Bol. Soc. Zool. Uruguay,
2ª época, 2010. 19: 1-19

AMPHIBIAN DIVERSITY OF URUGUAY: BACKGROUND KNOWLEDGE, INVENTORY COMPLETENESS AND SAMPLING COVERAGE

Andrés Canavero[1,2,3], Alejandro Brazeiro[1], Arley Camargo[4], Inés da Rosa[5], Raúl Maneyro[5] and Diego Núñez[5].

1. Grupo Biodiversidad y Ecología de la Conservación, Facultad de Ciencias, Universidad de la República, Uruguay. *acanavero@bio.puc.cl*
2. Center for Advanced Studies in Ecology & Biodiversity (CASEB), and Departamento de Ecología, Facultad de Ciencias Biológicas, Pontificia Universidad Católica de Chile, Chile.
3. Centro Universitario de Rivera, Universidad de la República, Uruguay, Ituzaingó 667.
4. Department of Biology, Brigham Young University, 177 WIDB, Provo, Utah 84602, USA.
5. Facultad de Ciencias, Universidad de la República, Uruguay.

ABSTRACT

The aim of this work is to update the scientific knowledge of Uruguayan amphibians. We address the trends of studies since the beginning of the 19^{th} century until today, describing the transition from descriptive studies focused on natural history to modern evolutionary and ecological perspectives. In order to assess the inventory completeness of the Uruguayan amphibians, we compiled 13,711 records from the main scientific collections in the country. Geographic distributions were derived from georeferenced records overlaid on a grid of 302 quadrants. We generated a cumulative species curve (quadrants as sampling units), which showed an asymptotic pattern with a maximum estimated value of 48 species (95%-confidence interval: 46-60), very close to the actual number of known species (50 species). The upper bound of the confidence interval reaches 60 species suggesting that 14 species could still remain unknown in the worst scenario. The data are heterogeneously distributed across the country: 43% of quadrants have no information, 50% are sub-sampled, and only 8% can be considered as well known. The extent of information gaps seriously challenges assessments of geographic distributions of the amphibian diversity at the quadrant resolution scale. Only the coastline borders of the Río de la Plata, the Atlantic coast, regions in the northern basaltic hills, and in the northwestern littoral zone, are relatively well known at this scale. We conclude that important sampling effort, mainly in the detected geographic information gaps, is needed to complete our knowledge about Uruguayan amphibian diversity.

Key Words: Amphibians, Biological Conservation, Geographic Distribution, Uruguayan Diversity.

RESUMEN

Diversidad de anfibios del Uruguay: estado de conocimiento, completitud del inventario y cobertura de muestreo. La meta de este trabajo es poner en perspectiva el conocimiento científico de los anfibios uruguayos. Analizamos las tendencias en el estudio de los anfibios desde principios el siglo XIX hasta nuestros días, describiendo la transición desde estudios descriptivos enfocados en la historia natural a modernos estudios evolutivos y ecológicos. A los efectos de evaluar la completitud de inventario de los anfibios de Uruguay, compilamos 13711 registros depositados en las principales colecciones científicas del país. La distribución geográfica de cada registro fue georeferenciado en una cuadrícula de 302 cuadrantes. Generamos una curva acumulada de especies (los cuadrantes como unidades de muestreo) que mostró un patrón asintótico, con un máximo estimado de 48 especies (Intervalo de Confianza: 46-60). Considerando el límite superior del intervalo de confianza del estimador (60 especies), 14 especies podrían permanecer desconocidas en el peor escenario. El grado de conocimiento se distribuye heterogéneamente en el país: 43% de los cuadrantes carecen de información, 50% están submuestreados y solo 8% puede ser considerado como bien conocido. La magnitud de los vacíos de información limita la capacidad de conocer apropiadamente la diversidad de anfibios a la resolución de cuadrante. Sólo el litoral del Río de la Plata, la costa atlántica, parte de la cuesta basáltica y el litoral Noroeste, están relativamente bien conocidos a esta escala. En tal sentido, aún resta un importante esfuerzo de muestreo, principalmente en los vacíos geográficos de información detectados, para completar nuestro conocimiento acerca de la diversidad de anfibios de Uruguay.

Palabras clave: Anfibios, Conservación Biológica, Distribución Geográfica, Diversidad Uruguaya.

INTRODUCTION

Conservation of biodiversity has to be based on a good knowledge of the taxonomy and distribution of the fauna and flora (Lomolino & Heaney, 2004). This knowledge is compiled in two basic forms: scientific publications and voucher specimens deposited in scientific collections (see Langone (2007) for Uruguayan amphibians). To assess the scientific knowledge of Uruguayan amphibians, (1) we reviewed the scientific publications to summarize a historical perspective of the study of Uruguayan amphibians, and (2) we assessed the inventory completeness of this threatened group of vertebrates (Blauustein & Wake 1995).

Taxonomy and Geographic Distributions

The first reference about the natural history of amphibians in Uruguay appeared at the beginning of the 19th century (see Klappenbach & Langone, 1992). The priest and naturalist Dámaso Antonio Larrañaga made the first descriptions of Uruguayan amphibians based on drawings and field notes of several native species (*Pseudis minuta*, *Hypsiboas pulchellus*, *Limnomedusa macroglossa*) that were published more than a century later (Larrañaga, 1823; Mañé Garzón, 2000; Mañé Garzón & Islas, 2000). After Larrañaga's pioneering work, several famous European naturalists, like A. d'Orbigny and C. Darwin, visited Uruguay in the mid-19th century. In the second half of the 19th century, several descriptive works included taxonomic classifications (Günther, 1859; Burmeister, 1861; Cope, 1862; Jiménez de la Espada, 1875; Boulenger, 1885; Berg, 1896). The first anuran species described from specimens collected in Uruguay (Montevideo) was *Pleurodema bibroni* (Tschudi, 1838). Subsequently, Duméril and Bibron (1841) described *Rhinella dorbignyi*, *Hypsiboas pulchellus*, *Leptodactylus gracilis,* and *Limnomedusa macroglossa* (also based on specimens from Montevideo). Several years later, Günther (1859) described *Pseudis minuta* from southern Uruguay and Jiménez de la Espada (1875) described *Leptodactylus latinatus*, again using specimens from Montevideo. At the beginning of the 20th century, Philippi (1902) described *Melanophryniscus montevidensis* with specimens from Montevideo and four decades later, this time with specimens from inland Uruguay, Schmidt (1944) described *Dendropsophus sanborni* (Departamento de Maldonado) and *Scinax uruguayus* (Quebrada de los Cuervos, Departamento de Treinta y Tres). A more complete historical perspective of the growth in the knowledge of amphibians from Uruguay can be found in Klappenbach and Langone (1992) and Maneyro and Carreira (2006).

The first species lists of amphibians from Uruguay are those of Langguth (1976, 34 species), de Sá (1986, 35 species), and Achaval (1989, 38 species) who recounted. These lists were based on the information from specimens deposited in collections as well as from publications reporting the discovery of new species for Uruguay (Vaz-Ferreira *et al.*, 1984), new species descriptions (Prigioni & Langone, 1986), and detailed accounts of geographic distributions (Prigioni, 1978; Prigioni, 1979; Prigioni & Langone, 1983; Langone & Basso, 1987). Another important source were the field surveys reported in Sierra *et al*. (1977), Achaval *et al*. (1979), and Prigioni and Langone (1984). Finally, Klappenbach and Langone (1992) reported 39 species and made an exhaustive compilation of the information available for each of these species.

In the last decade of the 20th century, several field surveys were published from eastern (Maneyro *et al*., 1995; Forni *et al*., 1995; Langone 1997), western (Cayssials *et al*., 2002), and northern Uruguay (Achaval, 1998). An important series of reports referred to as "Relevamientos de Biodiversidad", was published since 1998. This series contains species lists with remarks on the amphibians from Paso Baltasar, Departamento de Tacuarembó (González *et al*., 1998), Laguna de Castillos and Aguas Dulces, Departamento de Rocha (Gambarotta, 1999; González & Gambarotta, 2001), and Aguas Corrientes, Departamento de Canelones (Langone, 1999). All these studies constituted the baseline information for an updated species list of amphibians in Uruguay that reported a total of 43 species (Langone, 2003).

