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Original investigation

Past and present small mammals of Isla Mocha (Chile)

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Abstract

We describe archaeozoological and extant small mammals from Isla Mocha, an island located in south-central Chile. Species composition was compared among past and present assemblages. Also composition, as well as individual and population parameters were compared among island habitats. Specimens from archaeological sites included *Oligoryzomys longicaudatus*, *Abrothrix* sp., and *Octodon pacificus*, whereas *Abrothrix longipilis*, *A. olivaceus*, *Oligoryzomys longicaudatus*, and *Geoxus valdivianus* were captured. Higher richness was observed in intermediate-disturbed habitat. Body size and tail length, as well as body mass did not vary among island habitats for *A. longipilis* or *A. olivaceus*. Higher abundance was associated to less perturbed habitat.

Key words: *Octodon pacificus*, archaeozoology, Isla Mocha, Chile

Introduction

Islands comprise an important part of the Chilean territory. Despite this, little ecological research has been done in these ecosystems. One exception is Isla Mocha, one of the few islands that have been surveyed for its fauna, vegetation, and archaeology. One remarkable mammal is *Octodon pacificus* Hutterer, 1994, the only insular endemic Octodontid (Rodentia: Hystricognathi) (HUTTERER 1994). Unfortunately, it has only been captured once, in 1959 when two adult females and two juveniles were collected (now in the Museum Alexander Koenig, Bonn).

Isla Mocha has also been interesting for botanists, since it supports dense vegetation that is biogeographically related to mainland Valdivian forest (LEQUESNE et al. 1999). The forest on Isla Mocha is dominated by *Aextoxicon* and members of the Myrtaceae. Botanical, geological, and geographical descriptions suggest that the island has had similar vegetation conditions as at present since at least 1,760 years BP (LEQUESNE et al. 1999). Anthropologists have found a long history of human occupation starting ca. 3,300 years BP when hunter-gatherers occasionally occupied the island (QUIROZ and SÁNCHEZ 1993; QUIROZ and VÁSQUEZ 1996).

Islanders have always relied on island vegetation for their subsistence, and this has led to degradation of natural habitats. Human activity has resulted in the almost total deforestation of lowlands, which are now dominated by grasslands composed by in-

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troduced and cultivated species in which sparse and very small fragments of forest remain. In intermediate elevations, tree-cutting and subsequent erosion have given rise to an ecotone matorral that separates Valdivian forest from disturbed grasslands (PEFAUR and YÁÑEZ 1980). The Valdivian forest, now restricted to higher elevations, has suffered increased opening, and modification of species composition, primarily due to timber extraction (LEQUESNE et al. 1999).

To contribute to the knowledge of Chilean insular habitats, and the elucidation of the distribution of the genus *Octodon*, we investigated the small mammals of Isla Mocha. A further aim was to describe the faunal composition in time and space, analysing archaeozoological remains along with present-day small mammals that inhabit the different habitats of the island.

Material and methods

Isla Mocha is located 30 km W off the coast in front of the Arauco Province, in south-central Chile (Fig. 1). Its maximum extension is 13 km N–S and 5–7 km E–W. Valdivian forest is restricted to highland areas above 300 m – a. s. l. (LEQUESNE et al. 1999). PEFAUR and YÁÑEZ (1980) found 4 native rodents *Abrothrix longipilis* (Waterhouse, 1837), *A. olivaceus* (Waterhouse, 1837), *Oligoryzomys longicaudatus* (Bennet, 1832) and *Geoxus valdivianus* (Philippi, 1858). Two introduced murids (*Rattus rattus* Linnaeus, 1758 and *R. norvegicus* Berkenhout, 1769) were also part of the rodent assemblage. Ancient human occupation was restricted to the periphery of the island. This has left numerous archaeological sites, which are still being studied (QUIROZ and SÁNCHEZ 1997). Archaeozoological material that was analysed came from some of these sites (Fig. 1).

Archaeozoological small mammals

We analysed small mammal remains from 4 archaeological sites (P5-1, P22-1, P25-1, P31-1) excavated during 1993–1998 (Fig. 1). Archaeological material was extracted from each 10 cm of artificial levels, with a variable number of levels for each quadrant. All these levels date pre-Columbian occupation, having an aboriginal origin. Maximum excavation depth was achieved in site P25-1, where 15 levels were extracted. Excavation plots ranged between 1–8 m^2, with a total 18,600 l of sediment recovered (for excavation descriptions and details, see QUIROZ and SÁNCHEZ 1993). *Octodon bridgesi* Waterhouse, 1845 was previously mentioned as a component of the archaeozoological sample of site P31-1 (SÁNCHEZ et al. 1994). Here we inspected archaeozoological assemblage of this site to confirm this description.

