

Karyotype description of two species of the genus *Akodon* (Rodentia, Sigmodontinae) in the northern Rio Grande do Sul state, Brazil

Caroline Badzinski ¹

Daniel Galiano ^{2*}

Bruno Busnello Kubiak ³

Cassiano Estevan ²

Jorge Reppold Marinho ²

¹ Universidade Federal da Fronteira Sul, Campus de Cerro Largo
Rua Major Antônio Cardoso, CEP 97900-000, Cerro Largo – RS, Brazil

² Programa de Pós-Graduação em Ecologia
Universidade Regional Integrada do Alto Uruguai e das Missões, Campus de Erechim
Avenida Sete de Setembro, 1621, CEP 99700-000, Erechim – RS, Brazil

³ Programa de Pós-Graduação em Biologia Animal, Universidade Federal do Rio Grande do Sul
Avenida Bento Gonçalves, 9500, CEP 91501-970, Porto Alegre – RS, Brazil

* Corresponding author
galiano3@hotmail.com

Submetido em 07/10/2014
Aceito para publicação em 13/05/2015

Resumo

Descrição cariotípica de duas espécies do gênero *Akodon* (Rodentia, Sigmodontinae) no norte do estado do Rio Grande do Sul, Brasil. Entre os roedores sigmodontíneos, o gênero *Akodon* é o segundo mais especioso, atualmente, com cerca de 45 espécies reconhecidas. No estado do Rio Grande do Sul são registradas cinco espécies para o gênero. Este artigo apresenta dados sobre a distribuição de espécies do gênero *Akodon* na porção norte do estado do Rio Grande do Sul, bem como uma descrição dos cariótipos das espécies dessa região. Foram amostradas seis localidades no período de agosto de 2008 a maio de 2010. Um total de 44 exemplares foram submetidos à análise citogenética, sendo identificadas duas espécies (*Akodon montensis* e *Akodon paranaensis*). O cariótipo de *A. montensis* foi $2n = 24$, $NF = 44$ e o de *A. paranaensis* $2n = 44$, $NF = 46$. Os dados referentes à abundância e distribuição dessas espécies corroboram o padrão descrito em outros estudos com a comunidade de roedores da região norte do estado, onde as espécies de *Akodon* são apontadas como dominantes. O fato de apenas *A. montensis* e *A. paranaensis* terem sido capturadas é um indício de que essas duas espécies são as únicas com ocorrência confirmada para a região norte deste estado.

Palavras-chave: Cariótipo; Cricetidae; Floresta com araucária; Pequenos mamíferos

Abstract

Among the sigmodontine rodents, the genus *Akodon* is the second in numerical terms, with about 45 recognized species. In the Rio Grande do Sul state, there are 5 registered species. This article shows data on the distribution of the species of the genus *Akodon* in the northern Rio Grande do Sul state, as well as a description

of the karyotypes of species from this region are shown. Six localities were sampled from August 2008 to May 2010. A total of 44 specimens underwent cytogenetic analysis and 2 species were identified (*Akodon montensis* and *Akodon paranaensis*). The karyotype of *A. montensis* was $2n = 24$, $FN = 44$ and that of *A. paranaensis* was $2n = 44$, $FN = 46$. Data on abundance and distribution of these species corroborate the pattern described in other studies with the rodent community in the northern portion of the state, where the *Akodon* species are seen as dominant. The fact that only *A. montensis* and *A. paranaensis* were captured is an indication that these two species are the only ones with confirmed occurrence in the northern portion of this state.

Key words: Araucaria Forest; Cricetidae; Karyotype; Small mammals

Introduction

Among the South American rodent families, Cricetidae stands out, encompassing about 55% of the species described (MUSSER; CARLETON, 2005). This family is divided into 2 subfamilies: Sigmodontinae and Neotominae, and among the first one, there is the tribe Akodontini, which has 12 genera and 63 species, accounting for 35% of the total diversity of the group. The genus *Akodon* Meyen, 1833 is the second most specious in South America, and due to its complex taxonomy, the number of species has ranged from 90 (TATE, 1932) to 33 (HONACKI et al., 1982), also being divided into groups since its description (MYERS et al., 1990). Nowadays, about 45 species are accepted for this genus (SMITH; PATTON, 2007; BRAUN et al., 2008; D'ELÍA et al., 2011).

