ÖGH Herpetozoa
Austrian Herpetological Society

Herpetozoa 36: 335–343 (2023)
DOI 10.3897/herpetozoa.36.e107328

Geographic distribution of the rare and endangered *Telmatobufo venustus* (Philippi, 1899) (Anura, Calyptocephalellidae), with the description of a new locality and comments on the type locality

Claudio Correa[1], José Ignacio Osses[1], Jesús A. Morales[1,2], Juan Carlos Ortiz[1]

1 *Laboratorio de Sistemática y Conservación de Herpetozoos (SyCoH), Facultad de Ciencias Naturales y Oceanográficas, Universidad de Concepción, Concepción, Chile*
2 *NGO Vida Nativa, Santiago, Chile*

https://zoobank.org/F569A921-7B71-4A6B-93B0-288126E8E376

Corresponding author: Claudio Correa (ccorreaq@udec.cl)

Academic editor: Lukas Landler ♦ **Received** 1 June 2023 ♦ **Accepted** 4 December 2023 ♦ **Published** 22 December 2023

Abstract

Telmatobufo venustus was one of the rarest endemic amphibians of Chile until 2020. Prior to that year, this species had been known in four localities, three of them with uncertain location, including the type locality. However, three new precise localities have been reported successively since 2020, all based on a few individuals. In this study, we review the geographic information on the species and, based on literature and other documents, tentatively locate the three localities with uncertain location published before 2020. Furthermore, we describe a new locality near the uncertain southern end of its distribution. Although the number of localities has considerably increased since 2020, the species still has a highly fragmented known distribution, its type locality and southern limit cannot be located with certainty, and it is found in only two state-protected areas. Due to these reasons and because threats to the habitat have been identified in some localities, we suggest keeping the species as Endangered.

Key Words

altitudinal range, Altos de Lircay National Reserve, *Nannophryne variegata*, tadpoles, southern limit, type series

Introduction

Calyptocephalella gayi (the Chilean giant frog) and *Telmatobufo* (four species, Mountain false toads) comprise the family Calyptocephalellidae, one of the most ancient anuran lineages from South America (Feng et al. 2017). This family, endemic to south-central Chile (western side of the Andes), is more related to the Australasian family Myobatrachidae than to any South American lineage, which is consistent with a Gondwanan origin (Correa et al. 2008; Mörs et al. 2020). The family has a rich fossil record, mainly in Argentinean Patagonia, where several extinct species of the genus *Calyptocephalella* have been described (reviewed by Nicoli et al. 2022), but no fossils of the genus *Telmatobufo* are known. Due to its old evolutionary age, wider geographical distribution in the past, low number of current species, and high morphological and ecological disparity of the genera that compose it, Calyptocephalellidae can be considered as a relict lineage.

The two genera exhibit different distribution patterns. *Calyptocephalella gayi* (Duméril & Bibron, 1841) inhabits lentic environments, from the semi-arid

Copyright *Claudio Correa et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

zone (28°S) to the temperate forests of southern Chile (41°30'S), covering the entire intermediate Mediterranean zone (Mora et al. 2021). In contrast, the four species of *Telmatobufo* are distributed exclusively in the temperate forests of south-central Chile (35°30'S–41°S). *Telmatobufo ignotus* Cuevas, 2010, whose presence has only been confirmed at the type locality and surroundings (~ 36°S), and *T. bullocki* Schmidt, 1952 (37–38°S) have allopatric distributions in the Coastal Range, while *T. venustus* (Philippi, 1899) (35°30'S to ~ 38°S) inhabits the foothills of the Andes, and *T. australis* Formas, 1972 (39°25'S to ~ 41°S) is found in both mountain ranges (Formas et al. 2001).

Telmatobufo venustus is the species of the genus with the largest latitudinal distribution, but with the second fewest records. Since its description as *Bufo venustus* (Philippi 1899), there were no published records of the species until the year 1982. Formas and Veloso (1982) clarified the taxonomic status and generic assignment of *T. venustus* with material from a new locality, Alto de Vilches (Altos de Lircay National Reserve). In 1983, a tadpole was found in the locality of Ralco (Díaz et al. 1983), but the species has not been observed there again. Only recently, since 2020, three new localities have been reported (Caro-Lagos and Charrier 2020; Díaz-Páez and Alveal 2021; González-Véliz et al. 2022), one of which slightly extended the range of the species to the north (Caro-Lagos and Charrier 2020) (Table 1).

The description of *Telmatobufo venustus* (Philippi 1899) was based on specimens from two localities: Hacienda San Ignacio de Pemehue and Cordillera de Chillán, whose exact locations are currently unknown. Formas et al. (2001) reviewed the geographic distribution of the species and indicated that the type locality is Cordillera de Chillán, but they do not mention Hacienda San Ignacio de Pemehue. This locality potentially corresponds to the southern limit of its distribution and has been omitted from almost all sources of geographic information of the species, except for IUCN (2022). The two locations reported later, Alto de Vilches (Formas and Veloso 1982) and Ralco (Díaz et al. 1983), were described with low precision (sexagesimal coordinates up to minutes). In both cases, the coordinates do not agree with the named sites where the specimens were supposedly collected. Later, Araya and Cisternas (2008) provided a satellite map with points within and around the Altos de Lircay National Reserve, but no coordinates. Regarding Ralco, Fenolio et al. (2011) indicated that the place was flooded due to the construction of a dam. Only the localities reported since 2020 have been published with precise coordinates.

Telmatobufo venustus has always been considered rare. Philippi (1899, 1902) had already mentioned its rareness in Hacienda San Ignacio de Pemehue. Until 1998 (i.e., 99 years after its description), adults had not been collected again (Fenolio et al. 2011). They were observed that year in the Altos de Lircay National Reserve (Formas and Cuevas 2000). The most recent reports have been based on a few individuals, while only the Altos de Lircay National Reserve seems to host a stable population (Fenolio et al. 2011). In addition to its low abundance, the species appears to have a highly fragmented distribution. It is known from fewer than 10 areas, spaced over 300 km. The low number of known localities and the fragmentation of its distribution justify its classification as Endangered by the IUCN (2022) and the Chilean state categorization system, the Reglamento de Clasificación de Especies Silvestres (RCE).

