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## IN SEARCH OF THE HORNED FROG (*CERATOPHRYS ORNATA*) IN ARGENTINA: COMPLEMENTING FIELD SURVEYS WITH CITIZEN SCIENCE

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**Abstract.**—The Horned Frog (*Ceratophrys ornata*) is a threatened amphibian that occurs in the temperate grasslands of Argentina, Brazil, and Uruguay. Several populations from Argentina have apparently declined and the species has not been recorded in Uruguay and Brazil for the last 35 y. In Argentina, published occurrence data based on field surveys are scarce, representing only a few localities in the Pampean Region. Considering that *C. ornata* is an iconic and distinctive species, we conducted a citizen science program to obtain occurrence data as a complement to field surveys. From 2008 to 2017, we used auditory and visual methods to survey adult *C. ornata* at 78 localities in the Pampean Region during both spring and summer. From 2015 to 2017, we conducted the citizen science program using online surveys and direct interviews to gather records obtained in the last 10 y. The citizen science program yielded 147 records, representing a nine-fold increase from the 15 records obtained during field surveys. The species occurrence areas estimated using each approach overlapped, although the area estimated by the citizen science program was almost double the extent of the occurrence area estimated based on field surveys. Our results indicate that well-designed citizen science methods can provide a cost-effective approach to collecting occurrence data for *C. ornata*. This is the first amphibian citizen science program in Argentina and provides a model for future amphibian studies, especially those involving charismatic yet difficult to study species like *C. ornata*.

**Key Words.**—amphibians; distribution; grasslands; rural communities; South America

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### INTRODUCTION

The Horned Frog (*Ceratophrys ornata*; Appendix 1) is an amphibian species that occurs in the South American temperate grasslands. The historical distribution included the Pampean Region of Argentina, San José and Rocha Departments in Uruguay, and Río Grande do Sul State in Brazil (Maneyro and Carreira 2006). However, the species has not been recorded in Uruguay and Brazil in the last 35 y (Carreira and Maneyro 2015). Its global conservation status is Near Threatened (International Union for the Conservation of Nature [IUCN] 2016), while it is considered as Vulnerable in Argentina (Vaira et al. 2012) and Uruguay (Carreira and Maneyro 2015) and Critically Endangered in Brazil (Secretaria do Meio Ambiente 2014). The major threat to the species is habitat loss from agriculture and housing developments (Vaira et al. 2012). Water and soil pollution from agriculture, industry, and human settlements have also been suggested as factors causing population declines (Kwet, A., G. Skuk, D. Silvano, E. Lavilla, I. di Tada, and R. Lajmanovich. 2004. *Ceratophrys ornata*. The IUCN Red List of Threatened Species 2004: e.T56340A11464790.<http://dx.doi.org/10.2305/IUCN>.

UK.2004.RLTS.T56340A11464790.en [Accessed 23 March 2017]). Moreover, *C. ornata* is often persecuted because of unfounded beliefs that it is a venomous species, and it is illegally collected for the international pet trade (Kwet et al., *op. cit.*).

In Argentina, the estimated distributional range of *C. ornata* coincides closely (about 80% overlap) with the Pampean Region (AmphibiaWeb, University of California, Berkeley. 2017. Information on amphibian biology and conservation. Available from <http://amphibiaweb.org> [Accessed 23 Mar 2017]). The Pampean Region is one of the most human-impacted areas of the country and several vertebrate species in the region have already been documented as in decline (Demaría et al. 2004; Codesido et al. 2013). Given these threats, there is an urgent need to identify appropriate conservation actions aimed at protecting this species.