The genus *Akodon* includes species with high morphological similarity, thus showing a complex and poorly understood taxonomy (CHRISTOFF et al., 2000; HASS et al., 2008). For this reason, karyotypic analyzes are necessary in order to identify many Brazilian species (CHRISTOFF et al., 2000; GONÇALVES et al., 2007). However, this trait contrasts with its large multiplicity of the species' karyotypes (SBALQUEIRO; NASCIMENTO, 1996; SILVA; YONENAGA-YASSUDA, 1998; CHRISTOFF et al., 2000). In this study, data on the distribution of the genus *Akodon* in the northern portion of Rio Grande do Sul state, as well as a description of the karyotypes of the species from this region were shown.

Materials and Methods

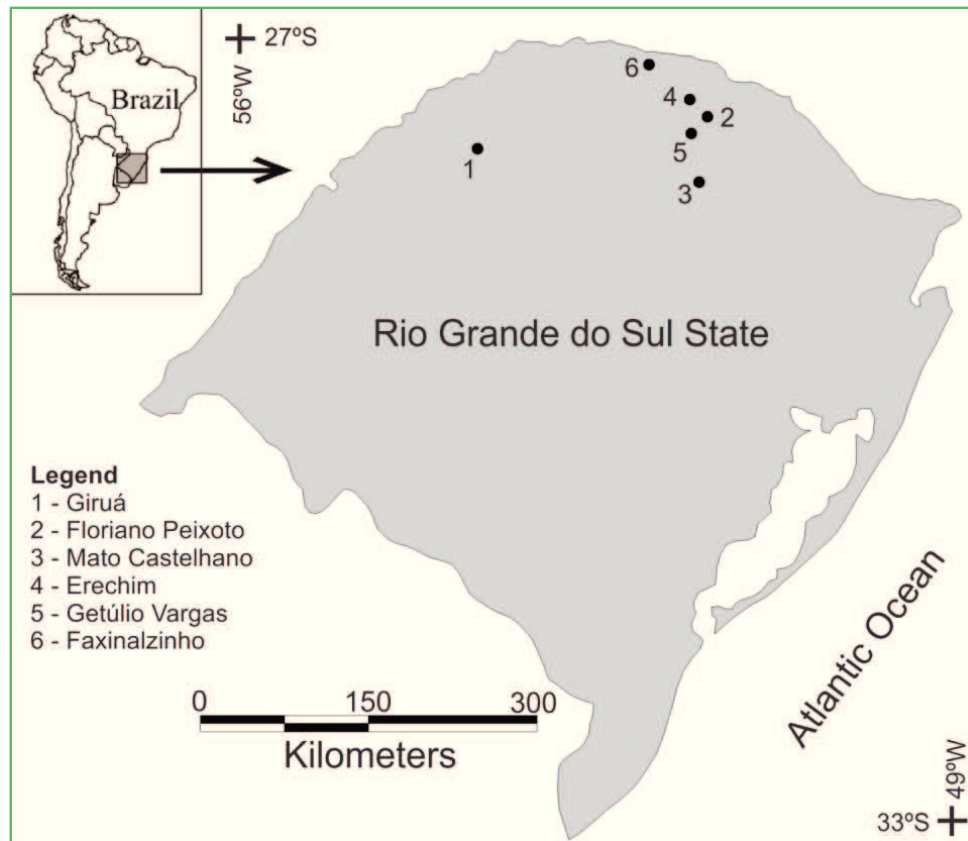
This study was carried out in the northern Rio Grande do Sul state, in 6 localities: (1) Giruá

(28°2'19.5"S, 54°19'20.8"W), (2) Floriano Peixoto (27°46'26.3"S, 52°6'44.4"W), (3) Mato Castelhano (28°19'08"S, 52°11'25"W), (4) Erechim (27°37'54"S, 52°16'52"W), (5) Getúlio Vargas (27°54'49"S, 52°16'1"W), and (6) Faxinalzinho (27°20'40.5"S, 52°40'32.2"W) (Figure 1).