An intensification of field work, especially in northern and northwestern Uruguay (Departamentos de Artigas, Cerro Largo, Rivera, Tacuarembó y Treinta y Tres), has resulted in the discovery and/or description of 18.8% of all known amphibians from Uruguay in the last 11 years. Within this unprecedented boom of previously unknown biodiversity are included: *Rhinella achavali*, *Dendropsophus minutus*, *Hypsiboas albopunctatus*, *Leptodactylus furnarius, Melanophryniscus pachyrhynus*, *Odontophrynus maisuma, Physalaemus cuvieri*, *Scinax aromothyella*, *S. fuscovarius*, *Melanophryniscus langonei* (Olmos *et al.*, 1997; Arrieta & Maneyro, 1999; Canavero *et al.*, 2001; Kwet *et al.*, 2002; Maneyro *et al.*, 2004a; Borteiro *et al.*, 2005; Prigioni *et al.*, 2005; Maneyro & Beheregaray, 2007; Maneyro *et al*., 2008a; Rosset, 2008). In addition to these recently discovered species, we also include *Lithobates catesbeianus*, which is an exotic species introduced for commercial purposes and accidentally released to the wild with the consequential risk of negative interactions with the native amphibians, other vertebrates, and the ecosystem in general (Maneyro *et al*., 2005; Laufer *et al*., 2008).

The information generated by investigators associated to the Colección de Zoología Vertebrados of Facultad de Ciencias and the Museo Nacional de Historia Natural has been synthesized in the "Lista de los vertebrados del Uruguay" (Achaval, 2009), which allows its immediate update and easy access for a general public in an internet website. We also should add the records of new localities that provide useful data for more accurate estimates of geographic distributions within Uruguay (Prigioni & Langone, 1983; Naya & Maneyro, 2001; Borteiro & Kolenc, 2007). Lastly, we highlight the publications "Distribución geográfica de la fauna de anfibios del Uruguay" (Núñez *et al*., 2004) and the synthesis by Maneyro and Kwet (2008) about bufonids from the border region between Uruguay and Brazil that summarized all the information available up to the moment, which represent the baseline data for the preparation of this work.

Natural History

The larval stage of anurans, the tadpole, is mostly aquatic and therefore the study of the terrestrial adult stage alone is insufficient to understand the life history of amphibians (McDiarmid & Altig, 1999). In contrast to the adult stage, the progress in the knowledge of the larval life history of Uruguayan amphibians is still incipient. In spite of few examples, studies of larval biology are of major importance due to the unique reproductive biology of some species such as the tadpoles of *Leptodactylus ocellatus*, which aggregate to form schools and receive their mother's parental care (Vaz-Ferreira & Gerhau, 1975, 1986; Laufer & Maneyro, 2008). There has been a considerable surge in the study of anuran larvae in recent years in Uruguay, which is reflected in the description and re-description of the tadpoles of several species: *Hypsiboas pulchellus*, *Leptodactylus gracilis*, *L. latinasus*, *L. mystacinus*, *Melanophryniscus montevidensis, M. orejasmirandai*, *M. sanmartini, Physalaemus biligonigerus*, *P. riograndensis*, *P. fernandezae*, *P. gracilis*, *P. henselii*, *P. riograndensis*, *Pleurodema bibroni*, *Pseudopaludicola falcipes*, *Rhinella dorbignyi*, *Scinax aromothyella*, *S. uruguayus* (Garrido-Yrigaray, 1989; Langone, 1989; Prigioni & Langone, 1990; Prigioni & Arrieta, 1992; Prigioni & García Sánchez, 2002; Kolenc *et al*., 2003; Langone & de Sá, 2005; Alcalde *et al*., 2006; Borteiro *et al*., 2006; Kolenc *et al*., 2006; Borteiro & Kolenc, 2007; Borteiro *et al*., 2007; Kolenc *et al*., 2008; Laufer & Barreneche, 2008; Kolenc *et al*., 2009). We highlight a series of studies that described larval anatomical features and generated evolutionary inferences upon their descriptive work (Lavilla & Langone, 1995; de Sá & Lavilla, 1997; Langone & Cardoso, 1997; Larson & de Sá, 1998; Lavilla & de Sá, 1999; Kolenc *et al*., 2003; Larson *et al*., 2003). The discovery of albino larva of *Melanophryniscus montevidensis* (Maneyro and Achaval, 2004), and the confirmation of chytridiomycosis in frogs from Uruguay represent relevant reports with conservation implications. Borteiro *et al*. (2009) reported this fungal disease caused by *Batrachochytrium dendrobatidis* for the first time in histological analyses of larval *Hypsiboas pulchellus*, *Odontophrynus maisuma, Physalaemus henselii*, and *Scinax squalirostris* (Borteiro *et al*., 2009). Moreover, Mazzoni *et al*., (2003) reported chytridiomycosis in Uruguay in farms of *Lithobates catesbeianus*).

Other aspects of the biology of amphibians from Uruguay, beyond their morphology and geographic distribution, started with the first behavioral studies of Vaz-Ferreira and Gerhau (1974, 1975, 1986). The research of foreign herpetologists (e.g. Barrio, 1964; Gallardo, 1964) contributed extensively to the knowledge of the Uruguayan anuran fauna because their work included many species present in Uruguay. More recently, a number of studies were published about the biology of *Phyllomedusa iheringii* and *Limnomedusa macroglossa* (Gudynas & Gerhau, 1981; de Sá & Gerhau, 1983; Langone *et al*., 1985; Langone, 1993), the gametogenesis in *Chthonerpeton indistinctum* (de Sá & Berois, 1985, 1986), the pelvic osteology in the genera *Bufo* (actually *Rhinella*) and *Elachistocleis* (Prigioni & Langone, 1992), and the ecology of herpetological communities including analyses of resource partitioning (Gudynas, 1985; Gudynas & Rudolf, 1987). Rinderknecht (1998) is probably the more relevant reference from the paleontological perspective.

In the beginning of the 21st century, a remarkable increase in 'functional' studies of amphibians included analyses of adult's diets (da Rosa *et al.*, 2002; Maneyro & da Rosa, 2004; Maneyro *et al.*, 2004b; Berazategui *et al.*, 2007), ecophysiology (Naya *et al.*, 2002; Naya *et al.*, 2003), and reproductive biology (Camargo *et al*., 2005; Kwet *et al*., 2005; Maneyro *et al*., 2008b; Camargo *et al.*, 2008) of several anurans of Uruguay. More recently, there are numerous anatomical and chemical analyses of skin gland secretions of several bufonids (Naya *et al.*, 2004; Mebs *et al.*, 2005; Mebs *et al.*, 2007a; Mebs *et al.*, 2007b), karyotype descriptions of species in the *P. henselii* group (Tomatis *et al.*, 2009), the spatio-temporal structure of assemblages (Canavero *et al.*, 2008; Canavero & Arim, 2009; Canavero *et al.*, 2009; Maneyro, 2008), and a synthetic work of population and community ecology in a well studied frog community in Espinas Creek, Departamento de Maldonado (da Rosa *et al.*, 2006). Among the most comprehensive, relevant publications are those of Cei (1980, 1987), Lavilla and Cei (2001), and the species accounts of the "Catalogue of American Amphibians and Reptiles" made for *Chthonerpeton indistinctum* (Gudynas & Williams, 1992), *Hypsiboas albopunctatus* (de Sá, 1995), *Leptodactylus mystacinus* (Heyer *et al.*, 2003), and *Leptodactylus furnarius* (Heyer & Heyer, 2004). One of the first books for the general public that reviewed and summarized all information about the Uruguayan herpetofauna is Klappenbach and Orejas-Miranda (1969), followed by another book with more scientific rigor that provided a necessary update of the systematics and biology of anurans (Langone, 1995). Two years later, a photographic field guide for amphibians and reptiles of Uruguay with two subsequent editions (Achaval & Olmos, 1997, 2003, 2007) became a source of basic information, identification, and conservation for the general public. The first key of amphibians of Uruguay was Prigioni & Achaval (1992), which served as the basis for a recent updated version (Ziegler & Maneyro, 2008).

