Natural history of the relict marsupial Monito del Monte at the most extreme altitudinal and latitudinal location

CARLOS MEJAS,1,2 CARLOS A. CASTRO-PASTENE,1,2 HÉCTOR CARRASCO,3 JULIAN F. QUINTERO-GALVIS,1,4 MAURICIO SOTO-GAMBOA,1 FRANCISCO BOZINOVIC,5 AND ROBERTO F. NESPOLO1,5,6,†

1Instituto de Ciencias Ambientales y Evolutivas, Facultad de Ciencias, Universidad Austral de Chile, Valdivia, Chile
2Programa de Magíster en Ecología Aplicada, Escuela de Graduados, Facultad de Ciencias, Universidad Austral de Chile, Valdivia, Chile
3Departamento de Areas Silvestres Protegidas (DASP), Región del Maule. Corporación Nacional Forestal (CONAF), Talca, Chile
4Programa de Doctorado en Ecología y Evolución, Escuela de Graduados, Facultad de Ciencias, Universidad Austral de Chile, Valdivia, Chile
5Center of Applied Ecology and Sustainability (CAPES), Departamento de Ecología, Facultad de Ciencias Biológicas, Pontificia Universidad Católica de Chile, Santiago, Chile
6Millennium Institute for Integrative Biology (iBio), Santiago, Chile

Citation: Mejías, C., C. A. Castro-Pastene, H. Carrasco, J. F. Quintero-Galvis, M. Soto-Gamboa, F. Bozinovic, and R. F. Nespolo. 2021. Natural history of the relict marsupial Monito del Monte at the most extreme altitudinal and latitudinal location. Ecosphere 12(6):e03577. 10.1002/ecs2.3577

Abstract. Until a few years ago, the “monito del monte” (Dromiciops gliroides) was considered the sole surviving species of Microbiotheria, the sister group of Australidelphia (Australian marsupials). However, the recent identification of a new species relegated to the northern range (Dromiciops bozinovici) and newly discovered populations of Dromiciops beyond the known limits for the geographic range demands for new studies in extreme locations. In this report, we describe the northernmost population of D. bozinovici at a high Andean location (Reserva Nacional Altos de Lircay [RNAL], which represents a record of Dromiciops distribution both in latitude [35° S] and in altitude [1696 m a.s.l.]). We live-trapped individuals, performed behavioral observations, and extracted mtDNA (Cytb) for analyzing phylogenetic affinities. Together with confirming the phylogenetic position of RNAL within the D. bozinovici clade, interesting aspects of this isolated population arose, such as the sympatry with a didelphid marsupial (Thylamys elegans), and phylogenetic closeness with populations 300 km southward coastal. Our trapping effort yielded approximately 9.3 individuals/ha, which is relatively high compared with other small mammal populations, but typical for Dromiciops. Using in situ thermographic imaging during a night transect, we detected free-ranging animals running vertically at ~3.6 km/h through the logs of mature trees (Nothofagus pumilio), which is fast compared with other small runners (e.g., cursorial rodents), and also compared with Dromiciops from other locations. We compared the critical time to escape, of RNAL individuals which resulted significantly higher than Dromiciops from Nahuelbuta and Valdivia, suggesting that animals from RNAL are more tolerant to human presence than other populations, which is probably due to the high level of isolation of this population. According to the IUCN the northernmost distribution of Dromiciops reaches Cauquenes, thus this report extends the distribution in 120 km to the North East. Interesting aspects, such as hibernation at freezing temperatures and the existence of a viable D. bozinovici population northward of RNAL, warrant further research on this interesting location.

Key words: arboreal; Australidelphia; Dromiciops; Gondwana; hibernation; marsupial; thermography; Valdivian forest.

Received 20 October 2020; revised 19 January 2021; accepted 11 February 2021; final version received 16 April 2021. Corresponding Editor: Rebecca J. Rowe.

