



## Predicting the distribution of *Omalonyx* (Mollusca: Pulmonata: Succineidae) species from literature review, museum databases and new sampling efforts in Brazil

Daniel Coscarelli<sup>1,2</sup>, Lângia C. Montresor<sup>3</sup>, Philip Russo<sup>4</sup>, Alan Lane de Melo<sup>2</sup> & Teofânia H.D.A. Vidigal<sup>1\*</sup> 

<sup>1</sup>Laboratório de Malacologia e Sistemática Molecular, Departamento de Zoologia, Universidade Federal de Minas Gerais, Av. Antônio Carlos, 6627, Pampulha, Belo Horizonte, MG, Brazil.

<sup>2</sup>Departamento de Parasitologia, Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, Av. Antônio Carlos, 6627, Pampulha, Belo Horizonte, MG, Brazil.

<sup>3</sup>Moluscário Lobato Paraense, Centro de Pesquisas René Rachou, Fiocruz, Av. Augusto de Lima, 1715, Barro Preto, Belo Horizonte, MG, Brazil.

<sup>4</sup>Laboratório de Aracnologia, Departamento de Zoologia, Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, Av. Antonio Carlos 6627 - Pampulha, Belo Horizonte, MG, Brazil.

\*Corresponding author: Teofânia H.D.A. Vidigal, email: [teofania.vidigal@gmail.com](mailto:teofania.vidigal@gmail.com)

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**Abstract:** Accurate distributional information is crucial for studies on systematics, biodiversity and conservation. To improve the knowledge regarding the geographical distribution of *Omalonyx* in South America, we present updated information based on data from a literature review, institutional collections and malacological surveys. All this information composed the dataset used to predict species distribution employing the Maximum Entropy Algorithm (MaxEnt). The model was run using data on species distribution, altitude and bioclimatic variables (WorldClim database). The model had consistent performance, and areas presenting similar conditions to areas where the species were recorded were considered areas of occurrence. The predicted occurrence areas included those that were already surveyed and those that are considered potential occurrence areas. The results demonstrate that the genus has widespread distribution in the Neotropical region and occurs in the tropical, temperate and arid regions of South America and Lesser Antilles. *Omalonyx* spp. were recorded in all South American countries and hydrographic regions. However, in some countries, there were only isolated records (ex: Colombia and Ecuador). Here, we also present the first record of *Omalonyx* spp. in four Brazilian States (Acre, Rondônia, Piauí, and Amapá). The genus was found in all hydrographic regions within Brazil and among 27 federative unities; it was absent from only two unities (Roraima State and Distrito Federal). This work contributes to the knowledge on *Omalonyx* spp. distribution and provides an important basis for the work of ecologists and taxonomists.

**Keywords:** *MaxEnt*, *niche model*, *species distribution*, *Modeling*, *Succineids*, *Neotropic*.

## Predição da distribuição de *Omalonyx* (Mollusca: Pulmonata: Succineidae) a partir da revisão da literatura, dados de museu e novo esforço amostral no Brasil

**Resumo:** A informação precisa sobre a distribuição é crucial para os estudos sobre sistemática, biodiversidade e conservação. Para melhorar o conhecimento sobre a distribuição geográfica de *Omalonyx* na América do Sul, apresentamos informações atualizadas com base em dados de revisão de literatura, coleções institucionais e pesquisas malacológicas. Toda essa informação compôs o conjunto de dados usado para predição da distribuição de espécies empregando o Algoritmo de Entropia Máxima (MaxEnt). O modelo foi executado usando dados de distribuição de espécies, altitude e variáveis bioclimáticas (banco de dados WorldClim). O modelo apresentou um desempenho consistente e as áreas que apresentaram condições semelhantes às áreas onde as espécies foram registradas, foram consideradas áreas de ocorrência. As áreas de ocorrências previstas incluíram aquelas que já foram pesquisadas e aquelas que são consideradas áreas de ocorrência potencial. Os resultados demonstram que o gênero tem uma distribuição Neotropical ampla e que ocorre nas regiões tropical, temperada e árida da América do Sul e nas Pequenas Antilhas. *Omalonyx* spp. foram registradas em todos os países e bacias sul-americanas. No entanto, em alguns países, apenas registros isolados foram encontrados (ex: Colômbia e Equador). Aqui, também apresentamos o primeiro registro de *Omalonyx* spp. em quatro estados brasileiros (Acre, Rondônia, Piauí e Amapá). O gênero foi encontrado em todas as regiões hidrográficas no

Brasil e nas 27 unidades federativas; sendo ausente em apenas duas unidades federativas (Estado de Roraima e Distrito Federal). Esse trabalho contribui para o conhecimento da distribuição das espécies de *Omalonyx* e fornece uma importante base para trabalhos de ecólogos e taxonomistas.

**Palavras chave:** *MaxEnt*, *modelagem de nichos*, *distribuição de espécies*, *Modelagem*, *Succineídeos*, *Neotrópico*.

## Introduction

The genus *Omalonyx* d'Orbigny, 1837 presents a reduced shell and represents one of the slug-like lineages within the family Succineidae (Patterson 1971, Tillier 1981, Barker 2001). The earliest fossil records of Succineidae were from the Tertiary of Europe and, currently, most of the diversity within the family occurs in the islands of the Pacific, in the Indian subcontinent and the Americas (Barker 2001). These Neotropical slugs are terrestrial, live on aquatic macrophytes or riparian vegetation and can also be found in humid soil (Garcia et al. 2012). They can act as agricultural plagues (Olazarri 1979, Garcia et al. 2012) and are agents in the control of water-cress (Poi de Neiff et al. 1977). They can also act as intermediate hosts of an avian trematode, *Leucochloridium* (Lutz 1921, Travassos 1928), in the wild and of the nematodes *Angiostrongylus costaricensis* and *A. vasorum* in the laboratory (Montresor et al. 2008, Mozzer et al. 2011).

Currently, it is assumed that the genus comprises six recognized species (Tillier 1980, 1981, Martínez 1993, Arruda & Thomé 2008a, b, Arruda et al. 2009, Coscarelli & Vidigal 2011): *Omalonyx convexus* (Martens, 1868), *Omalonyx unguis* (d'Orbigny, 1837), *Omalonyx brasiliensis* (Simroth, 1896), *Omalonyx matheroni* (Pontiez & Michaud, 1835), *Omalonyx geayi* Tillier, 1980, and *Omalonyx pattersonae* Tillier, 1981. However, identification of the species within this genus is greatly complicated by intraspecific morphological variation in the diagnostic characteristics such as the papillae on the internal surface of the penis, the insertion of the retractor muscle of the penis, the shape of papillae on the inner surface of the vagina and others (Tillier 1980, 1981, Martínez 1993, Arruda & Thomé 2008a, b, Arruda et al. 2009, Coscarelli & Vidigal 2011).

To improve taxonomic knowledge on *Omalonyx* species, studies encompassing morphological and molecular data are essential. However, the first step to elucidating these questions is to acquire knowledge on species geographical distribution. Accurate geographical distributional information is crucial to solve systematics and biogeographic problems and to drive conservation efforts. Species-distribution models infer potential distribution from data on observed distribution and from environmental variables related to the sites where occurrences were recorded (Bradie & Leung 2017). These models assume that climate ultimately restricts a species' distribution and summarize it with a number of climatic variables within the known range of the species, generating a bioclimatic profile. They play an important role as first filters in assessing the potential distribution of each species, improving the success of future sampling efforts and providing initial insight into the bioclimatic tolerance of different species (Beaumont et al. 2005, Rubio & Acosta 2011). These tools have also been applied in several conservation biology studies to identify areas with high species richness and to predict effects of climate change on species' distributions (Araújo & Rahbek 2006, Costa et al. 2010, Vogler et al. 2013).

There are several methods to model species distribution, and they may use presence/absence, abundance or presence-only data. Usually, species records have limited coverage and consist of presence-only data (Elith et al. 2011). The Maximum Entropy Algorithm (MaxEnt) presents high performance for modeling presence-only data and is widely used to model species distribution (Bradie & Leung 2017). Here, we use this method to improve the knowledge on the geographical distribution of *Omalonyx* spp., assembling literature data with specimens either collected in our surveys, from malacological collections or donated by partner laboratories. These data on species presence and the associated bioclimatic variables were

used to model species distribution, to investigate the main environmental factors related to the occurrence of *Omalonyx* species and to detect species with overlapping distribution areas. This work improves the knowledge on these slugs' distribution, providing information to propel advances in the morphological and molecular taxonomy of these neotropical succineids.

## Material and Methods

Literature data on *Omalonyx* was reviewed (until December 2016) in order to find records of its occurrence across the Neotropical region (see the topic *literature review* in the results). Institutions harboring preserved specimens were identified in the literature review and by onsite and virtual searching in institutional collections (Table 1), and information regarding the lot number and collection site was organized in two tables (Table 2 and 3). Donated specimens were also included in these tables (Table 2 and 3).

To investigate in detail the distribution of these slugs in Brazil, malacological surveys comprising all geographical regions (North, Northeast, Southeast, South and Central West) were conducted between 2006 and 2016 (permission from environmental agency: ICMBio/SISBIO no. 12113-3). Specimens were manually collected from wet soil and vegetation in the vicinity of freshwater systems. Voucher specimens were deposited in the malacological collection of the Laboratório de Malacologia e Sistemática Molecular (LMSM), at Universidade Federal de Minas Gerais, Minas Gerais, Brazil.

All localities from the literature review, museums, collections, donations and our own malacological surveys were listed (Table 2 and 3) and plotted on a map (Figure 1) using the software ArcGIS 10.4 (ArcGIS Desktop 10.4 Geostatistical Analyst, Environmental Systems Research Institute ESRI, 2016). The geographic position of the localities and the information about South American hydrography and geography were cross-checked with Google Earth, Global Gazetteer, Hydro web (a hydrologic information system of Agência Nacional de Águas - ANA, the national water resources agency of the Environment Ministry, Brazil). Information regarding the hydrography of Austral South America was obtained from Bonetto (1994).

Morphological identification of specimens collected in our malacological surveys was based on characteristics of the reproductive system according to the following literature: *O. convexus* (Hylton-Scott & Lapuente 1968, Hylton-Scott 1971, Tillier 1981, Arruda & Thomé 2008b), *O. unguis* (Coscarelli & Vidigal 2011), *O. matheroni*, *O. pattersonae* and *O. geayi* (Tillier 1981). Specific identification provided in the papers (literature review) and on the labels (museum specimens) was also used in this work. Some of these records were not identified to species level and are designated *Omalonyx* sp. Until 1981, there were several species of *Omalonyx*, now recognized as synonyms. Throughout the text, species are designated according to Tillier (1981) and Arruda & Thomé (2008a, b), where synonyms for the six valid *Omalonyx* species can be found. However, when consulting the topic references, the reader will find the former designation.

Data of occurrence (Table 2 and 3) were used to model the species geographic distributions using one topographic variable (altitude) and the nineteen bioclimatic variables derived from the WorldClim database v. 1.4 as showed by Vogler et al. (2013) (Table 4). The classifications of climate were based on Koppen-Geiger climate classification types for South America (Peel et al. 2007). Maps for the distribution of *O. matheroni*, *O. pattersonae*, *O. geayi*, *O. convexus* and *O. unguis* were produced.

**Table 1.** Institutions harbouring specimens of *Omalonyx* found after literature review, visits and virtual search in collections databases.

Abbreviation	Museum or collection name
ANSP	Academy of Natural Sciences of Philadelphia, Pennsylvania, United States of America.
BMNH	British Museum of Natural History, London, United Kingdom.
CM	Carnegie Museum, Pittsburgh, Pennsylvania, United States of America.
CMIOC*	Coleção de Moluscos do Instituto Oswaldo Cruz, Rio de Janeiro, Brazil.
FLMNH	Florida Museum of Natural, United States of America.
FMNH	Field Museum of Natural History, Chicago, Illinois, United States of America.
INPA*	Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil.
LMSM	Laboratório de Malacologia e Sistemática Molecular, Belo Horizonte, Minas Gerais, Brazil.
MACN	Museo Argentino de Ciencias Naturales, Bernardino Rivadavia, Buenos Aires, Argentina.
MCP	Museu de Ciências e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil.
MCNZ	Museu de Ciências Naturais, Fundação Zoobotânica do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil.
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, United States of America.
MIRR*	Museu Integrado de Roraima, Boa Vista; Roraima, Brazil.
MLP*	Museo de La Plata, La Plata, Argentina.
MNHCL	Museo Nacional de Historia Natural del Chile, Chile.
MHNG	Muséum d'Histoire Naturelle, Genève, Switzerland.
MNKMO	Museo de Historia Natural Noel Kempff Mercado, Santa Cruz de la Sierra, Bolivia.
MNHN	Muséum national d'Histoire naturelle, Paris, France.
MNHNM	Museo Nacional de Historia Natural de Montevideo, Uruguay.
MNRJ*	Museu Nacional da Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.
MPEG*	Museu Paraense Emílio Goeldi, Belém, Pará, Brazil.
MZUM	Museum of Zoology, University of Michigan, Ann Arbor, Michigan, United States of America.
MZUSP*	Museu de Zoologia da USP, São Paulo, São Paulo, Brazil.
RMNH	Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands
SMNH	Naturhistoriska Riksmuseet, Stockholm, Sweden.
UF	Florida Museum of Natural History (USA).
UFS	Universidade Federal de Sergipe, Aracajú, Sergipe, Brazil.
USDA	United States Department of Agriculture, Philadelphia, United States of America.
USMN	National Museum of Natural History, Smithsonian Institution, Washington, DC, United States of America.
ZMB	Museum für Naturkunde der Humboldt Universität, Berlin, Germany.
ZUECGAS	Museu de Zoologia da Universidade Estadual de Campinas, Campinas, São Paulo, Brazil.

Visited collections\*

**Table 2.** Records of *Omalonyx* in Brazil based on literature data, institutional collections, and our own malacological surveys.