Conservation

Several methodologies have been used for evaluating the conservation status of Uruguayan amphibians. An example is the method proposed by Langone (1995) and Achaval and Olmos (2007), but the analyses of Maneyro and Langone (1999, 2001) have broader interest because they used the standardized SUMIN index Reca *et al.* ,1994), which was calculated for all 42 species known at that moment. At the present, all amphibian species from Uruguay are categorized using IUCN criteria via the "Global Amphibian Assessment" (GAA) (IUCN 2010) and there has been a recent summary of the conservation status in Uruguay published by the "Declining Amphibian Population Task Force" (Langone, in press). More recently and based on the application of IUCN criteria (IUCN 2003) within the Uruguayan territory, Canavero *et al.* (2010) published the Red List of Amphibians (and also Reptiles) of Uruguay.

Synthesis

In general terms, the progress of the study of amphibians has followed the trends of the zoological studies in Uruguay where the discipline went from an idiographic phase (dominated by descriptive studies of taxonomy and natural history) to a nomothetic phase with an emphasis in the search for general patterns and processes (Hess, 1997). This focal change does not imply a rejection of the taxonomy and natural history since the advances in the nomothetic phase lead necessarily to the description of new species, revision of existing species, and progress in the study of their natural history (Davyt *et al.*, 2006).

MATERIAL AND METHODS

In Uruguay, the Class Amphibia Gray, 1825 includes 50 known species belonging to two orders and nine families (Table 1). In order to assess the completeness of the amphibians inventory, we reanalyzed the data from Uruguayan scientific collections in the Museo Nacional de Historia Natural (MUNHINA) and the Zoología Vertebrados de la Facultad de Ciencias, Universidad de la República (ZVCB), as well as from records of Uruguayan specimens stored in the Colección Herpetológica del Instituto Nacional Malbrán (now Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"), published by Nuñez *et al*. (2004). We also updated the database with the new records housed at ZVCB until 2006.

To analyze the geographic distribution of this information, every record was georeferenced on a grid of 302 quadrants of about 30x22 km each based on the National Cartographic Plan and integrated into a Geographic Information System (GIS). The records with undefined geographic positions were removed from the analyses. A total of 13,711 records of amphibians were included from 46 out of the 50 species known in Uruguay. Four species were not included in the analyses because one of them is an introduced species (*Lithobates catesbeianus;* Maneyro *et al*., 2005; Laufer *et al*., 2008), and the other three species have not been described or cited yet for Uruguay at the time the databases were analyzed for this study (*Physalaemus cuvieri*, Maneyro & Beheregaray, 2007; *Odontophrynus maisuma*, Rosset, 2008; *Melanophryniscus langonei*, Maneyro *et al*., 2008a).

We made species accumulation curves for the complete dataset to determine how close the observed records account for the number of species estimated to occur in Uruguay. We used the software ESTIMATES (Colwell, 2006) to analyze the recorded species richness per quadrant and fit the model 'Chao 2' for estimating the maximum richness (with confidence interval of 95%).

To estimate the optimal sampling effort based on records per quadrant (i.e., number of records needed to get an accurate estimate of the richness in a quadrant), we fit a moving average smoothing (lag = 10) to the relationship between the observed richness and the sampling effort (number of records) on each quadrant. The optimal sampling effort was defined in the point where the curve reaches the asymptote.

RESULTS AND DISCUSSION

The curve of accumulated richness showed an asymptotic value at 46 species, and the estimated richness curve also reached an asymptote indicating that the estimation procedure converged (Fig. 1). The estimated maximum richness (mean) based on the model Chao2 was 48 species, which was only two species greater than the observed richness (46), meaning that 96% of the species present in Uruguay have been accounted for in scientific collections. However, considering the upper bound of the confidence interval, the maximum species richness could be as high as 60 species, and therefore 14 species could be still unknown, and the degree of knowledge would be as low as 77%. It should be noted that recently two new species of amphibians were described from Uruguay that were not included in this study: *Odontophrynus maisuma* and *Melanophryniscus langonei* (Maneyro *et al*., 2008a; Rosset, 2008), and a third one *Physalaemus cuvieri*, was cited for the first time for the country (Maneyro & Beheregaray, 2007).

Table 1. Amphibian fauna of Uruguay. The list of genera is based on Achaval (2009) with the additions of Maneyro & Beheregaray (2007), Maneyro *et al.* (2008a), and Rosset (2008).

Order	Family	Genus	Number of species
GYMNOPHIONA Müller, 1832	Caeciliidae Rafinesque, 1814	*Chthonerpeton* Peters, 1880	1
ANURA Fischer von Waldheim, 1813	Bufonidae Gray, 1825	*Melanophryniscus* Gallardo, 1961	7
		Rhinella Fitzinger, 1826	5
	Ceratophryidae Tschudi, 1838	*Ceratophrys* Wied, 1824	1
	Cycloramphidae Bonaparte, 1850	*Limnomedusa* Fitzinger, 1843	1
		Odontophrynus Reinhardt & Lütken, 1862	2
	Hylidae Rafinesque, 1815	*Argenteohyla* Trueb, 1970	1
		Dendropsophus Fitzinger, 1843	3
		Hypsiboas Wagler, 1830	2
		Lysapsus Cope, 1862 actually	1
		Pseudis, Wagler 1830	1
		Phyllomedusa Wagler, 1830	1
		Scinax Wagler, 1830	7
	Leiuperidae Bonaparte, 1850	*Physalaemus* Fitzinger, 1826	6
		Pleurodema Tschudi, 1838	1
		Pseudopaludicola Miranda-Ribeiro, 1926	1
	Leptodactylidae Werner, 1896	*Leptodactylus* Fitzinger, 1826	7
	Microhylidae Günther, 1858 (1843)	*Elachistocleis* Parker, 1927	1
	Ranidae Rafinesque, 1814	*Lithobates* Fitzinger, 1814	1

The observed richness per quadrant shows an asymptotic curve but it is highly influenced by very well surveyed quadrants with 1,000 to 3,000 records and high species richness (e.g., Departamento de Rivera) (Fig. 2). In the range of 0-500 records, there is also an asymptotic pattern where the observed richness increases up to 100 records and then becomes independent from the sampling effort. This suggests that the minimal sampling effort is about 100 records per quadrant (Fig. 2).

We found that 43% of the quadrants have no information (number of records = 0) and 50% of all quadrants can be classified as sub-sampled because they have less than 100 records (Fig. 3). Only 8% of the quadrants have more than 100 records and can be considered as well known.

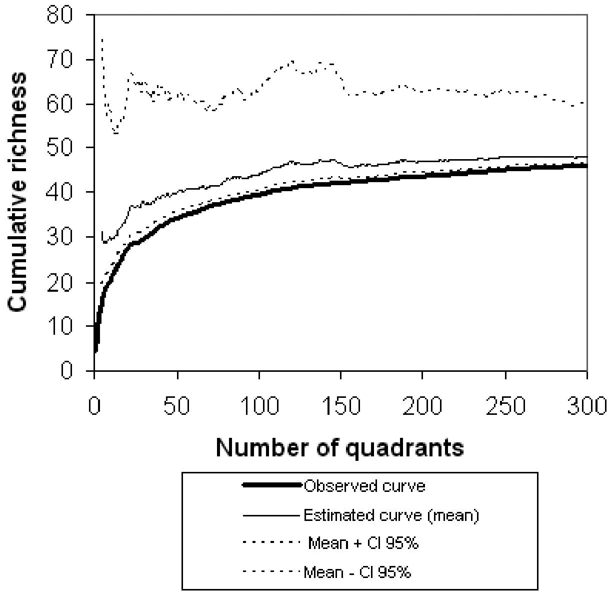

Fig. 1. Accumulated number of known species of amphibians in Uruguay based on records from scientific collections. The estimated richness was calculated with the Chao 2 index in the program Estimates. CI = confidence interval.

