

Evidence of predation on the Helmeted water toad *Calyptocephalella gayi* (Duméril & Bibron, 1841) by the invasive African clawed frog *Xenopus laevis* (Daudin 1802)

Evidencia de depredación sobre la rana chilena *Calyptocephalella gayi* (Duméril & Bibron, 1841) por la rana africana invasora *Xenopus laevis* (Daudin 1802)

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ABSTRACT

We report the first record of predation on a Helmeted water toad *Calyptocephalella gayi* tadpole by an adult specimen of the invasive African clawed frog *Xenopus laevis* in the locality of Pichi, Alhué (Santiago Metropolitan Region). This finding is discussed in the light of new sightings, in which both species have been detected to coexist in different localities of central Chile.

Keywords: Anura, Central Chile, invasive species, semi-urban wetlands

RESUMEN

Se reporta el primer registro de depredación de una larva de rana chilena *Calyptocephalella gayi* por un espécimen adulto de la rana africana invasora *Xenopus laevis* en la localidad de Pichi, Alhué (Región Metropolitana de Santiago). Este hallazgo es discutido a la luz de nuevos avistamientos en los cuales ambas especies han sido detectadas coexistiendo en diferentes localidades de Chile central.

Palabras clave: Anura, Chile central, especie invasora, humedales semiurbanos

Invasive alien species disrupt ecological processes and functions, mainly preying on native species or competing, to the point of exclusion, with them. This creates a severe damage to local biodiversity and ecosystems (Mooney 2005). One worldwide spread invasive amphibian is the African clawed frog *Xenopus laevis* (Daudin 1802). This species is native to sub-Saharan Africa, known for being totally aquatic, but with possible overland movement during drought or heavy rainfall (Measey 2016). *X. laevis* has been considered as an ecologically competitive alien species,

due to its rapacious unspecialized carnivorous habits on aquatic and terrestrial species (e.g. Lillo *et al.* 2011; Amaral & Rebelo 2012). On the other hand, it has been related to the cause of the global decline of amphibians, as being the main vector of emerging diseases such as chytridiomycosis and Ranavirus (Solís *et al.* 2010; Soto-Azat *et al.* 2016; O'Hanlon *et al.* 2018). The invasive routes of *X. laevis* in all continents, except Oceania, are strongly related to human spread, given its popularization as a pet (Measey *et al.* 2012), and its use in laboratory for pregnancy test during the last

century and developmental biology (Soto-Azat *et al.* 2013). Special conservation concerns arise from *X. laevis* adaptability to Mediterranean environments with similar conditions than its native distribution (Lillo *et al.* 2011; Ihlow *et al.* 2016). Predictive models based on habitat suitability suggest that an invasion towards north and southern Chile is feasible despite the low genetic diversity showed (Lobos *et al.* 2013, 2014).

Numerous studies from around the world have examined the local diet of *X. laevis*, suggesting that frogs in general, are consumed at a low proportion by this alien species (Courant *et al.* 2017). However, evidence suggests that the effect of *X. laevis* would be different, on the reproduction of native amphibian populations (Lillo *et al.* 2011).

In Chile, *X. laevis* was first reported in the 1970's and has currently established naturalized populations between Atacama and Maule Regions, where the core of its distribution is in central Chile (Jaksic 1998; Lobos & Jaksic 2005; Mora *et al.* 2019). Central Chile is considered a biodiversity hotspot (Myers *et al.* 2000); thus, it is very important to establish the ecological interactions between the alien species, *X. laevis*, and native fauna as well as its effects. In 1998, Jaksic *et al.* noted that "No information exists on the possible effects of the introduction of the African clawed frog on sympatric native fauna in central Chile". Reports since the invasion of *X. laevis* in central Chile suggest a rapid declination of other native amphibians. Three years after the first record of *X. laevis* in Talagante (Mapocho river, 1988), an event called "the silent spring" occurred, where mating calls from the local amphibian *Pleurodema thaul* (Schneider, 1799) disappeared. This event has been associated to the introduction of *X. laevis* into the water system (Rottman 2012); however, there is no direct evidence of predation of native amphibians by this invasive species, or any other detrimental interaction on local fauna caused by *X. laevis* (Lobos *et al.* 1999; Lobos & Measey 2002). Recently, Mora *et al.* (2016) reported predation of the Helmeted water toad (Chilean toad) *Calyptocephalella gayi* (Duméril and Bibron, 1841) on adult specimens of *X. laevis* and they suggested that this interaction could result in an easy infection with chytrid fungus by direct contact. A plausible scenario is that *X. laevis* could represent a predator of native amphibian larvae and freshwater fishes from Chile, because of its carnivorous diet and size. Up to now, evidence suggests that the (natural) diet of *X. laevis* in Chile is made up of chiefly zoobenthic and zooplanktonic taxa, mostly Chironomids, Ostracods and small invertebrates, mostly snails of the genus *Physa* (Lobos & Jaksic 2005), but no vertebrates.

