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SEVENTH INTERNATIONAL THERIOLOGICAL CONGRESS

Seventh International Theriological Congress

Acapulco, México, 6-12 september, 1997

Abstracts of oral and poster papers

Organized alphabetically by author's last names

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PATAGIAL SURFACE AREA AND LAUNCH PERFORMANCE IN GLAUCOMYS VOLANS.

Tiffani M. Addington, Department of Biology, Southeast Missouri State University, Cape Girardeau, MO. 63701 USA.

I studied gliding performance by the southern flying squirrel (*Glaucomys volans*) in a laboratory setting. The animals were induced to launch from a snag mounted in the lab. An infrared triggering device fired 2 high speed strobes at 12hz. Three still cameras captured multiple images of each launch and glide. These images were digitized and analyzed using SigmaScan. I determined patagial surface area at .083 second intervals for the launch. Patagial surface area measurements were then correlated with glide angle and glide velocity. The results are used to explore the effect of launch dynamics on overall glide performance.

EXPERIMENTAL TESTING OF FEMALE MATING STRATEGIES IN MICROTINE RODENTS

Jep Agrell, Dept. of Anima Ecology, Ecclgy Building, Lund University, S-223 62 Lund, Sweden.

The occurrence of male infanticide is likely to have direct effects on several aspects of female social behavior. Especially it can be expected that females adopt mating strategies that reduce the risk of being exposed to infanticidal males. In a series of experiments I examined female mating behavior in the field vole (*Microtus agrestis*), a species where males commonly exhibit infanticidal behavior. The influence of male distribution on female choice and mating behavior was determined in run-way systems in the laboratory, whereas movements and mate search activity of estrous females was studied in the field. In both these studies I used females with experimentally induced estrous. In an additional field study, I examined how female movements affect mating patterns by determining paternity (using DNA-fingerprinting) in litters from free-moving and caged females.

The results showed that a female mates primarily with a larger (dominant) male if internal distances are long, whereas she mates promiscuously if males are close together. From radio tracking in the field it could be established that oestrous females increase their movement activity and shift their centre of activity closer to neighbouring males. DNA-fingerprinting data also demonstrated that litters of caged females primarily were fathered by one male, whereas free running females produced litters with multiple paternity. These findings suggest that in order to avoid the threat from infanticidal males female microtine rodents adopt several counter-strategies: a) at low male density females associate only with the most dominant male, thereby seeking protection from incoming, potentially infanticidal males, b) at high male density females switch to promiscuous mating to confuse paternity, c) females increase movements during oestrous to monitor male distribution and dominance, and d) movement activity of females allows them to adopt a promiscuous mating strategy.

ESTRUCTURA DE LA COMUNIDAD DE MURCIÉLAGOS DE UNA SABANA NEOTROPICAL

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Durante cinco meses (cuatro continuos en 1992 y uno en 1995) se estudió intensivamente la composición, estructura y algunos aspectos ecológicos de la comunidad de murciélagos en los diferentes hábitats de la sabana inundable del Refugio de Vida Silvestre Espíritu, localizado en los Llanos de Moxos de Bolivia.

La sabana inundable, compuesta en su mayoría por áreas de pastizales poco drenados (85% del área), presenta formaciones de vegetación leñosas que son explotadas por 37 especies de murciélagos. Las formaciones vegetales estudiadas incluyen islas de bosque, bosques de galería, bosques abiertos caducifolios (tajibales), matorrales bajos y espinosos (tusecales), palmares de *Copernicia alba*, así como una zona antrópica.

Los hábitats más explotados y que tienen la mayor riqueza específica fueron las islas de bosque (26 especies), seguidos por los "tajibales" y bosques de galería (11 especies cada uno), zona antrópica (8 especies), "tusecal" (7 especies) y en menor grado los palmares (2 especies) y pastizales (1 especie). En el caso de este último la baja representación específica se debe a un problema metodológico antes que a la ausencia de especies de murciélagos que lo exploten ya que en otros ambientes se colectaron especies de molósididos que utilizan áreas abiertas como éstas para su alimentación.

Cuando se agrupan las especies de murciélagos por clases de largo del antebrazo (cinco categorías) y por grupos tróficos (ocho grupos) se evidencia que existe una dominancia de las especies insectívoras de tamaño mediano, especialmente de las voladoras lentas, seguidas por las especies frugívoras medianas que explotan todos los ambientes de la sabana, a excepción de los pastizales. Es notable la falta de especies nectarívoras ya que sólo se encontraron dos, donde una de ellas solamente fue colectada una sola vez. Dos especies de vampiros fueron colectados con regularidad, probablemente a causa de la existencia de ganadería en la zona. Las especies carnívoras, omnívoras y piscívoras fueron bien representadas en número de especies (3, 3, 1 especies respectivamente). Dos especies, carnívoras, fueron las más grandes entre todas y se las encontraron casi exclusivamente en el bosque de galería.

En el estudio realizado se encontraron varias especies con-

sideradas muy raras para Bolivia, entre ellas *Vampyrum spectrum*, *Peropteryx kappleri*, *Chrotopterus auritus* y otras. Más aún se encontró en una sola isla de bosque, la más grande (2 ha aproximadamente), un total de 21 especies de murciélagos, incluyendo las más raras. Con el método cuantificado de muestreo se pudo obtener un índice de diversidad Shannon-Wiener muy alto ($H' = 2,88$; $E = 0,82$) en comparación con La Selva y Lacandona (2,85 y 2,82). La alta riqueza de especies para este tipo de ambiente y la alta diversidad de murciélagos encontrada en sus diferentes formaciones vegetales muestran la importancia de este tipo de ambiente para mantener poblaciones considerables de estos mamíferos. La conservación de estos ambientes asegura la conservación de especies de murciélagos que juegan un papel muy importante en el mantenimiento de procesos ecológicos en las sabanas inundables de Bolivia.

THE CHROMOSOMES OF RODENTS FROM HIGH MOUNTAINS OF VENEZUELA

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Venezuela has two mountain systems North of the Orinoco river: the Cordillera de la Costa (CC) and the Cordillera de los Andes (CA). In these highlands occur about 40 rodent species. In the present study we determined the karyotypes of 5 species of cricetid rodents captured in 6 different localities of these mountain systems. *Aepeomys lugens*, *Thomasomys laniger*, *T. vestitus* were procured at CA, *Neacomys tenuipes* was captured at CC, while *Microrhizomys minutus* was procured in both Cordilleras. Metaphase chromosomes were obtained from bone marrow, after in vitro colchicine treatment; C-Banding patterns were obtained after Barium Hydroxide denaturation and Giemsa staining.

Aepeomys lugens had a karyotype composed of 14 chromosomal pairs ($2n=28$) and 48 autosomic arms ($FN=48$). Eleven pairs are biarmed (metacentric or submetacentric) and two pairs are one-armed. The X chromosome is submetacentric and the Y a submetacentric. The constitutive heterochromatin was localized around pericentromeric areas of the autosomic and the X chromosomes, while the Y chromosome is fully C-positive. This karyotype is very different from that of other *Aepeomys* species: *A. fuscatus* ($2n=54$; $FN=62$) from Colombia, and *Aepeomys* sp. ($2n=44$; $FN=46$) from Venezuela. *Thomasomys laniger* and *T. vestitus* present karyotypes of $2n=42$ ($FN=40$) and $2n=44$ ($FN=42$), respectively. In the former karyotype all autosomic chromosomes are acrocentric, being the X chromosome metacentric and the Y chromosome acrocentric. The karyotype of *T. vestitus* is different from that of *T. laniger* because in the latter an additional pair of small-sized metacentric chromosomes is present and also because the chromosome X is acrocentric. All chromosomes displayed heterochromatin in the pericentromeric area. These karyotype are similar to those of several species of *Thomasomys* from Colombia, Perú and Ecuador: *T. aureus*, *Thomasomys* sp. ($2n=44$; $FN=42$), *T. kalinoswskii*, *T. notatus* and *T. taczanowski* ($2n=44$, $FN=44$). These results show that *Thomasomys* is, from a cytogenetic point of view, a homogeneous genus whose species have experienced very little chromosomal diversification. *Microrhizomys minutus* has a $2n=758$ and $FN=56$ karyotype with all the autosomic

chromosomes being acrocentric. The X and the Y chromosomes are biarmed of different sizes. The C-banding pattern showed heterochromatic blocks only at the pericentromeric areas of the autosomic and the X chromosomes; while the Y chromosome is fully heterochromatic. This karyotype is similar to that of *M. minutus* from Perú. The karyotype of *Neacomys tenuipes* is $2n=56$ ($FN=68$). Twenty pairs of one-armed and seven pairs biarmed chromosomes form the autosomal complement. The X chromosome is the largest biarmed chromosome and the Y chromosome is the smallest acrocentric. This karyotype is very different from that of *N. spinosus* ($2n=64$; $FN=68$) of Colombia and Perú. Nevertheless the same FN in these two karyotypes suggests that Robertsonian rearrangements are involved in the karyological differentiation of *Neacomys* species.

BURROWING ACTIVITY AND BURROW SYSTEMS OF THE FOSSORIAL FORM OF THE WATER VOLE, *ARVICOLA TERRESTRIS* L.

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The fossorial water vole (*Arvicola terrestris* L.) digs galleries with its incisors and pushes the loosened soil behind itself, first through rapid movements of the forelegs and then with 2 or 3 slower strokes of the hindlegs. This sequence of leg movements is also used to forward soil from lower parts of a burrow system to higher ones, close to the soil surface. A vole positions itself behind a pile of excavated dirt and performs the sequence described above. By repeating it along the slope of a gallery the earth just excavated will be transported progressively towards the surface. The soil is pushed outside a gallery through a hole dug previously, either with a succession of head movements from down upwards or through backward movements, the back of the animal facing the entrance of the hole.

Not much is known about the ontogeny of digging behavior. Anecdotal evidence suggests that it is inborn, but more precise observations in captivity need to be done. Experiments using young animals alone or in company of adults will allow us to investigate the question to which extent the behavior is learned or modified.

Burrow systems can reach lengths of over 100 m (max. - 200 m). Most systems inhabited by a family group of 1 male and 1 female, with or without a litter of 3 to 6 young or subadults, are about 70 to 80 m long. The shorter burrows are usually linear structures with numerous galleries branching off in general from one main gallery. As the length increases, the burrows become more intricate, with many cycles (i.e. branches which rejoin previously built ones), offering the animals multiple choices to go from one place to another. It appears that this imbrication of galleries is correlated with population density and competition for space. The total length increases but the available area is smaller and the chance of a newly built branch to hit an existing one also increases. Burrow systems are normally not connected to each other. They represent territories and are probably defended against intruders although this is difficult to assess in the field. By removing the occupants of adjacent burrow systems it would be possible to see how fast an abandoned territory is taken over by neighbors.

Only few animals have been followed over an extended period of time, either in the field or in a vertical terrarium, in order to investigate the dynamics of burrow system construc-

tion. In a terrarium the gallery network changes constantly and the animals are building new galleries and filling up old ones. In the field it is observed that there are more mounds built in fall than in any other season. The question whether this corresponds to a true increase of activity or simply reflects a different strategy is still debated. In spring there are normally many abandoned galleries, since the populations decrease in winter as there is generally no reproduction during that season. Possibly the excavated soils is used to fill up old galleries; this would explain why there is not much above-ground activity in spring. For water voles such a behavior would be more beneficial in terms of energy expenditure and exposure to predators. A question remains however: why would this not be valid in fall as well?

Graph theory has been used to compute the shortest paths from any intersection or dead-end in a burrow system to any other one. An intersection which is at a minimal distance to any other point of a burrow system is called a center and amazingly enough in most of the burrow systems excavated so far, the nest (or at least one of them in case of several nests) is quite close to this center defined in terms of shortest paths. To what extent does an animal, or group of animals, build new galleries in such a way that a nest remains always closest to all other points in the burrow system? Is there a way for them to "measure" distances? An experimental approach would be to cut off certain galleries, making the whole system eccentric and see whether the occupants either displace the nest or build new galleries in a way such as to position the nest again in a central position.

DIVERSITY, ENDEMISM AND CONSERVATION OF COLOMBIAN MAMMALS

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Approximately 465 mammal species are found in Colombia, representing 15 orders, 49 families and 201 genera. Of the species included, 417 have been documented based on specimens in reference collections or reliable visual sightings. An additional 48 species are considered of probable occurrence, given their presence in neighboring countries not separated by geographical barriers. The most diverse groups are Chiroptera (173 spp., 37.2%) and Rodentia (131 spp., 28.2%), followed by Carnivora and Primates (33 spp., 7.1% each), Didelphimorphia (32 spp., 6.9%), and Cetacea (27 spp., 5.8%). Artiodactyla (7 spp.), Cingulata and Insectivora (6 spp., 1.3% each), Tardigrada and Vermilingua (4 spp., 0.9% each), Perissodactyla (3), and Paucituberculata, Lagomorpha, and Sirenia (with two species each) make up the least speciose groups of Colombian mammals.