Species	Region	Locality	Record	'Source	<sup>2</sup> Hydrographic Region	Coordinates
<i>O. matheroni</i>	North	Rio Branco, Acre	LMSM 3346, 3378-83, 3438	Survey	5	10° 31'48"S, 68° 18'54"W
<i>O. matheroni</i>	North	Nações Unidas Ave. Macapá, Amapá	LMSM 3205-07, 3216-17, 3144, 3146	Survey	4	0° 28'19.2"N, 51° 39'0"W
<i>O. matheroni</i>	North	Amazon River, Santana, Amapá	LMSM 3199, 3200-03, 3232-33	Survey	4	0° 33'50.4"N, 51°W 10'35.04"
<i>O. matheroni</i>	North	BR 156 Road, Calçoene, Amapá	LMSM 3215, 3220-21, 3145, 3147	Survey	4	2° 29'44.16"N, 50° 57'14.04"W"
<i>Omalonyx</i> sp.	North	Manicore, Amazonas	INPA 445	Museum	4	6° 27'35.28"S, 61° 26'47.4"W"
<i>Omalonyx</i> sp.	North	Novo Aripuanã, Amazonas	INPA 769, 779, 781, 785, 801, 802, 808 (Pimpão 2007)	Literature	5	6° 49'30"S, 60° 28'37.92"W
<i>Omalonyx</i> sp.	North	Juruá River, Amazonas	MZSP 18444, 31962	Museum	5	2° 44'19.68"S, 66° 45'41.76"W
<i>Omalonyx</i> sp.	North	Barurua Island, Amazonas	MZSP 18445	Museum	5	2° 31'48"S, 67° 21'59.76"W
<i>Omalonyx</i> sp.	North	Amaña Lake, Japurá River Basin, Amazonas	MZSP 31874	Museum	5	2° 35'53.16"S, 64° 39'47.16"W
<i>Omalonyx</i> sp.	North	Boca do Acre, Amazonas	MZSP 31881-83	Museum	5	8° 45'37.44"S, 68° 53'52.8"W
<i>Omalonyx</i> sp.	North	Manaus, Amazonas	INPA 575, 598, 614, 620, 858, 1081; MZSP 31963	Museum	5	3° 6'6.84"S, 60° 15'0"W
<i>O. pattersonae</i>	North	Itacotiara, Manaus, Amazonas	ANSP 109524	Museum	5	—
<i>Omalonyx</i> sp.	North	Marchantaria Island, Amazonas	INPA 522	Museum	5	3° 14'23.28"S, 59° 56'15.36"W
	North					
<i>O. geayi</i>	North	Careiro Marchantaria Island, Amazonas	MCNZ 30548 (Arruda et al. 2016)	Literature	5	3° 15'14.11"S, 59° 58'19.09"W
<i>Omalonyx</i> sp.	North	Parana Uauaçú, Amazonas	INPA 532	Museum	5	4° 18'50.04"S, 62° 9'55.08"W

Table 2. Continued...

Species	Region	Locality	Record	<sup>1</sup> Source	<sup>2</sup> Hydrographic Region	Coordinates
<i>O. matheroni</i>	North	Irاندوبا, Amazonas	LMSM 2270, 2276-77	Survey		3° 57'7.2"S, 60° 28'50.52"W
<i>O. matheroni</i>	North	Irاندوبا, Amazonas	INPA 551-2, 870	Museum	5	3° 57'7.2"S, 60° 28'50.52"W
<i>O. geayi</i>	North	Irاندوبا, Amazonas	INPA 1091 (Arruda et al. 2016)	Literature	5	3° 8'44.4768"S, 60° 15'26.6256"W
<i>O. matheroni</i>	North	Preto da Eva River, Amazonas	LMSM 2260, 2332-35	Survey	5	2° 31'47.64"S, 59° 38'17.52"W
<i>O. matheroni</i>	North	Preto da Eva River, Amazonas	INPA 1090 (Garcia et al. 2012)	Literature	5	2° 31'47.64"S, 59° 38'17.52"W
<i>Omalonyx</i> sp.	North	Preto da Eva River, Amazonas	INPA 1090 (Garcia et al. 2012)	Literature	5	2° 31'47.64"S, 59° 38'17.52"W
<i>O. pattersonae</i>	North	Preto da Eva River, Amazonas	LMSM 2260, 2332-35;	Survey	5	2° 31'47.64"S, 59° 38'17.52"W
<i>O. pattersonae</i>	North	Preto da Eva River, Amazonas	INPA 1090 (Garcia et al. 2012)	Literature	5	2° 31'47.64"S, 59° 38'17.52"W
<i>Omalonyx</i> sp.	North	Carauari, Amazonas	MCP 09184	Museum	5	5° 7'7.68"S, 67° 20'15.36"W
<i>O. geayi</i>	North	Carauari, Amazonas	INPA 1643; MCP 09183 (Arruda et al. 2016)	Literature	5	5° 7'7.68"S, 67° 20'15.36"W
<i>O. matheroni</i>	North		SMNH 1450 (Tillier 1981)	Literature		unespecified locality
<i>O. matheroni</i>	North	-	MHNG 53834.8 (Tillier 1981)	Literature		unespecified locality
<i>Omalonyx</i> sp.	North	Santarém, Pará	ZUECGAS 3313, 3215-3217; MZSP 31885	Museum	5	2°S 45°52.56", 55°W 56°16.8"
<i>O. matheroni</i>	North	Santarém, Pará	LMSM 2573-2579, 2583, 2646-49, 2663, 2670, 2761, 2765-67, 2789-94, 2835, 2849-76, 2910, 2930, 3234-36	Survey	5	2° 45'52.56"S, 55° 56'16.8"W
<i>O. matheroni</i>	North	Santarém, Pará	Lange de Morretes 1949; BMNH 1896.9.33 (Tillier 1981), Simone 2006	Literature	5	2° 45'52.56"S, 55° 56'16.8"W
<i>O. matheroni</i>	North	Alenquer, Pará	FMNH 29190 (Tillier 1981)	Literature	5	0° 32'10.68"S, 55° 41'56.4"W
<i>Omalonyx</i> sp.	North	Almerim, Pará	MZSP 31877	Museum	5	0° 17'56.4"N, 53° 53'37.68"W
<i>Omalonyx</i> sp.	North	Furo do Jurupari, Pará	MZSP 31879	Museum	5	2° 40'37.2"S, 53° 16'48"W
<i>Omalonyx</i> sp.	North	Lago Parú, Pará	MZSP 31959	Museum	5	1° 53'30.12"S, 55° 49'55.92"W
<i>O. matheroni</i>	North	Tucuruí, Pará	LMSM 2569, 2584-87, 2588, 2672, 2915-16	Survey	06/jul	3° 51'20.88"S, 49° 49'14.88"W
<i>O. matheroni</i>	North	Jurutí, Pará	LMSM 3151-52, 3168	Survey	5	2° 37'21.72"S, 56° 13'16.32"W
<i>O. matheroni</i>	North	Belém, Pará	LMSM 3230-31	Survey	7	1° 14'26.52"S, 48° 27'33.84"W
<i>O. matheroni</i>	North	Cereja River, Bragança, Pará	LMSM 4037-4043	Survey	7	1° 20'49.2"S, 46° 45'42.84"W
<i>O. pattersonae</i>	North	Cereja River, Bragança, Pará	LMSM 4037-4043	Survey	7	1° 20'49.2"S, 46° 45'42.84"W
<i>Omalonyx</i> sp.	North	Curuá, Pará	ZUECGAS 3204-9, 3210-4, 3218	Museum	7	1° 50'45.24"S, 55° 6'47.52"W
<i>O. matheroni</i>	North	Ji-Paraná, Rondônia	LMSM3360, 3362, 3367	Survey	5	10° 27'43.92"S, 61° 45'25.56"W
<i>O. matheroni</i>	North	Madeira River, Porto Velho, Rondônia	LMSM 3347-48, 3358-59, 3364-65, 3372-76, 3403-04, 3440	Survey	5	8° 46'14.16"S, 63° 54'29.16"W
<i>Omalonyx</i> sp.	Northeast	Malvina District, Arari, Maranhão	MNRJ 6305; CMIOC 9519 (Cantanhede et al. 2014)	Museum	7	3° 27'30.96"S, 44° 46'30"W
<i>Omalonyx</i> sp.	Northeast	Amaral Village, Monção, Maranhão	CMIOC 9409 (Cantanhede et al. 2014)	Literature	7	3° 30'7.92"S, 45° 16'33.6"W
<i>Omalonyx</i> sp.	Northeast	Palmeirândia, Maranhão	Cantanhede et al. 2014	Literature	7	2° 41'34.08"S, 45° 15'0"W
<i>Omalonyx</i> sp.	Northeast	Pedro do Rosário, Maranhão	Cantanhede et al. 2014	Literature	7	2° 59'20.76"S, 45° 25'48"W
<i>Omalonyx</i> sp.	Northeast	Peri-Mirim, Maranhão	Cantanhede et al. 2014	Literature	7	2° 34'18.12"S, 44° 53'43.44"W
<i>Omalonyx</i> sp.	Northeast	Santa Terezinha District, Pinheiro, Maranhão	CMIOC 9452-53 (Cantanhede et al. 2014)	Literature	7	2° 30'55.08"S, 45° 48'7.2"W
<i>Omalonyx</i> sp.	Northeast	Santa Helena, Maranhão	Cantanhede et al. 2014	Literature	7	2° 25'33.96"S, 45° 22'59.52"W
<i>Omalonyx</i> sp.	Northeast	Porto Grande District, São Bento, Maranhão	CMIOC 9471 (Cantanhede et al. 2014)	Literature	7	2° 42'0"S, 44° 49'21.36"W
<i>Omalonyx</i> sp.	Northeast	São João Batista, Maranhão	Cantanhede et al. 2014	Literature	7	3° 27'36"S, 44° 45'32.04"W
<i>Omalonyx</i> sp.	Northeast	Vitória do Mearim, Maranhão	Cantanhede et al. 2014	Literature	7	3° 34'26.4"S, 44° 55'24.96"W
<i>Omalonyx</i> sp.	Northeast	Parnaíba, Piauí	LMSM 4558-64	Survey	7	2° 57'37.8"S, 41° 45'12.96"W
<i>O. unguis</i>	Northeast	Baturité, Ceará	MNRJ 12382	Museum	7	4° 22'49.44"S, 38° 51'10.08"W
<i>O. matheroni</i>	Northeast	Fortaleza, Ceará	LMSM 2027-29, 4579-4580	Survey	7	3° 47'10.32"S, 38° 31'38.64"W
<i>Omalonyx</i> sp.	Northeast	Fortaleza, Ceará	LMSM 2027-29, 4579-4580	Survey	7	3° 47'10.32"S, 38° 31'38.64"W
<i>Omalonyx</i> sp.	Northeast	Redenção, Ceará	CMIOC 5155	Museum	7	4° 14'57.48"S, 38° 45'56.52"W
<i>Omalonyx</i> sp.	Northeast	Sobral, Ceará	LMSM 4581-2	Survey	7	3° 42'54"S, 40° 20'58.92"W
<i>O. matheroni</i>	Northeast	Natal, Rio Grande do Norte	LMSM 2491, 2514, 2537, 2540-41, 3243	Survey	7	5° 48'11.88"S, 35° 13'44.4"W

Table 2. Continued...