In the context of the project "Desarrollo de investigación aplicada y actividades de difusión para la conservación de la rana chilena (*Calyptocephalella gayi*) en la Región Metropolitana de Santiago" of the Chilean Ministry of the Environment,

fieldwork campaigns were done throughout the year to monitor populations of *C. gayi* in the Metropolitan Region (MR). The objectives of these campaigns were to determine the presence of *C. gayi* populations and sympatric species, to obtain data on emerging diseases and genetic samples, and to measure the water quality where they live. During one of the monitoring fieldworks of the Helmeted water toad population on June 11th of 2018, in the Pichi stream at the Cajón de Lisboa (-33.971457, -71.059351), Alhué, a total of ten *C. gayi* larvae (no adults) and an adult specimen of *X. laevis* (SVL=52 mm) were collected. Specimens of each species were put in different cages, and before obtaining the genetic samples, the specimen of *X. laevis* regurgitated a partially digested *C. gayi* tadpole (Figure 1). It is possible to differentiate *C. gayi* larvae from other species present at this site (i.e. *P. thaul* and *X. laevis*) by its large size, stout caudal musculature, the presence of dark spots in the dorsum and tail, and the absence of cloacal tube (Díaz & Valencia 1985). After taking genetic samples from the collected specimens of *C. gayi*, the *X. laevis* specimen was euthanized by immersion in a benzocaine solution, while *C. gayi* larvae were returned to its habitat (except for the digested tadpole). Both specimens, partially digested tadpole of *C. gayi* and adult *X. laevis*, were fixed in 100 % Ethanol and deposited in the herpetological collection of the Departamento de Biología Celular y Genética de la Universidad de Chile (DBGUCH-1806011 and DBGUCH-1806012 respectively). This observation confirms the predation of the Helmeted water toad's larvae by the African clawed frog in central Chile. Since Chilean populations of *X. laevis* can reach a large size (Lobos & Measey 2002), the aquatic vertebrate predator habit of this species implies an imminent danger to all other native aquatic vertebrates (i.e. fishes and amphibians). *Calyptocephalella gayi* is endemic to Chile and is currently classified as Vulnerable (A2ad criteria) by the International Union for Conservation of Nature (IUCN) and by the Reglamento de Clasificación de Especies (RCE) of Chile (DS 50 MINSEGPRES, 2008). Populations of this species are currently declining in central Chile, being practically absent in ponds and lagoons near towns, where it once was very abundant (IUCN 2010). Even though predation on *C. gayi* by invasive species has not been considered before among the principal threats, we found five sites in the MR in which *X. laevis* coexist with *C. gayi* (Table 1). Most of these sites have conditions that are favorable for the invasive species, like lentic and turbid water (Lobos *et al.* 2013). Therefore, the next efforts should be put into carrying out continuous monitoring fieldwork on sites where these two species coexist, mainly to quantify the effects of predation that the African clawed frog has on the Helmeted water toad's population sizes, if there is any significative effect at all.