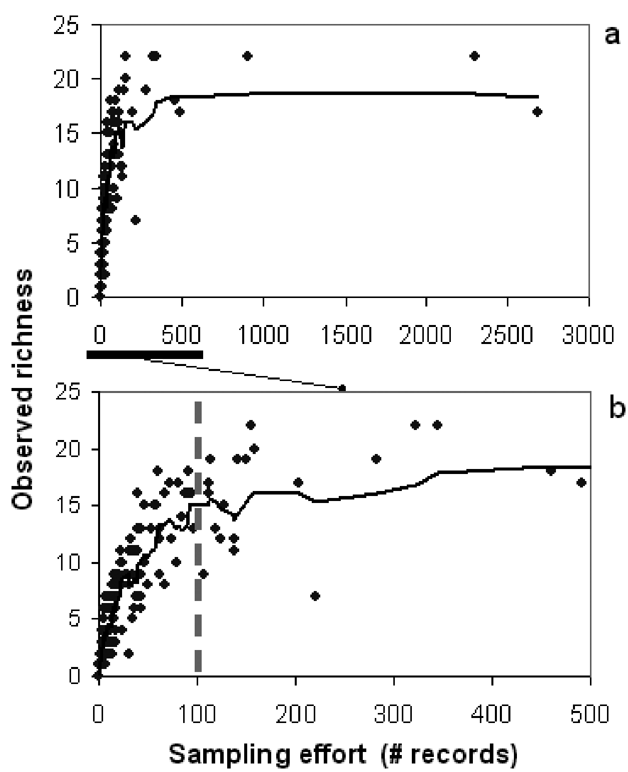

Fig. 2. Relationship between the observed richness per cell and the sampling effort (number of records) for all records (left) and for cells with 0-500 records (right). The relationship fit was done with moving average smoothing (lag = 10).

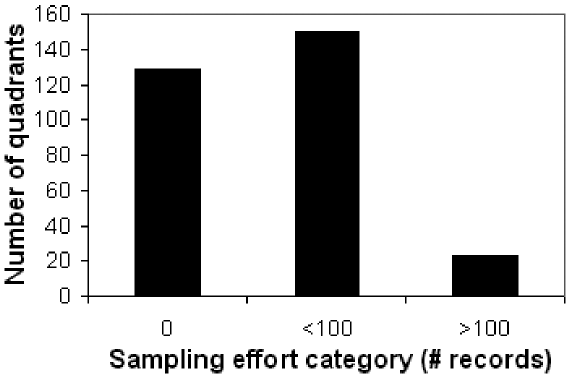

Fig. 3. Histogram of the sampling effort (number of records) of amphibians. Category 0: cells without records, category <100: undersampled cells, category>100: well-sampled cells.

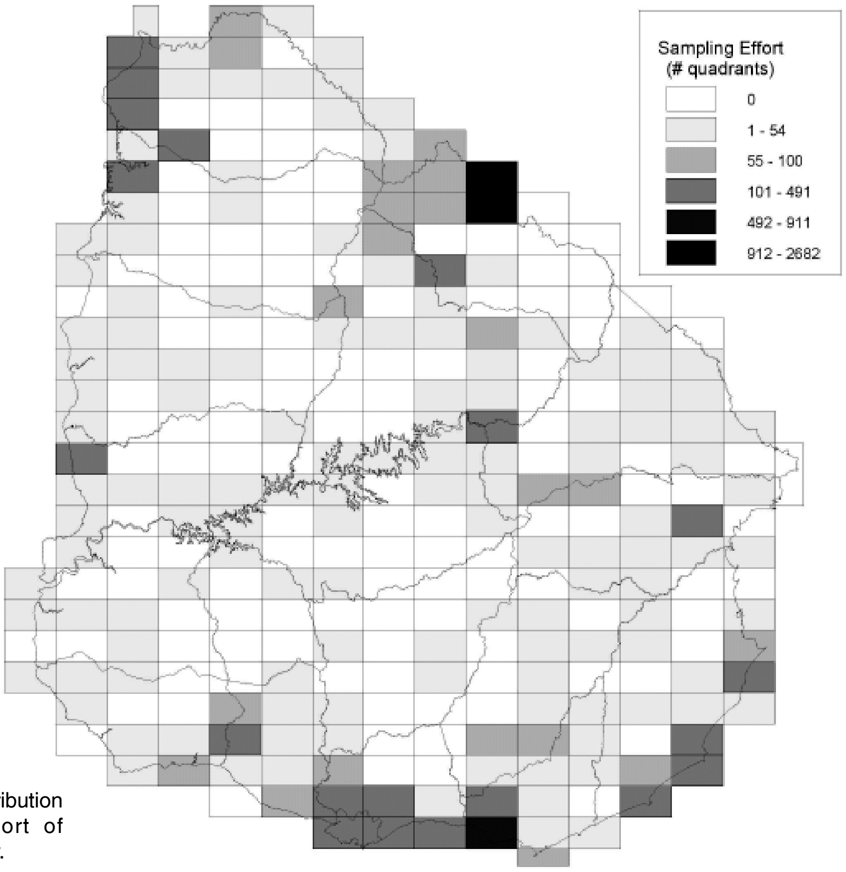

Fig. 4. Geographic distribution of the sampling effort of amphibians in Uruguay.

This indicates that the degree of knowledge of the amphibian diversity at the quadrant resolution, in terms of voucher specimens stored in scientific collections, is very limited (Fig. 3).

Because only 8% of the quadrants have been well sampled, it is clear that the geographic distribution of amphibians in most parts of the Uruguayan territory is unknown or poorly known. The quadrants with good sampling densities are associated with the coastline border of the Río de la Plata (Departamentos de San José, Montevideo, Canelones and western Maldonado), the Atlantic coast (mainly Rocha), parts of the basaltic hills (western Rivera and Tacuarembó), northwestern littoral zone (western Artigas and Salto), and some isolated quadrants sampled in a few intensive field surveys (e.g., Espinas Stream, in Maldonado).

CONCLUSION

The voucher specimens preserved in scientific collections, the digitized information from collection catalogs, and the syntheses made in previous studies (Maneyro & Langone, 2001; Núñez *et al.*, 2004; Maneyro & Kwet, 2008) provide vast amounts of distributional data in Uruguay and allows the generation of scientifically-informed conservation strategies. Herein, these data allowed us to detect the existence of information gaps in a large portion of Uruguay, which constitutes a useful guidance for planning the resources and efforts to fill these gaps in future field work.

Based on our estimates, a high percentage of the total richness in Uruguay is known, although new species may still remain undiscovered. However, this scenario is very different when we assess the degree of knowledge of geographic distributions at the scale of the quadrant. In this case, the sampling density showed considerable variation, where large regions had a deficit or show an absolute lack of information. In general terms, we conclude that the geographic distribution of the amphibian diversity in Uruguay has been surveyed in less than 50% at the analyzed resolution scale, especially in the central region of the country.

It is important to point out that a large portion of the information from scientific collections is based on historical records that do not demonstrate the occurrence of the species at the present. However, this information is critical for the analysis of long-term patterns in populations that appear to be declining: *Ceratophrys ornata* (this species could be considered extinct in future evaluations), *Melanophryniscus montevidensis*, and *Pleurodema bibroni* (Maneyro & Langone, 2001; Canavero *et al*. 2010). On the other hand, this kind of historical information might generate difficulties for inferring the present day distributions of species that can be used in conservation planning.

We should note that, although the knowledge of Uruguayan amphibian biology is broad, it is mostly restricted to the analysis of geographic distributions. There are far fewer studies about population dynamics, genetic and phenotypic variability, developmental biology, and other disciplines, especially in the case of the larval stage of these organisms, which in most species is virtually unknown. Given the complexity of the study of amphibians, due to their aquatic *vs*. terrestrial life histories and the lack of a complete knowledge of their geographic distributions, the generation of conservation strategies for amphibians in Uruguay is extremely difficult. In order to develop conservation plans, we suggest that it is essential to undertake field inventories in selected grid quadrants to survey largely unsampled regions of the country, especially those that have been proposed as candidate protected areas. We hope this article will become a tool for monitoring the status of conservation of Uruguayan amphibians and will work as baseline data for the implementation of a national system of protected areas in Uruguay (Hilton-Taylor, 2000). Moreover, long-term monitoring in protected areas as well as more research of the life history of most species will be required to contribute toward the conservation of amphibians for future generations.

ACKNOWLEDGMENTS

This work received partial financial support from the Programa de Desarrollo Tecnológico (DICYT, Uruguay), Project PDT 32-26 (Responsible: AB). RM acknowledges support from Comisión Sectorial de Investigación Científica (CSIC), Agencia Nacional de Investigación e Innovación (ANII) and Programa de Desarrollo de Ciencias Básicas (PEDECIBA). AC is grateful for the support of FONDECYT-FONDAP grant 1501-0001 and received a fellowship from the "Vicerrectoría Adjunta de Investigación y Doctorado-PUC, Chile".

