

New geographic record of *Eupsophus vertebralis* (Anura: Alsodidae): filling a distribution gap in the Andes foothills

Nuevo registro geográfico de *Eupsophus vertebralis* (Anura: Alsodidae): llenando un vacío distribucional en las estribaciones de los Andes

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ABSTRACT

Eupsophus vertebralis is an endemic species of the temperate humid forests of Chile and Argentina with an unclear geographic distribution. The first records of *E. vertebralis* in the Quelhue sector of Villarrica National Reserve, on the western margin of the Andes in the Araucanía Region, Chile, are reported. These findings represent a new type of habitat for this species in an area of high conservation value that has been sparsely explored.

Keywords: amphibians, distribution, Valdivia ground frog, Villarrica National Reserve.

RESUMEN

Eupsophus vertebralis es una especie endémica de los bosques húmedos templados de Chile y Argentina con una distribución no muy clara. Los primeros registros de *E. vertebralis* se informan en el sector Quelhue de la Reserva Nacional Villarrica, en el margen occidental de los Andes de la Región de la Araucanía, Chile. Estos hallazgos representan un nuevo tipo de hábitat para esta especie en un área de alto valor de conservación que ha sido escasamente explorada.

Palabras clave: anfibios, distribución, rana terrestre de Valdivia, Reserva Nacional Villarrica.

The humid temperate forests of South America, primarily distributed in Chile and the westernmost region of Argentina, constitute a biogeographic island separated by over 1500 km of geographical barriers from other forest ecosystems (Armesto *et al.* 1998). This prolonged isolation has led to notable endemism in numerous taxa (Villagrán & Hinojosa 1997; Armesto *et al.* 1998), with amphibians being particularly prominent among them (Formas 1979).

The genus *Eupsophus*, endemic to the humid temperate forests of Chile and Argentina (Blotto *et al.* 2013), comprises ten species divided into the *roseus* and *vertebralis* groups (Formas & Brieva 1992). The *vertebralis* group includes only two species, *Eupsophus vertebralis* (Grandison 1961) and *Eupsophus emiliopugini* (Formas 1989) (Suárez-Villota *et al.* 2018).

Eupsophus vertebralis is typically found in association with temperate forests of *Nothofagus*, where it has been reported to primarily inhabit microrefugia located near streams and humid environments (Rabanal & Nuñez 2008; IUCN 2019). It is primarily distributed along the coastal zone of Chile, from the north of the Nahuelbuta Mountain Range (37°19' S) to the coast of Osorno (40°49' S), with only two known locations outside this area, Tolhuaca National Park on the western edge of the Andes, and Puerto Blest in Argentina (Basso & Úbeda 1999; Úbeda & Basso 2012; IUCN 2019). The latter location is closer to the records of *E. emiliopugini*, a species with which Formas (1989) and Nuñez (2003) indicated allopatric distributions. However, later records of *E. emiliopugini* were reported in Raulintal (Olivares *et al.* 2014) and Pucatrihue (Suárez-Villota *et al.* 2018), localities within the southernmost

distribution of *E. vertebralis*, which would imply the sympatry of both species (Correa & Durán 2019). Furthermore, the maps presented by Rabanal & Nuñez (2008) and IUCN (2019) also imply areas of sympatry (Correa & Durán 2019), in the Coastal Range according to Rabanal & Nuñez (2008) and in the western foothills of the Andes according to IUCN (2019). However, none of these last two sympatric areas are supported by a review of the records in the literature (Correa & Durán 2019), so they can be considered implicit and not conclusively supported, clearly indicating that the distribution of *E. vertebralis* is still not fully understood. The main threats

to its populations include forest fires, as well as habitat loss and fragmentation (IUCN 2019).

The new record is located within the Villarrica National Reserve, specifically in the Quelhue sector, situated 5 km northeast of the town of Pucón in the Araucanía Region (Fig. 1). This Reserve is a component of the Protected Wild Areas System from Chile (SNASPE), aimed at the conservation and protection of soil resources and endangered species, the maintenance or improvement of water production, and the development and implementation of technologies for the rational use of vegetation and wildlife (CONAF 2008).

