Biota Neotropica 18(3): e20180530, 2018
www.scielo.br/bn

biotaneotropica
ISSN 1676-0611 (online edition)

Inventory

Reptile diversity of Sinos River Basin

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MOSER, C. F., AVILA, F.R., OLIVEIRA, R.B., OLIVEIRA, J.M., BORGES-MARTINS, M., TOZETTI, A. M. **Reptile diversity of Sinos River Basin**. Biota Neotropica. 18(3): e20180530. http://dx.doi.org/10.1590/1676-0611-BN-2018-0530

Abstract: This work aimed to catalog the species of reptiles of the Sinos River Basin based on records from scientific collections and data collected in the field. We recorded 65 species, including 46 snakes, nine lizards, five turtles, four amphisbaenians and one caiman. Snakes composed most of the recorded specimens (91.3%), and the three most representative are venomous and of medical importance. The most urban region of the basin (Lowland) has the highest number of records. This fact may be a reflection of the high human population density in this region, which would have favored the encounter of specimens and their sending to scientific collections and research centers. It is worth highlighting that most species with few specimens in the collections are also rarely observed in the wild, such as *Clelia hussani* and *Urostrophus vautieri*. This observation makes it feasible that these populations are small or that they are declining.
Keywords: *Chelonia, Crocodilia, Squamata, Vale dos Sinos, Atlantic Forest, Pampa.*

Diversidade de répteis da Bacia Hidrográfica do Rio dos Sinos

Resumo: Este trabalho teve como objetivo catalogar as espécies de répteis da Bacia Hidrográfica do Rio Sinos com base em registros de coleções científicas e dados coletados em campo. Registramos 65 espécies, incluindo 46 serpentes, nove lagartos, cinco tartarugas, quatro anfisbenas e um jacaré. As serpentes compuseram a maioria dos espécimes registrados (91,3%), e as três espécies mais representativas são peçonhentas e de importância médica. A região mais urbana da bacia (planície) possui o maior número de registros. Este fato pode ser um reflexo da alta densidade populacional humana nesta região, o que teria favorecido o encontro de espécimes e seu envio para coleções científicas e centros de pesquisa. Vale ressaltar que a maioria das espécies com poucos exemplares nas coleções também são raramente observadas na natureza, como *Clelia hussani* e *Urostrophus vautieri*. Esta observação torna viável que essas populações sejam pequenas ou que estejam em declínio.
Palavras-chave: *Chelonia, Crocodilia, Squamata, Vale dos Sinos, Mata Atlântica, Pampa.*

Introduction

The loss of natural habitats by human action is one of the main causes of the reduction of biological diversity (Sala et al. 2000). This effect extends to several taxonomic groups, including reptiles (Gibbon et al. 2000). In Brazil, one can notice that the knowledge regarding the impacts of habitat loss on the reptile fauna varies between different biomes and different localities. Regarding the Atlantic Forest, for example, the knowledge status for the Southeast region (e.g. São Paulo; Rio de Janeiro) is significantly higher than for its South portion (e.g. Rio Grande do Sul). This is an unsettling fact considering that in the last decades there was a loss of 20.7% of the natural vegetation cover at the southern limit of the Atlantic Forest and the Brazilian Pampas that was caused by human actions, which represents a mean loss of 845.04 km² per year (Cordeiro & Hasenack 2009). In Rio Grande do Sul, for example, only about 31.4% of the areas classified as natural or semi-natural regarding their original vegetation cover are remaining (Cordeiro & Hasenack 2009).

The Sinos River Basin (SRB), located in the northeast of the state of Rio Grande do Sul (RS), is composed of several ecosystems (forests, grasslands and wetlands) associated to the Pampa and Atlantic Forest biomes (Mauhs 2013). However, the natural ecosystems of this basin are drastically reduced and fragmented due to rural and urban occupation (Oliveira et al. 2013). This process has been intensified since the mid 19th century (Cordeiro & Hasenack 2009, Oliveira et al. 2013, Plano Sinos 2014) and today the region concentrates the largest cities of the state (IBGE 2010, Plano Sinos 2014). Considering the current context of the SRB, the acquisition of basic information on its biodiversity is a requirement for a good environmental management in its territory (Plano Sinos 2014). Although the reptile fauna of RS is well documented

(Lema et al. 1983, Lema 1994, Lema 2002), the knowledge of the species distribution in final scales is still superficial. On this regard, this work aimed to catalog the reptile species of the SRB, generating an unprecedented list of species of Squamata, Chelonia and Crocodilia of this region.