REFERENCES

Achaval F. 1989. Lista de las especies de vertebrados del Uruguay. Parte 2: Anfibios, Reptiles, Aves y Mamíferos. Departamento de Publicaciones de la Facultad de Humanidades y Ciencias, Montevideo. 41 pp.

Achaval F. 1998. Anfibios. *In* Berrini, R. (Ed.). Cuenca Superior del Arroyo Lunarejo, pp. 66-69. Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente y Sociedad Zoológica del Uruguay. Tecnograf, Montevideo. 153 pp.

Achaval F. 2009. Lista de vertebrados de Uruguay. *In*. http://zvert.fcien.edu.uy.

Achaval F., González J.G., Meneghel M. & Melgarejo A. 1979. Lista comentada del material recogido en costas uruguayas, transportado por camalotes desde el Río Paraná. Acta Zoológica Lilloana 35.

Achaval F. & Olmos A. 1997. Anfibios y Reptiles del Uruguay. Barreiro y Ramos, Montevideo. 128 pp.

Achaval F. & Olmos A. 2003. Anfibios y Reptiles del Uruguay, Segunda Edición. Graphis, Impresora, Montevideo, Uruguay. 136 pp.

Achaval F. & Olmos A. 2007. Anfibios y Reptiles del Uruguay, Tercera Edición. Biophoto, Montevideo. 160 pp.

Alcalde L., Natale G.S. & Cajade R. 2006. The tadpole of *Physalaemus fernandezae* (Anura: Leptodactylidae). Herpetological Journal 16: 203-211.

Arrieta D. & Maneyro R. 1999. Sobre la presencia de *Scinax fuscovaria* (A. Lutz, 1925) (Anura: Hylidae) en Uruguay. Boletín de la Sociedad Zoológica del Uruguay 10: 15-19.

Barrio A. 1964. Relaciones morfológicas, eto-ecológicas y zoogeográficas entre *Physalaemus henseli* (Peters) y *P. fernandezae* (Müller) (Anura, Leptodactylidae). Acta Zoológica Lilloana 20: 285-305.

Berazategui M., Camargo A. & Maneyro R. 2007. Environmental and Seasonal Variation in the Diet of *Elachistocleis bicolor* (Guérin-Méneville 1838) (Anura: Microhylidae) from Northern Uruguay. Zoological Science 24: 225-231.

Berg C. 1896. Batracios argentinos. Enumeración sistemática, sinonímica y bibliográfica de los batracios de la República Argentina. Anales del Museo Nacional de Historia Natural de Buenos Aires 5: 147-226.

Blaustein A. & Wake D. 1995. Declive de las poblaciones de anfibios. Investigación y Ciencia 225: 8-13.

Borteiro C., Cruz J.C., Kolenc F. & Aramburu A. 2009. Chytridiomycosis in frogs from Uruguay. Diseases of Aquatic Organisms 84: 159-162.

Borteiro C. & Kolenc F. 2007. Redescription of the tadpoles of three species of frogs from Uruguay (Amphibia: Anura: Leiuperidae and Leptodactylidae), with notes on natural history. Zootaxa 1638: 1-20.

Borteiro C., Kolenc F., Tedros M. & Gutiérrez F. 2005. *Melanophryniscus pachyrynus*. [Geographic distribution]. Herpetological Review 36: 199-200.

Borteiro C., Kolenc F., Tedros M. & Prigioni C. 2006. The tadpole of *Chaunus dorbignyi* (Duméril & Bibron) (Anura, Bufonidae). Zootaxa 1308: 49-62.

Borteiro C., Nieto C. & Kolenc F. 2007. Amphibia, Anura, Hylidae, *Scinax aromothyella*: Distribution extension and habitat. Check List 3: 98-99.

Boulenger G.A. 1885. Second list of reptiles and batrachians from the Province Rio Grande do Sul, Brasil, sent to the Natural History Museum by Dr. H. von Ihering. Annals and Magazine of Natural History (Ser.5) 16: 85-88.

Burmeister H. 1861. Reise durch die La Plata-Staaten mit bessonderer. Röcksincht auf die physiche Beschaffenheit und den Culturzunstand der Argentinische Republik. Ausgeführt in den Jahren 1857, 1858, 1859 und 1860. H.W. Schmidt Halle. iv + 538 pp.

Camargo A., Naya D.E., Canavero A., da Rosa I. & Maneyro R. 2005. Seasonal activity and the body size-fecundity relationship in a population of *Physalaemus gracilis* (Boulenger, 1883) (Anura, Leptodactylidae) from Uruguay. Annales Zoologici Fennici 42: 513-521.

Camargo A., Sarroca M. & Maneyro R. 2008. Reproductive effort and the egg number vs. size trade-off in *Physalaemus* frogs (Anura: Leiuperidae). Acta Oecologica 34: 163-171.

Canavero A. 2008. Patrones de actividad en comunidades de anuros neotropicales: estacionalidad local y gradientes latitudinales MSc. Tesis. PEDECIBA. Universidad de la República, Montevideo, Uruguay. 1-74 pp.

Canavero A. & Arim M. 2009. Clues supporting photoperiod as the main determinant of seasonal variation in amphibian activity. Journal of Natural History 43: 2975-2984.

Canavero A., Arim M. & Brazeiro A. 2009. Geographic variations of seasonality and coexistence in communities: the role of diversity and climate. Austral Ecology 34: 741-750.

Canavero A., Arim M., Naya D.E., Camargo A., da Rosa I. & Maneyro R. 2008. Calling activity patterns in an anuran assemblage: the role of seasonal trends and weather determinants. North-Western Journal of Zoology 4: 29-41.

Canavero A., Carreira S., Langone J.A., Achaval F., Borteiro C., Camargo A., da Rosa I., Estrades A., Fallabrino A., Kolenc F., López-Mendilaharsu M.M., Maneyro R., Meneghel M., Nuñez D., Prigioni C.M. & Ziegler L. 2010. Conservation status assessment of the amphibians and reptiles of Uruguay. Iheringia, Série Zoologica 100: 5-12.

Canavero A., Naya D.E. & Maneyro R. 2001. *Leptodactylus furnarius* Sazima & Bokerman, 1978 (Anura: Leptodactylidae). Cuadernos de Herpetología 15: 89.

Cayssials R., Pérez F. & Maneyro R. 2002. Pautas para la elaboración de un Plan de Manejo para el Área de Esteros de Farrapos; Primera Parte: Medio Físico y Fauna. DINAMA-UDELAR. 148 pp.

Cei J.M. 1980. Amphibians of Argentina. Monitore Zoologico Italiano, Monografia 2: 1-609.

Cei J.M. 1987. Additional notes to “Amphibians of Argentina”: an update, 1980 - 1986. Monitore Zoologico Italiano (N.S.) 21: 209-272.

Colwell R.K. 2006. EstimateS 8.2: statistical estimation of species richness and shared species from samples. (http:// viceroy.eeb.uconn.edu/estimates).

Cope E.D. 1862. Catalogues of the reptiles obtained during the explorations of the Paraná, Paraguay, Vermejo and Uruguay Rivers by Capt. Thos. J. Page, U.S.N.; and of the procured by Lieut N. Michler, U.S. Top. Eng., Commander of the Expedition conducting the survey of the Atrato River. Proceedings of the Academy of Natural Sciences of Philadelphia 14: 346-359.

da Rosa I. 2008. Efecto de la temperatura y la humedad relativa sobre la actividad anual de canto de *Hypsiboas pulchellus* (Anura, Hylidae) y efecto del tamaño corporal sobre el comportamiento de los machos. MSc. Tesis. PEDECIBA. Universidad de la República, Montevideo, Uruguay. 1-79 pp.

da Rosa I., Camargo A., Canavero A., Naya D.E. & Maneyro R. 2006. Ecología de un ensamble de anuros en un humedal costero del sudeste del Uruguay. Pages 447-455 *in* Menagra R., Rodríguez-Gallego L., Sacarabino F. & Conde D. (Eds.). Bases para la conservación y el manejo de la costa uruguaya. Vida Silvestre Uruguay, Montevideo.

da Rosa I., Canavero A., Maneyro R., Naya D.E. & Camargo A. 2002. Diet of four sympatric anuran species in a temperate environment. Boletín de la Sociedad Zoológica del Uruguay 13: 12-20.