Here we review the geographic information of *T. venustus* in the literature and online databases (Global Biodiversity Information Facility, GBIF, https://www.gbif.org; iNaturalist, https://www.inaturalist.org) to map all the points of presence described to date. We address the problem of locating the type locality, which is linked to the fact that no holotype was designed by Philippi (1899). We also propose possible locations for three historical localities reported until 1983, including the type locality and the point that would define the southern limit of the species, and clarify the altitudinal limits of the species. Finally, we describe a new population near the southern limit and the population of Ralco, where the species has not been seen for more than 40 years.

Materials and methods

Compilation of localities and related information

This review is based on all publications with information on *T. venustus*, including journal articles, books, book chapters, guides and online sources. Some of these sources contain dot maps (Formas et al. 2001; Caro-Lagos and Charrier 2020; Díaz-Páez and Alveal 2021; González-Véliz et al. 2022), surface maps (Charrier 2019; IUCN 2022) or less precise or incomplete information on the geographic range and/or altitudinal limits (e.g. Formas 1995; Veloso 2006; Rabanal and Nuñez 2008; Stuart et al. 2008; Lobos et al. 2013). Presence points were downloaded from GBIF and iNaturalist; both sites were accessed on March 30, 2023. In addition to the coordinates and altitude, for each point some clarifications on its location were added (Table 1, column Remarks).

Map

A map with all the localities collected was made in ArcMap v10.8, using satellite imagery as a base. We used the exact coordinates provided in each publication, except in the case of the localities of the Altos de Lircay National Reserve and surroundings (Araya and Cisternas 2008), which were extracted directly from their satellite map. The two original localities, Hacienda San Ignacio de Pemehue and Cordillera de Chillán (Philippi 1899, 1902), where the species has not been recorded again,

Table 1. Localities and areas where *Telmatobufo venustus* has been recorded. For each locality/area, the number with which it appears on the map in Fig. 1 is indicated in parentheses after the name. Only the source(s) where each locality/area was mentioned for the first time and where relevant information was added later are indicated. For each locality/area, published coordinates, atitude, and some clarifications about their location (Remarks column) are provided.

Locality/area	Source(s)	Published coordinates	Altitude (m)	Remarks
Hacienda San Ignacio de Pemehue (the four red segments of Germain's reconstructed routes, Fig. 2B)	Philippi (1899, 1902)	Not provided	914–1219 (originally, 3000–4000 feet above sea level, Philippi 1899)	One of the two localities, together with Cordillera de Chillán, from where the specimens used to describe the species came from
Cordillera de Chillán (9)	Philippi (1899)	Not provided	914–1219 (originally, 3000–4000 feet above sea level); ~ 1200 m (Formas and Veloso 1982; Formas et al. 2001)	One of the two localities, together with Hacienda San Ignacio de Pemehue, from where the specimens used to describe the species came from; omitted by Philippi (1902); type locality according to Formas and Veloso (1982) and Formas et al. (2001); it could correspond to the vicinity of Recinto (this study, see Results)
Alto de Vilches (= Altos de Vilches, Vilches Alto, Río Lircay, Altos de Lircay National Reserve)	Formas and Veloso (1982)	Not provided in Formas and Veloso (1982); 35°28'S, 71°11'W (Formas and Cuevas 2000; Nuñez and Formas 2000; Cuevas and Formas 2001); 35°32'S, 70°50'W (Araya and Cisternas 2008); 35°35'41"S, 71°04'27"W (Núñez and Gálvez 2015)	1280 (Formas and Veloso 1982); 900 (Cuevas and Formas 2001)	Coordinates of Formas and Cuevas (2000), Nuñez and Formas (2000) and Cuevas and Formas (2001) fall outside of the Altos de Lircay National Reserve; coordinates of Araya and Cisternas (2008) do not match their map, in which six exact points of presence within or around the Río Lircay National Reserve are shown (detailed below); coordinates of Núñez and Gálvez (2015) are only referential
Arroyo Puente del Tronco (inside the Altos de Lircay National Reserve) (2)	Araya and Cisternas (2008)	Not provided, but the site is shown on a map	1638	Located here approximately at 35°35'33"S, 71°00'04"W
Chorro de Checo (inside the Altos de Lircay National Reserve) (3)	Araya and Cisternas (2008)	Not provided, but the site is shown on a map	1554	Located here approximately at 35°35'40"S, 71°00'49"W
Arroyo Nido de Carpinteros (inside the Altos de Lircay National Reserve) (4)	Araya and Cisternas (2008)	Not provided, but the site is shown on a map	1543	Located here approximately at 35°35'53"S, 71°01'35"W
Río Lircay Camino Viejo (inside the Altos de Lircay National Reserve) (5)	Araya and Cisternas (2008)	Not provided, but the site is shown on a map	1346	Located here approximately at 35°35'44"S, 71°02'13"W
Estero Piedras Tacitas (near the Altos de Lircay National Reserve) (6)	Araya and Cisternas (2008)	Not provided, but the site is shown on a map	1164	Located here approximately at 35°36'33"S, 71°04'17"W
Pantano (near the Altos de Lircay National Reserve) (7)	Araya and Cisternas (2008)	Not provided, but the site is shown on a map	1435	Located here approximately at 35°37'06"S, 71°04'21"W
Ralco (12, two points)	Díaz et al. (1983)	37°59'S, 71°24'W; 37°53'28"S, 71°38'03"W (Núñez and Gálvez 2015)	Not provided	The tadpole was collected "in the Bío-Bío River", but the coordinates of Díaz et al. (1983) fall around 8 km east of this river; Fenolio et al. (2011) affirm that the locality was flooded by a dam; the referential coordinates of Núñez and Gálvez (2015) fall in the Biobío River, but ~ 22 km northwest of the point of Díaz et al. (1983); in the vicinity of the "Ralco River" according to González-Véliz et al. (2022)
Radal Siete Tazas National Park (1)	Caro-Lagos and Charrier (2020)	35.498174°S, 70.929807°W	1524	On a tributary of the Claro River (Caro-Lagos and Charrier 2020)
Altos de Malalcura, Cajón de las Pulgas (10)	Díaz-Páez and Alveal (2021)	37°23'06"S, 71°29'45"W	1062	On a tributary of the Malalcura River
ca. San Fabián de Alico (8)	González-Véliz et al. (2022)	36.740589°S, 71.376011°W	1228	Coordinates fall in Quebrada Los Baños, 25 km southeast of the town San Fabián de Alico
Estero Pichipangue (Fig. 2A), Pitrilon sector (11)	This study	37.8983°S, 71.5085°W	1150	Tributary of the Pangue River, which flows into the right bank of the Biobío River