We established The Giant of the Pampas initiative as a way to draw attention to this species and develop conservation measures. The first step in developing these actions is to better define where the species currently occurs. Occurrence data published in the last 30 y are scarce, only representing data from eight localities in the Pampean Region (Kaccoliris et al. 2006; Agostini et

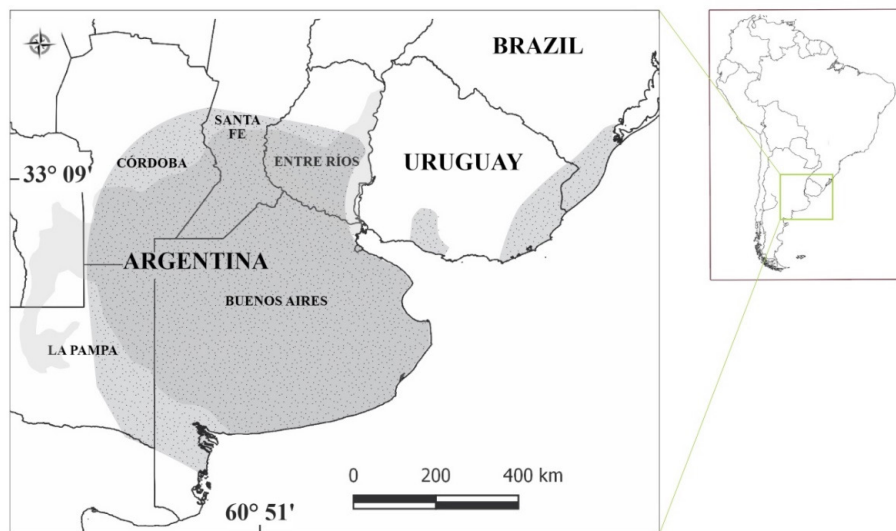


FIGURE 1. Map of the study area in Argentina, Uruguay, and Brazil. Gray surface represents the Pampean Region. Stippled surface represents the estimated distributional range of *Ceratophrys ornata* (Horned Frog; AmphibiaWeb. 2017. *op. cit.*). We conducted surveys in the areas of the Pampean Region overlapped by the estimated range of the species.

al. 2012; Agostini et al. 2016). This paucity of records likely reflects a combination of smaller population sizes as a consequence of declines (Begon et al. 1996) and natural history characteristics that make *C. ornata* difficult to sample and monitor in the field, specifically its burrowing habit and a short and unpredictable reproductive period (Ceí 1980). Given the challenges in expanding our knowledge of the distribution of this species, we decided to assess the potential benefits of employing citizen-science surveys of rural communities as a complement to traditional field surveys.

Citizen science is a method of integrating public outreach and scientific data collection locally, regionally, and across large geographic scales (Cooper 2007; Bonney et al. 2009). The citizen science model engages a dispersed network of volunteers to assist in professional research using methodologies that have been developed by, or in collaboration with, professional researchers (Trumbull et al. 2000; Silvertown 2009). In recent years, citizen science has become a valuable component to many fields of scientific research (Cohn 2008; Silvertown 2009; Miller-Rushing et al. 2012). Currently, at least 66 citizen science projects are already collecting amphibian or reptile data mostly from North America, Canada, Australia, South Africa, and the UK (Cosentino et al. 2014; Petrovan and Schmidt 2016). Additionally, the current use of citizen science methods in road-based studies has enabled the application of long-term datasets for amphibian population trend estimation, resolving statistical issues related to the heterogeneous datasets with imperfect detection and variable effort (Bonardi et al. 2011). However, these methods have been poorly developed in Argentina and, as far as we

know, there are no studies applying citizen science as a tool for surveying amphibians. Our goal was to assess whether citizen science could provide an effective complement to field surveys for gathering occurrence data for *C. ornata* in the Argentinean Pampas.

## MATERIALS AND METHODS

**Study site.**—Because approximately 80% of the estimated distributional range of *C. ornata* occurs in the Argentinean Pampean Region, we focused our work in this area. The Pampean Region includes Buenos Aires, Córdoba, Entre Ríos, La Pampa, and Santa Fe Provinces, covering an area of approximately 540,000 km<sup>2</sup> (Fig. 1).