Davyt A., Maneyro R. & Bardier C. 2006. Caracterización preliminar de la actividad de los zoólogos en Uruguay: una aproximación desde la producción científica en vertebrados tetrápodos. Boletín de la Sociedad Zoológica del Uruguay 15: 8-18.

de Sá R.O. 1986. Lista de las especies de vertebrados del Uruguay. Anfibios. Dirección General de Extensión Universitaria. División Publicaciones y Ediciones. Universidad de la República, Montevideo.

de Sá R.O. 1995. *Hyla albopunctata* Spix, 1824. Catalogue of American Amphibians and Reptiles 602: 1-5.

de Sá R.O. & Berois N. 1985. Gametogénesis en *Chthonerpeton indistinctum* (Reinhardt & Lutken, 1862) (Amphibia: Gymnophiona). Boletin de la Sociedad Zoologica del Uruguay 3: 25-30.

de Sá R.O. & Berois N. 1986. Spermatogenesis and histology of the testes of *Chthonerpeton indistinctum* (Gymnophiona: Typhlonectidae). Journal of Herpetology 20: 510-514.

de Sá R.O. & Gerhau A. 1983. Observaciones sobre la biología de *Phyllomedusa iheringii* Boulenger, 1885, (Anura, Hylidae). Boletín de la Sociedad Zoológica del Uruguay 1: 44-49.

de Sá R.O. & Lavilla E.O. 1997. The tadpole of *Pseudis minuta* (Anura: Pseudidae): an apparent case of heterochrony. Amphibia-Reptilia 18: 229-240.

Duméril A. & Bibron G. 1841. Erpétologie générale, ou histoire naturelle des Reptiles. Libraire Encyclopédique de Roret, Paris. 792 pp.

Forni F., Maneyro R. & Santos, M. 1995. Anfibios y Reptiles. Serie de Cuadernos del Potrerillo. PROBIDES, Rocha. 16 pp.

Gallardo J.M. 1964. *Leptodactylus prognathus* Boul. y *L. mystacinus* (Burm.) con sus respectivas especies aliadas (Amphibia, Leptodactylidae del grupo Cavicola). Revista del Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, (Zoología) 9: 91-121.

Gambarotta J.C. 1999. Aves, Reptiles y Anfibios. Pages 1-31 *in* Gambarotta J.C., Saralegui A. & González E.M. (Eds.). Vertebrados tetrápodos del Refugio de Fauna Laguna de Castillos, Departamento de Rocha. Relevamientos de Biodiversidad 3: 1-31.

Garrido-Yrigaray R.R. 1989. Descripción de la larva de *Melanophryniscus stelzneri montevidensis* (Philippi,1902) (Anura: Bufonidae). Boletín de la Sociedad Zoológica del Uruguay 5: 7-8.

González E.M. & Gambarotta J.C. 2001. Anfibios de Aguas Dulces, Departamento de Rocha, Uruguay (Amphibia: Anura). Relevamientos de Biodiversidad 5: 1-7.

González E.M., Saralegui A. & Arrieta D. 1998. Anfibios y reptiles de Paso Baltasar, Departamento de Tacuarembó, Uruguay (Amphibia; Reptilia). Relevamientos de Biodiversidad 1: 1-6.

Gudynas E. 1985. Estructura ecológica de la comunidad herpetológica y evaluación del impacto ambiental en un ecosistema periurbano satélite. Actas de las Jornadas de Zoología del Uruguay 23-24.

Gudynas E. & Gerhau A. 1981. Notas sobre la distribución y la ecología de *Limnomedusa macroglossa* (Duméril & Bibron, 1841) en Uruguay (Anura, Leptodactylidae). Iheringia, Série Zoologia 60: 81-99.

Gudynas E. & Rudolf J.C. 1987. La herpetofauna de la localidad costera de “Pajas Blancas” (Uruguay): Lista sistemática comentada y estructura ecológica de la comunidad. Comunicações do Museu de Ciências da PUCRS 46: 173-194.

Gudynas E. & Williams J.D. 1992. *Chthonerpeton indistinctum*. Catalogue of American Amphibians and Reptiles 531: 1-2.

Günther A. 1859. Catalogue of the Batrachia Salientia in the collection of the British Museum, London. 160 pp.

Hess D. 1997. Science studies. An advanced introducction. New York University Press, New York.

Heyer W.R. & Heyer M.M. 2004. *Leptodactylus furnarius* (Burmeister). Catalogue of American Amphibians and Reptiles 785: 1-5.

Heyer M.M., Heyer W.R. & de Sá R.O. 2003. *Leptodactylus mystacinus* (Burmeister). Catalogue of American Amphibians and Reptiles 767: 1-11.

Hilton-Taylor C. 2000. IUCN Red List of Threatened Species. Gland and Cambridge, IUCN.

IUCN. 2003. Guidelines for Application of IUCN Red List Criteria at Regional Levels: Version 3.0.ii + 26.

IUCN 2010. *IUCN Red List of Threatened Species. Version 2010.1.* <http://www.iucnredlist.org>. Downloaded on 11 March 2010.

Jiménez de la Espada M. 1875. Vertebrados del viaje al Pacífico verificado de 1862 a 1865 por una comisión de naturalistas enviada por el gobierno español. Batracios, Madrid.

Klappenbach M.A. & Langone J.A. 1992. Lista sistemática y sinonímica de los anfibios del Uruguay con comentarios y notas sobre su distribución. Anales del Museo Nacional de Historia Natural de Montevideo (2ª Serie) 8: 163-222.

Klappenbach M.A. & Orejas-Miranda B. 1969. Anfibios y Reptiles. Editorial Nuestra Tierra. Montevideo.

Kolenc F., Borteiro C. & Tedros M. 2003. La larva de *Hyla uruguaya* Schmidt, 1944 (Anura: Hylidae), con comentarios sobre su biología en Uruguay y su status taxonómico. Cuadernos de Herpetología 17: 87-100.

Kolenc F., Borteiro C., Tedros M., Núñez D. & Maneyro R. 2006. The tadpole of *Physalaemus henselii* (Peters) (Anura: Leiuperidae). Zootaxa 1360: 41-50.

Kolenc F., Borteiro C., Baldo D., Ferraro D.P. & Prigioni C. 2009. The tadpoles and advertisement calls of *Pleurodema bibroni* Tschudi and *Pleurodema kriegi* (Müller), with notes on their geographic distribution and conservation status (Amphibia, Anura, Leiuperidae). Zootaxa 1969: 1-35.

Kolenc F., Borteiro C., Alcalde L., Baldo D., Cardozo D. & Faivovich J. 2008. Comparative larval morphology of eight species of *Hypsiboas* Wagler (Amphibia, Anura, Hylidae) from Argentina and Uruguay, with a review of the larvae of this genus. Zootaxa 1927: 1-66.

Kwet A., Maneyro R., Zillikens A. & Mebs D. 2005. Advertisement calls of *Melanophryniscus dorsalis* (Mertens, 1933) and *M. montevidensis* (Philippi, 1902), two parapatric species from southern Brazil and Uruguay, with comments on morphological variation in the *Melanophryniscus stelzneri* group (Anura: Bufonidae). Salamandra 41: 1-18.

Kwet A., Solé M., Miranda T., Melchiors J., Naya D.E. & Maneyro R. 2002. First record of *Hyla albopunctata* Spix, 1824 (Anura: Hylidae) in Uruguay, with comments on the advertisement call. Boletín de la Asociación Herpetológica Española 13: 15-19.

Langguth A. 1976. Lista de las especies de vertebrados del Uruguay. Anfibios, Montevideo. Museo Nacional de Historia Natural y Facultad de Humanidades y Ciencias, Dapartamento de Zoología Vertebrtados. Montevideo. 30-32 pp.

Langone J.A. 1989. Descripción de la larva de *Physalaemus gracilis* (Boulenger, 1883) (Amphibia, Anura, Leptodactylidae). Comunicaciones Zoológicas del Museo de Historia Natural de Montevideo 12: 1-11.

