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Potential distribution and new records of *Trinomys* species (Rodentia: Echimyidae) in the state of Rio de Janeiro

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ABSTRACT. The spiny rats of the genus *Trinomys* Thomas, 1921 have a broad distribution in the Atlantic Forests of southeastern Brazil. However, some species are known only from their type locality and adjacent areas. In our study, nine areas in the state of Rio de Janeiro were surveyed and three species of the genus were captured – *Trinomys dimidiatus* (Günther, 1877), *T. setosus* (Desmarest, 1817) and *T. gratiosus bonafidei* (Moojen, 1948). We extended the distribution of *T. gratiosus bonafidei* in 100 km, in a straight line to the northwest, and into an area of Semidecidual Seasonal Forest. We captured *T. setosus*, which had not been previously recorded in the state, in the municipality of Cambuci, extending its distribution 150 km, in a straight line to the east of its closest record, in Juiz de Fora, state of Minas Gerais. The state of Rio de Janeiro has now six recognized species of *Trinomys,* however none of them were collected above 1300 m of altitude. We used occurrence points provided by our inventories data and from the literature to model the potential distribution of *Trinomys* species. We used climatic, topographic and phytogeographic variables to prepare the potential distribution maps. The algorithm used for modeling was provided by the software Maxent, version 3.2.1. Although species boundaries within *Trinomys* in Rio de Janeiro State are not yet clear, their distributions seem to be parapatric, except for *T. iheringi* and *T. dimidiatus*.

KEY WORDS. Ecoregions; climatic variables; distribution models; altitude.

Spiny rats of the genus *Trinomys* Thomas, 1921 (Echimyidae) have a broad distribution, with species being recorded across six Brazilian states (Lara *et al.* 2002). These species are found mostly in Atlantic Forest areas of eastern Brazil, at altitudes ranging from sea level to 1300 meters (Moojen 1948, Pessôa & Reis 1996, Bonvicino *et al.* 1997, Eisenberg & Redford 1999, Lara & Patton 2000, Lara *et al.* 2002, Geise *et al.* 2004). Aspects of their distribution, species limits and taxonomy are poorly known, with some species known only from their type locality and surroundings – e.g. *Trinomys gratiosus bonafidei* (Moojen, 1948), *Trinomys yonenagae* (Rocha, 1995) and *Trinomys moojeni* (Pessôa, Oliveira & Reis, 1992) – (Pessôa *et al.* 1993, Lara & Patton 2000, Lara *et al.* 2002, Corrêa *et al.* 2005).

These rodents have nocturnal habits, using fallen and hollow logs, and holes in the ground as shelters during the day. They are solitary, terrestrial animals, with a diet based on seeds, fruits, fungi, a few leaves and insects (Emmons & Feer 1997). The dorsal pelage is characterized by a superficial set of long and stiff guard hairs, with reddish brown coloration, that may be spinescent or soft, and the ventral hair is always whitish (Eisenberg & Redford 1999).

Five species of the genus have been recorded in the state of Rio de Janeiro: *Trinomys dimidiatus* (Günther, 1877), *T. iheringi* (Thomas, 1911), *T. gratiosus bonafidei*, *T. eliasi* (Pessôa & Reis, 1993) (Lara & Patton 2000, Rocha *et al.* 2004) and, more recently, *T. panema* (Moojen, 1948) (Iack-Ximenes pers comm.). *Trinomys dimidiatus* has a distribution restricted to the state of Rio de Janeiro and the northern coast of the state of São Paulo, being found in sympatry with *T. iheringi*, which has a distribution from southern São Paulo to southern Rio de Janeiro (Pessôa & Reis 1993, Pereira *et al.* 2001). *Trinomys eliasi* is endemic to the state of Rio de Janeiro, being found in the Restinga da Barra de Maricá, municipality of Maricá, in the Restinga de Jurubatiba National Park, municipality of Carapebus, and in the Poço das Antas Biological Reserve, municipality of Silva Jardim, state of Rio de Janeiro (Pessôa & Reis 1993, Brito & Figueiredo 2003, Bergallo *et al.* 2004, Rocha *et al.* 2005). *Trinomys gratiosus bonafidei* is also endemic to the state, and is only known to occur at the type locality in Fazenda Boa Fé, municipality of Teresópolis, and surroundings (Moojen 1948, Pessôa & Reis 1996, Oliveira & Bonvicino 2006). *Trinomys panema* is known from the states of Espírito Santo, Minas Gerais and Rio de Janeiro. In Rio de Janeiro, this species is known only from the Itatiaia National Park (Iack-Ximenes pers. comm.).

This study reports additional sites of occurrence for species of *Trinomys* in Rio de Janeiro and estimates their potential range using methods of distribution modeling.

MATERIAL AND METHODS

We carried out small mammal inventories in nine areas in the state of Rio de Janeiro from 2004 to 2006.

The captures in each area were done using 126 Sherman and Tomahawk live traps, set in three distinct lines. The traps, placed on the ground (90), were set 40 m apart from each other. Traps placed on trees (36) were set 100 m apart and at a minimum height of 2.5 m. They were opened during six consecutive nights with a total effort of 756 traps/night. Thirty buckets of 40 liters set in three distinct tracks were utilized as pitfalls, for a total of 180 buckets/night.

All the specimens were identified by a combination of characteristics of the cranium, teeth, hair, baculum structure, and external body measures, and classified within the nomenclature considered valid in Lara & Patton (2000).

The state of Rio de Janeiro (20°45'45" to 23°22'10"S, 40°57'20" to 44°53'20"W) has an area of 43.864,3 km^2 (Fidalgo *et. al.* 2007) and was originally covered by Atlantic Forest. However, today only 20.33% of the forest's original extension remains intact (Fundação SOS Mata Atlântica 2002), being distributed in several fragments of different sizes and conservation stages.

