

SHORT REPORT

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# Persistence of *Dromiciops gliroides* in landscapes dominated by *Pinus radiata* plantations

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## Abstract

**Background:** Monitos del monte (*Dromiciops gliroides*) are old-growth forest specialists and, thus, believed to be very sensitive to habitat transformation, although some recent studies show some level of plasticity of their habitat selection patterns.

**Findings:** In this note we report on records of *D. gliroides* living in a very modified environment, composed mostly by industrial pine plantations and small fragments of *Nothofagus* spp. forests and we report the extension of the northernmost limit of its currently known distribution.

**Conclusions:** Although highly reliant on native vegetation, *Dromiciops gliroides* has been able to persist in industrial forest landscapes dominated by pine plantations.

**Keywords:** Marsupial, fragmentation, conservation, habitat transformation

## Introduction

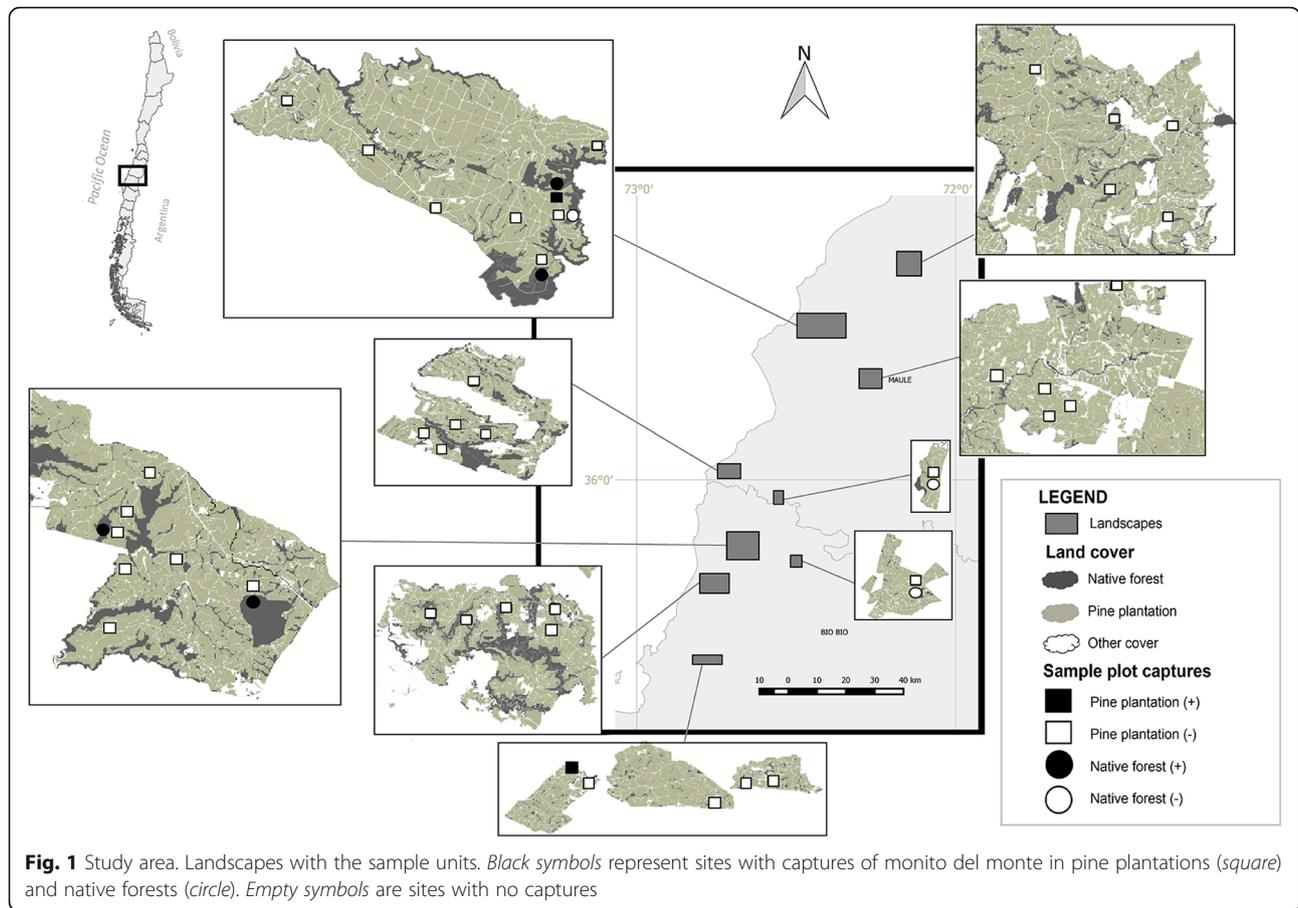
The Monito del monte (*Dromiciops gliroides*) is the only representative of the order Microbiotheria [1, 2], closely related to Australian marsupials [3, 4] and it is classified as Near Threatened by IUCN [5]. Historically, this species has been considered an old-growth forest specialist, selecting stands with dense bamboo (*Chusquea* spp.) thickets, in which they build their nests [6–8]. Despite the latter, there is increasing evidence that *D. gliroides* can use environments such as secondary forests, shrublands and even sparse *Eucalyptus* plantations with a rich native understory [9, 10]. Most of the studies on the ecology and biology of Monitos del monte have been conducted on populations in the evergreen forests of the Southern half of the species' range [e.g. [1, 9–15]]. In contrast, the information available for *D. gliroides* living in deciduous forests is very scant and anecdotal (e.g. [16, 17]). In this note we report on observations of some of the northernmost populations of *D. gliroides*, living in landscapes dominated by pine plantations.