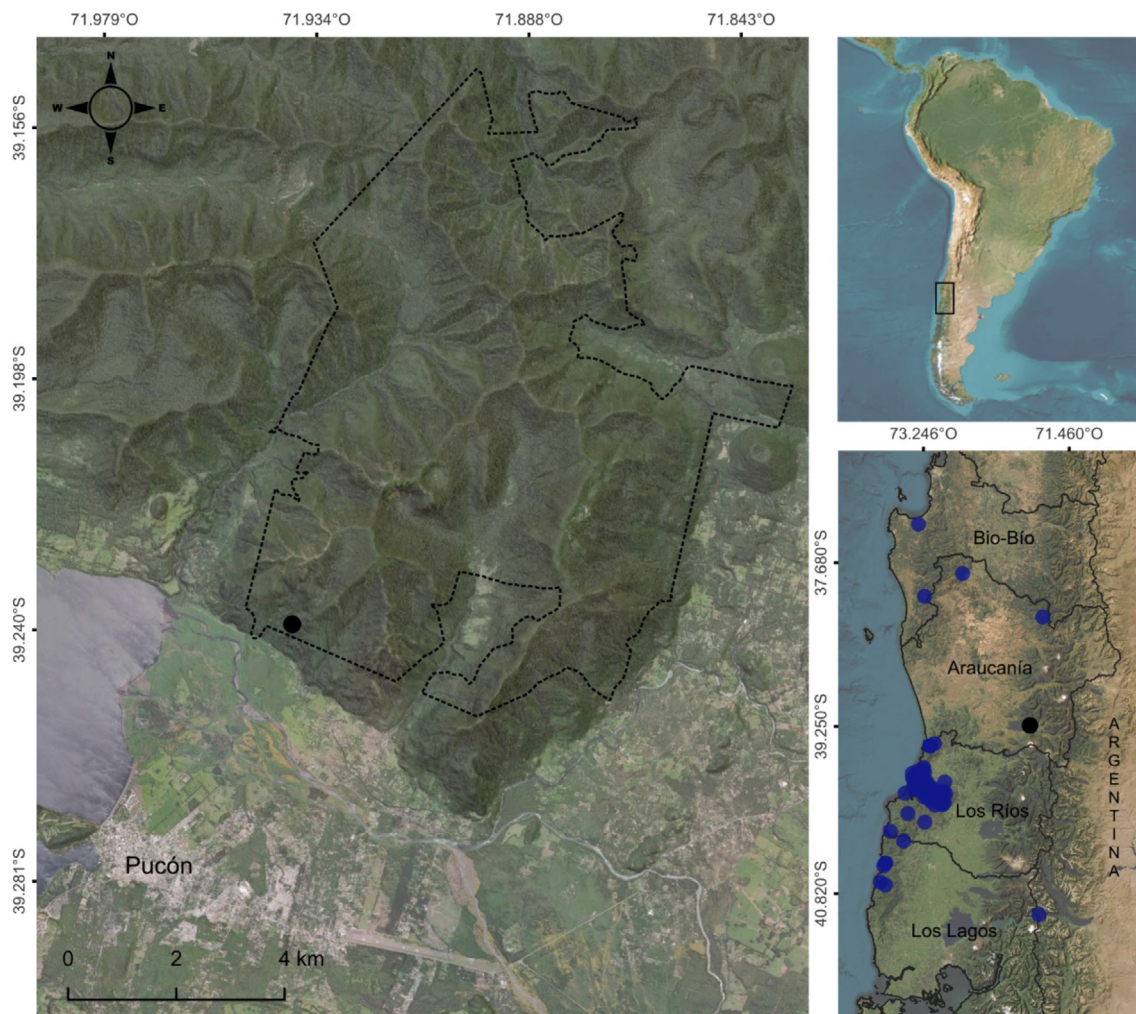


FIGURE 1. Location where *E. vertebralis* was recorded. Black circle: new record described here; blue circles: previous records reported (Velooso & Navarro 1988; Basso & Úbeda 1999; Úbeda & Basso 2012; Correa *et al.* 2017; Correa 2019; Correa & Durán 2019; IUCN 2019); black dotted line: boundaries of Quelhue sector, Villarrica National Reserve; black line: boundaries of Chilean regions. / Ubicación donde fue registrado *E. vertebralis*. Círculo negro: nuevo registro descrito aquí; círculos azules: registros reportados con anterioridad (Velooso & Navarro 1988; Basso & Úbeda 1999; Úbeda & Basso 2012; Correa *et al.* 2017; Correa 2019; Correa & Durán 2019; IUCN 2019); línea punteada negra: límites del sector Quelhue, Reserva Nacional Villarrica; línea negra: límites de las regiones de Chile.

Within its 60,005 hectares, it comprises deciduous forests, resinous coniferous forests, and predominantly low-altitude shrublands (CONAF 2008; Luebert & Pliscoff 2017). The Quelhue sector is constituted by a range of pre-Andean hills with steep topography that is difficult to traverse, where the predominant vegetation is primarily the temperate deciduous forest of *Nothofagus obliqua* (Mirb.) (Oerst. 1871) and *Laurelia sempervirens* (Ruiz & Pav.) (Tul. 1856) (CONAF 2008; Luebert & Pliscoff 2017). Knowledge about existing organism communities is relatively extensive regarding vegetation, however, it is extremely scarce regarding fauna (CONAF 2008), which is concerning because they are under constant anthropogenic pressures, especially amphibians. Due to their ectothermic condition, low vagility, and high philopatry, amphibians are extremely sensitive to environmental changes (Campbell-Grant *et al.* 2020). This sensitivity, combined with the continuous loss and degradation of their habitats and the spread of emerging diseases, has currently led many amphibian populations to experience global declines and an extinction crisis (Catenazzi 2015; Luedtke *et al.* 2023).