A maximum of 227 mammal species was found in the region where the Eastern and Central Cordilleras join and the Magdalena River has its headwaters. The least number (98 species) was found on the Caribbean coast of the Guajira Department. The mean number of mammal species for all 131 quadrants was 165. No latitudinal pattern of species richness was detected, despite the fact that Colombia spans a wide latitudinal range (12°N to 4°S).

Only 29 spp. (6.2%) of mammal species are endemic to Colombia. The majority of endemic mammals are rodents (21 spp., 72%) followed by primates and insectivores, with three species each. Five species are known only from the type locality, a clear indication of the insufficient level of current knowledge. There are no bat species known to be limited to Colombia in their distribution, despite being the most diverse group of mammals in this country. The highest number of endemic species was the central portion of the Antioquia Department, which includes parts of the Central and Western Cordilleras as well as the Cauca River valley. Colombia's islands are relatively unimportant in terms of their mammal fauna.

More than half (51.3%) of Colombian mammals are small (8-128 g) and include mostly marsupials, rodents, bats, insectivores and one species of carnivore. Medium-sized species (128-16,384 g) make up 31.2% of the total and include carnivores, rabbits, armadillos, sloths, anteaters, primates and some rodents. The largest mammals (16.5-1,000 kg) make up

9.1% and include three tapir species, deer, the Spectacled Bear, the larger cats and the capibara. The smallest species (<8 g) are all bats and represent 8.6% of the total. For endemic species, the average size of is notably smaller (243 g) than when considering all species.

More species of Colombian mammals (125 spp., 30.1%) belong to the omnivore trophic class than to any other dietary guilds. The second most common class (92 spp., 22.1%) includes the insectivores such as anteaters, shrews, and many bats. The frugivores follow with 82 species (19.7%), then the carnivores (63 spp., 15.1%), herbivores (24 spp., 5.8%), nectarivores (18 spp., 4.3%), and finally the folivores (5 spp., 1.2%), granivores (4 spp., 1.0%) and sanguivores (3 spp., 0.7%). Of the nine trophic categories, only five are represented by endemic species. The majority of endemics (15 spp., 51.7%) are omnivores, followed by frugivores (8 spp., 27.6%), carnivores (3 spp., 10.3%), herbivores (2 spp., 6.9%), and one granivorous species (3.4%).

At least 44 species of Colombian mammals show some degree of endangeredness at present, in addition to the extinct Caribbean Monk Seal. Threats to the conservation of mammal species in Colombia include subsistence hunting, the pet trade, commercial hunting, biomedical research trade, use of poisonous chemicals, pollution, and habitat destruction. Despite the fact that all of these and other environmental-related activities have been controlled by national legislation since 1968, the conclusion that there has been a tendency toward increased endangeredness of mammal and other natural populations is unavoidable.

FROM MICROHABITAT TO LANDSCAPE SCALES: IMPACTS OF CRESTED PORCUPINE DIGGINGS IN THE NEGEV DESERT HIGHLANDS

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Indian crested porcupines (*Hystrix indica*) are large (15 kg), nocturnally-active hystricomorph rodents that are widely distributed in Asia, and are a prominent mammal in Israel's Negev Desert. As generalist herbivores, crested porcupines forage on a large variety of native and crop plants. They are especially adept in exploiting below-ground storage organs of geophytes that comprise an important element of Negev plant communities. This unique food resource contributes significantly to the survival of crested porcupines in semiarid and arid habitats. Research by several investigators over the past two decades has yielded important insights in aspects of the nutritional and behavioral ecology of Negev porcupines, and on their influence on ecosystem processes. Porcupines forage on some 15 species of geophytes resulting in the loss of substantial plant tissue and many individual plants. The resultant digs, however, act as soil pockets that collect seeds, moisture, and organic matter; and thereby comprise uniquely favorable microhabitats for the germination of forage species. In this respect, porcupine foraging acts as a positive feedback mechanism for vegetation renewal. The distribution of porcupine foraging effort, and the size and longevity of porcupine digs varies greatly according to substrate, and are especially important in promoting plant cover in deep loess soils having little relief and unfavorable water regimes. On hillside ecosystems, porcupine also directly influences vegetation via plant predation and microhabitat formation. More importantly, perhaps, it is a major mechanism of soil displacement, thereby significantly affecting edaphic processes and water regimes, and secondarily influencing vegetation patterns and landscape characteristics. Negev highland landscapes would differ significantly in the absence of crested porcupine foraging.

PRELIMINARY RESULTS OF EQUIDAE MICROSATELLITES APPLIED TO TAPIRUS BAIIRDII (TAPIRIDAE) FROM PANAMA.

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The utilization of genetic molecular markers highly polymorphics, like DNA microsatellites (STRPs) are, become them in a powerful tool for the estimation of genetic variability in wild mammalian populations. Only some mammalian orders have been recently analyzed for different microsatellites. The most important examples are for Primates (Bruford and Altmann, 1993; Coote and Bruford, 1996; Constable et al., 1995; Morin et al., 1994), Rodents (Dalias, 1992), Felidae (Morin and Ryder, 1992; Menotti-Raymond and O'Brien, 1995), Canidae (Gotelli et al., 1994; Roy et al., 1994), Ursidae (Craighead et al., 1995), Cervidae (De Woody et al., 1995), Bovidae (Mannen et al., 1993) and Marsupials (Taylor et al., 1994). Although the methodology is factible and relatively easy, the application of microsatellites is limited for the definition of specific primers of the markers for a determined species. Nevertheless, an alternative strategy is using primers designed for phylogenetic near species. The Equidae and the Tapiridae belong to the order Perissodactyla. For this, we applied 11 hypervariable microsatellites (MPZ001, MPZ002, VHL20, HMS5, HTG14, HTG15, HMS6, HMS1, HMS3, VIASH7 and HTG8) designed for Equidae (Ellegren et al., 1992; Breen et al., 1994; Marklund et al., 1994; Guérin et al., 1994; Breen et al., 1994; Van Haeringen et al., 1994; Gralak et al., 1994; Ewen and Matthews, 1994) to 10 samples of *Tapirus baiirdii* from Panamá. Eight of them showed positive amplifications (PCR) similar in allele sizes to those found in horses (HMS1, HMS3, HMS5, HMS6, HTG8, VIASH7, HTG14, HTG15). For instance, in the HMS5 marker the allele found in *Tapirus* was around 104 pb. In horses there are known for the same marker five alleles (101, 103, 105, 109, 111 pb). Perhaps, in one marker where *Tapirus baiirdii* showed some allele (between 124 and 147 pb) smaller than horses (131, 132, 133 134, 135, 143, 145, 147 pb) was HTG 14. Generally, horses showed higher number of alleles than donkey (Folch, unpublished) and *Tapirus baiirdii*.

THE UTILIZATION DISTRIBUTION OF SPACE BY MARMOSA ROBINSONI (DIDELPHIDAE: MARSUPIALIA) IN AN ARID REGION.

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The objective of this study was to understand the relationship between the utilization distribution of space by *Marmosa robinsoni* and some characteristics of its life history and ecology. For this we used two methodological tools: Mark-recapture techniques and radiotelemetry. We established six localities where it sampled monthly during ten months (June 1995 to March 1996). In these localities we established fixed transects six hundred meters long and with random origin. On these transects it set a random number of Sherman traps in ten meters intervals. In total 2157 traps was set. The total number of animals captured was of 130. We monitored with radiotelemetry a total of nine individuals (seven females and two males) in an average time interval per animal of 30 ± 6 days. Also, it performed a vegetation analysis for each place in which we followed or mark-recaptured animals.

The most important results of these study are: The residence time (r_s) and distance between capture (dbc) were similar for both sexes ($r_s = 105 \pm 52$ days; $dbc = 5.9 \pm 28$ m). There is sexual dimorphism in *M. robinsoni* (males reach a weight 1.65 times bigger than females and grow 3.33 times faster). We also found strong variation in sex ratio over time, which could be accounted for by a higher selective pressure on males. Home ranges for males and females was similar too (25100 ± 8011 m²). However the females with litter have a much lower home ranges (6420 and 1274 m²). Additionally, home range of females don't overlap. On the other hand, for a use similar of the space by both sexes, males do used it with higher intensity. These results indicate the probable existence of territoriality in this species. We suggest that *M. robinsoni* is a territorial specie considering the following facts: 1) the existence of sexual dimorphism, 2) males present a scent gland, 3) the sex ratio vary over time, 4) the age and sexual structure change in different localities, 5) males and females have a use intensity very different for the same space, and 6) don't have overlap of home range of females.

ECOLOGICAL STRUCTURE OF TWO POPULATIONS OF APODEMUS FLAVICOLLIS AND CLETHRIONOMYS GLAREOLUS IN CENTRAL ITALY

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In this paper we report data on the ecological structure of two populations of *Apodemus flavicollis* and *Clethrionomys glareolus* in a mountain area of central Italy. Data were obtained through CMR and refer to the last six years of a long-term research started in 1987. The study area is located within the Maiella-Morrone national park and the 1,44 ha grid was established within a long-trunked beech forest.

Data collected from 1988 to 1992 suggest that both populations are non cycling (*A. flavicollis* $s=0.172$, *C. glareolus* $s=0.38$) in the study area. In the last year through (1995), the number of animals captured ($n = 371$) was much higher than in the previous years (avg, n 1990-1994= 91.6). Although this was true of both species, the increase showed by the bank voles was much greater than that of the yellow-necked wood mice.

Data on yearly abundance, sex ratio, proportions of sexually active individuals between the two species in the different years, average weight in the sexes and re-capture success in the two species are also examined.

The following environmental factors were recorded within the study grid the aim of analyzing habitat selection for the two species, also in relation to sex and reproductive conditions exposure, average incline, presence of boulders and rocks, vegetation structure (understore, including shrubs), canopy cover. One of the interesting aspects is that, according to our data, Bank voles tend not to use much clearing and other open areas within the forest.

ECOLOGICAL ASPECTS OF ALOUATTA SENICULUS (PRIMATES: CEBIDAE) IN AN ISOLATED FOREST PATCH IN COLOMBIA

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A population of howler monkeys (*Alouatta seniculus*) was studied in the Yotoco Forest Reserve, a fragment of forest located in the Western Cordillera, in the administrative Department of Valle del Cauca. The forest covers some 560 h, between 1200 and 1600 m, and is divided altitudinally by a high-traffic paved highway. The *Alouatta* are limited to the larger forest portion (ca. 440 h) that occupies the lower elevations of the Reserve. Beginning in November of 1996, observational data were obtained about size and composition of social groups as well as feeding behavior.

The activity pattern and behavior of these primates in the Yotoco forest are similar to those reported for the same species in non-fragmented forests. In general, they are easily observed on clear and sunny days, between 06:30 and 18:00 h, dedicating most of their time to resting. During rainy days, they notably reduce their activity, making observation nearly impossible. Feeding was observed at all hours, with no apparent preferred times. They eat leaves, flowers and fruits, with a certain preference for two tree species widely distributed in the forest: *Poulesenia armata* (fruits and leaves), *Helyocarpus popayanensis* (fruits and flowers). In addition, they occasionally consume leaves of *Inga* sp. and two species of Lauraceae.

At least eight groups of howler monkeys are found in this isolated forest habitat with a total of probably more than 80 individuals. Groups were notably larger (up to 17 individuals) and with more adult males (to three or four) than in continuous forest habitats in Colombia.

CACHE ESTABLISHMENT AND UTILISATION IN RELATION TO SOCIAL STRUCTURE OF BANK VOLES (CLETHRIONOMYS GLAREOLUS)

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To study cache establishment in bank voles, adult females were placed singly in forest enclosures (10 x 10 meter) with a food source in the centre consisting of 1-131 labelled beech nuts. Two enclosures were fenced in an ash wood (*Fraxinus excelsior*) on very moist soil and two were fenced in an oak wood (*Quercus robur*) on sandy soil. Bank voles are generally known as larder hoarders, but our results show a very plastic hoarding behaviour with different strategies in the two habitat types. The voles generally made small scattered caches on top of the mineral soil under the litter layer in the ash wood, while in the oak wood they larder hoarded all seeds in chambers and galleries of burrow systems closely associated with the roots of oak or *Juniperus communis*. Scatter hoarding, as found in the ash wood, was probably a result of the moist soil conditions, which would lower the longevity of caches if placed in burrows.

In another field experiment we examined the utilisation of food caches in relation to the social structure in bank voles during the winter-spring period, using zinc-65 as a radioactive tracer. Capture/recaptures showed that individual bank voles had overlapping home ranges which indicate that bank voles, also in Denmark, aggregate during winter. Experimental winter groups consisting of a mother and her young were formed by breeding in the laboratory. When food caches were established with radioactive beech nuts by the mothers, after a short time all the young were found radioactive, showing that the caches were used communally. Some non-group bank voles and yellow-necked mice (*Apodemus flavicollis*) captured in the hoarding areas were also found radioactive. The radioactivity of the non-group bank voles occurred sporadically and generally at a low level, indicating that relative few seeds were taken by these individuals, but a few yellow-necked mice were highly radioactive, which probably shows a natural competition between these species for cached food.