Species	Region	Locality	Record	<sup>1</sup> Source	<sup>2</sup> Hydrographic Region	Coordinates
<i>O. pattersonae</i>	Northeast	Natal, Rio Grande do Norte	LMSM 2491, 2514, 2537, 2540-41, 3243	Survey	7	5° 48' 11.88"S, 35° 13' 44.4"W
<i>O. matheroni</i>	Northeast	Formosa Bay, Rio Grande do Norte	CMIOC 8569	Museum	7	6° 22' 15.24"S, 35° 30' 0"W
<i>Omalonyx</i> sp.	Northeast	João Pessoa, Paraíba	MZSP 41365	Museum	7	7° 9' 59.04"S, 34° 52' 10.92"W
<i>O. matheroni</i>	Northeast	Caruaru, Pernambuco	LMSM 2783, 2837, 2909	Survey	7	8° 10' 48"S, 36° 9' 54"W
<i>O. matheroni</i>	Northeast	Caruaru, Pernambuco	ANSPA18032- A18038 (Dutra-Clarke et al. 2001)	Literature	7	8° 10' 48"S, 36° 9' 54"W
<i>O. matheroni</i>	Northeast	Pernambuco	BMNH 1887.9.8.31 (Tillier 1981)	Literature	8	8° 28' 56.64"S, 37° 46' 21.72"W
<i>Omalonyx</i> sp.	Northeast	Tacaratu, Pernambuco	MZSP 31960	Museum	7	8° 57' 24.48"S, 38° 45' 54"W
<i>Omalonyx</i> sp.	Northeast	Dois Irmãos Zoo, Recife, Pernambuco	MZSP 31967, 47767-818, 48050	Museum	9	8° 6' 0"S, 34° 56' 51.36"W
<i>Omalonyx</i> sp.	Northeast	Maceió, Alagoas	MNRJ 32140	Museum	9	9° 31' 12.36"S, 35° 42' 37.08"W
<i>O. geayi</i>	Northeast	Satuba, Alagoas	ZMB 90832 (Arruda et. al. 2016)	Literature	7	9° 34' 23.1924"S, 35° 49' 31.8216"W
<i>O. pattersonae</i>	Northeast	Itabaiana, Sergipe	MCP 09276	Literature	9	10° 41' 9.24"S, 37° 25' 18.84"W
<i>O. convexus</i>	Northeast	Itabaiana, Sergipe	UFS 400, 403 (Jesus & Manso 2010)	Literature	9	10° 41' 9.24"S, 37° 25' 18.84"W
<i>O. matheroni</i>	Northeast	Tororó Dam, Salvador, Bahia	LMSM 3261-62	Survey	9	12° 59' 42"S, 38° 30' 22.32"W
<i>Omalonyx</i> sp.	Northeast	Tororó Dam, Salvador, Bahia	CMIOC 9865; MNRJ 50523	Museum	9	12° 59' 42"S, 38° 30' 22.32"W
<i>O. unguis</i>	Northeast	Tororó Dam, Salvador, Bahia	Moricand 1836; Hidalgo 1870, 1872	Literature	9	12° 59' 42"S, 38° 30' 22.32"W
<i>O. matheroni</i>	Northeast	Vila Nova, Bahia	Lange de Morretes 1949	Literature	9	17° 30' 14.04"S, 40° 30' 28.8"W
<i>Omalonyx</i> sp.	Northeast	Uruçuca, Bahia	MZSP 18443	Museum	9	14° 30' 58.32"S, 39° 13' 35.76"W
<i>Omalonyx</i> sp.	Northeast	Campo Formoso, Bahia	MZSP 31880	Museum	8	10° 15' 39.6"S, 40° 42' 33.84"W
<i>O. matheroni</i>	Northeast	Prado, Bahia	LMSM 2914	Survey	9	17° 7' 55.2"S, 39° 21' 7.56"W
<i>Omalonyx</i> sp.	Northeast	Esplanada, Bahia	CMIOC 7973	Museum	9	11° 56' 23.64"S, 37° 53' 10.68"W
<i>Omalonyx</i> sp.	Northeast	Entre Rios, Bahia	CMIOC 8083	Museum	9	12° 43' 26.4"S, 38° 25' 22.8"W
<i>Omalonyx</i> sp.	Northeast	Wenceslau Guimarães, Bahia	CMIOC 8803	Museum	9	13° 37' 49.44"S, 39° 37' 36.48"W
<i>O. matheroni</i>	Southeast	Maracás, Bahia	MNRJ 14021, 32138	Museum	9	13° 29' 50.64"S, 40° 33' 11.16"W
<i>Omalonyx</i> sp.	Southeast	Maracás, Bahia	MNRJ 14021, 32138	Museum	9	13° 29' 50.64"S, 40° 33' 11.16"W
<i>O. unguis</i>	Southeast	Mocambinho, Jaíba, Minas Gerais	Oliveira & Almeida 2000. CMIOC 4307	Literature Museum	8	16° 6' 53.64"S, 43° 58' 28.92"W
<i>O. unguis</i>	Southeast	Mocambinho, Jaíba, Minas Gerais	CMIOC 4307	Museum	8	16° 6' 53.64"S, 43° 58' 28.92"W
<i>O. matheroni</i>	Southeast	Caratinga Biological Station, Caratinga, Minas Gerais	Arruda et al. 2006, Montresor et al. 2008	Literature	9	19° 43' 21.36"S, 41° 48' 21.96"W
<i>O. matheroni</i>	Southeast	Caratinga Biological Station, Caratinga, Minas Gerais	LMSM 711, 712, 714, 731-33, 744-45, 747-48, 763	Survey	9	19° 43' 21.36"S, 41° 48' 21.96"W
<i>O. matheroni</i>	Southeast	Caratinga Biological Station, Caratinga, Minas Gerais	MZSP 35387	Museum	9	19° 43' 21.36"S, 41° 48' 21.96"W
<i>Omalonyx</i> sp.	Southeast	Teófilo Otoni, Minas Gerais	MZSP 18442, 31886; MNRJ 18365	Museum	9	17° 42' 55.08"S, 41° 23' 24"W
<i>O. matheroni</i>	Southeast	Pampulha Lake, Belo Horizonte, Minas Gerais	LMSM 1378-87, 2383, 2516, 2525, 2527, 2529, 2536, 2787, 2918, 2929, 3153-55, 3162-63, 3166, 3186, 3208-10; MCP 09277-9, 09192	Survey	8	19° 54' 10.08"S, 43° 57' 36.72"W
<i>O. matheroni</i>	Southeast	Rio Doce State Park, Marliéria, Minas Gerais	LMSM 1962-68, 2104-06, 2108; MNRJ 18365	Survey	9	19° 38' 41.64"S, 42° 32' 9.6"W
<i>Omalonyx</i> sp.	Southeast	Rio Doce State Park, Marliéria, Minas Gerais	MNRJ 18365	Museum	9	19° 38' 41.64"S, 42° 32' 9.6"W
<i>O. matheroni</i>	Southeast	Januária, Minas Gerais	LMSM 2526-27	Survey	8	15° 19' 13.8"S, 44° 50' 55.32"W
<i>O. matheroni</i>	Southeast	Nova Serrana, Minas Gerais	LMSM 713, 746	Survey	8	19° 51' 8.64"S, 44° 58' 27.84"W
<i>O. matheroni</i>	Southeast	Ipatinga, Minas Gerais	LMSM 3046	Survey	9	19° 26' 20.76"S, 42° 36' 14.4"W
<i>O. matheroni</i>	Southeast	Betim, Minas Gerais	LMSM 3079-81, 3097-99, 3101, 3105, 3147-48, 3164-65	Survey	8	19° 56' 51"S, 44° 11' 57.84"W
<i>Omalonyx</i> sp.	Southeast	Cachoeira Dourada, Minas Gerais	CMIOC 7098	Museum	10	18° 36' 25.92"S, 49° 28' 48.36"W

Table 2. Continued...

Species	Region	Locality	Record	<sup>1</sup> Source	<sup>2</sup> Hydrographic Region	Coordinates
<i>Omalonyx</i> sp.	Southeast	Ilha dos Frades District, Vitória, Espírito Santo	MZSP 31965	Museum	9	20° 18'7.92"S, 40° 16'40.44"W
<i>Omalonyx</i> sp.	Southeast	Serra, Espírito Santo	LMSM 3027 (Donation from CMIOC)	Donation	9	20° 7'41.16"S, 40° 18'6.48"W
<i>Omalonyx</i> sp.	Southeast	Rio de Janeiro, Rio de Janeiro	MNRJ 32143; 9617	Museum	9	22° 55'24.24"S, 43° 26'51.36"W
<i>O. unguis</i>	Southeast	Rio de Janeiro, Rio de Janeiro	Lutz 1921	Literature	9	22° 55'24.24"S, 43° 26'51.36"W
<i>O. unguis</i>	Southeast	Rio de Janeiro, Rio de Janeiro	MNRJ 1916, 2199, 57865, 12378-79; 12381	Museum	9	22° 55'24.24"S, 43° 26'51.36"W
<i>O. convexus</i>	Southeast	Rio de Janeiro, Rio de Janeiro	MCZ unnumber (Parodiz 1963); MNHN, Gaudichaud coll. 1833 (Tillier 1981)	Literature	9	22° 55'24.24"S, 43° 26'51.36"W
<i>O. matheroni</i>	Southeast	Rio de Janeiro, Rio de Janeiro	LMSM 412-16, 3512-16 (Donation from CMIOC).	Donation	9	22° 55'24.24"S, 43° 26'51.36"W
<i>O. unguis</i>	Southeast	Aruama, Rio de Janeiro	MNRJ 12380	Museum	9	22° 45'16.92"S, 42° 17'36.24"W
<i>Omalonyx</i> sp.	Southeast	Parati, Rio de Janeiro	LMSM 419 (Donation from CMIOC)	Donation	9	23° 8'56.76"S, 44° 42'20.16"W
<i>Omalonyx</i> sp.	Southeast	Ilha Grande, Rio de Janeiro	LMSM 420-421 (Donation from CMIOC)	Donation	9	23° 9'7.56"S, 44° 13'44.04"W
<i>Omalonyx</i> sp.	Southeast	Macaé, Rio de Janeiro	LMSM 422-25, 431-32 (Donation from CMIOC). MNRJ30737	Donation	9	22° 17'42"S, 41° 58'29.64"W
<i>Omalonyx</i> sp.	Southeast	Raiz da Serra, Rio de Janeiro	LMSM 417, 426-28 (Donation from CMIOC)	Donation	9	22° 34'12"S, 43° 11'12.48"W
<i>O. matheroni</i>	Southeast	Duque de Caxias, Rio de Janeiro	LMSM 841, 857-58 (Donation from CMIOC)	Donation	9	22° 37'56.28"S, 43° 18'0"W
<i>Omalonyx</i> sp.	Southeast	Pendotiba, Niterói, Rio de Janeiro	CMIOC3877	Museum	9	22° 54'45"S, 43° 42'28.8"W
<i>Omalonyx</i> sp.	Southeast	São Fidélis, Rio de Janeiro	CMIOC 7515	Museum	9	21° 39'36"S, 41° 47'16.08"W
<i>Omalonyx</i> sp.	Southeast	Pinheiral, Rio de Janeiro	MCP 09187-8	Museum	9	22° 32'31.56"S, 43° 59'57.84"W
<i>Omalonyx</i> sp.	Southeast	Lagoa do Campelo, Campos, Rio de Janeiro	MNRJ 32139	Museum	9	21° 39'10.8"S, 41° 9'59.4"W
<i>Omalonyx</i> sp.	Southeast	Carmo, Rio de Janeiro	MNRJ1911	Museum	9	21° 54'7.56"S, 42° 34'8.4"W
<i>O. convexus</i>	Southeast	Campo dos Goytacazes, Rio de Janeiro	MNRJ 30735, 30785	Museum	9	21° 45'44.28"S, 41° 19'44.4"W
<i>Omalonyx</i> sp.	Southeast	Campos dos Goytacazes, Rio de Janeiro	MNRJ 30735, 30785	Museum	9	21° 45'44.28"S, 41° 19'44.4"W
<i>Omalonyx</i> sp.	Southeast	Santo Antônio de Pádua, Rio de Janeiro	MNRJ 32141	Museum	9	21° 33'24.84"S, 42° 11'33.72"W
<i>Omalonyx</i> sp.	Southeast	Itaguaí, Rio de Janeiro	MNRJ 32144	Museum	9	22° 50'29.4"S, 43° 49'12"W
<i>Omalonyx</i> sp.	Southeast	Cambuci, Rio de Janeiro	MNRJ 32148	Museum	9	21° 29'48.12"S, 41° 54'52.2"W
<i>Omalonyx</i> sp.	Southeast	Osasco, São Paulo	MZSP 17071	Museum	10	23° 31'44.04"S, 46° 47'20.76"W
<i>Omalonyx</i> sp.	Southeast	São José do Rio Preto, São Paulo	MZSP 18441, 31878; MNRJ 32137, 14024	Museum	10	20° 47'51"S, 49° 21'29.88"W
<i>O. unguis</i>	Southeast	São José do Rio Preto, São Paulo	MZSP 18441, 31878; MNRJ 32137, 14024	Museum	10	20° 47'51"S, 49° 21'29.88"W
<i>Omalonyx</i> sp.	Southeast	Caçapava, São Paulo	MZSP 31865	Museum	10	23° 6'12.6"S, 45° 42'48.24"W
<i>Omalonyx</i> sp.	Southeast	Barueri, São Paulo	MZSP 31875, 47749-51, 47819-50, 47879	Museum	10	23° 30'18.72"S, 46° 52'35.4"W
<i>Omalonyx</i> sp.	Southeast	Tremembé, São Paulo	MZSP 31876	Museum	9	22° 56'25.8"S, 45° 36'13.32"W
<i>Omalonyx</i> sp.	Southeast	Lins, São Paulo	MZSP 31966	Museum	10	21° 38'58.92"S, 49° 40'59.16"W
<i>Omalonyx</i> sp.	Southeast	Colômbia, São Paulo	MZSP 32664	Museum	10	20° 15'59.76"S, 48° 43'16.32"W
<i>Omalonyx</i> sp.	Southeast	Taubaté, São Paulo	MZSP 45129, 47718-26, 47738-47, 47858-67, 47907-10, 47939-82, 47995-8017, 48049, 48053	Museum	9	23° 52'48"S, 45° 30'7.92"W
<i>Omalonyx</i> sp.	Southeast	Paulínia, São Paulo	MZSP 47727-37, 47752-66	Museum	10	22° 44'51.72"S, 47° 8'41.64"W
<i>Omalonyx</i> sp.	Southeast	Americana, São Paulo	MZSP 47938	Museum	10	22° 43'23.52"S, 47° 17'20.04"W
<i>Omalonyx</i> sp.	Southeast	Santo André, São Paulo	MZSP 32774 (Eduardo et al. 2012)	Literature	10	23° 43'41.88"S, 46° 26'28.68"W
<i>O. matheroni</i>	Southeast	Santo André, São Paulo	MZSP 32774 (Eduardo et al. 2012)	Literature	10	23° 43'41.88"S, 46° 26'28.68"W
<i>O. matheroni</i>	Southeast	Ibitinga Powerplant, Ibitinga, São Paulo	MCP 09120 (Arruda et al. 2009)	Literature	10	21° 45'28.08"S, 48° 59'30.12"W
<i>O. matheroni</i>	Central West	Santa Rita do Novo Destino, Goiás	LMSM 3241-42	Donation	8	14° 52'35.4"S, 49° 33'46.8"W

Predicting the Distribution of *Omalonyx* species

Table 2. Continued...