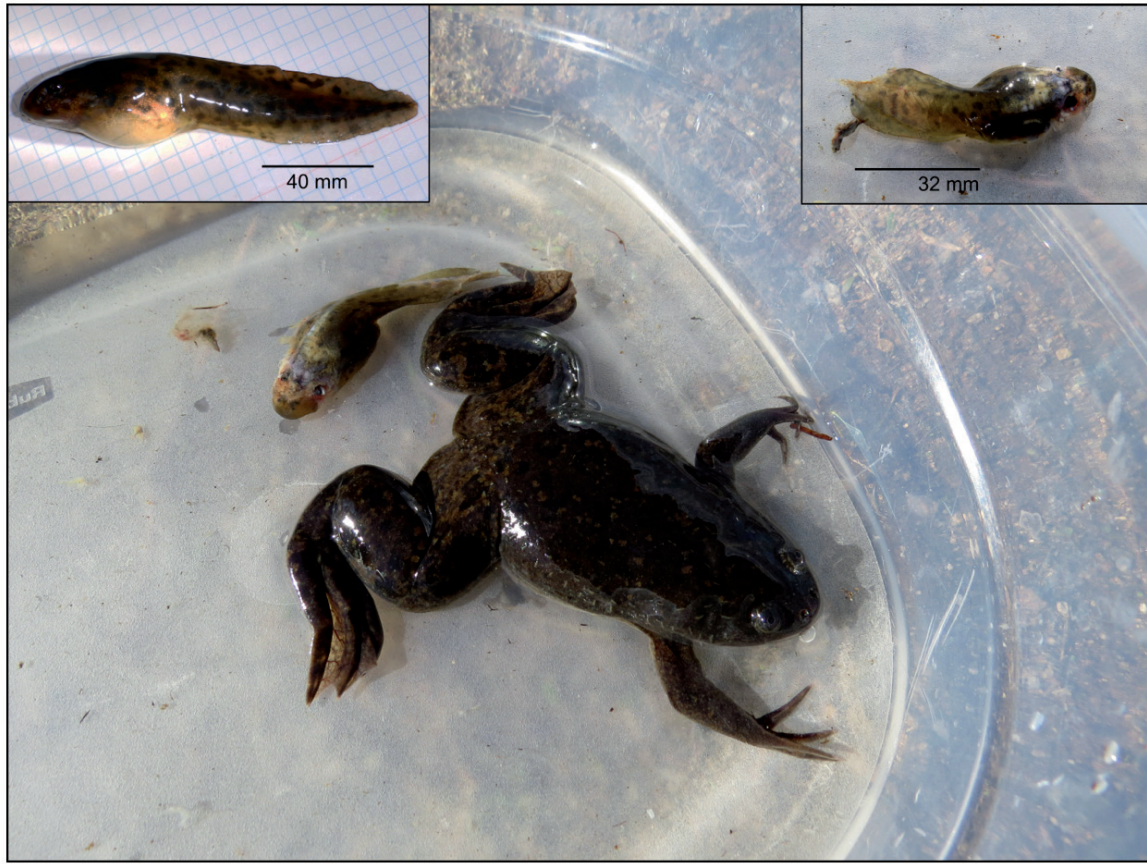


FIGURE 1. *Xenopus laevis* adult next to the regurgitated *Calyptocephalella gayi* tadpole. Upper panels show a zoom of the regurgitated tadpole (right) and a live tadpole captured in the study site (left). / Adulto de *Xenopus laevis* al lado la larva rejurgitada de *Calyptocephalella gayi* (Duméril and Bibron, 1841). Los paneles superiores muestran un acercamiento de la larva rejurgitada (derecha) y de una larva viva (izquierda) capturadas en el sitio de estudio.

TABLE 1. New records of *Calyptocephalella gayi*, *Xenopus laevis* and other native amphibians distributed in the Metropolitan region, Chile Central. *P. thaul* = *Pleurodema thaul*; *R. arunco* = *Rhinella arunco* (Molina, 1782). / Nuevos registros de *Calyptocephalella gayi*, *Xenopus laevis* y otros anfibios nativos distribuidos en la región Metropolitana, Chile central. *P. thaul* = *Pleurodema thaul*; *R. arunco* = *Rhinella arunco* (Molina, 1782).

Locality	Georeference (UTM)		Native amphibians	Presence of <i>X. laevis</i>
El Pangal, Curacaví	300176	6303890	<i>C. gayi</i> , <i>P. thaul</i> , <i>R. arunco</i>	Present
Estero Paine, Hospital	324013	6281001	<i>C. gayi</i> , <i>P. thaul</i>	Present
El Trapiche, Peñaflor	324028	6281030	<i>C. gayi</i> , <i>P. thaul</i>	Present
Rungue, Tiltil	319747	6342022	<i>C. gayi</i> , <i>R. arunco</i>	Present
Picipozas, El Paico	311490	6267953	<i>C. gayi</i> , <i>P. thaul</i>	Absent
Mapocho river, El Monte	316892	6271001	<i>C. gayi</i>	Absent
Pichi, Alhué	309420	6238689	<i>C. gayi</i> , <i>P. thaul</i>	Present

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