UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
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Dissertação de Mestrado

DINÂMICA POPULACIONAL E RELAÇÕES ESPACIAIS DO TUCO-TUCO-DAS-DUNAS *CTENOMYS FLAMARIONI* – (RODENTIA – CTENOMYIDAE) NA ESTAÇÃO ECOLÓGICA DO TAIM- RS/BRASIL.

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PORTO ALEGRE
SETEMBRO DE 2006

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Dissertação de mestrado apresentada ao Programa de Pós-Graduação e, Ecologia, do Instituto de Biociências da Universidade Federal do Rio Grande do Sul, como parte dos requisitos para obtenção do título de Mestre em Ecologia

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Resumo

Como parte de um estudo das interações ecológicas da espécie *Ctenomys flamarioni*, popularmente conhecido como Tuco-tuco-das-dunas, uma população que habita o sistema de dunas da planície costeira sul do Rio Grande do Sul foi estudada em um programa de captura-marcação-recaptura sazonal durante dois anos consecutivos (2004/2005). As informações espaciais são uma das metas mais importantes para predizer as necessidades de habitat e a dinâmica populacional de uma dada espécie. O gênero *Ctenomys* é conhecido como sendo de baixa vagilidade, por causa de sua morfologia, do consumo energético em cavar novos túneis e da exposição aos predadores que aumenta em seus deslocamentos acima do solo.

Os resultados deste trabalho mostram que esta é uma espécie de roedor de vida longa (pelo menos quatro anos), apresentando um crescimento rápido nos primeiros dois anos de vida. Depois do segundo ano, machos e fêmeas começam a apresentar marcado dimorfismo sexual para massa corpórea, largura dos incisivos e comprimento total do corpo. A variação do peso não tem diferença significativa entre estações do ano para animais adultos. A espécie é solitária, com adultos vivendo em seus próprios túneis e filhotes vivendo com suas mães por um período curto de tempo. A espécie apresenta um ciclo reprodutivo bem marcado, com cópulas no inverno, nascimentos na primavera e no verão, ausência de atividade sexual no outono, com um possível estro pós-parto e prenhês no verão.

As análises populacionais mostram que ocorreu uma importante flutuação entre os dois anos de estudo, que existe uma alta mortalidade de jovens, uma baixa densidade, uma proporção sexual balanceada para adultos e para filhotes, uma natalidade

moderada, seguida por uma grande mortalidade de filhotes, levando a uma população predominante de adultos. Estes resultados concordam com o que é encontrado para outras espécies do gênero mas apresenta números menores, em geral.

A análise espacial fornece importantes informações como um movimento inesperado entre adultos e uma dispersão desviada entre a população jovem, ausência de diferença significativa na área de vida entre machos e fêmeas adultos, uma distribuição uniforme dos indivíduos no habitat e nenhuma organização social entre vizinhos. Mais ainda, a dispersão é analisada nos movimentos entre estações e existe uma marcada diferença mostrando que os dispersores são as fêmeas adultas e os machos não adultos, que deslocam-se entre o verão e a primavera.

Os resultados são discutidos em comparação com outros roedores subterrâneos e as informações podem ser utilizadas para saber as necessidades da espécie. O ciclo reprodutivo apresentado mais a dinâmica populacional observada, associados a um ambiente instável onde a espécie habita levam-na a uma situação de baixa resistência e baixa resiliência, tornando-a um importante objeto para a conservação.

Abstract

As a part of a study on the ecological interactions of the species *Ctenomys flamarioni*, commonly known as tuco-tuco-das-dunas, a natural population inhabiting the dunes system in the south coast of Rio Grande do Sul/Brazil was live-trapped, in a seasonal capture-mark-release program made over two consecutive years (2004/2005). Spatial relations are one of the most important goal to predict habitat necessities and the population dynamic of a given species. The genus *Ctenomys* is known as a low vagility group of species, due to their morphology, energetic consumption in excavating new burrows and predators exposition aboveground.

The results shown that this is a long living small rodent (at least four years old), having an increased growth time in the first two years post partum. After the second year old, males and females starts to present a markedly sexual dimorphism for body mass, incisives large and total length. Body mass variation have no significant differences among seasons for adult tuco-tucos. The species is a solitary one, with adult animals leaving on their own burrows and pups leaving with their mothers for a restricted time. A markedly reproduction cycle is presented by copula in winter, births on spring and summer and no activity just in autumn, with a possible post-partum estrum and pregnancy in summer.

The populations analysis provides that occurred an important fluctuation between the two years, a high mortality over the young population, poor density in space, a balanced sex ratio over and a moderate natality followed by a great mortality of young, leading to an predominant adult population. These results agree with what is found for the genus, but the numbers seems to be less in general.

The spatial analysis provides important information like unexpected movements among adults and biased dispersal between young, non significantly differences between male/female home-range, an uniform distribution of individuals in the habitat and no significantly social spacing or space relation among neighbors. Moreover, dispersal is analyzed in the movements among seasons and a markedly difference is found for adult females and non-adult males.

Results are discussed in comparison with another subterranean mammals and the data could be used for information about the necessities of the species. The reproductive cycle plus the population dynamics, the instable environment that the species inhabits leads to a low resilience and resistance of the species, turning them on an important conservation focus.

Sumário

Introdução

Roedores fossoriais

Os mamíferos são animais que possuem adaptações para as mais variadas formas de vida, como terrestre, arborícola, aquática, ou aérea. Dentre os mamíferos terrestres, aqueles em que algum momento de sua vida utilizam túneis ou escavações abaixo da superfície do solo, para realizar alguma atividade vital, seja ela reprodução, alimentação ou proteção, são denominados fossoriais e exibem adaptações morfológicas para a atividade de escavação. Os grupos que, além de possuírem essas adaptações, conduzem a maioria de suas atividades vitais em galerias abaixo da superfície terrestre são denominados de subterrâneos. Os roedores apresentam um grande número de famílias com este hábito de vida (Lacey *et al.,* 2000).

Os mamíferos subterrâneos e herbívoros de diferentes famílias e gêneros de todo o mundo são marcadamente semelhantes na estrutura e no tamanho e apesar de métodos diferentes de escavação, constroem sistemas de túneis similares. Além disso, diversos gêneros de roedores subterrâneos deram origem a um grande número de espécies e subespécies. Poucas dessas são simpátricas, o que sugere que, em princípio, nos diferentes locais do mundo, exista somente um nicho passível de exploração por mamíferos herbívoros subterrâneos (Pearson, 1959). As semelhanças entre características corporais e hábitos de vida indicam uma evolução convergente na adaptação a este modo de vida. Estes animais possuem, em geral, uma faixa de peso corporal que vai de 50 a 1000 gramas, não importando qual a sua dieta ou origem evolutiva. Isto leva a crer que, para animais muito menores ou maiores que esta faixa, a construção de túneis é uma atividade muito dispendiosa do ponto de vista energético (Lacey *et al*., 2000).

Os roedores subterrâneos distribuem-se por todas as terras continentais, exceto a Austrália. Habitam, na sua maioria, campos, estepes, savanas ou desertos. Algumas espécies podem ocorrer em florestas ou mata arbustiva densa. Entretanto, não habitam solos saturados de água ou permanentemente congelados (Lacey *et al*., 2000).

Na América do Sul, os roedores subterrâneos estão representados pelas famílias Octodontidae, denominados popularmente de coruros, representados por uma única espécie (*Spalacopus cyanus*), que ocorre na parte central do Chile, e Ctenomyidae (Gênero *Ctenomys*), sendo os representantes desta família chamados popularmente de tuco-tucos.

O gênero *Ctenomys*

A especiação dentro do gênero *Ctenomys* é considerada como uma das mais explosivas dentro dos gêneros de mamíferos atuais (Cook & Lessa, 1988; Lessa & Cook, 1998), gerando mais de 56 espécies distribuídas na região Neotropical, sub-região Patagônica (Reig *et al*.,1990), desde a Terra do Fogo, na Argentina, até o sul da Bolívia e Peru e em altitude, desde o nível do mar até mais de 3700 metros, nos Andes peruanos (Pearson, 1959). O surgimento do gênero foi descrito (Contreras *et al*.,1987) como sendo no início do Pleistoceno, na região central da Argentina, sofrendo uma expansão posterior durante o período seco e aumentando sua área de distribuição a grande parte da América do Sul.
Dentro deste gênero, os túneis ou sistemas de galerias nos quais habitam podem ser construídos por um ou mais indivíduos (Lacey *et al*. 1998 e 2000).

Estes túneis são mantidos fechados pelos indivíduos ocupantes, o que proporciona não só proteção contra os predadores, mas também condições mais estáveis do que as do meio externo: menores flutuações de temperatura, alto grau de umidade relativa, concentrações de O_2 menos elevadas e de CO_2 mais elevadas (McNab, 1966). A diversidade de hábitats em que ocorrem estes roedores é, de fato, reflexo da estabilidade conferida pelo tipo de vida subterrâneo. Contudo, estudos mais detalhados de sua distribuição mostram que os tuco-tucos têm uma certa propensão a viver em solos arenosos ou, no mínimo, bem arejados (Contreras, 1973). Isto não é devido somente as restrições impostas pela dependência da atividade escavatória que realizam os indivíduos, mas também por restrições relacionadas com a manutenção do calor e o intercâmbio de gases com o meio externo (McNab, 1966 e 1979; Contreras e McNab, 1990).

As adaptações morfológicas relacionadas ao hábito fossorial dos tuco-tucos são a redução da cauda e pavilhões auditivos, um maior desenvolvimento da musculatura (principalmente dos membros anteriores) e das unhas, e abertura bucal atrás dos incisivos, que ficam expostos para fora da boca, mesmo em descanso. Os tuco-tucos são territoriais, apresentam baixa dispersão e, grande diversidade cariotípica, variando desde 2n=10 em *C.steinbachi* a 2n=70 em *C.pearsoni* (Reig & Kiblisky, 1969;Kiblisky et al., 1977; Gallardo,1979; Freitas & Lessa, 1984; Ortells et al., 1990; Massarini *et al*., 1991; Freitas, 1990,1994 e 1997; Gimenez e cols., 1997 e 1999; Mascheretti et al., 2000; Garcia et al., 2000).

Além disso a presença de tuco-tucos influencia diretamente na composição florística da região e na modificação das condições do solo, através do revolvimento e aeração deste (Zenuto & Busch, 1995, Rosi et al., 2000; Del Valle et al., 2001). Além disso a presença de tuco-tucos em uma região disponibiliza maior biomassa de presa para alguns predadores que possuem condições de capturá-los, sendo em alguns casos o principal item alimentar destes predadores, tais como grandes aves de rapina, cobras, graxains e furões (Pia et al., 2003).

Quatro das espécies de *Ctenomys* apresentam distribuição dentro do estado do Rio Grande do Sul. Exclusivas ao estado temos *C. flamarioni e C. lami.* *Ctenomys minutus* e *C. torquatus* apresentam parte de sua distribuição no estado de Santa Catarina e no Uruguai, respectivamente (Figura 01).

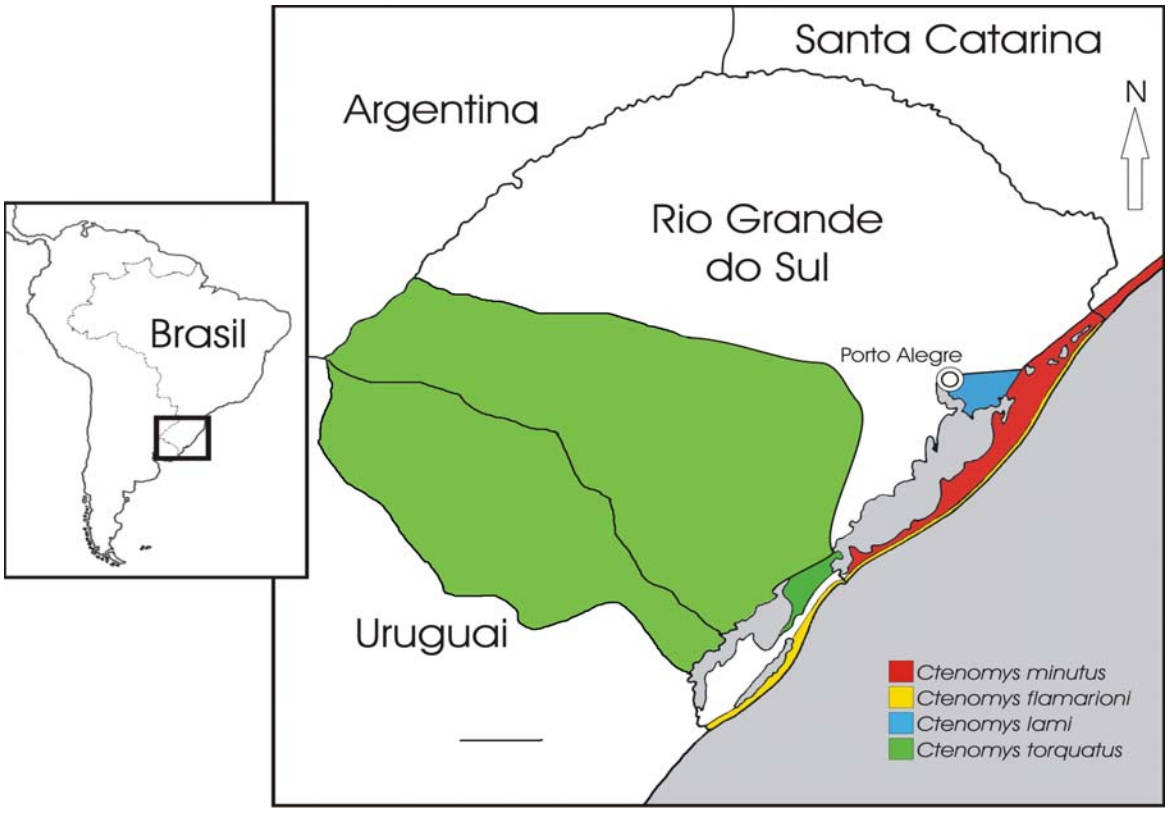

Figura 01 - Distribuição das espécies do Gênero Ctenomys no estado do Rio Grande do Sul, evidenciando em amarelo a distribuição do Tuco-tuco-das-dunas.