Species	Region	Locality	Record	<sup>1</sup> Source	<sup>2</sup> Hydrographic Region	Coordinates
<i>Omalonyx</i> sp.	Central West	Passo da Lontra, Mato Grosso do Sul	MZSP 41206	Museum	10	19° 34'29.28"S, 57° 22'40.8"W
<i>Omalonyx</i> sp.	Central West	Três Lagoas, Mato Grosso do Sul	MZSP 47748	Museum	10	20° 26'19.68"S, 52° 12'41.04"W
<i>O. unguis</i>	Central West	Campo Grande, Mato Grosso do Sul	LMSM 2747	Survey	10	20° 54'47.16"S, 54° 14'58.92"W
<i>O. unguis</i>	Central West	Miranda, Mato Grosso do Sul	LMSM 2705-07, 2739-42, 2769, 2780-81, 2788, 2797-99, 2898-99, 2900-08, 2911-13, 2917	Survey	10	20° 7'12.36"S, 56° 35'52.8"W
<i>O. unguis</i>	Central West	Transpantaneira Road, Mato Grosso	MNRJ 9969	Museum	10	16° 22'30"S, 56° 40'12"W
<i>O. unguis</i>	Central West	Transpantaneira Road, Poconé, Mato Grosso	LMSM 2673; LMSM 429-430 (Donation from CMIOC).	Donation	10	16° 22'30"S, 56° 40'12"W
<i>O. unguis</i>	Central West	Cáceres, Mato Grosso	LMSM 3334	Survey	10	16° 31'26.4"S, 57° 50'16.8"W
<i>O. unguis</i>	Central West	Várzea Grande, Mato Grosso	LMSM 3344	Survey	10	15° 33'23.4"S, 56° 16'53.04"W
<i>Omalonyx</i> sp.	Central West	Barão de Melgaço, Mato Grosso	LMSM 433 (Donation from CMIOC). CMIOC 9565	Donation Museum	10	16° 49'14.52"S, 56° 19'19.2"W
<i>Omalonyx</i> sp.	Central West	Barão de Melgaço, Mato Grosso	CMIOC 9565	Museum	10	16° 49'14.52"S, 56° 19'19.2"W
<i>Omalonyx</i> sp.	Central West	Manso Lake, Mato Grosso	LMSM 784-86, 791 (Donation from CMIOC)	Donation	10	15° 26'20.4"S, 55° 11'9.96"W
<i>Omalonyx</i> sp.	Central West	Chapada dos Guimarães, Mato Grosso	LMSM 3032 (Donation from CMIOC)	Donation	10	15° 6'30.24"S, 55° 32'22.92"W
<i>Omalonyx</i> sp.	Central West	Nobres, Mato Grosso	LMSM 3028, 3030 (Donation from CMIOC)	Donation	10	14° 21'51.12"S, 55° 46'48"W
<i>Omalonyx</i> sp.	Central West	Santo Antônio do Leverger, Mato Grosso	LMSM 3029 (Donation from CMIOC)	Donation	10	16° 27'23.4"S, 55° 26'22.92"W
<i>O. matheroni</i>	Central West	Barra do Garças, Mato Grosso	MCP 09189	Museum	10	15° 21'34.56"S, 52° 29'50.28"W
<i>O. matheroni</i>	South	Paranaguá, Paraná	MZSP 18440 (Arruda et al. 2009)	Literature	12	25° 32'39.48"S, 48° 32'47.4"W
<i>Omalonyx</i> sp.	South	Paranaguá, Paraná	MZSP 18440 (Arruda et al. 2009)	Literature	12	25° 32'39.48"S, 48° 32'47.4"W
<i>Omalonyx</i> sp.	South	Sete Quedas, Guaíra, Paraná	MZSP 31884	Museum	12	24° 48'25.2"S, 54° 15'12.24"W
<i>O. convexus</i>	South	Curitiba, Paraná	LMSM 2667, 2975, 2990-91, 3003, 3008, 3011	Survey	12	25° 28'41.16"S, 49° 17'17.16"W
<i>O. unguis</i>	South	Foz do Iguaçu, Paraná	LMSM 3260	Survey	12	25° 28'15.24"S, 54° 28'56.28"W
<i>O. unguis</i>	South	Foz do Iguaçu, Paraná	MNRJ 32146, 32205	Museum	12	25° 28'15.24"S, 54° 28'56.28"W
<i>O. unguis</i>	South	Foz do Iguaçu, Paraná	MNRJ 32146, 32205	Museum	12	25° 28'15.24"S, 54° 28'56.28"W
<i>O. convexus</i>	South	Araranguá, Santa Catarina	LMSM 1522, 2988-89, 3001-02, 3005-07	Survey	12	28° 56'33.36"S, 49° 28'22.08"W
<i>O. matheroni</i>	South	Near to Tironi Park, Piçarras, Santa Catarina	LMSM 3942, 4024-4028	Survey	12	26° 45'56.88"S, 48° 42'38.88"W
<i>O. convexus</i>	South	São João do Sul, Santa Catarina	MCP 09271 (Agudo-Padron 2008)	Literature	12	29° 12'22.32"S, 49° 48'46.08"W
<i>O. convexus</i>	South	Camboriú, Santa Catarina	Agudo-Padron 2008	Literature	12	27° 42'43.2"S, 48° 42'32.4"W
<i>O. convexus</i>	South	Paulo Lopez, Santa Catarina	Agudo-Padron 2008	Literature	12	27° 57'53.28"S, 48° 45'39.6"W
<i>O. convexus</i>	South	Criciúma, Santa Catarina	Agudo-Padron 2008	Literature	12	28° 42'59.04"S, 49° 22'49.8"W
<i>O. matheroni</i>	South	Biguaçu River, Biguaçu, Santa Catarina	LMSM 3507, 3508	Survey	12	27° 28'27.84"S, 48° 40'9.84"W
<i>O. convexus</i>	South	Florianópolis, Santa Catarina	MCP 09190-1	Museum	12	27° 24'24.12"S, 48° 25'45.84"W
<i>O. convexus</i>	South	Palhoça, Santa Catarina	MCP 09227	Museum	12	27° 46'44.76"S, 48° 40'15.6"W
<i>O. convexus</i>	South	Porto Alegre, Rio Grande do Sul	Martens 1868, Heynemann 1868; Lange de Morretes 1949; Tillier 1981, Simone 2006; MCNZ: 8058, 1524, 31590, 4439, 5501, 35546 (Arruda & Thomé 2011)	Literature	12	31° 14'58.56"S, 51° 30'37.08"W
<i>O. convexus</i>	South	Porto Alegre, Rio Grande do Sul	MCP 02066, 08834, 08837-8, 08849, 08842-3, 08845, 09273-4	Museum	12	31° 14'58.56"S, 51° 30'37.08"W
<i>O. convexus</i>	South	Camaquã, Rio Grande do Sul	Parodiz 1963; MCP 8841 (Arruda & Thomé 2011)	Literature	12	30° 55'21.36"S, 51° 47'18.6"W

Table 2. Continued...

Species	Region	Locality	Record	<sup>1</sup> Source	<sup>2</sup> Hydrographic Region	Coordinates
<i>Omalonyx</i> sp.	South	Camaquã, Rio Grande do Sul	MCP 09272; MZSP 7539	Museum	12	30° 55'21.36"S, 51° 47'18.6"W
<i>O. unguis</i>	South	São Leopoldo, Rio Grande do Sul	MCP 10247, 10240-1, 10291; MZSP 31961,18439	Museum	12	29° 45'19.08"S, 51° 8'42.72"W
<i>Omalonyx</i> sp.	South	São Leopoldo, Rio Grande do Sul	MCP 10247, 10240-1, 10291; MZSP 31961,18439	Museum	12	29° 45'19.08"S, 51° 8'42.72"W
<i>Omalonyx</i> sp.	South	Pelotas, Rio Grande do Sul	MZSP 31964	Museum	12	31° 34'7.68"S, 52° 21'38.16"W
<i>O. convexus</i>	South	Rio Grande, Rio Grande do Sul	MCP 08836 (Arruda & Thomé 2011)	Literature	12	32° 13'10.92"S, 52° 24'15.48"W
<i>O. convexus</i>	South	Viamão, Rio Grande do Sul	LMSM 2650-51, 2666, 2668-69, 2704, 2759, 2762-63, 2768, 2895-97	Survey	12	30° 10'12"S, 50° 52'10.56"W
<i>O. convexus</i>	South	Viamão, Rio Grande do Sul	MCNZ 2506 (Arruda & Thomé, 2011)	Literature	12	30° 10'12"S, 50° 52'10.56"W
<i>O. convexus</i>	South	Arambaré, Rio Grande do Sul	LMSM 3009-10, 3021-23, 3149-50, 3167, 3175, 3187	Survey	12	30° 55'9.12"S, 51° 34'42.6"W
<i>O. convexus</i>	South	Cachoeira do Sul, Rio Grande do Sul	MCP 08840 (Arruda & Thomé 2011)	Literature	12	30° 12'22.32"S, 52° 59'11.04"W
<i>O. convexus</i>	South	Santa Maria, Rio Grande do Sul	MCP 08829-31 (Arruda & Thomé 2011)	Literature	12	29° 47'56.4"S, 53° 49'29.28"W
<i>O. convexus</i>	South	Novo Hamburgo, Rio Grande do Sul	MCP 08848 (Arruda & Thomé 2011)	Literature	12	29° 44'6.72"S, 51° 29'13.2"W
<i>O. convexus</i>	South	Mampituba Stream, Torres, Rio Grande do Sul	MCP 08832 (Arruda & Thomé 2011);	Literature	12	29° 35'29.76"S, 49° 57'36"W
<i>O. convexus</i>	South	Mampituba Stream, Torres, Rio Grande do Sul	LMSM 3932-3941	Survey		29° 35'29.76"S, 49° 57'36"W
<i>O. convexus</i>	South	Cachoeirinha, Rio Grande do Sul	MCP 09548 (Agudo Padron 2012); MCP 08839 (Arruda & Thomé 2011)	Literature	12	29° 55'15.96"S, 51° 56'56.4"W
<i>O. convexus</i>	South	Vacaria, Rio Grande do Sul	MCNZ 7559 (Arruda & Thomé 2011)	Literature	12	28° 22'14.88"S, 50° 55'24.96"W
<i>O. convexus</i>	South	Sapiranga, Rio Grande do Sul	MCNZ 2877 (Arruda & Thomé 2011)	Literature	12	29° 36'50.4"S, 50° 59'43.8"W
<i>O. convexus</i>	South	Guaíba, Rio Grande do Sul	MCNZ 6000 (Arruda & Thomé 2011)	Literature	12	30° 10'39.36"S, 51° 26'9.6"W
<i>O. convexus</i>	South	Triunfo, Rio Grande do Sul	MCNZ 8058 (Arruda & Thomé 2011)	Literature	12	29° 50'37.32"S, 51° 34'17.04"W
<i>O. convexus</i>	South	Triunfo, Rio Grande do Sul	MCP 06487	Museum		
<i>O. convexus</i>	South	Triunfo, Rio Grande do Sul	MCP 06487	Museum	12	29° 50'37.32"S, 51° 34'17.04"W
<i>O. unguis</i>	South	Imbé, Rio Grande do Sul	MCNZ 31969 (Arruda & Thomé 2011)	Literature	12	29° 55'50.16"S, 50° 7'55.2"W
<i>O. convexus</i>	South	Capão do Corvo, Canoas, Rio Grande do Sul	MCNZ 597 (Arruda & Thomé 2011)	Literature	12	29° 54'48.24"S, 51° 10'37.2"W
<i>O. convexus</i>	South	Taquara, Rio Grande do Sul	MCNZ 2610 (Arruda & Thomé 2011)	Literature	12	29° 40'15.6"S, 50° 45'47.52"W
<i>O. convexus</i>	South	Portão, Rio Grande do Sul	MCNZ 3264 (Arruda & Thomé 2011)	Literature	12	29° 42'36"S, 51° 14'56.76"W
<i>O. convexus</i>	South	Estrela, Rio Grande do Sul	MCP 08844 (Arruda & Thomé 2011)	Literature	12	29° 30'33.48"S, 51° 55'11.64"W
<i>O. convexus</i>	South	Eldorado do Sul, Rio Grande do Sul	MCP 08835	Museum	12	30° 46'58.8"S, 51° 29'54.24"W
<i>Omalonyx</i> sp.	South	São Borja, Rio Grande do Sul	MCP 09270; MCP 08828; MCP 08835	Museum	10	28° 44'46.68"S, 55° 47'50.28"W
<i>O. convexus</i>	South	Mampituba, Rio Grande do Sul	MCP 08833	Museum	12	29° 15'43.92"S, 50° 13'12"W
<i>O. brasiliensis</i>	South	Rio Grande do Sul	ZMB 45.913 (Arruda & Thomé 2008a).	Literature	10/dez	29° 36'18.24"S 53° 12'10.25"W unespecified locality
<i>O. brasiliensis</i>	South	Rio Grande do Sul	MNRJ 57927, 57955	Museum	10/dez	29° 36'18.24"S 53° 12'10.25"W unespecified locality

Note: 1: Specimens from our malacological surveys in Brazil were deposited in LMSM and classified in the column source as "Survey"; Specimens that were donated by other researchers were deposited in LMSM and classified in the column source as "Donation"; 2: Hydrographic region numbers are according to Figure 1 and to the metadata information system of the water resources national agency - ANA - of the Environment Ministry, Brazil and to Bonetto 1994).



**Table 3.** Records of *Omalonyx* in South America and Lesser Antilles based on literature data, institutional collections and our own malacological surveys.

Species	Country	Locality	<sup>1</sup> Record	<sup>2</sup> Source	<sup>3</sup> Hydrographic Region	Coordinates
<i>O. unguis</i>	Argentina	Rio Santiago, Buenos Aires	MACN 10218-1 (Hylton-Scott 1968); MACN 10208; 10268; MLP 31321 (Arruda & Thomé 2008b), Coscarelli & Vidigal 2011	Literature	10	34° 55'15.96"S, 57° 57'15.84"W
<i>Omalonyx</i> sp.	Argentina	Punta Lara, Buenos Aires	MZSP 31866	Museum	10	34° 49'40.8"S, 57° 57'56.52"W
<i>O. convexus</i>	Argentina	Ezeiza, Buenos Aires	Camagni coll. 1971 (Tillier 1981); MNHN unnumbered (Arruda & Thomé 2008b)	Literature	10	34° 51'13.68"S, 58° 31'22.44"W
<i>O. convexus</i>	Argentina	La Plata, Buenos Aires	LMSM 3273, 3237	Survey	10	34° 55'15.96"S, 57° 57'15.84"W
<i>O. convexus</i>	Argentina	Rio Santiago, Buenos Aires	MNHN, unnumbered; MACN 14472 (Arruda & Thomé 2008b)	Literature	10	34° 55'15.96"S, 57° 57'15.84"W
<i>O. convexus</i>	Argentina	Tucumán, Tucumán	Hylton-Scott 1968, 1971; SMNH 2507 (Tillier 1981); MNHN unnumbered (Arruda & Thomé 2008b)	Literature	11	26° 48'30.24"S, 65° 13'33.6"W
<i>O. unguis</i>	Argentina	Tucumán, Tucumán	MNRJ 4470	Museum	11	26° 48'30.24"S, 65° 13'33.6"W
<i>O. convexus</i>	Argentina	Rosario, Santa Fe	CM and MZUM unnumbered (Parodiz, 1963); MACN 26577 (Hylton-Scott & Lapuente 1968); USNM 124546 (Tillier 1981); ZMB28513 (Arruda & Thomé 2008b)	Literature	10	32° 56'40.2"S, 60° 39'10.8"W
<i>O. convexus</i>	Argentina	Rosario, Santa Fe	ANSP 64116	Museum	10	32°56'40.2"S, 60° 39'10.8"W
<i>O. convexus</i>	Argentina	Rio Negro, Chaco	CM unnumbered (Parodiz 1963), (Arruda & Thomé 2008b)	Literature	10	27° 29'39.12"S, 58° 44'38.4"W
<i>O. convexus</i>	Argentina	Islands in Paraná River, near Santa Fe	CM unnumbered (Parodiz 1963), (Arruda & Thomé 2008b)	Literature	10	31° 56'57.84"S, 60° 27'28.44"W
<i>Omalonyx</i> sp.	Argentina	Lagunas Pampeanas, Buenos Aires	Tietze & Francesco 2012	Literature	10	–
<i>O. unguis</i>	Argentina	Locality between Santa Fe and Paraná, both in Argentina	Zilli et al. 2008	Literature	10	–
<i>O. unguis</i>	Argentina	Site within Chaco Province, on the west bank of the Paraná River at its confluence with Paraguay River	Franceschini et al. 2010	Literature	10	–
<i>O. convexus</i>	Argentina	Abra Vieja, Paraná River, Buenos Aires	CM and MACN unnumbered (Parodiz 1963), (Arruda & Thomé 2008b)	Literature	10	34° 34'43.32"S, 58° 48'15.12"W
<i>O. convexus</i>	Argentina	Perucho Verna Stream, Entre Rios	UF 159845 (Arruda & Thomé 2008b)	Literature	10	23° 34'25.32"S, 64° 8'31.2"W
<i>O. convexus</i>	Argentina	Vinalito, Jujuy	CM unnumbered (Parodiz 1963), (Arruda & Thomé 2008b)	Literature	10	23° 34'25.32"S, 64° 8'31.2"W
<i>O. convexus</i>	Argentina	Santa Bárbara Ridge, Jujuy	CM unnumbered (Parodiz 1963), (Arruda & Thomé 2008b)	Literature	10	23° 46'33.6"S, 64° 40'10.56"W
<i>O. convexus</i>	Argentina	Termas del Palmar, Salta	CM unnumbered (Parodiz 1963); MACN 27246 (Arruda & Thomé 2008b)	Literature	10	24° 14'54.96"S, 63° 27'12.96"W
<i>O. convexus</i>	Argentina	Orán, Salta	CM unnumbered (Parodiz 1963), (Arruda & Thomé 2008b)	Literature	10	23° 8'9.96"S, 64° 19'19.92"W
<i>O. unguis</i>	Argentina	Resistencia, Chaco	MACN22931 (Arruda & Thomé 2008b)	Literature	10	27° 29'39.12"S, 58° 44'38.4"W
<i>O. unguis</i>	Argentina	Resistencia, Chaco	MZSP 14748	Museum	10	27° 29'39.12"S, 58° 44'38.4"W
<i>O. convexus</i>	Argentina	Guaycurú Stream, Chaco	CM unnumbered (Parodiz 1963), (Arruda & Thomé 2008b)	Literature	10	26° 21'50.4"S, 60° 51'16.2"W
<i>O. convexus</i>	Argentina	Navarro, Buenos Aires	MACN 27241 (Hylton-Scott & Lapuente 1968)	Literature	10	34° 59'57.84"S, 59° 16'42.96"W

Table 3. Continued...