BANNER-TAILED KANGAROO RATS SHRUB INVASION IN DESERT GRASSLANDS

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Granivores are important elements of desert ecosystems and heteromyids, a family of nocturnal, bipedal rodents, are second only to ants in their importance as granivores in North American deserts. Although our knowledge of the population and community ecology of these rodents is extensive our understanding of the roles an these animals plays in North American deserts is limited. Banner-tailed kangaroo rats (*Dipodomys spectabilis*) are mound-building heteromyids of the Chihuahuan Desert grassland in the southwestern United States and northern Mexico. Each mound contains a complex burrow system, including caches of vegetative material, and is occupied by a single individual. Mounds differ from their surroundings in their vegetation, soil nutrient content, hydrologic properties, and soil fungi.

Research on desertified ecosystems indicates that shrub encroachment is a positive feedback process, and the shrub-dominated desertified ecosystems are resistant and resilient to anthropogenic and climatic influences. Grazing has been at least partially implicated in desertification and shrub encroachment in the American West. Little is known of the effects of shrub encroachment on wildlife, and of the possible roles of native animal species in promoting or thwarting the process of desertification. We present a conceptual model of the dynamics of desert grassland ecosystems in which *D. spectabilis* functions as a keystone species, and in which their mounds play a role analogous to the role of tree-fall gaps in patch-dynamics models of forest ecosystems. This conceptual model implies that perturbations in the rate of mound abandonment may play a role in initiating or continuing the process of shrub encroachment. We present original results and review previous results to test the hypothesis that kangaroo rat mounds can profoundly influence local vegetation.

ECTOPARASITES OF THE SPRINGHARE *PEDETES CAPENSIS* IN THE NORTHERN CAPE PROVINCE, SOUTH AFRICA

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Random, monthly sampling of a total of 118 springhares *Pedetes capensis* in the Northern Cape Province, South Africa, over a 12 month period (February 1993-January 1994), indicated that the animals act as exclusive hosts to two parasitic mite species, *Hirstionyssus santos-diasi* and *Radfordielaelaps meridionalis* (69%), as well as natural hosts to one sucking louse species *Eulitognathus denticulatus* (20%) and an ixodid tick species *Haemaphysalis pedetes* (1%). One pulicid flea species *Synosternus caffer* (9%), a common parasite of burrowing mammals, and two other ixodid tick species, *Hyalomma marginatum* and *Rhipicephalus* sp. (1%), only occurred in limited numbers. The springhare is nocturnal lifestyle, favorable burrow microclimate and close contact between females and juveniles all facilitated infestation.

Overall infestation rates were as follows: *Hirstionyssus santos-diasi* (86%), *R. meridionalis* (88%), *E. denticulatus* (57%), *S. caffer* (80%), *Haemaphysalis pedetes* (27%), *Hyalomma marginatum* (3%) and *Rhipicephalus* sp. (7%) respectively. Larvae and nymphae of both mite species were primarily encountered during the cold winter period and displaced by adults during the warmer summer months. Infestation by *Hirstionyssus santos-diasi* only was positively correlated with temperature. Adult *E. denticulatus* occurred in relatively low densities during the late summer/autumn period, but escalated to reach a 100% infestation frequency during summer. *S. caffer* adults maintained a high rate of infestation throughout the year. Larvae and nymphae of *Haemaphysalis pedetes* were encountered during the late summer/autumn period, but were rapidly displaced by adults which reached a 100% infestation frequency during midsummer. Adult individuals comprised 49% of the total population. Succession of *Rhipicephalus* sp. followed a trend similar to that of *Haemaphysalis pedetes*, but adults comprised a mere 25% of the total population. A reversed trend was experienced for *Hyalomma marginatum*, with adults being preceded by larvae at the end of winter.

The total parasite burden was skewed in favor of males and, in the absence of gender differences in spatial activity, increased mating activities and abated grooming activities

possibly played a role. Juvenile and sub-adult springhares carried significantly bigger burdens of lice, as well as both mite species, than their adult peers. Adult female springhares supported significantly more *Haemaphysalis pedetes* than non-adults. All seven recorded ectoparasite species were present on springhares showing low to average condition indices. *Hirstionyssus santos-diasi* and *E denticulatus* specifically targeted animals in bad condition, while springhares in extremely good condition carried the highest tick loads. Non-pregnant, postpubertal females harbored significantly higher *R. meridionalis*, fleas and lice burdens than any other female reproductive stage and were possibly caused by a drastic drop in condition as a result of a highly stressful parturition and lactation period. *Haemaphysalis pedetes* and *Hirstionyssus santos-diasi* targeted prepubertal and pregnant lactating females respectively, with parasite dispersal facilitated by close contact between females and juveniles. Parasite-related tissue damage was limited to adult springhares (25%) only. Rainfall, and not ectoparasites, proved to be the main driving force in the population regulation of Northern Cape springhares.

SIZE RATIOS BETWEEN JAGUAR AND PUMA; ANOTHER ALTERNATIVE TO COMPETITION

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Among mammals, the Order Carnivora exhibits notable variation with respect to physical size as a result of differences in environmental requirements, metabolic rates, social organization and other ecological factors. Throughout their distribution, both the jaguar (*Panthera onca*) and the puma (*Puma concolor*) vary greatly in body weight. The size of principal prey has been found to exert a strong influence on this factor. Jaguar and puma differ in both form and size and it has been proposed that these variations can be considered typical of species subject to ecological displacement, that is, of species which are potential competitors. Nevertheless, it has also been put forth that the principal prey of each of these two felids occupy size classes that are separated by constant ratios and that the difference in maximum gape between jaguar and puma (ratio 1.3) simply reflects the fact that both species have evolved to concentrate on different sized prey, without any effect of competition per se. The alternate explanation proposed here is that these two species evolved to concentrate on prey types that possess distinct suites of traits without any effect of the size per se: the puma on cervids or deer like prey, and the jaguar on tayasuids or peccary-like prey.

Ungulates are the principal prey of big cats worldwide. The jaguar is associated with tropical forests, while the puma inhabits a wide variety of environments, including tropical forests. Puma is considered a specialist in preying on cervids and its range coincides with that of Cervidae in the Americas. In tropical forests, apart from cervids, the only abundant ungulates are peccaries and the range of the jaguar coincides almost perfectly with that of the family Tayassuidae. Peccaries, although very similar in weight to tropical cervids, differ from them in important aspects, from the perspective of the predator: they have large, strong canines, a compact, heavily muscled body and social habits that allow them to attack as a group. A predator that preferentially hunts peccaries must have sufficient power to kill them rapidly, before they can inflict a dangerous bite. Preferential predation on peccaries could explain the robust build of the jaguar. On comparing a jaguar and a puma of similar weight, the jaguar appears to be of excessive build, principally in the front half of the body: head, neck, limbs and thorax. On the other hand, the puma is more cursorial than the jaguar, and this is in accordance with its specialization on cervids, which are more fleet than peccaries, their only defenses being their speed and their kick.

PHYLOGEOGRAPHY OF THE MEXICAN HARVEST MOUSE, *REITHRODONTOMYS MEXICANUS*

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The Mexican harvest mouse (*Reithrodontomys mexicanus*) occurs in mid- to high elevation habitats from southern Mexico south through Central America to portions of northern South America. Based on an analysis of 30 allozymes, samples of *R. mexicanus* collected in Central America are paraphyletic with respect to other species in the subgenus *Aporodon*. In this study we obtained DNA sequences from the 12S and cytochrome-b mitochondrial genes for 8 populations of *R. mexicanus* from the states of Hidalgo, Oaxaca, and Chiapas in Mexico; Baja Verapaz and Zacapa in Guatemala; and San Jose and Cartago Provinces in Costa Rica. Data were subject to parsimony analyzes using samples of *R. gracilis* (subgenus *Aporodon*) and *R. fulvescens* (subgenus *Reithrodontomys*) as phylogenetic outgroups. We present resulting phylogenetic trees depicting relationships among samples of *R. mexicanus* together with information regarding the genetic structure of this species. In turn, this phylogenetic structure is discussed in the context of the geographic distribution of these entities.

THE MAMMAL FAUNA OF MEXICO: GEOGRAPHIC PATTERNS IN A MEGADIVERSE COUNTRY

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Mexico is one of the so-called megadiverse countries of the world, i.e., the select set of about 12 nations that concentrate most of the biological diversity of the world. Depending on the dataset that is used, Mexico's mammalian fauna is either the second or the fourth most diverse in terms of species richness. An analysis of the diversity of non-volant mammals showed that Mexico is indeed an exceptionally rich country even when the effect of area is accounted for. In contrast, the number of species of bats found in Mexico is approximately the one that would be expected for a Latin American country of its size. Factors that promote the high biological diversity in Mexico include the combination of Nearctic and Neotropical elements and the complicated topography of the country, which produces a mosaic of contrasting environments that contribute to the isolation of populations. An analysis of species richness by state showed that the impressive diversity of Mexico is not shown at the local level, demonstrating that beta, or 'differentiation' diversity is the key to Mexico's richness of non-volant mammals.

The geographic distribution of species richness in Mexico has been analyzed since the mid sixties, when G. G. Simpson described the patterns of species density in the North American continent. Since then, several researchers have put Simpson's observations in the perspective of the modern concern for the conservation of diversity. Different "hotspots" of high species richness, of concentration of endemic, rare, or endangered species have been identified in the last 10 years, and this information has been applied to the proposal of nature reserves.

In a project financed by the Mexican Commission on Biodiversity (CONABIO), my group has been analyzing the geographic patterns of mammalian distribution in Mexico using alternative measures of diversity besides species richness. Among others, we have studied the patterns of beta diversity, distribution of species with restricted distribution, bodymass diversity, diet diversity, taxonomic and phylogenetic diversity. We have found general correlations of these parameters with species richness, but several spots of high diversity but with moderate species richness have been identified. These sites are important for the conservation of Mexican mammals because many of them are not included

in the list of priority areas for conservation.

Some of the topics that would be interesting to explore in the near future include: the analysis of spatial scaling of the mammalian diversity, the theoretical and conservation-oriented implications of the relationship between alpha, beta and gamma diversity, and the structure of the Nearctic-Neotropical intergradation. Another interesting challenge for the near future is to translate all the results of the analyses of distributional patterns into predictive models that describe past, present and future processes.

THE SPATIAL SCALING OF MAMMALIAN DIVERSITY IN MEXICO

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Biological diversity has been traditionally measured in terms of species richness and at single spatial scales. Although several authors have studied the relationship between alpha (local) and gamma (regional) diversity, few studies have analyzed the patterns of diversity at intermediate scales (mesoscales[®]). Similarly, several alternative measures of diversity, besides species richness, have been proposed, but the effect of spatial and temporal scales on these variables has not been explored thoroughly.

In this talk I present an analysis of the diversity patterns of the non-volant mammal fauna of Mexico at different spatial scales. To do so, I used several measures of biological diversity besides species richness (body-mass diversity, diet diversity, substrate-use diversity, taxonomic and phylogenetic diversity) and study how these variables change at different spatial scales. I found subtle changes that cannot be perceived by a simple comparison between the local and the continental scales. These patterns have considerable theoretical importance, and direct relevance for conservation purposes.

I used a database of the distribution of the non-volant mammals of Mexico in 1/2 by 1/2-degree quadrats organized in such a way that allowed me to compute species richness and other measures of diversity at four scales: half by half, one by one, two by two, and four by four-degree quadrats. Additionally, I used lists of species for particular sites to calculate local diversity and the whole fauna of Mexico as a large-scale point of comparison.

The scaling of species richness was analyzed with models built after the theory of fractals. Most large quadrats did not shown the scale-invariant structure of species richness expected from theory, but the analysis did show clear differences in scaling between areas of low environmental heterogeneity (e.g., the Yucatan peninsula) and high heterogeneity (e.g., Western Mexico).

Values for the alternative measures of diversity scaled in a similar way as species richness, but maximum diversity was attained at intermediate values of richness. For example, body-mass diversity had the highest values at quadrats with about 45 to 60 species, while showing slightly lower values when richness was greater than 60 species and considerably lower values when richness was below 40 species. The use of "SHE" analysis allowed me to dissect the components of

diversity (Species richness; H, the information function; and E, evenness) at different scales. In the case of body-mass diversity, for example, the increase in diversity from the local level to the 4 by 4 quadrats is given by the addition of new size categories, while evenness is maintained almost constant. From the 4 by 4-degree quadrats to the country level, in contrast, the number of categories increases, but the evenness decreases with the consequent lowering of the diversity value. These results are consistent with the findings of J. Brown and colleagues, who have found more even distributions of body mass at local than at continental scales. In this work, I show that subtler patterns can be found at intermediate scales.