Ctenomys flamarioni

Esta espécie tem registrada sua descrição recentemente, no ano de 1981 (Travi, 1981). Por este motivo, não existem muitos trabalhos relacionados a ela. *Ctenomys flamarioni* habita a primeira linha de dunas de areias móveis da Planície Costeira do Rio Grande do Sul (Villwock *et al*., 1986), desde Santa Vitória do Palmar, ao Sul, até Arroio Teixeira, ao Norte (Freitas, 1995). O ambiente em que vivem possui um alto grau de salinidade e não apresenta alta riqueza ou biomassa de espécies vegetais. É neste ambiente de dunas arenosas que os indivíduos cavam seus túneis, onde realizam a maior parte de seus processos vitais (Bretschneider, 1987).

O Tuco-tuco-das-dunas possui uma coloração clara (Figura 02) e são morfologicamnte mais robustos que a maioria das outras espécies de tuco-tuco. Este tamanho relativamente maior, também é encontrado na espécie argentina *C. australis*, sendo o fator causal deste tamanho o fato desta espécie ocorrer na região de dunas de areia da costa da Província de Buenos Aires, onde o solo é frouxo e arejado (Contreras & McNab, 1990).

Figura 02 - Fêmea adulta de *Ctenomys flamarioni* na entrada de seu sistema de túneis, mostrando a pelagem de tons claros que confunde-se com a areia da região de dunas móveis, ambiente onde habita.

Um único cariótipo é conhecido para *C. flamarioni,* 2n=48 (Travi & Freitas, 1984), o que não é comum para espécies deste gênero, que em geral apresentam alta variabilidade cromossômica. Embora todos os indivíduos analizados tenham o mesmo número diplóide, varia o número de braços autossômicos através de um gradiente norte-sul, sendo o número máximo de braços 78, e o número mínimo 50. Isto determina diferenças significativas na quantidade de heterocromatina constitutiva na distribuição geográfica da espécie, indo de maior a menor quantidade, neste mesmo gradiente norte-sul (Freitas, 1994).

Uma associação entre características cariotípicas e morfológicas dos espermatozóides tem posicionado *C. flamarioni* dentro do grupo de espécies denominado ‘mendocinus’, sendo que esta espécie se diferenciou das espécies argentinas através da migração e posterior isolamento (Freitas, 1994). A migração de *C. flamarioni* poderia ter ocorrido quando a Planície Costeira era 100Km mais ampla do que no presente, onde o *Rio de La Plata* não representava uma barreira geográfica importante (Correa et al., 1992). Além

das características cromossômicas compartilhadas entre *C. flamarioni* e as outras espécies do grupo mendocinus, existem outras que reforçam sua inclusão dentro deste grupo. Apesar da existência de uma barreira geográfica de cerca de 1.000Km de distância e o *Rio de La Plata* entre eles, *C. australis* e *C. flamarioni* têm a mesma coloração clara, vivem em dunas de areia da região costeira, possuem espermatozóides assimétricos e compartilham um único par com marcação na banda NOR e 67% de suas bandas-G cromossômicas (Freitas, 1994). Todavia, estudos comparando o crânio destas duas espécies através do Método de Diagrama de Simpson, revelam diferenças morfológicas entre elas (Travi & Freitas, 1984; Massarini & Freitas, 1995).

Além disso, um estudo genético sobre a variabilidade de microssatélites, comparando três diferentes populações com diferentes graus de impacto antrópico no Litoral Norte do Rio Grande do Sul, evidenciou que existe uma perda da variabilidade genética, provavelmente por endocruzamento e ou gargalos de garrafa das populações isoladas, sendo a população considerada anteriormente a mais impactada, a que apresentou menor grau de variabilidade genética dentre seus indivíduos (Fernández, 2002).

Ecologia populacional

Num estudo de dinâmica populacional, o esforço é concentrado em uma ou poucas populações em uma determinada área. Um entendimento de como é determinado o tamanho de tal população pode ajudar a entender o que determina o tamanho e a distribuição de todas as outras populações (Moss *et al*., 1982).

Muito da ecologia de populações diz respeito a estudar os efeitos de fatores ambientais e interações interespecíficas sobre parâmetros como tamanho populacional (N), densidade populacional, sobrevivência, recrutamento e áreas de vida. As conclusões de tais estudos, portanto, são apenas tão confiáveis quanto as estimativas destes parâmetros (Fernandéz, 1995).

Os principais atributos medidos no estudo da ecologia de populações são o ‘tamanho populacional’, que corresponde ao número total de indivíduos capturados; a ‘densidade’, que corresponde à relação entre o número bruto e uma determinada área; a ‘taxa de sobrevivência’ dos indivíduos, que é a quantidade de indivíduos que sobrevive a cada ciclo reprodutivo ou espaço de tempo; e o recrutamento.

Além disso, outros atributos podem ser descritivos de uma conjunto de indivíduos de uma população. A ‘área de vida”, ou “home-range”, representa quanto de espaço no terreno é necessário para a manutenção dos processos vitais de cada indivíduo. Analizando o conjunto de áreas de vida, temos a ‘distribuição espacial’ da população, que é o arranjo dos indivíduos no espaço em relação ao terreno e aos outros indivíduos.

Esta distribuição espacial muitas vezes nos demonstra a organização social da população que estamos analizando, pois existem padrões de distribuição espacial conhecidos que refletem esta organização social.

Estudos de captura-marcação-recaptura

Uma das maneiras possíveis de se obterem os atributos descritivos de uma população é através da realização de estudos de Captura-Marcação-Recaptura (CMR), em espécies onde a contagem direta não pode ser realizada (Moss,1982), como é o caso do Tuco-tuco-das-dunas, que tanto não é visível, como não deixa qualquer vestígio que possa dar base para uma estimativa do número de indivíduos. Por isso, usa-se uma metodologia de marcação dos indivíduos com o uso de dispositivos especiais (etiquetas, colares, tatuagens, anilhas, microchips), adequados a cada tipo de organismo, de forma que estes possam ser identificados posteriormente, no próximo evento de captura. É plausível assumir que, desde que estas marcações não interfiram na fisiologia ou comportamento dos animais marcados, estes terão a mesma probabilidade de serem capturados num próximo evento de captura do que os animais não marcados. Isto faz com que seja possível fazer estimativas de parâmetros descritores da dinâmica populacional da espécie com a qual se está trabalhando (Moss, 1982; Fernandéz, 1995).

Porém, uma população não é estática no tempo, e seus indivíduos podem mudar-se da região de estudo, morrer ou haver imigrações e nascimento de novos indivíduos. Estes ganhos e perdas nas populações podem ser calculados através de correções, sendo necessário um intenso programa de captura e recaptura para se obter bons dados (Moss, 1982). Em animais onde o tempo entre um período de nascimento e outro é curto, como no caso de pequenos roedores, e existem ganhos e perdas entre os eventos de coleta, é correto aplicarem-se interpretações e estimativas próprias de populações abertas.

Poucos estudos sobre as características populacionais tem sido feitos em relação a quantidade de espécies do gênero *Ctenomys* (Malizia, 1998; Fonseca, 2003; Lacey *et. al*, 1998; Pearson et al.,1968 e Zenuto & Busch, 1998), sendo dois estudos com a espécie em questão (Bretschneider, 1987; Fernández, 2002). Nestes estudos, existe uma variação de metodologia muito ampla, principalmente no esforço e na metodologia de captura, o que traz dificuldades à comparações entre os resultados. Por exemplo, a maioria dos trabalhos realizados foi de captura e morte, o que gera outro tipo de dados a serem analisados, ou quando da realização de captura-marcação-recaptura, estas foram realizadas em apenas um dia de coleta a cada excursão de coleta, o que também gera diferenças na obtenção de dados,uma vez podem haver desvios nas taxas de captura, levando a conclusões errôneas.

Objetivos

Objetivos gerais

Estudar características da ecologia de uma população do roedor subterrâneo *Ctenomys flamarioni* (Rodentia, Ctenomyidae), localizada na Estação Ecológica do TAIM.

Objetivos específicos

- Descrever, de acordo com os parâmetros apresentados na literatura atual, a distribuição espacial e a área de vida dos indivíduos.

- Descrever aspectos do ciclo de vida, tais como período de acasalamento, nascimento, recrutamento de adultos e a relação tamanho/maturidade.
- Determinar aspectos da dinâmica populacional de *C. flamarioni*, tais como a densidade, o tamanho populacional, a estrutura etária, a razão sexual, a natalidade e a mortalidade.
- Verificar através de medidas padrão para pequenos mamíferos se existe dimorfismo sexual.
- Determinar a estrutura social de *Ctenomys flamarioni*.

Materiais e métodos

Com o objetivo de acessar atributos demográficos de uma população de *Ctenomys flamarioni* (Tuco-tuco-das-dunas*)*, um programa de captura-marcação-recaptura foi realizado na Estação Ecológica do TAIM, Região Litorânea do Estado do Rio Grande do Sul, Brasil (aproximadamente 32º43'S, 52º26'W) no período de Fevereiro de 2004 a Fevereiro de 2006, com excursões de recaptura trimestrais, de acordo com as estações climáticas, totalizando nove excursões de captura e recaptura. O local de estudo foi escolhido por apresentar-se previamente como o local provável de menor modificação pela atividade humana de toda a distribuição da espécie, potencialmente revelando as características desta, sob condições de ausência da presença humana.

A área de estudo consiste em uma extensão contínua de dunas, com altitude de não mais do que cinco metros, não alagável, localizadas entre a área de marés e uma região de banhado, o qual está a Oeste destas dunas, que possuem uma largura aproximada de 120 metros. A extensão da área de estudo foi obtida através de uma amostragem piloto, e de acordo com o que vem sendo utilizado em outros trabalhos (Malizia,1998; Pearson *et al*. 1968; Fonseca, 2003; Zenuto & Busch, 1998, Marinho, 1997 , Fernández, 2002; El Jundi & Freitas, 2004), onde foi possível perceber que uma distância de 500 metros seria adequada. Dentro desta área, todos os eventos de captura tiveram sua posição registrada com o uso de um aparelho de posicionamento

global (GPS) da marca Garmin®, com precisão de pelo menos 5m no momento de tomada dos dados.

Os tuco-tucos-das-dunas apresentam problemas ao seu estudo, peculiares de todos os roedores fossoriais. A maioria de suas atividades se dão dentro de seus sistemas de túneis, o que torna impossível a distribuição de armadilhas em grades uniformemente distribuídas em quadrantes, como na maioria de estudos deste tipo para roedores de superfície. Por isso a técnica de captura constitui-se no uso de armadilhas tipo trampa, marca Oneida-Victor, tamanho zero. Estas armadilhas foram colocadas nas entradas das tocas que apresentavam atividade recente. Estas tocas foram localizadas pela visualização de montículos de areia fresca que são postos para fora das tocas, nas atividades de limpeza e forrageamento (Lacey *et al*. 2000; Malizia,1998; Fonseca, 2003) dos tuco-tucos. As armadilhas ficam sinalizadas por bandeiras numeradas, que são revisadas a cada quinze minutos durante o tempo de coleta, para evitar que os animais capturados se machuquem.