Copyright: © 2021 The Authors. This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.
† E-mail: robertonespolorossi@gmail.com
INTRODUCTION

The monitos del monte (genus *Dromiciops* Thomas, 1894; “monitos” hereafter) are considered the sole surviving lineages of the Microbiotheria order, which comprised several marsupial species that dominated southern South America in the Eocene-Miocene, encompassing a wide geographic range that extended from present-day Bolivia to Antarctica (Hershkovitz 1999, Goin and Abello 2013). Also, Microbiotheria is known to be the sister group of Australidelphia (Australian marsupials), which hypothetically colonized Australia through an Antarctic bridge during the Cretaceous (Mitchell et al. 2014).

Most Microbiotheriids disappear from the fossil record in the Middle Miocene, being *Microbiotherium* the most recent fossil genus and in several morphological aspects, similar to *Dromiciops* (Goin and Abello 2013). Monitos thus dominated temperate rain forest ecosystem (“Valdivian forest,” hereafter) during the last fifteen million years, suffering contractions and fragmentations due to desertification to the north, freezing to the south (Hershkovitz 1999), and flooding during the Miocene (Acosta et al. 2014). More recently, human influence has provoked profound modifications by replacing Valdivian forest by exotic plantations, especially at the northern range (Fonturbel et al. 2010), which is most fragmented and unknown.

The assignment of a species status for the northern clade of *Dromiciops* (i.e., the area encompassing Araucania, Bio Bio and Maule Region in Chile, and the Andean strip of the Neuquén province in Argentina), named *Dromiciops bozinovici* (“monito de Pancho”) was based on the high level of genetic (J. F. Quintero-Galvis et al., PhD thesis) and morphological (D’Elia et al. 2016) differentiation of these populations. This changed radically the taxonomic status of *Dromiciops*, which could impact conservation efforts because the new species is considerably less known. Such efforts are further complicated by the fact that the actual *Dromiciops* distributional range has not been actualized for at least 10 yr. In fact, according to the IUCN red list, monitos populations extend from coastal locations of Maule Region to Los Lagos and the Chiloé Island, and in Argentina from the Neuquén to Chubut provinces. However recently, dense *Dromiciops* populations have been described in the Southern edge, such as Chaitén and Futaleufú in Chile, and in Parque Nacional Los Alerces in Argentina (latitude 43° S; see Gurlovich et al. 2015, Oda et al. 2019). Here, we report the northernmost Andean *D. bozinovici* population, together with a description of its sympathy with *Thylamys elegans*, a didelphid marsupial not frequently found in sympathy with *Dromiciops* (Iriarte 2008). We also established phylogenetic affinities within the recently described new *Dromiciops* species (*D. bozinovici*) and measured some behavioral characteristics for comparison with other populations. Although several authors have provided behavioral observations of *Dromiciops* either in captivity (Mora and Soto-Gamboa 2011), using camera traps (Fonturbel et al. 2014), or using telemetry (Franco et al. 2011), just one study has presented behavioral observations in free-ranging individuals (foraging patterns, see Di Virgilio et al. 2014). This is especially important in a species with exclusive arboreal habits as in *Dromiciops*, where the tridimensional structure of the canopy is crucial for understanding displacements (Godoy-Guinao et al. 2018). To perform in situ observations, we took advantage of the unique conditions of Las Lengas site at Altos de Lircay, where animals are distributed in a small mature forest of *Nothofagus pumilio* (lenga) and *Nothofagus dombeii* (coihue), and visibility reaches 30 m within the canopy, which permits to follow long displacements of free-ranging animals. We thus compared this data with the previous observations and allometric expectations for running speeds in small quadrupeds. Also, we performed behavioral observations in captivity to compare these animals with southern populations (Nahuelbuta and Valdivia).

MATERIALS AND METHODS

Site description

This study was conceived after finding a single specimen found dead by one of us (ACP) in Reserva Nacional Altos de Lircay in 2019 (RNAL, 35°36’14.8” S, 71°03’29.3” W) near Camping Antahuara (Fig. 1; individual voucher IEE-UACH2020).