Nine localities were chosen for inventory (Fig. 1) based on absence of information on the area, accessibility, region of the state (we tried to survey all of the state regions – *sensu* Saraça *et al.* 2007), size and number of forest fragments in the area. The areas selected were: 1) Paraíso State Ecological Station (EEEP), 2) Santo Antônio da Aliança Farm (FSAA), 3) Rio das Pedras Ecological Reserve (RERP), 4) Desengano State Park (PED), 5) Vale da Pedra Branca Farm (FVPB), 6) Esmeralda Farm (FE), 7) Guapiaçú Ecological Reserve (REGUA), 8) Marimbondo Farm (FM), 9) Morro São João (MSJ). Characterization of each area is available in the appendix 1. Climate data were obtained in Hijmans *et al.* (2005) and vegetation characterization was conducted based on Ururahy *et al.* (1983).

To model the potential distribution of *Trinomys* spp., we used a total of 97 occurrence points provided by our inventories and from literature (Bittencourt 2003, Pereira *et al.* 2001, Cunha & Rajão 2007, Olifiers *et al.* 2007, Vaz *et. al.* 2007, Iack-Ximenes pers. comm.). The number of points per species was 26 for *T. dimidiatus*, 7 for *T. eliasi*, 5 for *T. gratiosus bonafidei,* 15 for *T. iheringi*, 12 for *T. setosus elegans*, 16 for *T. setosus setosus* and 16 for *T. panema*.

We used 19 climatic, one topographic and one phytogeographic variables to assemble the potential distribution maps (Olson *et al.* 2001, Hijmans *et al.* 2005). The variables were Annual Mean Temperature (AMT), Mean Diurnal Range (MDR), Isothermality (ISO), Temperature Seasonality (TES), Maximum Temperature of Warmest Month (MTWM), Minimum Temperature of Coldest Month (MTCM), Annual Temperature Range (ATR), Mean Temperature of Wettest Quarter (MTWE), Mean Temperature of Driest Quarter (MTDQ), Mean Temperature of Warmest Quarter (MTWA), Mean Temperature of Coldest Quarter (MTCO), Annual Precipitation (ANP), Precipitation of Wettest Month (PWM), Precipitation of Driest Month (PDM), Precipitation Seasonality (PRS), Precipitation of Wettest Quarter (PWE), Precipitation of Driest Quarter (PDQ), Precipitation of Warmest Quarter (PWQ), Precipitation of Coldest Quarter (PCQ), altitude (Hijmans *et al.* 2005) (Appendix 2) and a layer of terrestrial ecoregions (Olson *et al.* 2001). All layers had the resolution of 30 arc-seconds (i.e. ~1 km^2).

For *T. dimidiatus*, we used 75% of the occurrence points to generate the potential distribution model; 25% were used for model validation (Phillips *et al.* 2006). We applied the method suggested by Pearson *et al.* (2007) to predict the species distribution with few records of occurrence (i.e. <25). We used this method for all species, but *T. dimidiatus*. This method uses a statistical approach based on jackknife techniques for evaluation of the generated models. For species with n occurrence points, n models are constructed using n – 1 locations. Each generated model is tested for its ability to predict the deleted location. During the model validation, when a point was removed, it was verified if there was another near point, in a distance up to 10 km. In this case, the point was removed from the model (Pearson *et al.* 2007). The results of this procedure were used in the software pValueCompute (Pearson *et al.* 2007) to assess whether the model with all localities was able to predict the potential distribution better than a random prediction.

The algorithm used for modeling was provided by the software Maxent version 3.2.1 (http://www.cs.princeton.edu/~schapire/maxent/, accessed in May 2008). The software provides a continuous probability result of occurrence that ranges from 0 to 1 (Phillips & Dudik 2008). We used 10,000 points chosen randomly to characterize the entire area where the prediction was made (Phillips & Dudik 2008). We used the default convergence threshold (i.e. 10^{-5}) and the maximum number of interactions (i.e. 500).

The software provides a jackknife test to assess which variables were the most important in modeling the potential distribution. For this, the software generates a model using only one variable at a time. For each variable removed, another model is generated with the remaining variables. The results are then compared with the performance of the model created with all variables.

For jackknife validation approach we used two thresholds (Pearson *et al.* 2007). First, we chose the lowest presence

