



# Human attitudes as threats in amphibians: the case of the Ornate Horned Frog (*Ceratophrys ornata*)

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## ABSTRACT

We analyzed the characteristics of the human-animal conflict coming from the attitudes that local communities have toward *Ceratophrys ornata*, focusing on two threats: aversion and pet trade. Surveys conducted in Argentina, Brazil and Uruguay ( $n = 194$ ) showed a strong aversion to this species (45% of respondents), causing the death of at least 364 individuals. This aversion was strongly linked to symbolism and folklore beliefs, and also influenced by gender and education level. Pet trade interviews ( $n = 30$ ) showed that 77% of the specimens kept in captivity were wild-caught ( $\approx 178$  individuals). The killing of specimens based on aversion might have impacts at local level, especially in populations occurring in recent urbanized areas. Our results also revealed that capture of specimens for pet trade is an ongoing process. Due to the context of illegality in which trade occurs, it is highly challenging to determine/predict the extent of impacts.

## KEYWORDS

Aversion; pet trade; conservation; environmental education; neotropics

## Introduction

Amphibian populations have been declining globally in the last three decades and are at the forefront of the biodiversity crisis (6,680 species, 41% Threatened) (Bishop et al., 2012; IUCN, 2020). Several factors have been proposed as causes of the global amphibian decline, including habitat loss, pollution, introduced exotic species, disease, climate change and overexploitation related to the pet trade and food industry (Blaustein et al., 2011). The Neotropical realm contains nearly half of all amphibian species known in the world, most of which are endemic. This region also contains the largest proportion of threatened and extinct amphibian species worldwide (Bishop et al., 2012; IUCN, 2020). While studies have documented amphibian populations declines, few of them have explored the human attitude, values and folklore related to the threatened species (Ceríaco, 2012).

Humans and wildlife interact with each other in ways that can range from reverence to extreme conflict (Hunt, 2008). On the one hand, humans have valued nature and wild species in many contexts and situations. Wild species can have cultural and social relevance and be valued as resources. On the other hand, humans often and increasingly come into

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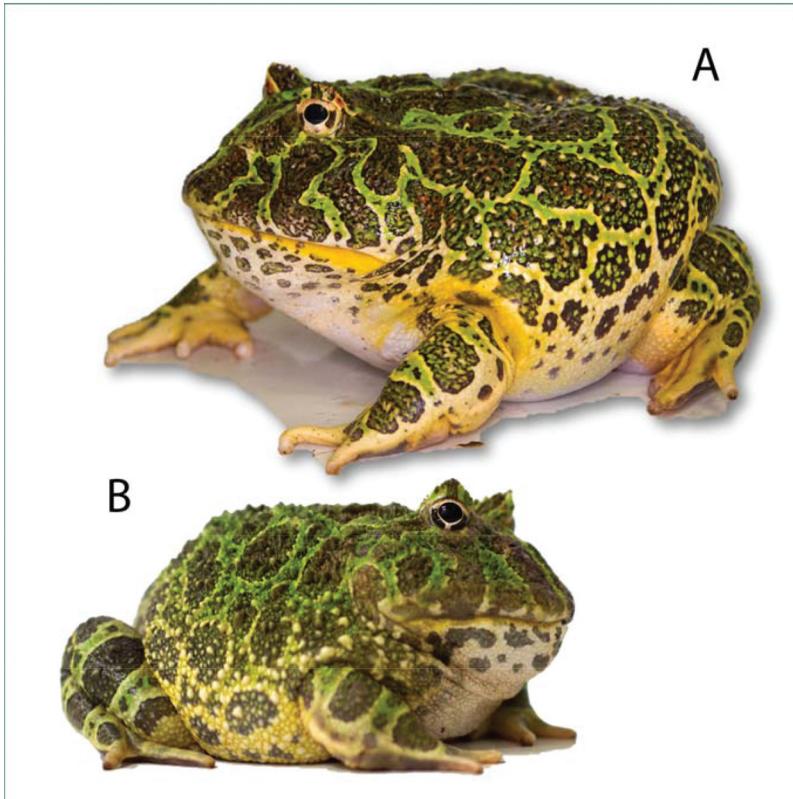
conflict with wildlife (Woodroffe et al., 2005). These conflicts between people over wildlife are widespread and damaging to both the wildlife and people involved. Such issues are often termed human-wildlife or human-animal conflicts (Redpath et al., 2015). Human-wildlife conflicts can take various forms (e.g., carnivores attacking and killing livestock or humans, species raiding crops). Conflicts also occur when humans deliberately injure, abuse, extract or kill wildlife because of perceived threats toward their property, livelihood or family (Madden, 2008). It has also been pointed out that conceptualization of nature and perception associated with religious or cultural beliefs and myths can shape other forms of human-wildlife conflict (Dickman & Hazzah, 2016).