Materials and Methods

1. Study site

The SRB is located in the northeast of Rio Grande do Sul (29° 20' S a 30° 10' S e 50° 15' W a51° 20' O), covering an area of about 4000 km² (Plano Sinos 2014) (Figure 1). This basin includes 32 municipalities distributed among the Upland, Midland and Lowland portions. The Upland (with altitudes of more than 1000 m above the sea level) covers 48% of the basin, including six municipalities: Caraá, Osório, Riozinho, Rolante, Santo Antônio da Patrulha and São Francisco de Paula. The Midland (altitudes up to 900 m) covers 26% of the basin and includes 10 municipalities: Araricá, Canela, Glorinha, Gramado, Igrejinha, Nova Hartz, Parobé, Santa Maria do Herval, Taquara and Três Coroas. The Lowland (altitudes up to 200 m), also with 26% of the area, includes 16 municipalities**:** Cachoeirinha, Campo Bom, Canoas, Capela de Santana, Dois Irmãos, Estância Velha, Esteio, Gravataí, Ivoti, Nova Santa Rita, Novo Hamburgo, Portão, São Leopoldo, São Sebastião do Caí, Sapiranga and Sapucaia do Sul.

The SRB is under the influence of a temperate climate, with abundant rainfall throughout the year, hot (Cfa) or warm (Cfb) summer, the latter in the higher areas (Peel et al. 2007) and inserted mainly in the Atlantic Forest biome (ca. 80%) and the Pampa biome in its lower stretch. Its vegetation cover has varied phytophysiognomies distributed according to the topography. The Upland is characterized by mixed forests of conifers and angiosperms (Mixed Ombrophilous Forest) and grasslands (Steppes), the Midland by caducifolious forests (Semidecidual Seasonal Forest) and the lowland by caducifolious forests, grasslands (savanna) and pioneer formations in wide flood areas in the region of the river mouth (Maus 2013). Due to the intense human occupation, the natural ecosystems of the SRB were drastically converted to agricultural and urban ecosystems. Regarding the total area of the SRB in 2010, 49% was covered by grasslands (most of them derived from deforestation), 28% by native forests, 9% by agricultural land, 8% by urban centers, 5% by forest plantations and 1% by wetlands (Oliveira et al. 2013).

2. Data survey in scientific collections

We consulted four scientific collections: Reptile Collection of the Museu de Ciência e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul (MCT-PUCRS), Reptile Collection of the Museu de Ciências Naturais da Fundação Zoobotânica (MCN-FZB), Herpetological Collection of the Universidade Federal do Rio Grande do Sul (UFRGS) and Herpetological Collection of the Universidade do

