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THE MIGHTY MINDS OF MICE: HOW THE PERSONALITY OF A MOUSE CAN SHAPE A WHOLE ECOSYSTEM

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Small mammals play a critical role in forest ecosystems by predating and dispersing seeds, to the point that entire families of plants depend on them for the dispersal of their propagules. Despite their fundamental role for the delivery of this critical ecosystem service, our understanding of the mechanisms regulating this process are limited. We know what kind of seeds small mammals like to disperse, we know how small mammal populations respond to seed masting events, nevertheless very little is known on how different individuals contribute to the dispersal process. More specifically, we have a very limited understanding on how individual personality affects the process of seed dispersal. Do individuals vary deterministically in the way they interact with seeds? By showing the results of a series of field experiments conducted over the past 8 years in Maine (USA) I will highlight how individual personality plays a key role in affecting all stages of seed dispersal: from the choice of seeds, to where these are dispersed. Indeed, results of our experiments show that some individuals (such as the boldest ones) are much more effective dispersers than others, whereas some individuals are pure predators and their interactions with seeds rarely lead to a germination. A key implication of our findings is that some individuals bear a disproportionate impact in the ecosystems they inhabit. This leads to a key question of high relevance for conservation: how can we conserve these individuals and their impacts in an ever changing planet? I will conclude my talk by discussing effective strategies to include knowledge on animal behavior into the management of the critical ecosystem service of seed dispersal.

ORAL PRESENTATIONS

Eliomys quercinus – ph. by Fabrizio Moglia, Archivio GPM

NEST BOXES AND TRACKING TUBES USE BY HAZEL DORMOUSE *MUSCARDINUS AVELLANARIUS* ALONG AN ALTITUDINAL GRADIENT

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The hazel dormouse *Muscardinus avellanarius* is an arboreal rodent that enters hibernation during winter. Patterns of activity are usually studied by monitoring animals occupying nest boxes. However, there is no information on how comprehensively the presence of the animals in the nest boxes documents their activity period. In 2022 we monitored six areas at different altitudes in the Gran Paradiso National Park. The study's objectives were to 1) assess the relative abundance of the species along the altitudinal gradient and 2) compare the pattern of nest box occupancy with the detections with tracking tubes.
Study sites were in Valsavarenche at 1500m, 1800m, and 2000m and in Val di Rhêmes at 1200m, 1800m, and 2000m. In 2019, about 40 nest boxes per site were placed on trees, with tracking tubes positioned at each nest box. Between May and December, every two weeks, we conducted 15 field sessions checking the presence of animals in the nest boxes and footprints. All the animals found in the nest boxes were handled to collect morphometric measurements and information on sex, age, and reproductive status. *M. avellanarius* were also marked.
Totally we handled 128 *M. avellanarius*, 27 *Eliomys quercinus,* 2 *Glis glis*, 2 *Myodes glareolus* and 4 *Apodemus* spp. In Valsavarenche, we found 6 individuals of *M. avellanarius* at 1500m, 2 at 1800m, and 17 at 2000m. In Val di Rhêmes 7 *M. avellanarius* at 1200m, 5 at 1800m, and 23 at 2000m. A total of 2015 paper strips with footprints were collected: 728 were assigned to *M. avellanarius*, 573 to *E. quercinus*, 21 to *G. glis*, 841 to *Apodemus* spp., and 1 to *Mustela nivalis*. In some cases, footprints of two or more species were found on the same paper strip.
The tracking tubes detected the presence of *M. avellanarius* and *E. quercinus* in a greater number than the nest boxes and for a more extended period at each study site. Specifically, *M. avellanarius* was detected in greater numbers at 2000m compared to lower sites. This shows how the species can adapt even to extreme climatic conditions. In contrast, *E. quercinus* was detected in greater numbers at lower altitudes with no detection at 2000m sites. Moreover, *M. avellanarius* used nest boxes until the first part of October, while its footprints were found in the tracking tubes until the beginning of December. Our study shows that dormice use nest boxes only for part of their activity season; this should be considered during long-term studies on the species. We also confirmed that tracking tubes are more sensitive than nest boxes in detecting the activity of *M. avellanarius* and *E. quercinus*.

MICE AND VOLES: SAME HABITATS DIFFERENT ECOLOGY

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Mountain offers an excellent study system by providing an elevational gradient and great variability of habitats, facilitating the study of species' adaptations to changing environmental conditions. This study aimed to increase the knowledge of mountain rodents' ecology and their adaptations to alpine habitats, focusing on their morphological, behavioural, and physiological strategies. Using a multi-species approach by selecting four sympatric species widely distributed in different habitat types, *Apodemus flavicollis, A. sylvaticus, A. alpicola* and *Myodes glareolus*, we were able to analyse and compare their adaptive strategies along a wide elevational range (400 to 1,800 m a.s.l.).
We observed an opposite trend in ecological adaptations between the *Apodemus* spp. and *M. glareolus*. Species differed in their camouflage ability. We observed that fur colouration in our target species was strictly linked with the background colouration, indicating a high match with their respective habitats. We also observed a different trend in colouration along the elevation; however, this trend was different between the two rodents' groups: *M. glareolus* presented an overall darker colouration compared to *Apodemus* species, but this colouration became lighter with elevation. This high-altitude colouration might be less noticeable in habitats that are snow-covered for long periods or that lack dark vegetation. The rodents also differed for some behavioural traits evaluated during arena experiments. *Apodemus* were consistently bold and showed active and exploratory behaviours; *M. glareolus* instead showed a less exploratory tendency and high variability between shy-bold traits, with a predominance of shy individuals who mainly froze during arena experiments. The absence of any effect of environmental variables on these traits suggests the existence of genetic and physiological factors underlying the behavioural traits of the species. Rodents' body temperature increased with elevation ($\beta \pm SE = 0.023 \pm 0.007$, $z = 3.53$, $p < 0.001$) and was higher in females than in males ($\beta = 0.004 \pm 0.001$, $z = 3.85$, $p < 0.001$). For most of the studied species, the effect was independent from variation in air temperature, habitat composition and body size or condition, suggesting other mechanisms behind the detected pattern.
These results show differential morphological, physiological, and behavioural responses between species, but the mechanisms underlying these detected patterns are unclear. A cross-analysis between the four adaptive mechanisms investigated in this study could provide more information on rodents' resilience to challenging mountain environments. This becomes even more important given climate change, particularly evident in the mountains. In recent years we have witnessed extreme and highly variable climatic conditions, greater drought also at high altitudes, with a consequent reduction in trophic availability, a melting of glaciers and an early melting of snow, and a progressive shift of vegetation to high elevations. Hence, understanding the adaptation strategies of these animals is a critical factor for predicting the impacts of future landscape changes and ongoing global climate change on alpine ecosystems.

RIVERS WITH BEAVERS: HOW TO GET A GOOD AMOUNT OF DATA ON A REINTRODUCED SPECIES WITH LIMITED FUNDS

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In March 2021, wildlife technicians discovered the presence of two populations of Eurasian beavers *Castor fiber* in central Italy for the first time since the Middle Ages. Fieldwork confirmed the presence of the species at least since 2019, and reproduction in all the rivers where beavers were detected. The project "Rivers with Beavers" was then financed by the Beaver Trust, aiming at 1) determining beaver distribution and presence signs in Central Italy through camera traps. The same method was used to determine the spatiotemporal behaviour of the beavers in these areas and potential overlaps with the spatiotemporal niche of other species; 2) assessing the social perception towards the presence of the Eurasian beaver in Central Italy through direct questionnaires. We surveyed the human population through standard methods commonly used in social science, for citizens > 18 years old and with respect to national privacy laws; 3) getting preliminary information on impacts on riparian forests, river flow and biodiversity, both with indirect (e.g., camera traps, linear transects in the study area) and direct methods (e.g., aquatic macroinvertebrate and meiofauna samplings, with 1 sampling day/season); 4) conducting molecular analyses to compare parasite and beaver populations in Italy with mitochondrial sequences already available on GenBank.
Beavers occurred in most of the Tevere rivers and in the last parts of the Ombrone and the Merse rivers. Camera traps allowed us to confirm reproduction events in several sites, with 1-2 cubs/litter. Beavers were confirmed to be mostly crepuscular, avoiding bright moonlight nights and activity of their predators (i.e., the grey wolf *Canis lupus*, although no beaver rests were detected in N = 68 wolf scats). Several native species used dams and lodges as resting and reproductive sites including imperilled ones.
We observed a general broad knowledge of issues related to the presence of the beaver (i.e., potential effects on indigenous biodiversity: 96.8%). The majority (64.3%) of the population interviewed was in favour of legally reintroducing beavers in Central Italy, and only 10.2% were strongly against it. The majority of interviewed people were against the removal of beavers from Central Italy (65.8%), whereas only 3.9% were in favour, fearing impacts on the river, crops, and fish populations.