O esforço de captura foi de até 40 armadilhas por dia, durante 5 dias, consecutivos, se houvessem condições meteorológicas para tal. Nestes dias, as coletas iniciam meia hora depois do amanhecer, estendendo-se por quatro horas e recomeçando à tarde, quatro horas e meia antes do crepúsculo, terminando meia hora antes deste, totalizando oito horas de atividade por dia. Estes horários foram escolhidos de acordo com visualizações anteriores de atividade da espécie neste período, o que corrobora com estudos em outras espécies do gênero (Lacey *et al*, 1998). Cada armadilha permaneceu na toca por no mínimo quatro horas. Se houvesse atividade nesta abertura (se o indivíduo houvese bloqueado a toca ou encoberto a armadilha com areia, tivesse sido capturado ou fechado a armadilha), a armadilha ficaria nesta abertura até o final do dia. Caso contrário, após quatro horas de inatividade, a armadilha era recolocada em outra abertura, visando aumentar a capturabilidade.

No primeiro evento de captura de cada animal, estes foram marcados com um microship de identificação marca AnimalTAG®, pesados, medidos quanto ao comprimento do corpo com cauda, comprimento da cauda, comprimento dos pés com unha e sem unha e largura dos incisivos. De cada animal foi também realizada a sexagem, de forma visual e tátil, sendo as fêmeas ainda

identificadas em prenhas (incluindo número de fetos), lactantes, cicatrizadas, cicatrizadas recentes, e não-cicatrizadas (Malizia, 1998; Malizia & Busch, 1991,1997, Zenuto *et al*. 1999). Com estes dados foram feitas as classificaçãoes e proporções etárias, sexuais e as análises do ciclo reprodutivo (Fonseca, 2003; Fernández, 2002 & Bretschneider,1987). Se o indivíduo for recapturado mais de uma vez na mesma campanha, apenas seu número identificador e sua posição georreferenciada são tomados novamente.

Os animais capturados ficaram detidos em uma caixa especial durante um período de quatro horas. Isto se suas tocas não apresentarem movimento ocasionado por outro indivíduo. Caso contrário, o indivíduo na caixa ficou condicionado a captura do tuco-tuco que está em sua toca ou era liberado num período máximo de 8 horas, para evitar que o stress do animal no evento de captura e manipulação seja prejudicial.

Os dados obtidos dos eventos de captura foram usados posteriormente para calcular duas estimativas de tamanho populacional. A primeira é baseada na estimativa de censo de captura, estimando o número mínimo de indivíduos conhecidamente vivos (Minimum number of individuals known to be alive – MNKA) entre intervalos (Krebs,1966; Krebs, Keller & Tamarin, 1969). O segundo método de estimativa do tamanho populacional é a estimativa estocástica de Jolly-Seber (Jolly,1965; Seber, 1965, Fernandéz, 1995).

Taxas de sobrevivência foram estimadas com os dados de freqüência de recaptura, também seguindo os modelos de população aberta de Jolly-Seber. A mortalidade em estudos de captura-recaptura é considerada como perda da população de indivíduos marcados da população de estudo, sendo acrescentada a esta perda posteriormente, as perdas por indivíduos migrantes.

Os dados de georreferenciamento dos indivíduos capturados foram utilizados na confecção de mapas para estimativas de distribuição espacial. Além disso, os “home-range” de *Ctenomys flamarioni* foram calculados através de um método modificado da área mínima de vida, considerando apenas os pontos mais extremos de recaptura na mesma coleta. Embora este método não seja suficiente para análises quantitativas do tamanho real dos “home-ranges”, ela provê uma estimativa importante na análise da distribuição dos indivíduos.

As análises sobre a estrutura social foram realizadas em comparação com a literatura existente, de acordo com os dados qualitativos obtidos nos eventos

de captura, como a presença ou ausência de outro indivíduo no mesmo sistema de túneis, qual a classificação etária e a movimentação espacial dos indivíduos ao longo do tempo e o acompanhamento de indivíduos através de recaptura durante diferentes fases de seu crescimento até o recrutamento (Lacey *et al*., 1998).

Resultados

Capítulo I

Life history of *Ctenomys flamarioni* (Rodentia: Ctenomyidae) in south dunes of Rio Grande do Sul – Brazil

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Abstract

As a part of a study on the ecological interactions of the species *Ctenomys flamarioni*, commonly known as tuco-tuco-das-dunas, a natural population inhabiting the dunes system in the south coast of Rio Grande do Sul/Brazil was live-trapped, with the aim of provide reliable information that helps in conservation plans and management of this threatened species. A Gompertz curve was made for growth, showing that this is a long living small rodent (at least four years old), having an increased growth time in the first two years post partum. After the second year old, males and females starts to present a markedly sexual dimorphism for body mass, incisives large and total length. Body mass variation have no significant differences among seasons for adult tuco-tucos. The species is a solitary one, with adult animals leaving on their own burrows and pups leaving with their mothers for a restricted time. A markedly reproduction cycle is presented by copula in winter, births on spring and summer and no activity just in autumn, with a possible post-partum estrum and pregnancy in summer. Results are discussed in comparison with another subterranean

mammals and the data could be used for information about the necessities of the species.

Introduction

The genus *Ctenomys* (known as tuco-tucos) is the species richest among all subterranean rodent taxa in the world and is distributed since Terra do Fogo, southern Argentina, until Bolivia; and from the Andes to the Atlantic ocean, being the dominant mammals in exploiting the subterranean niche in the South America (Reig *et al.*, 1990).

This subterranean mammals shown a group of morphological, physiological, behavioral and ecological adaptation to allow them to survive and reproduce underground (McNab, 1966; Hildebrand, 1974; Nevo, 1979; Zenuto *et al*, 1999).

Ctenomys flamarioni Travi, 1981 (commonly known as tuco-tuco-das-dunas) is a tuco-tuco species who habits the sand dunes near the sea in the Coastal Plain of southern Brazil (Freitas, 1995a). For approximately 500Km of their almost linear distribution over the dunes this tuco have a single karyotype (2n = 48) and variations in autosomal arm number, constitutive heterochromatin and C-band from north to south distribution (Freitas, 1994). Their cytogenetics characteristics plus their sperm form put *C. flamarioni* in a group of tuco-tucos known as mendocinus group (Freitas, 1995b). In this group, two species are considered ecologically similar because of the similarity of morphology, cytogenetics and habitat - *C. flamarioni* and *C. australis,* that inhabit the sand dunes in Buenos Aires Province - Argentina (Massarini and Freitas, 2005); although no ecological works have been published for *C. flamarioni*.

The tuco-tuco-das-dunas is listed as Vulnerable in Brazilian Red List of Threatened Fauna (IBAMA) because of their extremely restricted distribution and the human impacts that have been affecting the dunes, like sand removing for construction, silviculture, farming, alteration by human walking, house construction and presence of domestic fauna.

An important challenge in conservation biology is extracting pertinent information from the available data for endangered species (Buenau and Gerber, 2004). The purpose of this study is to bring reliable data on reproductive strategies, body growth and sexual dimorphism in *Ctenomys flamarioni*, with the aim of to provide important information to be used in future conservation plans for the species, and compare life history strategies with other species of subterranean rodents.

Material and methods

The study area is located in a sand dunes system of south Brazil coastal plane, in a protected area named Estação Ecológica do TAIM (ESEC-TAIM), city of Rio Grande, state of Rio Grande do Sul. The trapping area (6hec, approximately 500mX120m) comprehends the sand dunes between the ocean at East and a swamp at West, limited at South by a constant water flux from the swamp (1,5m width) and not limited at the North. This area is highly affected by the wind regimen and ocean variations, with climate temperate, humid, with an even distribution of rain throughout the year, averaging around 1300mm (Tomazelli *et al.*, 2000), forming dunes with four meters high approximately, covered sparsely by characteristic vegetation like *Blutaparon portulacoides, Panicum racemosum, Senecio crassiflorus* and *Hydrocotyle bonariensis*.

Trapping

Between February 2004 and November 2005 a capture-mark-release (CMR) program was established to obtain morphology information, sex characterization and individual growth in a temporal analysis. Once by season (total = 8) a five days trapping activity was developed with 40 Oneida Victor nº"0" traps, equipped with rubber for leg protection. The diary work started half one hour after the sunrise, going for four hours and stopping in the middle of the day, restarting four hours and a half after the sunset, reserving half one hour with day light, totalizing eight hours per day in the field. The traps were placed in the entrance of the burrows, signalized by fresh sand moved in that day. The traps were checked every 15min to avoid injuries in the animals, fixed with a numbered flag, which was marked and stayed during the five days of activity if a tuco-tuco-das-dunas were trapped in that burrow. For at least four hours the traps stayed in each tunnel, even if a tuco-tuco was captured, to verify the possible presence of another individuals in the same tunnels system.

Each animal captured were lightly anesthetized with Zoletil® to make the necessaries measures and in the first time captured they received a passive integrated transponder tag (12X1,8mm, AnimalTag®). During recapture events each individual was identified with the reader and the site of the injection was checked; no external infection was detected. The measures were weight, length of total body including tail, length of tail, length of foot whit and without nail, width of the right incisor in the basis and reproduction condition of the females, classifying in:

1) pregnant: when was possible to feel the embryos in the uteros by hand touching;

2) lactating: when the teets were elongated, turgescnt and the hairs were dispersed around the teets;
3) recently scared or perforated: when the vagina was opened or with scares cicatrizing;
4) scared: when the vagina looks closed but with scares mark.
The tuco-tucos were individually placed into a wood box and released at the end of the day in the same burrow that they were caught. The distribution of the traps tried to capture different individuals in the five days of field work, although many individuals were recaptured in the same five days period.
This study was realized under authorization of the Brazilian government by the document IBAMA nº02023,001955/03-86, license nº144/2003.

Analysis

To calculate the how old are the trapped animals we used a Gompertz model curve for body mass. The equation was:

$$M = A \cdot e^{-e^{-B \cdot (t-C)}}$$

M = body mass in time (t); A = maturity body mass (greater body mass); B = relative growth in the inflexion point (mass/day per mass unit); t = time and C = age in the inflexion point. Were the

$$\frac{dM}{dt} = A \cdot B \cdot e^{-B \cdot (t-C) - e^{-B \cdot (t-C)}}$$

Differences in body weight, total length, body length and right incisors width (at the basis) among the classes of males and females and among seasons were tested using ANOVA.

A T-test was used to estimate the significance of the reproduction status in different seasons. The growth curve were performed in the R Statistic Program®. All other statistical analysis were made in Systat11®.

Results

Trappability

During the two years of capture-mark-recapture program 38 females and 37 males were trapped a total of 152 times. 37 individuals were recaptured, 22 females and 15 males average two times each. All individuals trapped were used to the analysis.

Growth

For the construction of the growth curves six females and six males with reliable age classification that were trapped in the capture-recapture program (because they were captured since the first three months old, in the same burrow of their mothers) generated values for a initial growth curve. Pregnant females were not used in this analysis. Using the values generated in that curve we classify all other individuals captured adjusting the first time they were trapped in a younger age that the actual weight in that trap event permitted, and categorizing the following traps events in the time correspondent. This allow to classify all tuco-tucos with exact or sub estimate age classification in relation to the weight. A new growth curve was so generated using all individuals and the values founded were so considered as the growth values for the species (Tab. 01).

Tab. 01 - B e C values to a Gompertz curve to *C. flamarioni*. A = 440 for males and 280 for non pregnant females.

		Estimate	**Std. Error**	**t value**	**Pr(>|t|)**	**p**
Six females	B	0.32608	0.03858	8.453	1.22e-06	<0,0001
	C	1.44847	0.26085	5.553	9.34e-05	<0,0001
All females	B	0.3364	0.0145	23.20	< 2e-16	<0,0001
	C	1.4462	0.1446	10.00	2.18e-15	<0,0001
Six males	B	0.21704	0.02556	8.491	1.16e-06	<0,0001
	C	3.40379	0.17591	19.349	5.76e-11	<0,0001
All males	B	0.176797	0.009693	18.24	<2e-16	<0,0001
	C	3.118297	0.218966	14.24	<2e-16	<0,0001

Age classification

Using this growth curve we classified the tuco-tucos in four distinct classes that represents the year post partum that the tuco-tuco is living (Fig.01).

To verify if the age classification in relation of weight could be applied to classify the animals an Anova test was realized to test the differences in the age classes for males and females (ANOVA test:n = 80; R = 0936; df = 3; F-ratio = 180.004; p < 0.005 for females; n = 67; R = 0.958; F-ratio = 234.584; p<0.005 for males).