MEXICAN PLEISTOCENE MAMMALS

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The Pleistocene is the most recent epoch previous to the present one, the Holocene, and both constituted the Quaternary Period. It is considered to have lasted from 1.8 million years before present (BP) to 11,500 years BP. It is characterized by the intensely seasonal and highly cyclic climates, proceeding episodically, with progressive step-like increments to full glacial conditions at about 0.4 million year. Specially, the late Pleistocene (120,000-11,000 years BP) is a complex period of climatic shifts, changing faunal and floral communities, and impacted landscapes representing now extinct ecosystems.

In Mexico, Pleistocene sediments are widespread all over the country; however, most findings are isolated, lacking stratigraphic and radiometric controls, even accurate plotting of locality data, with poor descriptions. From the two land mammal ages recognized for the North American Pleistocene, Irvingtonian and Rancholabrean, the largest mammal diversity is known from the last one; true Irvingtonian localities are very few, if not only two, El Golfo (Sonora) and El Cedazo (Aguascalientes). Twenty years ago, five major faunas were defined for the Mexican Pleistocene (San Josecito Cave, Cedazo-both as local faunas, and Mexican, Chapala, Valle de Puebla-Tlaxcala-faunal assemblages); since then, one of them has gained more detailed data, both chronological and stratigraphically, providing elements to reevaluate the concept of faunal assemblages instead of local fauna (San Josecito Cave), while new important localities have been discovered in search for early human activities in México (Tlapacoya, El Cedral, Loltún Cave, etc.), accounting for the last 50,000 years.

Today the knowledge for the Mexican Pleistocene has been enhanced and is being synthesized on the Mexican FAUNMAP Project from CONABIO. This is a bibliographic-based database that is being compiled from most of the available sources in Mexico, as well as using publications found in the U.S. and Europe. One of the important points on the database will be that most localities will be located by geographic coordinates, as well as have available most data related to radiometrical datings from the bone or related materials. At present, there are 15087 mammal records in the database, from at least 100 species mentioned in the literature from 802 localities. Most of the localities remain to be georeferenced, as well as radiometrically controlled. It is clear that much work still is required to have a complete view for the Mexican Pleistocene.

PATTERNS OF EXCRETION OF ESTRADIOL AND PROGESTERONE IN FECES OF GREVY'S ZEBRAS (*EQUUS GREVYI*) OVULATORY CYCLES AND PREGNANCY

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The endangered Grevy's zebra has been maintained in captivity for nearly a century, but very little is known about its reproductive physiology and behavior, in contrast to its close relative the horse. One reason for the lack of data in zebras is the difficulty in obtaining blood samples for endocrine analysis, because of the aggressive nature of the animals and the risks of anesthesia. The development of assays for gonadal steroids excreted in feces presents an alternative approach for studies of reproductive physiology in this species. Three mares were studied during ovulatory cycles and two of these during pregnancy and parturition (two pregnancies each). Mares were separated overnight and fecal samples were collected from the loop in the morning, three times per week. Fecal samples were extracted and the extract assayed by enzyme-immunoassay for estradiol and progesterone. During the period when mares were cycling, they were observed with a stallion for two hours each morning. Fecal and urinary hormone assay results were compared to the pattern of mating behavior and to dates of parturition. Courtship and mating behaviors of the zebras were similar to those described for horses, but with elements common to asses, such as "jawing" by mares. Typically, mating occurred on three to six consecutive days, with courtship behavior evident during the transition days before and after the period of mating. Cycle length ranged from 28 to 35 days.

Patterns of excretion of estradiol and progesterone varied around observed estrous periods, with estradiol increasing during estrus followed by sustained increases in progesterone following presumed ovulation. Both estradiol and progesterone increased during early pregnancy, but estradiol declined dramatically during the two months prior to parturition while progesterone remained elevated during this period, falling precipitously just after parturition. Because of the lag time to appearance of these steroids in feces, it is likely that circulating levels of progesterone actually declined just prior to parturition.

Thus, assay of fecal estradiol and progesterone can reliably indicate changes in reproductive state in Grevy's zebra mares. This technique can be used for further studies of the dynamics of reproductive physiology of this species or for diagnosis of pregnancy and monitoring of ovarian activity.

POPULATION REGULATION IN FLUCTUATING POPULATIONS

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One of the most fundamental questions in population dynamics is what regulates a population. One of the most rigid definitions of population regulation concerns the propensity to return to an equilibrium density due to negative density dependence, i.e., regulation is thought to stabilize the dynamics. A debate whether certain mammalian populations are regulated by food or predators has been going on for a long time. If we want to understand the dynamics of interacting populations we must, however, realize that all processes influencing stability of the system is important, so that also destabilizing (positively or inverse density dependent) forces need to be concerned. So the question should not be What regulates a certain population but rather What factors influence the stability of this population.

We want to reestablish the necessity to measure per capita density dependencies in the interaction terms if factors influencing stability is to be disentangled. In this context we want to stress that the density dependence of the prey mortality rate per predator is the only unambiguous measure of the dynamic effects of the interaction terms. Prey mortality rate per predator is the functional response of each predator divided by the density of the prey. To calculate this, the number of prey eaten per predator for a range of prey densities need to be known. This type of data is often published but only very rarely the prey mortality rate per predator is calculated, and often some of the information needed for such calculations is missing. In some occasions also the tendency for density dependent aggregation of the predator need to be checked for, since such behavior can contribute to population stability.

We have also investigated the logic behind experimental food supplementation aimed at entwining the causes of cyclic population dynamics. Almost independently on how the food resources of a population is increased the population dynamics can be expected to be destabilized, giving higher amplitudes and longer periods. Even providing the amount of supplemental food as the inverse to the density of the focal population only destabilize the dynamics rather than preventing the cyclic population decline.

The premises for the predator-pit hypothesis will briefly be discussed. It is noted that a functional response of Holling type III (i.e. diet switching) is necessary in combination with the size of the predator population being fixed due to external factors or internal dynamics other than those related to the food (e.g., extreme interference between predators).

A SHORT TERM EXPERIMENT TO ASSESS DIFFERENTIAL EFFECTIVENESS OF BAITS AND TRAPS FOR NEOTROPICAL SMALL MAMMAL CAPTURE IN A BRAZILIAN LOWLAND ATLANTIC FOREST

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Several experiments on trap and bait effectiveness were conducted on the past decades, but almost all of them in temperate regions. The growth of Neotropical mammalogy has recently lead some researchers to develop and test protocols to assess the factors involved in differential capturability of species in the Neotropics. This experiment, although short termed, provides additional information on bait preference and the effectiveness that might prove to be useful to establish better sampling procedures.

The present experiment was developed in July 1996 in the Rio Doce State Park, Minas Gerais, Brazil, a lowland Atlantic Forest reserve, with primary and secondary forest areas, as part of a field course for the M. Sc. degree in Ecology, Conservation and Wildlife Management, UFMG. A secondary forest area and a swampy area were sampled. Transects were established in both areas, with two trap types (standard Tomahawk (40 x 13 x 13 cm) mesh wire and Sherman (22.9 X 7.6 x 8.9 cm) folding traps) in each point, one on ground level and the other at mid-height (ca. 1.8 m), for a total of 1.388 trap-nights. Traps were baited with an animal (bacon) and a vegetal (peanut butter) bait. Baits, trap type and position were alternated in order to have the same number of each combination. The number of captures (including recaptures) with each bait, trap type and position were compared by means of a Chi-square test, using Yates' correction for continuity. Thirteen species of rodents and marsupials were captured, for a total of 79 captures. Among marsupials, significantly more individuals were captured with bacon than with peanut butter ($X^2 = 11.2949$; g.l. = 1; $p < 0.001$), but no such difference was found for rodents. Rodents were more trapped in Sherman than in Tomahawk traps ($X^2 = 12.893$; g.l. = 1; $p < 0.001$), while no difference was observed for marsupials. All body measurements of all individuals captured in

Sherman traps were significantly inferior to those of individuals captured in Tomahawk traps. When analyzing rodents and marsupials altogether, more individuals were captured on ground level than on mid height ($X^2 = 6.127$; g.l. = 1; $p < 0.025$). The same pattern was observed for rodents alone (10.321; g.l. = 1; $p < 0.005$), but not for marsupials. No direct or clear relation between preferred bait and food habits could be established. The higher effectiveness of Sherman traps for rodents in this study is clearly related to the predominance of small body-sized species among rodents, while marsupials showed a wider range of body sizes, leading to no specific true type effectiveness. The higher efficiency of ground traps probably only reflects a high number of individuals of species with terrestrial or scansorial habits in the area, while it is important to state that some species were exclusively captured on tree-set traps. While effectiveness of trap type seems related to body size, and trap position efficiency to locomotory habits, it seems that using baits of varied composition is the most effective way to increase chances of a more accurate sampling of Neotropical small mammal communities.

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SIDE-STRIPED JACKAL ECOLOGY AND COMPETITION WITH BLACK-BACKED JACKALS

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Jackals were the subject of long-term behavioural ecology studies on commercial farmland (side-striped jackals) and wildlife areas (side-striped and black-backed jackals) in Zimbabwe. Side-striped jackals on farmland emerge as opportunistic foragers. Fruit, small mammals and medium mammals make up the bulk of the diet, and, although they prefer mammal foods, their foraging activities appear to be largely geared to efficient searches for fruit. They fulfill the predictions of the Resource Dispersion Hypothesis, in that territories are configured to encompass patches of important resources; the number of these patches appears to be important, and linked to security of food availability.

Both species of jackal exist sympatrically in parts of Zimbabwe, remarkably for two such similar species. This paper explores the mechanism of this sympatry, with regards to morphology and behaviour, by comparisons with empirical measurements from both species from allopatric areas.

Both species of jackal are heavily implicated in rabies epidemiology in Zimbabwe. However, we present evidence that rabies in jackals is driven largely by dog rabies, as jackals appear to exist at densities which are usually too low to maintain the disease.

INSECTOS ECTOPARASITOS DE LOS MURCIÉLAGOS DE LAS YUNGAS DE LA ARGENTINA

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En este trabajo se presentan los resultados de estudios realizados sobre los insectos ectoparásitos de los murciélagos de las yungas de Argentina, la relación hospedero-huésped, su sistemática, y aportes a la distribución. Los datos fueron obtenidos mediante relevamientos realizados entre 1991 y 1995, además del análisis de colecciones sistemáticas y la literatura. Los estudios estuvieron restringidos a los bosques de yungas, localizados entre los 22° y 28° de latitud sur. El muestreo de campo nos permitió coleccionar ectoparásitos en 29 de las 37 especies de murciélagos citadas para las yungas, insectos 19 y ácaros 10. En total se encontraron 16 especies de insectos ectoparásitos como huéspedes de los murciélagos de las yungas, en una proporción de 63% de Diptera (44% Streblidae y 19% Nycteribiidae), 19% de Hemiptera (Polyctenidae) y 18% de Siphonaptera (12% Ischnopsyllidae y 6% Pulicidae). Se incorporan a la fauna argentina una especie de Streblidae y dos de Polyctenidae; se registran 8 nuevas asociaciones hospedero-huésped, se amplía considerablemente la distribución de tres especies y se agregan dos especies a la entomofauna de las provincias de Jujuy, ocho a la de Salta, ocho a la de Tucumán, y una a la de Catamarca. Para la mayoría de las especies se agregan nuevas localidades de distribución. Los datos obtenidos durante este estudio indican que la Familia Streblidae parasita primariamente a especies de la Familia Phyllostomidae y con menor frecuencia a Vespertilionidae y Noctilionidae; la Familia Nycteribiidae lo hace sobre Vespertilionidae y secundariamente sobre Molossidae; la Familia Polyctenidae parasita a Molossidae y la familia Ischnopsyllidae parasita principalmente a Vespertilionidae y en segundo lugar a Molossidae; la familia Pulicidae (Hectopsyllinae) es parasita en primer lugar de especies de murciélagos de la familia Molossidae y en segundo lugar de Vespertilionidae.

PHYLOGENETIC RELATIONSHIPS WITHIN THE GENUS *ACOMYS* (RODENTIA, MURIDAE, MURINAE): INVESTIGATIONS USING CYTOCHROME B GENE ANALYSIS

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The genus *Acomys*, also called spiny mice, is widely spread over Africa and Middle-East, living in dry to arid zones, found in rocky habitats.

The monophyly of the genus is generally admitted, but the relations between species are much debated and has been many times rearranged, and many species are synonyms. These uncertainties are mostly due to discrepancies in interpretations of morphological data, and no study using DNA sequences analysis has been published until now. The present work investigates inter-species relationships by analysing the evolution of the mitochondrial cytochrome b gene.

This gene provides a strong phylogenetic signal, as shown by high statistical support of the reconstruction obtained. This topology confirms the plesiomorphic position of *A. spinosissimus* and *A. russatus*, and evidences a wide clade with three groups: *A. dimidiatus* from Near East, *Acomys* sp. from West Africa, and *A. cahirinus* from Cairo clustering with *A. airensis* from Niger.