Amphibians are animals that frequently go unnoticed or even generate antipathy among ordinary people (Ceríaco, 2012; Gibbons, 2003). In many regions, communities are averse to amphibian species because they feel disgusted, fearful, or believe that these animals are poisonous or disease-causing. These feelings lead people to exhibit attitudes such as throwing salt, hot water, or simply killing them when an encounter happens (Brom et al., 2020; Oliveira & Silva-Santana, 2015; Prokop & Fančovičová, 2012). This widespread lack of knowledge and the feelings of fear and repulsion rooted in certain cultures determine that amphibians are not traditionally a matter of public concern for conservation (Ceríaco, 2012).

While for some people amphibians are despicable and repulsive creatures, for others, amphibians are fascinating animals promoting their captivity (Brom et al., 2020; Burghardt, 2017). The desire to own an amphibian pet is growing and, with it, an increase in amphibian trade and the negative impacts on native populations, including disease transmission and invasive amphibian populations (Measey et al., 2019). Trade-in wildlife is globally an important billion-dollar industry (Nellemann et al., 2016) and amphibians and reptiles are among the most traded animals (Herrel & Meijden, 2014). It was estimated that 15 million live wild-caught amphibians entered the USA legally between 1998 and 2002, millions of which were for the pet trade (Schlaepfer et al., 2005).

The Ornate Horned Frog (*Ceratophrys ornata*) is an emblematic amphibian that occurs in the South American temperate grasslands of Argentina, Brazil and Uruguay (Carreira & Maneyro, 2015; Kwet et al., 2004). This region, named Rio de la Plata Grasslands, is the main complex of grassland ecosystems in South America and constitutes one of the most productive areas in the world (Soriano, 1991). The native grasslands have been extensively replaced by agroecosystems, including crops (mostly monocultures), forest plantations and pastures for livestock (Bilenca & Miñarro, 2004). Although the global conservation status of *C. ornata* is Near Threatened (Kwet et al., 2004), this assessment is currently outdated and incomplete. More recent and comprehensive national and regional assessments considered the species as Vulnerable in Argentina (Natale & Salgado Costa, 2012) and Uruguay (Carreira & Maneyro, 2015) and Critically Endangered in Rio Grande do Sul State, Brazil (Secretaria do Meio Ambiente, 2014). The major threats to the species seem to be habitat loss from agriculture and housing developments. Water and soil pollution, the persecution based on negative perception, and pet trade have also been suggested as factors causing population declines (Kwet et al., 2004). So far, the low abundances and difficult detection of *C. ornata* has been an obstacle in conducting studies which assess population dynamics and trends and measure the extent of the threats on native populations (Deutsch et al., 2017).

*Ceratophrys ornata* stands out from the other amphibian species due to specific characteristics of its physiognomy and unusual behavior. It is a robust animal, of considerable size, striking coloration (Figure 1) and a distinctive defensive



**Figure 1.** *Ceratophrys ornata* male (A) and female (B). Photos by Pablo Saibene.

behavior (Ceï, 1980; Gallardo, 1974). These characteristics arouse both aversion and fascination feelings (Berg, 1895; Measey et al., 2019) and represent an exceptional study subject to explore opposite human perceptions and attitudes in a single species. The interpretations of these characteristics have been reflected in stories, myths and legends, telling the danger and evil of *C. ornata*. These stories have been transferred from generation to generation and integrate an important part of the Argentine folklore (Berg, 1895). Classic contemporary literature from South America has *C. ornata* as the protagonists of tales and stories (e.g., Hudson, 1892, 1918; Lugones, 1906) and all of them refer to the animal as magic or disgusting venomous creature able to kill domestic animals and even humans. Superstitions and myths associated with amphibians can be pervasive in some cultures leading to harmful consequences both for the animals concerned and conservation efforts (Tarrant et al., 2016). A citizen science program conducted in Argentina to obtain novel records from the species (Deutsch et al., 2017) revealed that several encounters between citizens and *C. ornata* ended with the death of the animal because of the fear or disgust. On the other hand, *C. ornata* also arouses great interest in groups of collectors and exotic animal hobbyists. In fact, it is in the top ten of the most exported amphibians as a pet in the U.S. (Herrel & Meijden, 2014). It is also the most