Furthermore, we suggested that recolonization of beavers in Central Italy may be altering stream morphology and both macroinvertebrate and meiofauna assemblages. Beaver activity affects structure and biodiversity of the riparian woodlands in the first ten meters from the river bank; *Salix* spp. and *Populus* spp. are the main species gnawed, but also other species can be used based on the structural characteristics of the surveyed woodland. Beaver activity did not affect riverine woodlands, but improved forest regeneration, with reference to Salix spp. and Populus spp. Amongst parasites, we reported the occurrence of several *Schizocarpus* mites (probably two species), *Ixodes ricinus, Travassosius rufus, Giardia duodenalis* and *Chrysomya albiceps,* identified though DNA barcoding analysis. Preliminary molecular analyses on beaver samples confirmed that individuals in Italy all belonged to *C. fiber* and that they were similar to individuals occurring in Western Europe.

AN OVERVIEW OF THE ECOLOGY OF AN INVASIVE RODENT ON SMALL MEDITERRANEAN ISLANDS: A FIRST STEP IN MANAGEMENT

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Invasive rodent species are a great threat to island ecosystems, thus often requiring their control or eradication. Such practices must be optimized based on the demography and spatial behaviour of the species. Currently, relatively little information on these aspects is available on the house mouse *Mus musculus* on small islands, although this species is known to severely impact these fragile ecosystems. Using spatially-explicit capture-recapture (SECR) analysis, we estimated population density, capture probability and home range size of house mouse on three small islands in the Tavolara Punta Coda Cavallo marine protected area (Sardinia, Italy). Islands are characterized by the same vegetation type and free of mouse competitors and terrestrial predators. Capture sessions were carried out in April and September 2022, for an average of 6 consecutive trap-days. Out of 705 total captures, we trapped 258 individuals on Isola Piana, 39 on Spalmatore di Terra and 100 on Isolotto Rosso. Mouse densities greatly differed between the three sampling sites. With mean values around 100 and 125 individuals per hectare respectively, densities on Isola Piana and Isolotto Rosso were more than 10 times higher than on Spalmatore di Terra. Capture probability was lower and animal movements shorter on Isolotto Rosso compared to Spalmatore di Terra and Isola Piana. In particular, estimated sigma values ranged from 9 m (Isolotto Rosso) to 23 m (Spalmatore di Terra), reflecting different home range sizes among islands. Our research provides new insight into insular house mouse populations, evidencing the need to calibrate management protocols at local scale, even on small islands in close proximity.

HOST AGGREGATION AND LOCAL DENSITY CORRESPONDS TO HETEROGENEITY IN TICK-BORNE AND RODENT-BORNE DISEASES

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Host-parasite-pathogen dynamics in nature have been linked to a range of extrinsic and intrinsic factors, which shape the spatio-temporal heterogeneity of environment. Here we evaluated how anthropogenic food manipulation may affect hosts local density and space-use patterns, parasite burden, and pathogen prevalence The study was carried out from February 2019 to April 2021 in Cembra Valley (Trentino, Italian Alps), in a treatment-control field experiments. Treatment sites were at ungulate feeding sites dispensing supplemental ad libitum food, where roe deer were being captured and marked with GPS collars, whereas control sites were placed at least 500 m away from the closest feeding site. In both treatment and control sites, we performed monthly live capture-mark recapture of rodents by individually marking captured individuals with Passive-Integrated-Transponder (PIT) tag. Standard capture information, life-history traits and parasites' presence were recorded, while biological samples (blood, tissue, faeces) were collected. We applied Spatially-Explicit-Capture-Recapture models to spatially predict rodent density and space-use patterns, while we relied on GPS telemetry data to perform a recursion analysis with the aim of assessing roe deer revisitation patterns at treatment and control sites. Through Generalized Linear Mixed Models, we modelled how mice tick burden varied in dependence on the presence of ungulate feeding sites, rodent density and phenotypic traits (sex, status and body mass). Additionally, serological assays and molecular PCR-based methods coupled with sequencing were performed to assess the prevalence of rodent- and vector-borne pathogens at control and treatment sites. 398 yellow-necked and wood mice (*Apodemus* spp.), 109 bank voles (*Myodes glareolus*) and 12 roe deer individuals were captured at treatment sites. The availability of supplemental food shrunk rodents' space-use, increasing mice but not voles local densities. Roe deer revisitation rate was significantly higher at treatment respect to control sites. 1790 feeding *Ixodidae* ticks were counted on rodents. Tick burden was significantly higher in heavier individuals, but did not depend on site. Conversely, spatial pattern of rodent-(Dobrava-Belgrade and Puumula viruses) and vector-borne (Tick-borne Encephalitis virus, *Borrelia afzelii*, *Babesia microti*, *Anaplasma phagocytophylum* and *Hepatozoon* spp.) pathogens occurrence varied among control and treatment sites. Vector-borne pathogens showed a lower prevalence at feeding sites (mean prevalence, 8.69%) than at control sites (13.89%), while the opposite was found for rodent-borne ones (1.55% and 1.16%, respectively). Our findings suggest that both woodland rodents and roe deer were attracted by supplemental food resources. We argue that the co-occurrence of incompetent (roe deer) and competent hosts (rodents) at these sites might affect infectious pathogens' spreading. These results underline the importance of considering spatial distribution of competent and incompetent hosts, and not only overall density, to investigate zoonotic risk.

ECO-EPIDEMIOLOGICAL DYNAMICS OF TICK-BORNE PATHOGENS IN SMALL MAMMALS: A NOVEL INTEGRATED WILDLIFE MONITORING APPROACH

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Small mammal communities are an ideal system for studying multi-host pathogen/parasite transmission. Firstly, small mammal species, including rodents and shrews, have been found to harbour a large variety of endemic pathogens, involving a remarkable proportion of zoonotic ones, which are among the most significant (re)emerging zoonoses worldwide. This, coupled with anthropogenic environmental changes, predicted to profoundly alter population dynamics of these taxa, makes understanding small mammals-associated disease transmission dynamics paramount from an applied disease-control perspective. Investigating different community assemblages means shedding light on the potential heterogeneity in the transmission pool that each species represents for different pathogen/parasite. Small mammals are crucial tick hosts, and major reservoir of many tick-borne diseases, (re)emerging in the context of the aforementioned anthropogenic environmental changes. Epidemiological dynamics of these diseases are challenging due to multiple host species contributing to tick life cycle, and the differential reservoir potential of tick and host species. Capturing real tick population, disease prevalence, and assessing human disease risk is therefore extremely complex. Yet, it is paramount from a public health and, consequently, wildlife management, point of view. Research on tick populations generally focuses on charismatic host species, species of interest (e.g. hunting), or on a single epidemiological aspect, often overlooking the most competent species in sustaining transmission, ground-dwelling small mammals and their complex interactions with other tick hosts and the environment. Therefore, we propose an integrated approach – considering all epidemiological compartments – to shed light on the heterogenous contribution in transmission of multi-host tick-borne pathogens in different sites, aiming to provide better understanding of parasite ecology and formulate management actions to preserve wildlife and human health, decreasing wildlife-human conflict. Sites in La Mandria Park (Torino) and Maira Valley (Cuneo) have been regularly sampled for environmental ticks and wild ungulates (the latter via camera trapping). In the same sites, we designed a yearlong small mammal removal trapping to investigate the missing epidemiological link. Our aim is to test environmental ticks as well as small mammals and relative ectoparasites for *Anaplasma* spp., *Babesia* spp., *Bartonella* spp., *Borrelia* spp., *Ehrlichia* spp., *Hepatozoon* spp. We aim to uncover pathogens' patterns of infection, geographic distribution, and explore relationships between infection prevalence, degree of infestation, small mammal population dynamics, ungulate population abundance, host community composition, and other elements responsible for tick dynamics, as well as reservoir competence in different host species. Preliminary results on wild ungulates showed a variable community composition and abundance between those sites, and a significantly different abundance of environmental ticks, which seemed to be differentially correlated to the diverse ungulate species, suggesting that different species of ungulates might represent either diluter or amplifier species for tick-borne diseases. Similarly, prevalence of infection of environmental ticks showed great variability and a significant prevalence of pathogens whose main wild hosts are represented by small mammals. Data on small mammals will have the potential to reveal patterns of correlation between prevalence and competent host relative abundance (or community composition), co-infections, seasonal dynamics, and the interconnectedness with wild ungulates and environmental tick dynamics.