Species	Country	Locality	<sup>1</sup> Record	<sup>2</sup> Source	<sup>3</sup> Hydrographic Region	Coordinates
<i>O. convexus</i>	Argentina	Las Rosas, Buenos Aires	MACN 14860 (Hylton-Scott & Lapuente 1968), (Arruda & Thomé 2008b)	Literature	10	36° 26'56.4"S, 58° 50'27.96"W
<i>O. convexus</i>	Argentina	Chapadmalal, Buenos Aires	Hylton-Scott & Lapuente 1968; MACN 27242 (Arruda & Thomé 2008b)	Literature	11	38° 54'43.2"S, 58° 14'46.68"W
<i>O. unguis</i>	Argentina	Barca Grande, Buenos Aires	MACN 13996 (Hylton-Scott & Lapuente 1968, Arruda & Thomé 2008b); Coscarelli & Vidigal 2011	Literature	10	34° 14'54.24"S, 58° 44'45.6"W
<i>O. unguis</i>	Argentina	Guaycolec, Formosa	Hylton-Scott & Lapuente 1968, Coscarelli & Vidigal 2011	Literature	10	26° 11'49.2"S, 58° 10'32.88"W
<i>O. unguis</i>	Argentina	Formosa, Formosa	MLP 4567-1 (Arruda & Thomé 2008b), Coscarelli & Vidigal 2011	Literature	10	26° 11'49.2"S, 58° 10'32.88"W
<i>O. unguis</i>	Argentina	Manantiales, Corrientes	Hylton-Scott & Lapuente 1968, Coscarelli & Vidigal 2011	Literature	10	27° 55'19.2"S, 58° 59'42"W
<i>O. unguis</i>	Argentina	Oro River, Chaco	MACN unnumbered (Hylton-Scott & Lapuente 1968), Coscarelli & Vidigal 2011	Literature	10	26° 47'16.08"S, 59° 26'42"W
<i>O. unguis</i>	Argentina	Tragadero River, Locality between Barraqueras and Antequera, Chaco	Poi de Neiff et al. 1977	Literature	10	27° 29'39.12"S, 58° 44'38.4"W
<i>O. unguis</i>	Argentina	Catamarca, Catamarca	Cazzaniga 1985	Literature	11	28° 28'21"S, 65° 46'45.48"W
<i>Omalonyx</i> sp.	Argentina	Ensenada, Buenos Aires	MLP 31321	Museum	10	34° 51'53.28"S, 57° 54'30.6"W
<i>Omalonyx</i> sp.	Argentina	Atalaya, Buenos Aires	LMSM 23	Donation	10	35° 14'56.4"S, 57° 31'53.76"W
<i>Omalonyx</i> sp.	Argentina	Esteros de Iberá, Corrientes	LMSM 16-22, 234-35	Donation	10	28° 20'24"S, 57° 22'56.64"W
<i>O. convexus</i>	Argentina	Ciudad Autónoma de Buenos Aires, Buenos Aires	LMSM 3239-40; ANSP 23465	Survey	10	34° 35'58.92"S, 58° 22'54.84"W
<i>O. unguis</i>	Argentina	Villafañe, Formosa	MLP 11878 (Arruda & Thomé 2008b)	Literature	10	26° 14'10.32"S, 59° 7'48"W
<i>O. unguis</i>	Argentina	Bahía Blanca, Buenos Aires	Cazzaniga 1985	Literature	11	38° 43'58.8"S, 62° 15'58.68"W
<i>Omalonyx</i> sp.	Argentina	Misiones	MLP unnumbered (Gregoric et al. 2013)	Literature	10	27° 27'36"S, 54° 35'29.4"W
<i>O. unguis</i>	Argentina	Formosa	MLP 4567-1 (Arruda & Thomé 2008b)	Literature	10	24° 52'12"S, 60° 26'27.6"W
<i>O. unguis</i>	Argentina	Tigre, Buenos Aires	LMSM 734 (Arruda & Thomé 2008b)	Literature	10	34° 25'36.48"S, 58° 34'46.2"W
<i>O. unguis</i>	Argentina	Buenos Aires, Buenos Aires	ANSP 23465	Museum	10	34° 35'58.92"S, 58° 22'54.84"W
<i>Omalonyx</i> sp.*	Chile	Juan Fernandes	Odhner, 1922, Letelier et al. 2014	Literature	13	33° 46'23.52"S, 80° 46'33.6"W
<i>Omalonyx</i> sp.*	Chile	Valparaiso Region	ANSP 64117	Museum	13	32° 39'6.48"S, 71° 24'21.6"W
<i>Omalonyx</i> sp.*	Chile	Valparaiso Region Robinson Crusoe Island, Juan Fernandez Archipelago	ANSP 130450, A9768G	Museum	13	34° 10'12"S, 80° 49'59.88"W
<i>Omalonyx</i> sp.	Colombia	–	FMNH unnumbered (Vera-Ardila 2008)	Literature	5	0° 14'8.88"S, 72° 30'0"W
<i>O. matheroni</i>	Ecuador	Limoncocha Lake	Hermann & Dundee 1967; FMNH 157321(Tillier 1981)	Literature	5	0° 23'57.12"S, 76° 36'33.12"W
<i>O. geayi</i>	Ecuador	Limonconcha, Sucumbios	FMNH 328261 (Arruda et. al 2016)	Literature	5	0° 24'41.91"S, 76° 37'31.36"W
<i>O. matheroni</i>	French Guiana	Kourou Bridge	Tillier coll. 4.78 (Tillier 1981); MNHN (Arruda & Thomé 2008a)	Literature	4	5° 9'39.24"N, 52° 38'57.48"W
<i>O. geayi</i>	French Guiana	Route Cayene-Kourou, Kaw Swamps	MNHN, Tillier coll. 29.4.1977 (Tillier 1980); MNH. (Tillier 1981), (Arruda et al. 2016)	Literature	4	4° 30'52.92"N, 52° 39'57.6"W

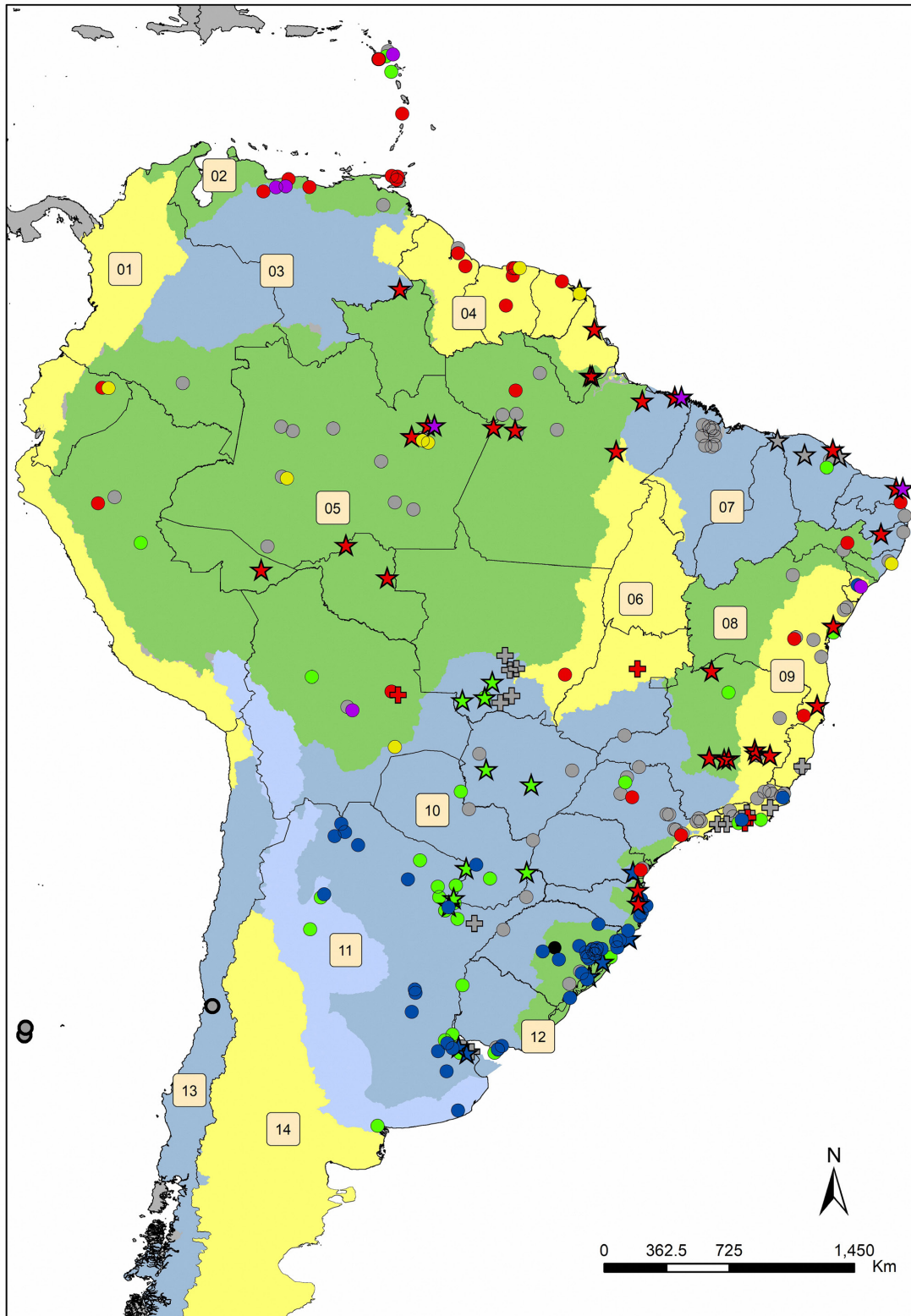
Table 3. Continued...