Moreover, cytochrome b sequences show a very high similarity between *A. minous* from Crete, *A. nesiotis* from Cyprus, and *A. cahirinus* from Cairo, which strongly suggests the possibility of a human introduction. The two insular species being considered up to now as endemic, this result comes as a surprise, and raises questions about their actual taxonomic position.

BEHAVIORAL AND DEMOGRAPHIC RESPONSES OF ROOT VOLES (*MICROTUS OECONOMUS*) IN A FRAGMENTED LANDSCAPE IN THE NETHERLANDS

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The landscape in The Netherlands is characterised by intensive human use. This landscape mainly consists of large arable fields, build-up areas, roads, canals, etc. The intensification of human presence during the recent history also has had effects on root vole habitat. In many cases habitat quality has decreased, patches have become smaller or have disappeared. These processes have resulted in a highly fragmented distribution of the root vole nowadays. The species recently has been included in the Red List of Endangered mammals in The Netherlands.

From 1990 until 1996 different studies have been undertaken to get an insight into the effects of this habitat fragmentation process on the root vole. These studies have addressed three different levels: metapopulation, population and individual. Most studies were performed in the delta area, which is situated in the south-western part of the country. Here the root vole is almost completely restricted to reed (*Phragmites australis*) vegetations.

From April 1993 until March 1994 we conducted a population study, using CMR, at four habitat patches which are situated very close to each other. The patches were separated by sea dikes only. These approximately thirty meters wide and four meters high structures have a short vegetation of grasses and herbs. In this study we measured several population processes that affect population survival, such as survival rates, population sizes, recruitment and disappearance. During the whole study period only one event was recorded in which an animal moved from one habitat patch to another one. This observation suggests that there is very little exchange between local populations.

The effects of habitat fragmentation on the metapopulation level were studied from 1990 until 1994. In this period four annual surveys of over forty root vole habitat patches were conducted. These patches were selected to cover the whole range of size and isolatedness of the patches in the delta area. In 1994 an additional survey was made of all other reed vegetations, present on the two major former

islands in the delta area. For every habitat patch we established the presence or absence of the root vole, as well as landscape ecological data. The analysis of the time series, and the analysis of the complete pattern in 1994 revealed that the root vole indeed suffers from the effects of habitat fragmentation. Empty patches, however, have been observed to be colonised during our study period. The root vole populations in the delta area are still in contact with one another, and may form one or more metapopulations. A relationship between occupation probability and connectedness of patches by ditches, indicates that root voles use ditches as dispersal corridors.

To test the assumption that ditches serve as dispersal corridors, we performed a field study in which the exact position of radio-tagged root voles was recorded every fourth hour during 24 hours after release in different landscape types. This study was conducted in 1995 and 1996 at localities where no root voles were present, but within the distribution area in the delta. In total some four hundred individuals were released in grassland, arable land (potato and best crops), and root vole habitat. Animals were either released in linear landscape element such as ditches or creeks or some 20 meters from these elements. The results, obtained so far, are in agreement with the hypothesis that ditches serve as dispersal corridors for root voles in The Netherlands.

INTRODUCTION: GEOGRAPHICAL VARIATION IN DYNAMICS AND DEMOGRAPHY OF CLETHRIONOMYS SPECIES

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The European rodent species *Clethrionomys glareolus* shows a gradient in density variations with mainly annual variations in central European mixed forests and pronounced 3-4 (-5) year population cycles in northern Fennoscandian boreal forests. In central European mixed forests interrelations between individuals may modify or limit the use of resources, and as a consequence no dramatic changes in density are seen. A third type of variation is observed in mast-producing deciduous forests in central and western Europe where *C. glareolus* demonstrates population outbreaks every six to eight years following mast seeding.

Changes in density of *C. glareolus* are associated with particular demographic events: a short breeding season (i.e. decreasing maturation rate of late-summer cohorts) occurs during a decline following a peak in density, and prolonged breeding (sometimes even in winter) takes place during the phase of population increase. Social relations (territoriality) among mature individuals appear essential for these phenomena.

We will examine how common these demographic changes are in different *Clethrionomys* species and in various environments. We will look for new methods of analysing demographic data, already partly available, and we want to apply these techniques to the more general question if variations in reproduction or survival are the main processes governing population dynamics. These two demographic variables, together with dispersal, may also affect different phases in the population changes and vary in influence between type of dynamics. These problems will be addressed by modelling of the dynamics from the primary demographic factors.

DEMOGRAPHY OF *CLETHRIONOMYS GLAREOLUS* IN CRABAPPLE ISLAND, POLAND

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A population of bank voles inhabiting Crabapple Island (NE Poland) has been monitored 5 times a year since 1966. Changes in the population numbers resulted from relatively stable reproduction (due to territoriality of sexually mature individuals) and randomly varying mortality, mainly of the young of the year. Limited dispersal rates did not affect seasonal or multiannual changes in the population size. Seasonal peak numbers, usually in summer or autumn, amounted a few times up to 120-150 individuals per hectare. In spite of that the multiannual fluctuation indices were the highest in spring and decreased toward autumn. Only once very high summer numbers could be affected by preceding winter reproduction resulting in high spring population. However, the cause of high peak numbers was increased number of mature and, as a consequence, pregnant females resulting in high recruitment ratio. It is concluded that an assumption on population regulation is unnecessary to explain the reasons for multiannual fluctuations of the population numbers. Unbalanced recruitment and mortality are directly responsible for seasonal and multiannual variations in the population size.

MOVEMENT RATES AND SURVIVAL OF ARCTIC GROUND SQUIRRELS DURING NATAL DISPERSAL

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Predation risk models assume that individuals that spend more time exposed to predators are at greater risk of mortality. Young animals may be especially vulnerable to predation during natal dispersal. Yet we know little about whether individuals that cover more ground during dispersal have a greater risk of being killed by a predator, or whether particular behaviours and movement patterns make certain individuals more vulnerable to predation. I tested the hypothesis that dispersing juvenile arctic ground squirrels (*Spermophilus parryii plesius*) that moved farther per day were more at risk of predation than juveniles that moved shorter distances. Juveniles were radio-collared at emergence from the natal burrow and radio-tracked daily with a hand-held antenna. Juveniles that survived their first active season had lower daily movement rates than juveniles that died from predation. In addition, juvenile males moved farther per day and survived a shorter time after emergence from the natal burrow than juvenile females. Juveniles that made longer daily movements were probably exposed to predators for longer periods of time, and these results support the hypothesis that individuals that spend more time exposed to predators increase their chances of mortality.

EVOLUTION OF LIFE HISTORY STRATEGIES IN AFRICAN MOLE-RATS (BATHYERGIDAE)

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The rodent family Bathyergidae includes five genera of subterranean mole-rats exhibiting different social behavior: three genera (*Bathyergus*, *Georchus* and *Heliophobius*) comprise animals of solitary habits, two genera, the naked mole-rat (*Heterocephalus*) and the Gray's mole-rat (*Cryptomys*) are highly social. Mole-rats of both genera live in colonies whose structure can be denoted as eusocial: the reproduction is monopolized by a single female and her mate(s), whereas most of their offspring remain within the parental family throughout their lives and do not reproduce. One of the most discussed questions concerns the evolution and functional meaning of this unique social structure.

R. D. Alexander has considered the predator safety of the subterranean ecotope to be a driving force in evolving eusociality. There is, however, no evidence of evolutionary convergence and in fact only 6 of 21 (23%) of the genera comprising subterranean rodents are in some way social (two genera being eusocial). Indeed, the social way of life is much more common among the above-ground rodents (about 64% of the genera include socially living animals).

Most authors agree with the cooperative (or aridity) hypothesis coined by Jarvis and Lovegrove, and relate sociality in mole-rats to small body size, semi-aridity of the habitat (rainfall less than 350 mm) and prevalent feeding on large but widely spaced geophytes. The scenario assumes that cooperative foraging is necessary for survival in semi-arid areas where also the risk of dispersal and not finding enough food is high.

Nevo and collaborators (1992) have found that *Spalax* in the desert habitats decrease the aggression. The authors hypothesized that this pacifistic behavior has been adaptively selected for survival in the harsh desert ecology. This strategy may minimize overheating, water and energy expenditure, and can be considered a prerequisite for social evolution. However, this finding has no relevance to the above cooperative hypothesis as colonies in eusocial bathyergids arise through cohesion of family members and not through aggregation of unfamiliar individuals. In fact, both naked and Gray's mole-rats are highly aggressive against unfamiliar conspecifics.

We (Burda, Kawalika, Scharff, Gr,tjen) have demonstrated that *Cryptomys* of several species (including large-sized *Cryptomys mechowii*) in Zambia are also highly social, most

probably eusocial, in spite of living under ecological conditions which should promote, according to the above hypotheses, a solitary way of life. I will argue that social way of life in bathyergids is an ancient, ancestral and conservative trait, as in all hystricognaths: Indeed 93% of all hystricognath genera comprise species which are in some way social. Even 67% of genera of subterranean hystricognaths (including *Heterocephalus*, *Cryptomys*, *Spalacopus*, *Clenomys*, *Acomaemys*, and *Clyomys*) are still social, while all the subterranean sciurognaths are solitary. From this point of view there is no necessity to assume that sociality in both, *Cryptomys* and *Heterocephalus*, has evolved independently and parallelly. The eusociality of bathyergid mole-rats is a continuum of monogamy with nonreproductive helpers (as known also in some other mammals) molded by the stability and non-seasonality of the subterranean way of life, longevity, and a long prenatal and still longer postnatal development.

A suppression of reproduction through social stress in *Heterocephalus* can be understood as a substitute for the more ancestral incest avoidance in *Cryptomys* (cf., Burda 1995), due to the failure of the individual recognition which, in turn, is a consequence of large turnover and regeneration of families of naked mole-rats.

The question is not why *Cryptomys* and *Heterocephalus* have become social when most other subterranean rodents are solitary but instead why they could not leave the social way of life and become solitary, as typical for subterranean mammals, and why the remaining bathyergid genera could.

THE MAMMAL FAUNA OF THE URALS AND WEST-SIBERIAN PLAIN IN LATE PLEISTOCENE AND HOLOCENE

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The Late Pleistocene and Holocene faunas of the Urals and West-Siberian Plain were studied. Two terms are used for faunas: the term disharmonious fauna is used for the one formed by species (or their ancestral forms) which are the components of different landscape theriocomplexes at present. The term non-analogues fauna is used for complexes formed by extinct species. In the Late Pleistocene the investigated territory had a mammoth type of biota, which was zonal by character. Three kinds of fauna could be distinguished according to the small mammal species complexes (BORODIN 1996): tundra fauna, disharmonious fauna and steppe fauna. The borders of the disharmonious fauna were detected at the southern border of genus *Dicrostonyx* area of distribution and the northern border of genus *Lagurus*. At the northern border of this zone communities of forest-tundra type were formed, forest-steppe type was formed at the southern border. Species composition of disharmonious faunas of the Urals and West-Siberian Plain were quite different. The fauna of megamammals also had the latitudinal zonation. According to the species composition the whole Late Pleistocene fauna of the Urals and West-Siberian Plain must be considered as a non-analogues one. *Mammuthus primigenius*, *Coelodonta antiquitatis*, *Equus ex. gr. caballus* were distributed throughout the whole investigated territory. Peculiarities of the zonation in faunas were dependent on the areas of other species. Zonal faunas from the North to the South of the West-Siberian Plain were presented by: *Ovibos-Rangifer* (up to 66° N); *Ovibos-Rangifer-Bison* (64°-66° N); *Ovibos-Rangifer-Bison-Saiga* (64°-59° N); *Rangifer-Bison-Saiga* (59°-54° N); *Bison-Saiga-Camelus* (to the south from 54° N). In the Urals zonal complexes were: *Ovibos-Rangifer* (up to 64° N); *Ovibos-Rangifer-Bison-Saiga* (63°-56° N); *Rangifer-Bison Saiga* (56°-52° N); *Bison-Saiga-Camelus* (to the south from 52° N). The boundaries of small mammal zonal faunas distribution did not coincide with those of megamammals.

During the Pleistocene/Holocene transition the transformation of the Late Pleistocene fauna to modern fauna took place, which was caused by two processes: extinction of a number of megamammal species, and changes in the areas of some species. In the West-Siberian Plain the disharmo-

nious fauna of small mammals was transformed to modern taiga fauna and the boundaries of the tundra and steppe faunas were displaced to the modern state. This process is well studied for the Urals. It had a different rate depending on latitude and on the group of mammals: small mammals or megamammals. In the South Urals megamammals were transformed to modern type about 11,000 years ago and in the North Urals - about 9,000 years ago. The time of the extinction of different species varied. In small mammal fauna (SMIRNOV 1994) the voles from genus *Lagurus* reduced their area about 10,000 years ago to the South, whereas collared lemmings still remained in the South Urals fauna 4,000-5,000 years ago, in the Middle Urals - 2,000 years ago, and in the Northern Urals up to the present time. The changes in areas of other species and/or their ratio in faunas indicate that the formation of the modern zonal complexes could be considered a result of the reaction of individual species on the changing conditions in accordance with their limits of tolerance.