RODENTS AND PATHOGENS DISTRIBUTION ALONG AN ALTITUDINAL GRADIENT IN THE ITALIAN ALPS.

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In a global change context, the association between generalists and specialists could be a determinant of ecosystem stability. This holds particularly true in mountain ecosystems, where the environmental tolerance of generalists to global warming may lead to their upward distributional shifts, while a decline is expected in specialists. As a consequence, even the parasites that these species carry can shift, eventually promoting the emergence of infectious diseases in newly colonized areas. We examined these relationships in small mammals along an altitudinal gradient in the Italian Alps (Province of Trento), where we identified 5 altitudinal belts from 500 to 2500 m a.s.l. with 500-meter intervals. We live-trapped small mammals applying capture-mark-recapture technique in 2019 and 2020. We counted ticks on rodents and collected blood and ear biopsy samples. Molecular PCR-based methods coupled with sequencing and serological assays were performed for vector- and rodent-borne pathogens screening. We analysed probability of infection with Generalized Linear Mixed Models . Overall, we captured 333 animals belonging to 11 species (*Apodemus flavicollis, A. sylvaticus, Chionomys nivalis, Microtus arvalis, M. subterraneus, M. agrestis, Myodes glareolus, Sorex araneus, S. alpinus, S. minutus, Crocidura leucodon*). *Apodemus* spp. and *My. glareolus* were sympatric in the montane belt, from 500 to 1500 m a.s.l. *My. glareolus* was also present in the alpine belts, from 2000 to 2500 m, together with *C. nivalis*, *Microtus* spp. and shrews. We counted 3782 feeding-ticks belonging to the genus *Ixodes*. From the molecular screening of 324 ear samples we detected an unevenly altitudinal pattern of tick-borne pathogens distributions , with *Borrelia* spp. occurring up to 1500 m a.s.l. (prevalence 13.88%), while *Anaplasma phagocytophilum* (7.09%) and *Babesia microti* (3.08%) mainly recorded in alpine belts. We screened 440 sera samples and detected Dobrava virus in *A. flavicollis* (0.8%). Also 10% *C. nivalis* tested positive to both Dobrava/Puumala viruses. All samples tested negative for Tick-borne encephalitis virus. The observed altitudinal segregation in pathogens distribution revealed that this factor acted in a space-for-time way, mimicking the long-term temporal climatic variations expected under global warming. This may be explained by the presence of a more specialist endophilic tick species at higher altitudes that solely utilize small mammals as hosts for all developmental stages (e.g., *Ixodes trianguliceps*). Moreover, our findings supported the expansion of the generalist species *My. glareolus* toward higher altitudes, where specialists, such as *C. nivalis*, resulted restricted only in some specific habitats. The potential replacement of specialists by generalists can cause an homogenization at the community level, which in turn could alter ecosystem functioning and host-parasite-pathogen association, with implication for spreading of emerging infectious diseases.

SEASONAL CHANGE IN BRAIN SIZE AFFECTS LEARNING SKILLS IN COMMON SHREWS (*SOREX ARANEUS*)

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Relative brain size has been linked to a species' capacity to learn a task efficiently. However, studying the influence of brain size on animal cognitive capacities is still a key challenge in brain evolution research. We tested the hypothesis that learning skills are positively correlated with individual variance in brain size in the common shrew. This small mammal shrinks its brain from summer to winter to cope with resource shortages, and we predicted that this should affect cognitive abilities. We compared the performance of the same shrew individuals when their brains were large in summer and small in winter in an associative learning task in an open arena. Shrews had to learn the position of a food item based on a visual cue (fluorescent light). At the same time, we recorded the variation of brain volume through *in vivo* Magnetic Resonance Imaging. As expected, shrews performed better in summer, suggesting a link between associative learning and brain size. However, we did not observe a significant increase in correct choices throughout 10 trials by individual shrews, either in summer or winter, suggesting that the shrew may not have learned the association solely on olfactory cues. Further research is needed to study associative learning skills in the common shrew using different cues.

SCOIATTOLI DI CITTÀ: EFFETTI DELL'URBANIZZAZIONE SULLA MORFOLOGIA DI UNA SPECIE NATIVA E DI UNA INVASIVA

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Il rapido processo di urbanizzazione ha una forte influenza su flora e fauna a livello globale, gli animali si trovano di fronte a pressioni ambientali differenti rispetto a quelle di habitat naturali, che possono comportare differenze fenotipiche tra conspecifici che vivono lungo il gradiente di urbanizzazione. In molte specie, il peso e la dimensione corporea sono tratti che influenzano la fitness degli individui, perciò, investigare la variazione di questi due tratti morfologici lungo il gradiente rurale-urbano è un primo passo per capire come gli animali rispondono all'urbanizzazione.
In questo lavoro, abbiamo studiato due specie di scoiattoli arboricoli: lo scoiattolo comune europeo (*Sciurus vulgaris,* specie nativa) e lo scoiattolo grigio nordamericano (*Sciurus carolinensis,* specie invasiva) utilizzando un design pseudo-sperimentale con più ripetizioni per ogni tipologia di area di studio (due rurali, due suburbane e due urbane per ogni specie). Abbiamo indagato le possibili differenze nei due tratti morfologici lungo il gradiente rurale-urbano e abbiamo ipotizzato che le differenze siano più marcate nella specie invasiva, indicando una maggiore capacità di adattamento di quest'ultima.
In questo studio, non abbiamo osservato variazioni nella dimensione degli scoiattoli comuni lungo il gradiente, mentre gli scoiattoli grigi avevano dimensioni leggermente maggiori in habitat urbano rispetto alle altre due tipologie di habitat. In entrambe le specie ed entrambi i sessi gli animali erano più pesanti nelle aree urbane rispetto a quelli in aree rurali, invece, la differenza tra urbano e suburbano varia in base alla specie e al sesso. Da questi risultati si evidenzia che entrambe le specie presentano cambiamenti morfologici simili, in particolare il peso maggiore rilevato nell'habitat urbano, che potrebbe portare ad avere una fitness più elevata, poiché la massa degli scoiattoli è positivamente relazionata con il successo riproduttivo.

SMALL MAMMALS IN A BIG CITY: AN HISTORICAL PERSPECTIVE FROM THE URBAN ATLAS OF MAMMALS IN ROME

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Checklists and atlases are useful tools for the study of local faunal assemblages, particularly if such listing exercises are repeated through time. In facts, atlases may provide an updated picture of species' local occurrence and spatial distribution, in turn allowing the testing of hypotheses on their ecology, conservation status, and trends. Specifically, urban atlases are key elements for the study of wildlife in cities, due to the extremely high rates of landscape changes in urban areas worldwide. Mammals are rarely considered as targets of urban atlases, due to their secretive habits. Nonetheless, a plethora of mammals occur in cities worldwide, with high numbers are within the orders Rodentia and Eulipotyphla, i.e. the so called "small mammals". Among European cities, Rome is one of the largest and most ancient ones, with a long history of wildlife investigations, which provide a temporal perspective on the mammal assemblage occurring within the city. Here we present results from the project "Atlas of mammals of Rome" by focusing on small mammals, and analyzing temporal and spatial trends of the species found in the urban area of Rome. Namely, we retrieved records from year 1832 to 2022, with evidence of occurrence of 49 mammal species, 21 of which are small mammals (6 Eulipotyphla, 14 Rodentia), including 7 introduced taxa. Apart from the latters, two species went extinct between the 19th century and today (*Eliomys quercinus* and *Arvicola italicus*), while two significantly increased their extent of occurrence in recent years (namely: *Erinaceus europaeus* and *Sciurus vulgaris*). Similarly, two introduced species have also increased their presence within Rome (*Hystrix cristata* and *Myocastor coypus*). Diversity hotspot for small mammals highly overlap with urban parks characterized by high levels of land cover diversity and low disturbance, in agreement with atlases focused on other vertebrate taxa. Taken together, our results highlight the importance of long term faunal assessments, as well as of urban green spaces, in fostering species conservation and habitat management in urban areas.