## Methods

The information presented in this note was collected as a part of two studies that we conducted in the Coastal Range of the Maule and Biobío regions of Central Chile, between 2008 and 2016 (see Additional file 1). The first study (S1, 2008–2012) involved live trapping of small mammals in seven landscapes dominated by industrial pine plantations, distributed from Constitución (35°13'S 72°08' W) to Dichato (36°36'S 72°50' W) (Fig. 1). At each site we installed five grids of 100 (10x10m) Sherman-like (240x80x90 mm) traps in mature (17–20 y) pine stands. All traps were set up on the ground and baited with oats, remaining active during three nights. Each grid was assessed once during the breeding (October to January) and once during the non-breeding season (May to August). Thus, the total sampling effort was seven landscapes × 5 grids × 100 traps × 3 nights × 2 seasons = 21,000 traps × night.

The second study (S2, 2012–2016) was also conducted in seven industrial forest landscapes distributed from Constitución (35°30'S 72°23' W) to Cobquecura (36°12'S 72°38' W) (Fig. 1), but this time we sampled small mammals in both pine plantations and native forests. At each site we installed a grid of 120 traps (60 2-trap groups 25 × 12m from each other) in a *Nothofagus*

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spp. (*N. glauca*, *N. obliqua* and *N. dombeyi*) forest fragmentation and another in the adjacent mature pine plantation. As in the previous study, traps were put on the ground, baited with oats and remained active during three nights. Some sites were assessed more than once per season, so the total sampling effort for pine plantations was 18 sites/times  $\times$  120 traps  $\times$  3 nights = 6,480 traps  $\times$  night during the breeding season, and 6 sites/times  $\times$  120 traps  $\times$  3 nights = 2,160 traps  $\times$  night during the non-breeding season. For the native forests, sampling effort was 35 sites/times  $\times$  120 traps  $\times$  3 nights = 12,600 traps  $\times$  night during the breeding season, and 6 sites/times  $\times$  120 traps  $\times$  3 nights = 2,160 traps  $\times$  night during the non-breeding season.

Although in both studies we ear-tagged most species, because of the small size of its ears and their low capture rates, we identified *D. gliroides* individuals through hair cuts. After sexing and weighting, we released all individuals in the same site of capture.