POPULATION ECOLOGY OF SUBTERRANEAN RODENTS

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The similarity of the subterranean environment in different regions of the world, which generates similar selective pressures and a limited number of possible adaptive responses, has led to the evolutionary convergence of different families of rodents that inhabit the subterranean niche. In spite of this global adaptive convergence to specializations for life underground, each group has evolved to a local adaptive peak due to a particular evolutionary history and different selective pressures in similar but distinct local habitats. This paper highlights aspects of the population ecology of different groups of subterranean rodents. Similarities and differences among groups are analyzed, as are their possible evolutionary determinants. The influences that environmental and biological factors have on the local distribution of subterranean rodents is discussed. Local environmental factors, especially those related to soil friability and porosity, vegetation and microtopography, seem to be crucial as limiting factors on the distribution of subterranean rodents. These factors are decisive since they affect the energetic balance of digging and feeding as well as heat and respiratory gas diffusion from burrows.

Like other characteristics of subterranean rodents, burrows show convergent patterns of structure and function. Nevertheless, burrows of different species have distinct structures as a consequence of different local selective factors. Burrow structure and design and the way that different groups have solved burrowing problems are analyzed. The high energetic cost of digging the tunnel system and the relatively low productivity of the subterranean habitat have led subterranean rodents to evolve toward a generalist feeding strategy. However, feeding preferences may be displayed during periods of resource abundance and/or during periods of high energetic or nutritional demands. Feeding strategies and the ways that subterranean rodents optimize foraging behavior are considered.

It has been postulated that due to microclimatic constancy, habitat discontinuity, and low plant productivity, subterranean rodents display adaptive patterns that include low population densities, low reproductive rates (mostly K-strategies) and subdivided population structures with low vagility

levels. Life history parameters are analyzed; both convergences and differences between populations are considered, as are their possible determinants. The need to reevaluate the role of dispersal as a factor affecting population dynamics of subterranean rodents is indicated. It has been generally assumed that the subterranean niche is buffered against intensive predation. In this paper, we document variation in predation pressure among groups of subterranean rodents and identify individual differences in vulnerability within populations as related to sex, age, and size.

VITAMIN D METABOLISM AND ITS ROLE IN SUBTERRANEAN DWELLING MOLE-RATS

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The active metabolite of the vitamin D endocrine system, calcitriol, is considered essential for life and is phylogenetically conserved throughout the animal kingdom. This pleiotropic hormone regulates numerous biological processes including mineral metabolism, cell differentiation and cell signaling. Vitamin D is endogenously synthesized in the presence of ultra violet light, however it may also be acquired through the consumption of animal products. Mole-rats live in an environment devoid of light and are also strictly herbivorous. As such they have no obvious access to vitamin D. It is therefore not surprising that these animals are vitamin D deficient, with undetectable levels of the principal circulating metabolite, low levels of the active hormone, and the absence of duodenal vitamin D-dependent calcium binding proteins. Mineral absorption in the intestine is via passive vitamin D independent pathways and remains unchanged following both vitamin D supplementation and sunlight exposure. Mole-rats, however do possess the necessary cellular mechanisms to convert vitamin D to the active metabolite and indeed have vitamin D receptors in the intestine and kidney. Vitamin D does not however play an active role in mineral metabolism in these animals, although mole-rats receiving supplements exhibit improved microbial fermentation processes and reproductive success.

PATCH SELECTION AND SPATIAL DYNAMICS OF GRAZING WOOD BISON

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We tested an energy-maximizing model of forage selection that incorporates trade-off between forage quantity and quality. Using captive wood bison in Northwest Territories, Canada, we measured digestive and ingestive constraints. Vegetation growth parameters were estimated from natural plant communities dominated primarily by sedges. Model predictions indicated that maximal energy intake occurred at intermediate plant biomass. We tested this under controlled conditions using three replicate enclosures erected on natural sedge meadows, each arranged in a 5x5 Latin square design. Plant biomass was manipulated through mowing. Behavioural observations of bison grazing in these paddocks confirmed model predictions that a significant preference for patches of intermediate biomass is demonstrated by grazing bison.

To test the model predictions on an equivalent spatial scale in a natural system, we selected five sedge meadows in the Mackenzie Bison Sanctuary, a reserve containing nearly 2000 free-ranging wood bison. We measured plant community composition and biomass by sampling every 25 m along 1200 m transects bisecting each meadow. Concomitant measures of grazing intensity along the transect showed similar biomass preferences to those observed in the captive trials.

On a grand scale, we examined bison distributions in relation to plant biomass over a 6000 km² area. Aerial reconnaissance flights were used to make total counts of wood bison occurring in spatially isolated patches. Simultaneous estimates of patch biomass were made using a digital photometer. At this scale, we found that plant biomass, in addition to a host of other variables, had a significant effect in explaining distribution patterns. These results agree with model predictions and have major implications for the large-scale spatial distribution and population dynamics of wood bison.

THE BIG PICTURE: GEOGRAPHICAL ECOLOGY AND MACROECOLOGY OF MAMMALS

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In one of their two co-authored papers, Hutchinson and MacArthur (1959) presented data on the distributions of body masses among North American mammals and then presented a model to account for the distinctive pattern. Nearly 40 years later, this pattern and the latitudinal gradient of species diversity (another pattern of interest to both Hutchinson and MacArthur) are perhaps the two most general features of biodiversity, but there is still not general agreement about the mechanistic explanations for these pervasive empirical relationships. In the intervening 40 years many additional macroecological patterns have been reported. These are statistical regularities in the distribution of ecologically relevant variables among many more or less equivalent biological particles - usually either individuals or species of organisms within large taxonomic or functional groups.

Here, I assess the prospects for making progress in understanding the mechanistic basis underlying these empirical patterns. I suggest that many of them reflect important ways that the limited energetic and other resources of the planet are subdivided among species, but new approaches and theories will be necessary to forge the connections between pattern and process. A key may be to identify and then build models to explain general emergent features of complex ecological systems. Recent advances in developing the theoretical basis of biological allometry (size-related variation) indicate one approach that may prove fruitful.

THE RECOVERY OF THE ALPINE LYNX POPULATION - AN EXAMPLE OF A LONG-TERM RE-INTRODUCTION PROGRAMME

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At the turn of the century, the large carnivore populations of the Alps became virtually extinct. In the 1970s, several re-introduction projects for lynxes (*Lynx lynx*) were launched; wild animals from the Carpathian Mountains were translocated to six different sites in the Alps and to two adjacent mountain ranges. During the subsequent years, two small populations and some isolated loci formed, and the re-introduction was believed to be a success. However, twenty years after the initiation of the projects, it became obvious that the expansion of the populations had stopped, and that several translocations had been complete failures. Reasons for this pitfall may have been (i) improper design of the re-introduction projects (too few animals, unsuitable sites), (ii) lack of a continuous monitoring programme to evaluate whether populations developed, and (iii) absence of public education campaigns to prevent opposition from local hunters and sheep breeders, which led to many illegal killings of lynxes. Furthermore, the recovery of a large carnivore population is a dynamic process also affected by changes in the predator-prey relationship as prey species re-adapt to the presence of the predator. The very recent increase of the lynx density in one part of the Swiss Alps, after a period of low abundance, indicates that such a process may undergo several long-lasting fluctuations. We have initiated the SCALP (Status and Conservation of the Alpine Lynx Population) project, a coordinated recovery plan for lynx for the entire Alps, including a robust monitoring of the existing populations, an analysis of the probable expansion and possible corridors, and a strategy for further releases if needed. Such a project has to be approved by all authorities in charge and must involve local people. To accomplish such a plan, however, is not easy, as the Alps stretch over seven countries and incorporate a number of different cultures.

LONG-TERM DYNAMICS OF THE SWISS RED FOX POPULATION IN RELATION TO RABIES CONTROL

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Rabies reached Switzerland in 1967 and spread through most of the country. At the pinnacle of the epizootic in the late 1970s, an oral vaccination system for red foxes (*Vulpes vulpes*) was developed, allowing to reduce rabies to a few cases along the border with France by 1990. A re-infection and the subsequent increase of the number of rabies cases from 1990 to 1994 showed the importance in fox population dynamics along with rabies control measures: From 1985 to 1995, the fox population (as evident from the hunting bag and road kills) had increased four times in Switzerland. A more detailed analysis of the mortality data showed that, hidden by the rabies-related decline from 1967 to 1985, there was a steady increase of the fox population since 1930. We hypothesize that this is the consequence of an increase in the carrying capacity, because of (i) the general increase in food available to foxes due to raised agricultural productivity and (ii) an expansion of the fox habitat as foxes adapt to urban environment.

BEHAVIORAL RESPONSES TO EXTRINSIC FACTORS AND THE POPULATION DYNAMICS OF VOLES

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The demography and density of animal populations fluctuate as individual performance (measured by reproduction, survival, growth, and movement) changes. Shifts in factors extrinsic to the population (such as food supply, predation pressure, or interspecific competition) or intrinsic to the population (such as sex ratio, age structure, or individual quality) cause physiological and behavioral responses that can affect individual performance. The result is a set of complicated relationships among multiple factors that make it difficult to establish consistent cause and effect relationships. To determine the relative impact of different environmental factors on population change, we constructed multifactorial hypotheses (verbal models) of relationships among variables based upon previous work, deduced new predictions that followed if the specified pathways operated according to the hypotheses, and tested our hypotheses by experimental manipulation of extrinsic factors using penned populations of voles. In this paper we review the results of our experiments with particular attention given to behavioral responses.

Our first multifactorial hypothesis concerned the direct effects of food quality and predation on reproduction and survival, respectively, and indirect effects on dispersal via changes in aggressive behavior and space use by prairie voles. We predicted that in addition to increasing reproductive success, the addition of supplemental food would reduce aggressive behavior and movement; both should reduce dispersal and increase population density. We expected protection from predation to increase survival and to increase movement of voles, the latter should increase dispersal and decrease density. The direct effects of food quality and predation were clear and had roughly equal strength. Food addition also appeared to reduce aggression between males and to reduce movement, and protection from predators also appeared to increase movement. However, the effect of food on movement was linked to direct effects on density (increased density led to decreased movement), and the changes in aggression and movement had little effect on dispersal rates. Thus, the indirect effects of extrinsic factors via behavior had little effect on population growth.

Undaunted, we developed a new, more complicated hypoth-

esis that included the influence of food quality, predators, and interspecific competition by meadow voles on prairie voles (meadow voles occur sympatrically with prairie voles and eat similar food). We expected the direct effects of supplemental food and predation to be as before, and we expected the addition of meadow voles to increase dispersal by the prairie voles because of aggressive encounters between species. However, we also expected interactions among factors: the effect of competition on dispersal should be reduced by the presence of supplemental food owing to reduced aggressive behavior of both species, and the effect of competition should be increased by protection from predators owing to increased interaction because of greater movement by both species. A three-way interaction of the effects of food, predators, and competition did occur, but it was not entirely as predicted. Dispersal of prairie voles increased as their own density and the density of meadow voles increased, and the effect interspecific competition on dispersal of prairie voles was greater for populations protected from predators. But addition of food increased the effect of competition, which was opposite to our prediction, and probably occurred because increased food caused increased densities of both species. Furthermore, the interaction of predators and competitors on the density of prairie voles was opposite to that predicted; the effect of competitors (decreased density) increased in the presence of predators. Predators were attracted to pens with higher densities where competition was also strongest. Thus, any effects of behavioral interactions on population dynamics were overwhelmed by the direct effects of food and predators on density and by the feedback relationships between density, dispersal, and predation.

These experiments led us to conclude that the direct effects of extrinsic factors on populations and density-dependent feedback are likely to be much stronger than are the indirect effects owing to behavioral responses. However, behavioral traits involved with dispersal and habitat selection still may have important influence on populations that are free to move among habitat patches of different quality, and we have begun a set of experiments to test hypotheses concerning this possibility.

EXPERIMENTAL ANALYSIS OF HABITAT QUALITY, BEHAVIOR, AND POPULATION DYNAMICS: SCALING UP TO THE LANDSCAPE.

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Multiple factors influence the dynamics of populations of small mammals in any given habitat, but factors can operate with very different strengths from site to site. Because most populations inhabit a heterogeneous environment, overall population performance across a landscape depends upon net recruitment of young and survival under a variety of local conditions and upon the movement of individuals among habitat patches. Thus, population dynamics in local habitat patches becomes linked with metapopulation dynamics over the landscape, and neither local nor metapopulation dynamics are likely to be well understood without study at both scales.

One approach to understanding the impact of different landscape patterns on population performance is to conduct experimental manipulations of patch characteristics within a single habitat type. This has been done by several investigators and has provided information on the effects of habitat fragmentation (patch size, shape, and isolation), but such experiments do not address problems associated with variable amounts of habitat patches that differ in quality. We propose that hypotheses concerning the effects of different combinations of habitat types can be tested most efficiently by using penned populations that are provided with varying amounts of habitats of different quality. Predictions of population dynamics would follow from a prior understanding of population processes. A review of a series of experiments moving in that direction follows.