**Field survey.**—From 2008 to 2017, we conducted field surveys to assess occurrence of *C. ornata*. We surveyed adults in breeding sites during both spring (October to December) and summer (December to March) especially after heavy rainfall, a circumstance that has been shown to be coincident with high adult activity (Ceí et al. 1980). To select breeding sites, we used satellite images from Google Earth (Google Earth Pro v.7.3.0.3832. 2017. Satellite images. Available from <http://www.google.es/earth/download/gep/agree.html> [Accessed January 2017]) to identify likely temporary flooded areas. In those areas, we randomly select a subset of 78 localities (we assigned the same locality to the breeding sites if they were < 1 km apart) from the pool of 313 potential breeding sites, and waited for rainfall of > 30 mm before sampling (Instituto Nacional de Tecnología Agropecuaria. 2017. Meteorological Radar Network. Available from <http://radar.inta.gov.ar/>

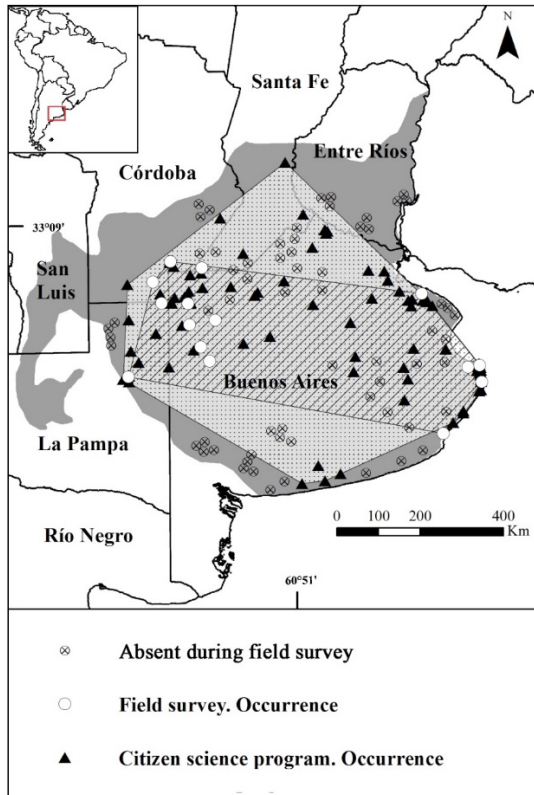


FIGURE 2. Occurrence areas of *Ceratophrys ornata* (Horned Frog) in Argentina estimated from field survey (striped polygon) and citizen science program (stippled polygon). Dark gray surface indicates the extension of the Pampean Region.

v3/ [Accessed 2008 to 2017]). We surveyed each site once. Two people conducted nocturnal surveys (2100–0300) using auditory and visual-encounter methods (Heyer et al. 1994). Auditory survey involved 15 min of listening and visual-encounter survey consisted in three  $30 \times 2$  m transects in each breeding pool.

**The citizen science program.**—To obtain records of *C. ornata* as a complement to field surveys, we developed a citizen science program including two types of surveys: online surveys and direct interviews. We conducted the program from January 2015 to September 2017. To make possible a comparison with occurrence data from field surveys, we only considered the citizen science records reported between 2008 and 2017.

The online survey form was intended for farmers, biologists, naturalists, and other citizens capable of recognizing the species (Appendix 1). We considered the records valid only if they were accompanied by a photograph or if they came from qualified people (biologists, naturalists, and rangers). We conducted the survey using Google Surveys (<https://docs.google.com/forms/d/1rrRn7D4vUlmagidzvKGKyzemOfepMa-HoopIHn6UXVA/edit>) and several social networks (Facebook: <https://www.facebook.com/conservacionagroecosistemas/>,

Twitter: @AnfibiosCoAnA, Web page: <http://coana.com.ar/>, and YouTube Channel: <https://www.youtube.com/channel/UCgqyeyrTPVajQcgecSD42yQ>). We also promoted this survey in Brazil and Uruguay using the same social networks. The survey form gathered the following data: location (country, province, and georeferenced data points), date, habitat description, climatic conditions (a brief description of temperature or if it was a sunny or rainy day), number of individuals observed, sex (male/female/not detailed), age (adult/juvenile/tadpole/not detailed) and activity (vocalizing/moving/dead on roads/amplexus/other).

We used direct interviews to collect data in rural areas where internet access was limited. These interviews included the same data described for the online survey form. We used a sheet containing several amphibian photographs, including *C. ornata* and other common frog and toad species that could be confused with it (Argentine Common Toad, *Rhinella arenarum*; Cururu Toad, *Rhinella schneiderii*; Common Lesser Escuerzo or American Ground Frog, *Odontophrynus americanus*; Chacoan Horned Frog, *Ceratophrys cranwelli*; Creole Frog, *Leptodactylus latrans*). Using photos and asking people about some unique behavioral features (like the typical and well-described defense behavior) allowed us to validate records.