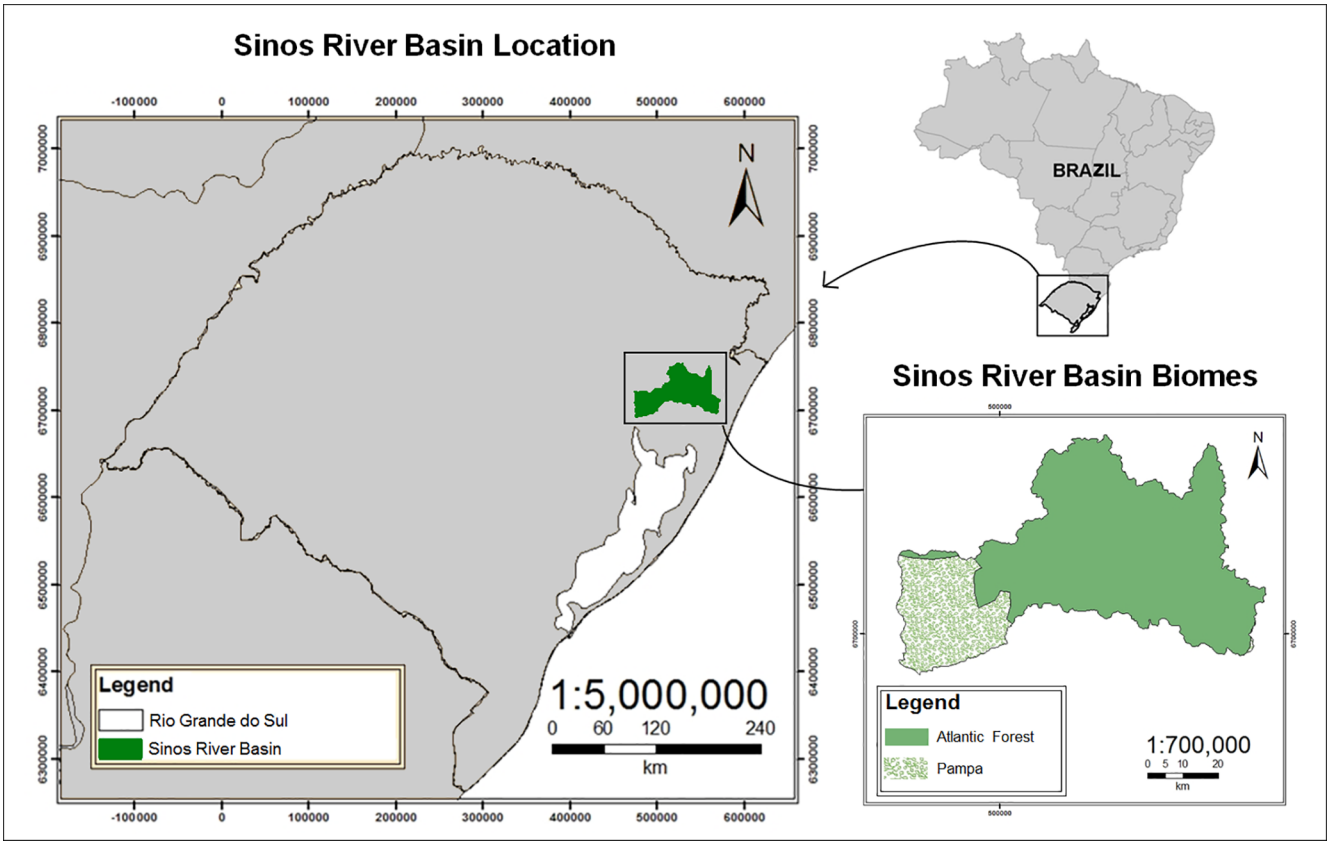

Figure 1. Map of the State of Rio Grande do Sul showing the location of the Sinos River Basin and the distribution of the Pampa and Atlantic Forest biomes within the limits of the basin.

 http://dx.doi.org/10.1590/1676-0611-BN-2018-0530

Vale do Rio dos Sinos (UNISINOS). Species with a single specimen collected or with dubious identification were carefully examined for a double check of original identification.

3. Occasional findings

Reptiles found during other field activities within the limits of the basin were also considered, but only as a record of the species for the corresponding region of the basin, not being counted for abundance.

Results

The evaluated scientific collections presented 3154 reptile specimens (Table 1) distributed in 64 species (Figure 2). Of this total, 2876 (91.1%; N = 46) were snakes, 126 (4%; N = 9) were lizards, 122 (4%; N = 4) were amphisbenians and 30 (0.9%; N = 5) were turtles (Table 1). One species of caiman, *Caiman latirostris*, was recorded only by occasional findings.

Snakes are the species with the largest number of specimens represented in the collections, the three most abundant species belonging to the family Viperidae (*Bothrops alternatus*, with 613 specimens; *Bothrops jararaca*, with 339 specimens) and Elapidae (*Micrurus altirostris*, with 262 specimens).

Of the 65 recorded species, 27 were recorded in the three portions of the basin, while 8 species were exclusive of the Upland (6 snakes and 2 lizards), 8 of the Lowland (3 snakes, 1 lizard, 3 turtles and 1 caiman) and 1 of the Midland (1 snake) (Figure 3).

The portion of the basin with the largest record of specimens was the Lowland (1907), followed by Upland (682) and Midland (565). Regarding species richness, Lowland had a richness of 54, Upland of 52 species, while the Miland had 35 species.

Discussion

The Sinos River Basin (SRB) hosts more than half of the species that occur in the Brazilian Pampas and the Atlantic Forest of Brazil's extreme South. Of these species, only the turtle *Phrynops williamsi* was categorized in the regional list of threatened species as near threatened (NT; Fundação Zoobotânica 2014, Decreto Estadual Nº 51.797/2014). Other two, a snake (*Clelia hussami*) (Figure 2R) and a lizard (*Urostrophus vautieri*) deserve attention because they are rarely recorded and were classified as data deficient (DD) in the regional list of threatened species. The relatively high species diversity of the SRB may be related to the presence of two different biomes in the study area, the Pampa and the Atlantic Forest, which provide a combination of unique ecosystems (Bérnils et al. 2007, Verrastro & Borges-Martins 2015). There are some species that, although not recorded for the SRB, deserve to be mentioned as potential occurrences, since they were recorded in nearby areas in vegetal formations present in the basin. Some snakes, such as *Dipsas alternans*, *Tropidodryas striaticeps* and *Uromacerina ricardinii*, for example, have records in areas of Dense Ombrophilous Forest (Lema 1973, 1994, Di-Bernardo et al. 2003) relatively close to the Sinos River's headwaters. We cannot rule out the possibility that these species occur in the Upland portion, and a greater sample effort directed toward them is necessary since they have low encounter rates even where their occurrence is known (Lema 1994, Di-Bernardo et al. 2003). Likewise, the snake *Crotalus durissus* has a large number of records for grassland areas in the locality known as Cazuza Ferreira (28°55'53.09"S and 50°39'34.13"O), in the municipality of São Francisco de Paula, very close to our sample area. On the other hand, there are species previously recorded in the Basin but that were not included in the list. One of the excluded species is *Chironius laevicollis*, which was recorded by Lema et al. (1983) based on a specimen from the didactic collection of a school in São Leopoldo and later listed in the MCN collection as coming from this municipality. The fact that this species is frequent on the coast of the state of Santa Catarina, which receives a large number of visitors from Rio Grande do Sul, together with the absence of other records of this species in the state, led Di-Bernardo et al. (2003) to suspect that the specimen from São Leopoldo was actually collected in Santa Catarina and deposited in the school's didactic collection without a reference to its origin. We agree with the authors regarding the uncertainty of this record, this being the reason why it was not considered in our list. Lema (1994) recorded another species of this genus, *C. brazili* (referred as *C. flavolineatus*) from two embryos at the final stage of development removed from eggs found in the locality of Poço do Carvão, municipality of São Leopoldo, but the absence of the material as evidence led Di-Bernardo et al. (2004) to propose the exclusion of this species from the list of reptiles of RS. More recently, the occurrence of the species in RS was finally confirmed through two specimens collected in Santa Cruz do Sul and São Francisco de Assis, which were deposited in the MCP collection (Hamdan & Fernandes 2015). Abbeg et al. (2016) made a review of the species' distribution in RS, presenting new records from the western region, and considered the validity of the record by Lema (1994) to be highly likely. Although we do not rule out the possibility of the species to occur in this area, we did not considered the record of Lema (1994) mainly due to the lack of the material to serve as evidence, as proposed by Di-Bernardo et al. (2004) and also because the habitat of this record does not match the habitats in which the species has been recorded (Abbeg et al. 2016). Additionally, contrary to the areas in which the species has been currently found, the region of the SRB is better represented in scientific collections so that the absence of records is possibly a result of the species not occurring in this region since a number of recent records indicate that the species is not rare.