were published without coordinates. Therefore, we resorted to literature and other documents from the late 19th and early 20th centuries to pin down their location more precisely. One of these sources (Germain 1894) was used to trace the possible route of the trip where that author supposedly collected one of the type specimens. Areas within the altitudinal limits specified in the description of the species, between 914 and 1219 meters (3000–4000 feet), were mapped using ArcMap to restrict the location of possible collection places for this specimen. Moreover, a layer was added with the areas protected by the Sistema Nacional de Áreas Silvestres Protegidas del Estado of Chile (SNASPE) to determine which localities are state protected. Finally, a similar map was produced for the GBIF and iNaturalist points.

New locality

The new locality of *T. venustus* was discovered by chance by one of the authors (J.I. Osses). The coordinates and altitude were recorded in situ with a cell phone and verified on Google Earth. The size of the adult individuals (snout-vent length, SVL) was estimated with the lid of a camera (diameter 52 mm) placed next to them. None of the observed individuals was captured.

Results

Compilation of localities

We compiled 14 localities of *Telmatobufo venustus*, including the new one described by us (Table 1). We did not include the locality of Niblinto (Ibarra et al. 1999) in Table 1, cited as an imprecise record by González-Véliz et al. (2022). The original source does not specify if it is in the National Reserve or in the Nature Sanctuary called Los Huemules del Niblinto, it was mentioned without coordinates, and it is not supported by collected or photographed material. Therefore, we consider that the presence of the species in that area requires confirmation. We mapped only 13 localities (Fig. 1), since Alto de Vilches (Formas and Veloso 1982) was replaced with more precise sites subsequently reported within and around the reserve (Araya and Cisternas 2008). Five of the mapped locations are within state-protected areas (SNASPE): one in the Radal Siete Tazas National Park, which constitutes the northern end of the distribution of the species, and four in the Altos de Lircay National Reserve (Fig. 1). Eighteen points were downloaded from iNaturalist and nine from GBIF (Suppl. material 1), but six of the latter (the only ones with coordinates) come from iNaturalist and have the same associated coordinates. Most of the iNaturalist points fall in low-lying anthropized areas, along roads or in difficult-to-access mountainous areas, but all around the Altos de Lircay National Reserve (Suppl. material 2). Therefore, we assume that the observations were made in that reserve, but the coordinates have been obscured by default (with an accuracy of ~ 28.7 km) because it is a threatened species (taxon geoprivacy). Thus, we do not include these points in the collection of localities (Table 1, Fig. 1) because we consider them redundant with the published geographic information of the species.

Type locality and type series

Formas and Veloso (1982) were the first to indicate that the type locality of *T. venustus* is Cordillera de Chillán (Andean foothills, east of the city of Chillán), which has been included in some maps despite being an indeterminate place (Formas et al. 2001; Díaz-Páez and Alveal 2021). The mention of Cordillera de Chillán as the type locality is based on a specimen from the collection of the Museo de Zoología de Concepción (MUZUC or MZUC 205051) labeled as the holotype (as it appears in the photograph of the same source), and recognized as such in subsequent publications (e.g. Formas 1995; Formas et al. 2001). The problem with this type locality is that Philippi (1899) described the species from four specimens from Hacienda San Ignacio de Pemehue and Cordillera de Chillán, without defining a holotype, and the only remaining specimen of the type series (MZUC 205051) apparently has a wrong collection number and is currently missing. The only specimen from the Hacienda San Ignacio de Pemehue had already been lost at the time of the description (Philippi 1899). In the 1970s, only one of the three specimens from Cordillera de Chillán could be in the collection of the Museo Nacional de Historia Natural of Santiago (MNHN). Apparently, this specimen is one of the two that existed in the MNHN collection at the beginning of the 20th century, whose localities of origin were Chillán and El Recinto (Quijada 1914). This specimen appears photographed in Donoso-Barros (1972) and is the same one identified as MZUC 205051 by Formas and Veloso (1982). There is no published information on the specimen MZUC 205051 before 1982, so we speculate that it was entered into the collection and identified as the holotype by Roberto Donoso Barros in the early 70's, but without a nomenclatural act formally published in the peer-reviewed literature. Furthermore, since Philippi (1899) did not select a specimen from the type series as the holotype, this only remaining syntype should have been designated as the lectotype (International Code of Zoological Nomenclature, ICZN 1999), thereby also automatically defining the type locality (Cordillera de Chillán). Unfortunately, we could neither find any specimen accurately identifiable as *T. venustus* in the MZUC collection nor a record with the number 205051, since the number of the collection does not reach 50,000 specimens yet. The apparent loss of the only remaining specimen of the type series and confusion about its collection number prevent us from amending its typification (designating it the lectotype), and from recognizing the currently accepted type locality of the species. Consequently, following the rules of the ICZN (1999), in the absence of a holotype or lectotype, the type locality of *T. venustus* corresponds to the two localities of origin of the type series: Hacienda San Ignacio de Pemehue and Cordillera de Chillán.

