ea = Estancia, FSVA = Fundación Vida Silvestre, PP = Parque Provincial, RUM = Reserva de Usos Múltiples, RB = Reserva de la Biósfera.

N°	Ecoregion	Locality	Latitude S	Longitude W
BS1	Pampas	RP 76 km 225	-38.0790	-62.0053
BS2	Pampas	A° de las Brusquitas y RP 11	-38.2332	-57.7790
BS3	Pampas	Laguna Chascomús	-35.5440	-58.0796
BS4	Pampas	Calle 143 y Diagonal 630, Arana	-35.0070	-57.9093
BS5	Pampas	Balneario La Balandra	-34.9293	-57.7162
BS6	Pampas	Pereyra	-34.8372	-58.0898
ER1	Pampas	A° Ana y RP 130, Villa Elisa	-32.1212	-58.4500
ER2	Pampas	RP 130, 2.5 km al NW de Villa Elisa	-32.1541	-58.3362
ER3	Espinal	Ea. Santa Ana de Carpinchori	-30.6806	-58.7056
CO1	Esteros del Iberá	Ea. San Juan Poriahú	-27.7097	-57.1888
CO2	Campos y Malezales	Paraje Atalaya, 4 km al N de Santo Tomé	-28.5014	-56.0344
CO3	Delta e Islas del Paraná	Paraje El Carmen, Esquina	-29.6167	-58.9833
CO4	Delta e Islas del Paraná	Parque Provincial San Cayetano	-27.5455	-58.6760
CO5	Esteros del Iberá	Portal San Nicolás, PN Iberá	-28.1286	-57.4343
CO6	Campos y Malezales	Reserva Santo Domingo, 20 km al N de Paso de los Libres	-29.6056	-56.9903
CO7	Campos y Malezales	Ea. La Higuera Cué, Cerro Nazareno, La Cruz	-29.1098	-56.9306
CO8	Esteros del Iberá	RP 118, km 169	-27.6863	-57.2116
CO9	Esteros del Iberá	RP 94 y Arroyo Pariopá	-28.4482	-56.0098
CH1	Chaco Húmedo	7 km S Puerto Las Palmas	-27.1613	-58.6742
CH2	Chaco Húmedo	5 km NW de Puerto Las Palmas	-27.0792	-58.6684
CH3	Chaco Húmedo	RP 33, 7 km al N de Selvas del Río de Oro	-26.7414	-58.9815
CH4	Chaco Húmedo	RP 48 y río de Oro, 7,8 km al E de Pampa Almirón	-26.7252	-59.0491
FO1	Chaco Húmedo	Ea. de Animales Silvestres Guaycolec	-25.9804	-58.1637
FO2	Chaco Húmedo	INTA IPAF-NEA, Laguna Naineck	-25.2028	-58.1205
MI1		Ea. Santa Inés, RP 105, Km 8.5	-27.5331	-55.8729
MI2	Selva Paranaense	PP Piñalito	-26.4278	-53.8440
MI3	Selva Paranaense	Campo Anexo M. Belgrano, INTA, San Antonio	-26.0479	-53.7725
MI4	Selva Paranaense	Refugio Moconá, margen derecha del A° Oveja Negra	-27.1414	-53.9279
MI5	Selva Paranaense	RUM Guaraní	-26.9189	-54.2231
MI6	Selva Paranaense	Reserva de Vida Silvestre Urugua-í, FVSA	-25.9733	-54.1161
MI7	Selva Paranaense	RP 19 y A° Uruzú, PP Urugua-í	-25.8610	-54.1674
MI8	Selva Paranaense	RP 19, 5.1 km al NE del cruce con el A°Uruzú, PP Urugua-í	-25.8287	-54.1294
MI9	Selva Paranaense	RP2, 6 km NE A° Paraíso	-27.2133	-54.0333
MI10	Selva Paranaense	Sendero de la Gruta, PP Moconá, RB Yabotí	-27.1565	-53.9029
MI11	Selva Paranaense	Salto El Paraíso, 1 km aguas arribe RP 2 y A° Paraíso	-27.2305	-54.0194

