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Preface

We are very pleased to welcome you to Canberra for the 8th International Conference on Rodent Biology and Management (ICRBM), in Canberra, Australia. We look forward to excellent presentations and discussions and hope that new collaborations and networks are developed during the week. As always, the breadth of the scientific contributions has allowed the Scientific Program Committee to develop an excellent program across many research disciplines.

This ICRBM continues the tradition of excellence established by its predecessors, held approximately every four years. The inaugural conference took place in Beijing, China, in 1998, followed by Canberra, Australia, in 2003; Hanoi, Vietnam, in 2006; Bloemfontein, South Africa, in 2010; Zhengzhou, China, in 2014; a joint 6th ICRBM and 16th Rodens et Spatium in Potsdam, Germany, in 2018; and most recently, Arusha, Tanzania, in 2022. We look forward to many more successful gatherings in the years ahead!

We thank our sponsors for their contributions: Commonwealth Scientific and Industrial Research Organisation (CSIRO), International Society for Zoological Sciences (ISZS), Grains Research and Development Corporation (GRDC), Australian Centre for International Agricultural Research (ACIAR), The Crawford Fund for Food Security, IMTRADE Crop Science, Botstiber Institute for Wildlife Fertility Control and Australian Pork Limited (APL). Their support for our Plenary speakers has ensured both national and international experts are attending the Conference. We also greatly appreciate the sponsor's support for our Early Career Researchers who will have the opportunity to meet other researchers and begin to develop or extend their networks in rodent research in their own discipline and beyond.

It is with considerable regret that we have been unable to welcome many of our colleagues from developing countries. This is partly due to limited funding support and partly due to difficulties in obtaining visa approvals in a timely manner. We will miss the many and varied contributions from our African and Asian colleagues. They are with us in spirit.

Our 8th ICRBM Scientific and Local Organising Committee acknowledges the many suggestions from the members of our International ICRBM Committee – we greatly appreciate their continuing willingness to contribute to another successful conference.

The experience and efficiency of our Conference Secretariat, Consec, has contributed greatly to ensuring the Conference is an organisational success. Thank you particularly to Barry Neame and Isobel Davie.

Thank you all for your contributions and enjoy the week.

Lyn Hinds
On behalf of the 8th ICRBM Scientific and Local Organising Committee

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Listening to farmers to improve house mouse management

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Mice remain a problem in Australian cropping systems. Periodically mouse populations reach plague proportions, resulting in not only economic loss but ongoing negative psycho-social impacts for people in rural communities. Research and extension have, for the most part, played a role in the one-way flow of information from scientists to farmers, helping to minimise the impact of mouse outbreaks. In this presentation I will outline the circumstances that led to the establishment of a meaningful two-way dialogue between researchers and agricultural stakeholders. This relationship has provided a forum for open discussion, identifying key issues faced when trying to control mice. Information provided by grain growers led to four highly relevant research projects reassessing the efficacy of zinc phosphide (ZnP) for controlling mice. Unexpected results from the initial trial, testing different bait substrates, raised questions about the sensitivity of mice to ZnP. Data from a subsequent LD_{50} trial confirmed that mice were less sensitive to ZnP than had previously been reported. Regulatory approval to manufacture bait at the higher concentration (an Emergency Permit) enabled a large field trial comparing ZnP mixed at 25 g ZnP/kg with the new concentration of ZnP mixed at 50 g ZnP/kg (equating to a lethal dose on each grain of bait for a 15 g mouse). Simulations of the data from this experiment showed a high degree of variability in the results achieved with the 25 g ZnP/kg bait in comparison to the consistently high efficacy achieved by the 50 g ZnP/kg bait. The fourth study investigated the role of background food (spilt grain) on the effectiveness of the 25 g ZnP/kg bait. The results of this trial showed that as background food increased the efficacy of the bait decreased. Together the results of these experiments have challenged conventional wisdom and confirmed reports that farmers had provided about the lack of efficacy of ZnP mixed at 25 g ZnP/kg of bait. This strong relationship with farmers has helped to inform strategies to achieve improved outcomes from the use of ZnP to control mice in grain production systems.

