



<http://dx.doi.org/10.11646/zootaxa.3760.1.1>

<http://zoobank.org/urn:lsid:zoobank.org:pub:949EBA3E-5779-478C-9A6F-464E06908AAF>

## An integrative appraisal of the diversification in the Atlantic forest genus *Delomys* (Rodentia: Cricetidae: Sigmodontinae) with the description of a new species

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### Abstract

Recent taxonomic studies on Neotropical mammals have benefited from the use of genetic data to unravel and recognize species diversity in a number of genera, including the Atlantic forest endemic genus *Delomys*. However, the success of this approach depends on ability to link genetically identified lineages to species names based on voucher specimens that lack genetic data. Cytogenetic studies in the Atlantic forest endemic rodent genus *Delomys* have revealed two widespread karyotypes,  $2n=72/FN=90$  and  $2n=82/FN=80$ , which have been respectively ascribed to *Delomys sublineatus* (Thomas, 1903) and *D. dorsalis* (Hensel, 1872). More recently, a third karyotype,  $2n=82/FN=86$ , reported from specimens collected on two montaintops in southeastern Brazil, was interpreted as evidence for a third species, *D. collinus* Thomas, 1917. This nominal form had originally been described as a subspecies of *D. dorsalis* from Itatiaia, one of the mountain ranges where the third karyotype was later detected. The detection of two sympatric karyotypes at the type locality of *D. collinus* in the Itatiaia mountain range, Southeastern Brazil, prompted a reevaluation of the association of karyomorphs and species names. In this paper, we assessed the congruence of molecular (cytochrome *b*), cytogenetic and morphological characters, to diagnose the species in the genus, including data from recently collected series and type specimens. Our results indicate that the genetic and morphological patterns are largely congruent with the recognition of three species, each of which is karyotypically and morphologically diagnosable. Our morphological analyses of sympatric samples from Itatiaia refute the former association of the  $2n=82/FN=86$  karyotype with the holotype of *D. dorsalis collinus* (which is more similar to *D. dorsalis* with  $2n=82/FN=80$ ). Instead, we recognize and describe a new species for the  $2n=82/FN=86$  populations from the highest altitudinal zones of the Itatiaia and Caparaó mountains. The geographical variation in *D. dorsalis* is also explored and the status of *D. d. collinus* is discussed in the light of the molecular and morphological evidence. Finally, we discuss biogeographic hypotheses concerning the disjunct distributions of *D. dorsalis* and the new species.

**Key words:** Itatiaia, Caparaó, altitudinal gradient, speciation, geographic variation, karyotype

### Introduction

The Neotropical subfamily Sigmodontinae is the most diverse clade of rodents of the family Cricetidae, comprising 83 genera and about 400 living species (Musser & Carleton 2005; Pine *et al.* 2012). Although sigmodontine rodents have been studied for more than two centuries, a substantial portion of their diversity has only recently been recognized. In the last twenty years (1992–2012) 74 new species have been named and described, corresponding to roughly 18% of the current species-level diversity of the group (Reeder *et al.* 2007; Paglia *et al.* 2012). A dozen genera and even a new tribe have also been erected to account for the phylogenetic diversity of the subfamily (Weksler *et al.* 2006; D'Elia *et al.* 2007; Percequillo *et al.* 2011; Pine *et al.* 2012). As those numbers suggest, the taxonomy of sigmodontine rodents has been a prolific and dynamic field, and the current rate of new species descriptions is comparable to those of the age of scientific discoveries in the 19<sup>th</sup> century, when a vast spectrum of the diversity of mammals still remained to be described. Renewed collecting efforts, larger scientific collections of poorly known taxa or from unexplored remote areas, and an increasing number of taxonomists have