The objectives of our research have been to gauge the relative strengths of direct, indirect, and interactive effects of food quality, predation, and competition on population growth and to assess the role of behavior in modifying those effects on population performance as measured by reproduction, survival, and movement patterns. Our concern has been to understand the mechanisms by which the actions and interactions of multiple environmental factors are integrated into a population response. Our approach has been to manipulate environmental factors affecting populations of small mammals (two species of voles) in natural habitat, but contained in large pens. We have used pens to distinguish between mortality and emigration, processes that can not, be

separated in free living populations. A series of experiments conducted in grassy old fields that provided high natural cover indicated strong effects of food quality (positive), interspecific competition (negative) and predation (negative) on population growth. Although voles responded behaviorally to changes in extrinsic factors, such responses did little to modify population dynamics. To examine whether mechanisms of population control were similar in habitats of different quality, we initiated a series of experiments in which voles could move among habitat patches. Results to date suggest that the two species of voles respond differently to identical conditions, apparently because of differences in their vulnerability to predators. Prairie voles consistently maintained positive net recruitment of young in low cover, but these subpopulations became stabilized at low densities owing to emigration (density-dependent net movement). In high cover, their subpopulations stabilized at much higher densities owing to density-dependent net recruitment (births - deaths). Meadow voles could not always maintain subpopulations in low cover, and such habitats sometimes became population sinks. Subpopulations in high cover may then stabilize because of density-dependent emigration, as expected in a typical source-sink situation. In our next experiment of this series, both species will be present, and we expect less movement into high cover by prairie voles, which may change the mechanisms of population control.

Theoretical considerations suggest that local dynamics may depend upon both the quality and spatial extent of habitat types. Thus, predicting the kind of dynamics (stable, cyclic, erratic) that a local population should have depends upon detailed understanding of population processes and the ability to scale up from experimental results to the landscape. Our next series of experiments will test our ability to predict local dynamics in a landscape setting by providing penned populations with varying amounts of high and low quality habitat.

THE OLDEST NEW WORLD PROCYONIDS: ORIGINS, GEOLOGIC SETTING AND BIOGEOGRAPHY

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Fossils of unequivocal New World procyonids first appear in North America in early Miocene sediments of the central Great Plains. The oldest procyonines occur in the early Hemingfordian Runningwater Formation (~17-18 Ma) of northwestern Nebraska, represented by the coati-like *Edaphocyon*. The oldest bassariscine is found in probable late Arikareean sediments (~19 Ma) of southwestern South Dakota, represented by dental remains retained in a private collection. Also found at several localities in the Runningwater Formation in northwestern Nebraska are mandibles that compare with the Old World early Miocene procyonid *Stromeriella*. Early Hemingfordian sediments in the Great Plains indicate wetter environments than in the preceding Arikareean age, thus these procyonids very likely occupied well-vegetated habitats in proximity to water courses.

The existence of three differentiated procyonid lineages in the early Miocene of the North American midcontinent suggests an earliest Miocene or Oligocene diversification of the family, yet the geographic location of this diversification, even within North America, is uncertain. The scarcity of these small carnivorans in the fossil record requires caution in biogeographic inference: New World procyonid diversification may have occurred in more mesic forested environs of the coastal Pacific Northwest or in montane settings in western North America during the late Paleogene, rather than in the midcontinent where sedimentation has preserved the earliest fossils. New World procyonid diversification was also influenced by communication with Old World early Miocene procyonids belonging to the *Broiliana-Stromeriella-Amphictis* group which may represent the ancestral procyonid clade.

METRODIVERSITY OF A VERY SMALL TERRESTRIAL MAMMAL: SUNCUS ETRUSCUS (SAVI, 1822) FROM ITALY

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Metrodiversity was defined (CONTOLI, 1994) as the metric components of the intraspecific morphological diversity. As in previous works (see, e.g., AMORI and CONTOLI, 1994), principal components methodology was adopted in order to evaluate the variance explained by the components factors, then to compute a customary diversity index based on relevant class frequencies (e.g., of the beta type; see PATIL and TAILLIE); among others, the well known Gini and Shannon-Wiener indices are in this group.

In the present work, specimens obtained throughout owl pellets (the overall significance of this data source was tested, i.a., by SANS COMA et al., 1980) from peninsular Italy (inclusive of the subpeninsulae of Salento and Calabria), Sardinia and Sicily was studied.

A number of skull and jaw dimensions were measured, but for the purposes of the present work, only the most reliable ones were utilised; y.a.: zygomatic breadth, palate length, coronoid height, articular jaw length, jawis ramus height.

Despite of the well known morphometric homogeneity of this species, some differences in metrodiversity were detected among different collecting sites, possibly in relation to geographic (and biogeographical) v.s ecological (climatological and bioclimatological, but also anthropic) factors. Even taxonomic factors must be taken in account, owing to the bigger dimension of the *S. e. pachyurus* subspecies (possibly present not only in Sardinia, but also in continental Italy) with respect to the nominal form *S. e. etruscus*.

In particular, the previous evidences, showing a relation with interspecific competitive pressure by ecologically strictly similar species, need the consideration of non-mammalian insect-eaters, like e.g. lizards, already (CONTOLI, 1988) suspected to compete with Soricidae mostly as bioclimate tends towards the Mediterranean type.

REFERENCES:

AMORI G. & CONTOLI L., 1994, Morphotypic, craniometric and genotypic diversification in *Apodemus flavicollis* and *Apodemus sylvaticus*. *Boll. Zool.*, 61:353-357.

CONTOLI L., 1996. Sulle collezioni museali nello studio della biodiversità fenetica. *Museol. sci., Suppl. Atti 10° Congresso A. N. M. S.*; 51-59.

CONTOLI L., 1985. La nicchia trofica di *Allocco* (*Strix aluco*) e *Barbagianni* (*Tyto alba*) in Italia: acquisizioni e problemi. *Naturalista sicil.*, s. IV, Xil (suppl.): 129-143.

PATIL G. P. & TAILLIE C., 1979. An overview of Diversity. In: Grassle J. F., Patil G. P., Smith W., Taillie C. (Eds.). *Ecological diversity in theory and practice*. Int. Coop. Publ. House, Fairland: 1-28.

SANS-COMA V., FONS R., VESMANIS I., 1981. Eine morphometrische Untersuchung am Schadel der Etruskerspitzmaus, *Suncus etruscus* (SAVI, 1822) aus Sud-Frankreich (Mammalia, Insectivora, Soricidae) *Zoologische Abhandlungen*, 37(1): 1-31

A CONTROLLED, HIERARCHICAL STUDY OF HABITAT FRAGMENTATION: RESPONSES AT THE INDIVIDUAL, PATCH, AND LANDSCAPE SCALE

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We compared the performance of individuals and whole populations of *Microtus pennsylvanicus* within and between experimentally created habitat fragments of three sizes (1.0, 0.25, and 0.00625 ha) and between a 20-ha fragmented and a 20-ha continuous habitats landscape. We recorded 10,020 captures of 3946 individuals over 17 censuses between June 1993 and October 1994. Five demographic parameters showed significant, positive population responses to fragmentation at the landscape but not at the fragment-size scale: i.e., mean and peak population densities averaged 149 - 172% higher, population growth rate averaged 219% higher, and adult recruitment 170% higher in fragmented than in the continuous control landscape. Survivorship did not vary between landscapes or among patches of different size. Observations at the individual level suggest that these landscape differences involved enhanced performance of adult females associated with edge habitats rather than differential immigration or emigration. Underlying causal factors may include increased nutritional quality of new-growth vegetation along the mowed periphery of fragments, or reduced territorial costs for individuals living along edges with fewer boundaries to defend. If the principal response to fragmentation involved the enhanced performance of individuals living on or adjacent-to fragment edges, the detection of such responses w/w be greater when comparing fragmented and unfragmented landscapes with qualitatively different structure than for fragments of varied size with differing proportions of edge. That responses to habitat fragmentation may be more evident at the very small (individual) and very large (landscape) scales, but may be obscured at the intermediate scale of fragments is a proposition that clearly requires more attention.

MATERNAL BEHAVIOR AND ADAPTATION TO (SUB)URBAN SITUATIONS IN TWO EUROPEAN MARTEN SPECIES: *MARTES MARTES* (L.) AND *M. FOINA* (ERXLEBEN)

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The numerical development of both continental European marten-species, the pine marten *Martes martes* and the beech- or stone marten *M. foina*, shows remarkable differences. In most Mid- and West European countries the hunting bags of stone martens are increased since the fifties or sixties until new levels were reached and this species appeared to become better adapted to (sub)urban habitats. The bags of the pine marten remained more or less stable and although there are many similarities in behavior and a considerable overlap of the ecological niches of both species, adaptation of the pine marten to suburban habitats is not reported.

Although it is unclear which factors caused the numerical increase and the obviously better adaptation of the stone marten, the question raised whether there are behavioural aspects which prevent such adaptation in the pine marten.

In The Netherlands we studied the activity patterns of a stone- and a pine marten female during the period they stayed with their kittens in the nest. Although both are known as nocturnal species, it turned out that the stone marten female left her young during the night for about 4 to 5 hours in total, starting 1.5 to 2 hours after sunset and mostly interrupted by a period of 1 to 4 hours, dependent on the age of the young. The pine marten female, on the contrary, left the nest before sunset after the young became older than two weeks, sometimes even at noon. After the pine marten young were eight weeks old and capable to climb outside the nest cavity but still dependent on their mother's food supply, there was no recognizable day-night pattern in the mother's visits to the nest. The stone marten female's activity on the other hand, remained nocturnal.

We hypothesis that the stone marten female's constant nocturnal activity pattern enabled this species to adapt to human's neighborhood, while the around the clock activity of the pine marten female during the period the young are mobile but can not support them selves with food, prevents such adaptation.

IRRELEVANCE OF PREDATORS TO THE OCCURRENCE OF CYCLES

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The most notorious mistake in science is to confuse correlation with causation. To avoid this fallacy we must show that removing the supposed cause removes the effect also. If we can't do this experiment (e.g., remove predators) we must make comparative observations of other kinds.

Predators often consume many of the voles, mice, lemmings, and snowshoe hares that disappear during cyclic declines. This point is not in dispute. The question is whether predators are necessary for the decline or whether their prey would die anyway. Predators are abundant in Fennoscandia, especially when prey is abundant. This correlation, together with new ideas about specialist and generalist predators, has led to a revival of the idea that an increase in predators such as weasels is also a cause of the decline in prey. If, as claimed, specialist predators are necessary for the decline, cycles will be absent when such predators are removed or where they are absent or scarce (cycles may, of course, be absent for other reasons as well.)

Cyclic declines can be recognized from a syndrome that includes the recurrence, severity, and patterns of the declines together with a refractory low phase and changes from high to low body weight. Such declines are common to Scandinavia, Britain, Europe, North America, and elsewhere, regardless of differences in the species and abundance of predators. Further evidence against the relevance of predators is that declines may leave one sex or one species unaffected. As well, the number of animals disappearing is even greater than can be accounted for by sudden increases in appetites of the predators.

Declines also occur despite attempts to reduce or remove predation. Reducing predation may increase prey density, without, however, decreasing the numbers lost in the decline. In combination with prior cover, predation is a plausible explanation for populations remaining below peak densities and thus being noncyclic. In other instances the apparent lack of a cycle may be due to inefficient sampling of low-density populations. For if no animals are caught in some years, the amplitude of a fluctuation is unknown.

We conclude that predators are irrelevant to the occurrence of cycles but are one of many local variables that modify them and so may be relevant to their absence.

THE ECOLOGY OF FEAR: OPTIMAL FORAGING, GAME THEORY, AND TROPHIC INTERACTIONS

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Actual mammalian predator-prey systems are behaviorally sophisticated games of stealth and fear. But, traditional mass-action models of predator-prey dynamics treat the individuals as behaviorally unresponsive molecules in Brownian motion. Foraging theory should provide the conceptual framework for envisioning the interaction. But, current models of predator-feeding behavior generally envision a clever predator consuming large numbers of sessile and behaviorally inert prey (e.g. kangaroo rats collecting vast numbers of seeds from food patches). Here, I extend foraging theory to consider the predator-prey game of stealth and fear, and then embed this game into the predator-prey population dynamics. The melding of the prey and predator's optimal behaviors with their population and community-level consequences constitutes the Ecology of Fear.

The ecology of fear identifies the endpoints of a continuum of N-driven versus fear-driven systems. In N-driven systems the major dynamical feedback involves changes in prey and predator population sizes; while in fear-driven systems it involves changes in fear levels and prey catchability. In fear-driven systems the prey respond to predators by becoming more vigilant or by moving away from suspected predators. In this way, a predator (e.g. mountain lion) depletes a food patch (e.g. local herd of mule deer) by frightening the prey rather than by actually killing the prey. Behavior buffers the system: a reduction in predator numbers should rapidly manifest as less vigilant and more catchable prey. The ecology of fear explains why big, fierce carnivores should be and can be rare. In understanding the trophic interactions of mammals, ignore the behavioral game at one's peril.