The region has the Araucaria Forest as the typical forest formation of southern Brazil, which occurs in the higher parts of the South Brazilian Plateau, and it is restricted to high altitudes (HUECK, 1972). In several areas of the region, the Araucaria Forest shares many species with the Seasonal Forest, indicating different ranges of transition between these two forest formations (MARQUES et al., 2005). Sampling effort was carried out in fragments of a native vegetation characteristic of the region. The altitude varies from 400 to 789 m asl.

Specimens were collected from August 2008 to May 2010. During this period, one expedition in each locality was conducted: Giruá (Aug/08), Floriano Peixoto (Sep/08), Mato Castelhano (Oct/08), Erechim (Jan/09), Getúlio Vargas (Mar/09), and Faxinalzinho (May/10). Standard Tomahawk traps of one size (12×12×25 cm) mounted for four consecutive nights were used, totaling a sampling effort of 1,200 trap-nights (200 at each site). Traps were baited with a mixture of peanut butter, mashed bananas and sardines applied to a slice of maize. The captured animals were identified in field, and later taken to the laboratory, where they were submitted to cytogenetic analysis in accordance with the standard protocol of Ford and Hamerton (1956). The animals were captured with the consent of environmental agencies (ICMBio), under the permanent and personal license number 15224-2 (J.R.M.).

FIGURE 1: Sample localities in the northern Rio Grande do Sul state, Brazil's Southern region.



The method of Ford and Hamerton (1956) for mitotic bone marrow preparation was followed. Cytogenetic data were obtained through analysis of the optical microscope slides, settling the diploid number of chromosomes by counting the metaphases, and the best were selected for photograph and assembly karyotype.

Results

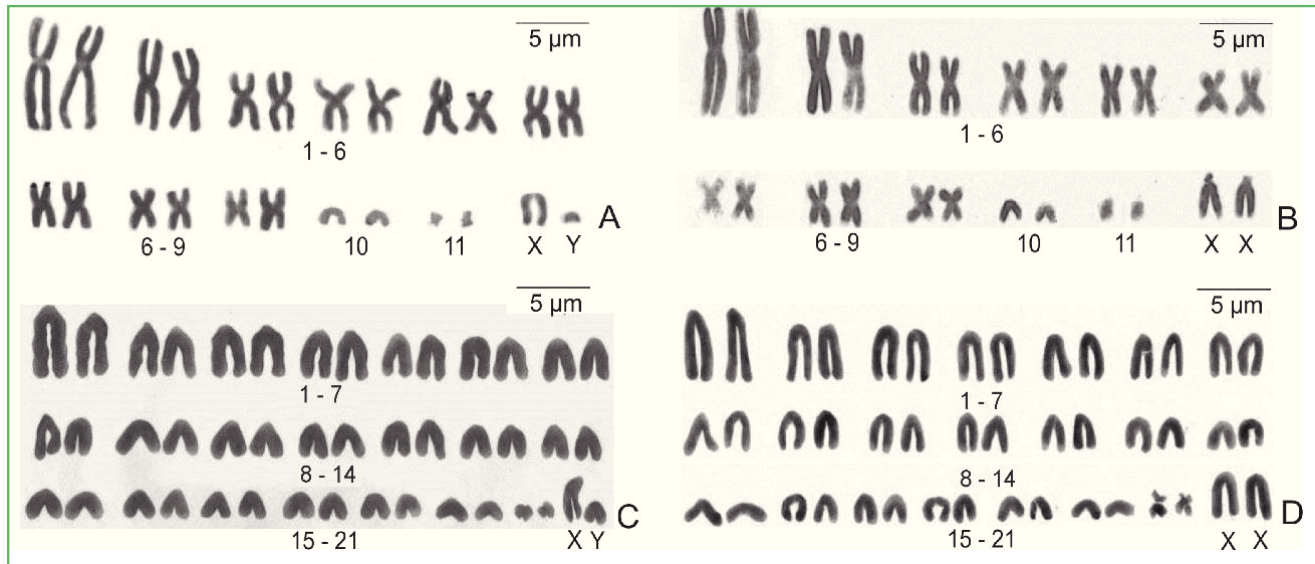
In total, 72 individuals of *Akodon* were captured, and 44 specimens were karyotyped. Two species were identified: *Akodon montensis* ($n = 29$) and *Akodon paranaensis* ($n = 15$).