Previously, Valladares-Gomez et al. (2019) captured one individual in RNAL for microsatellite analysis, without further descriptions (Valladares-Gomez et al. 2019). In RNAL, the forest occupies...
the lowest altitudes in humid streams, protected from the wind, where it achieves its best development in height, density, and basal area, in addition to a greater structural complexity and floristic richness (San Martin et al. 1991). Vegetation is dominated by the typical forest species found in protected Southward slopes and humid ravines in places of lower altitude (Fig. 1b), where the dominant species is *N. pumilio*, which is mixed with *Nothofagus obliqua, N. dombeyi, Maytenus disticha, Maytenus chubutensis, Schinus crenatus, Berberis darwinii*, and *Codonorchis lessoni* (San Martin et al. 1991).

**DNA extraction and phylogenetic analysis**

To understand phylogenetic relationships, we sequenced the mtDNA (Cytb; sequence based in Himes et al. 2008, 430 base pairs) of the specimen (liver), which was found at Sendero Los Conones (near Camping Antahuara, see Fig. 1b), and compared it with sequences from GenBank to determine its phylogenetic affinities (Suarez-Villota et al. 2018; J. F. Quintero-Galvis et al. 2021). The sequence was deposited in GenBank with the accession number MW478284. We used two individuals from the outgroup Didelphidae to root the tree, and the software Geneious v.11.1.4 (Kearse et al. 2012) for filtering, trimming, and sequence alignment. Phylogenetic reconstruction was done by Maximum likelihood (ML) and Bayesian inference (BI) using Geneious (v.11.1.4). The most appropriate nucleotide substitution model was selected using the Akaike information criterion as implemented in JMODELTEST 2.1.4 software (Darriba et al. 2012). Trees were visualized and edited in FIGTREE 1.4 (2012, tree.bio.ed.ac.uk/software/figtree).

**Live captures**

An expedition to the site was carried out from 14 to 21 February 2020, where we laid out 141 live traps, in three sites (Tacitas, 35°36’33.4″ S, 71°04’09.4″ W, 1205 m a.s.l.; Vilches alto, 35°36’32.5″ S, 71°03’58.8″ W, 1211 m a.s.l.; and Camping Antahuara, 35°35’52.7″ S, 71°02’39.9″ W, 1422 m a.s.l.; Fig. 1b); thus, each line had 47 traps...
covering a sampling area of ca. 0.5 ha (assuming each trap attracts individuals in an approximate two-meter area, i.e., 12.6 m²). Hence, the total sampling area was about 1.5 ha and the trapping effort was 987 trap nights. Animals were captured using Tomahawk traps baited with banana and attached to branches in trees that were approximately 2 m above the ground level. Each captured individual was marked subcutaneously using PIT-tag (BTS-ID, Sweden) and weighed and fur and skin were clipped from the ear region to obtain skin samples for stable isotopic analysis. All animals were released in the same capture site, this occurred the day after capture (there were no recaptures). Given the limited trapping effort, the density estimates presented here should be considered as rough approximation.

**Thermography and night sightings**

In addition to the trappings, we performed observations at night by walking in a 3-km transect to observe free-ranging individuals. These observations to observe direct sightings of free-ranging animals occurred between 11 p.m. and 2 a.m. at Las Lengas location (35°35′32.11″ S 70°59′38.70″ W, 1696 m a.s.l., which to our knowledge is the highest known altitude for monitos, see Fig. 1c), a site that is 7 km away from Tacitas. We used a flashlight (Astro, 150, 3000 lumens) which permits us to identify the animals by the shine of their eyes in a range of 30 m (Fig. 2a), together with a thermograph (FLIR systems, Willisonville, Oregon, USA) set for an emissivity of 0.98 which is used to detect heat patterns and blood flow in body tissues (Fig. 2b).

For estimating approximate displacements, we identified areas in the trees used by the monitos and estimated the distance from them using a Wesco WS8902 laser distance measurement (maximum distance, 40 m). Then, the displacement of the animal was estimated approximately by observation of two points of reference where the animals passed.