Each bone was identified to the most specific taxonomic and anatomical level possible. We discriminated to species, family, order or class levels, using available identification keys (e. g. REISE 1973; PEARSON 1995). Due to the lack of keys for *Octodon pacificus*, and to the ambiguous presence of this species in the archaeozoological record, we compared *Octodon* specimens with those described by HUTTERER (1994). To infer depositional process, at the anatomical level we discriminated between cranial and post-cranial elements (GILBERT 1980). Also we established whether each bone was fragmented or showed evidence of human use such as fire or cuts, as well as its age (i. e., juvenile or adult).

Present day rodents

In January 2000, we trapped small mammals in Isla Mocha with lines of medium and large size Sherman-type traps, located each 10 m apart in the three main habitats of the island (Fig. 1). Trapping effort included coastal forest (500 trap-nights), ecotone matorral (450 trap-nights) and Valdivian forest (495 trap-nights), for a total of 1,445 trap-nights. Traps were baited with oat, and kept open for five consecutive nights. Traps were checked each morning, and captured specimens were marked, measured and released. Species composition was compared among island habitats, along with individual and population parameters. Individual condition was assessed through body weight, body size, and tail length. At the population level, we described population size using trapping success as an estimator of abundance. Also, reproductive and juvenile proportion were used to describe population structure.

Results

Archaeozoological small mammals

We recovered 462 specimens in all excavated sites. 76.4% of specimens were collected from site P31-1 (Tab. 1). Sigmodontines were the most important group in