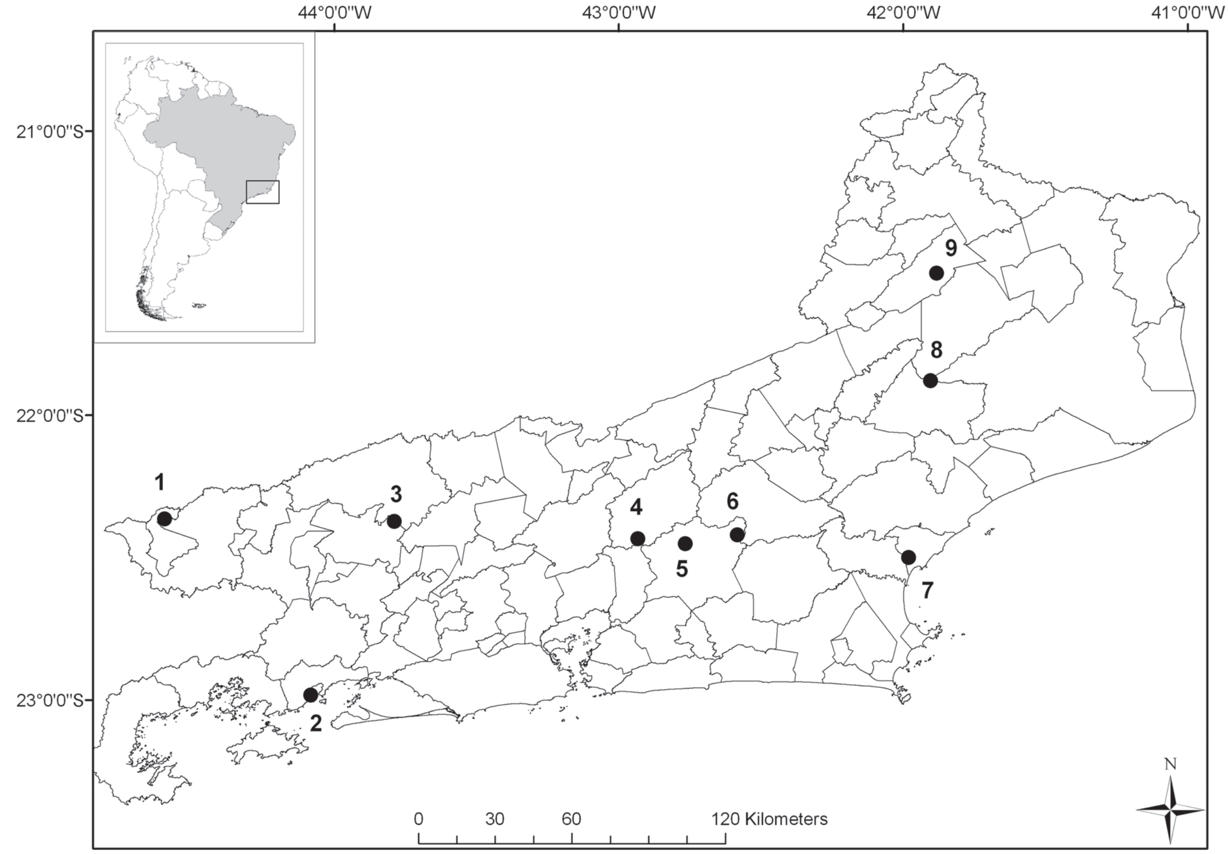


Figure 1. Map of the state of Rio de Janeiro showing the nine localities sampled in this study. Legend: 1) Marimbondo Farm, 2) Rio das Pedras Ecological Reserve, 3) Santo Antônio da Aliança Farm, 4) Paraíso State Ecological Station, 5) Guapiaçú Ecological Reserve, 6) Vale da Pedra Branca Farm, 7) Morro São João, 8) Desengano State Park, 9) Esmeralda Farm.

threshold (LPT) able to include in predicting distribution all points used in training model (i.e. the model with all *n* points). This can be interpreted as an identification of pixels with similar conditions to those found in the species record localities. The second threshold applied was chosen aiming to withdraw 10% of the lowest prediction values (T10). This second approach is less conservative and identifies a larger portion of the area. We made the final maps of potential distribution using the software ArcGis 9.2. We plotted only the LPT maps, due to its conservative characteristics.

RESULTS

We captured three species of *Trinomys* in the studied areas, namely *T. dimidiatus*, *T. gratiosus bonafidei*, and *T. setosus*. All of them were captured in traps placed in the ground, in both live traps and/or pitfall traps. Specimens of *Trinomys* were not captured in three localities – MSJ, FM and REGUA. The data on the collected specimens can be viewed in table I.

The potential distribution maps generated with the T10 threshold showed a high success rate and were statistically significant (Tab. II). The results for the maps using the LPT threshold were also validated. However the species *T. eliasi* (0.428) and *T. gratiosus bonafidei* (0.200) showed low success rates with LPT threshold. *Trinomys dimidiatus* (1.000), *T. iheringi* (0.867), *T. panema* (0.938) and *T. setosus setosus* (0.938) showed equal success rates for both LPT and L10 thresholds (Tab. II).

Except for *T. eliasi*, the ecoregion was the variable with highest gain when used in isolation and the variable that most decreases the gain when omitted (Tab. II). Only for *Trinomys eliasi*, altitude had a higher effect than ecoregion. For *T. gratiosus bonafidei,* PWQ was the highest gain variable (Tab. II).

All species occurred in Alto Paraná Atlantic Forest, except *T. setosus* subspecies and *T. dimidiatus* (Tab. III). *Trinomys eliasi* also occurred in Atlantic Coastal Restingas, *T. g. bonafidei* in Campos Rupestres Montane Savanna and *T. iheringi* in Southern Atlantic Mangroves. *Trinomys dimidiatus* is restricted to Serra do Mar Coastal Forest and Southern Atlantic Mangroves ecoregions. On the other hand, *Trinomys panema* occurred in five of the nine ecoregions reported for the studied species (Tab. III and Fig. 2).

Table I. Specimens of *Trinomys* captured in the studied areas (Locality), museum number, number of individuals captured (N), mean and standard deviation of body weight (W) and of the measurements: head and body (HB), tail (TA), head (HE), ear (E), hind foot with (HFU) and without nails (HF).

Species	Locality	Museum number	N	W	HB	TA	HE	E	HF	HFU
T. gr. bonafidei	FSAA	MN 70154	4	203.00±36.50	16.50±4.36	14.43±5.77	5.37±0.81	2.50±0.46	4.57±0.15	4.90±0.26
T. dimidiatus	EEEP	MN 70155, MN 70156	82	204.54±53.79	19.02±2.15	15.53±4.15	5.57±0.64	2.05±0.06	4.26±0.45	4.27±0.17
T. dimidiatus	RERP	MN 70157	15	172.00±63.31	19.22±2.83	17.04±3.19	5.36±0.66	2.45±0.71	4.31±0.33	4.63±0.35
T. dimidiatus	PED	MN 70158, MN 70159	16	176.43±36.92	17.39±2.97	16.01±3.32	5.15±0.46	2.11±0.19	4.17±0.22	4.44±0.20
T. dimidiatus	FVPB	MN 70160	3	220.00	20.70	16.00	4.50	2.80	4.40	4.7
T. setosus	FE	MN 70161, MN 70162	11	198.43±77.14	18.69±1.94	18.40±3.66	5.60±0.60	2.37±0.32	4.81±0.18	5.23±0.14

Table II. Jackknife tests of distribution models for six *Trinomys* species. (LPT) Lowest presence threshold, (T10) withdrawing 10% of the lowest prediction values, (PWQ) Precipitation of Warmest Quarter.