Plenary talks

From data to knowledge to wisdom: lessons learned from the Vancouver Rat Project

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Over the past 15 years, the Vancouver Rat Project has been striving to understand, monitor, and manage urban rats and rat-related impacts to human health and wellbeing in North American cities. One of the key things this interdisciplinary research has shown is that, while research has traditionally focused on the individual components of the 'rat problem,' rat-related harms are created, magnified, or mitigated at the interfaces among rats, people, and the environment. Similarly, though each scientific discipline can provide data to help characterize, monitor, and mitigate rat-associated harms, it is the interface between these disciplines from which the *intelligence* to solve current rat problems emerges, and from which we can create the *wisdom* needed to predict and prevent future issues.

In this presentation, I will describe how we combined veterinary medicine, epidemiology, ecology, population genetics, policy analysis, social sciences and more, to change the way we assess, monitor, and mitigate diverse risks associated with urban rats.

Themes that will be explored include:

- How rats, microbes, and vectors interact to influence zoonotic pathogen ecology and associated public health risks.
- How urban rats can carry diverse bacteria normally found in other species, particularly humans, the drivers and significance of 'reverse zoonoses', and how carriage of these pathogens by rats could impact public health risk assessments.
- How local and global rat population structures impact pathogen transmission and rat management options.
- How fine scale urban 'microenvironments' can have significant and sometimes unpredictable impacts on rats and the microbes they carry.
- How the things that make rats sick are different than the things that make people sick (and vice versa) and how health and disease in rats could provide a new window into rat population ecology.
- How understanding the impact of rats on human mental health and wellbeing can provide new avenues for rat management.
- How the centuries old 'war on rats' approach to municipal rat management is destined for failure and why an interface-focused approach can help drive innovation, identify new leverage points for intervention, and provide opportunities for more efficient and effective policies and programs.

Plenary talks

Rodent management in urban landscapes – developing country perspectives

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Effective rodent management is a critical global public health priority. Various strategies have been employed to manage their populations, including chemical application, trapping, environmental interventions and integrated rodent management (IRM), which combines multiple approaches. While IRM has shown relatively greater efficacy compared to the exclusive use of chemicals, the overall sustainability and long-term impact of these strategies remain limited. This limited effectiveness is often rooted in persistent knowledge and implementation gaps, including inadequate understanding of rodent ecology, resource constraints, overreliance on non-locally adapted interventions, lack of adequate community involvement and poor collaboration among relevant key stakeholders, such as researchers, municipal health agencies and pest control authorities. For over 15 years, our multidisciplinary team has been conducting research in informal urban communities in Salvador, Brazil, using leptospirosis as a model for investigating rodent-environment-human interactions. Through this work, we have generated critical insights into urban rodent ecology and the dynamics of rodent-borne disease transmission. We have observed relatively stable rodent population sizes and reproductive patterns across seasons, with notable increase in female body weight during the rainy season. Our studies have characterized the genetic structure and gene flow among rodent populations, developed local surveillance tools adapted from the CDC exterior and interior surveillance form and introduced an affordable, user-friendly and effective proxy (tracking plate) for evaluating rodent activity in densely populated urban communities, likewise describing rodent parasite loads. These tools have been instrumental in understanding both the spatial connectivity and temporal stability of rodent populations to formulate effective management strategies. We integrated those studies into environmental and epidemiological work, and as a consequence, our modeling of leptospirosis transmission pathways has underscored how spatial distribution of rodents contributes to environmental contamination and human infection risk in urban settings. We have shown that environmental and hydrological factors, such as vegetative land cover and seasonal flooding, play a crucial role in disease transmission dynamics within vulnerable communities. This extensive experience has shaped the development of context-specific rodent control strategies that are both nationally and internationally relevant. Beyond Brazil, we have contributed to the development of surveillance protocols and training programs in the Bahamas and Indonesia, illustrating the scalability and adaptability of our approach. Recently, our work has shown that urban warming and growing population densities are exacerbating rodent activity and increasing disease risk, especially in low- and middle-income countries. These findings highlight the need for cities to adapt rodent management strategies to the realities of climate change. In summary, our research demonstrates the importance of locally tailored, multidisciplinary and community-engaged approaches to rodent population management. By integrating ecological, environmental and social perspectives, we can develop more effective and sustainable interventions to mitigate rodent infestations and the public health threats they pose.