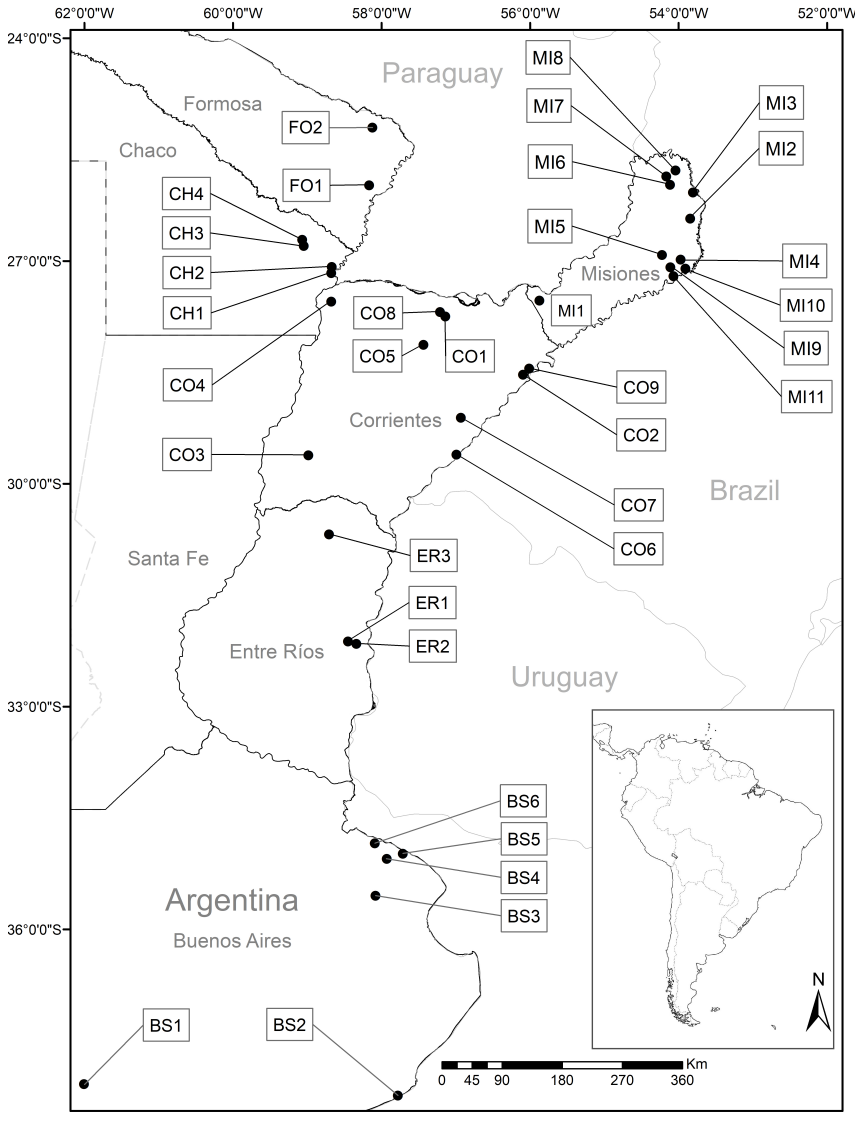

Fig. 1. Localities corresponding to six political provinces: Buenos Aires (BS), Entre Ríos (ER), Corrientes (CO), del Chaco (CH), Formosa (FO) and Misiones (MI). Each locality name is abbreviated according to the province.

(MLP-CG688/M1, MLP-MK131/M1), BS6 (MLP-CNP6316/M1, MLP-LTU585/M1), CO1 (MLP-CNP5989/M1), ER1 (MLP-CG878/M1), ER2 (MLP-CG860/M1), and M12 (MLP-CG783/M1).

Oligoryzomys fornesi: 4 specimens collected from CH2 (MLP-CG404/M1), CH4 (MLP-CG408/M1, MLP-CNP5277/M1), and FO2 (MLP-LTU581/M1).

Oligoryzomys nigripes: 29 specimens collected from BS5 (MLP-CG919/M1, MLP-MK065/M1), CH1 (MLP-CNP1748/M1-M2,) CO4 (MLP-LTU422/M1-M2), CO5 (MLP-CNP5640/M1-M2), CO6 (MLP-CNP4737/M1, MLP-CNP5089/M1), FO1 (MLP-CG96/M1-M2), MI11 (MLP-CNP5725/M1-M2) MI2 (MLP-CG803/M1-M2), MI3 (MLP-CNP4281/M1-M2), MI4 (MLP-CNP6005/M1-M2),

MI5 (MLP-CNP5634/M1), MI6 (MLP-CG476/M1-M2, MI7 (MLP-CNP4822/M1-M2), MI8 (MLP-CG602/M1-M2), and MI9 (MLP-CNP5973/M1-M2).