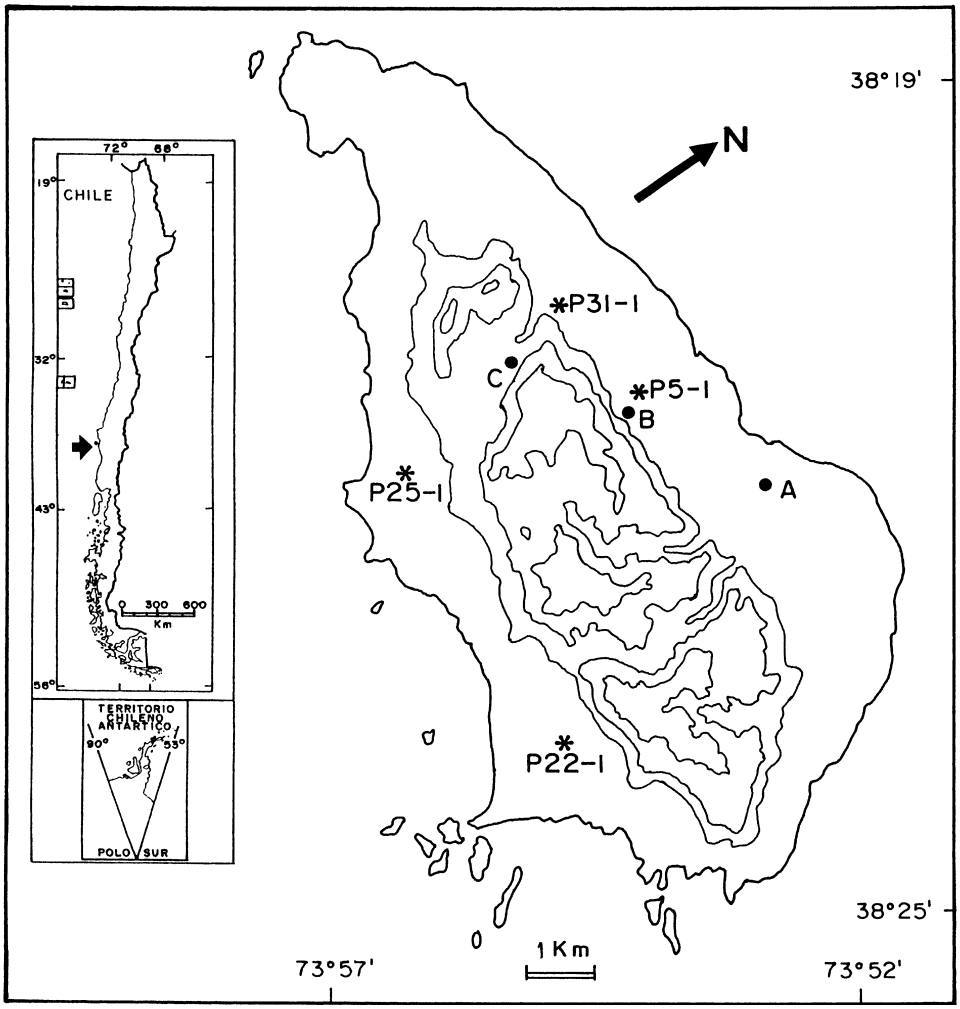

Fig. 1. Diagram of Isla Mocha, VIII Región, Chile. Archaeological sites P25-1, P31-1, P5-1 and P22-1 are shown by an asterisk. Small mammals trapping sites are: A, Coastal forest; B, Ecotone matorral and C, Valdivian forest.

the archaeozoological record, comprising 89.9% of small mammals. All specimens were adults, with only one of them showing fire marks. Bone fragmentation varied among groups, with caviomorphs showing 40.4% of the recovered material fragmented, whereas only 25% of the sigmodontines were fragmented. Post-cranial portions of animals were over-represented compared to cranial remains, comprising 79.7% (N = 368) of the total sample. As for fragmentation, cranial representation varied among taxa. For caviomorphs 57.4% of recovered remains corresponded to post-cranial elements, whereas for sigmodontines this proportion increased to 82.2%.

Oligoryzomys longicaudatus, *Abrothrix* sp., and *Octodon pacificus* made up the archaeozoological record. These species represented 60% of the native taxa described for the island today. *O. longicaudatus* was represented by 35 specimens of 25 individuals. Eight specimens of *Octodon* were of ≥ 6 individuals. These specimens were

Table 1. Number of identified rodent specimens in archaeozoological samples from Mocha Island, VIII Región, Chile. Dates are chronological intervals (i. e. B. P. before present) from radiocarbon dates. Number of radiocarbon dates per site is shown in parentheses.

Site	Date (years B. P.)	Taxon		Total (%)
		Caviomorphs	Sigmodontines	
P5-1	1,200–700 (2)	2	39	41 (8.9)
P22-1	1,200–1,000 (1)	1	13	14 (3.0)
P25-1	900–700 (4)	5	49	54 (11.7)
P31-1	800–450 (12)	39	314	353 (76.4)
Total	1,200–450	47	415	462

Table 2. Maximum width (mm) of *Octodon pacificus* molars recovered in archaeozoological samples from Isla Mocha, VIII Región, Chile.

Localization	Molar		
	PM	M_1	M_2
Site P-31, Quadrant 2C, Level 3, depth 80–90 cm	2.7	2.9	2.7
Site P31-1, Quadrant 2C, Level 2, depth 70–80 cm	2.8	2.9	3.0
Site P25-1, Quadrant C4, Level 2	2.1	3.0	2.7

clearly larger than other species of the genus. Due to high fragmentation, we could only establish molar width of some of these specimens (Tab. 2). These values were similar to those of HUTTERER (1994) for *O. pacificus* (Tab. 2). Therefore, we assigned the archaeozoological specimens to this taxon.

Present day rodents

We captured 104 individuals in 197 captures (13.6% trapping success) on Isla Mocha in January 2000. These captures consisted of 4 species: *Abrothrix longipilis* (N = 87), *A. olivaceus* (N = 15), *Oligoryzomys longicaudatus* (N = 1) and *Geoxus valdivianus* (N = 1). The ecotone matorral showed the highest species richness, with all 4 species (*A. longipilis*: N = 37; *A. olivaceus*: N = 13) captured. *A. longipilis* (N = 31) and *A. olivaceus* (N = 2) were the only taxa present in Valdivian forest. The coastal forest was the least inhabited, with only *A. longipilis* (N = 19).