Proposed locations for historical localities

The only specimen of *T. venustus* from Hacienda San Ignacio de Pemehue known to date (Philippi 1899) was collected by the entomologist Philibert Germain. At the time, that estate ("hacienda") covered more than 240,000 hectares (Flores 2013), from near the city of Mulchén to the town of Lonquimay in the south, and eastward to the border with Argentina. We reconstructed the possible route that Germain followed during his exploration of the estate in December 1893 (Germain 1911), which is described in Germain (1894). The trip can be divided into two parts. In the first stage, Germain started from a place called El Cisne, following the right bank of the Renaico River, then, crossed a small mountain range, Pichinitrun (also known as Pichinitro, Pichinitron or Pichi-Nitron), to reach the Vilucura River basin (also known as Vilicura or Villucura), and followed the right bank of this river to reach a place called Lolco. We used the map of the Comisión Chilena de Límites (1908) to plot this part of the journey as there is a road that exactly matches the description of Germain

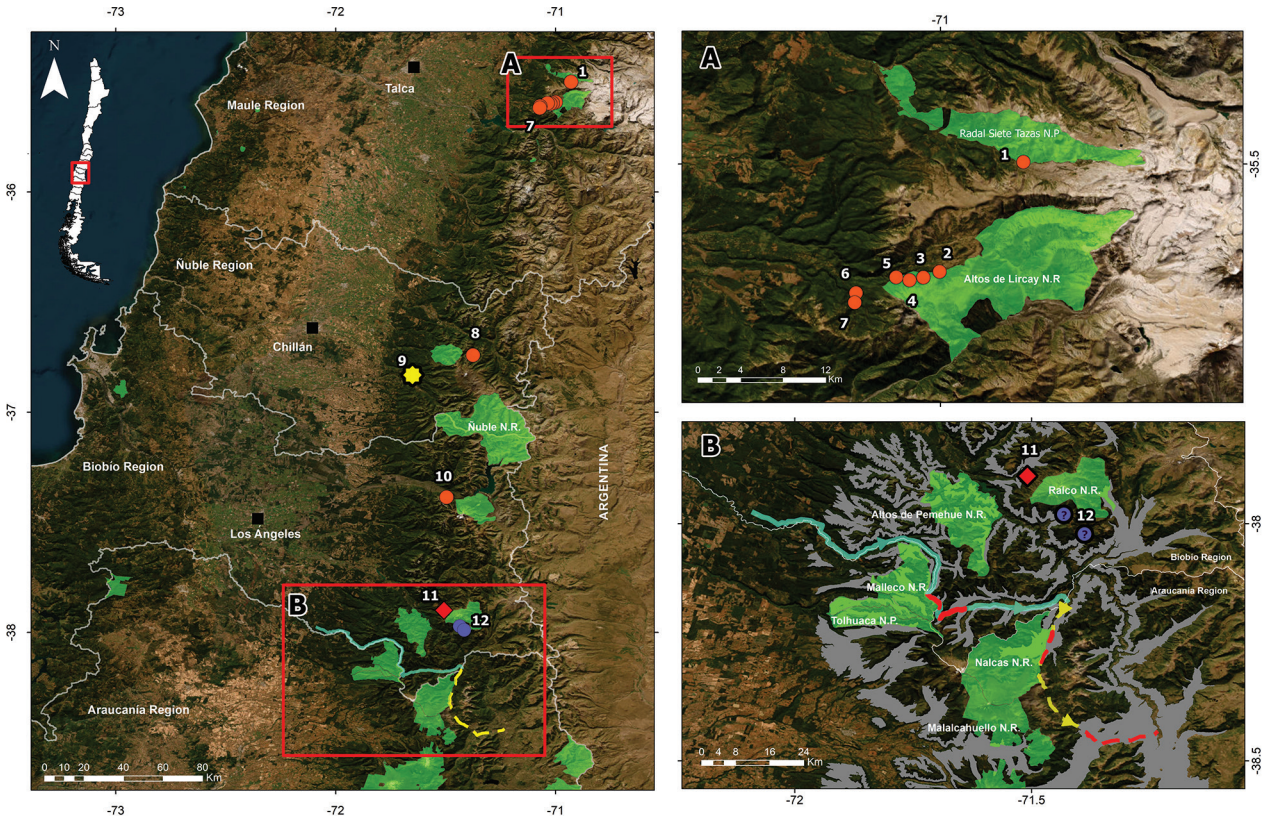

Figure 1. Geographic distribution of *Telmatobufo venustus*. Orange circles: literature localities; yellow octagram: possible location of Cordillera de Chillán according to this study; red diamond: new locality described here; blue circles: possible locations of Ralco. The insets to the right show enlargements of the northern (**A**) and southern (**B**) ends of its distribution. Inset B shows the possible routes (greenish solid and yellow dashed lines) that Philibert Germain followed, from west to east, on his journey inside the Hacienda San Ignacio de Pemehue in 1893 (see details in Results). The red segments of the solid and dashed lines represent the sectors of Germain's routes that lie between 914 and 1219 meters (gray areas of inset B). The semi-transparent green areas represent the areas protected by the state of Chile (SNASPE). The thin white lines within Chile correspond to the boundaries of the administrative regions (named with white letters).

(1894) (Fig. 1B, greenish solid line). The second part of the trip was not described in detail by Germain (1894). He apparently set out from Lolco up the right bank of the river almost to its source (the Headwaters of Lolco), crossed a bare alpine area of the Cordillera de Toluaca (Tolhuaca Range) to reach the basin of the Lonquimay River, and finally followed a tributary of this river (not named) until reaching the Lonquimay "pampa", where the administrator's house of this sector of the estate was located. This part of the trip (Fig. 1B, dashed yellow line) was traced partly following current paths (Google Earth); the location of the administrator's house was located according to the map by Soza (1891). We identified four areas along the reconstructed tracks, one of which could correspond to the southern limit of the range of the species (red segments of the paths in Fig. 1B), considering the elevation range specified (3000–4000 ft) in the species description (Philippi 1899). Regarding the accepted type locality until now, Cordillera de Chillán (Formas and Veloso 1982), González-Véliz et al. (2022) highlighted that the new locality near San Fabián de Alico described by them would be close to it. In fact, the new locality is in the Andean foothills, approximately 66 km east of Chillán, but there is no direct way to get there from this city. Instead, we propose a more precise place for the locality of Cordillera de Chillán, in the vicinity of the town of Recinto, located about 47 km southeast of the city of Chillán, on the road that ends at Termas de Chillán. This is based on a specimen of *Bufo venustus* that appears in the catalog of amphibians housed in the MNHN at the beginning of the last century published by Quijada (1914), labeled "El Recinto, 1897". According to Philippi (1899), Germain brought to the Museum the specimens from the Cordillera de Chillán that were used to describe the species in January 1897. Germain described numerous insects in Chile, including some beetles from Termas de Chillán (Germain 1911). Thus, it is possible that he collected the individuals of *T. venustus* from Cordillera de Chillán at an intermediate point of the way such as Recinto. Finally, we also propose possible locations for the locality of Ralco (Díaz et al. 1983). The only specimen observed there, until now, was collected supposedly in the Biobío River, but this type of river is different from the typical environment where the species is known up to now (Fenolio et al. 2011). In addition, the imprecise coordinates that appear in Díaz et al. (1983) fall about 8 km east of the Biobío River, on the side of a mountain at ~ 1885 m elevation and far from

currently recognizable roads. Therefore, we tentatively locate "Ralco" in the upper part of the two tributaries (Malla and Quepuca rivers; points 12 of Fig. 1B) of the Biobío River closest to the coordinates given by Díaz et al. (1983). We also emphasize that there is no additional data or information published about the locality reported by Díaz et al. (1983) to affirm that it was flooded after 1983 as it appears in the literature (Fenolio et al. 2011; Díaz-Páez and Alveal 2021).