It is worth highlighting that the number of specimens of some species does not safely reflect their abundance in local populations. Regarding snakes, for example, the species with the largest number of records (*Bothrops alternatus*, *B. jararaca* and *Micrurus altirostris*) (Figure 2AX, 2AZ and 2AW) are venomous and of medical importance and are usually killed by local inhabitants and sent to universities (Barbo et al. 2008). The small number of specimens of lizards, turtles, amphisbaenians and caimans in the collections is likely the result of the population's lack of interest in these animals, as well as the scarcity of research groups dedicated to these organisms. Furthermore, storing large animals, such as crocodilians, turtles and some lizards is often impracticable due to the lack of available room in scientific collections. Despite these limitations, the collected data allow some considerations. The Midland portion, for example, had a considerably smaller amount of specimens and species than both the Upland and the Lowland (17.8% of the specimens and 35 species). This result most likely does not represent the real diversity of this portion, since the Midland includes a region with

Table 1. List of species recorded in the Sinos River Basin with the number of specimens in the examined collections, location in the basin and record method. Legend: Record in Scientific Collection (C) and Occasional Finding (OF); Portions of the basin: U (Upland), M (Midland) and L (Lowland); N (Number of specimens); Distribution in the basin: portions in which the species was recorded. Data regarding the number of specimens in the areas where each species was recorded were based exclusively on data from scientific collections.

Taxon	Record Method	Number of specimens in the collections				Distribution in the basin
		U	M	L	N	
CHELONIA						
CHELIDAE						
Acanthochelys spixii (Spix, 1824)	C	2	0	1	3	UL
Hydromedusa tectifera Cope, 1869	C	0	0	7	7	L
Phrynops williamsi Rhodin & Mittermaier, 1983	OF, C	0	0	1	1	L
Phrynops hilarii (Duméril & Bibron, 1835)	OF, C	1	0	3	4	UL
EMYDIDAE						
Trachemys dorbigni (Duméril & Bibron, 1835)	OF, C	0	0	15	15	L
LACERTILIA						
ANGUIDAE						
Ophiodes fragilis (Raddi,1826)	OF, C	1	7	22	30	UML
Ophiodes aff. *striatus* (Spix, 1824)	C	2	0	11	13	UL
GEKKONIDAE						
Hemidactylus mabouia (Moreau de Jonnès, 1818)	OF, C	0	0	3	3	L
LEIOSAURIDAE						
Anisolepis grilli (Boulenger, 1891)	C	8	0	1	9	UL
Enyalius iheringii Boulenger, 1885	OF, C	1	0	0	1	U
Urostrophus vautieri Duméril & Bribon, 1837	C	2	0	0	2	U
GYMNOPHTALMIDAE						
Cercosaura schreibersii Wiegmann, 1834	C	20	2	14	36	UML
TEIIDAE						
Salvator merianae (Duméril & Bibron, 1839)	OF, C	6	6	9	21	UML
Teius oculatus (D'Orbigny & Bibron, 1837)	C	1	0	10	11	UL
AMPHISBAENIA						
AMPHISBAENIDAE						
Amphisbaena darwini (Duméril & Bibron, 1839)	C	2	0	2	4	UL
Amphisbaena kingii (Bell, 1833)	C	0	1	46	47	ML
Amphisbaena prunicolor (Cope, 1885)	C	1	0	9	10	UL
Amphisbaena trachura Cope, 1885	C	27	1	33	61	UML
SERPENTES						
COLUBRIDAE						
Chironius bicarinatus (Wied-Neuwied, 1820)	C	19	7	26	52	UML
Chironius exoletus (Linnaeus, 1758)	C	3	0	0	3	U
Mastigodryas bifossatus (Raddi, 1820)	C	13	27	85	125	UML
Spilotes pullatus (Linnaeus, 1758)	C	1	4	6	11	UML
Tantilla melanocephala (Linnaeus, 1758)	C	5	0	1	6	UL
DIPSADIDAE						
Atractus reticulatus (Boulernger, 1885)	C	0	1	16	17	ML
Boiruna maculata Boulenger, 1896	C	3	0	12	15	UL
Clelia hussami Morato, Franco & Sanches, 2003	C	2	0	0	2	U
Echinanthera cyanopleura (Cope, 1885)	C	4	7	6	17	UML
Erythrolamprus almadensis (Wagler, 1824)	C	2	1	12	15	UML
Erythrolamprus jaegeri (Günther, 1858)	C	32	2	24	58	UML