Remarks: *Androlaelaps fahrenholzi* presents a cosmopolitan distribution and a high variety of associations with rodents (Muridae, Cricetidae, Heteromyidae, Echimyidae, Sciuridae), marsupials (Didelphidae), and some birds (Strandtmann & Wharton 1958; Tipton et al. 1966; Furman 1972). Among *Oligoryzomys* species, *A. fahrenholzi* has been reported in association with *O. nigripes* in southern Brazil (Foz do Iguaçu) (Barros et al. 1993) and Uruguay (Lareschi et al. 2006b), and in Panama associated with *Oligoryzomys fulvescens* (Saussure, 1860) (Tipton et al. 1966). Also, in central and northern Argentina *A. fahrenholzi* was reported from a variety of mammals (Lareschi & Mauri 1998; Autino et al. 2003; Lareschi et al. 2003, 2019). *O. flavescens* and *O. nigripes* were reported as hosts of *A. fahrenholzi* in Buenos Aires and Entre Ríos provinces (Mauri 1965; Abba et al. 2001; Lareschi et al. 2003). The southern limit of *A. fahrenholzi* is located in Miramar associated with a variety of hosts including *O. flavescens* (Mauri 1965). Herein *A. fahrenholzi* is reported for the first time associated with *O. flavescens* and *O. nigripes* in the provinces of Corrientes, Misiones as well as in Formosa province with *O. nigripes*. In addition, *O. fornesi* is reported as a new host for *A. fahrenholzi* in Formosa, Corrientes and Chaco provinces. The new records extend the known distribution of the association *O. nigripes* - *A. fahrenholzi* from northeastern Buenos Aires province farther northeast to Corrientes and Misiones and similarly for *O. flavescens* - *A. fahrenholzi* including Entre Ríos province.

Additionally, the known southern limit of *O. flavescens* - *A. fahrenholzi* (Miramar) (Mauri 1965) is extended 460 km farther southeast to Sierra de la Ventana. This is the southern-most record for the species. Through the association with *O. fornesi* the known distribution of *A. fahrenholzi* in Argentina extends farther northwest for both *O. nigripes* and *O. fornesi* to Chaco and Formosa provinces.

Genus *Gigantolaelaps* Fonseca, 1939.
Gigantolaelaps wolffsohni (Oudemans, 1910)
Type-host: An unidentified rat
Type locality: Near Valparaíso, Chile.
Material examined: 77 specimens.
Oligoryzomys flavescens: 30 specimens collected from BS1 (MLP-ROB10/M1-M2), BS2 (MLP-CNP6022/M1-M2), BS3 (MLP-CG930/M2-M3) BS4 (MLP-CG655/M1), BS5 (MLP-CG914/M1), BS6 (MLP-CNP6314/M6), CH1 (MLP-LTU585/M2), CO1 (MLP-CNP5960/M2-M3), CO3 (MLP-CNP5751/M1-M2), CO4 (MLP-CNP6004/M4-M5), CO5 (MLP-CNP5631/M1-M2), CO6 (MLP-CG383/M1-M2), ER1 (MLP-CG878/M2-M3), ER2 (MLP-CG860/M1-M2), ER3 (MLP-CNP5966/M1-M2), M1 (MLP-CNP5797/M1-M2), and MI2 (MLP-CG783/1M2-M3).
Oligoryzomys fornesi: 9 specimens collected from CH3 (MLP-CG404/M2), CH3 (MLP-CG404/M3), CH4 (MLP-CG408/M2), CO4 (MLP-CNP5617/M1-M2), FO1 (MLP-CNP5277/M2-M3), FO1 (MLP-CNP5277/M3), and FO2 (MLP-LTU581/M2-M3).
Oligoryzomys nigripes: 38 specimens collected from: BS5 (MLP-CG919/M2), CO1 (MLP-CNP5963/M1-M2), CO4 (MLP-LTU422/M3), CO5 (MLP-CNP4720/M1-M2), CO5 (MLP-CNP5640/M3-M4), CO6 (MLP-CNP5089/M2-M3), CO7 (MLP-CG609/M1-M2), CO8 (MLP-LTU409/M1-M2), CO9 (MLP-CNP5604/M1-M2), FO1 (MLP-CG96/M3-M4), MI1 (MLP-CG736/M1-M2), MI2 (MLP-CG803/M3-M4), MI3 (MLP-CNP5212/M1-M2), MI4 (MLP-LTU831/M1-M2), MI5 (MLP-CNP5800/M1-M2), MI6 (MLP-CNP4647/M1-M2), MI7 (MLP-CNP4822/M3-M4), MI8 (MLP-CG602/M3-M4), MI9 (MLP-CNP5973/M3-M4), and MI11 (MLP-CNP5974/M1-M2).