SMALL MAMMALS IN THE GREAT FISH RIVER RESERVE (SOUTH AFRICA) AS INDICATORS OF PREY AVAILABILITY FOR SMALL CARNIVORES

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Prey availability and ecosystem structure represent the two main variables which influence the presence and fitness of small carnivore populations, especially in the primary environments of South Africa. In these environments there are 106 species of small mammals and 22 of small carnivores, whose relationships are still largely to be studied. As part of a project on the ecology of small carnivores, research was conducted on the presence of small mammals in the Great Fish River Reserve complex. The reserve is located in the Eastern Cape Province, roughly in between the towns of Fort Beaufort and Grahamstown, covering an area of around 45,000 ha. The Great Fish River Reserve falls into the area of the Albany Thicket Biome, mainly consisting of bush clumps of different sizes. The study aimed to investigate the presence and abundance of small mammals in as many different habitats as possible. Ten study sites falling into 7 different vegetation types were targeted. Every site was sampled by laying 2 parallel transects of 10 traps each, with a 10 m spacing between traps. Traps were set for 3 continuous days and checked twice a day. Sherman traps were used at 9 out of 10 sites, while Willan PVC traps were used at one site to try avoiding cold-related mortality at night. Both terrestrial and arboreal species were targeted where possible. Body mass, sex, and sex condition were assessed for every trapped individual, animals were marked by trimming hair on the back. Vegetation structure was analyzed by considering a 500 m² circular area around the rough center of each sampling site. In order to describe the vegetation, soil cover, rock cover, small plants cover, bush cover, tree cover, and water source proximity were assessed. Out of 1198 valid trap-nights, 467 captures (39.8%) were made, for a total of 272 individuals belonging to 10 different species, namely: *Rhabdomys pumilio* (64.9%), *Mastomys coucha* (17.1%), *Micaelamys namaquensis* (7.7%), *Mus minutoides* (7.3%), *Grammomys cometes* (1.1%), *Graphiurus murinus* (0.9%), *Elephantulus rupestris* (0.4%), *Crocidura cyanea* (0.2%), *Desmodillus auricularis* (0.2%), and *Otomys irroratus* (0.2%). Ecological indexes were used to analyze how vegetation structure shapes the small mammal community and abundance in the study area. Abundance and trapping success were then considered to assess prey availability for small carnivores in the reserve.

IT'S TIME TO ENSURE PROTECTION FOR NON-PROTECTED NATIVE ITALIAN SMALL MAMMALS

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The Italian national law 157/1992 protects all mammals and birds with established populations in Italy (art. 2.2), except for rats, mice, voles and moles (a total of 20 native and 3 introduced species). Therefore, homeothermic species introduced and established in the country are automatically protected by law (though their management is aimed at eradication or population control, DPR 31/2015), while twenty native mammal species lack any protection.
Among the non-protected native species, four are endemic to Italy (*Talpa romana*, *Arvicola italicus*, *Microtus nebrodensis*, *Microtus brachycercus*), and three are subendemic (*Talpa caeca*, *Microtus multiplex*, *Microtus savii*). Three species are classified as Near Threatened in the national red list; other three lack information and are considered Data Deficient.
This species group was excluded from protection due to a perception of their negative impact on crops and human well-being. *Rattus* spp. and *Mus domesticus* are global pests with negative impacts on urban and agricultural areas and human well-being; however, they are introduced to Italy. Among native non-protected species, only some *Microtus* species are responsible for the damage to agriculture. Since damage is localised and rodenticides patented against voles have almost disappeared from the market, rodents' protection would have minimal consequences on agricultural activities. It could also reduce the risk of secondary poisoning of their predators. On the other hand, most non-protected rodents and moles play pivotal ecological roles in food chains and are ecosystem-service providers.
Looking to other European countries, in Great Britain, the water vole *Arvicola amphibius* is becoming rare and is considered a national flag species for conservation. By contrast, the endemic Italian water vole *Arvicola italicus* is not protected, the population trends are unknown, and there is no national monitoring project.
Between non-protected small mammals, there are endemic or subendemic species, species declining or lacking data. There is no reason not to consider them as protected as other mammals. Therefore, it is time to give these species the legislative protection they deserve, removing them from art. 2.2 of the Law 157/1992 the words '*le norme della presente legge non si applicano alle talpe, ai ratti, ai topi propriamente detti, alle arvicole*' (i.e., 'the provisions of this law do not apply to moles, rats, mice proper, and voles').

CONSERVARE IL MOSCARDINO IN PAESAGGI FRAMMENTATI: IL RUOLO ECOLOGICO DEI FILARI

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Il moscardino (*Muscardinus avellanarius*) è un gliride arboricolo fortemente sensibile alla frammentazione degli habitat forestali. Numerosi studi hanno dimostrato che il mantenimento di metapopolazioni vitali di moscardino in paesaggi frammentati dipende dalla presenza di una rete interconnessa di filari che fungano da corridoi ecologici tra i frammenti forestali residui. Recentemente, alcuni studi hanno dimostrato che il moscardino utilizza i filari non solo come corridoi ecologici ma anche come habitat aggiuntivo. Tuttavia, sono ancora pochi gli studi fatti al fine di valutare quali caratteristiche rendano i filari corridoi ecologici e/o habitat aggiuntivi funzionali per il moscardino.
L'obiettivo di questo studio è stato quello di valutare quali sono le caratteristiche ecologiche dei filari, misurate sia a scala di paesaggio sia a scala locale, che lo rendono un buon corridoio ecologico e/o habitat per il moscardino.
A tal fine, in un'area fortemente antropizzata della Lombardia (nord Italia), sono stati selezionati 60 filari seguendo un disegno di campionamento stratificato a due livelli: distanza da aree sorgenti (>1000ha) ed eventuale connessione a frammenti forestali (>5ha). All'interno di ciascun filare è stato collocato un tubo-nido ogni 15 m per un totale di 250 tubi-nido nell'area di studio. I tubi sono stati ispezionati durante tre controlli (maggio, giugno e luglio 2019). Il micro-habitat di ciascun filare è stato caratterizzato mediante 21 variabili rilevate a scala locale. Per ciascun filare sono state successivamente misurate 5 variabili relative alla composizione e configurazione del paesaggio. Al fine di indagare l'effetto delle variabili misurate a scala locale (raggruppate in due componenti principali ottenute mediante una *Principal Component Analysis of mixed data*) e a scala di paesaggio sulla probabilità di presenza del moscardino all'interno di un filare è stato adottato un approccio di *ensemble modelling*.
L'*ensemble model* sviluppato ha mostrato un'eccellente capacità predittiva (AUC=0.89, TSS=0.90) e ha evidenziato che, a scala di paesaggio, la probabilità di presenza del moscardino all'interno di un filare è negativamente influenzata dalla distanza dall'area sorgente più vicina e dalla superficie occupata da tessuto urbano nell'intorno al filare stesso. Al contrario, la connessione con frammenti forestali non aumenta la probabilità di presenza del moscardino all'interno dei filari, suggerendo che questi siano sfruttati come habitat aggiuntivo, e non solo come elemento connettivo, da parte della specie. A livello di micro-habitat, il modello ha evidenziato che il moscardino sembra favorire alternativamente due tipologie di filari: (i) filari caratterizzati da grandi alberi con struttura complessa (es. ontani) e da un'elevata diversità floristica dello strato arbustivo e (ii) filari caratterizzati da alberi di piccola dimensione (es. noccioli) e da uno strato arbustivo esteso e ben sviluppato.
I risultati ottenuti hanno permesso di approfondire le conoscenze sull'ecologia della specie e possono fornire spunti utili allo sviluppo di misure gestionali che possano essere inserite in progetti di pianificazione territoriale finalizzati alla conservazione della specie in aree antropizzate.