**Data analysis.**—We estimated the occurrence area of *C. ornata* using a minimum convex polygon approach to compare patterns of occurrence estimated from field surveys to those obtained via citizen science surveys. For this we used the convex hull function (ArcGIS 10.2; Esri, Redland, California, USA). We excluded records without georeferenced data points from the analysis.

## RESULTS

During field surveys conducted from 2008 to 2017, we documented occurrence of *C. ornata* in 15 of the 78 sampling localities in Argentina (Fig. 2). In the citizen science program between 2015 and 2017, we received 125 records from the online survey forms, 12 of which were misidentified. The species that were confused with *C. ornata* were *Ceratophrys cranwelli* and *Odontophrynus americanus*. Additionally, we excluded 15 records without photographs, resulting in 98 valid records. All the records were from Argentina (Fig. 2), and we received no confirmed records from Brazil or Uruguay. Online surveys were highly successful in ensuring inclusion of georeferenced data points (100%). In total, online surveys documented occurrence of *C. ornata* in 74 localities from the Pampean Region. It is important to note that we received 31 records obtained in different years from the same seven localities (Trenque

Lauquen, Banderoló, General Villegas, Santa Teresita, Mar del Tuyú, and San Clemente), highlighting a higher frequency of occurrence in these areas. The online survey also provided habitat description data (96%), even though data about climatic conditions were poorly provided (50%).

We conducted 62 direct interviews in rural communities, obtaining 49 confirmed records of *C. ornata* occurrence (Fig. 2). We dismissed 13 records because the interviewees were not able to recognize the species, confusing it with *Odonthophrynus americanus*, *Cerathophrys cranwelli*, or *Rhinella arenarum*. Most of the interviewees did not remember the exact location where they registered the species so we only obtained the georeferenced data points from 65.3% of surveys (32 localities). Additionally, most of the interviewees failed to provide an adequate description of the climatic conditions and habitat description. Based on data obtained during field survey and the citizen science program, the estimated occurrence areas were 190,986 km<sup>2</sup> and 320,253 km<sup>2</sup>, respectively (Fig. 2).

## DISCUSSION

Our results indicate that a well-designed citizen science method can provide a cost-effective approach to collecting occurrence data on species like *C. ornata*, which can be difficult to detect but are readily identifiable. Through the application of the citizen science program, we increased the number of occurrences obtained in 10 y of field surveys by about nine times. The occurrence area estimated using both techniques overlapped, although the area estimated by the citizen science program was almost double the extent of the occurrence area estimated based on field surveys.

In addition to increasing the number of documented occurrences of *C. ornata*, we were also able to improve our understanding of the distribution of the species. Previously published records of *C. ornata* (Kaccoliris et al. 2006; Agostini et al. 2012; Agostini et al. 2016) suggest a disjunct distribution, with two areas of occupancy, one on the east of the Pampean Region and one on the west, and an intervening area where the species had not been found. This pattern was clearly modified by the citizen science data, which demonstrated a continuous occurrence of the species across the study area.

While our research has expanded our understanding of the current distribution of *C. ornata* in the Pampean Region, it is important to note that the predicted distribution of this species also encompasses the Espinal Region of Argentina (AmphibiaWeb. 2017. *op. cit.*). We strongly suggest that further field work is needed to determine if *C. ornata* occurs in the Espinal Region and also in marginal areas of the Pampean Region where we did not confirm its presence. A proper

species distribution analysis including records from field surveys as well as historical data from museum herpetological collections is needed to determine the current geographic distributions of *C. ornata*.

We did not conduct personal interviews in Brazil and Uruguay; however, the lack of records obtained from the online survey coincides with the results coming from field monitoring (Maneyro and Langone 2001). Based on the apparent decline and extinction of populations from Uruguay (Gambarotta 1999), and the lack of records from Brazil and Uruguay during the last 35 y (Carreira and Maneyro 2015), currently available data indicate that the distribution of the *C. ornata* is restricted to the Argentinean grasslands. Nonetheless, a more exhaustive citizen science strategy could contribute to our understanding of the *C. ornata* population status for both Brazil and Uruguay.