Contined Table 1

Taxon	Record Method	Number of specimens in the collections				Distribution in the basin
		U	M	L	N	
Erythrolamprus miliaris (Linnaeus, 1758)	OF, C	21	21	2	44	UML
Erythrolamprus poecilogyrus (Wied – Neuwied, 1825)	OF, C	16	22	144	182	UML
Erythrolamprus semiaureus (Cope, 1862)	C	4	0	19	23	UL
Gomesophis brasiliensis (Gomes, 1918)	C	0	1	0	1	M
Helicops infrataeniatus (Jan, 1865)	OF, C	5	19	65	89	UML
Lygophis anomalus (Günther, 1858)	C	0	0	4	4	L
Lygophis flavifrenatus (Cope, 1862)	C	6	0	6	12	UL
Oxyrhopus rhombifer Duméril, Bibron & Duméril, 1854	OF, C	15	21	71	107	UML
Oxyrhopus clathratus Duméril, Bibron & Duméril, 1854	C	1	2	1	4	UML
Paraphimophis rustica (Cope, 1878)	C	1	0	5	6	UL
Phalotris lemniscatus (Duméril, Bibron & Duméril, 1854)	C	8	5	23	36	UML
Philodryas aestiva (Duméril, Bibron & Duméril, 1854)	C	17	6	5	28	UML
Philodryas arnaldoi (Amaral, 1933)	C	1	0	0	1	U
Philodryas olfersii (Liechtenstein, 1823)	C	4	13	33	50	UML
Philodryas patagoniensis (Girard, 1858)	OF, C	71	13	78	162	UML
Pseudoboa haasi (Boettger, 1905)	C	2	0	0	2	U
Psomophis obtusus (Cope, 1864)	C	0	0	1	1	L
Sibynomorphus neuwiedi (Ihering, 1911)	OF, C	5	16	18	39	UML
Sibynomorphus ventrimaculatus (Boulenger, 1885)	OF, C	1	3	41	45	UML
Taeniophallus affinis (Günther, 1858)	C	5	2	0	7	UM
Taeniophallus bilineatus (Fischer, 1885)	C	5	5	0	10	UM
Taeniophallus occipitalis (Jan, 1863)	C	1	0	0	1	U
Taeniophallus poecilopogon (Cope, 1863)	C	11	1	0	12	UM
Thamnodynastes hypoconia (Cope 1860)	C	4	0	8	12	UL
Thamnodynastes strigatus (Günther, 1858)	OF, C	8	7	15	30	UML
Tomodon dorsatus Duméril, Bibron & Duméril, 1854	C	9	20	33	62	UML
Xenodon dorbignyi (Duméril, Bibron & Duméril, 1854)	C	12	0	7	19	UL
Xenodon merremii (Wagler, 1824)	OF, C	34	81	117	232	UML
Xenodon neuwiedii Günther, 1863	OF, C	39	30	3	72	UML
DIPSADIDAE Incertae sedis						
ELAPIDAE						
Micrurus altirostris (Cope, 1860)	C	26	38	198	262	UML
Micrurus decoratus (Jan, 1858)	C	0	0	1	1	L
VIPERIDAE						
Bothrops alternatus Duméril, Bibron & Duméril, 1854	OF, C	82	19	512	613	UML
Bothrops cotiara (Gomes, 1913)	C	3	0	0	3	U
Bothrops jararaca (Wied, 1824)	OF, C	110	153	76	339	UML
Bothrops pubescens (Cope, 1870)	C	3	2	39	44	UML
CROCODYLIA						
ALLIGATORIDAE						
Caiman latirostris (Daudin, 1802)	OF	0	0	0	0	L
TOTAL		682	565	1907	3154	
Richness		54	35	52	65	
Number of exclusive species		8	1	8		