Species	Locality sample size	LPT		T10		Highest gain variable	Highest information variable
		Success	p value	Success	p value		
T. dimidiatus	26	1.000	< 0.000001	1.000	< 0.000001	Ecoregions	Ecoregions
T. eliasi	7	0.428	< 0.000001	1.000	< 0.000001	Altitude	Altitude
T. gratiosus bonafidei	5	0.200	0.004200	1.000	0.000004	PWQ	Ecoregions
T. iheringi	15	0.867	< 0.000001	0.867	< 0.000001	Ecoregions	Ecoregions
T. panema	16	0.938	< 0.000001	0.938	< 0.000001	Ecoregions	Ecoregions
T. setosus elegans	12	0.833	< 0.000001	0.917	< 0.000001	Ecoregions	Ecoregions
T. setosus setosus	16	0.938	< 0.000001	0.938	< 0.000001	Ecoregions	Ecoregions

Table III. The occurrence of six *Trinomys* species by ecoregions. Ecoregions are according to Olson *et al.* 2001.

Ecoregions	*T. dimidiatus*	*T. eliasi*	*T. g. bonafidei*	*T. iheringi*	*T. panema*	*T. s. elegans*	*T. s. setosus*
Alto Paraná Atlantic Forest	0	1	3	1	1	0	0
Atlantic Coastal Restingas	0	1	0	0	0	0	0
Bahia Coastal Forest	0	0	0	0	4	0	8
Bahia Interior Forest	0	0	0	0	9	10	5
Campos Rupestres Montane Savanna	0	0	1	0	1	0	0
Cerrado	0	0	0	0	1	2	1
Pernambuco Interior Forest	0	0	0	0	0	0	2
Serra do Mar Coastal Forest	25	5	1	13	0	0	0
Southern Atlantic Mangroves	1	0	0	1	0	0	0

Trinomys dimidiatus showed a potential distribution ranging from São Paulo to the north of Rio de Janeiro, very similar to the known distribution (Fig. 3). *Trinomys eliasi* also showed a potential distribution very similar to the known distribution, being restricted to the coastal area of Rio de Janeiro and to a small portion of the coast of Espírito Santo (Fig. 4). *Trinomys gratiosus bonafidei* presented a large and disjoint potential distribution ranging from the central portion of Minas Gerais to the coast of Santa Catarina, including Rio de Janeiro, São Paulo and Paraná. (Fig. 5). *Trinomys iheringi* presented a potential distribution restricted to the coastal region, from Rio de Janeiro to Santa Catarina (Fig. 6). *Trinomys panema* has a broad distri-

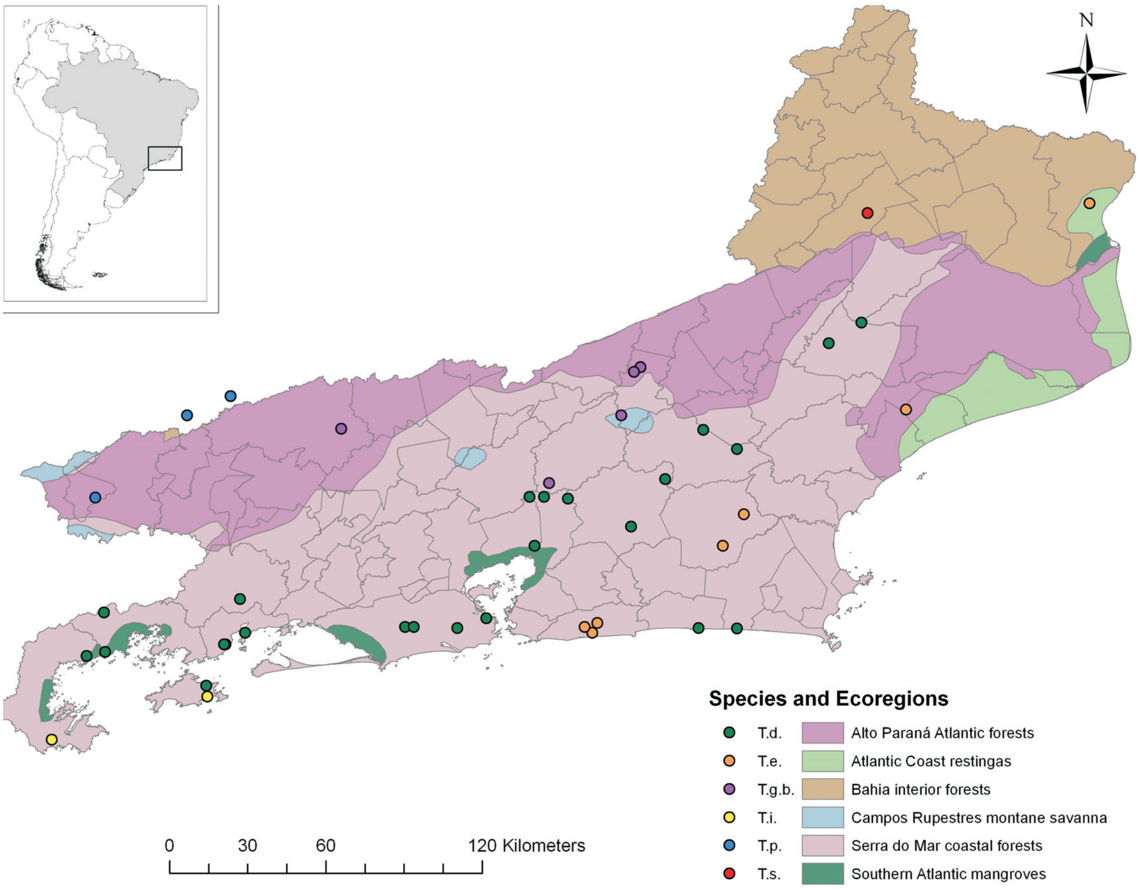


Figure 2. Map of Rio de Janeiro State, divided in ecoregions, showing the records from the literature and the present study for the six *Trinomys* species.