Remarks: *Gigantolaelaps wolffsohni* has a neotropical distribution and has been reported from Brazil, Venezuela, Chile (Lareschi & González-Acuña 2010), Uruguay (Lareschi et al. 2006b) and Panama (Tipton et al. 1966), mainly associated with oryzomyine species (Fonseca 1958; Furman 1972). Regarding the hosts of the present study in other countries, *G. wolffsohni* was reported in association with *O. nigripes* in north-eastern and southern Brazil (Gettinger 1987; Barros et al. 1993) and in association with *O. nigripes* and *O. flavescens* in Uruguay (Lareschi et al. 2006b). Also in Argentina, *G. wolffsohni* was registered in Buenos Aires province parasitizing *O. flavescens* and *O. nigripes* (Mauri 1965; Lareschi & Mauri 1998; Lareschi et al. 2003) with the southern limit in Miramar (Mauri 1965). Furthermore, the association between *O. flavescens* and *G. wolffsohni* was also reported in Villa Elisa (Entre Ríos province), San Juan Poriahú (Corrientes province) (Lareschi et al. 2006b) and Santa Inés (Misiones province) (Lareschi et al. 2019), where *G. wolffsohni* was reported parasitizing both *O. flavescens* and *O. nigripes*. Further associations with *Oligoryzomys* spp. for *G. wolffsohni* were reported for north-western Argentina in Tucumán province with *O. brendae* (Autino et al.

2003). Moreover, *G. wolffsohni* is reported from "rata silvestre" from San Pedro, Jujuy province (Mauri 1965; Lareschi & Mauri 1998). Also, in our study *G. wolffsohni* was collected from all three *Oligoryzomys* species, demonstrating a wide geographical distribution, and reflecting the distributional pattern of each host. Hence, we report the new association *O. fornesi* - *G. wolffsohni* for Chaco, Corrientes and Formosa provinces. Also this is the first report of the associations *O. nigripes* - *G. wolffsohni* for Corrientes and Formosa provinces, and *O. flavescens* - *G. wolffsohni* for Chaco province. Furthermore, the known southern limit in Argentina (Miramar) (Mauri 1965) of *O. flavescens* - *G. wolffsohni* is extended 460 km farther southeast to Sierra de la Ventana. The known northern limit of *G. wolffsohni* in Misiones province (Santa Inés) (Lareschi et al. 2019) is herein extended 300 km farther north for *O. nigripes* and *O. flavescens*. Additionally, new records in Corrientes province (associated with all three species) amplify the distribution comprehensively to the previously known locality San Juan Poriahú (Lareschi et al. 2006b). Thus, our study supports a broad geographical range of the association between *O. nigripes, O. flavescens* and *G. wolffsohni* from north-eastern Brazil, connecting with Uruguay and almost reaching the southern limit of each host's distribution in Argentina. The association between *O. fornesi* and *G. wolffsohni* confirms the preference for the tribe Oryzomyini mentioned above (Gettinger 1987; Barros et al. 1993).

Genus *Laelaps* Koch, 1836

Laelaps paulistanensis Fonseca, 1936

Type host: unidentified "wild rat" with the number N270

Type locality: São Paulo, Brazil

Material examined: 43 specimens.

Oligoryzomys nigripes: 43 specimens collected from: BS5 MLP-CG919/M3), CH1 (MLP-CNP1748/M3-M4), CH2 (MLP-CNP6252/M1-M2), CO1 (MLP-CNP5963/M3-M3), CO4 (MLP-LTU422/M4-M5), CO5 (MLP-CNP5640/M5-M6), CO6 (MLP-CNP4737/M1), CO7 (MLP-CG608/M1-M2), CO8 (MLP-LTU409/M3-M4), CO9 (MLP-CNP6016/M1-M2), FO1 (MLP-CG96/M5-M6), MI1 (MLP-CG736/M4-M5), MI2 (MLP-CG803/M5-M6), MI3 (MLP-CNP5212/M3-M4), MI4 (MLP-LTU831/M3-M4), MI5 (MLP-CNP5800/M3-M4), MI6 (MLP-CNP4647/M1-M2), MI7 (MLP-CNP4822/M5-M6), MI8 (MLP-CG602/M5-M6), MI9 (MLP-CNP5973/M5-M6), MI10 (MLP-CNP6017/M1-M2), and MI11 (MLP-CNP5725/M3-M4).