Figure 2. Reptile of Sinos River Basin: **A.** *Acanthochelys spixii*, **B.** *Hydromedusa tectifera*, **C.** *Phrynops hilarii*, **D.** *Trachemys dorbigni*, **E.** *Anisolepis grilli*, **F.** *Enyalius iheringii*, **G.** *Cercosaura schreibersii*, **H.** *Salvator merianae*, **I.** *Amphisbaena kingii*, **J.** *Amphisbaena prunicolor*, **K.** *Amphisbaena trachura*, **L.** *Chironius bicarinatus*, **M.** *Chironius exoletus*, **N.** *Mastigodryas bifossatus*, **O.** *Tantilla melanocephala*, **P.** *Atractus reticulatus*, **Q.** *Boiruna maculata*, **R.** *Clelia hussami*, **S.** *Echinanthera cyanopleura*, **T.** *Erythrolamprus almadensis*, **U.** *Erythrolamprus jaegeri*, **V.** *Erythrolamprus miliaris*, **W.** *Erythrolamprus poecilogyrus*, **X.** *Erythrolamprus semiaureus*, **Y.** *Gomesophis brasiliensis*, **Z.** *Helicops infrataeniatus*, **AA.** *Lygophis anomalus*, **AB.** *Lygophis flavifrenatus*, **AC.** *Oxyrhopus rhombifer*, **AD.** *Oxyrhopus clathratus*, **AE.** *Paraphimophis rustica*, **AF.** *Phalotris lemniscatus*, **AG.** *Philodryas aestiva*, **AH.** *Philodryas arnaldoi*, **AI.** *Philodryas olfersii*, **AJ.** *Philodryas patagoniensis*, **AK.** *Pseudoboa haasi*, **AL.** *Psomophis obtusus*, **AM.** *Sibynomorphus neuwiedi*, **AN.** *Taeniophallus affinis*, **AO.** *Taeniophallus bilineatus*, **AP.** *Taeniophallus poecilopogon*, **AQ.** *Thamnodynastes hypoconia*, **AR.** *Thamnodynastes strigatus*, **AS.** *Tomodon dorsatus*, **AT.** *Xenodon dorbignyi*, **AU.** *Xenodon merremii*, **AV.** *Xenodon neuwiedii*, **AW.** *Micrurus altirostris*, **AX.** *Bothrops alternatus*, **AY.** *Bothrops cotiara*, **AZ.** *Bothrops jararaca*, **BA.** *Bothrops pubescens*, **BB.** *Caiman latirostris*.

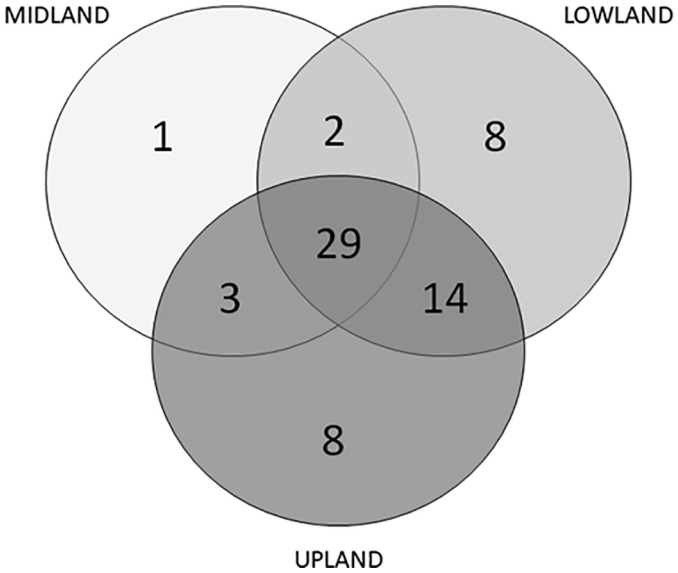

Figure 3. Diagram representing the number of species in the three portions of the Sinos River Basin. The intersections indicate the species shared by different portions. This diagram considered all record methods.

a relatively low population density and some of the largest remains of natural habitats, generating a high potential to harbor several species. A possible explanation for this result is the low human population density, which limits the encounters with the animals. The portion with the largest number of records (58.3% of the specimens) was the Lowland, a highly urban region, with a higher potential of impacts on the reptile fauna. Possibly this result is due to the geographic proximity to research centers and universities, facilitating logistic aspects of collections, and the proximity with the population, facilitating the receipt of specimens. Something similar may have occurred regarding the Upland that, despite being geographically distant from research centers, is a region with a high tourist appeal and has an important area of scientific interest (São Francisco de Paula National Forest) in which many studies were developed in the last two decades.

The species that were exclusive to Lowland (8) are all generalist species regarding habitat, have wide geographic distribution (Lema 1994, 2002, Borges-Martins et al. 2013) and it is likely that they were not collected in other localities due to the sample gaps, with the exception of *Micrurus decoratus*. This species has only one record in the state (Lema & Azevedo 1969) in the municipality of São Leopoldo, based

on a specimen sent to the Instituto Pinheiros/SP and later donated to the MCN. In a review on the geographic distribution of *M. decoratus*, Gonzalez et al. (2014) did not consider this record due to the little information about it and its exclusivity for the state. However, we do not have justifications to disregard it, as the material with detailed information on the collection exists (see Lema & Azevedo 1969), even agreeing with the possibility of occurrence of an error when the specimen was placed in the Instituto Pinheiros/SP. We also include in our list the caiman species *Caiman latirostris* (the only crocodilian species of Rio Grande do Sul - Figure 2BB). This species was recorded occasionally (visual record by one of the authors) in the Lowland, in a marsh of the municipality of São Leopoldo. The difficulty in collecting specimens of this species, together with a possible low population density in the basin, are factors that explain its absence in scientific collections.