bution and presented a very large potential distribution occupying completely the Rio de Janeiro and Espírito Santo, a great portion of São Paulo and Minas Gerais and a portion of south Bahia. (Fig. 7). *Trinomys setosus elegans* appears to be restricted to Minas Gerais, presenting only small bordering areas in Rio de Janeiro and Bahia (Fig. 8). *Trinomys setosus setosus* presented the broadest potential distribution among all species analyzed in this study. The potential distribution shows a disjoint distribution that ranges over several states in the coast and central portion of the country (Fig. 9).

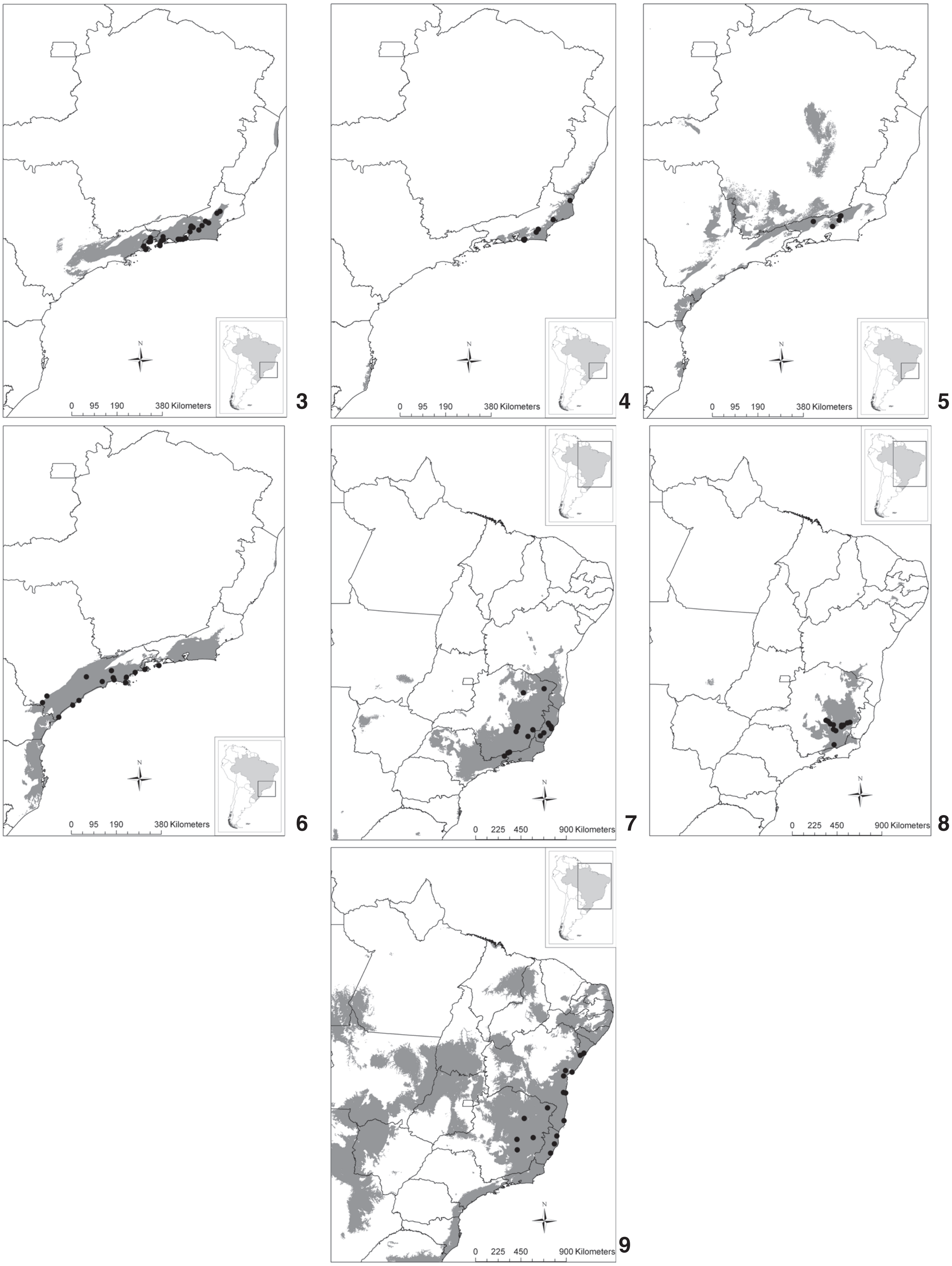
DISCUSSION

Species of *Trinomys* are common in faunal inventory and in studies carried out in the Atlantic Forest (e.g. Pereira *et al.* 2001, Geise *et al.* 2004, Vaz 2005). However, in three sampled localities in Rio de Janeiro, we did not capture *Trinomys* (MSJ, FM and REGUA). MSJ is located in coastal plain of Rio de Janeiro, in a region that is subject to considerable anthropic disturbance. The small mammal richness was very low in the area (only four species), and the absence of *Trinomys* may not be due to sampling problems, but to the fact that MSJ is very degraded and isolated from other forest fragments, being surrounded by pasture. It is possible, that the *Trinomys* population in the area could have become locally extinct.