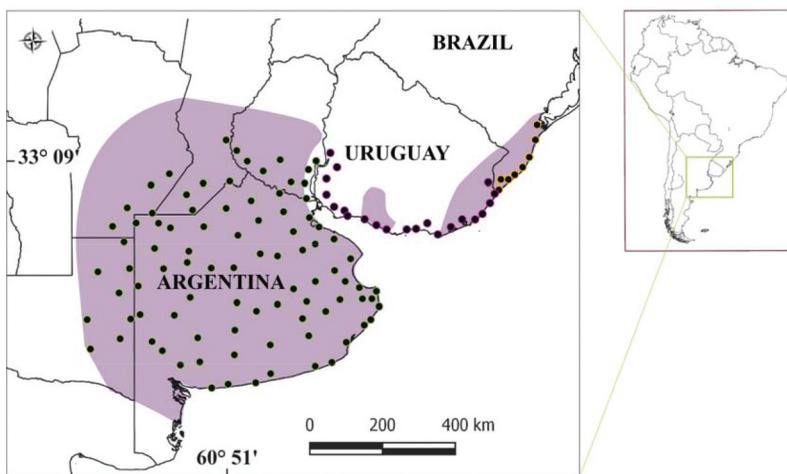
filmed amphibian in captivity uploaded to social networks and YouTube (Measey et al., 2019). In recent years, several specimens have been illegally offered for sale in Argentina and Uruguay. These offers appear with relative frequency in social networks hiding the origin of the animals, raising the question of whether specimens have been collected and extracted from wild populations for the illegal pet trade.

In this article, we analyzed the characteristics of the human-animal conflict coming from the attitudes that communities have about *C. ornata*, focusing on two of the threats proposed for the species: aversion and pet trade. We explored whether aversion and pet trade are likely to represent critical threats for the species. Finally, we recommend conservation actions in order to mitigate their effects on wild populations.

## Methods

Between 2015 and 2019, we carried out surveys and interviews to explore the aversion and pet trade characteristics regarding *C. ornata*. We defined aversion as a feeling of dislike, disgust, fear or hate that could end in the persecution or killing of individuals. We considered pet trade when the captivity of the specimens has recreational purposes (pet or exhibition) and they were acquired by legal or illegal purchase or exchange for another pet.

To assess aversion, we designed surveys based on the guidelines proposed by Sierra Bravo (1994). Considering the variety of questionnaires available to use, we decided to apply the recommended one in the Knowledge, Attitude and Practices (KAP) that can analyze both quantitative data and qualitative information concerning social behaviors and beliefs (Médicins du monde, 2011). We conducted at least five face-to-face surveys in 112 localities. These localities were selected based on historical and current confirmed records of *C. ornata* in Argentina, Brazil, and Uruguay (Carreira & Maneyro, 2015; Kwet et al., 2004) (Figure 2). The respondents were randomly chosen in each locality. The survey included personal data



**Figure 2.** Map of the study area. The purple surface represents the estimated distributional range of *Ceratophrys ornata* (AmphibiaWeb, 2020). Black circles show the localities where surveys were conducted.

of the respondent: name, age, gender (female, male or other) and education level (primary school, secondary school, or university). We included two closed and two open questions regarding (a) the perception toward the species (positive, neutral or negative), (b) the reaction to an encounter with a specimen (left it alive or killed), (c) the reasons that supported its decision, and (d) the estimated number of killed specimens. Since the vernacular name of the species may be used to name other anuran species, we implemented the methodology validated by Deutsch et al. (2017) to confirm that the respondent was referring to *C. ornata*.

To study the pet trade phenomenon, we performed personal interviews (Newing, 2011; Young et al., 2017). To recruit interviewees, we conducted an exhaustive search in social networks of exotic animal hobbyists' groups and pet shops to obtain a list of contacts who offered *C. ornata* for sale, exchange or exposition. Then, we also searched for people who had or currently have specimens in captivity. Finally, we obtained from the Ministry of Environment and Sustainable Development of Argentina (<https://www.argentina.gob.ar/ambiente>), the list of imported animals by date along with authorized breeding centers. We performed anonymous interviews, conducted informally (Liu et al., 2011). All information obtained during each oral interview was recorded onto a standardized questionnaire including (a) the acquisition type (purchase, exchange, gift or wild-caught), (b) acquisition date, (c) motivations for having the animals in captivity, (d) the number of specimens kept in captivity and (e) the provenance of the specimens. When the acquisition was by purchasing or exchange, we asked whether legal permits were obtained or not.

### Data Analysis

We used Generalized Linear Models (GLMs) to explore the aversion toward *C. ornata*. To test whether the perception toward *C. ornata* is defining the reaction of people after seeing the specimens, we employed a GLM with binomial family distribution and *logit* link function (Crawley, 2007). This model was built using perception (positive, neutral and negative) as a fixed effect, and the reaction (killed or left the specimens alive) transformed to *cbind* response term (number of killed, number of left alive) as a response variable. We were also interested in defining whether the reaction was influenced by age, gender and education level of the respondents. We performed a separate GLM with binomial family distribution and *cbind* response term. Age, gender and education level were introduced to the models as fixed effects. Age was ranked into three categories ( $\leq 18$ , 19–40, or  $\geq 41$  years old) and gender involved two levels (males, females). The education level involved three levels (primary school, secondary school, or university) and we only included those respondents +18 years old in order to avoid bias in the results. We checked for overdispersion by comparing residual deviance and residual degrees of freedom and corrected the models if needed. We used Tukey's honest significant difference (HSD) post hoc comparison tests to determine significant treatment differences. We used two-tailed test and Type I error rate ( $\alpha$ ) of .05. Statistical analyzes were carried out in R environment (R Development Core Team, 2020)