Only one snake was exclusive to the Midland, *Gomesophis brasiliensis* (Figure 2Y). This species inhabits areas associated with aquatic and muddy environments (Lema 2002) and may also occur in other localities of the basin. However, there is little available information on this snake. Seven species, *Bothrops cotiara*, *Chironius exoletus*, *Clelia hussami*, *Enyalius iheringii, Philodryas arnaldoi, Taeniophallus occipitalis* and *Urostrophus vautieri* (Figure 2AY, 2M, 2R, 2F and 2H) were exclusive to the Upland but *Taeniophallus occipitalis* and *Urostrophus vautieri* likely occur along the whole basin due to their generalist habits and wide geographic distribution (Lema 2002, Di-Bernardo et al. 2003, Quintela et al. 2011). *Chironius exoletus*, although more frequent in areas of Dense Ombrophilous Forest, has records in areas with other forest formations of the Atlantic Forest, both in the plateau and the coastal plain, thus it likely occurs in the three portions of the basin. *Bothrops cotiara* is a species whose distribution is limited to the Mixed Ombrophilous Forest and likely occurs in elevated areas of the Midland as well, where this forest formation is present. Lema (1980, et al. 1983) mentions the existence of two specimens of *Bothrops cotiara* collected in São Leopoldo and deposited in the collection of the Institute of Biogeography of the Saarland University in Saarbrücken, Germany, without citing the registration number. Checking this material would be necessary to confirm the presence of this species in the Lowland. Likewise, *Philodryas arnaldoi*, a rare species that is also associated with environments of dense forest in the plateau (Di-Bernardo et al. 2003), may occur in areas with these characteristics in the Midland. *Enyalius iheringii* has its distribution associated with the Dense Ombrophilous Forest (Verrastro & Borges-Martins 2015) and likely does not occur in other portions of the basin.

It is worth highlighting that the expansion of urban and agricultural areas, as well as the loss of natural landscapes in the SRB, is constant and intense, and some species listed here may be in an advanced process of population decline.

Supplementary material

The following online material is available for this article:
Appendix 1 - List of vouchers

Author Contributions

Camila Fernanda Moser: wrote the text, collected and revised the data.

Fernanda Rodrigues de Avila: contributed writing the text, collected and revised the data.

Roberto Baptista de Oliveira: contributed writing the text and revised the data.

Juliano Morales de Oliveira: contributed writing the text.

Márcio Borges-Martins: revised the text and provided the photos.

Alexandro Marques Tozetti: contributed writing the text.

Conflicts of interest

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

References

ABEGG, A.D., BORGES, L.M., DA ROSA, C.M., ENTIAUSPE-NETO, O.M., AROCHA, N.M. & SANTOS-JR, A.P. 2016. Included, excluded and re-included: *Chironius brazili* (Serpentes, Colubridae) in Rio Grande do Sul, southern Brazil. Neotrop. Biol. Conserv. 11(3): 198-203.

BARBO, F.E., MALAGOLI, L.R., BAJESTERO, F.B. & WHATELY, M. 2008. Os Répteis no Município de São Paulo: aspectos históricos, diversidade e conservação. In Além do Concreto: contribuições para a proteção da biodiversidade paulistana (L.R. Malagoli, F.B. Bajestero & M. Whately, eds.). São Paulo: Editora Instituto Socioambiental, p. 234–267.

BÉRNILS, R.S., GIRAUDO, A.R., CARREIRA, S. & CECHIN, S.Z. 2007. Répteis das porções subtropical e temperada da Região Neotropical. Ciênc. Ambient. 35: 101-136.

BORGES-MARTINS, M., SCHOSSLER, M., VERRASTRO, L., BUJES, D.E., SOUZA, C., OLIVEIRA, R.B., MOSENA, M. 2013. Répteis da Reserva Biológica do Lami José Lutzenberger e arredores no município de Porto alegre, RS, Brasil. In Fauna e Flora da Reserva Biológica do Lami José Lutzenberger (P.B.R. Witt, ed.). Porto Alegre: Secretaria Municipal do Meio Ambiente, p. 81–90.

CORDEIRO, J.L.P. & HASENACK, H. 2009. Cobertura vegetal atual do Rio Grande do Sul. In Campos Sulinos: conservação e uso sustentável da biodiversidade (V.D.P. Pillar, S.C. Müller, Z.M.S. Castilhos & A.V.A. Jacques, eds.). Brasília: Ministério do Meio Ambiente, p. 285 – 299.

DI-BERNARDO, M., BORGES-MARTINS, M. & OLIVEIRA, R.B. 2003. Répteis. In Livro vermelho da fauna ameaçada de extinção no Rio Grande do Sul (C.S. Fontana, G.A. Bencke & R.E. Reis, eds.). Porto Alegre: Edipucrs, p 165–188.

DI-BERNARDO, M., BORGES-MARTINS, M. & OLIVEIRA, R.B.D. 2004. Proposed deletion of eight species of snakes from the Brazilian State of Rio Grande do Sul herpetofauna. Comun. Mus. Ciênc. Tecnol. PUCRS, Sér. Zool. 17(1): 45–50.

FUNDAÇÃO ZOOBOTÂNICA. 2014. Avaliação do Estado de Conservação de Espécies da Fauna. Lista Vermelha. https://secweb.procergs.com.br/livlof/?id_modulo=1&id_uf=23&ano=2012 (last access in 24 May 2017).