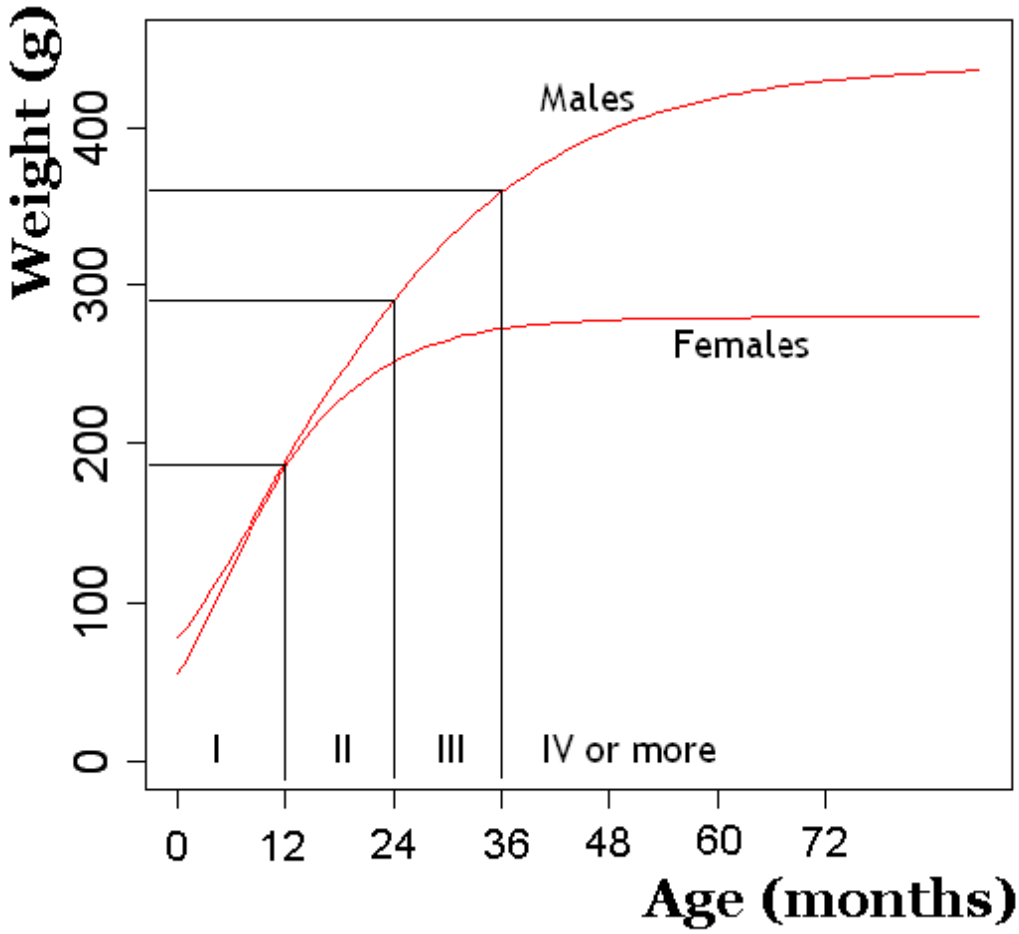

Fig. 01. - Growth of body mass (g) of *Ctenomys flamarioni* fitted to the Gompertz equation for age (months) in a population inhabiting in ESEC-TAIM/RS-Brasil. I,II,III and IV indicates the years post partum that the weight indicates (n = 38 females and 37 males).

Sexual dimorphism

To verify the existence of sexual dimorphism in this population of *C. flamarioni* a series of T-tests were realized in the four year classes. The results are showed in Table 02.

Tab.02 – Sexual dimorphism for *Ctenomys flamarioni* in a population inhabiting the sand dunes of the ESEC-TAIM/RS-Brazil. The values represents the results of an ANOVA test based in four age classes (years old) for this species.

Age	Measure	Group	N	Mean	SD	df	p
I	Weight	f	13	138.077	44.700	27.7	0.565
		m	17	148.529	53.437		
	Body length	f	13	158.231	18.615	27.8	0.938
		m	17	158.882	27.030		
	Incisive	f	13	2.273	0.389	26.0	0.875
		m	17	2.296	0.390		
	Total length	f	13	237.154	27.799	27.9	0.911
		m	17	235.765	39.510		
II	Weight	f	35	236.143	25.120	29.9	0.185
		m	18	247.222	29.567		
	Body length	f	35	191.771	9.801	43.2	0.106
		m	18	195.778	7.527		
	Incisive	f	35	2.889	0.138	39.3	0.922
		m	18	2.885	0.119		
	Total length	f	35	279.086	11.741	39.8	0.062
		m	18	285.000	9.959		
III	**Weight**	f	32	259.219	18.496	38.8	**0.000**
		m	21	335.952	21.132		
	Body length	f	32	196.063	6.777	23.8	**0.025**
		m	21	205.857	17.940		
	Incisive	f	32	2.946	0.091	43.5	**0.000**
		m	21	3.111	0.089		
	Total length	f	32	283.562	7.696	24.2	**0.008**
		m	21	296.429	19.317		
IV	**Weight**	f	5	289.000	26.552	13.5	**0.003**
		m	11	360.000	51.381		
	Body length	f	5	203.000	3.391	12.5	0.114
		m	11	210.091	12.903		
	Incisive	f	5	2.964	0.109	7.3	**0.006**
		m	11	3.181	0.101		
	Total length	f	5	293.400	6.542	13.9	**0.029**
		m	11	305.909	14.067		

Body mass variation

To verify if the body mass is a measure that have no important fluctuation over the year and possibly mask the correct age classification we realized an ANOVA test with all class II and older individuals to verify the body mass variation between the climatic seasons. This analysis presents no statistic significant differences for males as females (for males: ANOVA test, df=3, R=0.234, F-ratio=0.77, p=0.518; for females: ANOVA test, df=3, R=0.375, F-ratio=2.625, p=0.061).

Sociality

As we never trapped adult tuco-tucos (age II or older) with another adult tuco in the same burrow system no statistic test was made, concluding that if hundred per cent of the tuco-tucos trapped lived alone in the burrow, the species is solitary. Despite them, females were trapped in the same burrow of their probably suns, demonstrating female's parental care, and three times females with the pups living in their tunnels were pregnant, demonstrating that the species have a post partum estrum, being pregnant at the same time they are taking care there pups in the burrow, but the males have never trapped in the same tunnel, with no evidence of males parental care.

Reproductive cycle

For the reproductive cycle analysis we grouped the two years of the trapping program to elevate the number of individual information since there was no statistical differences among the two years. With the external reproductive characteristics we were able to distinguish significant differences in the female reproductive cycle with a markedly seasonality (Chi-square: value = 23.377; df = 12; p = 0.025). Scared females were captured all year, but had statistical significance for Autumn. Recently scared were not captured just in Spring, with significant differences in Winter. Perforated females were more abundant and significant in Spring sessions. Pregnant were not captured just in Autumn. Lactating were significantly found in Summer. Pups were not captured just in Winter, with significant differences in Summer (Fig. 02).

Litter size were measured by the counts of touchable embryos and pups in the same mother burrows. A total of eigth females were captured with embryos detectables. Five of this females carrying two embryos and tree carrying just one. Two of this

pregnants were leaving with another two pups each in theirs burrows and one pregnant were leaving with just one pup. Another trhee females were captured with their pups in the same burrow. Two females with one and one female leaving with two pups.

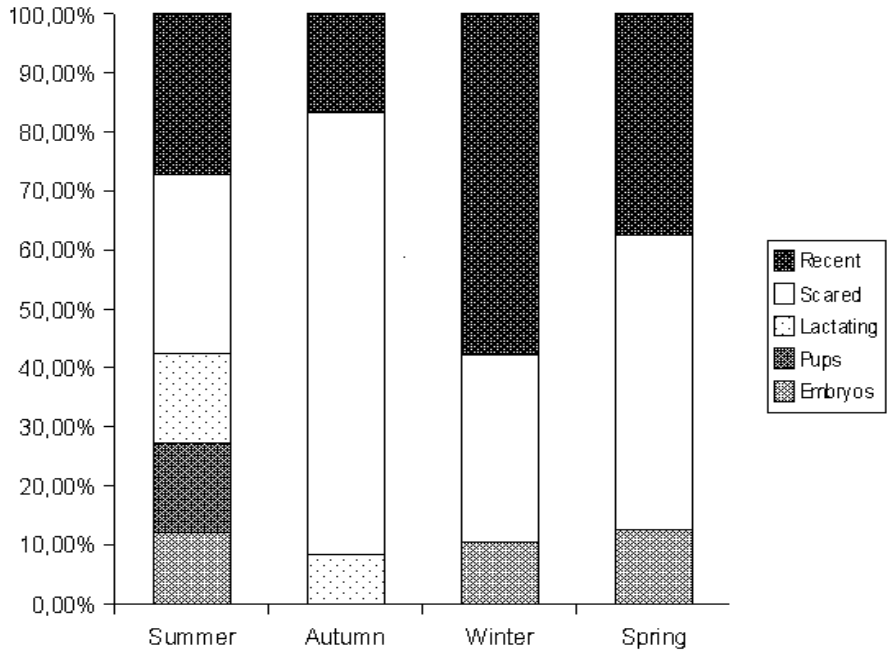

Fig. 02 – Proportion of reproductive status in females of *Ctenomys flamarioni* in two years (2004-2005) in a population leaving in ESEC-TAIM/RS-Brazil. Recent = vagina scars not cicatricized; Scared = vagina scars cicatricized, Lactating = breasts with lactating evidence; Pups = period with presence of pups and Embryos = period with embryos detectable.

Discussion

There are no rich information among growth for subterranean rodents, even less for the genus *Ctenomys*. The data available permit compare the information with *C. talarum*, that has a growth time around two years (Malizia and Busch, 1991), reaching the maturity in the end of the first year old. In this case, *C. flamarioni* seems to be more slowly, reaching the adult size in the second year end for females and in the third year end for males. Both species seem to grow after sexual maturity, what cannot be affirmed for males once that live capture programs supply no external information about their sexual activity. For *Heterocephalus glaber*, an African subterranean rodent species, the adult phase is reached in the end of second year old and the growth starts to stabilize in this time too, but on that species, males can grown over the normal size if the breeding male of the colony dies (O'Riain and Jarvis, 1998). Moreover, the use of

the Gompertz curve is an appropriate statistic form to evaluate growth, in particular for rodents (Gaillard *et.al*. 1997), and this analysis agree with this, with data adjusted significantly over the curve estimation.

Comparing with another hystricognathi rodent (*Cavia magna*), the tuco-tuco-das-dunas have a slowly growth too, once that species starts to stabilize their growth before the first year old (Kraus *et.al.*, 2005).

Age classification is a controversial theme in subterranean rodents, once there is a few data available and it is been evaluated generally in kill-trap programs, what provides information of internal measures that are not possible in live-capture programs, like eyes lens weight and humerus closure. Even that, once that a growth curve is produced, age estimations based on measures as body mass, body length, and other measures that can be measured in the field are totally useful. With this approach, a total of four class ages were reached based on weight for *Ctenomys flamarioni*. Comparisons are possible with a considered ecologically similar species, *C. australis,* that show a growth more accelerated, reaching values of weight estimation almost doubled in the end of the first year old. However the final body mass of *C. australis* seems to grow fast, reaching maturity before the first year old, in opposition of this species, that follows growing fast until the end of the second year old. For a *Ctenomys* species that inhabits close the sea in Rio Grande do Sul (*Ctenomys lami*), three age categories were determined for females based on external sexual signs, but no age estimations were realized for time (El Jundi and Freitas, 2004).

Body mass variations may occur among species that inhabit seasonal environments and is a characteristic of animals who hibernates or have torpor periods (Koprowsky, 2005). Although there is no information about torpor periods for the genus *Ctenomys*, body mass variations can be detected in the field. This work found no differences between seasons both as males and females, although form females, a significant difference appears between Spring and Summer. This could be explained by the pregnancy period, that occurs primarily in the Spring, increasing the females body mass by the gestation of theirs pups.

As have been reported for other subterranean rodents as another *Ctenomys* species (Malizia and Busch, 1991; Zenuto and Busch, 1998; Zenuto et al.,1999; El Jundi and Freitas, 2004; Marinho and Freitas, 2006), *C. flamarioni* presents sexual dimorphism. The males are significantly more heavier, more lengthy, and have larger incisors than females starting on the end of the second year old, increasing the

difference during the grown. In the population study we observed a larger number of males with three or more years with scars in the lips. This scars kind have been reported for other subterranean rodents like *Bathyergus suillus* (Jarvis and Bennet, 1991) and was suggested like being fight marks between males disputing for females or territory.