Altitudinal range

There is no current consensus in the literature about the altitudinal limits of *T. venustus*. For example, Formas et al. (2001) defined the range between 600 and 1280 m, while an earlier source (Formas 1995) specified higher limits (1500–1700 m), which appear in most of the subsequent publications and sources of information about the species (e.g. Díaz-Páez and Ortiz 2003; Rabanal and Nuñez 2008; Stuart et al. 2008; Fenolio et al. 2011; Díaz-Páez and Alveal 2021), and even in the species summary information file of the Ministry of the Environment of Chile (https://clasificacionespecies.mma.gob.cl/wp-content/uploads/2019/10/Telmatobufo_venustus.pdf). Considering the records with precise altitudes collected here (Table 1), the highest point is Arroyo puente del tronco, at 1638 m, inside the Altos de Lircay National Reserve (Araya and Cisternas 2008). Regarding the lower limit, we discard that of Formas et al. (2001) (600 m) because there is no reliable precedent that allows to locate any population at that altitude. On the other hand, Cuevas and Formas (2001) reported the presence of *T. venustus* at the type locality of *Alsodes hugoi* Cuevas & Formas, 2001, Altos de Lircay National Reserve, at 900 m, specifically on the banks of the Lircay River. In the extreme northwest of the Reserve, there are sectors on the south bank of the Lircay River at around 900 m, which could be the area where the type series of *A. hugoi* was collected. Furthermore, this limit would be close to the originally minimum altitude (3000 ft = 914 m) reported by Philippi (1899). Therefore, we define the altitudinal limits of *T. venustus* as between ~ 900 and 1638 m.

New locality

The new locality, Estero Pichipangue (Fig. 2A), corresponds to a melt stream with crystalline waters located on the northwest slope of the Callaqui volcano and that flows into the Pangue river, which in turn flows into the Biobío River, in a sector called Pitrilon (southeast of the Biobío Region). On February 16, 2022, eight *T. venustus* adults (Fig. 2B) were observed at night on the

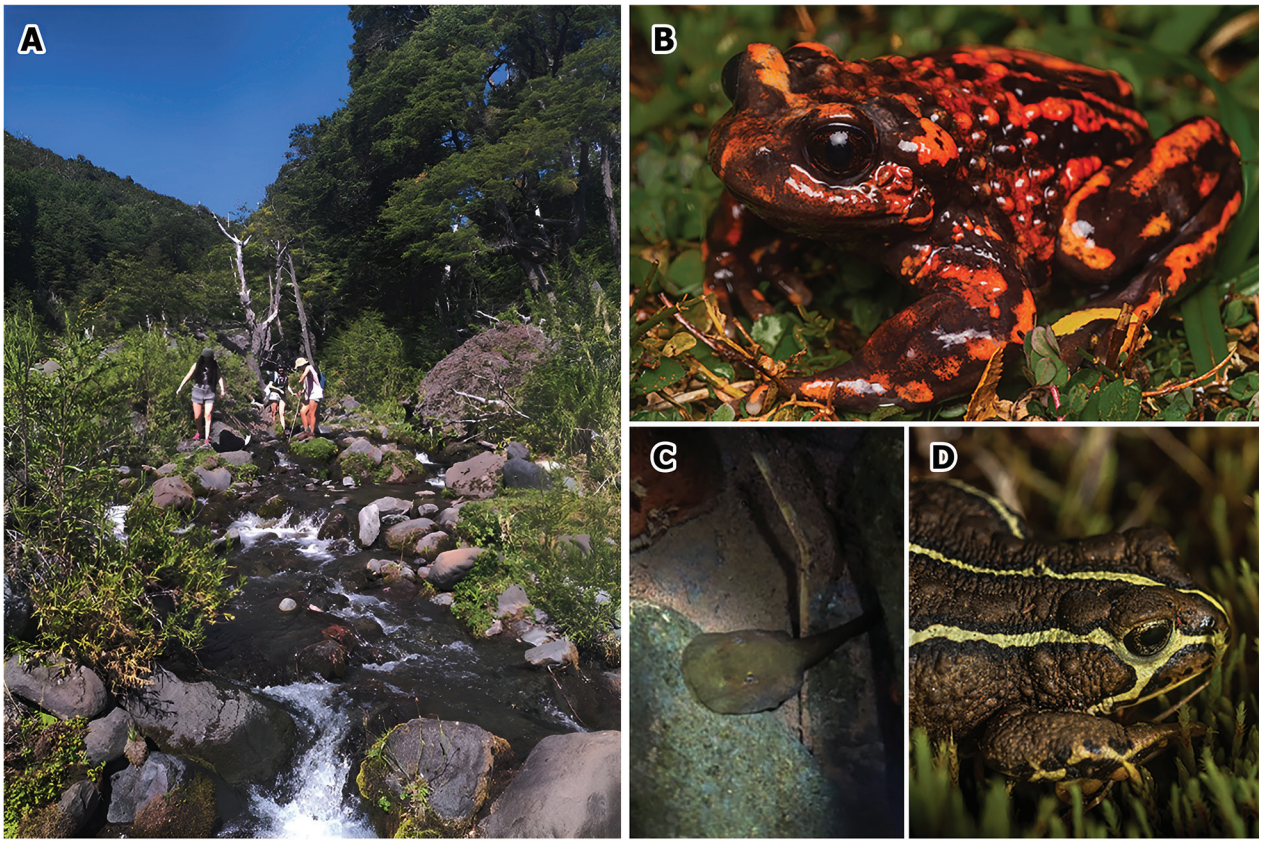

Figure 2. Stream and anurans observed at the new locality of *Telmatobufo venustus*, Estero Pichipangue, Biobío Region, Chile. **A.** Stream near the site where the adults and larvae of *T. venustus* were found; **B.** Adult male of *T. venustus* from Estero Pichipangue; SVL ~ 6.5 cm; **C.** Tadpole of *T. venustus*; **D.** Adult of *Nannophryne variegata*.