Langone J.A. 1993. Notas sobre *Phyllomedusa iheringii* Boulenger, 1885 (Amphibia, Anura, Hylidae). Comunicaciones Zoológicas del Museo de Historia de Montevideo 12: 1-7.

Langone J.A. 1995. Ranas y sapos del Uruguay (reconocimiento y aspectos biológicos). Museo Zoológico Municipal Dámaso Antonio Larrañaga, Montevideo.

Langone J.A. 1997. El componente faunístico de vertebrados tetrápodos marinos y terrestres. Anfibios. *In* PROBIDES (Ed.). Reserva de Biósfera Bañados del Este. Avances del Plan Director. Pp. 120- 121.

Langone J.A. 1999. Anfibios de Aguas Corrientes, Departamento de Canelones, Uruguay (Amphibia). Relevamientos de Biodiversidad 4: 1-6.

Langone J.A. 2003. Diversidad de la Biota Uruguaya. Amphibia. Anales del Museo Nacional de Historia Natural y Antropología (2ª Serie) 10: 1-12.

Langone J.A. 2007. Bibliografía asociada a especímenes depositados en las colecciones herpetológicas uruguayas (Amphibia). Publicación extra. Museo Nacional de Historia Natural y Antropología. 3: 1-22.

Langone J.A. *in press*. [Conservation of] Amphibia of Uruguay. *in* Heatwole, H., (Ed.). Amphibian Biology.

Langone J.A. & Basso N.G. 1987. Distribución geográfica y sinonimia de *Hyla nana* Boulenger,1889 y de *Hyla sanborni* Schmidt, 1944 (Anura, Hylidae) y observaciones sobre formas afines. Comunicaciones Zoológicas del Museo de Historia Natural de Montevideo 11: 1-17.

Langone J.A. & Cardoso A.J. 1997. Morfología larval externa de *Scinax eringhiophila* (Gallardo, 1961) (Amphibia, Anura, Hylidae). Comunicaciones Zoológicas del Museo de Historia Natural de Montevideo 12: 1-9.

Langone J.A. & de Sá R.O. 2005. Redescripción de la morfología larval externa de dos especies del grupo de *Leptodactylus fuscus* (Anura, Leptodactylidae). Phyllomedusa 4: 49-59.

Langone J.A., Prigioni C.M. & Venturino L. 1985. Informe preliminar sobre el comportamiento reproductor y otros aspectos de la biología de *Phyllomedusa iheringi*, Boulenger, 1885 (Anura, Hylidae). Comunicaciones Zoológicas del Museo de Historia Natural de Montevideo 9: 1-12.

Larrañaga D.A. 1823. Escritos. Instituto histórico y geográfico del Uruguay. Imprenta Nacional, Montevideo. 512 pp.

Larson P.M., & de Sá, R. O. 1998. Chondrocranial morphology of *Leptodactylus* larvae (Leptodactylidae: Leptodactylinae): its utility in phylogenetic reconstruction. Journal of Morphology 238: 287-305.

Larson P.M., de Sá R.O. & Arrieta D. 2003. Chondrocranial, hyobranchial and internal oral morphology in larvae of the basal bufonid genus *Melanophryniscus* (Amphibia: Anura). Acta Zoologica 84: 145-154.

Laufer G. & Barreneche J.M. 2008. Re-description of the tadpole of *Pseudopaludicola falcipes* (Anura: Leiuperidae), with comments on larval diversity of the genus. Zootaxa 1760: 50-58.

Laufer G., Canavero A., Núñez D. & Maneyro R. 2008. Bullfrog (*Lithobates catesbeianus)* invasion in Uruguay. Biological Invasions 10: 1183-1189.

Laufer G. & Maneyro R. 2008. Experimental Test of Intraspecific Competition Mechanisms Among Tadpoles of *Leptodactylus ocellatus* (Anura: Leptodactylidae). Zoological Science 25: 286-290.

Lavilla E.O. & Cei J.M. 2001. Amphibians of Argentina. A second update, 1987-2000. Museo Regionale di Scienze Naturali, Torino 28: 1-178.

Lavilla E.O. & de Sá R.O. 1999. Estructura del condrocráneo y esqueleto visceral de larvas de *Pseudis minuta* (Anura, Pseudidae). Alytes 16: 139-147.

Lavilla E.O. & Langone J.A. 1995. Estructura del condrocráneo y esqueleto visceral de larvas de *Elachistocleis bicolor* (Valenciennes, 1838) (Anura, Microhylidae). Cuadernos de Herpetología 9: 45-49.

Lomolino, M.V. & Heaney L.R. 2004. Frontiers of Biogeography: New Directions in the Geography of Nature. Sunderland, Massachusetts. 436 pp.

Maneyro R. 2000. Análisis del nicho trófico de tres especies de anfibios en un grupo de cuerpos de agua lénticos. MSc. Tesis. PEDECIBA. Universidad de la República, Montevideo, Uruguay. 1-99 pp.

Maneyro R. 2008. Padrões de atividade espaço - temporais em uma comunidade neotropical de anuros. PhD. Tesis. Pontifícia Universidade Catolica de Rio Grande do Sul, Porto Alegre, Brasil. 1-146 pp.

Maneyro R. & Achaval F. 2004. *Melanophryniscus montevidensis* (Darwin's Toad). Albino larvae. Herpetological Review 35: 261.

Maneyro R., Arrieta D. & de Sá R.O. 2004a. A new toad (Anura: Bufonidae) from Uruguay. Journal of Herpetology 38: 161-165.

Maneyro R. & Beheregaray M. 2007. First record of *Physalaemus cuvieri* Fitzinger, 1826 (Anura, Leptodactylidae) in Uruguay, with comments on the anuran fauna along the borderline Uruguay-Brazil. Boletín de la Sociedad Zoológica del Uruguay 16: 36-41.

Maneyro R. & Carreira S. 2006. Herpetofauna de la costa uruguaya. *In* R. Menafra, L. Rodríguez-Gallego, F. Scarabino & D. Conde (Eds.). Bases para la conservación y manejo de la Costa Uruguaya, pp. 233-246. Vida Silvestre Uruguay, Montevideo.

Maneyro R. & da Rosa I. 2004. Temporal and spatial changes in the diet of *Hyla pulchella*. Phyllomedusa 3: 101-113.

Maneyro R., Forni F. & Santos M. 1995. Los anfibios del departamento de Rocha. PROBIDES. Divulgación Técnica 1:1-24.

Maneyro R. & Kwet A. 2008. Amphibians in the border region between Uruguay and Brazil: Updated species list with comments on taxonomy and natural history (Part I: Bufonidae).

Stuttgarter Beiträge zur Naturkunde A, Neue Serie 1: 95-121.

Maneyro R. & Langone J.A. 1999. Advances in the conservation status of Uruguayan amphibians. Froglog 34:3.

Maneyro R. & Langone J.A. 2001. Categorización de los anfibios del Uruguay. Cuadernos de Herpetología 15: 107-118.

Maneyro R., Laufer G., Nuñez D. & Canavero A. 2005. Especies invasoras: Primer registro de rana toro, *Rana catesbeiana* (Amphibia, Anura, Ranidae) en Uruguay. Actas VIII Jornadas Zoológicas del Uruguay: 139.

Maneyro R., Naya D.E. & Baldo D. 2008a. A new species of *Melanophryniscus* (Anura, Bufonidae) from Uruguay. Iheringia, Série Zoologia 98: 189-192.

Maneyro R., Naya D.E., da Rosa I., Canavero A. & Camargo A. 2004b. Diet of the South American frog *Leptodactylus ocellatus* (Anura, Leptodactylidae) in Uruguay. Iheringia, Série Zoologia 94: 57- 61.

Maneyro R., Núñez D., Borteiro C., Tedros M. & Kolenc F. 2008b. Advertisement call and female sexual cycle in Uruguayan populations of *Physalaemus henselii* (Peters, 1872) (Anura: Leiuperidae). Iheringia, Série Zoologia 98: 210-214.

Mañé Garzón F. 2000. Un manuscrito inédito de Dámaso Antonio Larrañaga. Cuadernos de Marcha 59-64.

Mañé Garzón F. & Islas A. 2000. Viaje de Dámaso Antonio Larrañaga de Toledo a la villa de Florida. Cuadernos de Marcha 25-37.