In the Quelhue sector of the Villarrica National Reserve, on March 27th, at coordinates approximately 39°14'25" S 71°56'26" W, at an altitude of 400 m asl, three subadult individuals (Fig. 2a, 2b) and two juveniles of *E. vertebralis* (Fig. 2c, 2d) were found. Regarding microhabitats, subadult individuals were found on the ground with abundant leaf litter and moisture within a plantation composed of *Pseudotsuga menziesii* (Mirb.) (Franco 1950) (Fig. 2e). Meanwhile, juvenile individuals were found near small pools (~50 cm²) located in an environment dominated by *Raukava valdiviensis* (Gay) (Frodin 2003) within the plantation (Fig. 2f). The understory showed regeneration of *L. sempervirens* along with individuals of *Rhaphithamnus spinosus* (Juss.) (Moldenke 1937), *Rhamnus diffusus* (Clos 1847), the herbaceous *Nertera granadensis* (Mutis ex L.f.) (Druce 1917), the climber *Boquila trifoliolata* (DC.) (Decne. 1839), and the fern *Blechnum hastatum* (Kaulfuss 1824) (Fig. 2e, 2f).

The identification of individuals was corroborated by observing a distinctive creamy-colored dorsal midline with dark lateral borders on the back, extending from the tip of the snout to the cloaca, a characteristic trait of the species that also gives it its specific epithet (Lavilla 2021). Additionally, they exhibited free digits without interdigital membranes ending in rounded shapes, whitish ventral coloration, a broad head with black eyes with golden reticulations and horizontal

pupils, dorsal skin with granulations, and a clearly visible tympanic ring (Rabanal & Nuñez 2008).