banks of Estero Pichipangue, at an approximate height of 1150 m. The individuals were easily recognized as members of the genus *Telmatobufo* by the presence of parotid glands, the numerous and prominent glands on the back, highly developed interdigital webbing on the hindlegs and the vertical pupil, and at the species level by their orange-reddish spots on a dark background. An average SVL of 65 mm was estimated for the eight observed adults (range, ~ 60–70 mm). The stream where the adults were observed presents a gentle slope, with a maximum depth of 30 cm, and a rocky and sandy bottom. Inside the stream, three *T. venustus* larvae were observed clinging to the bottom rocks (Fig. 2C). The tadpoles were identified as *Telmatobufo* by their dorsoventrally flattened bodies, the presence of a suctorial oral disk, and by its thick tail, particularly at the base (Díaz et al. 1983; Fenolio et al. 2011). The habitat where the adults and larvae of *T. venustus* were found corresponds to mountain mixed forest dominated by *Nothofagus dombeyi*, and, to a lesser extent, by *N. alpina*; the understory is dominated by *Chusquea quila*, *Fuchsia magellanica* and abundant *Gunnera tinctoria*. About 3.2 km upstream from the site where the *T. venustus* individuals were observed, close to the tree line, an adult of *Nannophryne variegata* Günther, 1870 (SVL = ~ 50 mm) was observed on the bank of the stream, among the riparian vegetation (Fig. 2D). This new record of *N. variegata* is located about 50 km south from the northernmost known point of the species (Cisternas-Medina et al. 2019). The Estero Pichipangue is far from human settlements and shows very few signs of human intervention. No salmonids were observed in the stream, a potential threat to *T. venustus* larvae and other amphibians (Fenolio et al. 2011), but the area around the stream could be threatened by livestock, since it is used for "veranadas" (summer pastures).

Discussion

After 124 years since its description, *T. venustus* is still only known from a few precise localities and its altitudinal and southern distribution limits cannot be clearly inferred from the literature. In fact, almost half of the known points are within or around the Altos de Lircay National Reserve, the only area where the species can currently be observed with relative ease (Fenolio et al. 2011; C. Correa and J. Morales, personal observations, February 2022). This is partly because it is a protected area with several trails to walk that receives many visitors, mainly in summer. Regarding online databases, GBIF and iNaturalist do not contain additional points that contribute to better define the distribution of the species, since they are all concentrated around the Altos de Lircay National Reserve, and do not have precise coordinates or names. The latter adds more uncertainty to the scarce precise geographic information on the species, which is why we recommend not using the *T. venustus* records of those databases.

The present review allowed us to propose locations for some historical localities and better clarify the altitudinal limits of the species. Specifically, we identified possible places for the two localities that we consider here as the type locality, Hacienda San Ignacio de Pemehue and Cordillera de Chillán. Furthermore, we specified the altitudinal limits, although we emphasize that, with the available information, the lower limit (900 m) cannot be determined with certainty. According to the literature, *T. venustus* is a rare and secretive species (Stuart et al. 2008; Fenolio et al. 2011). The scarcity of records and the small number of individuals observed in most localities over 120 years support this perception. The low number of known localities is probably due to a lack of exploration, since the four locations described as of 2020, including the one in this study, are found in hard-to-reach areas and generally far from public roads. In fact, there are still relatively large gaps throughout the distribution; for example, more than 120 km between Altos de Lircay National Reserve and the vicinity of San Fabián de Alico; and more than 50 km between Cordillera de Chillán and Altos de Malalcura, and between this last locality and Estero Pichipangue (Fig. 1).

Telmatobufo venustus is listed currently as Endangered by the IUCN (2022; assessment from 2015) and the RCE (Decree of 2011), based on criteria related to geographic distribution (B1 and B2, IUCN; only B2, RCE). The IUCN considers that the species only occurs in two threat-defined locations, Altos de Lircay National Reserve, where the only stable subpopulation would be, and Ralco, and has an area of occupancy (AOO) of 499 km^2 and an extent of occurrence (EOO) of 996 km^2. Using the geographic information updated here, a precise estimate of the EOO cannot be obtained, as long as the southern distribution limit of *T. venustus* is not clear, but following the IUCN recommendations (4 km^2 per location) and defining nine threat-defined locations, the AOO could be 36 km^2. This estimate may vary depending on how many locations are defined for the six points of the Altos de Lircay National Reserve and surroundings (here they were grouped into two, considering their distances, water connectivity and their protection status; see Fig. 1A) and if the populations of historical records are considered extinct or not. However, the value falls below the limit of subcriterion B2 (< 500 km^2) to preliminarily ratify the species as Endangered.

To assign a category of threat under criterion B, the species also must meet two or more conditions related to some characteristics of its geographic distribution and the quality of its habitat. The first condition (a), severely fragmented distribution, is maintained despite the sustained increase in known localities since 2020. Fenolio et al. (2011) provided arguments to apply the second condition (b), based on observations in the Altos de Lircay National Reserve: a decrease in the quality of the habitat where the larvae develop due to the presence of rainbow trout and the potential presence of chytrid fungus (not detected for them). After more than a decade, one more threat may

be added. Caro-Lagos and Charrier (2020) describe how several streams within the Radal Siete Tazas National Park have been progressively drying up due to the megadrought that has been affecting central Chile for more than a decade (Garreaud et al. 2020), phenomenon that could also be occurring in the Altos de Lircay National Reserve, located only 12 km further south (Fig. 1A). In addition, the megadrought is closely associated with the increase in the frequency and intensity of forest fires (González et al. 2018), another threat identified for the species by Veloso (2006) and for *T. ignotus* (Ortiz & Briones, 2022) in the Coastal Range. Thus, the detected and potential threats to the habitat justify maintaining the Endangered category for the species (under subcriterion B2ab(iii)), despite the recent increase in known populations.