Plenary talks

Putting rodents at the centre of One Health programmes – lessons and experiences

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Rodents occupy a critical interface between humans, animals, and the environment, where addressing the roles of commensal and many sylvatic species should be a key mandate within any One Health programme. A One Health interdisciplinary approach recognizes that the health of people is closely connected to the health of animals and the health of their shared environment. Rodents are known reservoirs and vectors for a range of zoonotic pathogens which can spill over into human populations, particularly in densely populated and low-resource settings. Pathogen spillover between rodents, other wildlife, livestock and domestic animals occurs in both directions, enabling pathogens to persist, mutate and proliferate. Invasive rodent species disrupt ecosystems, causing extinctions and biodiversity loss, weakening the dilution effect. Rodent pest species serve as bioindicators of environmental contamination due to their close association with agricultural production, human refuse and wastewater systems. Much like the paradigm of Ecologically-Based Rodent Management, the practices of One Health have been around for centuries where many communities have inherently applied their core values using an ecosystem approach to health. Since at least the 1980's scientific publications have referred to human and animal health being influenced by the environment, but the use of One Health as a conceptual framework only started to appear in the early 2000's bringing together growing discussions around One Medicine, Planetary Health and EcoHealth. It is around this time when one of the first fundamental research projects on rodents was funded by the European Union that explicitly aimed to bring together multidisciplinary teams to look at the interactions of rodents across agriculture, health and the growing connectivity between rural, peri-urban and urban communities in sub-Saharan Africa. Starting in 2003, the RatZooMan project did not explicitly refer to One Health but did set out to integrate social anthropological case studies with eco-epidemiological surveys of rodent populations and empirical implementation of ecologically-based rodent management. RatZooMan is arguably one of first One Health research projects focussed on rodents where earlier applied research on rodents in low-resource communities tended to focus on smallholder agriculture. With four European and four African countries and 12 institutions, including government agencies, universities, research institutes and the private sector, the benefits of working together across such different institutions was not immediate. RatZooMan achieved many of its scientific goals by the end of its three-year duration, but one important lesson was that building and integrating diverse skills and perspectives across multidisciplinary teams and countries takes time to build and is a necessary goal in itself. Through concerted efforts and a degree of good luck, the RatZooMan experience helped build new multidisciplinary rodent research projects in Africa including: EcoRat, StopRats, EcoRodMan, RedRoz and OHRatSA projects. This continuity of funding, at least for some partners over the past 20+ years, has meant that many elements of the rodent One Health nexus are now much better understood, where some examples will be presented during this plenary. More importantly, new ways of thinking about rodent pest management have been identified through how rodent population management intersects with the drivers of disease spillover, public health, human behaviour and biodiversity conservation. The direction of new research concepts that can put rodents at the centre of One Health will be discussed.