Quantitatively categorizing amphibians in Chile is a challenge due to limited available information, where often data on taxon abundance and precise geographic distribution are lacking (Vidal *et al.* 2024). Therefore, the discovery of *E. vertebralis* in the Villarrica National Reserve is a significant milestone that adds a new locality to the species current distribution range and enhances understanding of its habitat, presenting the second record on the western margin of the Andes, over 120 km south of Tolhuaca National Park, and constituting the first record within a *P. menziesii* plantation. Additionally, one of the locations within the Reserve where the species likely breeds has been identified, primarily because the area had a shady microclimate with high humidity, where abundant microrefugia were observed, creating a suitable environment for larval development and feeding, enhancing the Villarrica National Reserve as a crucial habitat for biodiversity conservation.

This finding could indicate a certain capacity for adaptation by the species, as well as the possibility of the presence of other potential populations in the area, which would be auspicious news. Although the individuals were found within a Protected Area, they are exposed to a significant degree of threat related to habitat loss that could occur with potential intervention in *P. menziesii* plantations. Therefore, it is imperative to advance the need to strengthen Protected Areas and improve strategic public policies (Vidal *et al.* 2024), essential to ensure the survival and continuity of amphibians in the territory, enabling the implementation of specific protection measures to preserve critical habitats necessary for amphibian reproduction. This would contribute to maintaining the biological diversity of the reserve and protecting amphibian populations, which are important indicators of ecosystem health (Welsh & Ollivier 1998; Zaghoul *et al.* 2020).

The new record provides insight into a new type of habitat dominated by the exotic species *P. menziesii* where *E. vertebralis* is distributed and contributes to the species baseline within the Reserve. This will enable progress towards studies focused on amphibian conservation within it, such as initiating monitoring to assess population size and health, which is essential for better understanding their dynamics and detecting potential threats, a crucial task in the current context of global change affecting them.



FIGURE 2. Records of *E. vertebralis* in the Quelhue sector. a) and b) Subadult individual. c) and d) Juvenile individual. e) and f) Microhabitat of the records. Photographs by R. González-Vásquez. / Registros de *E. vertebralis* en el sector Quelhue. a) y b) Individuo subadulto. c) y d) Individuo juvenil. e) y f) Microhábitat de los registros. Fotografías por R. González-Vásquez.