Acknowledgements

We thank Herman Núñez for providing the information on the specimens deposited in the MNHN and Eileen Fuentes for her assistance with English.

References

Araya S, Cisternas J (2008) Antecedentes sobre el hábitat, localización y anuros simpátricos a *Alsodes hugoi* (Amphibia, Cycloramphidae) en la localidad tipo. Boletín del Museo Nacional de Historia Natural 57: 127–131. https://doi.org/10.54830/bmnhn.v57.2008.251

Caro-Lagos J, Charrier A (2020) Primer registro de *Telmatobufo venustus* (Philippi 1899) (Anura, Calyptocephalellidae) en el Parque Nacional Radal Siete Tazas: Ampliación de su distribución geográfica en la Región del Maule, Chile. Boletín Chileno de Herpetología 7: 42–45. http://www.boletindeherpetologia.com/uploads/3/2/2/9/32291217/6.caro_charrier2020.pdf

Charrier A (2019) Guía de Campo: Anfibios de los Bosques de la Zona Centro Sur y Patagonia de Chile. Ed. Corporación Chilena de la Madera, Chile, 300 pp. https://fundacionphilippi.cl/wp-content/uploads/2020/03/Anfibios-de-los-bosques-de-la-zona-centro-sur-y-patagonia-de-Chile.pdf

Cisternas-Medina I, Ortiz JC, Úbeda C, Díaz-Páez H, Vidal M (2019) Distribución geográfica del sapito de rayas o sapo variegado *Nannophryne variegata* Günther, 1870, nuevas localidades y comentarios sobre su hábitat en Chile y Argentina. Gayana 83(1): 33–45. http://dx.doi.org/10.4067/S0717-65382019000100033

Comisión Chilena de Límites (1908) Mapas de la Rejión Andina (1906–1912). Comisión Chilena de Límites, Santiago.

Correa C, Núñez J, Méndez MA (2008) Relaciones filogenéticas de anfibios. In: Vidal MA, Labra A (Eds) Herpetología de Chile. Science Verlag, Santiago, 107–135.

Cuevas CC, Formas JR (2001) A new species of *Alsodes* (Amphibia, Anura, Leptodactylidae) from Central Chile. Amphibia-Reptilia 22(2): 187–198. https://doi.org/10.1163/15685380152030418

Díaz N, Sallaberry M, Núñez H (1983) The tadpole of *Telmatobufo venustus* (Anura: Leptodactylidae) with a consideration of generic relationships. Herpetologica 39(2): 111–113. https://www.jstor.org/stable/3892549

Díaz-Páez H, Alveal N (2021) A new geographic record of the endangered *Telmatobufo venustus* (Amphibia: Calyptocephalellidae) in the Biobío Region, Chile. Revista Chilena de Historia Natural 94: 3. https://doi.org/10.1186/s40693-021-00100-8

Díaz-Páez H, Ortiz JC (2003) Evaluación del estado de conservación de los anfibios en Chile. Revista Chilena de Historia Natural 76(3): 509–525. https://doi.org/10.4067/S0716-078X2003000300014

Donoso-Barros R (1972) Contribución al conocimiento del género *Aruncus* Philippi. Boletín de la Sociedad de Biología de Concepción 44: 109–116. https://www.biodiversitylibrary.org/item/98537#page/119/mode/1up

Feng Y-J, Blackburn DC, Liang D, Hillis DM, Wake DB, Cannatella DC, Zhang P (2017) Phylogenomics reveals rapid, simultaneous diversification of three major clades of Gondwanan frogs at the Cretaceous-Paleogene boundary. Proceedings of the National Academy of Sciences 114(29): E5864–E5870. https://doi.org/10.1073/pnas.170463211

Fenolio DB, Charrier A, Levy MG, Fabry MO, Tirado MS, Crump ML, Lamar WW, Calderón P (2011) A review of the Chile mountains false toad, *Telmatobufo venustus* (Amphibia: Anura: Calyptocephalellidae), with comments on its conservation status. Herpetological Review 42(4): 514–519.

Flores J (2013) La construcción del espacio. Una mirada histórica al territorio cordillerano de la Araucanía. El territorio andino de la Araucanía, concepto y antecedentes. In: Núñez A, Sánchez R, Arenas F (Eds) Fronteras en movimiento e imaginarios geográficos. La cordillera de Los Andes como espacialidad sociocultural. Instituto de Geografía Pontificia Universidad Católica de Chile y RiL editores, Santiago, 415–449.

Formas JR (1995) Anfibios. In: Simonetti JA, Arroyo MTK, Spotorno AE, Lozada E (Eds) Diversidad biológica de Chile. Comisión Nacional de Investigación Científica y Tecnológica, Santiago, 314–325.

Formas JR, Cuevas CC (2000) Comparative cytogenetic analysis of the Chilean leptodactylid frog genus *Telmatobufo*, with the description of the chromosomes of *T. venustus*. Proceedings of the Biological Society of Washington 113(4): 890–899.

Formas JR, Veloso A (1982) Taxonomy of *Bufo venustus* Philippi, 1899 (Anura: Leptodactylidae) from Central Chile. Proceedings of the Biological Society of Washington 95(4): 688–693.

Formas JR, Núñez JJ, Brieva LM (2001) Osteología, taxonomía y relaciones filogenéticas de las ranas del género *Telmatobufo* (Leptodactylidae). Revista Chilena de Historia Natural 74(2): 365–387. https://doi.org/10.4067/S0716-078X2001000200013

Garreaud RD, Boisier JP, Rondanelli R, Montecinos A, Sepúlveda HH, Veloso-Aguila D (2020) The Central Chile Mega Drought (2010–2018): A climate dynamics perspective. International Journal of Climatology 40(1): 421–439. https://doi.org/10.1002/joc.6219

Germain P (1894) Apuntes sobre los insectos de Chile. Anales de la Universidad de Chile 87: 59–76. https://anales.uchile.cl/index.php/ANUC/article/view/20781

Germain P (1911) Catálogo de los Coleópteros chilenos del Museo Nacional. Boletín del Museo Nacional de Chile 3(1): 47–73. https://doi.org/10.54830/bmnhn.v3.1911.914

González ME, Gómez-González S, Lara A, Garreaud R, Díaz-Hormazábal I (2018) The 2010–2015 Megadrought and its influence on the fire regime in central and south-central Chile. Ecosphere 9(8): e02300. https://doi.org/10.1002/ecs2.2300

González-Véliz N, Valdés-Puga M, Espinoza-Carbullanca P, Serrano-Serrano JM, Velásquez NA (2022) Confirmation of a new locality of *Telmatobufo venustus* Philippi, 1899 in the Andean precordillera of the Ñuble Region, Chile. Revista Latinoamericana de Herpetología 5(2): 68–72. https://doi.org/10.22201/fc.25942158e.2022.2.348

Ibarra H, López R, Figueroa R (1999) El hombre en la trama ecológica. Cartilla de educación ambiental. CODEFF, Chile, 32 pp.