Species	Country	Locality	<sup>1</sup> Record	<sup>2</sup> Source	<sup>3</sup> Hydrographic Region	Coordinates
<i>O. geayi</i>	French Guiana	Kaw Swamps	LMSM 3204, 3222-24, 3226	Survey	4	4° 30'52.92"N, 52° 39'57.6"W
<i>O. matheroni</i>	Guyana	Demerara	Gibbson 1879; BMNH 1930.5.14.6.11 (Tillier 1981)	Literature	4	6° 37'53.04"N, 58° 38'27.6"W
<i>O. matheroni</i>	Guyana	Manikol Swamps (upper Tuyuni)	BMNH 1936.12.2.27.29 (Tillier 1981)	Literature	4	5° 57'18"N, 57° 41'26.16"W
<i>Omalonyx</i> sp.	Guyana	Georgetown	CMIOC 455	Museum	4	6° 47'52.8"N, 58° 9'19.08"W
<i>O. matheroni</i>	Lesser Antilles, Trinidad and Tobago,	Port Spain	ANSP A1173	Museum	—	10° 39'44.28"N, 61° 31'48"W
<i>O. matheroni</i>	Lesser Antilles, Guadeloupe	Pointe-à-Pitre	MNHN (Arruda & Thomé, 2008a)	Literature	—	16° 13'59.88"S, 61° 31'59.88"W
<i>O. matheroni</i>	Lesser Antilles, Guadeloupe	Pico Spring	LMSM 379-85, 2186-95 donated by Dr. J. P. Poitier collection	Donation	—	16° 13'59.88"S, 61° 31'59.88"W
<i>O. matheroni</i>	Lesser Antilles, Guadeloupe	Céligny and other localities	Lesson 1838, Tillier 1981 (Dr. J. P. Poitier collection)	Literature	—	16° 13'59.88"S, 61° 31'59.88"W
<i>O. matheroni</i>	Lesser Antilles, Guadeloupe	Vallet Pond	ANSP A22070	Museum	—	16° 13'59.88"S, 61° 31'59.88"W
<i>O. matheroni</i>	Lesser Antilles, Santa Lucia	-	Hermann & Dundee 1967	Literature	—	13° 54'7.2"N, 60° 58'42.96"W
<i>O. pattersonae</i>	Lesser Antilles, Antigua	-	Hermann & Dundee 1967; MZUM, (Patterson 1971); USNM 272284, 215047; BMNH 95.1.29.17 (Tillier 1981)	Literature	—	17° 42'14.4"N, 61° 48'25.2"W
<i>O. unguis</i>	Lesser Antilles, Antigua and Barbuda	-	ANSP 71975	Museum	—	17° 42'14.4"N, 61° 48'25.2"W
<i>O. matheroni</i>	Lesser Antilles, Trinidad and Tobago	-	USNM 162058	Museum	—	10° 26'44.52"N, 61° 16'17.04"W
<i>O. matheroni</i>	Lesser Antilles, Trinidad	-	BMNH 1950.618.407; LMNH (Tillier 1980, 1981)	Literature	—	10° 26'44.52"N, 61° 16'17.04"W
<i>O. matheroni</i>	Lesser Antilles, Trinidad and Tobago	Tunapuna-Piarco, Saint George East	USDA 100453 (Arruda et al. 2016)	Literature	—	10° 37'29.7336"N, 61° 13'6.5316"W
<i>O. matheroni</i>	Lesser Antilles, Monserrat	St. Peter	ANSP A23921	Museum	—	16° 44'18.24"N, 62° 12'31.68"W
<i>Omalonyx</i> sp.	Lesser Antilles, Antigua and Barbuda	-	USNM 460663, 151347	Museum	—	17° 42'14.4"N, 61° 48'25.2"W
<i>O. unguis</i>	Paraguay	Paraná River near Corrientes and Moxos (Bolivia)	d'Orbigny 1835, 1837; Tillier (1981)	Literature	10	27° 57'57.6"S, 58° 14'35.52"W
<i>O. unguis</i>	Paraguay	Asunción	CM unnumber (Parodiz 1963); MACN 19968 (Arruda & Thomé 2008b)	Literature	10	25° 16'32.88"S, 57° 38'16.08"W
<i>O. unguis</i>	Paraguay	Asunción	LMSM 3436	Survey	10	25° 16'32.88"S, 57° 38'16.08"W
<i>O. unguis</i>	Paraguay	Pilar, Ñe	LMSM 3341	Survey	10	26° 51'11.88"S, 58° 17'44.88"W
<i>O. convexus</i>	Paraguay	San Bernardino	CM unnumber (Parodiz 1963)	Literature	10	25° 16'46.92"S, 57° 17'7.08"W
<i>O. unguis</i>	Paraguay	Villa Rica	MCZ unnumber (Parodiz 1963), (Arruda & Thomé 2008b)	Literature	10	25° 49'26.4"S, 56° 24'18"W
<i>O. unguis</i>	Paraguay	Puerto Guarani	MACN 18181 (Hylton-Scott & Lapuente 1968), Coscarelli & Vidigal 2011	Literature	10	21° 17'20.4"S, 57° 55'26.4"W
<i>Omalonyx</i> sp.	Paraguay	Riacho Nepengue, Concepción	INPA 485	Museum	10	22° 27'23.76"S, 57° 35'19.68"W
<i>O. unguis</i>	Paraguay	Paso de Patria, Ñe	LMSM 3434, 3350	Survey	10	27° 14'52.08"S, 58° 32'20.04"W
<i>Omalonyx</i> sp.	Peru	Tarapoto, San Martín Morales, San Martín	MZSP 43266; USMN 612118 (Tillier 1981)	Literature	5	6° 11'6.36"S, 76° 28'44.4"W
<i>O. matheroni</i>	Peru	San Martín	MCP 08850	Museum	5	6° 25'30.72"S, 76° 49'51.24"W

Table 3. Continued...

Species	Country	Locality	<sup>1</sup> Record	<sup>2</sup> Source	<sup>3</sup> Hydrographic Region	Coordinates
<i>O. unguis</i>	Peru	Lake Yarínacocha, Ucayali	Ramirez, 1991, Ramirez et al. 2003	Literature	5	8° 18'29.88"S, 74° 36'7.2"W
<i>O. matheroni</i>	Suriname	Zanderij	RMNH 15.6.67 (Tillier, 1981)	Literature	4	5° 27'21.24"N, 55° 12'39.6"W
<i>O. matheroni</i>	Suriname	Belwaarde	RMNH 2.9.69 (Tillier 1981)	Literature	4	5° 51'6.12"N, 55° 52'55.2"W
<i>O. matheroni</i>	Suriname	Paramaribo	RMNH 6.68 (Tillier 1981)	Literature	4	5° 51'7.2"N, 55° 12'13.32"W
<i>O. geayi</i>	Suriname	Paramaribo	FLMNH 463461 (Arruda et al. 2016)	Literature	4	5° 51'7.2"N, 55° 12'13.32"W
<i>O. matheroni</i>	Suriname	Brokobačka, Brokopondo	RMNH unnumbered (Tillier 1981)	Literature	4	3° 53'22.56"N, 55° 34'28.56"W
<i>O. unguis</i>	Uruguay	Fuente Salto, close to Salto city	Olazarri 1979	Literature	10	31° 23'31.2"S, 57° 49'55.2"W
<i>Omalonyx sp.</i>	Uruguay	Montevideo	MZSP 31873	Museum	10	34° 54'43.2"S, 56° 9'52.2"W
<i>O. convexus</i>	Uruguay	Montevideo	ANSP 70261	Museum	10	34° 54'43.2"S, 56° 9'52.2"W
<i>O. unguis</i>	Uruguay	Near from Carrasco Stream, Montevideo	Scarabino 2003	Literature	10	34° 54'43.2"S, 56° 9'52.2"W
<i>O. convexus</i>	Uruguay	Miguelete Stream, Prado, Montevideo	Scarabino 2003	Literature	10	34° 54'43.2"S, 56° 9'52.2"W
<i>O. convexus</i>	Uruguay	Canelones	MNHNM8691 (Arruda & Thomé 2008b)	Literature	10	34° 43'29.28"S, 55° 57'34.56"W
<i>O. unguis</i>	Uruguay	Colonia, Uruguai River in front of Punta Gorda	MNHNM 3368 (Arruda & Thomé 2008b)	Literature	10	33° 57'7.56"S, 58° 21'36"W
<i>O. matheroni</i>	Venezuela	Caracas	Martens 1873, Tillier 1981, Arruda et al. 2009	Literature	2	10° 28'43.68"N, 66° 54'12.24"W
<i>O. matheroni</i>	Venezuela	Laguna de Ramón Coronel, near Bejuma	Baker 1925, 1926; Martinez 1993	Literature	3	9° 50'47.4"N, 68° 12'52.92"W
<i>O. pattersonae</i>	Venezuela	Lake Valencia, Carabobo	Martinez 1993	Literature	2	10° 9'13.32"N, 67° 53'40.92"W
<i>O. pattersonae</i>	Venezuela	Zuata Dam, Aragua	Martinez 1993	Literature	2	10° 11'39.84"N, 67° 23'40.56"W
<i>O. matheroni</i>	Venezuela	Santa Elena de Uaiarém, Bolívar	LMSM 2271-75, 2336-372353-54, 2356-57, 2372-73, 2377, 2378-79, 2522-24	Survey	5	4° 35'43.08"N, 61° 6'10.08"W
<i>O. pattersonae</i>	Venezuela	Lake Tacarigua	ANSP 161142	Museum	2	10° 48'10.8"N, 65° 48'21.24"W
<i>O. pattersonae</i>	Venezuela	-	ANSP 140961	Museum	-	unspecified locality
<i>Omalonyx sp.</i>	Venezuela	Amacuro Delta	MCP 09193	Museum	2	9° 29'31.2"N, 62° 31'22.8"W
<i>O. unguis</i>	Bolivia	Santa Cruz de la Sierra	MZUM unnumbered (Parodiz 1963)	Literature/	5	17° 7'59.88"S, 63° 55'12"W
<i>O. pattersonae</i>	Bolivia	Santa Cruz de la Sierra	MCP 09185	Museum	5	17° 7'59.88"S, 63° 55'12"W
<i>O. geayi</i>	Bolivia	Santa Cruz	MNKMO 7 (Arruda et al. 2016)	Literature	10	19° 7'45.0912"S, 61° 41'57.804"W
<i>Omalonyx sp.</i>	Bolivia	-	ANSPA1826c	Museum	5	17° 7'59.88"S, 63° 55'12"W
<i>O. unguis</i>	Lesser Antilles, Guadeloupe		ANSP 23463	Museum	-	16° 15'47.52"N, 61° 33'10.8"W
<i>O. matheroni</i>	Lesser Antilles, Montserrat	Daly River, Saint Peter	ANSPA23919	Museum	-	16° 44'18.24"N, 62° 12'31.68"W
<i>O. matheroni</i>	Lesser Antilles, Montserrat		ANSP 144327	Museum	-	16° 44'13.92"N, 62° 11'33.36"W
<i>O. matheroni</i>	Lesser Antilles, Montserrat	Runaway Ghaut, Saint Peter	ANSP A23917-18, A23920, 466625, A23921	Museum	-	16° 45'27"N, 62° 13'12"W
<i>O. matheroni</i>	Lesser Antilles, Montserrat	Woollands, Saint Peter	ANSP A23921	Museum	-	16° 44'18.24"N, 62° 12'31.68"W

Note: 1: Museum abbreviation is according to Table 1; 2: Specimens from our malacological surveys were deposited in LMSM and they were classified in the column source as "Survey"; Specimens that were donated by other researchers were deposited in LMSM and they were classified in the column source as "Donation". 3: Hydrographic basin numbers are according to Figure 1 and to the metadata information system of the water resources national agency - ANA - of the Environment Ministry, Brazil and to Bonetto 1994); \* Specimens from Chile that were previously identified as *O. gayana*, however, Tillier 1981 considered that this species belongs to the genus *Succinea*.

Predicting the Distribution of *Omalonyx* species

**Figure 1.** Updated distribution of the genus *Omalonyx* across Neotropical region. The coloured areas represent different hydrographic regions and their respective numbers. The solid black line indicates the borders among South American countries and within Brazilian administrative regions. The species records were represented by colours dots: red = *O. matheroni*; blue = *O. convexus*; green = *O. unguis*; yellow = *O. geayi*, purple = *O. pattersonae*, black = *O. brasiliensis*; gray = do not identified until species level, or *Omalonyx* sp. and gray circle with black border = Specimens from Chile that were previously identified as *O. gayana*. The stars represents the records made in our surveys, the circles represents literature or museums data and the cross symbol represents the samples that were donated by other researchers. Details about each sample are on tables 2 and 3. Hydrographic regions are indicated by numbers: 1) Pacific Coast; 2) Caribbean sea; 3) Orinoco River; 4) Amapá-Esequibo; 5) Amazon River; 6) Tocantins River; 7) North Atlantic; 8) São Francisco River; 9) Eastern Atlantic; 10) Del Plata; 11) Border strip of the Brasilica (North) and the Chilean-Patagonian (South West) Subregion; 12) Eastern; 13) Chilean-Patagonian Subregion of the Pacific Versant; 14) Chilean-Patagonian Subregion of the Atlantic Versant.

**Table 4.** Bioclimatic variables used in models development.

Variable	Description
Alt	Altitude
bio1	Annual mean temperature
bio2	Mean diurnal range (monthly mean, T° max-T° min)
bio3	Isothermality (bio2/bio7) x 100
bio4	Temperature seasonality (standard deviation x 100)
bio5	Maximum temperature of warmest month
bio6	Minimum temperature of coldest month
bio7	Temperature annual range (bio5-bio6)
bio8	Mean temperature of wettest quarter
bio9	Mean temperature of driest quarter
bio10	Mean temperature of the warmest quarter
bio11	Mean temperature of coldest quarter
bio12	Annual precipitation
bio13	Precipitation of wettest month
bio14	Precipitation of driest month
bio15	Precipitation seasonality (coefficient of variation)
bio16	Precipitation of wettest quarter
bio17	Precipitation of driest quarter
bio18	Precipitation of the warmest quarter
bio19	Precipitation of the coldest quarter

To minimize the spatial autocorrelation of the bioclimatic variables and to determine which variables contributed more to the development of the model, a principal component analysis (PCA) was carried out in the areas of *Omalonyx* species occurrence. The resulting rasters were used to generate a potential distribution model for South America. The input parameters followed the MaxEnt (version 3.3.3k) (Phillips et al. 2004) default options except for the threshold rule, which was set as “minimum training presence”. The resulting models were processed and reclassified using ArcGIS. A binary map (absence-presence) for the potential distribution of a species was generated considering the average map that represents the induced and adjusted habitat of each species.

## Results

### 1. Literature review

Inferences on the distribution of *Omalonyx* species have been made since its description, and it was assumed to be throughout South America east of the Andes (d’Orbigny 1837). This first inference was based on records from Bolivia and Paraguay (d’Orbigny 1835a, 1837). However, at that time (1837), the name *Omalonyx* was used as the subgenus *Succinea* (*Omalonyx*) *unguis*. Later, *Omalonyx* was used at the genus level (Herrmannsen 1849). In addition to the publications of d’Orbigny other species were described at that time as showed below. In the next century, Patterson (1971) extended the distribution of the genus to several West Indies islands and Central America. However, the basis for this conclusion was not clearly demonstrated. After that, Tillier (1981) demonstrated the occurrence of *Omalonyx* species in all South America east of the Andes and the Lesser Antilles. His conclusion was based on preserved specimens from malacological collections that did not include significant sampling material from Brazil, although there were already records on the presence of *Omalonyx* spp. in the country years before (e.g., Moricand 1836, Gibbons 1879). In fact, Tillier (1981) studied animals from only eight localities in Brazil, and four of these could not be clearly located and were excluded from his study. In this work, Tillier also discusses the origin and evolution of South American and Juan Fernández Islands (Chile) succineids. He suggests that the southeast region of Brazil is the center of *Omalonyx* radiation

once three species can be found in this region (*O. unguis*, *O. matheroni* and *O. brasiliensis*). Details on the records of *Omalonyx* occurrence in the Neotropics are given below in the subsections “*Omalonyx* in Brazil” and “*Omalonyx* in other South American countries and Lesser Antilles”.

#### 1.1. Literature review: *Omalonyx* in Brazil

The first record of *Omalonyx* in Brazil was made in the 19<sup>th</sup> century in the Northeastern region (Moricand 1836) on a lake in Bahia State named “*la Digue*” or “*le Bari*”. The specimens were identified as *O. unguis*. Hidalgo (1869) also identified as *O. unguis* specimens collected by Paz and Martinez in Bahia State. Two years later, the same author (Hidalgo 1872) stated that Paz and Martinez collected those specimens at “*Lago Digue*” (Dike Lake), Salvador, Bahia. We suppose that the specimens cited by Moricand (1836) and Hidalgo (1869, 1870) were collected in an urban lake known since the colonial period as “*Dique do Tororó*”. Gibbons (1879) identified two different species of *Omalonyx* in Bahia State, *O. unguis* and *O. matheroni*. However, no other information about the locality was provided, and the morphology described in Gibbons (1879) is not compatible with *O. unguis*; thus these records were not included in Table 2. *Omalonyx convexus* was described by Martens (1968) as *Succinea convexa* from specimens collected in Porto Alegre, Rio Grande do Sul State, in southern Brazil (type locality), and it was later included in the genus *Omalonyx* (Arruda & Thomé 2008b). The map provided by Arruda and Thomé (2008b) shows overlapping distribution of *O. convexus* and *O. unguis* in the Argentinean region of the Paraná River basin (in Figure 1 the Paraná River basin is included in the Del Plata hydrographic region) and adjacent localities in Uruguay. *Omalonyx brasiliensis* was described by Simroth (1896) based on specimens collected by H. von Ihering in Rio Grande do Sul State.