At all sampling plots we characterized the vegetation by visually estimating foliage volume of different strata and plant species [18]. We described the land use at each of the studied landscapes using a land

cover data base for the country in 2014 [19]. The main land uses of each studied landscape are summarized in Table 1.

### Findings

During our work we captured a total of 17 monitos del monte, two in pine plantations (0.067 individuals/1,000 traps contrast, the information available night) and 15 in native forest fragments (1.01 individuals/1,000 traps  $\times$  night). The details of these captures are presented in Table 1.

The first individual recorded in pine plantations corresponded to a juvenile captured during the non-breeding season in S1, in a site 200 m from a narrow creek with native vegetation and 600 m from a 25-ha patch of native forest. There was a highly used forest road 20 m from the trap. The second record of the species in a pine stand was that of an adult captured 90 m from a 190-ha continuous patch of native vegetation during the second breeding season of S2 (Fig. 1). Both sites had a well developed understory (>20% cover).

The individuals recorded in native forest fragments were captured in four of the seven sites sampled, and two of them correspond to the northernmost records for

**Table 1** Studied landscapes and captures of *Dromiciops gliroides* in the coastal range of the Maule and Biobío regions

Region/ Municipality	Landscape	Land use (% cover)			Captures			
		Native forest	Pine	Other	n	Coord. Lat/Long	Forest type	Study
Maule								
/Constitución	Quivolgo	29	63	8	0			
	San Pedro-Las Cañas	19	70	11	1	35°30'5.05"S 72°22'42.88"W	Pine	S2
						1	35°29'59.83"S 72°22'38.45"W	Native
					12	35°31'42.24"S 72°22'58.22"W	Native	S2
/Pelluhue	Trehualemu	37	51	12	0			
/Cauquenes	Name-Melencura	32	61	7	0			
	Matanza segura	27	58	15	0			
Biobío								
/Cobquecura	Montezorro	12	82	6	0			
/Cobquecura-Quirihue	Tollo-Guanaco	26	57	17	1	36°11'44.74"S 72°41'32.46"W	Native	S2
					1	36°13'14.85"S 72°37'46.56"W	Native	S2
/Quirihue	Chipre	7	92	1	0			
/Dichato	Crisoles-Leonera-Guinerál	18	67	15	1	36°32'56.39"S 72°52'51.91"W	Pine	S1

the species. Interestingly, 12 individuals were captured during a three-day campaign in just one site.

**Discussion**

This note provides two pieces of novel information. Before our observations, *Dromiciops gliroides* had never been recorded in pine plantations. These observations were conducted in pine stands with dense (>20%) understory. Our observations also expanded the known distribution of the species 35 Km to the North (previous limit was Los Ruiles National Reserve 35°50'S 72°30'W [17]). The latter agrees with the predictions by Martin [20] whose models give a 1–10% probability of presence of monito del monte between 34–36°S in the Coastal Range of Central Chile.

Although monitos del monte were recorded un frequently in our studies (0.09% of all captured small mammals), our results show that *D. gliroides* has been able to persist in an extremely altered environment. Also, the fact that we set up the traps on the ground and used a bait that is not particularly attractive to the species [11], suggests that we might have underestimated the abundance of the species.

The low abundance of *D. gliroides* in pine plantations is likely due to their simple vertical structure, which reduces their ability to climb and move through the foliage. Although some pine stands have well developed understories, bamboo (*Chusquea* spp.) thickets are

uncommon in these artificial forests (average (SE), 267.3 (123,6) m<sup>3</sup> foliage/ha, Uribe, unpublished data). This might favour the limited use of pine stands by monitos del monte, as these plants have been considered a key component of the species' breeding habitat, because of their importance for the construction of nests [1, 11]. Other key elements as ferns and vines are also uncommon in pine plantations. Fonturbel et al. [9] recorded *D. gliroides* at similar rates in native forests and *Eucalyptus* plantations, but in this unusual case, due to a lack of management, this stand had a rich native understory.