DYNAMICS OF EUROPEAN HARE: PRODUCTION AND DISPERSAL OF YOUNG

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The demographic output of hare populations is most often time - and space- dependent. Up to now, correlation analyses have failed to explain this mosaic in situations as a function of environmental factors. The underlying patterns in population dynamics have been poorly studied, as only some estimations of adults survival rates are available. Very few is known, indeed, about the production of young and their dispersal before breeding. The present work focused on estimating these parameters in a hare population living in a mixed arable/livestock farmland area in central France. Using bagged does, young production was estimated from the analysis of uterine horns and counting of placental scars. The proportion of breeding females was age-dependent: about 10% of juvenile females bred (14 out of 116 animals), as opposed to 95% of adult females (92 out of 97 animals). Mean number of young produced was larger in adult females than in young ones (3.7 versus 13.8). The number of litters averaged 5 in adults, and young females delivered 0-3 litters. Time and space variations in these parameters will be investigated in the next future. In addition, young hare less than 2 months old were radio-tagged and their long-range movements studied. Some of them exhibited surprising patterns: 30% (n=90) moved further than 1 km from the capture site, without any overlap between pre/post dispersal home ranges. Much longer movements also occurred 8 up to 17 km). Dispersal patterns did not depend either on sex or density.

SAREM: SOCIEDAD ARGENTINA PARA EL ESTUDIO DE LOS MAMIFEROS

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SAREM (Sociedad Argentina para el Estudio de los Mamíferos) is a non-profit association of mammalogists dedicated to advancing scientific and technical research on mammals, improving communication between national collections and research centers, and publishing research reports on living and extinct mammals. SAREM was formally established in June 1983 in a meeting held at the School of Medicine of the University of Buenos Aires. From its inception, the society has attracted a large number of members, particularly from Latin American countries. Today, membership includes mammalogists from Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Italy, Mexico, Paraguay, Peru, Spain, the United States, Uruguay, and Venezuela. Average membership is 286, with an additional 500 institutional members. Annual meetings have been held, each in a different province of Argentina, since 1985. In 1990, SAREM hosted a joint meeting with the American Society of Mammalogists. In total, 12 annual meetings have been held at which about 1300 formal presentations of research were made, with about 300 being given by students and professional mammalogists at each meeting. Although the society is relatively new, it has adhered to its organizing principles, and has produced and supported an international journal in mammalogy, *Mastozoología Neotropical* (Neotropical Mammalogy), which has been published twice each year since 1994. Recently, the Director's Commission authorized the initiation of the *Mastozoología Neotropical Publicaciones Especiales* (Neotropical Mammalogy Special Publications), which will publish monographic length papers in mammalogy. The Society also occasionally publishes a *Boletín Informativo* (Bulletin) and other publications of general interest in mammalogy to Society members. The Society's development has been overseen by a Director's Committee, a Treasurer, and an Editorial Committee. There are also various subcommittees such as Media Relations, Systematic Collections, Conservation, Scientific Events and Meetings, and International Relations.

TIMING AND SYNCHRONY OF PARTURITION IN ALASKAN MOOSE: LONG-TERM VERSUS PROXIMAL EFFECTS OF CLIMATE

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We studied timing and synchrony of parturition in Alaskan moose (*Alces alces gigas*) in Denali National Park and Preserve, Alaska, from 1990 to 1994. Mean date of birth was 25 May (SD = 5.7 days) and did not differ significantly among years. Although moose did not congregate to give birth, parturition was highly synchronized (95% of births occurred in 16 days) with no significant differences among years. Most young moose were killed by predators, especially grizzly bears (*Ursus arctos*), but timing of reproduction by this cervid had no effect on the survivorship of young, which was low (ca. 0.20 by 16 June). We reject the hypothesis that moose timed births to avoid predation. We also measured snow depth in winter, and precipitation, cloud cover, and temperature in spring; none of these variables was related to timing of births. Likewise, the quality of willow (*Salix pulchra*) in three disparate springs in which nitrogen content and in vitro dry-matter digestibility of this important forage for moose varied markedly was unrelated to timing of births by moose. We reject the hypothesis that moose timed parturition in response to proximal changes in their environment. We hypothesize that both the timing and synchrony of parturition in moose are adaptations to long-term patterns of climate that provide the most hospitable conditions to bear and rear young. Consequently, moose may be more susceptible to climate change than other ungulates that are more adaptable to climatic variability.

AVIAN DIVERSITY ON PRAIRIE DOG COLONIES

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There is a widely held perception that black-tailed prairie dogs (*Cynomys ludovicianus*) are a keystone species on Great Plains prairie ecosystems. In part, this is based on the belief that many species of birds are closely associated with, or even dependent upon, prairie dogs for their continued survival. However, additional data are needed to better understand how associations vary across species and across the range of remaining complexes. Specifically, our study compares the patterns of difference in density of testing birds observed on prairie dog colonies to nearby undisturbed habitats. We also explain differences relative to cover and height of vegetation, and location of complex at the broader landscape scale. Using a design that pairs colonies with nearby off sites, we sampled birds and vegetation from May to July 1996 on the following complexes: Janos, Chihuahua, Mexico; Comanche/Cimarron National Grasslands, Colorado; Wind Cave National Park, Badlands National Park/Buffalo Gap National Grassland, and Pine Ridge and Cheyenne River Indian Reservations, South Dakota, Thunder Basin National Grassland, Wyoming, and; Charles M. Russell National Wildlife Refuge/Malta BLM and Fort Belknap Indian Reservation, Montana. Our results confirm that prairie dogs modify vegetation structure and plant species composition on a wide variety of grassland and shrub habitats throughout the Great Plains. Birds such as the burrowing owl (*Athene cucularia*), mountain plover (*Charadrius montanus*) and horned lark (*Erimophila alpestris*) clearly favored colonies, whereas grasshopper sparrows (*Ammodramus savannarum*) clearly favored habitat undisturbed by prairie dogs. We suggest that prairie dogs can create or improve habitat for some avian species, thereby increasing regional biodiversity; however, diversity and/or abundance of certain species may actually be lower on colonies than on adjacent undisturbed habitats. We also present preliminary results of our 1997 study of Gunnison's (*C. gunnisoni*) and white-tailed (*C. ludovicianus*) prairie dogs in Arizona, Utah, Colorado, and Wyoming.

TRAVELED DISTANCE, HOME RANGE AND TERRITORIALITY IN TWO BRAZILIAN RODENT SPECIES IN AN ATLANTIC FOREST AREA

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Species home range can be influenced by factors such as weight, food availability and social structure. The main purpose of this study was to determine if the traveled distance and home range of individual *Nectomys squamipes* and *Oryzomys intermedius* (Muridae, Sigmodontinae) differ between sex and reproductive season, and to evaluate the effects of rainfall and food availability on those parameters. The rats were monthly captured in a grid of 8.78 ha, marked and released, from February 1993 to January 1995, in an Atlantic rainforest area in Cardoso Island, SP, Brazil. The traveled distance and home range were calculated on those individuals captured at least three months (residents). The distances traveled by *N. squamipes* were not related to weight and they were larger for males during the breeding season. Among individual *O. intermedius*, there was no difference in the traveled distance between seasons, but males traveled larger distances than females. For both species, the effects of food availability and rainfall were not significant on the traveled distance. During the breeding season, the male home ranges of *N. squamipes* were larger than those of females. The home range of *O. intermedius* did not differ between sexes. The home range of female *N. squamipes* and male *O. intermedius* were exclusives, without intrasexual overlapping. The differences observed on the factors that influence the traveled distance and home range of *N. squamipes* and *O. intermedius* must be related to the breeding system - the first species being promiscuous and the latter, monogamous.

CONVERGENCE IN MORPHOLOGICAL PATTERNS AND COMMUNITY ORGANIZATION BETWEEN OLD AND NEW WORLD RODENT GUILDS

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The occurrence of convergent communities is a striking indication for the operation of general rules that govern the structure of ecological communities; if similar selection regimes produce noticeably similarly structured ecological communities, then structuring rules can be sought and analyzed. A striking case of apparent convergence is found among North American heteromyid rodents and Old World gerbillids. Interspecific competition has been demonstrated in both families; however, it does not necessarily follow that competition will affect community structure. Kotler and Brown (1988) point to differences in perceived community organization between the two communities studied, and point to an intriguing lack of shared convergence of morphology and community ecology (Brown et al., 1994). They suggest that the kinds of factors that shape the more conspicuous attributes of species may not be the same as those factors that promote or inhibit species coexistence.

However, morphological patterns may also be directly related to community or guild structure: community-wide character displacement has generally been interpreted as resulting from interspecific competition, and indicating resource partitioning by food size as a mechanism of coexistence. In heteromyids, Dayan and Simberloff (1991) demonstrated regular morphological relationships among the upper incisors, which are used for husking seeds. Regular patterns in incisor width may reflect specializing on different seed size as a result from competition between coexisting heteromyids.

We carried out a comparative morphological study of Israeli gerbillids, plus studies of seed size selection, in order to gain insight into the relationship between morphological convergence and convergence in community organization, with the following specific goals in mind:

To test for convergent morphological patterns between heteromyids and gerbillids.

To determine the ecological basis for morphological partitioning among Israeli gerbillids.

Morphological patterns were studied in the Tel Aviv University Zoological Museum. We studied size relationships among 9 gerbillid species (*Gerbillus allenbyi*, *G. gerbillus*, *G. henleyi*, *G. nanus*, *G. pyramidum*, *Meriones crassus*, *M.*

sacramenti, *M. trisrami*, *Psammomys obesus*) in three different guilds with different species combinations. We measured the width of the upper incisor and the condylo-basal length of the skull. Seed size selection was studied among 2 species: *Gerbillus pyramidum* and *G. allenbyi*, in semi-natural conditions in two large enclosures at the Jacob Blaustein Institute for Desert Research, Ben Gurion University, Sede Boqer campus, in two different experiments: one using commercial seeds of different size and the other using hulled wheat ground to 3 different size groups. The seed was mixed with 3 litres of sand and set out in trays.

We found a non-random pattern of overdispersed means for incisor widths in the Israeli gerbillid guild, much the same as is found among North American heteromyids. Condylo-basal lengths of the skull display a similar but not as regular pattern. Feeding experiments using commercial seeds of different size support a hypothesis of seed size selection: *G. pyramidum* took larger seeds than the smaller *G. allenbyi*. No size-dependent selection was found when using ground wheat particles, which do not require husking.

The morphological patterns displayed by Israeli gerbillids parallel those found for heteromyids in North America. Incisors of gerbillids and heteromyids are used for husking seeds, and both patterns can only be interpreted as a result of competition. Our results suggest that seed size selection is a further mechanism of coexistence in both rodent guilds. Such patterns indicate either morphological coevolution or species sorting by size. While among heteromyids there is actual coevolution (Dayan and Simberloff 1991), among gerbillids this remains to be studied. Our study suggests a convergence in ecomorphological patterns and in community organization among heteromyid and gerbillid rodent guilds.

MACROGEOGRAPHIC PATTERNS OF HABITAT CHARACTERIZATION IN THE POCKET GOPHERS *THOMOMYS BOTTAE* AND *T. TALPOIDES*.

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Habitat preferences for the pocket gophers *Thomomys bottae*, and *T. talpoides* have not been characterized, although their general preferences are known. Ecological and geographical parameters, such as local vegetation and altitude, can effect their distributions and possibly serve to segregate the two species. However, complete qualitative studies of habitats associations have yet to be performed. Typically, *T. talpoides* are found in mesic montane habitats, while *T. bottae* occur in a wide range of vegetative communities and elevations, but seem to be excluded from the higher elevations where *T. talpoides* are found. Sympatric populations, although uncommon, do occur, thus begging the question: how do two congeners coexist in small meadows where burrow space is at a premium, especially if their habitat preferences supposedly differ. In order to address such questions, analyses of important ecological factors determining species distributions and habitat preferences were carried out. An ecological model was constructed using elevational, latitudinal, and vegetative community data to predict the distributions of the two species. Data were gathered for more than 2,500 specimens collected from New Mexico, Arizona, Nevada, Utah, and Colorado. Results indicate that *T. talpoides* occur at higher elevations than *T. bottae*, and are limited to cooler, wetter environments. *T. bottae* is not characterized by any particular vegetative community or elevation, but in higher elevations are excluded by *T. talpoides*, presumably via a superior competitive advantage. The model performs well in predicting large scale distributional patterns for *T. talpoides*, but does not perform well predicting distributional requirements of *T. bottae*. Additional biogeographical, soil, and climatic data may help to refine the model for predicting the distribution of *T. bottae* over both macro and micro scales.