To analyze the phenomenon of the pet trade, we explored the data by obtaining percentages according to the responses and estimating the number of captive specimens. First, we separated the interviewees who acquired *C. ornata* specimens for purchasing or exchanging (pet trade) from those who got them from another source and not involving

a commercial transaction (gift or wild-caught). We then used the total number of individuals kept in captivity to explore the provenance of specimens (wild populations, importation or breeding establishments). The motivations for having *C. ornata* as pets were also informed by obtaining percentages according to the responses of interviewees.

## Results

### Aversion

We conducted a total of 563 surveys in the study area. We dismissed 369 surveys due to incorrect recognition of the species or because the respondent never had contact with it. People who have had contact with *C. ornata* ( $n = 194$ ) showed a strong aversion about the species (45% negative, 36% neutral, 19% positive). The number of surveys conducted according to age, gender and education level is shown in [Table 1](#).

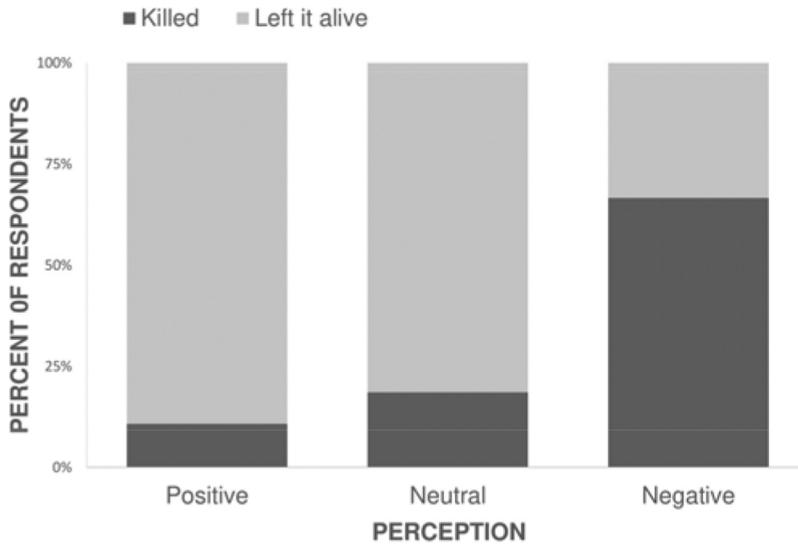
Results of the GLM indicated that the perception toward *C. ornata* significantly influenced the reaction of people after seeing specimens ( $Z = 2.05$ ;  $p < .05$ ). In this sense, 67% of the respondents who expressed a negative perception toward *C. ornata*, killed the animal after an encounter ([Figure 3](#)). The estimated number of killed animals per person ranged from 1 to 12, summarizing a total of 364 individuals killed from 1960 to 2019. Since we proved the dependence between reaction and perception, the analysis involving age, gender and education level was performed using the reaction as a dependent variable.

The reaction after the encounters was significantly influenced by gender ( $Z = 1.02$ ;  $p < .05$ ) and education level ( $Z = -2.98$ ;  $p < .05$ ). In contrast, the age of respondents had no effect on the reaction ( $Z = 1.13$ ;  $p = .15$ ) ([Figure 4a](#)). Women surveyed were significantly ( $p < .05$ ) more prone to kill *C. ornata* than men ([Figure 4b](#)). HSD *post hoc* comparison test showed that people with high education level (university studies) significantly ( $p < .05$ ) killed less animals than those respondents with low education level ([Figure 4c](#)).

Respondents gave several reasons supporting the decision to kill the animals or to leave them alive. The diversity of reasons provided for those who killed the animal were grouped into three categories: (a) myths, tales and folklore belief (“it is dangerous, it is evil, it is venomous species, the animal smoke if you put a cigarette in its mouth”), (b) economic damage (“it feeds on chicks”), and (c) dislike (“is a disgusting and/or ugly creature”). The

**Table 1.** Number of surveys distributed for age, gender and education level of the respondents.

	Number of respondents
<b>Age</b>	
≤18	70
19–40	60
≥41	64
<b>Gender</b>	
Female	69
Male	125
<b>Education level</b>	
Primary School	66
Secondary School	90
University	38