Females and males of *A. longipilis* did not differ in body size (F = 1.6; P = 0.2) or body weight (F = 0.04; P = 0.8). The same pattern appeared for body size (F = 0.2; P = 0.7) and body weight (F = 1.3; P = 0.3) of *A. olivaceus*, and therefore, individual condition was compared combining sexes. Body length, tail length, and body mass did not vary among island habitats (Tab. 3) for *A. longipilis* (body length F = 3.0; 84 d. f.; P = 0.41; tail length F = 2.3; 84 d. f.; P = 0.10; weigth F = 0.75; 84 d. f.; P = 0.47), or *A. olivaceus* (body length F = 0.18; 13 d. f.; P = 0.68; tail length F = 0.02; 13 d. f.; P = 0.88; weigth F = 1.29; 13 d. f.; P = 0.28). Measurements of *O. longicaudatus* (body size = 106.4 cm; tail length = 89.6 cm), and *G. valdivianus* (body length = 101 cm; tail length = 38.4 cm; weight = 13 gr) were estimated for each specimen captured.

Population abundance varied among habitats ($\chi^2 = 27.5$, 2 d. f., $P \ll 0.05$), with coastal forest showing the lower trapping success (7.0%), followed by ecotone matorral (15.3%), and Valdivian forest with a trapping success of 18.9%. Trapping success of the coastal forest was significantly lower compared to Valdivian forest (Z = 4.9;

Table 3. Morphological attributes of *Abrothrix longipilis* and *A. olivaceus* captured in three habitats of Isla Mocha, VIII Región, Chile.

	Habitat type								
	Coastal forest			Ecotone matorral			Valdivian forest		
	Media	SD	n	Media	SD	n	Media	SD	n
Abrothrix longipilis									
Body length (mm)	111.9	13.3	19	113.9	18.9	37	121.9	14.4	31
Tail length (mm)	82.2	7.7	19	76.1	13.9	37	81	10.3	31
Weight (g.)	56.7	20.5	19	60.4	21.8	37	63.8	17.4	31
Abrothrix olivaceus									
Body length (mm)	–	–	–	94	11.9	13	90.3	0.14	2
Tail length (mm)	–	–	–	63.9	5.7	13	63.8	3.9	2
Weight (g.)	–	–	–	34.3	11.2	13	25	5.6	2

Table 4. Sex, reproductive, and juvenile proportion of *Abrothrix longipilis* and *A. olivaceus* individuals captured in Isla Mocha, VIII Región, Chile.

	Abrothrix longipilis	*Abrothrix olivaceus*
Females	30	7
Males	57	8
Adult	69	14
Juvenile	18	1
Reproductive	18	14
Non-Reproductive	69	1

$P \ll 0.001$) and to ecotone matorral ($Z = -4.7$; $P \ll 0.001$), but ecotone matorral and Valdivian forest did not differ in trapping success ($Z = 0.11$; $P = 0.45$). 79.3% of the captured *A. longipilis* were non-reproductive (Tab. 4).

Discussion

Differences in the composition of past and present small mammal assemblages from Isla Mocha raise several questions regarding insular effects. The presence of *O. pacificus* in archaeozoological samples confirms the long-term existence of this species on the island. Previously, Sánchez et al. (1994), described *Oligoryzomys longicaudatus* and *Octodon bridgesi* in the Isla Mocha archaeozoological record. Here, we add *Abrothrix* sp. to the record, and suggest the misidentification of *Octodon* in Sánchez et al. (1994). Since Hutterer (1994) described *O. pacificus* after Sánchez et al. (1994), most probably the latter assumed the presence of *O. bridgesi* due to high similarity among mandibular characters of these taxa. *O. pacificus* is similar to *O. bridgesi*, a taxon that lives in association with dense matorral (Muñoz-Pedreros 2000), and probably this insular representative lived associated to dense Valdivian forest that formerly covered most part of the island. Probably this explains the presence of this taxon in archaeozoological assemblages from sites located at lower elevations of the island, where forest no longer exists. Once lowlands were cleared for agricultural purposes (Quiroz and Sánchez 1993; Sánchez et al. 1994; Quiroz 1997), *O. pacificus* probably became restricted to highlands, where the forest has remained uncut. Despite our trapping efforts, we were not able to capture specimens of *O. pacificus* in any of the major habitats of the island. *O. pacificus* has never been captured since Hutterer (1994) despite trapping efforts made by Pefaur and Yáñez (1980), or ourselves. Island populations are now probably extremely small, and additional trapping efforts should be directed especially to mountaintops, which are less disturbed parts of the island.