Remarks: *Laelaps paulistanensis* has a wide neotropical distribution, with records from north-eastern to southern Brazil (Fonseca 1958; Nieri-Bastos 2004; Saraiva et al. 2012), Panama (Tipton et al. 1966), Venezuela (Furman 1972) and Uruguay (Lareschi et al. 2006b). In Argentina, *L. paulistanensis* was reported mainly associated with *O. flavescens* and *O. nigripes*, and was extensively recorded from both species in Buenos Aires province (Mauri 1965; Lareschi & Mauri 1998; Lareschi et al. 2003). In addition, *L. paulistanensis* was reported from both species in Villa Elisa (Entre Ríos province) (Abba et al. 2001), San Juan Poriahú (Corrientes province) (Lareschi et al. 2006b) and in Santa Inés (Misiones province) (Lareschi et al. 2019). In north-western Argentina, *L. paulistanensis* was reported associated with *O. brendae* in Tucumán province (Autino et al. 2003) and *Euryoryzomys legatus* (Thomas, 1925) in Jujuy province (cited as *Oryzomys russatus* in Autino et al. 2003). There is also a record of *L. paulistanensis* associated presumably with *O. f. occidentalis* in Tucumán province (Mauri 1965) and in La Rioja province associated with *O. brendae* (López Berrizbeitia et al. 2013).

In our study, *L. paulistanensis* is reported exclusively associated with *O. nigripes*. The reports herein presented extend the known distribution of *L. paulistanensis* in Argentina from Santa Inés (Misiones province) about 300 km farther north to Parque Provincial Urugua-í (MI8, **Fig**. 1, **Table** 1), and farther northwest to provinces of Chaco and Formosa, where the species is recorded for the first time. Also, for Corrientes province, the association *O. nigripes* - *L. paulistanensis* in San Juan Poriahú (Lareschi et al. 2006b) is widely expanded with six new localities (**Fig**. 1, **Table** 1). Overall, the localities recorded in our study for *L. paulistanensis* collected from *O. nigripes* and the previous records for that host in Uruguay (Lareschi et al. 2006a) and Brazil (Fonseca 1958; Saraiva et al. 2012) reflect the distributional pattern of the host *O. nigripes*.

Laelaps schatzi Savchenko & Lareschi, 2019

Type host: *Oligoryzomys flavescens*

Type locality: Pereyra, Partido de Berazategui, Buenos Aires, Argentina -34.837178°; -58.089833°

Material examined: 19 specimens.

Oligoryzomys flavescens: 11 specimens collected in BS3 (MLP-CG930/M4-M5), CH1 (MLP-LTU585/M3), CO5 (MLP-CN5606/M1-M2), ER1 (MLP-CG855/M1-M2), M1 (MLP-CG775/M3-M4), and MI2 (MLP-CG805/M1-M2).

Oligoryzomys fornesi: 8 specimens collected in CH1 (MLP-CNP5609/M1), CH3 (MLP-CG404/M4-M5), CH4 (MLP-CG408/M3), CO5 (MLP-CNP5626/M1-M2), and FO1 (MLP-CNP5010/M1-M2).

Remarks: Previously, *L. schatzi* has only been reported associated with its type host, *O. flavescens*, in north-eastern Buenos Aires province, Estancia Santa Ana de Carpinchori, in Entre Ríos province, Parque Provincial San Cayetano and Estancia San Juan Poriahú in Corrientes province, and at Estancia Santa Inés, Misiones province (Savchenko & Lareschi 2019). This rodent was previously reported associated with a morphologically similar mite species, *L. paulistanensis* (Lareschi et al. 2006a, 2019). In the course of this work, we reviewed specimens collected from *O. flavescens* and reported as *L. paulistanensis* in Santa Inés (Misiones province) (Lareschi et al. 2019) and subsequently identified them as the recently described species, *L. schatzi*. Furthermore, in the locality La Balandra (Buenos Aires province) where *O. flavescens* - *L. paulistanensis* associations were previously reported (Lareschi et al. 2003), we could identify the only *O. flavescens* - *L. schatzi* relationship. An extensive review of the *O. flavescens* - *L. paulistanensis* association is needed.