Many species were captured in FM, but most of them are recognized as typical of high altitudes. This area is located from 1220 to 1775 m and *Trinomys* species do not seem to occur in localities above 1300 m. Bonvicino *et al.* (1997) and Geise *et al.* (2004) captured, respectively, *T. gratiosus,* in the Caparaó National Park and *T. panema* (= *T. gratiosus* in Geise *et al.* 2004) in the Maciço do Itatiaia, below 1200 m. Species from the genus probably do not occur in areas above the Montane region (from 500 to 1499 m) (*sensu* Ururahy *et al.* 1983).

The lack of *Trinomys* spp. in REGUA (altitudes varying from 175 to 325 m a.s.l.) was unexpected. Specimens of *T. dimidiatus* were captured in adjacent areas, as the EEEP and Vale da Pedra Branca Farm (Fig. 1), both localities at Serra dos Órgãos and in similar altitudes, suggesting that this species should occur in REGUA.

Trinomys gratiosus bonafidei, until now, was known only from its type locality, in Boa Fé Farm, in Teresópolis Municipal-



Figures 2-9. Potential distribution of *Trinomys* species in the Brazilian territory: (3) *T. dimidiatus*; (4) *T. eliasi*; (5) *T. gratiosus bonafidei*; (6) *T. iheringi*; (7) *T. panema*; (8) *T. setosus elegans*; (9) *T. setosus setosus*.

ity, and adjacent areas in Serra dos Órgãos, a region dominated by Evergreen Forest. The new record of this species in Serra da Concórdia extends its distribution in 100 km, in a straight line to northwest and into a region of Semidecidual Seasonal Forest. *Trinomys gratiosus bonafidei* is now known from three different ecoregions: Alto Paraná Atlantic Forest, Campos Rupestres Montane Savanna and Serra do Mar Coastal Forest.

Trinomys setosus was not known in Rio de Janeiro, with its southernmost record located in Juiz de Fora, Minas Gerais (21º45'S 43º20'W). Until the present time, *Trinomys setosus* occurred from Sergipe to Minas Gerais, including Bahia and Espírito Santo (Lara *et al*. 2002). *Trinomys setosus* has three subspecies with disjoint distributions, *T. s. elegans*, *T. s. denigratus* and *T. s. setosus*, the latter being restricted to Minas Gerais (Lara *et al*. 2002). However, it was not possible to identify the specimens captured in Cambuci in a subspecific level. When considered only in at the species level, the distribution of *T. setosus* was extended in 150 km east from Juiz de Fora, into the Rio de Janeiro.

Trinomys eliasi and *T. gratiosus bonafidei* showed low rates of success (0.428 and 0.200, respectively) suggesting that the models were not efficient. However, the potential distribution of both species is congruent with the altitudinal and ecoregion distributions, respectively. The potential distribution of *Trinomys eliasi* followed the coast up to south Espírito Santo in Atlantic Forest Restinga, Bahia Coastal Forest and Southern Atlantic Mangroves ecoregions in low altitudes. Restricted to the coast, *T. eliasi* may be more susceptible to threats due to the vulnerability of the region to human disturbance, especially real estate developments. Habitats of restinga, for example, have considerable biological relevance, yet they are subject to intense degradation (Rocha *et al.* 2005).

Trinomys g. bonafidei presented a potential distribution mainly in the Alto Paraná Atlantic Forest ecoregion, where the species was recorded. Although it is endemic to Rio de Janeiro, the potential distribution of *T. g. bonafidei* suggests that this species may also occur in northeast São Paulo and south Minas Gerais. The absence of the species in these localities may reflect small sample effort, as these areas are more distant from the major urban centers.

The potential distributions of *T. dimidiatus* and *T. iheringi* overlapped considerably. Both potential distributions followed the Serra do Mar Coastal forest ecoregion, with the southern range of *T. iheringi* reaching Santa Catarina. However, sympatry is observed in the border of Rio de Janeiro and São Paulo in the coast. The inferred potential distributions were similar to those suggested by Lara *et al.* (2002).

The potential distribution of *Trinomys setosus elegans* seems to be restricted to Bahia Interior Forest ecoregion. The specimen collected by us in Esmeralda Farm, in the municipality of Cambuci, can belong to this subspecies, since the municipality is located in the same ecoregion. Although *T. panema* was the species occurring in most ecoregions (5, see Tab. III), the potential distribution was restricted mainly to the southeastern region (São Paulo, Rio de Janeiro, Espírito Santo and Minas Gerais) and a small portion of Bahia. On the other hand, *T. s. setosus*, recorded for four ecoregions, showed the broadest studied distribution, including states from north to south and east to west of Brazil. This distribution is probably overestimated and more records are necessary to better evaluate its distribution. *Trinomys panema* and *T. s. elegans* seem to overlap in their potential distributions with *T. moojeni* (Lara *et al.* 2002).

These new records show the importance of a greater research effort in areas that have not been well studied and in small remaining fragments. We still were not able to define the species boundaries of *Trinomys* spp. due to the number of records available. But the potential distribution estimated in this study can be used as a guideline to fill these information gaps, defining future study areas. The efforts must encompass as many ecoregions as possible, since this variable had a great effect in the distribution of the *Trinomys* species.

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Appendix 1. Characterization of the surveyed areas.

1) Paraíso State Ecological Station – EEEP (22°26'S, 42°56'W), located between the municipalities of Guapimirim and Cachoeiras de Macacú, in the central portion of Rio de Janeiro State. The EEEP has an area of 4290 ha being covered by Atlantic Forest in different stages of conservation, with remnants of forests with low disturbance occurring in the least accessible areas, due to the terrain. The climate of the region is warm and humid and the annual rainfall of the area varies from 2000 to 2500 mm; the average temperature is 24ºC. The vegetation is characterized by Evergreen Dense Forest. The altitude in EEEP varies between 60 and 1350 m a.s.l. The inventory was carried out in areas with altitudes between 20 and 340 m, in September of 2004.