Plenary talks

Developing CRISPR gene drives for invasive rodent population suppression

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Invasive rodents are a major cause of environmental damage and biodiversity loss, particularly on islands. Current control methods rely principally on the widespread distribution of anticoagulant rodenticides, an approach that is costly to apply at scale, carries ethical concerns regarding toxicity, and is not species specific. Genetic biocontrol strategies, including population-suppressing gene drives with biased inheritance, offer a potential alternative approach for landscape-scale suppression of invasive rodents. Although genetic biocontrol technologies are progressing rapidly in insects, less is known about their potential for rodent control. To investigate this, we developed a spatially-explicit, individual-based *in silico* modelling platform. Modelling of established gene drive strategies (e.g. homing drives) demonstrated considerable potential for population suppression of mice, encouraging us to explore these as well as novel gene drive approaches in the laboratory. Despite longer generation times and the higher experimental costs of rodent research (compared to insects), we have now investigated several gene drive strategies in laboratory mice, identifying key parameters that must be optimised to achieve efficient suppression. To date, a novel strategy termed t_{CRISPR} has proven to be the most effective system in the laboratory. t_{CRISPR} is a murine-specific gene drive that leverages super-Mendelian (>50%) transmission of a natural drive element (the *t* haplotype) to spread inactivating mutations in a haplosufficient female fertility gene. Using our *in silico* modelling platform, we show that t_{CRISPR} can eradicate island populations under a range of realistic field-based parameter values. We have also engineered transgenic t_{CRISPR} mice which, crucially, exhibit biased transmission of the modified *t* haplotype and (target) female fertility gene mutations at levels predicted to cause eradication. The potential of t_{CRISPR} and other strategies for invasive mouse population suppression will be discussed, as well as the key issues of safety, specificity and field testing.

Plenary talks

Scaling up rodent management: leveraging stakeholder networks, communication strategies, and innovative solutions

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Rodent management remains a critical challenge in agriculture, particularly in developing countries where smallholder farmers face significant production losses. Whether it is for a decision tool, community surveillance, or a package of integrated management options, there are sociological approaches commonly used in the field. Varied approaches have been used to study farmers and communities as well as enabling them to decide on and implement the options, a co-design process influenced by Systems Thinking. There are also documented ways to nudge certain behaviours. Moreover, harnessing existing collectives such as farmer associations or village groups has also been a proven pathway. While there are myriad ways to work with the human dimension in rodent management, beneficial solutions must be adapted and applied at scale to maximize their effect. How can we ensure that proven solutions are used across a wide geographic scale, and their use sustained by end users? Building on cases where sociological and communication approaches have been used to support rodent management, a framework is presented for scaling rodent management solutions. At its base, it involves forming and harnessing stakeholder networks, alongside intentional communication processes. These strategic partnerships enable further co-design or adaptation of tools and management options, as well as embedding into the current arrangements that could bring about policy, market and cultural change. Generating policy support at varied levels, especially at a national level, not only brings widespread awareness and change in narratives, but also the supportive arrangements for different stakeholders to change and create an enabling environment for rodent management. Market system changes, and improvements in business and institutional capacity are also needed particularly for those manufacturing tools, including digital tools. Effective rodent management at scale requires holistic approaches that not only improve local decision-making but also foster broader changes, paving the way for enhanced access, affordability, and incentive mechanisms for end users to implement and sustain rodent management.

Plenary talks

Rodent eradications on islands: bridging strategic vision and operational success

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Islands are critical havens for global biodiversity but face intense pressure from invasive rodents (*Mus musculus, Rattus exulans, R. norvegicus,* and *R. rattus*). Eradication, the complete removal of the target population, is a powerful tool for ecological restoration, with numerous success stories worldwide. Yet the field has also seen significant failures, from bold large-scale attempts to seemingly straightforward projects. This presentation explores the strategic thinking and essential planning required to maximise the chances of success. While some failures arise from pioneering efforts that push the boundaries of scale or confront novel challenges, many are preventable, often rooted in flawed or insufficient planning and weak implementation, despite the availability of best-practice guidance and resources. The reality is stark: eradication is a binary outcome, and 99% success still means failure. Drawing on the comprehensive framework developed by the New Zealand Department of Conservation's Island Eradication Advisory Group, this talk will examine the fundamental questions that must be addressed from the outset: Why is this eradication necessary? Is it truly achievable given ecological and logistical constraints? Can the gains be sustained through robust biosecurity? Is the project socially and culturally acceptable? What are the potential unintended ecological consequences? And critically, what resources, expertise, and long-term commitments are required to succeed? Using real-world examples of both successes and failures, this plenary will offer practical advice and insights on best practice at each stage of a rodent eradication campaign. It will encourage critical reflection on project design and highlight the importance of investing in planning, consultation, and trials to build confidence before implementation—rather than letting external pressures like funding cycles dictate key decisions. Ultimately, truly feasible projects are those that are achievable, sustainable, acceptable, and ecologically sound, ensuring lasting benefits for island ecosystems, wildlife, and people.