Herein, we present a new host association between *L. schatzi* and *O. fornesi*, and in two new provinces, Chaco and Formosa. Also, *L. schatzi* is reported associated with *O. fornesi* in Corrientes province. Additionally, the association between *O. flavescens* and *L. schatzi* is newly reported for Chaco province. We also add further locality records for the association *O. flavescens* - *L. schatzi* for Entre Ríos and Misiones provinces. The habitat of both rodents is characterized by open vegetation and grasslands near water, and Massoia (1973) highlighted in the original description of *O. fornesi* its strong morphological resemblance to *O. flavescens*. Nevertheless, the taxonomic status of *O. fornesi* is still unclear, especially whether *O. fornesi* is a full (sister) species or a subspecies of *O. flavescens* and further morphological and cytogenetic data should be analyzed (Rivera et al. 2018). Only recently, *O. fornesi* was evaluated together with *O. flavescens* as part of the same species using unilocus delimitation methods and subsequently was considered as a junior subjective synonym of *O. flavescens* (Hurtado & D'elía 2019). At least from the parasitological point of view the composition of laelapid species herein reported support the close relationship of the two hosts and do not exhibit characteristics to differentiate between them. Regardless of the actual specific status of *O. fornesi* further review of specimens of *L. schatzi* collected from *O. fornesi* is needed to explore potential differences at the intraspecific level for the nominal mite species between both rodents. Until now, the distribution of *L. schatzi* association for both hosts is restricted to Argentina. Especially for *O. flavescens* it will be interesting to explore whether the association includes the entire distribution of the host in other countries.

Genus *Mysolaelaps* Fonseca, 1936

Mysolaelaps microspinosus Fonseca, 1936

Type-host. Undetermined rodent, captured with the host number (n°. 318)

Type-locality. São Paulo, Brazil.

Material examined: 38 specimens.

Oligoryzomys flavescens: 22 specimens collected from BS1 (MLP-ROB61/M1-M2), BS2 (MLP-CNP6022/M3-M4), BS3 (MLP-CG930/M6-M7), BS4 (MLP-CG690/M5), BS5 (MLP-CG914/M2), BS6 (MLP-CNP6314/M7), ER3 (MLP-CNP5990/M3-M4), CO1 (MLP-CNP5989/M2-M3), CO2 (MLP-CNP5780/M1), CO5 (MLP-CNP5631/M3-M4), CO6 (MLP-CG383/M3-M4), M1 (MLP-CG770/M1-M2), and MI2 (MLP-CG805/M3-M4).

Oligoryzomys fornesi: 9 specimens collected from CH3 (MLP-CG413/M1-M2), CH4 (MLP-CG408/M4-M5), CO5 (MLP-CNP5626/M3-M4), FO1 (MLP-CNP5010/M3-M4), and FO2 (MLP-LTU581/M4).

Oligoryzomys nigripes: 7 specimens collected from BS5 (MLP-MK132/M1), CO6 (MLP-CG380/M1-M2), MI4 (MLP-CNP6008/M1-M2), and MI8 (MLP-CG532/M1-M2).

Remarks: The distribution of *M. microspinosus* was restricted to south-eastern Brazil after a broad survey, primarily associated with *O. nigripes* and *O. mattogrossae* (Fonseca 1958). Subsequent reports in Brazil did not expand the area of distribution but confirmed the association between *O. nigripes* and *M. microspinosus* (Lopes et al. 1989; Linardi et al. 1991). In central and southern Chile (Lareschi & González-Acuña 2010) *M. microspinosus* is reported in association with *O. longicaudatus* and in Uruguay associated with *O. nigripes* and *O. flavescens* (Lareschi et al. 2006b). This report supports the strong association with the genus *Oligoryzomys*, although the species is distributed north to Venezuela is associated with other Oryzomyines (Furman 1972). In central Argentina, *M. microspinosus* was extensively reported in Buenos Aires province associated with *O. nigripes* and *O. flavescens* (Lareschi & Mauri 1998; Lareschi et al. 2003) with the southern limit for the latter association in Miramar (Mauri 1965), and furthermore in Villa Elisa (Entre Ríos province) associated with *O. flavescens* and *O. nigripes* (Abba et al. 2001). *Mysolaelaps microspinosus* was also reported in Tucumán province associated with *O. f. occidentalis* (cited as *O. flavescens* in Mauri 1965) and *O. brendae* (Mauri 1965; Autino et al. 2003)