2) Santo Antônio da Aliança Farm – FSAA (22°22'18"S, 43°47'23"W), located between the municipalities Barra do Piraí and Valença, and including the Serra da Concórdia Wildlife Sanctuary. This locality has an area of 295 ha, of which 220 ha are a legal reserve, with altitudes between 600 and 925 m a.s.l. The average annual temperature is 20.4°C, with maximum of 28.7°C and minimum of 10.8°C. The annual precipitation is 1469 mm. The vegetation is characterized by a Semidecidual Seasonal Forest with several stages of succession. The inventory of this area was carried out in April of 2005.

3) Rio das Pedras Ecological Reserve – RERP (22°59'S, 44°05'W) is located in the municipality of Mangaratiba, in the west of the state of Rio de Janeiro, on the Atlantic side of the Serra do Mar, near Sepetiba Bay. The reserve area encompasses 1360 ha of Evergreen Dense Forest in several stages of succession. The altitude in the reserve varies between the sea level and 1100 m, but the study was carried out from 25 to 700 m. The average annual temperature is 22°C, with maximum of 38°C and minimum of 12°C. The highest rainfall rates occur between December and February (MEDEIROS *et al.* 2004). The inventory of this area was carried out in August of 2005.

4) Desengano State Park – PED (21°52'43,2"S, 41°54'14,1"W) is located in the municipalities of Santa Maria Madalena, São Fidélis and Campos dos Goytacazes. The park, which is considered the last continuous remnant of Atlantic Forest in the region, has a total area of 23,000 ha. The altitude varies between 800 and 1700 m a.s.l. The vegetation is composed by Evergreen Dense Forest. The annual temperature varies between 12º e 30º C, with average annual temperature 16.7ºC and annual precipitation 1471 mm. This study was carried out in a region called Morumbeca, in Santa Maria Madalena Municipality, with altitude between 1060 and 1425 m, in May of 2006.

5) Vale da Pedra Branca Farm – FVPB (22°25'07,9"S, 42°34'52,9"W) is located in the municipality of Nova Friburgo, adjacent to Três Picos State Park. The locality has an area of 550 ha and is covered by well preserved Atlantic Forest. The area climate is hot and humid. The annual rainfall varies between 2000 and 2500 mm and the annual average temperature is 24º C with maximum of 27.7°C and minimum of 10.5°C. The altitude in the area varies from 500 to 1600 m a.s.l., although the studied area comprises altitudes only from 500 to 850 m. The vegetation in the area is mostly Evergreen Dense Forest. The study in this area was carried out in October of 2006.

6) Esmeralda Farm – FE (21º29'03"S 41º52'21,8"W), municipality of Cambuci, located north of Paraíba do Sul River. The vegetation of the area is composed by fragments of secondary forest, (Semidecidual Seasonal Forest), located mainly in the less accessible portions of the hills. The surroundings of the fragments show signs of human pressure, being commonly dominated by abandoned pastures and with the presence of the exotic grass, *Brachiaria*. The average annual temperature varies from 15 º to 35º C and the annual rainfall is 1276 mm. The whole forest fragment has approximately 1000 ha, being the only one in the region with this extension (FIDALGO *et al.* 2007), although the studied area was small (approximately 5 ha). The inventory of this area was carried out in August of 2006.

7) Guapiaçú Ecological Reserve – REGUA (22º 24' S, 42º 44' W), located in the municipality of Cachoeiras de Macacú. The locality has an area of 2588 ha and is covered by Atlantic Forest in different stages of conservation with remnants of forests with low disturbance occurring in the less accessible areas, due to the relief. Along with State Park of Três Picos and National Park of Serra dos Órgãos, REGUA occupies a strategic location for conservation and protection of the hydrographic basin of Guanabara Bay. The climate is

Continue

Appendix 1. Continued.

hot and humid with an annual rainfall ranging from 2000 to 2500 mm and an average temperature of 24ºC with maximum of 28.9°C and minimum of 11.5°C. The altitude varies from 80 to 1600 m a.s.l. although the study was carried out in areas between 80 and 400 m a.s.l., on the margins of Manuel Alexandre river. The vegetation in the study area is characterized by an Evergreen Forest. The inventory of this area was conducted in October of 2004.

8) Marimbondo Farm– FM (22°21'47"S, 44°35'47,47"W), property of Agropecuária Santa Fé, part of the APA Serra da Mantiqueira (Environmental Protection Area), municipality of Itatiaia, in the northwestern part of the state. The farm, with an average altitude of 1549 m, has an area of 34475 ha. The annual average temperature in the region is 14.9°C, with maximum of 22.9°C and minimum of 3.7°C. The annual rainfall is 1813mm. Our study was conducted in altitudes from 1200 to 1775 m in November of 2005. The vegetation of the area is characterized by Evergreen Mixed Forest. This area has experienced a great impact with human occupation and now is dominated by pasture and secondary vegetation that surrounds the preserved area.

9) Morro São João – MSJ (22°31'00"S, 42°00'00"W), municipality of Casimiro de Abreu. The region, with an extension of 1395 ha, is actually a hill of volcanic origin with 640 ha covered by secondary forest and around 670 m of altitude. The annual average temperature is 23°C, with maximum of 29.7°C and minimum of 15.9°C, and the annual rainfall is 1058 mm. The locality is within an area of Evergreen Dense Forest and surrounded by pastures and farmlands. The inventory of this area was conducted in June of 2005.