In the 20<sup>th</sup> century, specimens of *Omalonyx* infected by *Leucochloridium*, an avian trematode, were found by Lutz (1921) in the surroundings of the institute where he used to work in Rio de Janeiro city, Rio de Janeiro State. The author also reported that this slug is abundant in the north of Brazil. This trematode was also found in birds from Mato Grosso and used in the experimental infection of *Omalonyx* (Travassos 1928). Both of these works have a parasitological focus, and the specific identification of the slug was not provided. Haas (1939) registered *O. unguis* for the State of Pernambuco but did not specify the locality. Parodiz (1957) recorded *O. unguis* in Brazil but did not include the locality. He also mentioned the occurrence of *O. unguis* in Porto Alegre (Rio Grande do Sul State) and observed its similarity to *O. convexus*. Based on specimens from the MCZ (lot number unavailable), Parodiz (1963) registered the occurrence of *Omalonyx* in Rio de Janeiro (*O. unguis*) and Camaquã, Rio Grande do Sul. The specimens from Camaquã were later identified as *O. convexus* (Arruda & Thomé 2008b). Lange de Morretes (1949) recorded *O. brasiliensis* and *O. unguis* in Vila Nova (Bahia State) and *O. matheroni* in Santarém (Pará State). In a taxonomical review using specimens from institutional collections, Tillier (1981) studied animals from eight localities in Brazil. Three of them were easily identified: Santarém and Alenquer in Pará State, and Rio de Janeiro in Rio de Janeiro State. The other four localities, due to insufficient labeling information, could not be precisely located. Two of them were only superficially specified: “Brazil” Pernambuco State and Praya (=Praia) Grande (Rio de Janeiro State). The other two localities could not be identified: Santa Amélia, Amazonas and “Makthlawara” (BMNH 1929.10.2.6.22). This author also mentioned the occurrence of *Omalonyx* in Porto Alegre, Rio Grande do Sul State, and cited Martens (1868) and Simroth (1896), who also recorded *O. brasiliensis* in this State (Tillier 1981). The distribution of *Omalonyx* in Brazil was revisited by two authors whose results were similar to those of Lange de Morretes (1949). First, Salgado & Coelho (2003) reported some species of the

genus in a review about Brazilian land snails but did not cite any locality. After that, Simone (2006) cited the occurrence of *O. brasiliensis* in Rio Grande do Sul State and considered the occurrence area for the genus *Omalonyx* to be from Bolivia to Patagonia. Several other records were made in Brazil, including Minas Gerais (Oliveira & Almeida 2000, Arruda et al. 2006, Montresor et al. 2008) and São Paulo State (Arruda et al. 2009, Eduardo et al. 2012) in the southeast; Paraná (Arruda et al. 2009, Coscarelli & Vidigal 2011), Rio Grande do Sul (Arruda & Thomé 2008a, b, Arruda & Thomé 2011, Maltchik et al. 2010) and Santa Catarina State (Agudo-Padron 2008, 2012) in the south; Mato Grosso and Mato Grosso do Sul State (Coscarelli & Vidigal 2011) in the central west; Pernambuco (Dutra-Clarke et al. 2001), Sergipe (Jesus & Manso, 2010) and Maranhão State (Cantanhede et al. 2014) in the northeast; and Amazonas State in the North (Pimpão 2007, Garcia et al. 2012). Coscarelli & Vidigal (2011) investigated the distribution of *O. unguis* in Brazil and included new records for this species. Recently, new records for *O. geayi* extended the distribution range of this species in northern South America including Brazil (Arruda et al. 2016). The presence of *Omalonyx* was recorded in several Brazilian States representing all geographic regions (Table 2). All data and details (i.e., species and coordinates) on species distribution in Brazil were included in Table 2 and are shown in Figure 1.

### 1.2. Literature review: *Omalonyx* in other South American countries and Lesser Antilles

Several South American and Lesser Antilles countries are included in the distribution area of the genus *Omalonyx* (Figure 1, Table 3). The occurrence of *O. unguis* in Paraguay and Bolivia was reported by d'Orbigny (1835a, b, 1837). On this occasion, the author did a complete textual description of the external appearance of the animal and specified the collection sites: the flooded margins of Paraná River, near Corrientes, and the swamps of Moxos Province in Bolivia. Corrientes is a city on the riverbank of the Paraná River in Argentina, very close to the frontier with Paraguay, which is defined by the Paraná River itself. Later, Asunción, in Paraguay, was considered to be the type locality for *O. unguis* (Arruda & Thomé 2008b).

*Omalonyx matheroni* was described from individuals collected in Guadeloupe, Lesser Antilles (Potiez & Michaud 1835). Tillier (1981) studied specimens he collected or borrowed from institutional collections that were from several localities including the Lesser Antilles, Guiana, Suriname, French Guyana, Ecuador, Paraguay, Argentina and Peru (Table 3). *Omalonyx* occurrence in South American countries has been well documented by several authors: Argentina (Arruda & Thomé 2008a, b); Brazil (see above the topic geographic distribution of *Omalonyx* in Brazil); Colombia (Vera-Ardila 2008); Uruguay (Olazarri 1979, Scarabino 2003, Arruda & Thomé 2008b.); French Guiana (Tillier 1981, Arruda et al. 2016); Ecuador (Hermann & Dundee 1967, Tillier 1981, Arruda et al. 2016); Suriname (Tillier 1981, Arruda et al. 2016) Venezuela (Martens 1873, Baker 1925, 1926, Escarbassiere 1993); Guyana (Gibbons 1879, Tillier 1981); Peru (Tillier 1981, Ramirez, 1991; Ramirez et al. 2003) and Paraguay (Hylton-Scott & Lapuente 1968). Parodiz (1963) listed *Omalonyx* specimens from Paraguay, Argentina and Bolivia that were deposited in different institutional collections. Cazzaniga (1985), based on a bibliographic review, concluded that the known distribution area for *O. unguis* is southern Brazil, northern and eastern Argentina, Uruguay, Paraguay, and Bolivia and that the presence of *O. unguis* in the west of Argentina is known only in Tucumán (Hylton-Scott 1971) and Catamarca Provinces. The latter represents a new record made by Cazzaniga (1985) himself. Arruda & Thomé (2008b) showed that the distributions of *O. convexus* and *O. unguis* overlap in the Argentinean area of the Paraná River hydrographic region and adjacent localities in Uruguay. Gutiérrez Gregoric et al. (2013) recorded the occurrence of *Omalonyx* sp. in Misiones Province, Argentina using data

from the La Plata Museum Mollusk Collection, literature and his own field work. For further literature data about *Omalonyx* occurrence in Argentina see Table 3. There are some records of *Omalonyx* in Chile (Odhner 1922, Letellier et al. 2003, 2014), and some of them are recent. However, in 1981, Tillier studied specimens from Chile that were identified as *O. gayana* and stated that, despite its limaciform shape, the species belongs to the genus *Succinea*. The recent records from Chile (Letellier et al. 2003, 2014) do not include a description of the specimens nor any discussion on this taxonomic issue related to Chilean succineids. Thus, we suppose that the specimens are in fact *Succinea gayana*.

The distribution of the genus in the Lesser Antilles is also well documented. *Succinea haliotideae* Mittre 1841 was found in Martinique by Mittre (Tillier 1981). However, Tillier (1981) did not include this species in the genus *Omalonyx*, and indicates that they do not even belong to the family Succineidae once neither he nor Fischer found any *Omalonyx* in Martinique. Therefore, we did not include Martinique within the occurrence area of *Omalonyx*. Hermann & Dundee (1967) studied *Omalonyx* from Sta. Lucia and Antigua, both in the Lesser Antilles. Other authors have also worked in this region. Patterson (1971) and Tillier (1981) studied specimens from Antigua, and Robinson et al. (2009) recorded the occurrence of *Omalonyx* in several localities in Dominica. Arruda et al. (2016) showed new records of *O. geayi* and extended the range of distribution of this species in South America to include Suriname, Ecuador, and Bolivia. All references and localities are in Table 3.

### 2. Records from institutional collections

Based on data of Brazilian institutional collections obtained through literature, museum databases or onsite research, we verified 21 records for the genus in the North region of the country, 28 in the Northeast, four in the Central West, 33 in the Southeast and 31 in the South (Table 2). Specimens were found in eight Brazilian institutional collections (INPA, MCP, MCNZ, MZSP, MNRJ, UFS, ZUECA and CMIOC). Among the institutional collections that were visited, two of them did not present specimens belonging to the genus (MIRR and MPEG) in (Table 1). Brazilian specimens of *Omalonyx* were also registered in six foreign institutional collections (ANSP, FMNH, BMNH, ZMB, MNHN, and MCZ). We also investigated the presence of *Omalonyx* in other South American countries and Lesser Antilles using engines for virtual searching in databases from Brazilian (CMIOC, MCP, MZSP, MNRJ) and foreign institutional collections (ANSP, BMNH, USNM, CM, MACN, MLP) (Table 3).

### 3. Malacological surveys in Brazil

Specimens of *Omalonyx* were sampled across Brazilian hydrographic regions, and the sites were classified above according to the presence or absence of *Omalonyx* spp. (Table 2 and 5).

#### 3.1. Surveyed sites with *Omalonyx* spp. presence

Specimens were collected in all Brazilian geographic regions, and we found *Omalonyx* in three States of the South region (Rio Grande do Sul, Santa Catarina, Paraná) where six localities were sampled, one State in the Southeast region (Minas Gerais) where seven localities were sampled, two States in the Central-west region (Mato Grosso, Mato Grosso do Sul) where four localities were sampled, five States in the Northeast region (Piauí, Ceará, Rio Grande do Norte, Pernambuco and Bahia) where nine localities were sampled, and five States (Acre, Amazonas, Pará, Rondônia and Amapá) in the North region where 15 localities were sampled. Among these localities, we made new records for four Brazilian States: Acre, Rondônia, Amapá and Piauí. All coordinates for 41 surveyed sites are listed in Table 2 and indicated in the map (Figure 1).

**Table 5.** Surveyed sites within the Brazilian administrative regions where *Omalonyx* spp. was absent.

Administrative regions	Locality	Coordinates	
Distrito Federal	Brasília	15° 51'36"S, 47° 52'20" W	
		15° 50'21"S, 47° 54'26"W	
		15° 50'41"S, 47° 54'59"W	
		15° 44'26"S, 47° 52'52"W	
	Brazlândia	15° 42'49"S, 48° 12'14"W	
	Palmas	10° 12'34"S, 48° 19'21"W	
		10° 13'18"S, 48° 21'51"W	
	Tocantins	Porto Nacional	10° 07'49"S, 48° 18'25"W
			10° 41'54"S, 48° 24'39"W
		Lagoa da Confusão	10° 44'39"S, 48° 26'06"W
10° 46'04"S, 48° 24'50"W			
10° 47'54"S, 49° 37'21"W			
10° 43'50"S, 49° 32'27"W			
Boa Vista		02° 48'30"N, 60° 44'27"W	
Anauá Park		02° 49'52"N, 60° 40'47"W	
Caracarái		01° 25'16"N, 60° 59'17"W	
Estação Ecológica de Viruá		01° 29'24"N, 61° 00'07"W	
Maloca da Raposa	03° 50'25"N, 59° 58'24"W		
Mucajai	02° 41'05"N, 61° 12'56"W		
Villa Villena	02° 12'30"N, 60° 05'06"W		
Igarapé do Fogo	02° 18'53"N, 60° 04'56"W		
Taboca	02° 27'25"N, 60° 12'32"W		
Açude do Barroso	02° 30'38"N, 60° 17'54"W		
Tepequém	03° 41'31"N, 61° 42'41"W		
Roraima	Alto Alegre	02° 53'54"N, 61° 29'30"W	
	Caracaranã Lake	03° 46'21"N, 59° 50'02"W	
	Estação Ecológica de Maracá	03° 22'51"N, 61° 26'13"W	
		03° 22'13"N, 61° 26'13"W	
		03° 21'46"N, 61° 25'59"W	
	Serra do Murupu	03° 08'55"N, 60° 40'54"W	
	Localities known only from the coordinates	04° 11'46"N, 60° 47'56"W	
		03° 51'42"N, 60° 12'58"W	
		02° 55'37"N, 60° 42'57"W	
		03° 05'18"N, 60° 52'52"W	
02° 14'38"N, 60° 06'13"W			
	02° 16'58"N, 60° 05'16"W		

### 3.2. Surveyed sites with *Omalonyx* spp. absence

Despite the surveying effort, there were no records of *Omalonyx* spp. in three States: Distrito Federal (Central-west region), Tocantins and Roraima (North region). The coordinates are shown in Table 5.

### 4. Modeling of species distributions

The potential distribution of each species is indicated in the maps (Figure 2) where different colors and color densities are related to different probabilities of occurrence of suitable conditions for their presence. The environmental model applied here agrees with the data on species distribution (Figure 1) and supports geographic constraints on the species. Some species presents overlapping ranges of distribution. This is the case for *O. matheroni*, *O. pattersonae* and *O. geayi*, which tend to occur in tropical areas within the northern half of South America (Figure 2A, B and C) and for *O. convexus* and *O. unguis*, which tend to occur in temperate areas in the southern half of South America (Figure 2 D and E). *Omalonyx matheroni*, *O. pattersonae* and *O. geayi* present moderate probability of occurrence

in a vast area within northern South America, merged with intermittent areas of high probability of occurrence (Figure 2A, B and C). *Omalonyx convexus* and *O. unguis* present a smaller area of occurrence; however, there are many regions of high probability of occurrence.

There was a high probability of occurrence of *O. matheroni* in the Lesser Antilles, in the central region of South America (hydrographic region 5 and 10), in the Atlantic coast (hydrographic region nine), and in the south of South America (hydrographic region 13) (Figure 2A). These areas are predominantly tropical; however, there are also some temperate areas.