and also associated with *O. brendae* in La Rioja province (López Berrizbeitia et al. 2013). Herein we report a new host of *M. microspinosus*, *O. fornesi*, in Corrientes, Chaco and Formosa provinces. The records for Chaco and Formosa provinces are reported for the first time. In addition, we report for the first time *M. microspinosus* associated with *O. flavescens* and *O. nigripes* in Corrientes and Misiones provinces. These reports extend about 300 km the known distribution of *M. microspinosus* in Argentina to the northernmost region in Misiones and in the northwest to Laguna Naineck (FO2, **Fig**. 1, **Table** 1) in Formosa province. Furthermore, *M. microspinosus* specimens from *O. flavescens* extend the known distribution of this mite in Argentina 460 km farther southeast to Sierra de la Ventana.

Mysolaelaps parvispinosus Fonseca, 1936

Type-host. Type species was described from two cotypes captured on a wild rat of undetermined species (°n. 226) and topotypes of rats (°ns. 269 and 270).

Type-locality. São Paulo, Brazil

Material examined: 44 specimens.

Oligoryzomys flavescens: 5 specimens collected from CO1 (MLP-CNP5960/M4), CO4 (MLP-CNP6004/M6), CO5 (MLP-CNP5631/M5), MI1 (MLP-CG751/M1), MI2 (MLP-CG805/M5).

Oligoryzomys fornesi: 9 specimens collected from CH3 (MLP-CG404/M6-M7), CO1 (MLP-CNP5962/M1), CO5 (MLP-CNP5626/M5-M6), FO1 (MLP-CG446/M1-M2), FO2 (MLP-LTU581/M5-M6).

Oligoryzomys nigripes: 30 specimens collected from CO4 (MLP-LTU422/M6-M7), CO6 (MLP-CNP4737/M2-M3), CO8 (MLP-LTU409/M5-M6), FO1 (MLP-CNP5084/M1-M2), MI1 (MLP-CG736/M6-M7), MI2 (MLP-CG803/M7-M8), MI3 (MLP-CNP5212/M5-M6), MI4 (MLP-CNP6025/M1-M2), MI5 (MLP-CNP5800/M5-M6), MI6 (MLP-CG591/M1-M2), MI7 (MLP-CG600/M1-M2), MI8 (MLP-CG602/M7-M8), MI9 (MLP-CNP5973/M7-M8), MI10 (MLP-CNP6017/M3-M4), and MI11 (MLP-CNP5974/M3-M4).

Remarks: The known distribution of *M. parvispinosus* reaches from northeast to south Brazil (Fonseca 1958; Nieri-Bastos 2004; Cruz et al. 2012), northern Peru (Lareschi & Velazco 2013), Venezuela (Furman 1972) and Panama (Tipton et al. 1966), primarily associated with *Oligoryzomys* spp. and some other oryzomyine species. In Brazil, one of the main reported hosts is *O. nigripes* (e.g., Fonseca 1958; Botelho & Williams 1980; Linardi et al. 1991; Barros et al. 1993). In Venezuela, *M. parvispinosus* was reported associated with several species from the Tribe Oryzomyini, mainly *O. fulvescens* (Furman 1972), and in Peru collected from *O. destructor* (Lareschi & Velazco 2013). In Argentina, *M. parvispinosus* was registered for the first time in Misiones province associated with *Oryzomys* sp. (Mauri 1982). Subsequently, *M. parvispinosus* was reported only two other times, in San Juan Poriahú, Corrientes province (Lareschi et al. 2006b) associated with *O. flavescens* and in Estancia Santa Inés, Misiones province (Lareschi et al. 2019) associated with *O. flavescens* and *O. nigripes*.