Considering the two options for sociality in the genus *Ctenomys*, we confirm that the tuco-tuco-das-dunas is a solitary one, once that never was reported two adult individuals in the same burrow system. This corroborate with the social system of the majority *Ctenomys* species (Lacey *et al*., 1998; El Jundi and Freitas, 2004; Marinho and Freitas, 2006).

The sexual dimorphism and the males scars that suggests fight for females, seems to present a polygynous reproduction system. Although this same signs are not related with polygyny in *Thomomys bottae* (Patton and Feder, 1981; Daly and Patton, 1990), there are DNA fingerprint information that *Ctenomys* species could be polygynous (Zenuto *et.al*., 1999), so genetic confirmation about paternity is needed to prove the reproductive system of *C. flamarioni*.

Reproduction can only be measured indirectly in live-trapping program and this restricts the interpretation of the results (Malizia, 1998). Even that we acquire significant data that agree what is known for the genus *Ctenomys*.

The gestation of the species seems to be like other tuco-tuco species, during approximately 90-120 days (Pearson, 1959; Weir, 1974) once we capture no pregnant females in Winter, some pregnant in Spring and then pups in Summer, mostly of them with approximately 30-60 days old.

The reproductive cycle is markedly seasonal, with a period of copula in the winter, pregnancy in spring and born at the early and middle summer, with one or two litters per cycle. This characteristic is equally observed in *C. australis* (Zenuto and Busch, 1998), *C. lami* (El Jundi and Freitas, 2004), considered ecologically similar to *C. flamarioni,* as much a post partum estrous that allow the females to have two litters in the same reproductive season. Seasonality has been seen too in *C. opimus* and *C. peruanus* (Pearson, 1959) and *C. mendocinus* (Rosi *et al., 1992*), and in *C. talarum*, but with variation of the reproduction months among different populations (Malizia and Busch, 1991; 1997). This seasonality for the tuco-tuco-das-dunas could to be regulated by environmental factors that act in the subterranean niche despite its stability (Nevo, 1979), being food availability a primarily factor in a poor vegetated terrain like the sand dunes (Zenuto and Busch, 1998).

Litter size seems to be small among subterranean rodents (Lacey et al., 2000). The average number of descendants encountered in this job is lesser than the general for the genus *Ctenomys*. Species with less body mass that live away from the coast dunes presents elevated numbers of descendant (Malizia and Busch, 1991,1997; Malizia, Vassalo and Busch, 1991) but *C. australis* present a slightly great litter size, considered possibly overestimated (Zenuto and Busch, 1998). In this case litter size could be underestimated because the capacity of identifies embryos with hand touch in the beginning of fetal development and latter the difficulty in trap all the pups living in their mother's burrows.

Sexual maturity for *Ctenomys* with live-trapping methodology could bring only female information once that males have no external evidences of their reproductive period. For females, the data concerns with found to other *Ctenomys* species (Pearson, 1959; Malizia and Busch, 1991, 1997; Zenuto and Busch, 1998) that the females begin their sexual activity with less than a year age. In this case, no females born in the reproduction season presents copula signs until Winter, seem that at least six months are necessary to reach maturity.

Acknowledgments

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Capítulo II

Population attributes and conservation of *Ctenomys flamarioni* (Rodentia: Ctenomyidae) in south dunes of Rio Grande do Sul – Brazil

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Abstract

As a part of an ecological studies to generate data for help in the conservation of a sand dunes habitant of south Brazilian coast , *Ctenomys flamarioni* (Rodentia, Ctenomyidae), commonly known as tuco-tuco-das-dunas, a capture-mark-release program was made seasonally over two consecutive years (2004/2005). Results shown a important fluctuation between the two years, a high mortality over the young population, poor density in space, a balanced sex ratio over and a moderate natality followed by a great mortality of young, leading to an predominant adult population. These results agree with what is found for the genus, but the numbers seems to be less in general. This fact causes plus the instable environment that the species inhabits leads to a low resilience and resistance of the species, turning them on an important conservation focus.

Introduction

Population biology is considered by some as one of the most important focuses in ecology (Berryman, 2002) and the population level is a necessary data to make conservation plans of threatened species (McCarthy and Thompson, 2001; Brito and Figueiredo, 2002).

Despite the works published in the last two decades about the genus *Ctenomys*, a few of them evaluate population level, what is worst if we think in the almost 60 species of the genus (Reig *et.al*., 1990), and even worst if we think that some of this species are suffering some kind of disturbance provoked by human modifications on nature, how is the case of one sand dunes species from Brazil.

Ctenomys flamarioni Travi, 1981 (commonly known as tuco-tuco-das-dunas) is a tuco-tuco species who habits the sand dunes near the sea in the Coastal Plain of southern Brazil (Freitas, 1995a). For approximately 500Km of their almost linear distribution over the dunes this tuco have a single karyotype (2n=48) and variations in autosomal arm number, constitutive heterochromatin and C-band from north to south distribution (Freitas, 1994). Their cytogenetics characteristics plus their sperm form put *C. flamarioni* in a group of tuco-tucos known as mendocinus group (Freitas, 1995b). In this group, two species are considered ecologically similar because of the similarity of morphology, cytogenetics and habitat - *C. flamarioni* and *C. australis* (Massarini & Freitas, 2005) – although no ecological works have been published for *C. flamarioni*.

The tuco-tuco-das-dunas is listed as Vulnerable in Brazilian Red List of Threatened Fauna (IBAMA) because of their extremely restricted distribution and the human impacts that have been affecting the dunes, like sand removing for construction, silviculture, farming, alteration by human walking, house construction and presence of domestic fauna.

An important challenge in conservation biology is extracting pertinent information from the available data for endangered species (Buenau & Gerber, 2004). The purpose of this study is to bring reliable data on population dynamics of *Ctenomys flamarioni*, with the aim of to provide important information to be used in future conservation plans for the species, and compare life history strategies with other species of subterranean rodents.

Material and methods

The study area is located in a sand dunes system of south Brazil coastal plane, in a protected area named Estação Ecológica do TAIM (ESEC-TAIM), city of Rio Grande, state of Rio Grande do Sul (Fig.:01). The trapping area (6ha, approximately 500mX120m) comprehends the sand dunes between the ocean at East and a swamp at West, limited at South by a constant water flux from the swamp (1,5m width) and not

limited at the North (Fig.:01). This area is highly affected by the wind regimen and ocean variations, with climate temperate, humid, with an even distribution of rain throughout the year, averaging around 1300mm (Tomazelli *et al.*, 2000), forming dunes with five meters high approximately, covered sparsely by characteristic vegetation like *Blutaparon portulacoides, Panicum racemosum, Senecio crassiflorus* and *Hydrocotyle bonariensis*.

Trapping

Between February 2004 and November 2005 a capture-mark-release (CMR) program was established to obtain morphology information, sex characterization and individual growth in a temporal analysis. Once by season (total = 8) a five days trapping activity was developed with 40 Oneida Victor nº"0" traps, equipped with rubber for leg protection. The diary work started half one hour after the sunrise, going for four hours and stopping in the middle of the day, restarting four hours and a half after the sunset, reserving half one hour with day light, totalizing eight hours per day in the field. The traps were placed in the entrance of the burrows, signalized by fresh sand moved in that day. The traps were checked every 15min to avoid injuries in the animals, fixed with a numbered flag, which was marked and stayed during the five days of activity if a tuco-tuco-das-dunas were trapped in that burrow. For at least four hours the traps stayed in each tunnel, even if a tuco-tuco was captured, to verify the possible presence of another individuals in the same tunnels system.

Each animal captured were lightly anesthetized with Zoletil® to make the necessaries measures and in the first time captured they received a passive integrated transponder tag (12X1,8mm, AnimalTag®). During recapture events each individual was identified with the reader and the site of the injection was checked; no external infection was detected. The measures were weight, length of total body including tail, length of tail, length of foot whit and without nail, width of the right incisor in the basis and reproduction condition of the females, classifying in pregnant, lactating, recently scared, scared and perforated.

The tuco-tucos were individually placed into a wood box and released at the end of the day in the same burrow that they were caught. The distribution of the traps tried to capture different individuals in the five days of field work, although many individuals were recaptured in the same five days period.

This study was realized under authorization of the Brazilian government by the document IBAMA nº02023,001955/03-86, license nº144/2003.

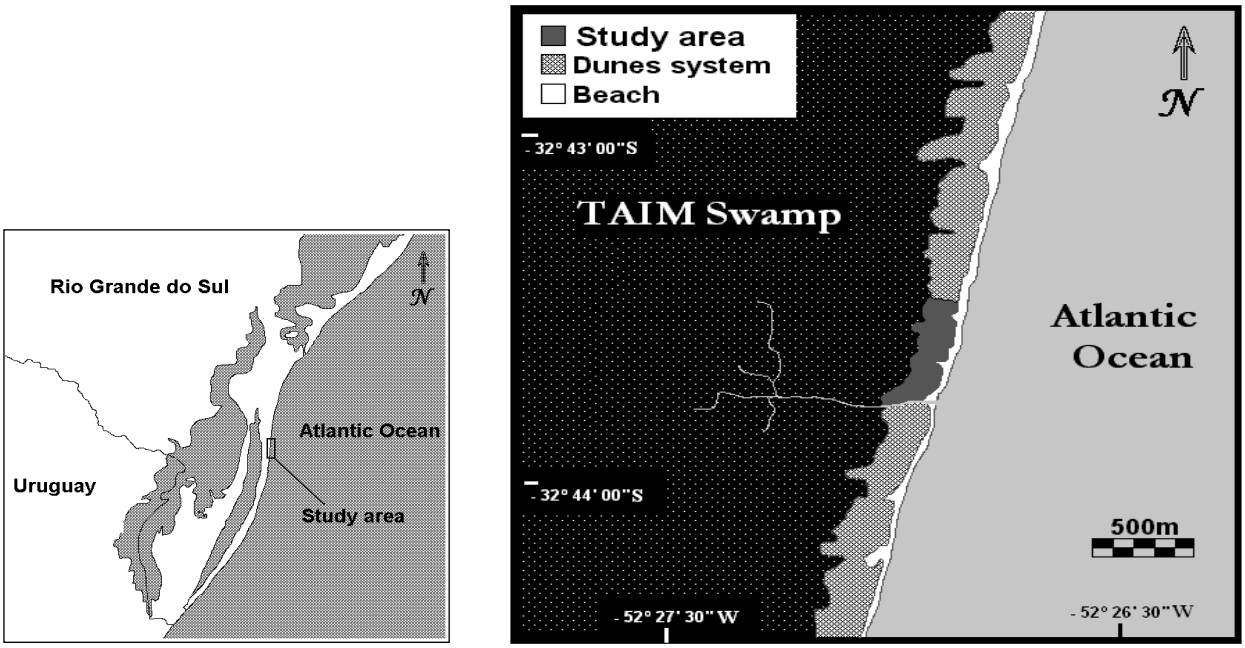

Fig.01 – Study site of a *Ctenomys flamarioni* population in Estação Ecológica do TAIM/Rio Grande do Sul (RS) – Brazil. Left = area indication in the RS State. Right = Study site in ESEC-TAIM.

Analysis

Population size

Population size were calculated using minimum number of individuals known to be alive (MNKA) between intervals (Krebs, 1966; Krebs, Keller and Tamarin, 1969) and the stochastic estimate of Jolly-Seber (Jolly, 1965; Seber, 1965). Surviving and recruitment between seasons were calculated using the Jolly-Seber methods too.

Density

Population density was calculated dividing the MNKA by the area (6ha). This methodology have less influence by the edge effects due to the tuco-tucos have their established burrows that are in general detectable in space. This allow a trap disposition orientated individually. This and the fact that individuals coming from outside the trapping area cannot be captured unless they start to excavate their own burrow reduce the edge effect (Wilson and Anderson, 1985), and the density estimation error.

Sex ratio and age structure

Sex ratio and age structure were made using age classes established by Stolz *et.al.* (*in.prep*.) that are: class I , until one year old was considered as pups; classes II,III and IV were considered adults (For males = I: <50 and 180>; II: <190 and 280>; III: <285 and 350>; IV: < 355 and 440>. For females = I: <50 and 180>; II: <190 and 235>; III: <240 and 265>; IV: <270 and 280>). A series of Kolmogorov-Smirnov tests were performed to compare the number of total males, total females, adult males, adult females, males pups, female pups, total adults and total pups.

Natality

Natality were evaluated taking into consideration the number of embryos that could be distinguished in the mothers uterus by hand touching and pups living with her mothers. Due to this species have a post partum estrum and females can be pregnant two times in summer, the maximum number of fertility possible was considered.

Mortality

The values used to make the static life table are the number of individuals captured at least two times in the eight campaigns. The age classes were classified following Stolz *et.al.* (*in.prep*.) in four different classes. Disappearance of more than three campaigns and emigration were considered death.