Efforts to successfully conserve and recover populations of endangered species are increasingly recognizing the importance of working closely with local communities (Smith and Sutherland 2014). Our citizen science program included a strong outreach campaign primarily intended to encourage people to collect and report occurrence data. Because we developed this program within the framework of a comprehensive conservation strategy, the outreach campaign was also designed to promote and raise awareness of *C. ornata*, the threats it is facing, and other conservation issues. This extensive work allowed us to maintain contact with farmers who are still reporting occurrence data of the species, playing an important role for future monitoring studies needed to set up conservation actions.

Up to 175 amphibian taxa occur in Argentina, 51 of which are threatened or under some threat category (Vaira et al. 2012). Many of these amphibians have characteristics that make them especially difficult to sample and monitor in the field (e.g., fossorial habits and reproductive cycles that are not very predictable). As far as we know, this is the first program using citizen science aimed at collecting amphibian data in Argentina. We hope that our program will show the scientific community the relevance of citizen science and serve as a model to be used in future amphibian studies in Argentina, especially those involving threatened and/or iconic species.

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**GABRIELA AGOSTINI** is an Assistant Researcher at the Ecology, Genetic and Evolution Institute (UBA-CONICET) where she studies the impacts of agricultural practices on amphibian assemblages in Argentina. For five years she has led the initiative Amphibian Conservation in Agro-ecosystems (COANA). This initiative joins efforts of private rural institutions, non-governmental organizations, and government agencies, and it includes research and education activities. Gabriela has also collaborated with other conservation amphibian initiatives in the neotropics, including projects with endangered species in Bolivia, Puerto Rico, and different corners of Argentina. (Photographed by Pablo Saibene).

## APPENDIX 1

Registros del Escuerzo común (*Ceratophrys ornata*)

### Registros del Escuerzo común (*Ceratophrys ornata*)

*Ceratophrys ornata* es un anfibio anuro que habita uno de los ecosistemas más alterados de Argentina: el pastizal pampeano. Esta especie ha experimentado recientes retracciones poblacionales y cuenta con estatus de conservación Casi Amenazada (IUCN) a nivel global y Vulnerable a nivel nacional. Desde Conservación de Anfibios en Agroecosistemas (CoAnA) estamos investigando diferentes aspectos relacionados con esta especie para generar acciones de conservación. Necesitamos reunir la mayor cantidad de registros posibles que a su vez sean confiables. Agradeceremos enormemente que completes esta breve encuesta si alguna vez fuiste tan afortunado de cruzarte con un escuerzo.

Algunas cosas importantes

1. Si tenés fotos del registro envialas a [gigantedelaspampas@gmail.com](mailto:gigantedelaspampas@gmail.com)
2. En caso de que necesites cargar más de un registro, al enviar la primer encuesta podrás iniciar una nueva y con ella un nuevo registro.
3. Para más información sobre *Ceratophrys ornata* podés consultar a: <http://anfibiosconservacionenagroecosistemas.blogspot.com.ar/2014/12/anfibios-de-argentina-ceratophrys-ornata.html>

\*Obligatorio

### Escuerzo común (*Ceratophrys ornata*)



1. Nombre del observador \*

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2017-5-23

Registros del Escuerzo común (Ceratophrys ornata)

2. **Profesión/Trabajo \***

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3. **Mail de contacto \***

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4. **Localidad del registro \***

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5. **Provincia \***

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6. **País**

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7. **Coordenadas geográficas**

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8. **Fecha \***

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9. **Hora**

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10. **Ambiente \***

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11. **Descripción de las condiciones climáticas**

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12. **Cantidad de individuos observados \***

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2017-5-23

Registros del Escuerzo común (Ceratophrys ornata)

**13. Sexo \***

*Marca solo un óvalo.*

- Hembra
- Macho
- Juvenil
- Indeterminado

**14. Actividad \***

*Marca solo un óvalo.*

- En amplexo
- Desplazándose
- Vocalizando
- Muerto en caminos o rutas
- Otro: \_\_\_\_\_

**15. Comentarios**

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Con la tecnología de  
 Google Forms