Herein, the association between *O. fornesi* and *M. parvispinosus* is reported for the first time, as well as the record of *M. parvispinosus* in Formosa and Chaco provinces. Considering the previous records for other *Oligoryzomys* species, these reports are not unexpected. Also, the known association with *O. nigripes* was extended to Formosa province. Furthermore, the report of *M. parvispinosus* with *O. nigripes* extends the known distribution of this association from Santa Inés (Misiones province) to about 300 km farther north and adds three new localities for Corrientes province. Therefore, in Argentina the new northern limit of the *O. nigripes* - *M. parvispinosus* relationship is Parque Provincial Urugua-í (MI8, **Fig**. 1, **Table** 1), and in the south in Paso de los Libres (CO6, **Fig**. 1, **Table** 1). This locality in Corrientes province is now the most southern report of the species *M. parvispinosus* (in this case associated with *O. nigripes*). Additionally, for Corrientes province, the known distribution of the association *O. flavescens* - *L. paulistanensis* in San Juan Poriahú (Lareschi et al. 2006b) is amplified with three new localities (**Fig**. 1, **Table** 1). Hence, *M. parvispinosus* broadly reflects the distribution of *O. nigripes* in Brazil, reaching Uruguay and Argentina. It is unknown why the species is not collected farther south in Entre Ríos and Buenos Aires provinces in the Pampas and Espinal ecoregions (Burkart et al. 1999), respectively, although the corresponding hosts are present there. Also in the north of Corrientes province, *M. parvispinosus* is encountered in various ecoregions including Delta e Islas del Paraná but is absent in the same ecoregion farther south of the province. Several biotic or abiotic factors (Krasnov et al. 2019) may play an important role in the distribution of *M. parvispinosus* but additional studies are needed to determine them.

CONCLUSION

The results obtained in this study present new host and locality records for laelapids associated with

species of *Oligoryzomys* from north-eastern and central Argentina. This paper presents the first records of all mentioned records for Formosa and Chaco provinces, as well as the host-mite associations for the rodent *O. fornesi*. Previous reports of mites associated with *O. fornesi* can be found for central Brazil (Gettinger 1987, 1992); however the taxonomy of the host species has been revised and most populations are now referred to *O. mattogrossae* (Allen, 1916) (see Weksler et al. 2017). Thus, these references from Brazil were not considered as host-mite records for the host *O. fornesi* and were interpreted as *O. mattogrossae*. Nevertheless, the host-mite associations presented for *O. fornesi,* distributed in Argentina, are reported for the first time.

The distribution of previously reported associations between *O. flavescens* and *O. nigripes* and corresponding laelapids is expanded to new provinces including Misiones, and new localities such as Corrientes province are now included. The three species of *Oligoryzomys* reported in the study were parasitized with *A. fahrenholzi, G. wolffsohni, M. microspinosus* and *M. parvispinosus. Laealps paulistanensis* was associated exclusively with *O. nigripes*, whereas *L. schatzi* was associated only with *O. flavescens* and *O. fornesi*. These mites have wide distributions in Argentina, some extending more than 1 500 km from Sierra de la Ventana to Parque Provincial Urugua-í, covering several of those ecoregions described by Burkart et al. (1999). A partial exception is *M. parvispinosus*, unrecorded in Espinal and Pampas ecoregions (in Buenos Aires and Entre Ríos provinces, respectively) but represented in Delta e Islas del Paraná although limited to the northern region of Corrientes province. Perhaps *M. parvispinosus* has a comparatively higher dependency to the environment than the other laelapid species. The decreasing gradient in temperature and humidity, from warm, subtropical climate in the north to temperate pampean conditions in the south may affect the development of the species. In any case, further studies are necessary to confirm this hypothesis.

Combined integrative work between mammalogists and parasitologists is needed and highly recommended to assure correct identification of both the host and the mite. Broad surveys of host-mite associations have enormous value for many biological questions (co-evolution, parasitism, factors of distributional patterns, host-specificity, etc.) as well as zoonotic studies. For instance, O. *nigripes* and *O. flavescens* are important as hosts of a group of viruses of the family Hantaviridae (Carbajo & Teta 2009; González-Ittig et al. 2014) which cause the Hantavirus Pulmonary Syndrome, a disease of high mortality in humans (Martinez et al. 2010). *Oligoryzomys flavescens* can also be associated with the bacterium *Leptospira interrogans*, responsible for Leptospirosis, a zoonotic systemic disease (Lovera et al. 2017).

The role of mesostigmatid mites in the circulation of some disease agents has lately received more attention globally, and is being attributed mainly to the members belonging to the family Laelapidae (Miťková et al. 2015). Especially the genus *Laelaps* has been shown to harbour rickettsial agents (Kuo et al. 2020). The list of host-mite associations presented here is an incentive to continue the research, as it raised many interesting questions to address in the future.

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