## Acknowledgements

We are grateful to Bruce Patterson (FMNH), James Patton (MVZ), Gisele Lessa (MZUFV), Helio Fernandes (MBML), Mario de Vivo (MZUSP), Paula Jenkins (BMNH), Valéria Tavares (UFMG) and Tereza Cristina Castellano Margarido (MHNCI) for allowing access to the mammal collections. We are indebted to Lena Geise, Cibele Bonvicino, Yuri Leite, James Patton and Renata Pardini for providing tissue samples from recently collected specimens. We also thank Adriana Bueno, Cibele Bonvicino, Edmar Manduca, Julio Vilela, Jânio Moreira, Laura Naxara, Liliani Tiepolo, Maria Olímpia G. Lopes and Renata Pardini for their help during field work, and Carina Azevedo for her assistance with the karyograms. Marcelo Weksler, Robert Voss and an anonymous reviewer gave important suggestions on a previous version of this manuscript. Collecting licenses in Caparaó and Itatiaia national parks (070/2003 and 143/2004) were provided by Instituto Brasileiro de Meio Ambiente e de Recursos Naturais Renováveis. Funding was provided by Conselho Nacional de Pesquisa e Desenvolvimento Tecnológico (CNPq, processes 45379/2010-7 and 481869/2008-5) and Fundação Carlos Chagas Filho de Amparo à Pesquisa do Rio de Janeiro (FAPERJ Processes E-26/110.605/2009 and E-26/111.404/2012). PRG benefited from a doctoral and a postdoctoral fellowship from CNPq (processes 201.268/2004-3 and 160.050/2007-3), and JAO benefited from research fellowships from CNPq (processes 3068801/2007 and 306935/2010-4).

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## APPENDIX

Gazetteer of collecting localities and specimens examined. Numbers in brackets refers to localities mapped in Fig. 1. Localities are numbered from north to south, followed by latitude and longitude (south and west, respectively, in negative decimal degrees), elevation in meters and samples sizes of morphologically (*morph*) and molecularly (*mtDNA*) analyzed specimens. Uncatalogued specimens will be deposited in the collections of the Museu Nacional, Universidade Federal do Rio de Janeiro (HGB, LG, JAO, M), and the Museu de Zoologia, Universidade de São Paulo (AB, EBB).

### *Delomys altimontanus*

- [6] Parque Nacional do Caparaó (includes Terreirão-Segredo-Arozal-Cachoeira Bonita), Alto Caparaó, MG (Caparaó Mt.), (-20.4339°S, -41.8494°W, 2500m), (*morph* = 13), (*mtDNA* = 8): FMNH uncatalogued (PH10024, 10029, 10066, 10080, 10089, 10180, 10190, 10219, 10373, 10433, 10434, 10437), MN69592.
- [18] Brejo da Lapa (includes Hotel Alsene), Itamonte, MG (Itatiaia Mt.), (-22.3483°S, -44.6939°W, 1843m), (*morph* = 14), (*mtDNA* = 5): MN uncatalogued (LG106, 205), MN33698–33702, 60573–60576, 60584, 60585, 79013.
- [21] Campos do Itatiaia (Abrigo Rebouças), Parque Nacional do Itatiaia, RJ (Itatiaia Mt.), (-22.3906°S, -44.6706°W, 2450m), (*morph* = 3), (*mtDNA* = 2): MN69712, 69746, MZUSP2163.
- [23] Abrigo Macieiras, Parque Nacional do Itatiaia, RJ (Itatiaia Mt.), (-22.4165°S, -44.6442°W, 1880m), (*morph* = 1): BMNH14.2.23.11.