**Behavioral quantifications of captive individuals**

To know how monitos perform under risky conditions, we performed qualitative in situ behavioral observations in captive individuals at the sampling sites and compared them with our similar field-caught individuals *D. bozinovici* ("monitos," hereafter) from previous visits to Parque Nacional Nahuelbuta and also with *Dromiciops gliroides* from Valdivia (R. F. Nespolo et al., *unpublished manuscript*). These observations consisted in estimating the critical time to escape (CTE) of an isolated individual located in the cage (plastic, 60 × 40 × 25 cm) at room temperature (20°C) with food ad libitum and forest bedding (200 g of twigs and leaves from their captures sites), in complete darkness. When lights are turned on, monitos usually freeze during a few seconds before escaping being this period a good proxy of their reactivity to perturbation. We recorded CTE for five individuals from RNAL and compared these values with other five individuals of Parque Nacional.

![Fig. 2. (a) Dromiciops bozinovici at Reserva Nacional Altos de Lircay free-ranging in Nothofagus pumilio (lenga) forests at Las Lengas site. (b) a thermographic image used for locating free-ranging individuals, (c) D. bozinovici monito de Pancho, and (d) Dromiciops gliroides monito del Sur. (e) Thylamys elegans (left) found in the same line of traps with one Dromiciops individual (right). Photos: Héctor Carrasco (a), Roberto Nespolo (b, e). Drawings: Mauricio Alvarez.](image)
Nahuelbuta (D. bozinovici, as well, see D’Elia et al. 2016) and other five individuals captured at Valdivia (D. gliroides), performed during similar field excursions this summer. All procedures presented in this study were approved by the Chilean Agriculture and Livestock Bureau (SAG) permits No 4371/2019 and 3393/2019 and by the Bioethics Committee of the Austral University of Chile, resolution 313/2018 annex 2019.

RESULTS

Maximum-likelihood (ML) trees using Cytb gene; Bayesian analyses (BA) recovered a similar topology in both cases (Fig. 3). Support values (bootstrap posterior probabilities) are shown below each branch. The obtained phylogeny located our sequenced individual nested within the D. bozinovici clade, specifically associated with individuals from the Nahuelbuta populations (Fig. 3). Live captures were successful, with n = 5 (two males, three females, M_B = 25 ± 3 g, mean ± SE) captured at Tacitas, n = 4 (one male, three females, M_B = 28 ± 2 g) individuals collected at Vilches alto and n = 4 individuals captured at Camping Antahuara M_B = 26 ± 3.1 g, which gave an estimated density of 9.3 individuals/ha (14 individuals in 1.5 ha). We also captured rodents in our traps which included three Abrothrix olivaceous and one Geoxus valdivianus, and we captured one marsupial didelphid T. elegans (Fig. 2e). In addition, during our 3-km walking transect at Las Lengas (10 p.m.–1 a.m.), 15 monitos were identified in the canopy, at between 15 and 35 m above ground (Fig. 2a), several of them by our thermograph (Fig. 2b, surface body temperature T_s = 30°C, approximately). These animals remained immobile in

![Fig. 3. Phylogenetic relationships of the sequenced individual within the Dromiciops complex. The vertical columns at the right represent the two species that correspond to geographical distribution. Names at tips are from GenBank and locality names are from literature (Himes et al. 2008, Suarez-Villota et al. 2018, Quintero-Galvis et al. 2021).](image-url)
front of the light of our flashlight for up to three minutes, and we managed to follow the displacement in five individuals, which covered vertical distances of approximately 1 m in a second, thus giving a maximum running speed of about 3.6 km/h, which is extremely fast for a non-cursorial mammal (see Djawdan and Garland 1988, and Discussion). Further visits are planned for measuring these speeds more exactly. The comparison of the CTE gave significant differences among monitos from the three compared populations (H statistic = 10.41, P = 0.006, Kruskal–Wallis test); RNAL, 5 ± 0.44 s (mean ± SE, range = 4–6; Nahuelbuta, 3.4 ± 0.40 [2–4]; Valdivia, 1.8 ± 0.37 [1–3]). Thus, this preliminary result would suggest that Altos de Lircay animals are significantly less prone to escape than the other two populations.