The native forest fragments studied by us had a much higher abundance of bamboos (average (SE), 1312.8 (540.6) m<sup>3</sup> foliage/ha, Uribe, unpublished data) than pine stands, and, coincidentally, the capture rate of *D. gliroides* was an order of magnitude higher than that of plantations. However, this rate showed a significant variation among sites and campaigns, with 80% of the individuals captured in just one session in a plot of approximately 2 ha. We cannot begin to explain this aggregation of individuals by any evident factor associated to the habitat characteristics. In fact, this particular fragment had a below-average *Chusquea* cover (936 m<sup>3</sup> foliage/ha). Also, the land use composition of San Pedro-Las Cañas was similar to the rest of the landscapes (19% native forest and 70% pine plantation, vs an average (SE) of 23.5 (3.6) and 66.4 (4.9), respectively,

Table 1). However, there is one anecdotal observation about this record that is worth mentioning. During the days in which we captured these animals, the neighboring plantations were being cut. We can only speculate on a transient aggregation of monitos in the native forest, while escaping from the timbering operations taking place in the nearby plantations. A study conducted by us in the area [21] showed no such effect for the rodent *Abrothrix longipillis*, as most individuals died crushed by the machinery because of their tendency to hide under the forest litter when in danger. However, a more mobile animal such as *D. gliroides*, that usually climbs trees for protection (authors' pers. obs), will likely try to abandon the tree harvesting area. Testing this hypothesis would be very important to understand the mechanisms affecting the long term persistence of this species in pine plantation landscapes. The available information is not sufficient to determine whether the presence of *D. gliroides* in landscapes dominated by pine plantations is a sign of some level of adaptation to this novel ecosystem (with its inherent disturbance regime [22]) or if it is only due to the "extinction debt" (i.e. populations are slowly declining towards extinction, [23]). However, the history of this region tends to favor the first explanation. For example, most plantations in this region of Chile are in their second or third 20-year rotation, which means that several generations of monitos have been born in these landscapes since the major transformations took place. Also, in the 1950's approximately a 45% of the landscape in the coastal range of South Central Chile was already transformed into agriculture [24, 25], whereas the current proportion of "open" land uses in this region is approximately 21% [26]. This means that the present landscape might be more favorable to forest specialists such as *D. gliroides*, who might avoid moving through non forested habitats [10].

In any of the latter cases, management of pine plantations has the potential to influence a significant proportion of *D. gliroides* populations. Two main issues that should be addressed are the potential transformation of pine plantations into breeding habitat for the species, via the improvement of the understory [27], and the enhancement of the role of pine plantations as connectors for populations living in native forest fragments. Specific management recommendations will likely arise after more detailed information on the species' ecology is obtained.

Recently, D'Elia et al. [28] proposed a division of *D. gliroides* into three different species. Should this new classification be adopted, our observations would then correspond to the northern species, *D. bozinovici*. The fact that a significant portion of this taxon's distribution range is dominated by pine plantations would make our observations even more relevant.

## Additional file

**Additional file 1:** Table 1. Years of evaluation of different landscapes during Study 1 (S1). Numbers in parentheses are sample units in each field campaign. Table 2. Years of evaluation of study sites, during Study 2 (S2). Numbers in parentheses are the number of field campaigns for each site. (PDF 208 kb)

## Abbreviations

S1: First study (period 2008–2012); S2: Second study (period 2012–2016); SE: Standard error; y: Years

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## Availability of data and material

Please contact author for data request.

## Authors' contributions

SVU designed the studies, collected data and wrote the manuscript. RGC collected data and interpreted the results. CFE designed the studies, interpreted the results and wrote the manuscript.

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## Competing interests

The authors declare that they have no competing interests.

## Consent for publications

Not applicable.

## Ethics approval

Captures were made under the following permits granted by the Chilean Agriculture and Livestock Service (SAG) to CFE: 2944(2008), 2794(2009), 3860(2010), 2916(2011), 4663(2012), 6513(2013), and 4056(2014–2016).

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