Mazzoni R., Cunningham A.A., Daszak P., Apolo A., Perdomo E. & Speranza G. 2003. Emerging pathogen of wild amphibians in frogs *(Rana catesbeiana)* farmed for international trade. Emerging Infectious Diseases 9: 995-998.

McDiarmid R.W. & Altig R. 1999. Tadpoles: the biology of anuran larvae. The University of Chicago, Chicago. 444 pp.

Mebs D., Maneyro R. & Pogoda W. 2007a. Further studies on the pumiliotoxin 251D and hydroquinone content of the skin secretion of *Melanophryniscus* species (Anura, Bufonidae) from Uruguay. Toxicon 50: 166-169.

Mebs D., Pogoda W., Maneyro R. & Kwet A. 2005. Studies on the poisonous secretion of individual red bellied toads, *Melanophryniscus montevidensis* (Anura, Bufonidae), from Uruguay. Toxicon 46: 641-650.

Mebs D., Wagner M., Pogoda W., Kauert G., Maneyro R. & Kwet A. 2007b. Lack of bufadienolides in the skin secretion of red bellied toads, *Melanophryniscus* spp. (Anura, Bufonidae), from Uruguay. Comparative Biochemistry and Pharmacology 144: 398-402.

Naya D.E., Camargo A., Maneyro R., da Rosa I. & Canavero A. 2002. Intestinal length of four South American anuran species. Cuadernos de Herpetología 16: 165-167.

Naya D.E., Langone J.A. & de Sá R.O. 2004. Caracteristicás histologicás de la tumefacció frontal de *Melanophryniscus* (Amphibia: Anura: Bufonidae). Revista Chilena de Historia Natatural 77: 593-598.

Naya D.E. & Maneyro R. 2001. *Melanophryniscus sanmartini* Klappenbach, 1968 (Anura: Bufonidae). Cuadernos de Herpetología 15: 89-90.

Naya D.E., Maneyro R., Camargo A., Canavero A. & da Rosa I. 2003. Seasonal changes in gut length of the South American common frog *Leptodactylus ocellatus* (Amphibia, Anura). Biociências 11: 47-52.

Núñez D., Maneyro R., Langone J.A. & de Sá R.O. 2004. Distribución geográfica de la fauna de anfibios del Uruguay. Smithsonian Herpetological Information Service 134: 1-34.

Olmos A., Prigioni C.M. & Achaval F. 1997. *Hyla minuta* Peters, 1872. Un nuevo hylidae para el Uruguay (Amphibia: Anura: Hylidae). Acta Zoológica Platense 1: 1-7.

Philippi R.A. 1902. Suplemento a los Batracios Chilenos descritos en la Historia Física y Política de Chile de Don Claudio Gray. Imp. E. Blanchard-Chessi, Santiago. 161pp.

Prigioni C.M. 1978. Los verdaderos “escuerzos”. Boletín del Museo Nacional de Historia Natural 2: 4-6.

Prigioni C.M. 1979. Nuestra “Cecilia”. Boletín del Museo Nacional de Historia Natural 2: 8-10.

Prigioni C.M. & Achaval F. 1992. Clave para determinación de los anfibios de Uruguay. Servicio de Publicaciones Docentes Internas. Facultad de Ciencias. Universidad de la República, Montevideo.

Prigioni C.M. & Arrieta D. 1992. Descripción de la larva de *Melanophryniscus sanmartini* Klappenbach, 1968 (Amphibia: Anura: Bufonidae). Boletín de la Sociedad Zoologica del Uruguay 7: 57-58.

Prigioni C.M., Borteiro C., Tedros M. & Kolenc F. 2005. *Scinax aromothyella*. [Geographic distribution]. Herpetological Review 36: 464.

Prigioni C.M. & García Sánchez J.E. 2002. Descripción de la larva de *Physalaemus riograndensis* Milstead, 1960 (Anura, Leptodactylidae). Acta Zoológica Platense 5: 1-5.

Prigioni C.M. & Langone J.A. 1983. Nuevo hallazgo de *Physalaemus riograndensis* Milstead, 1960 (Anura, Leptodactylidae). Boletín de la Sociedad Zoológica del Uruguay 1: 81-84.

Prigioni C.M. & Langone J.A. 1984. Notas sobre la batracofauna de los bañados de Carrasco, Uruguay. I. Comunicaciones Zoológicas del Museo de Historia Natural de Montevideo 11: 1-4.

Prigioni C.M. & Langone J.A. 1986. *Melanophryniscus orejasmirandai* n. sp., un nuevo Bufonidae (Amphibia, Anura) de Uruguay con una clave para las especies del grupo tumifrons. Comunicaciones Zoológicas del Museo de Historia Natural de Montevideo 11: 1-11.

Prigioni C.M. & Langone J.A. 1990. Descripción de la larva de *Melanophryniscus orejasmirandai* Prigioni & Langone, 1986 (Amphibia, Anura, Bufonidae). Comunicaciones Zoológicas del Museo Nacional de Historia Natural 12: 1-9.

Prigioni C.M. & Langone J.A. 1992. Osteología pélvica de anfibios uruguayos I. Los géneros *Bufo* Laurenti, 1768 y *Elachistocleis* Parker, 1927 (Amphibia, Anura). Boletín de la Sociedad Zoologica del Uruguay 7: 96-97.

Reca A., Úbeda C. & Grigera D. 1994. Conservación de la fauna de tetrápodos. I. Un índice para su evaluación. Mastozoología Neotropical 1: 17-28.

Rinderknecht A. 1998. Nuevos microvertebrados fósiles para el Pleistoceno Superior del Uruguay (Amphibia, Reptilia, Aves). Comunicaciones Paleontológicas del Museo de Historia Natural de Montevideo 2: 133-143.

Rosset S.D. 2008. New Species of *Odontophrynus* Reinhardt and Lütken 1862 (Anura: Neobatrachia) from Brazil and Uruguay. Journal of Herpetology 42: 134–144.

Schmidt K.P. 1944. New frogs from Misiones and Uruguay. Field Museum of Natural History (Zoological Series) 29: 153-160.

Sierra B., Osorio H., Langguth A., Soriano J., Maciel E., Mora O., Ayup R., Lombardo A., Palerm E., Gonzalez J. & Achaval F. 1977. Ecosistemas afectados por la construcción de la represa de Salto Grande. Introducción a su prospección ecológica en territorio uruguayo. Seminario Medio Ambiente y Represas 1: 89-130.

Tomatis C., Baldo D., Kolenc F. & Borteiro C. 2009. Chromosomal variation in the species of the *Physalaemus henselii* group (Anura: Leiuperidae). Journal of Herpetology 43: 555–560.

Tschudi J.J.V. 1838. Classification der Batrachier, mit Bercksichtigung der Fossilien Thiere dieser Abtheilung der Reptilien. Mémories de la Société des Sciences Naturelles de Neuchâtel 1: 1-102.

Vaz-Ferreira R., de Sá R.O., Achaval F. & Gerhau A. 1984. *Leptodactylus podicipinus* (COPE, 1862) y *Leptodactylus chaquensis* CEI, 1959 (Anura, Leptodactylidae) en el Uruguay. Boletín de la Sociedad Zoológica del Uruguay 2: 72-77.

Vaz-Ferreira R. & Gerhau A. 1974. Protección de la prole en leptodactílidos. Revista de Biología del Uruguay 2: 59-62.

Vaz-Ferreira R. & Gerhau A. 1975. Comportamiento epimelético de la rana común *Leptodactylus ocellatus* (L.) (Amphibia, Leptodactylidae) I. Atención de la cría y actividades alimentarias y agresivas relacionadas. Physis 34: 1-14.

Vaz-Ferreira R. & Gerhau A. 1986. Comportamiento de los renacuajos gregarios de *Leptodactylus ocellatus*. Universidad de la República. Facultad de Humanidades y Ciencias. Dirección General de Extensión Universitaria. División Publicaciones y Ediciones. Montevideo. 23 pp.

Ziegler L. & Maneyro R. 2008. Clave para la identificación de los anfibios del Uruguay. DIRAC - Facultad de Ciencias, Universidad de la República, Montevideo, Uruguay. 72 pp.