Faunal composition of the extant and archaeozoological remains varied within the island. *G. valdivianus* were not present in

the archaeozoological material, although it was captured in live-trapping on the island. This discrepancy is probably explained by the small population size of the species, as it shows low abundance in its overall distributional range (REDFORD and EISENBERG 1992). Higher species richness was observed in the ecotone matorral, as predicted by the intermediate disturbance hypothesis. Species richness pattern is not paralleled by species abundance which shows elevated values in less perturbed Valdivian forest.

At the present, lower species richness is associated with Isla Mocha, compared to mainland assemblages. Other species that are part of the mainland small mammal assemblage, but were not captured during summer trapping period, included *D. glirroides* (Philippi, 1893) and *I. tarsalis* (Philippi, 1900) (PEFAUR and YÁÑEZ 1980). These species, absent on Isla Mocha are rare, and show low abundances throughout their distribution (REDFORD and EISENBERG 1992; SAAVEDRA and SIMONETTI 2000, 2001). Among exotic mammals, PEFAUR and YÁÑEZ (1980) captured two introduced rats (*R. rattus* and *R. norvegicus*) on Isla Mocha. These taxa were associated with the coastal areas, where human settlement is concentrated. Despite our trapping efforts, we were not able to trap any of these introduced species. They seem to live in close association with houses (islanders recognized their existence in their roofs), not invading vegetational areas.

Population abundance for *Abrothrix longipilis* and *A. olivaceus* differed among island habitats, as well as with mainland assemblages. Higher abundance is associated with valdivian forest on the island. Interestingly, on Isla Mocha greater abundance is associated with native forest, whereas in the mainland the same taxa achieve elevated abundances in non-native exotic plantations (SAAVEDRA unpubl. data). A significant habitat alteration has been observed on the mainland, where native forest has been replaced by exotic *Pinus* plantations (LARA et al. 1995; SAN MARTÍN and DONOSO 1995). At the organismal level insular specimens of *A. longipilis* are smaller (tail length, 79.2 cm ± 11.7 cm v/s 88.9 ± 10.0 cm, ANOVA $F_{86,48\,d.f.} = 2.7$; $P < 0.001$) and lighter (weight 60.8 ± 20 gr v/s 64.2 ± 15.9 gr, ANOVA $F_{86,48\,d.f.} = 11.7$; $P < 0.001$) on Isla Mocha compared to mainland specimens captured for the same time period (SAAVEDRA unpubl. data). *A. olivaceus*, on the contrary does not show body (tail length 63.8 cm ± 5.4 cm v/s 63.1 ± 11.0 cm, ANOVA $F_{14,20\,d.f.} = 0.04$; $P = 0.82$) or weight (33.1 ± 11 gr v/s 32 ± 7.6 gr, ANOVA $F_{14,20\,d.f.} = 0.11$; $P = 0.74$) differences among island and mainland populations (SAAVEDRA unpubl. data). Generalist habits of these taxa may help to understand this pattern.

Isla Mocha rodents, both extinct and extant, constitute a significant reservoir of biological information. Genetic, morphological, as well as stratigraphic studies may yield information useful for testing phylogenetic and phylogeographic hypotheses. The fact that Isla Mocha remained unglaciated during the last glacial maximum (LEQUESNE et al. 1999), makes it useful for contrasts of animal responses to isolation and glaciation, along with associated phenomena like founder effects or local adaptations. Also, the long and intimate association of humans and the native biota in this island renders to these populations additional value, since anthropogenic fragmentation of natural habitats is generating an island-type environment in many mainland areas (e. g. BUSTAMANTE and CASTOR 1998). Understanding the population responses to isolation on real islands, where significant habitat changes took place may represent an important starting point for developing conservation policies in non-natural fragmented landscapes.

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Zusammenfassung

Vergangene und gegenwärtige Kleinsäugerfauna der Isla Mocha (Chile)

Die Autoren beschreiben archäozoologische Reste und die aktuellen Kleinsäuger der Isla Mocha, einer Insel im Süden von Zentral-Chile. Der Artenbestand der früheren und gegenwärtigen Gesellschaften wurde verglichen. Für die aktuelle Fauna wurden verschiedene Parameter in unterschiedlichen Inselhabitaten ermittelt. Archäologische Fundstellen enthielten Reste von *Oligoryzomys longicaudatus, Abrothrix* sp. und *Octodon pacificus*, während *Abrothrix longipilis, A. olivaceus, Oligoryzomys longicaudatus* und *Geoxus valdivianus* lebend gefangen wurden. Die höchste Artenvielfalt wurde im degradierten Wald/Buschland beobachtet. Körpermaße, Körpergröße und Schwanzlänge von *A. longipilis* und *A. olivaceus* variierten nicht innerhalb der verschiedenen Inselhabitate. Eine höhere Abundanz wurde in den weniger gestörten Habitaten beobachtet.