**Discussion**

The official distribution of *Dromiciops* (e.g., in the red list of IUCN), who described a geographic range extended from Maule region to Los Lagos region in Chile and in Argentina from the Neuquén to the Chubut provinces (Martin 2010), where the northern extreme is represented by the coastal populations at Constitución in Chile (Urie et al. 2017). Then, our study, together with previously described populations at the Palena province in Chile (Chaitén and Futaleufú, see Oda et al. 2019) and in Parque Nacional Los Alerces in Argentina (latitude 43° S; Gurovich et al. 2015), would expand this range in more than 100 kms to the west. Our fieldwork experience during this study and several visits for other studies strongly suggest that the geographic range of *Dromiciops* in Chile extends even more, to the north (e.g., it was reported in Radal 7 Tazas, 15 km north of RNAL, Carlos Augusto Castro, personal communication), and to the south, beyond the Parque Nacional Corcovado in Chile (Oda et al. 2019).

Our phylogenetic reconstruction shows that the RNAL population associates well with the populations of the northern clade of *Dromiciops*, particularly with Nahuelbuta and Malleco-Tolhuaca, which is consistent with the acceptance of the Northern clade as an independent genetic unit for *Dromiciops*, which was elevated above the species level by D’elia et al. (2016; *D. bozinovici*, which we used here; however, see discussions in Suarez-Villota et al. 2018, Valladares-Gomez et al. 2019). The existence of *D. bozinovici* was recently confirmed by a broad genetic-population analysis including nuclear and mitochondrial markers, and fossil calibration (J. F. Quintero-Galvis et al. 2021). However, it is unknown whether these populations differ in aspects other than genetic divergence, for example, external and internal anatomy, physiology or behavior (see below).

Our results suggest *D. bozinovici* has some behavioral differentiation in running speed. In fact, the speed of 3.6 km/h that we estimated in free-ranging animals is fast for *Dromiciops* (Di Virgilio et al. 2014, estimated a maximum speed of 1.8 km/h in a population of Puerto Blest) and is extremely fast compared to other cursorial small mammals (e.g., *Octodon degus* of 150 g has a maximum speed of 1.81 km/h running straight on plain ground, see Kenagy et al. 2002). Actually, the record for running speed in small mammals is for *Neotoma* rats (110.6 g) that can run at 17.1 km/h (Djawdan and Garland 1988). This level of movements is consistent with a large home range in *Dromiciops* (1.6 ± 0.6 ha, see Fonturbel et al. 2012), which is 2.9 times the predictions of allometric equations (i.e., 0.55 ha for an animal of 28 g; using the equation: 14.9 \( M_b^{0.63} \), of Garland 1983). Thus, our calculated density of 9.5 individuals/ha, which is coincident with other estimations (8–27 individuals/ha in several populations, see Fonturbel et al. 2012), suggests these rapid animals cross the vegetation cover several times in a single night. This is consistent with our observations at Las Lengas, where we frequently saw monitos rapidly climbing through the logs to ~10 m of height and returning to the ground in a couple of seconds.

Roughly, the geographic range of *Dromiciops* is a fragmented mosaic covering about 150,000 km² just taking the Andean-coastal rectangle from RNAL to Chaitén in Chile and south to Parque Nacional Los Alerces in southern Argentina. Also, the altitudinal gradient of *Dromiciops* is large, ranging from sea level in coastal populations to over 1690 m a.s.l. Thus, it would be naive to assume that monitos are monotypic, genetically homogeneous, or morphologically undifferentiated. This species, despite having been recognized as emblematic...
for science several decades ago because of its role as a disperser, its relict condition, and its phylogenetic affinities with Australian marsupials, began to be studied in a comprehensive way only a few years ago (e.g., Schneider and Gurovich 2017, Gurovich and Ashwell 2020). These studies showed that *Dromiciops* varies both in external and in cranial morphology, showing a strong genetic structuration across its range, with important particularities in islands and other isolated populations (D’Elia et al. 2016, Valladares-Gómez et al. 2017, Valladares-Gómez et al. 2019; J. F. Quintero-Galvis et al. 2021). In addition, several unpublished results in the form of photos, museum specimens, and manuscript in preparation indicate that the external morphology (i.e., colors and pigmentation patterns) varies enormously in different *Dromiciops* populations, distantly just a few kilometers (e.g., coastal vs. inland Valdivian populations D’Elia et al. 2016, Chiloé Island vs. inland, see Himes et al. 2008). Our comparison with animals from Nahuelbuta and Valdivia gave significant differences in a simple behavior, but we are positive that more detailed physiological and morphological analyses will give important clues of local adaptation to some environments.