Plenary talks

Conserving an endangered cultural icon, the water vole, in the face of American mink invasion of Britain: ecology, management and people

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Rodent management typically focuses on reducing their numbers and minimizing their impact. However, some species once considered pests have declined to the point of becoming endangered. This shift raises important questions: Should we conserve declining rodent populations? Should we celebrate their reduction? Or should we determine acceptable population levels for species once deemed over-abundant? Answering these questions requires an understanding of the ecological roles and cultural significance of rodents. The European hamster offers a striking example of changing fortunes. Once controlled as an agricultural pest, it is now listed as critically endangered. Similarly, several rodent species formerly managed as pests are now at risk, mostly due to intensified farming practices. As with many conservation challenges, it is difficult to identify and mitigate the multiple causes behind these declines. The water vole (*Arvicola amphibius*) illustrates this complexity. A large (200–300 g) amphibious rodent, it is regarded as both a pest and a conservation icon, depending on location. In the UK, water voles were once widespread and beloved, popularized by a classic children's story. Since 1950, however, their population has plummeted by 95%, primarily due to predation by the invasive American mink, which escaped from now-closed fur farms. Female mink can enter vole burrows, making local coexistence impossible. Water voles have a metapopulation structure, with local extinctions and recolonizations occurring frequently, even without mink. Although water voles are excellent dispersers, mink are even more mobile and can affect multiple vole populations in a neighbourhood. While this structure once gave voles some resilience, extinction can be delayed but not avoided. The ecological impact of their burrowing behaviour, such as supporting diverse riparian plant communities, lingers even after their disappearance. The scale of mink invasion in Scotland overwhelmed government resources. Instead, a broad network of citizen conservationists was mobilized to manage mink across over 29,000 km², roughly a third of Scotland. Volunteers, many of whom never saw a water vole, used floating mink rafts that detect mink presence and trigger cage traps only upon confirmation. Though far from complete eradication, this community-led effort achieved significant success. Sustained control lowered mink densities and allowed water voles to recover in many areas, reaching population levels not seen since the 1980s. This process also deepened our understanding of predator-prey dynamics and the motivations behind public involvement in conservation. However, recovery was not immediate. Residual mink, reinvasion, and disrupted recolonization processes created time lags. Even in mink-free areas, colonization of distant habitats was rarer than expected, and the survival of small, isolated populations remained low—likely due to the lack of a "rescue effect" from neighbouring populations. Restoring rodents from the brink, even highly reproductive and mobile species like the water vole, is a gradual process. Maintaining public engagement and celebrating conservation successes are ongoing challenges, alongside the lighter task of protecting volunteers' carrots from recovering yet hungry voles.

Plenary talks

Contrasting dynamics of small desert mammals and the implications for conservation and management