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REFERENCES

- Armesto, J., Rozzi, R., Smith-Ramírez, C., Arroyo, M. 1998. Conservation targets in South American temperate forests. *Science* 282(5392): 1271-1272.
- Basso, N., Úbeda, C. 1999. Geographic distribution: *Eupsophus vertebralis*. *Herpetological Review* 30(3): 172.
- Blotto, B., Nuñez, J., Basso N., Úbeda, C., Wheeler, W., Faivovich, J. 2013. Phylogenetic relationships of a Patagonian frog radiation, the *Alsodes* + *Eupsophus* clade (Anura: Alsodidae), with comments on the supposed paraphyly of *Eupsophus*. *Cladistics* 29: 113-131.
- Campbell-Grant, E., Miller, D., Muths, E. 2020. A synthesis of evidence of drivers of amphibian declines. *Herpetologica* 76(2): 101-107.
- Catenazzi, A. 2015. State of the world's amphibians. *Annual Review of Environment and Resources* 40: 91-119.
- CONAF. 2008. Plan de manejo Reserva Nacional Villarrica-Hualafafquén. Corporación Nacional Forestal. Región de la Araucanía, Chile. 132 pp.
- Correa, C. 2019. Nueva lista comentada de los anfibios de Chile (Amphibia, Anura). *Boletín Chileno de Herpetología* 6: 1-14.
- Correa, C., Durán, F. 2019. Taxonomy, systematics and geographic distribution of ground frogs (Alsodidae, *Eupsophus*): a comprehensive synthesis of the last six decades of research. *ZooKeys* 863: 107.
- Correa, C., Vasquez, D., Castro-Carrasco, C., Zúñiga-Reinoso, A., Ortiz, J., Palma, R. 2017. Species delimitation in frogs from South American temperate forests: the case of *Eupsophus*, a taxonomically complex genus with high phenotypic variation. *PLoS One* 12(8): e0181026.
- Formas, J. 1979. Amphibians of the Chilean southern temperate forest: a proposal about its origin. *Archives of Biological and Medical Research* 72: 191-196.
- Formas, J. 1989. A new species of *Eupsophus* (Amphibia: Anura: Leptodactylidae) from Southern Chile. *Proceedings of the Biological Society of Washington* 102(3): 568-576.
- Formas, J., Brieva, L. 1992. Immunological relationships of the South American frog genus *Eupsophus* (Leptodactylidae). *Biochemical Systematics and Ecology* 20(8): 747-751.
- IUCN. 2019. *Eupsophus vertebralis*. The IUCN Red List of Threatened Species 2019: e.T57080A79812871. <https://www.iucnredlist.org/species/57080/79812871>. Accessed: March 3, 2024.
- Lavilla, E. 2021. Etimologías de los anfibios de Chile. *Boletín Chileno de Herpetología* 8:36-54.
- Luebert, F., Plissock, P. 2017. Sinopsis bioclimática y vegetacional de Chile. Segunda Edición. Editorial Universitaria, Santiago, Chile. 384 pp.
- Luedtke, J., Chanson, J., Neam, K., Hobin, L., Maciel, A., Catenazzi, A., Borzée, A., Hamidy, A., Aowphol, A., et al. 2023. Ongoing declines for the world's amphibians in the face of emerging threats. *Nature* 622(7982): 308-314.
- Nuñez, J. 2003. Taxonomía y sistemática de las ranas del género *Eupsophus* (Leptodactylidae). PhD Thesis, Universidad Austral de Chile, Valdivia, Chile.
- Olivares, A., González, N., Puente-Torres, S., Contreras-Carrillo, C., Nuñez, J. 2014. Nuevos registros geográficos de la rana de pecho espinoso de Cordillera Pelada, *Alsodes valdiviensis* Formas, Cuevas & Brieva, 2002 (Amphibia: Alsodidae) y evaluación de su estado de conservación. *Boletín de Biodiversidad de Chile* 9: 11-20.
- Rabanal, F., Nuñez, J. 2008. Anfibios de los bosques templados de Chile. Universidad Austral de Chile, Valdivia, Chile. 206 pp.
- Suárez-Villota, E., Quercia, C., Díaz, L., Vera-Sovier, V., Nuñez, J. 2018. Speciation in a biodiversity hotspot: phylogenetic relationships, species delimitation, and divergence times of Patagonian ground frogs from the *Eupsophus roseus* group (Alsodidae). *PLoS One* 13(12): e0204968.
- Úbeda, C., Basso, N. 2012. *Eupsophus vertebralis* (Grandison, 1961). Categorización del estado de conservación de la herpetofauna de la República Argentina. Ficha de los Taxones. *Anfibios. Cuadernos de Herpetología* 26: 189.
- Veloso, A., Navarro, J. 1988. Lista sistemática y distribución geográfica de anfibios y reptiles de Chile. *Bollettino del Museo Regionale di Scienze Naturali* 6(2): 481-539.
- Vidal, M., Henríquez, N., Torres-Díaz, C., Collado, G., Acuña-Rodríguez, I. 2024. Identifying strategies for effective biodiversity preservation and species status of Chilean amphibians. *Biology* 13(3): 169.
- Villagrán, C., Hinojosa, L. 1997. History of the forests of southern South America, II: phytogeographical analysis. *Revista Chilena de Historia Natural* 70: 241-267.
- Welsh Jr, H., Ollivier, L. 1998. Stream amphibians as indicators of ecosystem stress: a case study from California's redwoods. *Ecological Applications* 8(4): 1118-1132.
- Zaghloul, A., Saber, M., Gadow, S., Awad, F. 2020. Biological indicators for pollution detection in terrestrial and aquatic ecosystems. *Bulletin of the National Research Centre* 44(1): 1-11.

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