All individuals of *A. montensis* were captured in traps placed on the ground, in areas of understory vegetation, border areas and within the native forest. The karyotype shown by the species was $2n = 24$ and

$FN = 44$. The first pair of chromosomes is composed of two large submetacentrics; the second pair is composed of two large metacentrics; pairs 3-6 are composed of medium-sized metacentrics; pairs 7-9 are composed of small metacentrics; pair 10 is composed of two small acrocentrics, and the pair 11 of two tiny metacentrics. The X chromosome is a small acrocentric and Y is a tiny acrocentric (Figure 2).

Individuals of *A. paranaensis* were captured in traps placed on the ground, inside the forest, in areas of low vegetation and inner edge of native forest. The karyotype shown by the species was $2n = 44$ and $FN = 46$. The first pair of chromosomes is composed of two large acrocentrics; pairs of chromosomes 2-12 are composed of medium-sized acrocentrics; pairs 13-20 are composed of small acrocentrics; pair 21 is composed of two tiny metacentrics. The X chromosome is a medium-sized acrocentric and Y is a small acrocentric (Figure 2).

FIGURE 2: Conventional karyotype colored with Giemsa obtained from a sampled male of *Akodon montensis* (A); female of *Akodon montensis* (B); male of *Akodon paranaensis* (C); female of *Akodon paranaensis* (D), in the northern Rio Grande do Sul state, Brazil's Southern region.



Discussion

The data obtained in this study are in accordance with the already known distribution patterns of the genus *Akodon* described by D'Elia (2003) and Pardiñas et al. (2003), where *A. paranaensis* and *A. montensis* might occur in sympatry. *Akodon montensis* has a wide distribution and it is one of the dominant Sigmodontinae species in primary or secondary forest, in the Rio Grande do Sul state. It has been identified as one of the dominant species of rodent communities in other fragments of the northern Rio Grande do Sul state (GALIANO et al., 2007; 2013; KUBIAK et al., 2009). Both *Akodon* species are found in high altitude regions, especially *A. montensis*, found at an altitude above 700 meters in some regions along its distribution (GEISE et al., 2004; GONÇALVES et al., 2007; GALIANO et al., 2014).

These two species belong to the *cursor* group (SMITH; PATTON, 2007), which shows an extensive karyotypic diversity, ranging from $2n = 14-15$ in *Akodon cursor* Winge, 1887, to $2n = 44$ in *Akodon mystax* Hershkovitz, 1998, *Akodon paranaensis* and *Akodon reigi* González, Langguth & Oliveira, 1998. For species such as *A. paranaensis* and *A. reigi*, which are considered morphologically cryptic, the karyotype may be a tool

in determining the correct species. However, these species show no distinction between their karyotypes in the conventional cytogenetic analysis, as performed in this study. In the results, individuals identified with the karyotype $2n = 44$ were assumed to be *A. paranaensis* due to the geographical location of the sampling points, since, according to González et al. (1998), *A. reigi* is distributed only among the southeastern portion of the Rio Grande do Sul state. This species occurs in eastern Uruguay and extreme southern Brazil (Rio Grande do Sul state) (MUSSER; CARLETON, 2005), and was never registered in other regions of this state. The identification of *A. paranaensis* was based only on the karyotype and geographical information, and no morphological analysis was performed.

Besides these two species of *Akodon* found in this study, the region may show the occurrence of *A. serrensis* Thomas, 1902 and *A. azarae* Fischer, 1829 (BONVICINO et al., 2008). The fact that only *A. montensis* and *A. paranaensis* were captured might be an indication that these species are the only ones with confirmed occurrence in the northern portion of this state, as reported in other studies carried out in the region (GALIANO et al., 2007; 2013; KUBIAK et al., 2009). Accurate information on the distribution of

the genus *Akodon* in the Riograndense Plateau is still scarce, making it necessary to increase the number of specimens karyotyped, with the aim of generating increasingly reliable data, and analyzing the patterns of distribution of the species in the region, given the taxonomic difficulties of identification. Despite the lack of broad revisionary treatments of *Akodon*, the number of recognized species within the genus has experienced a steady increase in the last years (GONÇALVES et al., 2007). This inventory contributes to the knowledge of the distribution of *Akodon* species in the region of transition between the Araucaria Forest and the Seasonal Forest.