All statistical analysis were made in Systat11®.

Results

Trappability

Along two years and eight campaigns each season a total of 75 tuco-tuco-das-dunas were trapped. 38 males and 37 females were captured and recaptured 152 times. All individuals were used in the analysis.

Population size

Table 01: Jolly-Seber statistic for a two years (8 campaigns by season) capture-mark-release program with *Ctenomys flamarioni* inhabiting the sand dunes of Brazilian South coast. i = time (campaign); n_i = number of individuals trapped in time i; mi = number of recaptures on time i; R_i = number of released animals on time i; r_i = number of R_i that

were recaptured at least one time; Z_i = number of animals marked before time i, not trapped on time i but trapped after time i; M_i = number of 'marks on risk' (number estimated of total marked individuals in time i); $\Phi_{i,i+1}$ = estimate survival between time i and i+1; B_i = estimated recruitment between time i and time i+1; N_i = estimated population size on time i.

i	n_i	m_i	R_i	r_i	Z_i	M_i	$\Phi_{i,i+1}$	$B_{i,i+1}$	N_i
1(Summer2004)	34	0	34	22	-	0	**0,58**	-	-
2(Autumn2004)	24	19	24	16	3	22	0,63	0,62	27,79
3(Winter2004)	22	15	22	19	2	17	0,88	18,85	24,93
4(Spring2004)	25	17	25	10	4	21	0,48	11,39	30,88
5(Sumer2005)	21	13	21	7	1	14	**0,36**	13,09	22,62
6(Autumn2005)	14	5	14	4	3	8	0,41	8	22,4
7(Winter2005)	8	7	8	6	0	7	-	-	8
8(Spring2005)	7	6	7	-	-	-	-	-	-

Density

Density were estimated using the MNKA number of individuals in each campaign and dividing by the area surface (6ha). The density values are 3,67+-1,67 ind./ha, being the maximum number of individuals in the area 34 and the minimum 7.

Survival

Survival of the population trough the seasons were estimated with Jolly-Seber method for capture-mark-release programs with open populations and the results are shown on table 01. Mortality trough different age classes were made using a static life table valid for the two years (2004/2005) and comparing males and females. Results are shown on table 02 and Figure 03.

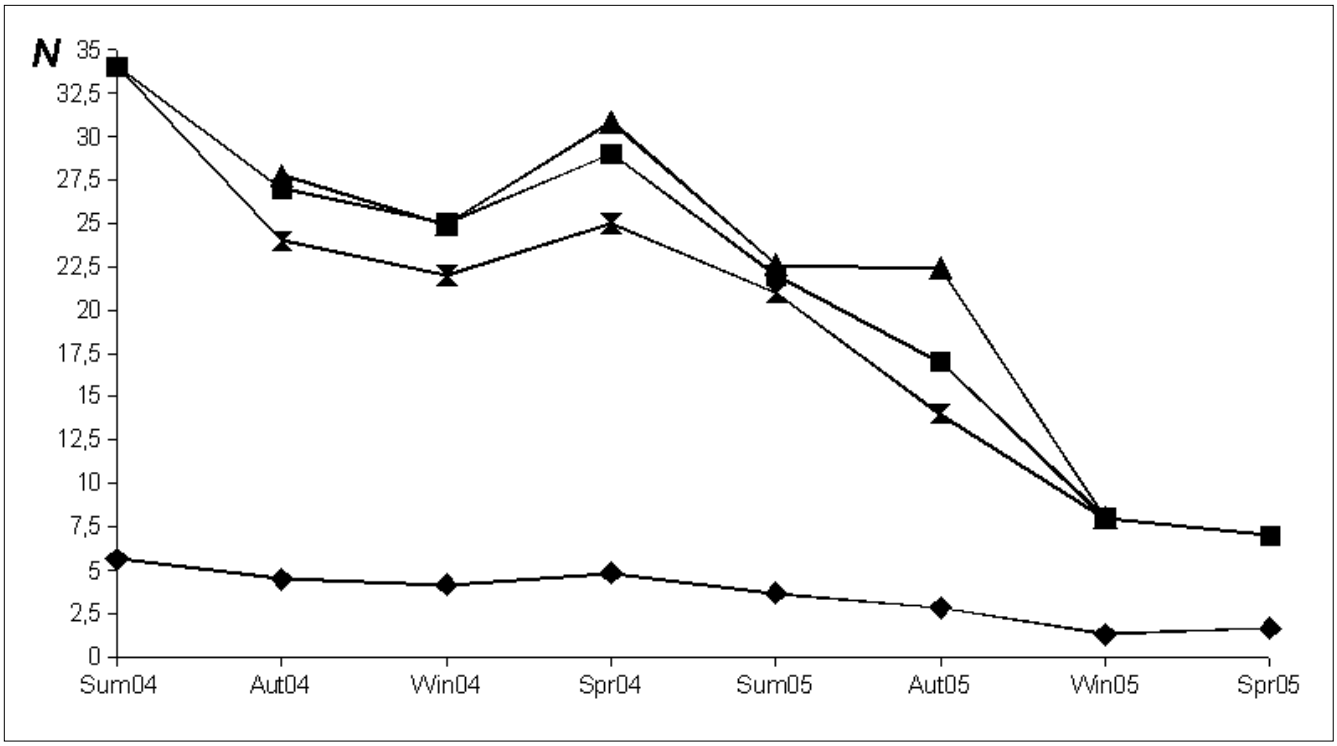

Fig.02: Population size of *Ctenomys flamarioni* inhabiting a sand dunes close the Atlantic Ocean in South Brazilian coast. (⧗) Number of captures; (■) MNKA ; (▲) Jolly-Seber population size estimation; (◆) Density estimation using MNKA..

Sex ratio and age structure

A series of Kolmogorov-Smirnov tests where made to verify if the number of males and females in different classes and if the age classes presents significant statistical differences. There is no sex biases considering all population (KS test; $p = 0,906$); there is no sex biases considering adult males and females (KS test; $p = 0,187$); there is no sex biases between males and females with until one year old (Class I – Stolz, in.prep.; KS test; $p = 0,906$). The significantly difference is found between the age classes, showing that are difference between the first year old age class and the another older age classes (KS test; $p < 0,005$), with markedly larger number of older and few young individuals along seasons.

Natality

A total of eight females captured during the program present detectable embryos. Five of them presents two and tree of them carrying just one embryo. Two of this pregnants were leaving with her pups (two) and another three of this pregnants are living with just one another pup in their burrow. This allow to conclude that the maximum number of new individuals per female per year are four, if all of the sexual

active females have a post partum estrum. The number of sexual active females on the first reproductive season (Stolz, *in.prep*.) are 07 and 16 females presents reproductive activity in the second year, estimating a maximum number of individuals increase in the population are 28 and 64 in 2004 and 2005 respectively. This data do not agree with the population size variation for this time, markedly for the second year, when the number of reproductive females are greater but the population size decreased.

Table 02: Static life table for a *Ctenomys flamarioni* population inhabiting ESEC-TAIM/RS – Brazil between Summer 2004 and Spring 2005.

Age	***N***		***Deaths in each age class***		***Mortality rate per 100 individuals (100 q_x)***	
	M	**F**	**M**	**F**	**M**	**F**
I	6	10	3	7	50	70
II	7	9	6	3	86	33
III	6	16	2	6	33	37
IV	5	9	3	8	60	89

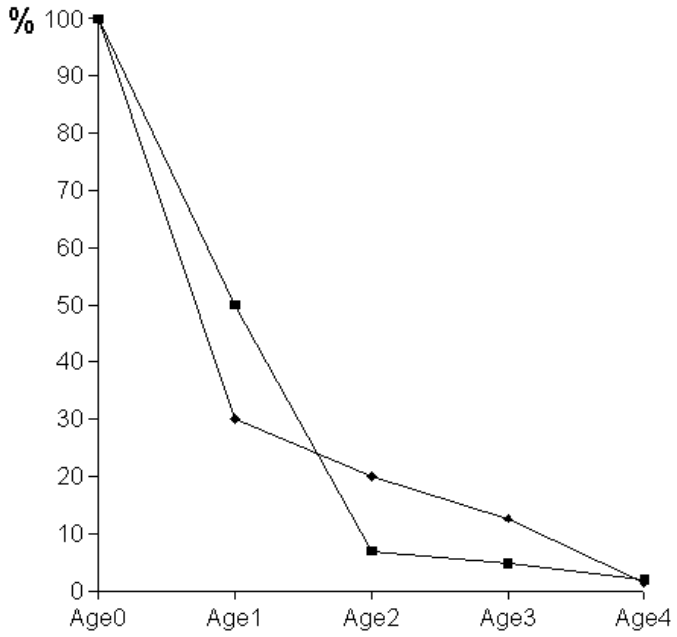

Fig.: 03 – *Per capita* mortality rate of *Ctenomys flamarioni* in a two years capture-mark-release program in ESEC-TAIM/RS – Brazil.(■) males;(◆) females.

Discussion

Population size seems to be relatively constant in the first year of the trap program and in the second year a higher mortality leads the population to less than one third of the initial number. To verify if a trap effect starts to appear over the population, since summer 2005, an extense area at north of the 6ha started to be trapped and only two tuco-tucos where trapped there, one of them less than 30m of the area and another more than 600m far from the area established limits. A natural catastrophe (the first extra-tropical cyclone) in summer 2005 and the successive rain storms could be the reason for this fluctuation (Reed *et.al*., 2003).

Population density tends to be lower than those for many surface-dwelling species. Even that *C. flamarioni* presents a lower density in comparison with other subterranean rodents and even with another *Ctenomys* species (Pearson, 1968; Malizia, Vassalo and Busch, 1991; Malizia, 1998; Marinho and Freitas, 2006). This low density seems to have connection with aridity, having a positive correlation with this habitat characteristic (Lacey *et.al.,* 2000). Moreover, in the case of the tuco-tuco-das-dunas the poor plant cover and the soil alterations produced by the wind regimen (Tomazelli and Dillemburg, 2000) seems to affect in the resources (food and habitat quality). Even in comparison with *C. australis*, that lives in a much similar habitat in Argentina, this species presents less than a half number of individuals per hectare (Zenuto and Busch, 1998).

Mortality rates presented in the static life table show that there are different traits for males and females. The first two years seems to be the more difficult to be passed, but females have a particular mortality in his first year, reducing to one third of the borned female population. After that they appear to be more capable to survive and reproduce, probably due to their heavier body size and the fact that have found a place on the habitat. The same is saw for the males, but them follow dying until the end of the second year. This could be due to the males at this time starts to have sufficient body mass to integrate the male reproductive population, what should have to make them fight with another males for females and space, leading to a higher death rate in the second year and a much more stabilized death rate to who pass this period. The body size effect is constantly pointed as a reason for young high mortality by predation

(Pearson, 1968; Malizia, 1998) and the patterns of mortality among adults are less clear (Lacey *et.al.*,2000).

Accordant to the more predominant K-selected strategy of the genus *Ctenomys*, the litter size are lesser than other surf-dwelling rodents (Malizia, 1998). The tuco-tuco-das-dunas is not different, and presents a litter size close to *C. australis*, its ecologically similar (Zenuto and Busch, 1998) and a little smaller. Even that, not all reproductive female has a second pregnancy in the reproductive annual cycle, leading to a low annual increment in the population. This and the higher mortality rates of pups leads to a poor resilience of the species, turning it in a more problematic and a high important species for conservation support.

Sex ratio can vary in genus *Ctenomys*. Some species presents female-biased sex ratios (Pearson, 1959; Malizia and Busch, 1991; Zenuto and Busch, 1998) while another presents balanced sex ratio (Rosi *et.al*.1996; Malizia, 1998; Malizia and Busch, 1998; Marinho and Freitas, 2006). *Ctenomys flamarioni* shows no significant differences between male/female proportion among seasons considering total population, only pups and only adults. This shows that births seem to be balanced and mortality do not unbalance this proportion over the adult population, with no sex death pressure for one or another adult sex.

The age structure of *C. flamarioni* are expected, once that the major mortality seems to occurs in the first year old, when the individuals are smaller and are more susceptible to predation. The adult body mass and structure seems to be an impediment to most avian predation. This and the long life span leads to the accumulation of adult individuals in the population (Lacey *et.al*., 2000). Moreover, the trap system is not accurate for very young individuals due to the lighter body mass, which could be underestimate the young population. This fact however do not agree with the lower capture rate of class II individuals, who should be much more represented if Class I individuals survive.

The low resilience and the low resistance, once that the species is suffer constant physics injuries (sea level higher, strong wind storms, strong rain seasons) leads the species to constant population changes in size. This is a problematic fact to conservation, once this kind of species is in constant high risk of point local extinctions.