International Commission on Zoological Nomenclature (1999) International Code of Zoological Nomenclature. 4th Edn. The International Trust for Zoological Nomenclature, London.

IUCN (2022) The IUCN Red List of Threatened Species. Version 2022–2. https://www.iucnredlist.org [Accessed on April 30, 2023]

Lobos G, Vidal M, Correa C, Labra A, Díaz-Páez H, Charrier A, Rabanal F, Díaz S, Tala C (2013) Anfibios de Chile, un desafío para la conservación. Ministerio del Medio Ambiente, Fundación Facultad de Ciencias Veterinarias y Pecuarias de la Universidad de Chile y Red Chilena de Herpetología, Santiago, 104 pp. https://www.curriculumnacional.cl/614/articles-143451_recurso_pdf.pdf

Mora M, Bardi F, Labra A (2021) State of knowledge of the Chilean giant frog (*Calyptocephalella gayi*). Gayana 85(1): 22–34. https://doi.org/10.4067/S0717-65382021000100022

Mörs T, Reguero M, Vasilyan D (2020) First fossil frog from Antarctica: implications for Eocene high latitude climate conditions and Gondwanan cosmopolitanism of Australobatrachia. Scientific Reports 10: 5051. https://doi.org/10.1038/s41598-020-61973-5

Nicoli L, Muzzopappa P, Espinoza N, Melchor R (2022) A new fossil species of *Calyptocephalella* (Anura: Australobatrachia) from the Miocene of northern Patagonia: Novel evidence of the broad past diversity of the genus. Journal of South American Earth Sciences 119: 104008. https://doi.org/10.1016/j.jsames.2022.104008

Núñez H, Gálvez Ó (2015) Catálogo de la Colección Herpetológica del Museo Nacional de Historia Natural y Nomenclátor basado en la Colección. Publicación Ocasional del Museo Nacional de Historia Natural 64: 1–203. https://publicaciones.mnhn.gob.cl/668/articles-71131_archivo_01.pdf

Nuñez JJ, Formas JR (2000) Evolutionary history of the Chilean frog genus *Telmatobufo* (Leptodactylidae): an immunological approach. Amphibia-Reptilia 21(3): 351–356. https://doi.org/10.1163/156853800507543

Ortiz JC, Briones R (2022) Anfibios y reptiles del bosque de ruil. In: San Martín Acevedo J (Ed.) Los bosques relictos de ruil: ecología, biodiversidad, conservación y restauración. El Sur Impresores Ltda., Chile, 339–362. https://bibliotecadigital.infor.cl/handle/20.500.12220/32506

Philippi RA (1899) Descripciones breves de dos especies nuevas de sapos (*Bufo*). Anales de la Universidad de Chile 104: 723–725.

Philippi RA (1902) Suplemento a los Batraquios chilenos descritos en la Historia Física i Política de Chile de don Claudio Gay. Librería Alemana de José Ivens, Santiago, [XI +] 161 pp. https://doi.org/10.5962/bhl.title.104403

Quijada B (1914) Catálogo de los batracios chilenos i estranjeros conservados en el Museo Nacional. Boletín del Museo Nacional de Historia Natural 7: 319–326. https://doi.org/10.54830/bmnhn.v7.1914.851

Rabanal FE, Nuñez JJ (2008) Anfibios de los Bosques Templados de Chile. Primera Edición. Universidad Austral de Chile, Valdivia, 206 pp.

Soza C (1891) San Ignacio de Pemehue. Hacienda de Don Francisco Puelma Castillo. Map scale 1:250,000.

Stuart S, Hoffmann M, Chanson J, Cox N, Berridge R, Ramandi P, Young B (2008) Threatened Amphibians of the World. Lynx Editions, Barcelona, Spain; IUCN, Gland, Switzerland; and Conservation International, Arlington, Virginia, [XV +] 776 pp.

Veloso A (2006) Batracios de las cuencas hidrográficas de Chile: origen, diversidad y estado de conservación. In: Vila I, Veloso A, Schlatter R, Ramírez C (Eds) Macrófitas y vertebrados de los sistemas límnicos de Chile. Editorial Universitaria, Santiago, 103–140.

Supplementary material 1

Some data associated with iNaturalist and GBIF geographic records

Authors: Claudio Correa, José Ignacio Osses, Jesús A. Morales, Juan Carlos Ortiz

Data type: csv

Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.

Link: https://doi.org/10.3897/herpetozoa.36.e107328.suppl1

Supplementary material 2

Geographic records of *T. venustus* obtained from iNaturalist and GBIF

Authors: Claudio Correa, José Ignacio Osses, Jesús A. Morales, Juan Carlos Ortiz

Data type: tif

Explanation note: The yellow circles represent the points from iNaturalist, while the blue squares are the ones that appear on both platforms. Orange circles are the nearby points described in the literature (1–7, Fig. 1A and Table 1)

Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.

Link: https://doi.org/10.3897/herpetozoa.36.e107328.suppl2

ZOBODAT - www.zobodat.at

Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: Herpetozoa

Jahr/Year: 2023

Band/Volume: 36

Autor(en)/Author(s): Correa Claudio, Osses Jose Ignacio, Morales Jesus A., Ortiz Juan Carlos

Artikel/Article: Geographic distribution of the rare and endangered Telmatobufo venustus (Philippi, 1899) (Anura, Calyptocephalellidae), with the description of a new locality and comments on the type locality 335-343