References

Bustamante, R. O.; Castor, C. (1998): The decline of an endangered temperate ecosystem: the ruil (*Nothofagus alessandrii*) forest in central Chile. Biodiv. Conser. **7**, 1607–1626.

Gilbert, B. M. (1980): Mammalian Osteology. Columbia: Missouri Archaeological Society.

Hutterer, R. (1994): Island rodents: a new species of *Octodon* from Isla Mocha, Chile (Mammalia: Octodontidae). Z. Säugetierkunde **59**, 27–51.

Lara, A.; Donoso, C.; Aravena, J. C. (1995): La conservación del bosque nativo en Chile: problemas y desafíos. In: Ecología de los bosques nativos de Chile. Ed. by J. J. Armesto, C. Villagran, and M. Kalin Arroyo. Santiago: Editorial Universitaria. Pp. 335–362.

Lequesne, C.; Villagran, C.; Villa, R. (1999): Historia de los bosques relictos de "olivillo" (*Aextoxicon punctatum*) y Mirtáceas de la Isla Mocha, Chile, durante el Holoceno tardío. Rev. Chil. Hist. Nat. **72**, 31–47.

Muñoz-Pedreros, A. (2000): Orden Rodentia. In: Mamíferos de Chile. Ed. by A. Muñoz-Pedreros and J. Yañez Valenzuela. Temuco: CEA Ediciones. Pp. 73–126.

Pearson, O. P. (1995): Annotated keys for identifying small mammals living in or near Nahuel Huapi National Park or Lanín National Park, southern Argentina. Mastozool. Neotrop. **2**, 99–148.

Pefaur, J. E.; Yañez, J. (1980): Ecología descriptiva de la Isla Mocha (Chile), en relación al poblamiento de los vertebrados. Bol. Museo Nacional Historia Natural, Chile **37**, 103–112.

Quiroz, D. (1997): Ecología, cultura e historia en Isla Mocha, provincia de Arauco: 1850–1994. In: La isla de las palabras rotas. Ed. by D. Quiroz and M. Sanchez. Santiago: Ediciones de la Biblioteca Nacional de Chile. Pp. 17–37.

Quiroz, D.; Sanchez, M. (1993): Poblaciones tempranas en Isla Mocha (Siglo XIV a. C.). Museos **15**, 9–11.

Quiroz, D.; Sanchez, M. (1997): La Isla de las Palabras rotas. Santiago: Ediciones de la Biblioteca Nacional de Chile.

Quiroz, D.; Vasquez, M. (1996): La presencia del Arcaico Tardío en Isla Mocha: excavaciones preliminares del sitio P27-1. Museos **21**, 21–26.

Redford, K. H.; Eisenberg, J. F. (1992): Mammals of the Neotropics: the Southern Cone. Vol. 2. Chile, Argentina, Uruguay, Paraguay. Chicago: The University of Chicago Press.

Reise, D. (1973): Clave para la determinación de marsupiales y roedores chilenos. Gayana **27**, 1–20.

Saavedra, B.; Simonetti, J. A. (2000): A northern and threatened population of *Irenomys tarsalis* (Mammalia: Rodentia) from central Chile. Z. Säugetierkunde **65**, 243–245.

Saavedra, B.; Simonetti, J. A. (2001): New records of *Dromiciops gliroides* (Microbiotheria: Microbiotheriidae) and *Geoxus valdivianus* (Rodentia: Muridae) in central Chile: their implications for biogeography and conservation. Mammalia **65**, 96–100.

Sanchez, M.; Quiroz, D.; Becker, C. (1994): Un sitio Alfarero Tardío en Isla Mocha: P31-1. Boletín del Museo Regional de la Araucanía **5**, 103–109.

San Martin, J.; Donoso, C. (1995): Estructura florística e impacto antrópico en el Bosque Mauino de Chile. In: Ecología de los bosques nativos de Chile. Ed. by J. J. Armesto, C. Villagran, and M. Kalin Arroyo. Santiago: Editorial Universitaria. Pp. 153–168.

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