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Capítulo III

To move or not to move? The spatial relations in a population of Tuco-tuco-das-dunas *Ctenomys flamarioni* in TAIM/RS – Brazil.

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Abstract

Spatial relations are one of the most important goal to predict habitat necessities and the population dynamic of a given species. The genus *Ctenomys* is known as a low vagility group of species, due to their morphology, energetic consumption in excavating new burrows and predators exposition aboveground. Despite them, unexpected movements among adults and biased dispersal between young have been seen. This work presents some aspects of the spatial relations on a *Ctenomys flamarioni* population inhabiting the sand dunes of the south coast of Rio Grande do Sul/Brazil. The results show a non significantly differences between male/female home-range, an uniform distribution of individuals in the habitat and no significantly social spacing or space relation among neighbors. Moreover, dispersal is analyzed in the movements among seasons and a markedly difference is found for adult females and non-adult males. This results agreeing with new approaches in the genus dispersal interpretation and is useful for action plans that looking for indicatives of population necessities and dynamics.

Introduction

Understanding how animals disperse and the extension of their habitat are a major issue for the management and conservation of populations (Millsap *et.al*., 1990; Vuilleumier and Metzger, 2006). Dispersal is strongly tied to resources availability, neighborhood, social system, morphology and behavior (Mares and Lacher, 1987;

Ostfeld, 1990; Travis, 2003; Jetz *et.al*. 2004) and will cause modifications on home-range, territoriality and social organization of the population.

The genus *Ctenomys* (known as tuco-tucos) is a subterranean rodent that inhabits in South America (Reig *et al.*, 1990). These subterranean mammals shown a group of morphological, physiological, behavioral and ecological adaptation to allow them to survive underground (McNab, 1966; Hildebrand, 1974; Nevo, 1979; Zenuto *et al*, 1999).

Ctenomys flamarioni Travi, 1981 (commonly known as tuco-tuco-das-dunas) is a tuco-tuco species who inhabits the sand dunes near the sea in the Coastal Plain of southern Brazil (Freitas, 1995). The tuco-tuco-das-dunas is listed as Vulnerable in Brazilian Red List of Threatened Fauna (IBAMA) because of their extremely restricted distribution and the human impacts that have been affecting the dunes, like sand removing for construction, silviculture, farming, alteration by human walking, house construction and presence of domestic fauna.

An important challenge in conservation biology is extracting pertinent information from the available data for endangered species (Buenau & Gerber, 2004). The purpose of this study is to bring reliable data on animals distribution and the implications of this distribution for the population, with the aim of to provide important information to be used in future conservation plans for the species.

Material and methods

Study area

The study area is located in a sand dunes system of south Brazil coastal plane, in a protected area named Estação Ecológica do TAIM (ESEC-TAIM), city of Rio Grande, state of Rio Grande do Sul (Fig.:01). The trapping area (6hec, approximately 500mX120m) comprehends the sand dunes between the ocean at East and a swamp at West, limited at South by a constant water flux from the swamp (1,5m width) and not limited at the North (Fig.:01). This area is highly affected by the wind regimen and ocean variations, with climate temperate, humid, with an even distribution of rain throughout the year, averaging around 1300mm (Tomazelli *et al.*, 2000), forming dunes with five meters high approximately, covered sparsely by characteristic vegetation like *Blutaparon portulacoides, Panicum racemosum, Senecio crassiflorus* and *Hydrocotyle bonariensis*.

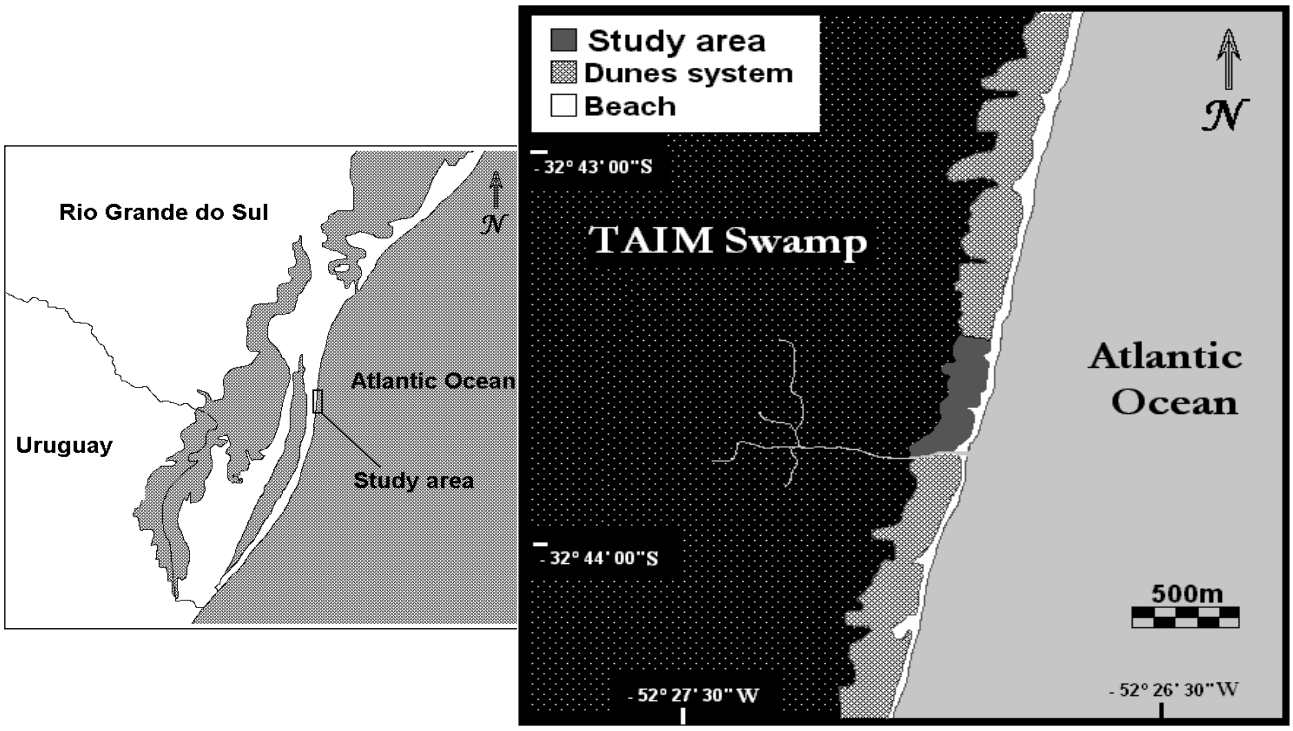

Fig.01 – Study site of a *Ctenomys flamarioni* population in Estação Ecológica do TAIM/Rio Grande do Sul (RS) – Brazil. Left = area indication in the RS State. Right = Study site in ESEC-TAIM.

Trapping

Between May 2004 and February 2006 a capture-mark-release (CMR) program was established to obtain population and spatial characterization of *C. flamarioni* in ESEC-TAIM. Once by season (total = 8) a five days trapping activity was developed with 40 Oneida Victor nº"0" traps, equipped with rubber for leg protection. The diary work started half one hour after the sunrise, going for four hours and stopping in the middle of the day, restarting four hours and a half after the sunset, reserving half one hour with day light, totalizing eight hours per day in the field. The traps were placed in the entrance of the burrows, signalized by fresh sand moved in that day. The traps were checked every 15min to avoid injuries in the animals, fixed with a numbered flag, which was marked and stayed during the five days of activity if a tuco-tuco-das-dunas were trapped in that burrow. For at least four hours the traps stayed in each tunnel, even if a tuco-tuco was captured, to verify the possible presence of other individuals in the same tunnels system.

Each animal captured were lightly anesthetized with Zoletil® to make the necessaries measures and in the first time captured they received a passive integrated transponder

tag (12X1,8mm, AnimalTag®). During recapture events each individual was identified with the reader and the site of the injection was checked; no external infection was detected. The tuco-tucos were individually placed into a wood box and released at the end of the day in the same burrow that they were caught. The distribution of the traps tried to capture different individuals in the five days of field work, although many individuals were recaptured in the same five days period.

The points of capture were marked in Global Position System (GPS – Garmin Vista®), with accuracy at least five meters close. This error was not considered a problem once the exact point of capture represents a space close the own tunnel, that could be considered an use area of the individual for foraging, and so inside the home range.

Home range estimation

Considering that the genus *Ctenomys* is extremely dependent of their burrows and realize almost all their activities into the tunnels, and the architecture of the burrows studied until now do not differ too much from a linear burrow (Antinuchi and Busch, 1992; Gastal, 1994; Lacey *et.al.* 1998; Rosi *et.al.* 2000), and considering that the minimum convex polygon method is not adequate in the case of few points of recapture because the possible bias in this approach (Burgman and Fox, 2003), we propose here a method to analyze the home range in a linear way, taking into account two points of capture of the same individual in the same campaign.

Spatial distribution and social organization

All tuco-tucos were measured between themselves and the five closer neighbors to produce a pool of data that allow to verify if there some kind of spatial organization inside the area. An ANOVA test was realized to compare the distances among these six individuals in each campaign. The five closest neighbors and no more were used because in some campaigns six were the maximum number of tuco-tuco captured. For the social organization the first closest neighbors were considered in relation to the sex, to verify a possibly grouping of different sexes, indicating the formation of couples. The frequencies of male-male, female-female, male-female and female-male occurrences and the seasons were used in a Chi-square test.

Movements

To analyze movements and dispersal, all georreferenced points of the same tuco-tuco measured between successive campaigns were considered. The individual classification in ages was: I & II = until 230g (first two years) and III & IV = over 230g (tree years or more - Stolz *et.al, in.prep.).* The sex characterization was made by external morphology. An ANOVA test was used to verify the influence of sex and age in the movement analysis. All statistical analysis were made with software Systat11®.
This study was realized under authorization of the Brazilian government by the document IBAMA nº02023,001955/03-86, license nº144/2003.

Results

Home ranges

Differences in home ranges were not found between males and females using recapture points of the same campaign (t-test, N = 13 females and 10 males; df = 21, t = -0.817, p=0,423). Home ranges varying between 7m and 45m, with 21+-11.237. Another four individuals were recaptured in the same campaign, but their measures were excluded because they were captured over more than 80m far from the original point, always passing through another individuals burrows or over natural barriers like temporary water bodies or recent sand deposits caused by the wind, were they are no able to excavate, concluding that this individuals moved aboveground during the campaign days. Moreover, all burrows identified in the same campaign by recapture of the same tuco-tuco presented no overlap in relation of their neighbor burrows.

Spatial distribution

An ANOVA test followed by a Tukey test was made to verify if the distance between the individual and their five closest neighbors are equal. Results shows that the distance between the tuco-tuco and their first neighbor is different of the distance between this individual and their second neighbor and so on (ANOVA, N = 122; R = 0.475, df = 4, F = 43.806, $p<0.0001$). So, each individual is significantly closer of their first neighbor then their second neighbor, forming a uniform distribution in space.

Social organization

A possible social organization could be represented in the proximity of individuals forming couples or groups, like a male close to one or more females or a female closer to one or more males. To test this possibility a Chi-square was realized considering the frequencies of individuals closer to tuco-tucos of the same an the opposite sex, with no significant results. (Chi-square test: value = 14.788; df = 9; p = 0.097). So, if the sex of the first neighbor does not matter and the distribution in space are uniform, this means that the species have no social or reproductive organization, at least expressed in the spatial distribution.

Movements

With the aim to test if there some kind of seasonality inside the movements realized all over the year, an ANOVA test was realized, taking into consideration the measures among campaigns (seasons), with previously classified individuals about sex and relative age, using two distinct classes of development: pups (ages I&II) and adults (III&IV). The results can be seen in Table 01. The last squares means of the statistical significant data were taking into consideration above (Fig.02 and 03). The tuco-tuco-das-dunas presents individual movements all over the year, with markedly an significant seasonality. The period between summer and autumn are highly distinct in the distances traversed in the habitat for adult females and non-adult males, due to aboveground movements larger than 250m.