MARMOTS FROM THE SKY: USE OF DRONE TO STUDY *MARMOTA MARMOTA* DEN SYSTEMS

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Burrowing animals are a keystone specie in different ecosystems but it is often difficult to examine their location due to complex and rough areas in which they live. Drones can represent a new opportunity for their study, thanks to their high-resolution images, safe work conditions and data reproducibility. To evaluate if drone could be an effective method in these contexts, it has been used a quadricopter type drone with an RGB sensor to study the burrows of the Alpine marmot *Marmota marmota*. The drone used had 3 batteries set that, in conditions of no wind, give an autonomy of 1h 30min. The drone has been flown over Passo Vezzena (TN), an area with a high density of marmots (till 7 marmots per hectare). Five flights have been performed taking overlapping images following a pre-determined linear transect with different value of overlapping between images (60%, 30% and 10%) and fixed values of speed and altitude to assess which could be the most successful drone parameters to identify the burrows. The images were, then, processed by a photogrammetry software to obtain orthomosaics on which to count the burrows. The base of the comparison was prepared counting all the burrows during a ground survey over the whole main area of 15,6 ha inhabited by marmots. The values of the F-score, that ranges between 0 (no burrows detected) and 1 (all burrows detected), have been compared between the flights to recognize the one with the parameters that enables the most accurate burrow identification. The best flights were the ones with the lowest value of image overlap (10%) with a value of F score of 0,41 and 0,45. The results show that there is no difference in the identification quality with a changing in image overlap. Image overlap influence the duration of the flight related to the battery life. Moreover, identification success depends more on the characteristic of the environment rather than on drone parameters. In this context drones have shown their potential of being an important tool in ecology. The implementation of drones for this type of study could be useful to monitor species that live in difficult environments or that are distributed over large areas.

MOLECULAR INSIGHTS INTO THE DIETARY HABITS OF GROUND-DWELLING MEDITERRANEAN RODENTS

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The Mediterranean basin is known for its diverse and unique biodiversity, providing animals living in this region a wide spectrum of species to be exploited as food resource. Considering the ecological traits of rodents, investigating the dietary habits of these mammals is crucial to assess their ecological roles and potential impacts on the ecosystem. Here we present the first results of a study on the diet of three ground-dwelling rodent species inhabiting the sub-Mediterranean oak woods of central Italy, i.e. *Apodemus flavicollis*, *A. sylvaticus* and *Myodes glareolus*. Using DNA metabarcoding on fecal samples from these rodents, we investigated the dietary habits of each species and determined whether there were any sex- or season-related differences. The results showed that the rodents primarily consumed plant matter, with a smaller proportion of their diet made up of insects and fungi. More specifically, *A. flavicollis* and *A. sylvaticus* mostly consumed *Quercus* spp. plant parts, whilst *M. glareolus* relied more on shrub species such as *Rubus* and *Prunus* spp. Within species, diet composition did not significantly differ between sexes. The study also revealed noticeable seasonal differences in the diet of the rodents, with *Quercus* spp. prevailing in the diet of *A. sylvaticus* during fall and winter months. On the other hand, *Rubus* and *Prunus* spp. were more present in spring and summer in the diet of all three rodent species, especially for *M. glareolus*. We believe that a new and important understanding of ground-dwelling rodent communities in sub-Mediterranean oak woods is provided by this study, emphasizing the importance of the metabarcoding method to study animal dietary habits, especially in habitats with high biodiversity.

THE HARVEST MOUSE IN ITALY: GENETIC DIVERSITY, ACTUAL DISTRIBUTION AND HABITAT SUITABILITY

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Climate and land use changes are re-shaping the distribution of species around the world, so that understanding biogeographical patterns is key to protect and manage wildlife, particularly in the case of threatened or declining species. Species with wide ranges are usually considered as common, yet the occurrence of high intraspecific variability and adaptation to local conditions may pose serious challenges to their conservation. We selected the harvest mouse *Micromys minutus*, as a model species to assess the role of intraspecific genetic variability in shaping the environmental preferences and, eventually, distribution, of a widely distributed mammal across Europe. Mitochondrial cytochrome-b gene was amplified from 15 samples from throughout the Italian range and compared with other samples from the rest of Eurasia. We recorded a very low genetic diversity, in line with the rest of the harvest mouse range. In the comparative phylogenetic tree, Northern Italy samples clustered together as a divergent sister group of the rest of Europe, whereas those from Central Italy and Alto Adige clustered with Central Europe samples.
By applying an integrative approach combining species distribution modelling and molecular phylogenetic reconstruction, we assessed the clade-specific habitat suitability of all mitochondrial clades of the species occurring in Europe, unveiling distinct bioclimatic niches for each clade. Most of central Europe was suitable to the presence of *M. minutus*, whereas different clades showed distinct distributions of suitable areas across European, with very limited overlap. We then combined mitochondrial analyses with clade-specific suitability maps to determine the geographic delimitations of Italian and central European clades. We showed that individuals from the northernmost Italian regions actually belong to the central European clade, consistently with the biogeographical patterns of other small mammals, and indicating dispersal between the Italian Peninsula and central Europe, possibly through the Balkans. Our results seem to highlight the importance of intraspecific variability in shaping biogeographical patterns of widely distributed species.

LONG TERM MONITORING OF THE HAZEL DORMOUSE IN LAZIO REGION

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The Hazel dormouse is a hibernating rodent with a marked arboreal attitude. It is protected by Italian national law (L. 157/1992) and the EU Habitats Directive 92/43, where it is listed in Annex IV (strict protection). Regions are in charge of monitoring and reporting on the conservation status of its populations. In 2015 the Department of Environment of Lazio Region launched a long-term monitoring project, involving regional and national protected areas and Natura 2000 sites, and established a permanent monitoring network. The monitoring protocol includes a standard sampling strategy (with some local variations), with the aim of making data comparable over the entire regional territory. Nest boxes or nest tubes are arranged either in grids (6x6) or transects (2x10), in both cases with 40 m spacing between devices. Four controls plus a "maintenance-and-clean" check are carried out in each study site during the year. 41 study sites (31 transects, 10 grids; 9 with nest tubes, 32 with boxes), spanning from sea level to 1600 m a.s.l., were active for at least three consecutive years. In each control, we count the number of adults and juveniles and take note of the presence of fresh nests. In this contribution we present the results for the period 2015-2022, coming from the field data collected by the personnel of the protected areas and the Department of Environment involved in the Regional Monitoring Network.

The occupancy of nest boxes and nest tubes was found to vary over the years, overlapped to high seasonal variability (highest occupancy in November). A mixed model (with the study area entered as a random effect) showed: (i) a significant interaction between month and materials (in November there were more dormice in tubes than in boxes), (ii) highest occupancy in November, and (iii) an increasing trend of individuals present over the years and with elevation (m a.s.l.). The highest frequency of juveniles was found in September and November.

Consistent with findings from other studies carried out in Italy and Europe over the past decades, the study also highlights the effect of the presence of residual habitat on the frequency of individuals: the species was significantly less abundant in sites within landscapes where residual habitat was less than 15 percent.

The protocol is suitable to be applied on other Italian areas. Thus, the ATIt Small Mammal Group (GPM) launched the National Monitoring of the Hazel dormouse, which will have several positive effects for participants: i) monitoring of a species indicative of forest habitat fragmentation; ii) using the data for the periodic mandatory reporting of the status of the Natura 2000 species; iii) involving people, in particular schools and park visitors, in environmental education and awareness programs, also through active participation in field activities.