GIBBON, J.W., SCOTT, D.E., RYAN, T.J., BUHLMANN, K.A., TUBERVILLE, T.D., METTS, B.S., GREENE, J.L., MILLS, T., LEIDEN, Y., POPPY, S. & WINNE, C.T. 2000. The Global Decline of Reptiles, Déjà Vu Amphibians: Reptile species are declining on a global scale. Six significant threats to reptile populations are habitat loss and degradation, introduced invasive species, environmental pollution, disease, unsustainable use, and global climate change. BioScience 50(8): 653–666.

GONZALEZ, R.C., SILVA-SOARES, T., DE CASTRO, T.M. & BÉRNILS, R.S. 2014. Review of the geographic distribution of *Micrurus decoratus* (Jan, 1858) (Serpentes: Elapidae). Phyllomedusa, J. Herpetol.13(1): 29–39.

HAMDAN, B. & FERNANDES, D.S. 2015. Taxonomic revision of *Chironius flavolineatus* (Jan, 1863) with description of a new species (Serpentes: Colubridae). Zootaxa 4012(1): 97–119.

IBGE – Instituto Brasileiro de Geografia e Estatística (2010) Censo Demográfico. http://www.ibge.gov.br/home/estatistica/populacao/censo2010/ (last access in 24 May 2017).

LEMA, T. 1973. Ocorrência de *Uromacerina ricardinii* (Peracca 1897) no Rio Grande do Sul e contribuição ao conhecimento desta rara serpente (Ophidia, Colubridae). Iheringia, Zool. 44: 64–73.

LEMA, T. 1994. Lista comentada dos répteis ocorrentes no Rio Grande do Sul, Brasil. Comun. Mus. Ciênc. Tecnol. PUCRS, Sér. Zool. 7: 41–150.

LEMA, T. 2002. Os répteis do Rio Grande do Sul: atuais e fósseis, biogeografia, ofidismo, 1 ed. Porto Alegre: Edipucrs. 264 pp.

LEMA, T. & AZEVEDO, A.C.P. 1969. Ocorrência de *Micrurus decoratus* (Jan) no Rio Grande do Sul, Brasil (Serpentes, Elapidae). Iheringia, Zool. 37: 118–117.

LEMA, T., FABIÁN-BEURMANN, M.E., ARAÚJO, M.L., ALVES, M.L.M. & VIEIRA, M.I. 1980. Lista de répteis encontrados na região da Grande Porto Alegre, estado do Rio Grande do Sul, Brasil. Iheringia, Zool. 55: 27–36.

LEMA, T., VIEIRA, M.I. & ARAÚJO, M.L.D. 1983. Fauna reptiliana do norte da Grande Porto Alegre, Rio Grande do Sul, Brasil. Rev. Bras. Zool. 2(4): 203–227.

MAUHS, J. 2013. Vegetação da Bacia do Rio dos Sinos. In Projeto VerdeSinos – Resultados das pesquisas científicas (U.H. Schulz org). São Leopoldo: C5 News-Press, p. 72–88.

OLIVEIRA, J.M., MOURA, G.R., DA COSTA, L.J., PINHEIRO, C.C., VIEIRA, M.L. & FAGUNDES, M.V. 2013. Conversão de ecossistemas (1985-2010) e impacto do desmatamento de florestas ciliares na diversidade de árvores e arbustos na Bacia Hidrográfica do Rio dos Sinos. In Projeto VerdeSinos – Resultados das pesquisas científicas (U.H. Schulz org). São Leopoldo: C5 News-Press, p. 56–61.

PEEL, M.C., FINLAYSON, B.L. & MCMAHON, T.A. 2007. Updated world map of the Köppen-Geiger climate classification. Hydrology and earth system sciences discussions, 4(2): 439-473.

PLANO SINOS. 2014. Plano de Gerenciamento de Bacia Hidrográfica do Rio dos Sinos. Pró-Sinos. http://www.consorcioprosinos.com.br/downloads/PBHSINOS-R10-Volume%20%C3%9Anico.pdf (last access in 18 February 2017)

QUINTELA, F.M., MEDVEDOVSKY, I.G., IBARRA, C., NEVES, L.F.M. & FIGUEIREDO, M.R.C. 2011. Reptiles recorded in Marinheiros Island, Patos Lagoon estuary, southern Brazil. Herpetol. N. 4: 57–62.

SALA, O.E., CHAPIN, F.S., ARMESTO, J.J., BERLOW, E., BLOOMFIELD, J., DIRZO, R., HUBER-SANWALD, E., HUENNEKE, L.F., JACKSON, R.B., KINZIG, A., LEEMANS, R., LODGE, D.M., MOONEY, H.A., OESTERHELD, M., POFF, N.L., SYKES, M.T., WALKER, B.H., WALKER, M. & WALL, D.H. 2000. Global biodiversity scenarios for the year 2100. Science 287(5459): 1770–1774.

VERRASTRO, L., & BORGES-MARTINS, M. 2015. Biodiversidade de Répteis. In Os Campos do Sul (V.D.P. Pillar & O. Lange, eds.). Porto Alegre: Rede Campos Sulinos–UFRGS, p. 81–90.

Received: 14/02/2018
Revised: 02/05/2018
Accepted: 06/06/2018
Published online: 16/07/2018