Table 01: Values of ANOVA test realized with measures of movements among seasons made by individuals of *Ctenomys flamarioni* in ESEC-TAIM/RS – Brazil, between Autumn/04 and Autumn/06, taking into consideration the sex and the development stagium post partum. N = 62 . R = 0.659.

	df	F - ratio	p
Season	3	5.695	**0.002**
Age	1	0.165	0.687
Sex	1	0.437	0.512
Season*age	3	0.828	0.485
Season*sex	3	0.969	0.416
Age*sex	1	0.207	0.651
Season*age*sex	3	3.000	**0.040**

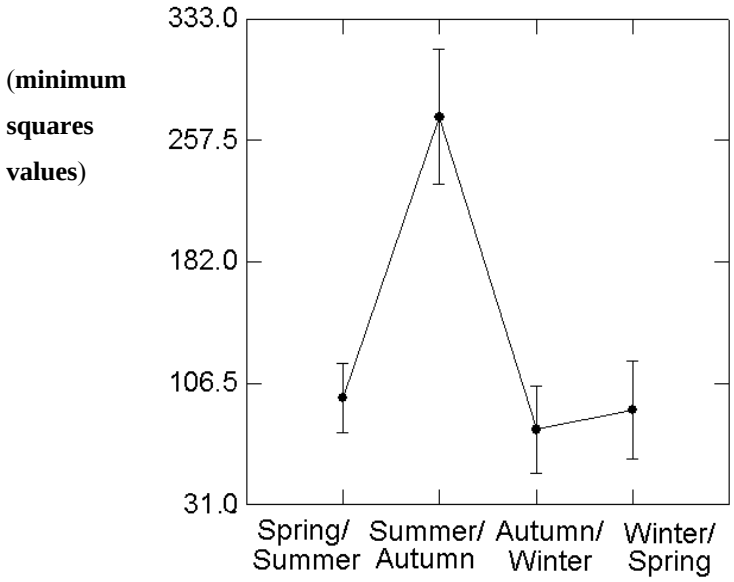

Fig. 02 – Last squares means in an ANOVA test to verify seasonality in the inter seasons movements in a *Ctenomys flamarioni* populations inhabiting ESEC-TAIM/RS-Brasil with all individual movements realized.

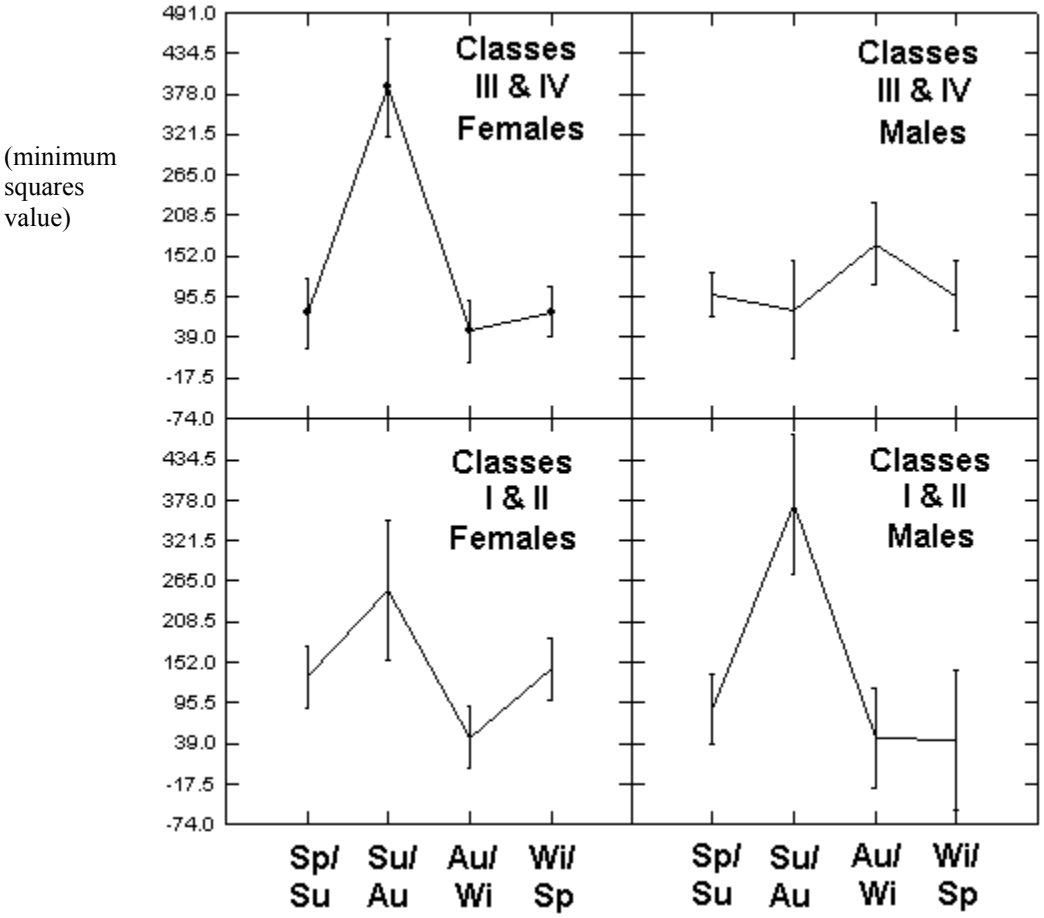

Fig. 03 – Last squares means in an ANOVA test to verify seasonality in the inter seasons movements in a *Ctenomys flamarioni* populations inhabiting ESEC-TAIM/RS-Brasil, taking into consideration the relative age and sex of the individuals.

Discussion

Home ranges

Home range and territory are considered synonymous for the genus *Ctenomys* (Malizia, 1998), so, comparisons between home-range and burrows system size could be used. The space used by animals increases with increasing in body size (Jetz *et.al.*, 2004). Comparing *C. flamarioni* with smaller species is clear that home-ranges values are greater (Gastal, 1994; Malizia,1998; Lacey *et.al*.1998; Rosi *et.al.* 2000), agreeing with the body mass supposition. Moreover, this home-ranges seems to be transitories,

once that even adult tuco-tucos change their position in space, moving to or excavating new burrows, what was observed by Malizia (1998) and is well discussed later.

Spatial distribution

Although patchily distribution is the most common spatial distribution for subterranean rodents (Lacey *et.al.*, 2000), *C. flamarioni* have a uniform distribution in space. This is only seen for subterranean rodents under high-density conditions in poor habitats (Pearson *et.al.* 1968) and differs from *C. australis*, which are considered an ecologically similar species that leaves in the sand dunes of Argentina, having a random distribution in space (Zenuto and Busch, 1998), due to this species inhabits an homogeneous habit. This homogeneity of the sand dunes seems have distinct effect in *C.flamarioni*. In this case the sand dunes are in constantly movement caused by the wind regimen (Tomazelli and Villwock, 2000) and this fact forces the animals to move constantly looking for food, what probably causes some kind of spatial organization and equally distributed area for each individual based on the temporal resources availability.

Social organization

Majority works of social organization on genus *Ctenomys* are interested to known if the species are a social or a solitary one. The analysis if distinct sexes inhabiting grouped on space are generally applied to the social species (Lacey *et.al.*, 2000). This work presents a new approach, asking if even being a solitary species the spatial distribution can predict something about the reproductive system. The answer is yes, the distribution of both sexes in space can indicate preferences in proximity of distinct sexes, possibly indicating couple formations, although there is no evidence of preferential proximity between sexes to *C. flamarioni.* Another works are more interested in the proportion male/females, with few or nothing sexes neighborhood analysis (Pearson *et.al*., 1968; Malizia and Busch, 1991; Zenuto and Busch, 1998; El Jundi and Freitas, 2004; Marinho and Freitas, 2006).

Movements

Due to their morphological characteristics, the assumption of expend high energy in excavate a new burrow and the exposition to predators aboveground, the tuco-tucos are considered low vagility animals. Contrary of this idea, some recent studies

(Malizia *et.al*. 1995; Malizia, 1998;) show that adult tuco-tucos have unexpected movements based on food, space or mates availability. This work found an elevated number of movements among seasons and speculates finely these movements. It is important to mark that the movements here are not referred to home-range ones, once that they are unidirectional, occur aboveground and in longer distances of possible tunnels of the same individual.

Despite ecological advantages caused by dispersal, this behavior is responsible and is essential to reduce inbreeding, to maintain genetic diversity and the evolutionary potential in small populations (Barton, 1992). The results showed here show that genetic diversity should be maintained by two distinct classes, adult females and non-adult males, that move greater distances in the habitat in the end of reproductive season (between summer and autumn – Stolz *et.al*, *in.prep*.). A juvenile dispersion was seen to *C. talarum* (Malizia, 1995), were a male biased dispersal were dominant in some localities. This fact influences the genetic scenario and shows the influence of who are moving in the population (Cutrera, Lacey and Busch, 2005).

Non-adult dispersal is not a rule between the genus. *Ctenomys lami* show exactly the opposite, with low dispersion of young males (El Jundi and Freitas, 2004). For a more ecologically closer species – *C. australis* – dispersal are made aboveground too, and have no insignificant differences between sex. Although no sex biased dispersal, no reproductive males were dominant in habitat occupation (Zenuto and Busch, 1998). The contrary seems occur within females, that half of dispersal individuals are members of the reproductive population, what is not seen for *C. flamarioni*, where adult females are disperser dominant in relation of non-adult females. In both species, pregnant females actuate in dispersal. This fact must show that non predictive movements are mostly common that have been thought for the genus, what agree with the appoints of Malizia (1998).

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Considerações finais

O gênero *Ctenomys* é hoje um dos gêneros de roedores mais estudados na América do Sul, tanto por motivo de seu grande número e distribuição das espécies como pela relativa facilidade de captura destes animais através de sistemas de armadilhamento. Apesar disso, a maioria dos trabalhos com o gênero tratam de aspectos genéticos, fisiológicos, morfológicos e evolutivos, ficando a ecologia das espécies a segundo plano com poucos trabalhos em relação às demais áreas do conhecimento biológico. Um pouco desta dificuldade deve-se ao tempo dedicado ao estudo de campo, que além de demorado é também dispendioso, e nem sempre apresenta resultados satisfatórios. Mesmo assim, é importante salientar que os aspectos ecológicos são essenciais também como complemento do conhecimento sobre o gênero e para elucidar problemas específicos de conservação e manejo dos tuco-tucos.

Sendo assim, este estudo tenta trazer à luz do conhecimento científico algumas características de uma população residente na ESEC-TAIM, encontrando resultados importantes como:

Ctenomys flamarioni parece com outros tuco-tucos em relação aos aspectos de ecologia populacional, mas tem características definidas para as espécies de porte maior dentro do gênero, principalmente quanto ao crescimento, longevidade, densidade populacional e ciclo reprodutivo. Estas características provavelmente ocorrem por causa do habitat desta espécie, que não é tão estável como o das espécies mais continentais, que estão sob solo mais firme, forçando a estratégias evolutivas para driblar os percalços da manutenção da espécie.

Além disso, informações sobre o sistema social servem para um futuro manejo da espécie, se necessário, dando condições de minimizar os danos causados pela translocação dos indivíduos ou pela formação de novas populações.

Outra informação importante são as taxas de natalidade e mortalidade, que ajudam nas previsões de crescimento e manutenção das populações. Neste sentido, este trabalho demonstrou-se inovatório, apresentando a primeira tabela de vida para o gênero. Deve-se a isso uma classificação etária baseada

em caracteres morfológicos externos, que permite a execução de um trabalho de captura-marcação-recaptura, ao contrário de muitos trabalhos ecológicos com captura e morte que vinham sendo feitos. Muitas vezes a alta representatividade da classe adulta foi apontada como sendo causada pela morte de muitos indivíduos que não atingiram esta classe. Este trabalho vem comprovar esta teoria, demonstrando através do acompanhamento individual suas características e valores.

A grande novidade porém fica por conta da informação trazida pela análise espacial, onde existem fortes indicações de que a mãe, após o término do ciclo reprodutivo, após um período de cuidado parental, abandona seus filhotes na toca e desloca-se para longe destes, buscando ou produzindo um novo sistema de túneis para ela. Isso traz uma nova visão sobre o gênero *Ctenomys* e possibilita testar se outras espécies que ocupam ambientes de solo mais denso, que por sua vez demandam de maior energia para escavação de novos túneis, também o fazem, mesmo sob risco de maior gasto energético e exposição à predação.

Uma das conclusões deste trabalho diz respeito a metodologia empregada. Até o momento apenas dois trabalhos de captura sem morte haviam sido realizados para todo o gênero. Alguns outros autores que haviam tentado realizar trabalhos de menor esforço de campo não foram felizes na quantidade de informação alcançada (dados não publicados) e não puderam realizar muitas avaliações ecológicas ou publicar seus dados por efeito de problemas de desenho amostral. Afirmamos aqui que este esforço, em uma área desta magnitude, deve ser considerada como base para futuros trabalhos para a espécie, a fim de poder aumentar as chances de obtenção de informações sobre as espécies que forem alvo destes estudos populacionais.

Por fim, sugerimos a espécie *Ctenomys flamarioni* como uma espécie-chave do ambiente de dunas da Planície Costeira do Rio Grande do Sul, uma vez que ela encontra-se intimamente ligada com este ambiente, realizando todas suas funções biológicas sob o sistema de dunas e sua vegetação peculiar, e dependendo deste ambiente e de sua dinâmica.

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