*Omalonyx pattersonae* showed a high probability of occurrence in tropical and arid regions (Figure 2B) in hydrographic region one, two and three (at isolated points in arid regions within hydrographic regions two and three) and in hydrographic regions six, seven and eight (in tropical and arid regions). Moderate probabilities of occurrence of *O. pattersonae* were observed in hydrographic regions nine and five (tropical region), where discontinuous areas of high probability of occurrence were observed in the Amazonian region (tropical and arid region) (Figure 2B).

*Omalonyx geayi* is a predominantly tropical species that can also occur in arid areas with high probability of occurrence within hydrographic regions one, two, three, four and five (Figure 2C). In hydrographic region five there are several small areas of high probability of occurrence merged in a vast area of moderate probability. There are areas of moderate probability of occurrence of *O. geayi* in hydrographic regions six, seven and 13.

Temperate areas along the southeast of South America present the highest probability of *O. convexus* occurrence. Areas with high probability of occurrence are within hydrographic regions 10, 12 and 13 (Figure 2D). There is moderate probability of occurrence in a vast area of hydrographic region 10 and in small areas within hydrographic regions 11 and 13.

Temperate areas in the southeast of South America that presented high probability of *O. unguis* occurrence includes hydrographic regions 10, 11, 12 and 13 (Figure 2E). Some areas within tropical (hydrographic regions five, nine and 10), arid (hydrographic region 11) and temperate areas (hydrographic region 14 and Malvinas Islands) were considered to have moderate probability of occurrence.

The PCA analysis resulted in three layers with highest eigenvalues that better explain the relationship between the variables in the selected study area. The most representative variables within these PCA-analysis axes were BIO4 (Temperature seasonality), BIO12 (Annual precipitation), and Altitude. As a consequence, the modeling of the species of *Omalonyx* was strongly influenced by these three variables, and their potential distribution was mainly determined by them. There is only one record of *O. brasiliensis*, thus, it was not possible to model this species' distribution due to technical limitations.

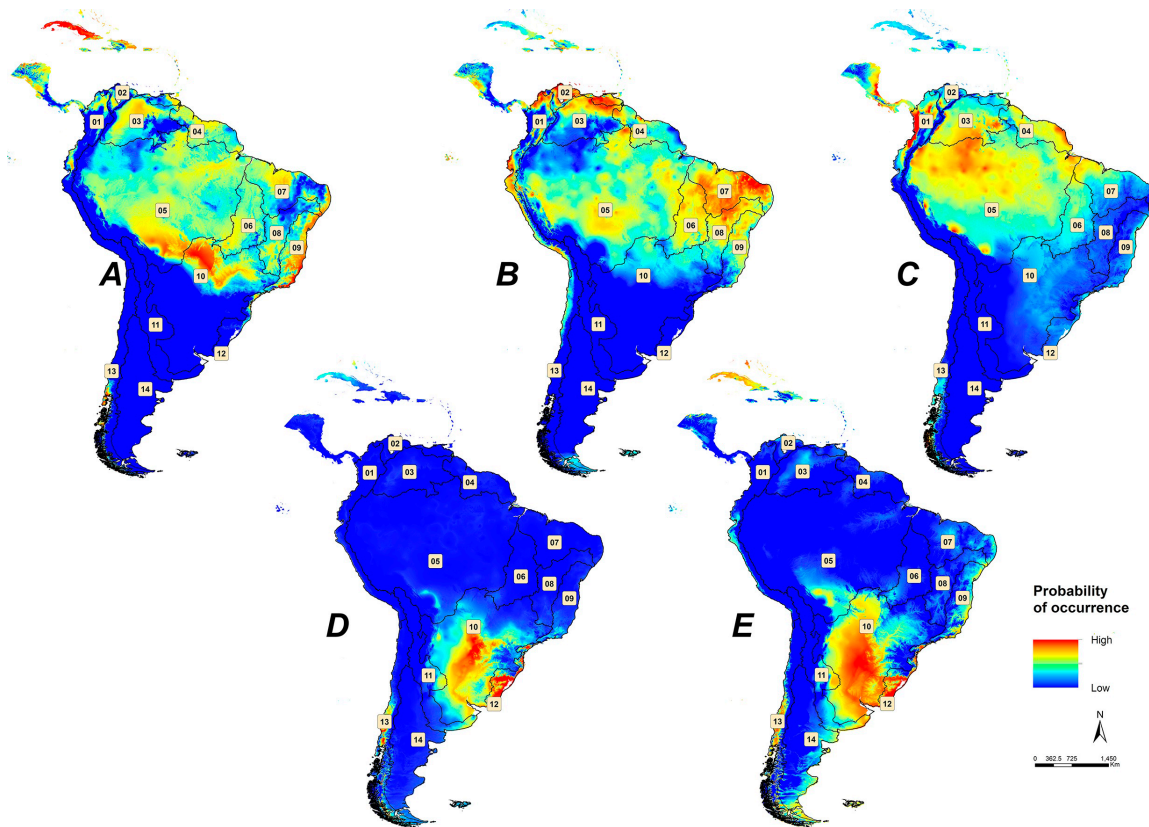
## Discussion

This work addresses *Omalonyx* species distribution. The genus has a widespread Neotropical distribution, covering most South American hydrographic regions (except hydrographic regions one and 14) and the Lesser Antilles. The species occurrence map and the model of species distribution showed that three species are related to the north of South America (*O. matheroni*, *O. pattersonae*, *O. geayi*) and Lesser Antilles, and three species are related to the south of South America (*O. unguis*, *O. convexus*, *O. brasiliensis*).

*Omalonyx matheroni* is the most widespread species, and its distribution is more concentrated in northern South America (North and Northeast of Brazil, Guyana, French Guiana and Suriname) and in the Lesser Antilles. *Omalonyx matheroni* occurs in all Brazilian hydrographic regions. The most southern record for this species is Santa Catarina State in the south of Brazil (12, Figure 1).

Among northern species, *O. matheroni* is the most widespread. On the other hand, the records for *O. geayi* and *O. pattersonae* are discontinuous.



Predicting the Distribution of *Omalonyx* species

**Figure 2** Potential distribution of *Omalonyx* species modeled with Bioclim analyses using all 19 bioclimatic variables, altitude and the full dataset showed on tables 2 and 3. (A) *Omalonyx matheroni*; (B) *Omalonyx pattersonae*, (C) *Omalonyx geayi*, (D) *Omalonyx convexus*, (E) *Omalonyx unguis*. The numbers represents the mainwatersheds within South America. The hydrographic regions are indicated by numbers: 1) Pacific Coast; 2) Caribbean sea; 3) Orinoco River; 4) Amapá-Esequibo; 5) Amazon River; 6) Tocantins River; 7) North Atlantic; 8) São Francisco River; 9) Eastern Atlantic; 10) Del Plata; 11) Border strip of the Brasilica (North) and the Chilean-Patagonian (South West) Subregion; 12) Eastern; 13) Chilean-Patagonian Subregion of the Pacific Versant; 14) Chilean-Patagonian Subregion of the Atlantic Versant.

Despite a huge area with high or intermediate probability of occurrence (Figure 2), the records for *O. pattersonae* and *O. geayi* are sparser (Figure 1). *Omalonyx geayi* was known to occur only in Kaw Swamp, French Guiana, the type locality (Tillier 1981). However, new records published recently expanded its distribution to Ecuador, Bolivia, Suriname and some localities in Brazil (Arruda et al. 2016). In this work, we recorded *O. pattersonae* for the first time in three hydrographic regions in North and Northeast of Brazil. There is one state in Brazil (Amazon State) where all three of these species occur at sites that are very close.

The other three species (*O. unguis*, *O. convexus*, *O. brasiliensis*) are concentrated in the south of South America. Among these species *O. unguis* reaches the most northern positions. This species was even found outside its distribution range (Lesser Antilles, Bolivia, Peru and in Ceará State, in the Northeast of Brazil). *Omalonyx convexus* records are very concentrated (Figure 1) and are restricted to sites where high or intermediate probability of occurrence was predicted (Figure 2B). However, there are some exceptions, and the species was also recorded in the north shore of Venezuela and in the Northeast of Brazil (Sergipe State). Until now, *O. brasiliensis* was known only from its type locality in Rio Grande do Sul State, Brazil. Despite all the surveying efforts already concentrated in Rio Grande do Sul State (Figure 1), *O. brasiliensis* was never found again since its description and the species remain known only for the type specimens from an unspecified site that could be related to hydrographic region 10 or 12 (Figure 1). Thus, *O. brasiliensis* remains to be rediscovered. This is a large State where *O. convexus* is widespread (Table 2, Figure 1); thus, both species may occur in sympatry.

There are several records from literature review, museums and collections that were not identified to species level and are designated *Omalonyx* sp. They were not used to model species distribution. These records are widespread throughout South American hydrographic regions (e.g., five, seven, nine and 10) and should also be carefully analyzed in future studies. On the other hand, some records identified to species level seem to be inconsistent (e.g., *O. convexus* was recorded for the Northeast of Brazil) and should be revised. All the records situated outside the area predicted for the species distribution should be carefully investigated. We suppose that the lack of taxonomists dealing with this group is the main cause for the great amount of records identified to genus level. On the other hand, the lack of training and the subtle morphological differences among species must be a cause of misidentification. These problems contribute to gaps in the knowledge regarding *Omalonyx* distribution (Tillier 1981, Coscarelli & Vidigal 2011).

Brazil is the best-sampled region in South America. Here, based on our malacological surveys, new records were made in Acre, Rondônia, Piauí, and Amapá. However, despite the absence of records even after intensive surveys in some administrative unities (Roraima, Tocantins and Distrito Federal) (Table 5), the genus was registered in all Brazilian hydrographic regions. There were no records for the central area of Tocantins River hydrographic region (surveyed sites: Palmas and other surrounding areas such as Lagoa da Confusão and Porto Nacional). However, the genus was present in the upper part of the hydrographic region (comprising Goiás and Pará States; Figure 1 and Table 2). Distrito Federal is an administrative unity that encompasses a small area when compared to the Brazilian States,

and within this small area, there are the frontiers of three hydrographic regions: Tocantins River, São Francisco River and Del Plata. Despite its proximity to Goiás State where we found *Omalonyx* sp., there were no records in Distrito Federal (surveyed sites: the margins of Paranoá Lake, in Brasília, and in Brazlândia, all of them in the upper Del Plata hydrographic region where the genus is widely distributed; Figure 1). In Roraima State, northern Brazil, despite the surveying efforts (23 records of absence) no record was made. Roraima is within the Amazon River hydrographic region in which *Omalonyx* is widely distributed (Figure 2). However, all these negative localities are in the northeastern quadrant of Roraima, which is characterized by unusual vegetation, a seasonally flooded savannah, locally called “Lavrado” (Barbosa et al. 2007), which may have some ecological features that prevent *Omalonyx* spp. colonization. Future sampling efforts should focus on areas within these States that were not investigated until now. Considering that *Omalonyx* spp. occur in the hydrographic regions that cover these States, the absence of records is probably due to insufficient sampling effort.

In South America *Omalonyx* species were found in all hydrographic regions (except hydrographic regions one and 14) and countries. However, there were only isolated records in Colombia, Ecuador and Chile, indicating the need for more sampling effort in these areas (Figure 1). However, the occurrence of this genus in Chile must be further investigated due to different point of views regarding the identification of the Chilean slug-like succineids (Tillier 1981). The record from Chile (Letellier et al. 2014) should be carefully investigated since Tillier (1981) considered that the species recorded in Chile, *O. gayana*, belongs to the genus *Succinea*. In fact, Chile is separated from the other South American countries by the Andes mountain range, which is the major water divider in South America. d’Orbigny (1837) stated that the genus occurs only on the east side of the ridge, and until now, there is no evidence suggesting otherwise. Our results agree with those from d’Orbigny (1837) and Tillier (1981). Bioclimatic analysis proved to be a valuable tool for gaining insight into the geographical distribution of a species, especially when few records are available (i.e., *O. geayi* and *O. pattersonae*). Predictions showed that *O. matheroni* and *O. geayi* are tropical species. *Omalonyx pattersonae* usually occurs in arid regions; however, its distribution moderately extends over tropical areas. However, the prediction of *O. geayi* to hydrographic region 13 (temperate and very cold area) could be related to low numbers of records. In fact, bias can occur if species are insufficiently sampled. Thus, climatic envelopes may generate incomplete results, and the accuracy of predicted distributions will be decreased (Beaumont et al. 2005).

The occurrence records and the predictions both indicated that *O. convexus* and *O. unguis* have largely overlapping distributions in temperate areas within southern South America. These results are in accordance with those from Arruda & Thomé (2008b) and Coscarelli & Vidigal (2011). However, the distribution of *O. convexus* is constrained to temperate regions while *O. unguis* is well represented in tropical, temperate and arid regions indicating that the latter presents a broader tolerance range for environmental variables and is adapted to different bioclimatic conditions.

Considering the extension and the great diversity of habitats in the neotropical region and the wide occurrence area of *Omalonyx* species, bioclimatic models can be used to extrapolate information on species distribution if the high cost of field surveys in such a vast area is unfeasible. Information on the distribution of *Omalonyx* species will help to improve the taxonomic and biogeographic studies on these slug-like gastropods.

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## Author Contributions

Ms. Daniel Coscarelli: contributed to the conception and design of the study. He did most of the malacological surveys, dissections (morphological identification) and visits to museums and collections. Moreover he wrote the first version of the manuscript and after some changes in the manuscript structure, he critically reviewed the paper.

Dra. Lângia C. Montresor: contributed to this manuscript since the beginning of the project. She reviewed the project that was submitted in order to get grants. She visited malacological collections in Rio de Janeiro State and also provided some field specimens. She is working in the manuscript since the first versions, writing and critically revising the text and improving the quality of the analysis.

Dr. Alan de Melo: has a vast experience with invertebrates and scientific writing and improved the quality of the manuscript. He contributed to data analysis and interpretation and critically revised the manuscript.

Philipp Russo: used our distribution data and WorldClim database to build the models of species distribution using the Maximum Entropy Algorithm (MaxEnt).

Teofânia Vidigal: contributed to the conception and design of the study. She wrote the project and got the grants that gave origin to this paper. She supervised and coordinated the project. She also provided field specimens, dissected (morphological identification), analyzed data and worked in the manuscript since the first until the last version, critically revising the manuscript.

## Conflicts of interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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