POSTER PRESENTATIONS

Suncus etruscus – ph. by Leonardo Ancillotto, Archivio GPM

FATTORI AMBIENTALI CHE INFLUENZANO LA PRESENZA E L'ABBONDANZA DI GLIRIDI E AMPIEZZA E SOVRAPPOSIZIONE DELLE LORO NICCHIE

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Il presente lavoro si è inserito nell'ambito di un più ampio studio pilota mirato a conoscere meglio la microteriofauna arboricola di un'area boscata della Pianura Padana. L'area, formata dalla ZSC "Boschi Siro Negri e Moriano" e da una porzione della ZSC "Basso corso e sponde del Ticino", è contraddistinta dall'alternanza di aree coltivate (40,8%) e aree naturali (38,5%). Disponendo 300 hair tubes su alberi e arbusti, è stata rilevata la presenza di Apodemus sp., Rattus sp., Sciurus vulgaris, Glis glis, Muscardinus avellanarius. Tale ricerca si è incentrata sui roditori della famiglia Gliridae – ghiro e moscardino – con l'obiettivo di studiarne la selezione dell'habitat (macrohabitat e microhabitat) e ampiezza e sovrapposizione delle nicchie ecologiche.
L'area di studio è stata suddivisa in 20 celle, in ognuna delle quali è stato collocato un transetto lineare di 200 m. Lungo ogni transetto sono stati posizionati 10 hair tubes con diametro di 3 cm e 5 con diametro di 6 cm; tra maggio e settembre 2021 sono stati sottoposti a quattro check. Attraverso test statistici non parametrici è stata verificata l'esistenza di relazioni statisticamente significative tra le variabili ambientali e presenza e abbondanza dei due gliridi; per quelle variabili che hanno raggiunto la significatività sono stati costruiti modelli lineari generalizzati.
Per nessuna variabile macroambientale sono state rilevate relazioni statisticamente significative con presenza e abbondanza del moscardino, sebbene i boschi di latifoglie abbiano mostrato un'influenza positiva. La copertura percentuale dello strato arbustivo, la sua ricchezza specifica e la presenza di farnia sono variabili microambientali che hanno influenzato in maniera positiva e statisticamente significativa presenza e abbondanza del roditore, mentre la presenza di nocciolo solo l'abbondanza.
Il ghiro non ha dimostrato relazioni statisticamente significative con le variabili microambientali, lasciando ipotizzare sia meno esigente del moscardino. Parlando di variabili macroambientali, la copertura percentuale di fasce erbose ha mostrato un'influenza positiva statisticamente significativa sull'abbondanza della specie, che si ipotizza le sfrutti come corridoi per muoversi tra frammenti boschivi separati da aree coltivate. Più studi hanno infatti evidenziato come specialmente giovani individui percorrano aree aperte per spostarsi da frammenti boschivi densamente popolati ad altri che lo sono meno.
L'indice di Feinsinger e l'indice di Hurlbert, calcolati in base alle variabili macroambientali, hanno evidenziato rispettivamente che entrambi i gliridi hanno una stretta nicchia ecologica e che le loro nicchie si sovrappongono in termini di macroambienti sfruttati. Probabilmente ghiro e moscardino riescono a convivere negli stessi macroambienti grazie a una differenziazione nei microambienti occupati. Infatti lo strato arbustivo presentava coperture percentuali maggiori nelle celle dove ghiro e moscardino convivevano rispetto a quelle dove il ghiro era da solo. In questo modo il moscardino occuperebbe maggiormente lo strato arbustivo e meno l'arboreo non sovrapponendosi al ghiro.

OCCURRENCE OF FAT DORMOUSE AND HAZEL DORMOUSE IN THE VICO VALLEY: FIRST DATA ON THE USE OF NEST BOXES

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This work presents the first data on the occurrence of the fat dormouse (*Glis glis*) and the hazel dormouse (*Muscardinus avellanarius*) in nest boxes located in the Lago di Vico Natural Reserve (Viterbo). We collected the data as part of a broader study on ecology of these species. We installed 44 nest boxes (mean distance ± SD = 50±18m, range = 24-97 m), along 4 transects within a coppice forest, at different altitudes and distances from the hazelnut groves dominating the Lago di Vico landscape.
During the first six field inspections, we verified the filling of the boxes, measuring the volume occupied by the material used by the animals to build the nest. The percentage in volume of the nest box occupied by the nesting materials was considered to verify its use over time, deterioration due to desiccation and a possible species-specific relationship between material, occupied volume and occupying species. The type of material used was also recorded. We classified it into general categories (leaves, sawdust, moss, other), specifying, when possible, the plant species to which the material belongs.
The nest boxes are located on chestnut (52%) and turkey oak (25%) trees, or on other tree species (23%). The average stem diameter is 24 cm (range = 13-48 cm). Leaves (hazelnut, chestnut and turkey oak, ivy and other species) and other material (e.g., bark, moss) were found in the nests. The fat dormouse did not occupy more than 7% of the boxes, while the occupancy of the hazel dormouse was more variable (2.3-13.6%) and also used boxes previously occupied by the other species. The analysis of box filling was carried out by dividing the box volume into five classes (0 / 25 / 50 / 75 / 100 %). In the first surveys, 41 boxes (93%) were classified into class 0, while in the winter surveys 39% of the boxes were occupied and most of them were filled to 25% at least. In the winter, the hazel dormouse was found in boxes with filling between 50% and 100%, while the fat dormouse was found in boxes filled to 50% at most. The maximum number of boxes occupied in a single survey by the hazel and fat dormouse was respectively 6 (6 animals) and 3 (3 animals).

BYCATCH DATA TO DISCOVER HIDDEN MICRO-WORLDS

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Camera trapping is a widespread method to study mainly mammals' ecology and abundance. It is particularly useful for collecting data on elusive species, and/or those species living in remote areas difficult to reach due to infrastructures lack or harsh environmental conditions. Literature is plenty of studies on large carnivores conducted by camera trapping and fewer works are tailored to small carnivores. Usually, the last ones are studied through data caught by sampling designed for large carnivores. What happens when the sampling is designed for small carnivores? Data may return thousands of rodents and lagomorphs detections! In this study, we describe "bycatch data" related to rodents occurring in the Central Mongolian steppe. The sampling conducted between August 2019 and August 2020, was designed to detect Pallas's cat (*Otocolobus manul*), using 40 camera traps, arrayed predominantly within shelters used as marking points by the felid, which often consume there its prey. An accumulated effort of 10,725 trap days, enabled to detection of 10 species belonging to the Rodentia (n=6), Lagomorpha (n=2), and Eulipotyphla (n=2). The study shows how even on "bycatch data" detections the sampling design is crucial since the species with the highest relative abundance (RAI) were the Daurian pika (*Ochotona dauurica*) RAI=33.2 (detections n=3561), and the Mongolian silver vole (*Alticola semicanus*) RAI=22.7 (detections n=2436), which are known widely co-occur with Pallas's cat, representing its most abundant prey. Remarkable was the data recorded for the Mongolian marmot (*Marmota sibirica*) RAI=3.2 (detections n=338), which is Globally Endangered according to the IUCN Redlist. Much lower is the RAI of the other species (all below 0.6), which data can be seldomly analyzed to infer ecological aspects, but remain relevant to assess the species occurrence. Our results indicate camera trapping as a robust method, which can be an alternative for studying small mammals (i.e. <600gr). The live trapping widely used to carry out intensive small mammals survey, may be stressful or lethal to animals and not feasible in very remote areas under severe environment and logistic conditions, which constrain a limited sampling effort. However, when sampling is designed to detect micro-mammals by camera trapping, the habitat use of target species has to be strongly considered. Due to the detection probability limited by the method, the camera trapping could be suitable only for those micro-mammals strictly depending on rocky areas rather than those living mainly on trees and open grassland. As shown in our case study bycatch data could be an important data source for small mammals but only when referred to those species whose site use is widely related to the sampling main target.

SCIURUS MERIDIONALIS DYNAMICS IN THE FORESTED AREA OF CALABRIA

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We investigated the distribution expansion of the endemic *Sciurus meridionalis* in forested area of Calabria. Presence/absence of squirrels was monitored using species-specific cone remains in transect and observation points in Pollino, Sila, Catena costiera mountains. The study confirmed the areal expansion happened mostly in low and medium mountain areas (600- 1.400 m) in some cases even in low-altitude areas (0-600 m), therefore close to human activities. The expansion of the squirrel's range is colliding disastrously with the areal expansion off the alien species *Callosciurus finlaysonii* in the northern part of the areal. We also analysed the forest variables that influence the presence of this species. The analysis shows that *S. meridionalis* is related to forests with a prevalence of deciduous oaks (19% of positive cases), forests with mountain pines and oro-Mediterranean woods (12%), mixed woods with a prevalence of deciduous trees (11%). From the analysis of the fragmentation, it results that lower degree of fragmentation positively predicted squirrel presence. We underlined the importance of this endemism that have also to face the expansion of a concurrent alien species.

LA PRESENZA DI *ELIOMYS QUERCINUS PALLIDUS* E *ARVICOLA ITALICUS* NELL'ALTO LAZIO: POPOLAZIONI RIDOTTE ED ELUSIVE O DIFETTO DI RICERCA?