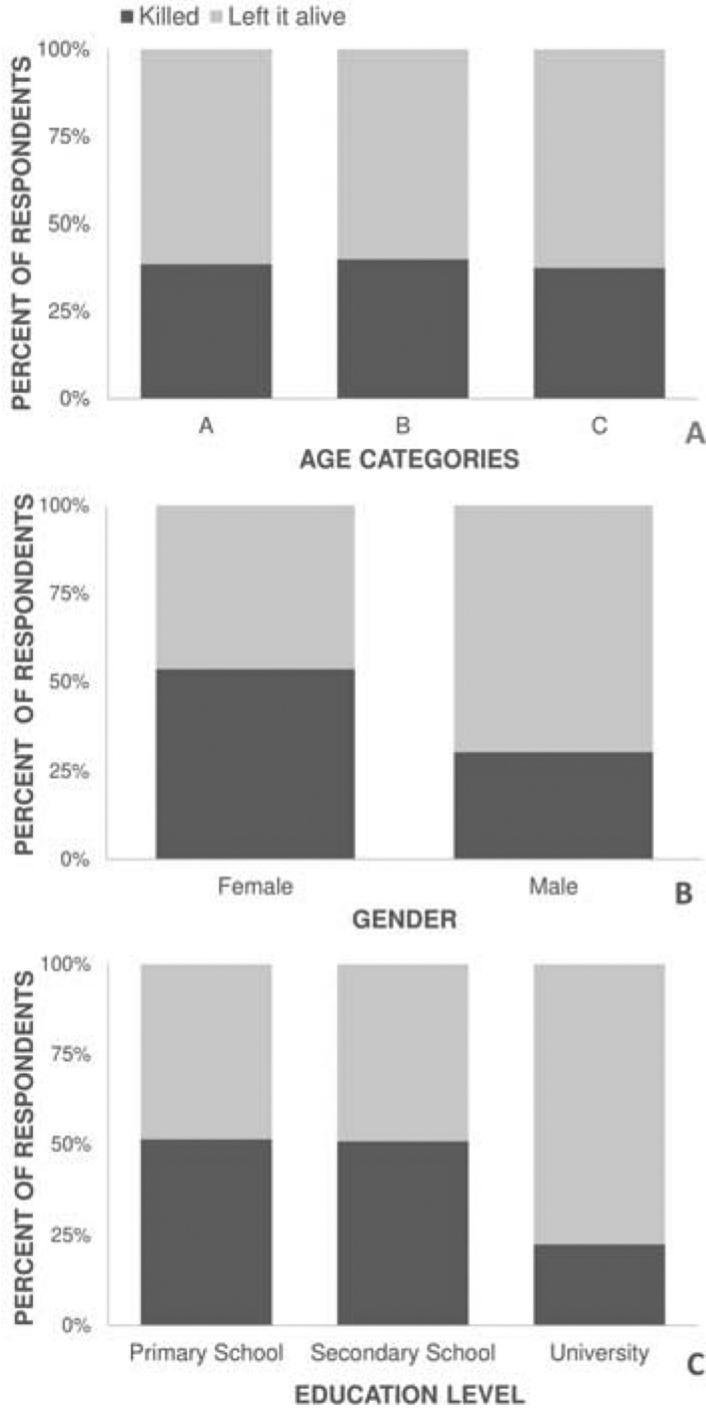
**Figure 3.** Comparison of indicated reactions (killed or left it alive) of respondents with positive, neutral, and negative perceptions toward *C. ornata* ( $n = 194$ ).

reasons for leaving the specimens alive were grouped into four categories: (a) ethical reason (“I do not usually kill animals”), (b) like (“it is a beautiful creature”), (c) conservation knowledge (“it is important for the ecosystem, it is an endangered species”), and (d) pet (“it is nice as a pet”). Some interviewees provided more than one reason for killing/leaving the animal. We recorded the results using all the reasons provided. The percentages for each category are shown in [Figure 5](#).