### *Delomys dorsalis*

- [16] Serra de Macaé, Macaé, RJ, (-22.3167°S, -42.3333°W, 1200m), (*morph* = 3): MZUSP2786–2787, 2789.
- [17] Parque Estadual dos Três Picos, Salinas/Nova Friburgo, RJ, (-22.3473°S, -42.7383°W, 1600m), (*morph* = 7), (*mtDNA* = 7): MN80378, 80393, 80396, 80397, 80410, 80411, 80415.
- [18] Brejo da Lapa, Itamonte, MG (Itatiaia Mt.), (-22.3483°S, -44.6939°W, 1843m), (*morph* = 20), (*mtDNA* = 13): MN44058, 44059, 44062–44064, 60572, 60577–60583, 60586, 60588, 60589, 70048, 70049, 79005, 79021.
- [19] Serrinha do Anambari, Itatiaia, RJ (Itatiaia Mt.), (-22.3667°S, -44.5500°W, 850m), (*morph* = 1), (*mtDNA* = 1): MN (HGB 64).
- [20] Posses, 13km SE Itanhandú, MG, (-22.3813°S, -44.8380°W, 1600m), (*morph* = 1): UFMG1876.
- [22] Faz. C. Guinle, Teresópolis, RJ, (-22.4122°S, -42.9656°W, 900m), (*morph* = 23): FMNH53871, 53872, MN11608, 11609, 11665, 6339, 7001, 7004, 7005, 7007–7013, 7015, 7016, 7064, 7082, 7085, 7087, 7089.
- [23] Abrigo Macieiras, Parque Nacional do Itatiaia, RJ (Itatiaia Mt.), (-22.4165°S, -44.6442°W, 1880m), (*morph* = 1): BMNH14.2.23.13.
- [24] Subaio, Teresópolis, RJ, (-22.4358°S, -42.9317°W, 1050m), (*morph* = 1): MN uncatalogued (JAO230).
- [25] Maromba, Itatiaia, RJ (Itatiaia Mt.), (-22.4384°S, -44.6245°W, 1170m), (*morph* = 6), (*mtDNA* = 4): BMNH14.2.23.12, MN uncatalogued (HGB-DB 19, 20), MN78909, 78915, 78927.
- [26] Parque Nacional da Serra dos Órgãos (Paquequer), Teresópolis, RJ, (-22.4547°S, -42.9972°W, 1000m), (*morph* = 14), (*mtDNA* = 3): MN70005, 70006, 70008, 70009, 700012, 700013, 70016, 70019, 70028, 70029–70031, 70033, 70034.
- [27] Parque Nacional da Serra dos Órgãos (Vale das Antas), Teresópolis, RJ, (-22.4639°S, -43.0425°W, 1950m), (*morph* = 11), (*mtDNA* = 3): MN70127, 70128, 70130–70133, 70139, 70149–70152.
- [28] Fazenda do Itaguaré, 10–16km SW Passa Quatro, MG, (-22.4667°S, -45.0833°W, 1500m), (*morph* = 5), (*mtDNA* = 2): UFMG1868–1870, 1872, 1873.
- [29] Fazenda da Onça, 13km SW Delfim Moreira, MG, (-22.5531°S, -45.2673°W, 1850m), (*morph* = 2), (*mtDNA* = 2): UFMG1874, 1875.
- [30] Piquete, SP, (-22.6000°S, -45.1833°W, 800m), (*morph* = 1): BMNH1.6.6.43.
- [31] Estação Ecológica do Bananal, Bananal, SP, (-22.6836°S, -44.3233°W, 800m), (*morph* = 2), (*mtDNA* = 2): MZUSP uncatalogued (EEB711, 712).
- [32] Parque Nacional da Bocaina, São José do Barreiro, SP, (-22.7200°S, -44.6150°W, 1400m), (*morph* = 1), (*mtDNA* = 1): MN (HGB DB 18).
- [33] Campos do Jordão, SP, (-22.7394°S, -45.5914°W, 1600m), (*morph* = 9): MZUSP2103, 2105–2111, 2114.
- [34] Pedra Branca, Parati, RJ, (-23.2178°S, -44.7131°W, 800m), (*morph* = 15): MN6207, 6211, 6213, 6224, 6226, 6290, 8147–8149, 8408, 8409, 8414, 8416, 8419, 8420.
- [36] Casa Grande, Biritiba Mirim, SP, (-23.5725°S, -46.0386°W, 850m), (*morph* = 19): FMNH136940, MN32450, MZUSP22796, 22810, 22811, UFMG0006, 0009, 0012, 0017, 0018, 0037, 0038, 0071, 0074, 0088–0090, 0128, 0170.
- [37] Estação Ecológica de Boracéia, Salesópolis, SP, (-23.6333°S, -45.8667°W, 850m), (*morph* = 54), (*mtDNA* = 6):