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Dal 2016 gli autori stanno censendo la microteriofauna presente in habitat presenti all'interno del territorio conosciuto come Maremma Laziale. L'area di studio si estende lungo la fascia costiera tirrenica e la corrispondente pianura, a nord-ovest dal confine con la Toscana, mentre a sud ha il limite nel Promontorio di Capo Linaro, in comune di Santa Marinella (provincia di Roma), che rappresenta la propaggine più meridionale dei Monti della Tolfa. Le metodologie di rilevamento hanno riguardato la ricerca di nidificazioni di rapaci notturni per la raccolta di borre e l'analisi dei resti scheletrici in esse contenuti, il controllo di bottiglie abbandonate in ambiente e delle strade per il rilevamento di carcasse, l'intervista a persone pratiche degli ambienti in questione. Tra i risultati degni di rilievo, per il periodo 2018-2022, emerge il ritrovamento di resti scheletrici, affatto saltuari, di due specie particolarmente elusive e poco note per l'Alto Lazio: il quercino appenninico, *Eliomys quercinus pallidus* Barrett-Hamilton, 1899 e l'arvicola d'acqua italiana, *Arvicola italicus* Savi, 1838. Si tratta di due roditori in declino. Il quercino è classificato dall'IUCN come Near Threatened, mentre non risulta ancora valutato nella Lista Rossa nazionale lo status dell'Arvicola d'acqua italiana, vista la sua recentissima distinzione di specie, rispetto ad *Arvicola amphibius,* e l'ancora troppo poco nota sua situazione distributiva e di consistenza numerica delle popolazioni. La presenza di questi taxa per l'area considerata è stata riportata con due sole segnalazioni per *Eliomys quecinus* (zone di Civitella Cesi e Vulci) e con una per l'arvicola (Saline di Tarquinia (bibliografia mammiferi del Lazio).
Si riportano i dati delle nostre ricerche, che confermano le segnalazioni passate di quercino, ma indicano per l'arvicola acquatica italiana una più diffusa presenza, per quanto oltremodo elusiva. Si evidenzia quindi la necessità di approfondire le conoscenze su queste specie nell'area in questione, anche con ricerche dirette e mirate.

PERSONALITY OF EURASIAN RED SQUIRREL AND INFECTION OF A NEMATODE ALONG RURAL-URBAN GRADIENT

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The urbanization process is one of the primary causes of biodiversity loss and biotic homogenization and thus, represents a great challenge for wildlife. Nevertheless, some species appear to thrive in the urban environment, demonstrating the remarkable adaptability of some animals. Arboreal squirrels, such as the Eurasian red squirrels (*Sciurus vulgaris*), are one of the typical mammalian groups which has been colonising urban areas in many regions. To cope with anthropogenic disturbance, one of the first adaptations observed in urban environments are behavioural changes. Moreover, host-parasite interactions may be affected by changes in the environment, typical for urban areas.
We monitored populations of *S. vulgaris* in six study areas classified in three habitat categories based on the degree of urbanization (rural, suburban, urban). We used a replicated design with two independent study sites in each category. The aim of this study is to explore whether some personality traits such as the activity, exploration and sociability change along the gradient. We predicted that animals in urban areas should be more active, explorative and social to cope with new environmental challenges. Moreover, we investigate whether the infection by the nematode *Trypanoxyuris (Rodentoxyuris) sciuri* varied with the degree of urbanization, and was related to the animal's personality, expecting more social, active and explorative animals having a higher change to be infected due to the parasite mode of transmission.
To test our hypothesis, we perform the Open Field Test (OFT) to analyse the activity and exploration traits, and the Mirror Image Stimulation (MIS) for the sociability trait. Both OFT and MIS are two well-established methods used in an arena test to quantify animal personality and thus are used here for behavioural comparisons. Tape-tests were collected during capture sessions to investigate the presence/absence of *T. sciuri*.
In contrast with our predictions, we found higher explorative and social individuals in rural areas, while activity did not show any difference along the gradient. In the first test, squirrels were more active, explorative and social than in the successive ones, suggesting some form of habituation to the arena test. The probability to find infection by *T. sciuri* was significantly related to habitat type; in rural and suburban areas the presence of nematode was higher than in urban areas. Furthermore, there was a significant interaction between activity and habitat, suggesting that the effect of personality on infection by *T. sciuri* differed with the degree of urbanization.
Possible causes explaining the differences in the expression of personality traits and the probability of infection among the rural-urban gradient will be discussed.

IS BETTER LIVING UPWARD OR DOWNWARD? SPATIAL SEGREGATION OF WATER SHREWS *NEOMYS FODIENS* AND *NEOMYS MILLERI* IN AN ALPINE REGION

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Two species of water shrews are known to occur in South Tyrol: Miller's water shrew (*Neomys milleri*) and Eurasian water shrew (*Neomys fodiens*), both listed as DD in the Italian red list 2022. Their dependence on water sources, wetlands, and rivers makes them highly susceptible to land use changes or degradation and water pollution. In South Tyrol, both species have been declining in recent decades due to the exploitation of wetland habitats, especially in valley bottoms. Based on their distributions and habitat requirements, sympatric occurrences or potential competitive exclusion between these two water shrew species were investigated.
Occurrence data were collected in the database of the Museum of Nature South Tyrol since 1995. Data from 59 sites with Miller's water shrew (48 individuals) and Eurasian water shrew occurrences (26 individuals) were analyzed in relation to topographic and climatic parameters, and habitat characteristics. Generalized Linear Models were applied to investigate the statistical relationship between species occurrence and environmental variables.
While the Eurasian water shrew is exclusively detected in sites above 1,000 m a.s.l., more than 2/3 of the Miller's water shrew records occurred at elevations up to 1,000 m. *N. fodiens* prefers locations with lower temperatures ($p = 0.003$) and higher precipitation values ($p = 0.03$), whereas the opposite is true for *N. milleri*. The Eurasian water shrew has been detected on the proximity of large and small watercourses, often situated in forest habitats or on their margins. Their occurrences in streams at high elevation support the need for good freshwater quality. However, Miller's water shrew is characterised by greater ecological plasticity and its sites were mostly located at a larger distance from fast running waters ($p = 0.04$). The species was detected in riparian vegetation of streams and standing waters, and in riparian forests. In intensive agricultural areas, it also inhabits small ditches, especially at low elevations. Wetland protected areas play an important role as refuge for this species in the valley bottoms.
The two species occupy a different ecological niche, as evidenced by sympatric occurrences at only two sites. Competitive phenomena between them as a cause for the existing distribution gaps therefore seem unlikely. For the conservation of these two threatened shrew species, maintaining freshwater quality and structurally rich riverbanks is crucial for the Eurasian water shrew, while the preservation of small protected wetlands and the connection and maintenance of ditches in valley bottoms is essential for the conservation of the Miller's water shrew.

TALPA ROMANA: EVALUATION AND CONTROL IN EQUESTRIAN COMPETITION FIELD IN THE HILLS OF ROME PROVINCE (LATIUM, ITALY)

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Talpa romana is an endemic mole of southern Italian peninsula. The species show a complex ecology and it is possible to meet this mole it in a large diversity of ecosystems and from lower altitudes to 2000 m. Only in particular environments, such as equestrian fields, its tunnels and mounds can locally represent a problem related to the security of horses and riders. In the framework of a control program, the study has been performed on the area of Pratoni del Vivaro in Rocca di Papa (Roma) from the 26th of April to the 3rd of September to mitigate the presence of the moles. The land is an outdoor of the Italian Equestrian Sport Federation (F.I.S.E.). The used traps were chosen to decrease as much as possible the mortality of the captured moles. For each trapping period, inspections were provided to identify and register the active feeding areas and mounds and tunnel development. Also the presence of preys (e.g. earthworms,) in the areas has been evaluated. At each session the presence of the molehills and soil movements for the tunnels was recorded on maps and a quadricopter drone has been used in the two subareas taking aerial images. The flights have been performed in manual mode, meaning that the pilot was controlling the aircraft during all its flights. A total of 14 flights have been performed with different values of flight altitude (17 m, 29 m, 37 m and 58 m) to estimate the best one to see the burrows. Three objects with different colors (red, yellow and violet) and the same dimension have been positioned over the burrows to geolocate them and helping in the estimation of the best altitude value taking into account the objects visibility from the aerial images. Lower altitudes allowed a better recognition of the color of the objects but did not allow a full perspective of the moles 'burrows. Instead, higher flight altitude allowed a full vision the burrows present, but it was difficult to distinguish the different colors giving the focal length (35 mm) and the viewing angle (77°) of the drone used. A total of 25 moles has been captured in all the controlled surface of 81 Ha during April and May using 369 trap days. Only 4 nests were found on the edge of the foraging areas. In contrast to the initial interpretations related to the extent of the soil movements necessary for feeding in environments with such low biomass available, the number of moles captured and released was small, reaching 0.3 specimens per hectare. A control plan linked to the tillage and water change intake of the area is under way to test an integrated approach to the problem.