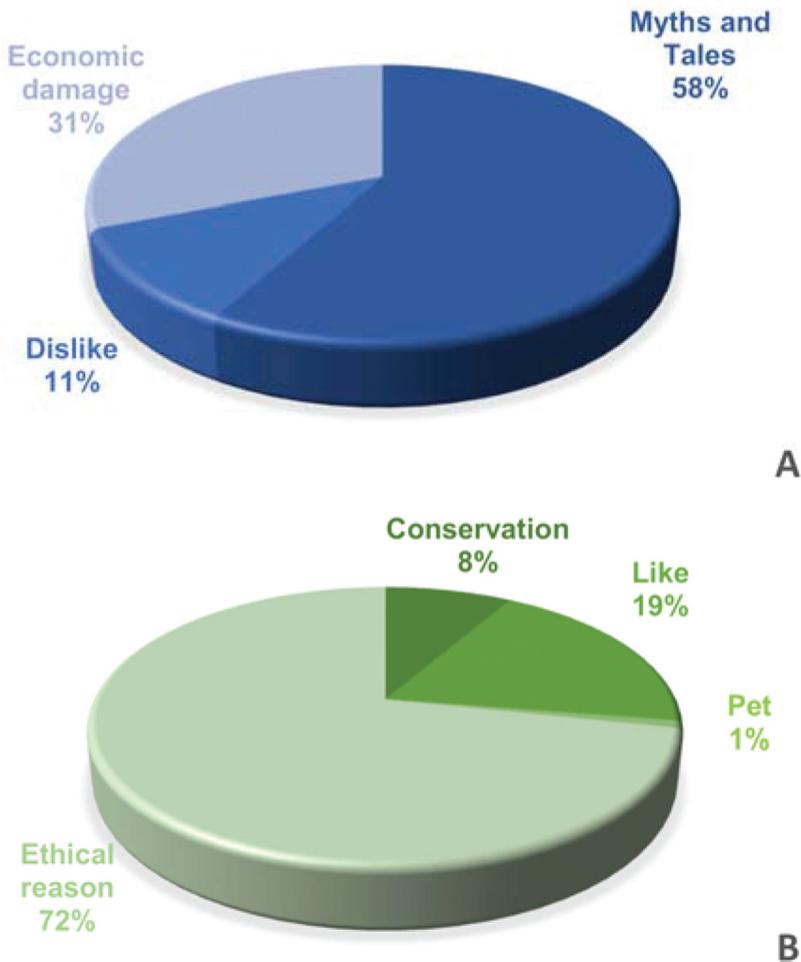
### **Pet Trade**

Data provided by the Ministry of Environment and Sustainable Development of Argentina (MAyDS) indicated that six specimens of *C. ornata* were legally imported from the USA in 2000. Before 2000 and after 2009, there was no data available on importation or exportation of *C. ornata*. The MAyDS confirmed that there is only one authorized establishment for commercial breeding of *C. ornata* in Argentina. We used this information to corroborate the legal acquisition of the specimens kept in captivity since any type of acquisition other than those declared by the MAyDS is considered an illegal possession (Ley Nacional de Fauna 22.421 and Ley Provincial 5786 Decreto 4477/56).

We interviewed a total of 30 people who had or have *C. ornata* in captivity. The 30% of the interviewees reported that they obtained the specimens through a commercial transaction that involved the purchase or exchange of specimens; 33% asserted that they obtained the animals as a donation or gift. The other 37% personally acquired the specimens directly from wild populations. The motivations expressed for keeping the specimens in captivity were: to have an exotic pet (67%), educational purposes (17%), to preserve the species (*ex-situ* conservation) (31%), and for business (16%). Some of the interviewees expressed more than one motivation.



**Figure 4.** Comparison of indicated reactions (killed or left it alive) after an encounter with *C. ornata* of respondents according to age categories (A), gender (B) and education level (C) ( $n = 194$ ).



**Figure 5.** Percentages of reasons (grouped in categories) for killing *C. ornata* (A) or left it alive (B).

Eight interviewees refused to report the number of specimens owned. However, we confirmed that at least 231 individuals of *C. ornata* have been kept in captivity, 178 of which were wild-caught between 1980–2019. All the known specimen extraction locations belonged to the Buenos Aires Province in Argentina (e.g., San Clemente del Tuyú, Trenque Lauquen, La Plata, Etcheverry, Gobernador Udaondo, Alejandro Korn and América) although the owners mostly resided in big cities (e.g., Buenos Aires Capital City) and surrounding areas.

When we analyzed the provenance of the specimens specifically for the pet trade, data showed that 61% of them were collected from the field, while the remaining 39% were obtained from breeding establishments in Argentina (not only from the unique authorized establishment but also from illegal exotic pet breeders and a university research animal facility). It should be noted that only one interviewee was able to demonstrate the legal

**Table 2.** Number of specimens of *Ceratophrys ornata* kept in captivity according to the type of acquisition and provenance of the specimens.

Type of acquisition	Provenance	
	Wild Populations	Breeding establishment
Pet trade (purchase/exchange)	59	38
Gift	10	15
Personal wild-caught	109	-

provenance of the specimen kept in captivity. Table 2 shows the number of specimens kept in captivity according to the type of acquisition and provenance.

## Discussion

Our study shows that both feelings of contempt and fascination strongly influenced the human attitude toward *C. ornata*, confirming that it is an appropriate study subject to explore opposite human perceptions and attitudes in a single species. Most of the studies examining the social-psychological determinants of behaviors related to amphibians have focused on general beliefs toward amphibians (Brom et al., 2020; Ceríaco, 2012; Frynta et al., 2019). Still, almost none have ever established a clear link between perception as a threat affecting a single species. There is no clear consensus between the consequences of aversion/persecution on amphibians in general. While the persecution for illegal pet trade, food or medicine uses have been suggested as important threats for some Neotropical species (e.g., *Telmatobius culeous*, *Conraua goliath*) (IUCN, 2020) direct human persecution based on negative perception (aversion) appears to be a non-significant threat for European amphibians (Brom et al., 2020; Cox et al., 2006). Therefore, a species-dependent context appears to be an appropriate approach to explore human attitudes toward amphibians.