**How this population survived?**

The RNAL population of *D. bozinovici* represents an isolated Andean relictual lineage associated with *Nothofagus* forests which, according to the fossil pollen record, covered large extensions of land South of Talca (35° S) during the Miocene (Acosta et al. 2014). Most of these forests went extinct South of Arauco Gulf (37° S), especially at coastal locations, initially because of extensive flooding of sea water that covered them (i.e., the middle Miocene transgressions, Acosta et al. 2014) but later due to quaternary glaciations (Himes et al. 2008). Several patches of forest escaped extinction as refuges in elevated zones, where dense populations of *D. bozinovici* are still thriving (e.g., Parque Nacional Nahuelbuta and Cordillera Pelada, see Himes et al. 2008). Then, RNAL represents perhaps the oldest *Dromiciops* lineage, surviving as a tiny spot of isolated Andean forest, encompassing a few square kilometers from Tacitas to Las Lengas (see Fig. 1). This last location, Las Lengas, is impressively small and contains perhaps the most unique and intriguing populations of the emblematic Monito de Pancho. Further studies and focused conservation actions on these populations are urgent.

**Acknowledgments**

We thank Esteban Oda for fieldwork and laboratory help in DNA extraction. We also thank two anonymous reviewers for their helpful comments to this manuscript. This study was funded by Fondecyt grant 1180917 to R. Nespolo, ANID PIA/BASAL grant no. FB-0002 to FB and RN, and Instituto Milenio de Biología Integrativa (iBio). ANID PhD fellowship 2016 N° 21160901 is acknowledged by J.F Quintero-Galvis. The authors declare no conflicts of interest.

**Literature Cited**

Acosta, M. C., P. Mathiasen, and A. C. Premoli. 2014. Retracing the evolutionary history of Nothofagus in its geo-climatic context: new developments in the emerging field of phylogeology. Geobiology 12:497–510.

Darriba, D., G. L. Taboada, R. Doallo, and D. Posada. 2012. jModelTest 2: more models, new heuristics and parallel computing. Nature Methods 9:772.

D’Elia, G., N. Hurtado, and A. D’Anatro. 2016. Alpha taxonomy of *Dromiciops* (Microbiotheriidae) with the description of 2 new species of monito del monte. Journal of Mammalogy 97:1136–1152.

Di Virgilio, A., G. C. Amico, and J. M. Morales. 2014. Behavioral traits of the arboreal marsupial *Dromiciops gliroides* during *Tristerix corymbosus* fruiting season. Journal of Mammalogy 95:1189–1198.

Djawdan, M., and T. Garland. 1988. Maximal running speeds of bipedal and quadrupedal rodents. Journal of Mammalogy 69:765–772.

Fonturbel, F. E., A. B. Candia, and C. Botto-Mahan. 2014. Nocturnal activity patterns of the monito del monte (*Dromiciops gliroides*) in native and exotic habitats. Journal of Mammalogy 95:1199–1206.

Fonturbel, F. E., M. Franco, M. A. Rodriguez-Cabal, M. D. Rivarola, and G. C. Amico. 2012. Ecological consistency across space: a synthesis of the ecological aspects of *Dromiciops gliroides* in Argentina and Chile. Naturwissenschaften 99:873–881.

Fonturbel, F. E., E. A. Silva-Rodriguez, N. H. Cardenas, and J. E. Jimenez. 2010. Spatial ecology of monito del monte (*Dromiciops gliroides*) in a fragmented landscape of southern Chile. Mammalian Biology 75:1–9.

Franco, M., A. Quijano, and M. Soto-Gamboa. 2011. Communal nesting, activity patterns, and population characteristics in the near-threatened monito...
del monte, *Dromiciops gliroides*. Journal of Mammalogy 92:994–1004.

Garland, T. 1983. Scaling the ecological cost of transport to body mass in terrestrial mammals. American Naturalist 121:571–587.