Acknowledgments

We thank all our colleagues from the Museu Regional do Alto Uruguai (MuRAU) for their support in fieldwork. URI for providing the first author with a student scholarship from PIIC/URI. CNPq/Brazilian Ministry of Science and Technology for granting scholarships to the second and third authors. We would also like to thank Dr. Paulo Roberto Hofmann and the anonymous reviewers, for all comments and suggestions which greatly improved the manuscript.

References

- BONVICINO, C. R.; OLIVEIRA, J. A.; D'ANDREA, P. S. **Guia dos roedores do Brasil, com chaves para gêneros baseadas em caracteres externos**. Rio de Janeiro: OPAS/OMS, 2008. 122 p.
- BRAUN, J. K.; COYNER, B. S.; MARES, M. A.; BUSSCHE, V. D. Phylogenetic relationships of South American grass mice of the *Akodon varius* group (Rodentia, Cricetidae, Sigmodontinae) in South America. **Journal of Mammalogy**, Lawrence, v. 89, p. 768-777, 2008.
- CHRISTOFF, A. U.; FAGUNDES, V.; SBALQUEIRO, I. J.; MATTEVI, M. S.; YONENAGA-YASSUDA, Y. Description of a new species of *Akodon* (Rodentia: Sigmodontinae) from southern Brazil. **Journal of Mammalogy**, Lawrence, v. 81, p. 838-851, 2000.
- D'ELÍA, G. Phylogenetics of Sigmodontinae (Rodentia, Muroidea, Cricetidae), with special reference to the akodont group, and with additional comments on historical biogeography. **Cladistics**, New York, v. 19, p. 307-332, 2003.
- D'ELÍA, G.; JAYAT, J. P.; ORTIZ, P. E.; SALAZAR-BRAVO, J.; PARDIÑAS, U. F. J. *Akodon polopi* Jayat et al. 2010 is a senior subjective synonym of *Akodon viridescens* Braun et al. 2010. **Zootaxa**, Auckland, v. 2744, p. 62-64, 2011.
- FORD, C. E.; HAMERTON J. L. A colchicine hypotonic citrate squash sequence for mammalian chromosomes. **Stain Technology**, Cambridge, v. 31, n. 6, p. 247-251, 1956.
- GALIANO, D.; KUBIAK, B. B.; ESTEVAN, C.; MORAES, R. M.; MALYSZ, M.; HEPP, L. U.; MARINHO, J. R.; FREITAS, T. R. O. Small mammals in Araucaria rain forest: linking vegetal components and the arthropod fauna. **Studies on Neotropical Fauna and Environment**, Tübingen, v. 49, p. 1-6, 2014.
- GALIANO, D.; KUBIAK, B. B.; MARINHO, J. R.; FREITAS, T. R. O. Population dynamics of *Akodon montensis* and *Oligoryzomys nigripes* in an Araucaria forest of Southern Brazil. **Mammalia**, Paris, v. 77, p. 173-179, 2013.
- GALIANO, D.; KUBIAK, B. B.; QUEIROZ, E.; MARINHO, J. R. Ecologia e distribuição de *Oligoryzomys flavescens* (Rodentia: Muridae) em um fragmento florestal na região norte do estado do Rio Grande do Sul. **Perspectiva**, Erechim, v. 31, p. 47-54, 2007.
- GEISE, L.; WEKSLER, M.; BONVICINO, C. R. Presence or absence of gall bladder in some *Akodontini* rodents (Muridae, Sigmodontinae). **Mammalian Biology**, Jena, v. 3, n. 69, p. 1-5, 2004.
- GONÇALVES, P. R.; MYERS, P.; VILELA, J. F.; OLIVEIRA, J. A. Systematic of species of the genus *Akodon* (Rodentia: Sigmodontinae) in Southeastern Brazil and implications for the biogeography of the Campos de Altitude. **Miscellaneous Publications of the Museum of Zoology, University of Michigan**, Ann Arbor, v. 197, p. 1-24, 2007.
- GONZÁLEZ, E. M.; LANGGUTH, A.; DE OLIVIERA, L. F. A new species of *Akodon* from Uruguay and southern Brazil (Mammalia: Rodentia: Sigmodontinae). **Comunicaciones Zoológicas del Museo de Historia Natural de Montevideo**, Montevideo, v. 191, p. 1-8, 1998.
- HASS, I.; SBALQUEIRO, I. J.; MULLER, S. Chromosomal phylogeny of four Akodontini species (Rodentia, Cricetidae) from Southern Brazil established by Zoo-FISH using *Mus musculus*. **Chromosome Research**, Durham, v. 16, p. 75-88, 2008.
- HONACKI, J. H.; KINMAN, K. E.; KOEPL, J. W. **Mammal species of the world: a taxonomic and geographic reference**. Lawrence: Allen Press, Inc., and the Association of Systematics Collections, 1982. 694 p.
- HUECK, K. **As florestas da América do Sul: ecologia, composição e importância econômica**. São Paulo: Polígono, 1972. 466 p.
- KUBIAK, B. B.; ESTEVAN, C.; GALIANO, D.; MARINHO, J. R. Comparação da fauna de pequenos mamíferos entre uma área de Floresta Estacional semidecidual e reflorestamento de *Pinus* sp. **Perspectiva**, Erechim, v. 33, p. 155-164, 2009.
- MARQUES, M. C. M.; ROPER, J. J.; SALVALAGGIO, P. B. Phenological patterns among plant life-forms in a subtropical forest in southern Brazil. **Plant Ecology**, Dordrecht, v. 173, p. 203-213, 2005.
- MUSSER, G. G.; CARLETON, M. D. Superfamily Muroidea. In: WILSON, D. E.; REEDER, D. M. (Ed.). **Mammal species of the world a taxonomic and geographic reference**. 3. ed. Johns Hopkins University Press, Baltimore, 2005. p. 894-1531.
- MYERS, P.; PATTON, J. L.; SMITH, M. F. A review of the *boliviensis* group of *Akodon* (Muridae: Sigmodontinae) with emphasis on Perú and Bolivia. **Miscellaneous Publications of the Museum of Zoology, University of Michigan**, Ann Arbor, v. 177, p. 1-104, 1990.