### Aversion

Our results showed that aversion toward *C. ornata* is strongly linked to different aspects and symbolisms that appear in the popular imagination as myths and tales or folklore beliefs. The persecution of animals because of fear, disgust or hatred is common in non-charismatic species (like snakes, bats or spiders) but it has been a challenge to document that as a threat in terms of conservation and even more in a single species (Perry-Hill et al., 2015). Our results are in agreement with Ceríaco (2012), who found that the presence of folklore and negative values clearly predicts elimination and anti-conservation attitudes toward amphibians. Further, the willingness to protect animals and support conservation actions is negatively correlated with disgust and fear (Marešová & Frynta, 2008; Prokop & Fančovičová, 2013).

We also found that aversion (and the reaction to an encounter with the species) toward *C. ornata* was influenced by both socio-demographic variables, gender and education level, while age did not influence it. Our results showed that women are more likely to kill *C. ornata* than men. A possible explanation lies in the tendency of women to report significantly higher levels of fear and dislike than men, showing negative attitudes toward a vast majority of fearsome or non-charismatic animals like spiders, bats, snakes or amphibians (Kellert, 1993; Musila et al., 2018; Prokop & Fančovičová, 2012; Tarrant

et al., 2016; Tomažič, 2011). Finally, some authors have pointed out that the positive attitudes toward frogs expressed for men compared with women are related to the higher probability that men have to experience direct contact with frogs (Jimenez & Lindemann-Matthies, 2015).

Our results also showed that respondents with higher education levels are less prone to show aversion and kill *C. ornata*. These results are in agreement with several studies showing that greater respect, connection, knowledge and empathy for nature are achieved through higher levels of education (Bjerke et al., 2003; Ceriaco, 2012; Frigerio et al., 2019; Kellert, 1993; Musila et al., 2018; Røskaft et al., 2003; Sousa et al., 2016). In addition, less-educated people exhibit stronger associations with common myths compared to respondents with high education levels (Tarrant et al., 2016).

Although the strong beliefs based on myths and tales were the most expressed reasons to kill the animals, the economic damage and esthetical reasons (dislike) were also presented as motivations. Economic damage was indicated because *C. ornata* feeds on chickens raised for domestic consumption as food. This reason was expressed by a few respondents who had a positive perception of *C. ornata* but still killed the specimens. In this regard, lethal control of wildlife associated with damage has been firmly documented for a wide range of carnivores (Johnson et al., 2001) and large herbivores (Naughton-Treves & Treves, 2005), resulting in dramatic population declines and striking contractions in geographic range (Marchini, 2014). Nonetheless, there are no similar cases reported for amphibians. Finally, it is well known that amphibians are not appreciated creatures by most people globally (Ceriaco, 2012; Prokop et al., 2016), and *C. ornata* is not an exception. The disgust of the respondents was related to esthetical reasons (dislike) about the body size of *C. ornata* (“it is the largest amphibian I saw”) and the size of its mouth (“the mouth is disproportionately large”). This kind of attitude toward amphibians was also reported by Frynta et al. (2019).

Among the respondents who decided not to kill the specimens, a vast majority based their decision on ethical reasons, (i.e., the belief that killing animals is simply wrong) but not on the knowledge of the importance of species/biodiversity conservation. A low proportion did not kill *C. ornata* based on the role of the species in nature, its conservation issues, and its intrinsic relationship with the native grasslands. These results evidence the lack of knowledge that the vast population majorities may have about the ecological role and conservation status of non-charismatic species (Douglas & Winkel, 2014; Loyau & Schmeller, 2017).

### **Pet Trade**

From the results gathered through interviews to analyze the pet trade, we were able to observe that the highest proportion of captive individuals of *C. ornata* are mostly acquired from the field, followed by purchase or exchange. Most interviewees who keep captive specimens do not live in those areas where the species occurs, implying that several wild-caught specimens are being translocated to main cities in Buenos Aires Province. A large percentage of the specimens were collected in Argentina between 1980 and 2000, revealing that the removal of *C. ornata* for the illegal pet trade and recreational purposes may have been more frequent in the past. However, wild specimens are still being collected, so it is important to continue gathering evidence about this phenomenon to prevent further spread.

Except for one, none of the interviewees who declared to have acquired specimens from breeding establishments were able to confirm the provenance of the animals by presenting the legal permission and certifications to keep them in captivity. This indicates that either the individuals were purchased from an illegal breeder or were collected from native populations. The illegal trade in wildlife is estimated to value over 20 billion USD per year (Nellemann et al., 2016), ranking it among the top five of illegal transnational businesses, along with weapons and drugs (Esmail et al., 2020). Historically, Argentina is a country with a leading role – local and international – in the illegal trade of wildlife species. However, qualitative and quantitative knowledge about illegal trade is precarious (Bertonatti, 2017). Our study confirmed the need for intervention and more reliable controls by the authorities to reduce the illegal trade of *C. ornata*.