USE OF DRONE IN VISCACHA *LAGOSTOMUS MAXIMUS* BURROW CHARACTERISATION

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Drones surveys can be used to monitor burrows of large animals at a landscape level and, thanks to their reproducibility, a potential method to assess changes in population according to the observable changes in burrow appearance over time. The study focused on the Plain Viscacha (*Lagostomus maximus*), a nocturnal and gregarious large rodent present in different South American ecoregions. Their burrow systems, locally called "*vizcacheras*", are formed by many entrances and up to 100 tunnels all connected to each other and can reach 2-3 m in depth. The Plain Viscacha is considered a keystone species because it is preyed upon by several carnivores and because its *vizcacheras* can cover very large areas and host other species, from smaller rodents to Burrowing owls (*Athene cunicularia*). Because of their large extent, *vizcacheras* are often destroyed by local livestock breeders. Thus, detecting and mapping *vizcacheras* can be helpful for management plans of Plain viscacha populations, but is challenging to accomplish over vast areas.
For this methodological trial, we used a quadricopter type drone in an area located at the ecotone between the Pampas and Espinal ecoregion, close to Bahia Blanca, Buenos Aires province (Argentina), approximately 38°31'S and 63°26'O. The flights have been done over fields where the presence of *vizcacheras* was formerly known thanks to farmers' reports. Flights were programmed through the "waypoint flight mode", with constant values of height and speed, in order to record series of waypoints and create a route that could then be executed automatically. The autonomous flights mean duration was 16:45 minutes and the path followed by the drone had a length of 3 km.
The homogeneity of the environment allowed a proper identification of the *vizcacheras* from the images captured by the drone. The *viscacheras* overflown, and then checked on the ground, had a diameter of 15 to 20 m. The analysis of the series of images produced by the different flights showed how the best drone speed was of 10.8 km/h, because it was the best compromise between saving batteries and avoiding blurry photos. The flight height that best allowed the recognition of the presence of the burrow systems and the counting of the entrances was of 20 m, considering the focal length (35 mm) and the viewing angle (77°) available on the drone model used.
We conclude that the first flight trials in Bahia Blanca indicate that drones can be a useful tool to investigate the distribution and use of Plain Viscacha burrow systems.

GLIRIDAE IN SAN MARINO REPUBLIC: IS *MUSCARDINUS AVELLANARIUS* ENDANGERED?

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The atlas of mammals of the republic of San Marino was published in 2015, collecting twenty years of observations, includes the presence of *Glis glis*, *Muscardinus avellanarius* and *Eliomys quercinus* for the Gliridae. The 61 km^2 of the territory of the Republic are diversified into a series of hilly landscapes where inhabited areas and a mosaic of agricultural areas dominate. On the steepest parts of the cliffs there remain strips of thickets predominantly of oaks with xerophilic tendencies. There are few well-preserved areas such as the San Marino stream and its outlooks. There are numerous caves and artificial hypogea that complete the environmental picture. The rarest species is *E. quercinus* with only two quadrants of presence over the 64 1x1 km designed. The species was found in the area of the vertical walls of Monte Titano and as a prey by *Strix aluco*. *G.glis* is widespread in 14 quadrants, in the hilly landscapes and in Mount Titano where it is found quite common in the last forest patchess and has been the elective prey for *S.aluco*. *M.avellanarius* was found to be present in only 4 quadrants and we start a standardized sampling with the use of nest tubes, to evaluate the state and structure of the populations. 21 nest tubes have been placed in 7 potentially suitable locations with bushes and small hardwood thickets. The average number of days in the field of the nests was 150. In 6 stations there were no reports and only in one there was evidence of the presence of the dormouse with a nest. As the monitoring plan continues, it appears clear that the species is very rare, contrary to what has been reported locally for the past, and the state is being urged to implement conservation plans for the species.

SHOULD I STAY OR SHOULD I GO? SEASONAL FLUCTUATIONS OF WOOD MOUSE POPULATIONS IN FIELDS SURROUNDED BY WOODLANDS

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The wood mouse *Apodemus sylvaticus* is commonly found in ground-dwelling rodent communities in both woodlands and open areas of Western Palearctic. Despite this species having been broadly studied, little is known about its population ecology in fields. Here, we investigated wood mice seasonal fluctuations in abundance and population structure by sampling long-fallow fields and two woodland types, i.e. oak forest and conifer plantation, in the Mediterranean region. Our objectives were (i) to assess seasonal variations of wood mice abundance in fields and surrounding woodlands; (ii) to identify the factors driving rodent abundance variation in fields by investigating population structure in the three different habitats and (iii) to evaluate the effect of the variation in grass height within fields.

From September 2011 to July 2014, small mammals were live-trapped in three independent sites for each habitat type (total of 23.814 trap-days). By analysing abundance, sex ratio, age structure, proportion of residents and breeding individuals, and body weight of mice, we tested whether there are differences between fields and the two types of woodland. Furthermore, we systematically measured the grass height for each field to verify the existence of a correlation between herbaceous species phenology and mice abundance.

The sampling effort resulted in 350 captures of 245 different wood mice (fields N = 75; oak forest N = 63; conifer plantation N = 107). Season affected wood mice abundance in all three habitat types and, specifically, captures peaked in September in fields. In this habitat type, reproductive individuals occurred at high percentages throughout all the year, except in January. Non-resident adults inhabit fields mainly during the hot season (May, July and September), when they are more abundant than in woodlands. On the other hand, during the cold months (November, January and March), immature individuals occurred in fields more than in surrounding resource-rich habitats (i.e. oak and conifer woodlands), probably forced by intraspecific competition. The lower body mass of adults in fields than in oak woodland we recorded suggests that fields could be a nonoptimal habitat probably due to the absence of valuable trophic resources (i.e. acorns). Finally, wood mice abundance was not found to be correlated to grass height in fields, as abundance in these unstable habitats is likely to be driven more by other factors (e.g. life history of surrounding populations and competition rates).

Overall, our study found evidence of seasonal variations in wood mice abundance in fields of the Mediterranean region, offering a first insight into these dynamics. Further studies are required to understand the relative importance of life history (i.e. seasonal patterns of mortality and fecundity), intraspecific competition, and changes in habitat structure (i.e. presence of refuges, suitable nesting sites and trophic resources) in explaining such variations.

THE UNDERGROUND FORM OF *ARVICOLA ITALICUS* IN SOUTH TYROL AND ITS TRADITIONAL CONTROL

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The Italian water vole *Arvicola italicus* Savi, 1839 is considered an Italian near-endemic after that molecular genetic study indicated that the Italian lineage is divergent from other European populations. The species has fossorial and aquatic forms that increase the discussion over the systematics of the taxon. The presence of fossorial forms in South Tyrol is known from previous surveys for Val Passiria but actually we collect some more distribution evidence also in other valleys of the Province. Also we are collecting information on damages caused by the rodent and the related traditional control. Farmers accuse the species of the production of tunnels and mounds that make it difficult to cut the grass in stable meadows and damage the roots and trunk of freshly planted apple trees. There are still operators who with traditional methods try to reduce the number of specimens in the cultivated areas and their activities are documented as a historical approach to the management of voles and moles. Specimens were found in Val di Vizze where it is present throughout the western part and in the valley floor towards the east. Also in Val Pusteria abundant presences have been found in the meadows as well as in the Vipiteno area. This vole is digging in meadows and nibbling in orchards as attested starting from 1986 in the municipality of Varna (Bressanone). Some damages are then attributable to other arvicolides and it is not possible to generalize without direct observations. The presence of these widespread populations is of great biogeographical and ecological interest, as well as to be investigated for their important role in parasitic and zoonotic transmission.

BEHAVIOURAL RESPONSES TO CLIMATE CHANGE AND NATURAL HAZARDS IN SMALL MAMMALS: A REVIEW AND META-ANALYSIS.

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The Anthropocene is characterised by enormous changes to the planet. Climate change and the extreme weather events associated with it are particularly disruptive to natural environments, and can lead to higher mortality or reduced resources to the populations inhabiting the affected area, impacting social structures within the populations. For example, recent studies show that weather related disasters causing a shortage of resources can lead to an increase in social tolerance and social connections. In contrast, other examples show an increase of aggression toward conspecifics. Understanding behavioural adaptations is paramount considering that the intensity and frequency of weather related disasters are inevitably growing with the climate crises we are facing. I am conducting a systematic review of the literature on the relationship between extreme weather events and behavioural changes in small mammals, with a particular focus to social tolerance. I will 1. present results from the systematic review on the association between disasters and behavioural change; 2. compare different hypotheses on sociality response to ecological shocks developed in behavioural ecology. As of now, I have completed a first round of screening and selected 84 studies for inclusion by reviewing the titles and abstracts of 347 articles identified from a systematic search through multiple databases. I am currently conducting full-text screening to select a final set of studies for review and meta-analysis, based on predefined inclusion criteria. When finished, this study will provide evidence for evaluating how and why sociality might be shaped by weather related disasters.

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