Godoy-Guinao, J., I. A. Diaz, and J. L. Celis-Diez. 2018. Confirmation of arboreal habits in *Dromiciops gliroides*: a key role in Chilean Temperate Rainforests. Ecosphere 9:6.

Goin, F. J., and M. A. Abello. 2013. South American Metatherians from the beginning of the Neogene (early Miocene, Colhuehuapian land-mammal age). Microbiotheria and polydolopimorphia. Ameghiniana 50:51–78.

Gurovich, Y., and K. W. S. Ashwell. 2020. Brain and Behavior of Dromiciops gliroides. Journal of Mammalian Evolution 27:177–197.

Gurovich, Y., H. J. Stannard, and J. M. Old. 2015. The presence of the marsupial *Dromiciops gliroides* in Parque Nacional Los Alerces, Chubut, Southern Argentina, after the synchronous maturation and flowering of native bamboo and subsequent rodent irruption. Revista Chilena de Historia Natural 90:5.

Iriarte, A. 2008. Mamíferos de Chile. Santiago, Chile: Lynx.

Kearse, M., et al. 2012. Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. Bioinformatics 28:1647–1649.

Kenagy, G. J., R. A. Vasquez, R. F. Nespolo, and F. Bozinovic. 2002. A time-energy analysis of daytime surface activity in degus, *Octodon degus*. Revista Chilena de Historia Natural 75:149–156.

Martin, G. M. 2010. Geographic distribution and historical occurrence of *Dromiciops gliroides* Thomas (Metatheria: Microbiotheria). Journal of Mammalogy 91:1025–1035.

Mitchell, K. J., et al. 2014. Molecular phylogeny, biogeography, and habitat preference evolution of marsupials. Molecular Biology and Evolution 31:2322–2330.

Mora, J. P., and M. Soto-Gamboa. 2011. Legítima dispersión de semillas *Ugni molinae* Turcz. (Myrtaceae), por monito del monte, *Dromiciops gliroides*. Gayana Botánica 68:309–312.

Oda, E., G. B. Rodriguez-Gomez, F. E. Fonturbel, M. Soto-Gamboa, and R. F. Nespolo. 2019. Southernmost records of *Dromiciops gliroides*: extending its distribution beyond the Valdivian rainforest. Gayana 83:145–149.

Quintero-Galvis, J. F. 2021. Species delimitation and genetic differentiation of the genus Dromiciops: implications for the phylogeography of Dromiciops gliroides (Microbiotheria, Microbiotheriidae) an endemic marsupial to Chile and Argentina. PhD thesis. Universidad Austral de Chile.

San Martin, J., A. Troncoso, A. Mesa, T. Bravo, and C. Ramirez. 1991. Estudio fitosociológico del bosque caducifolio magallánico en el litoral norte de su área de distribución. Bosque 12:29–41.

Schneider, N. Y., and Y. Gurovich. 2017. Morphology and evolution of the oral shield in marsupial neonates including the newborn monito del monte (Dromiciops gliroides, Marsupialia Microbiotheria) pouch young. Journal of Anatomy 231:59–83.

Suarez-Villota, E. Y., C. A. Quercia, J. J. Nunez, M. H. Gallardo, C. M. Himes, and G. J. Kenagy. 2018. Monotypic status of the South American relictual marsupial *Dromiciops gliroides* (Microbiotheria). Journal of Mammalogy 99:803–812.

Uribe, S. V., R. G. Chiappe, and C. F. Estades. 2017. Persistence of *Dromiciops gliroides* in landscapes dominated by *Pinus radiata* plantations. Revista Chilena de Historia Natural 90:5.

Valladares-Gómez, A., J. L. Celis-Diez, R. E. Palma, and G. Manriquez. 2017. Cranial morphological variation of *Dromiciops gliroides* (Microbiotheria) along its geographical distribution in south-central Chile: a three dimensional analysis. Mammalian Biology 87:107–117.

Valladares-Gomez, A., J. L. Celis-Diez, C. Sepulveda-Rodriguez, O. Inostroza-Michael, C. E. Hernandez, and R. E. Palma. 2019. Genetic diversity, population structure, and migration scenarios of the marsupial “monito del monte” in south-central Chile. Journal of Heredity 110:651–661.