- PARDIÑAS, U. F. J.; D'ELÍA, G.; CIRIGNOLI, S. The genus *Akodon* (Muroidea, Sigmodontinae) in Misiones, Argentina. **Mammalian Biology**, Jena, n. 68, p. 129-143, 2003.
- SBALQUEIRO, I. J.; NASCIMENTO, A. P. Occurrence of *Akodon cursor* (Rodentia, Cricetidae) with 14, 15, and 16 chromosomes cytotypes in the same area. **Brazilian Journal of Genetics**, Ribeirão Preto, v. 19, n. 4, p. 565-569, 1996.
- SILVA, M. J. DE J.; YONENAGA-YASSUDA, Y. Karyotype and chromosomal polymorphism of an undescribed *Akodon* from Central Brazil, a species with the lowest known diploid chromosome number in rodents. **Cytogenetics and Cell Genetics**, Würzburg (Germany), v. 81, p. 46-50, 1998.
- SMITH, M. F.; PATTON, J. L. Molecular phylogenetics and diversification of South American grass mice, genus *Akodon*. In: KELT, D. A.; LESSA, E. P.; SALAZAR-BRAVO, J.; PATTON, J. L. (Ed.). **The quintessential naturalist**: honoring the life and legacy of Oliver P. Pearson. Berkeley: University of California Publications in Zoology, 2007. p. 827-858.
- TATE, G. H. H. The taxonomic history of the South and Central American Akodont rodent genera: *Thalpomys*, *Deltamys*, *Thaptomys*, *Hypsimys*, *Bolomys*, *Chroeomys*, *Abrothrix*, *Scotinomys*, *Akodon* (*Chalcomys* and *Akodon*), *Microxus*, *Podoxymys*, *Lenoxus*, *Oxymycterus*, *Notiomys*, and *Blarinomys*. **American Museum Novitates**, New York, v. 582, p. 1-32, 1932.