Appendix 2. Minimum (Min), maximum (Max) and mean of climatic variables and altitude for *Trinomys* species. (AMT) Annual Mean Temperature, (MDR) Mean Diurnal Range, (ISO) Isothermality, (TES) Temperature Seasonality, (MTWM) Maximum Temperature of Warmest Month, (MTCM) Minimum Temperature of Coldest Month, (ATR) Annual Temperature Range, (MTWE) Mean Temperature of Wettest Quarter, (MTDQ) Mean Temperature of Driest Quarter, (MTWA) Mean Temperature of Warmest Quarter, (MTCO) Mean Temperature of Coldest Quarter, (ANP) Annual Precipitation, (PWM) Precipitation of Wettest Month, (PDM) Precipitation of Driest Month, (PRS) Precipitation Seasonality, (PWE) Precipitation of Wettest Quarter, (PDQ) Precipitation of Driest Quarter, (PWQ) Precipitation of Warmest Quarter, (PCQ) Precipitation of Coldest Quarter. Temperature measures are in Celsius (ºC) and Precipitation measures are in millimeters.

Variables	*T. dimidiatus*			*T. eliasi*			*T. gratiosus bonafidei*			*T. iheringi*		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
AMT	15.40	23.70	20.64	22.90	23.30	23.17	18.20	21.80	19.80	16.60	23.70	20.41
MDR	7.40	11.80	9.75	8.00	9.10	8.44	10.00	11.80	10.90	7.40	10.50	9.06
ISSO	5.50	6.20	5.82	5.50	6.00	5.69	5.70	6.10	5.98	4.90	5.90	5.43
TES	191.80	232.90	211.61	179.70	207.90	197.59	214.00	224.10	220.10	206.50	312.70	243.73
MTWM	23.50	31.10	28.66	30.00	30.70	30.39	26.70	30.90	28.44	23.90	30.90	28.12
MTCM	4.60	16.80	11.90	14.60	16.20	15.70	9.30	11.80	10.36	7.30	15.40	11.61
ATR	13.20	19.40	16.55	14.10	15.70	14.69	17.40	19.10	18.08	14.30	19.20	16.51
MTWE	18.00	26.10	23.11	24.40	25.80	25.10	20.60	24.40	22.36	19.20	26.30	23.37
MTDQ	12.40	21.30	17.90	20.30	20.80	20.69	15.50	18.80	16.94	13.40	20.70	17.29
MTWA	18.10	26.40	23.38	25.40	26.20	25.80	20.80	24.60	22.54	19.50	26.50	23.49
MTCO	12.40	21.30	17.81	20.30	20.80	20.69	15.30	18.80	16.88	13.40	20.70	17.22
ANP	1203.00	1986.00	1528.78	1005.00	1192.00	1131.29	1406.00	1724.00	1512.40	1334.00	2946.00	1960.67
PWM	147.00	305.00	234.89	148.00	181.00	160.43	269.00	305.00	281.20	199.00	359.00	269.93
PDM	20.00	69.00	41.63	26.00	50.00	40.43	15.00	40.00	24.20	29.00	123.00	70.27
PRS	35.00	69.00	52.93	36.00	50.00	42.57	62.00	73.00	69.80	36.00	61.00	43.87
PWE	439.00	816.00	654.04	414.00	475.00	433.57	696.00	797.00	735.20	569.00	1054.00	773.13
PDQ	81.00	212.00	138.30	92.00	152.00	127.14	58.00	136.00	85.80	111.00	391.00	238.20
PWQ	439.00	783.00	604.70	316.00	411.00	383.14	596.00	706.00	647.40	567.00	1030.00	757.13
PCQ	90.00	212.00	142.37	92.00	152.00	127.14	58.00	136.00	93.80	111.00	391.00	240.20
Altitude	5.00	1311.00	430.67	0.00	41.00	15.71	369.00	963.00	683.60	2.00	914.00	374.40

Continue

Appendix 2. Continued.

Variables	*T. panema*			*T. setosus elegans*			*T. setosus setosus*		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
AMT	17.10	24.90	21.51	19.70	23.30	21.35	20.40	25.10	23.69
MDR	8.50	13.00	11.26	10.20	12.50	11.76	6.30	12.90	9.03
ISSO	6.10	7.00	6.38	6.10	6.70	6.39	6.00	7.00	6.39
TES	163.00	224.40	190.87	165.70	217.00	196.44	92.60	203.60	151.37
MTWM	25.20	32.70	29.64	27.50	32.10	29.62	28.50	32.90	30.52
MTCM	7.40	18.00	12.12	9.70	13.10	11.32	10.00	20.30	16.55
ATR	13.90	20.00	17.53	16.70	19.10	18.30	10.00	19.70	13.97
MTWE	18.50	26.30	23.21	21.20	25.00	23.06	22.00	26.50	24.33
MTDQ	15.10	22.70	18.93	17.00	20.50	18.75	17.60	26.20	22.81
MTWA	19.10	27.10	23.72	21.70	25.60	23.54	22.60	27.00	25.43
MTCO	14.70	22.70	18.87	16.90	20.50	18.58	17.60	23.40	21.56
ANP	845.00	1560.00	1263.75	1116.00	1523.00	1280.50	845.00	1840.00	1340.25
PWM	182.00	297.00	233.56	207.00	324.00	257.58	140.00	410.00	214.50
PDM	5.00	41.00	21.13	6.00	19.00	11.92	6.00	123.00	49.00
PRS	49.00	91.00	70.19	75.00	90.00	81.33	13.00	90.00	50.69
PWE	466.00	795.00	641.00	611.00	824.00	700.58	326.00	948.00	564.69
PDQ	18.00	149.00	77.56	25.00	65.00	41.67	21.00	379.00	167.75
PWQ	289.00	716.00	486.81	442.00	685.00	527.67	182.00	640.00	369.81
PCQ	18.00	156.00	80.69	35.00	87.00	52.83	29.00	552.00	262.38
Altitude	13.00	1282.00	557.81	280.00	978.00	633.42	2.00	827.00	218.88

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