Finally, it has been pointed that the commercial breeding of amphibians for the pet trade can help to reduce the number of animals collected from wild populations (Smith et al., 2019; Tyler et al., 2007). Unfortunately, the evidence supporting that breeding farms are more cost-efficient than poaching is scarce, mainly because the sustainability of this commercial activity is compromised by the high cost of feeding, housing and biosecurity measures (Mockrin et al., 2005; Tensen, 2016). Tensen (2016) concludes that for many species (including mammals, birds, reptiles, fishes, and amphibians) commercial breeding and a legalized trade in farmed products will have the opposite effect to what is desired for conservation. Furthermore, given the scarce mechanisms of control and regulation of the pet trade in a large number of countries of South America (Bertonatti, 2017; Natush & Lyons, 2012; Pistoni & Toledo, 2010), we argue that it would not be prudent to encourage or promote the legal commercialization of *C. ornata*, especially in those countries where the species occurs.

### **Conservation Actions**

Based on the results of aversion obtained from this study, we recommend that an education and awareness program should be conducted at national and local levels. Education programs aimed at increasing tolerance of people toward wildlife are compelling strategies to reduce human-animal conflicts (Fita et al., 2010; Lindsey et al., 2005; Loyau & Schmeller, 2017; Pontes-da-Silva et al., 2016; Prokop et al., 2016; Seger et al., 2019; Sousa et al., 2016). It is urgent to demystify the myths and tales toward *C. ornata*. This should be done through an environmental education program showing the species as a harmless animal and essential for the ecosystem balance. Since the analysis of aversion did not reveal a dependence between the age of the respondents and the attitudes toward the species, we propose that education and awareness-raising programs must be intended for all age ranges (from children to elderly).

The resolution of conflicts involving economic damage deserves an alternative approach besides educational activities. Bearing in mind that people who kill specimens in farms do not necessarily have a negative perception toward the species, management involving the capture and relocation of specimens could mitigate the killing of those specimens feeding on chicks and occurring near farms. In this sense, relocations, repatriations and translocations as conservation management have been widely discussed and criticized by many authors (Burke, 1991; Dodd & Seigel, 1991; Fischer & Lindenmayer, 2000; Griffiths & Pavajeau, 2008). While some examples of relocations of mammals to solve human-animal conflicts have been unsuccessful and

failed (Fischer & Lindenmayer, 2000), the relocation of wild amphibians was highly successful in sustaining stable populations in the wild (Griffiths & Pavajeau, 2008; Weyrauch & Amon, 2002). Thus, we argue that an interdisciplinary approach aimed at detecting specimens occurring in farms and relocating them in nearby populations could be an effective and affordable conservation action. This strategy should consider movement patterns, territorial behavior and suitable relocation areas, which are currently unknown for this species. Cooperation between rural communities, conservationist NGOs and government agencies will lay the groundwork for a successful strategy.

The captivity of *C. ornata* (including pet trade) and the need for developing *ex-situ* conservation strategies, deserve a proper discussion since the interviewees repeatedly mentioned it as a motivation for keeping the species captive. *Ex-situ* managements have long been cited for playing a potential role in the recovery of threatened species (McGowan et al., 2017). In this sense, the *ex-situ* breeding management was suggested as a conservation action for protecting and recovering *C. ornata* populations in Argentina (Natale & Salgado Costa, 2012). Several authors have designed guidelines offering an objective process for evaluating the role of *ex-situ* management in species conservation (IUCN, 2014). This process involves a detailed pre-assessment of the threats faced by the species; determine the role, characteristics and dimensions of the *ex-situ* program; define the resources and expertise needed for the *ex-situ* management and the running of an effective and continuous monitoring plan (IUCN, 2014). In agreement with this, a more accurate understanding of population genetic flows and natural history traits of *C. ornata* should be achieved for conducting a proper evaluation of *ex-situ* conservation management. We suggest that a comprehensive strategy combining research, mitigations of threat effects and educational and awareness-raising programs should gain priority as a viable and practical approach to conserve *C. ornata*.

*Ceratophrys ornata* is a unique species highly associated with the temperate grasslands of South America (Carreira & Maneyro, 2015; Kwet et al., 2004). Given the high loss rates of native grasslands, habitat loss can be expected to be affecting *C. ornata* populations as the main threat. Nonetheless, we argue that the elimination of specimens based on aversion may have an impact at a local level, especially in those subpopulations occurring in recent urbanized areas where coexistence frequently occurs.

The severity of threat concerning specimen extraction from wild populations for pet trade is challenging to determine and predict given the context of illegality in which this activity occurs. Nonetheless, we proved that wild-caught specimens are the primary source for trade in Argentina, highlighting the need for regulation policies and adequate controls on wildlife trade.

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