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Extreme climatic events are a major abiotic driver for dryland species. However, drylands are undergoing rapid environmental change, with higher temperatures and an increase in the frequency and magnitude of extreme rainfall events. Wildfire return intervals are also predicted to decrease due to climate change, making it imperative that we understand how both biotic and abiotic interactions shape small mammal population dynamics. How small mammal populations respond across space to biotic and abiotic events may vary from where all sub-populations are synchronous or creating distinct sub-population structures across a species range. In this presentation, we will first show how the extreme rainfall events (>90th percentile) drive wildfire and the rapid 'booms' in the population of rodent species in Australian desert systems, thereby setting the scene for the general dynamics. We will then use long-term (22 years) live-trapping data of rodents and dasyurids (small insectivorous and carnivorous marsupials) across nine sites in central Australia. We tested if sub-populations are asynchronous (independent hypothesis), two sub-populations, ephemeral water sources versus open desert (Oasis hypothesis), experienced a wildfire or remained unburnt (wildfire hypothesis), three sub-populations, organised by shared rainfall gradients (productivity hypothesis), or if all sub-populations are synchronous (single population hypothesis). Secondly, we use the best fitting model to incorporate potential drivers, such as local rainfall, dominant plant cover and other species interactions that may regulate these small mammal populations. Sub-populations were shown to be synchronous (single populations hypotheses), if driven by a large-scale driver (e.g. rainfall) or asynchronous (independent hypothesis) if driven by local events, with both extrinsic and intrinsic drivers contributing at different strengths. For small insectivorous dasyurids, environmental stochasticity and interactions with other species on a local scale are more important in driving their population dynamics than intrinsic factors. In contrast, rodent and the carnivorous dasyurid populations were driven by both extrinsic and intrinsic factors that operate on the landscape scale. We will then discuss how the climate has changed in central Australia and use near-term ecological forecasting to predict short-term fluctuations in rodent and dasyurid populations to different climate scenarios. We will then use this information to build ecosystem-scale models to predict how changes in rainfall and wildfire are likely to influence the cover and productivity of the dominant vegetation and the impacts of predators on their primary native rodent prey over a 100-year timeframe. Our results show that, while vegetation cover will decline due to climate change, the primary influence on prey populations is top-down suppression. Introduced predators have the strongest negative effects on prey. Throughout the presentation, we will discuss the conservation and management implications for native small mammals and how a 'one size fits all' approach may not be appropriate.

Managing overabundant rodents

Managing overabundant rodents

Forecasting mouse plagues in Australian grain growing regions

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Irregular outbreaks of introduced house mice over large areas in southeastern Australia cause significant economic, environmental, physical and psychosocial harm to regional communities. Mouse plagues in Australia are among the most extreme global examples of boom-bust population dynamics. Further, ecological drivers of mouse abundance seem to vary mechanistically across regions. Accordingly, standard near-term ecological forecasting approaches may fall short in predicting mouse outbreaks across the entire Australian grainbelt. Here we aimed to develop new modelling tools to provide spatially-varying seasonal forecasts of mouse abundance across Australia's eastern grain growing regions. We also examined variability in drivers of mice abundance across different regions. In this presentation I will focus on antecedent rainfall, as sustained drought-breaking rains are hypothesised to be a key driver of mouse plagues. We combined different monitoring data types in a Bayesian multivariate autoregressive state-space model. In this model, we incorporated hierarchical, nonlinear distributed lagged effects of rainfall, investigating how responses vary across 'agro-ecological' zones. Mice had variable responses to rainfall across Australia, which was statistically evident in the data-rich regions. However, in regions with sparser data, rainfall effects closely resembled the average response. Nonetheless, sharing information on rainfall effects across regions allowed more accurate forecasts with lower data requirements. This new model specification avoids the need to manually select one lag period in which mice respond to antecedent rainfall, instead statistically tempering the direction and magnitude of the effect across many time periods. This added flexibility, combined with hierarchical information sharing, can improve near-term forecasts of animal abundance.

Managing overabundant rodents

In wildlife conservation and pest control, do management efforts cause the observed outcomes and show diminishing returns?

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A desirable outcome of biodiversity conservation and agricultural production is that the observed outcomes were caused by the management efforts. At high levels of effort, it is expected that diminishing returns occur – for each unit increase in effort there is a progressively smaller change in outcomes. At low levels of effort there can be accelerated losses, because of exponential growth. Effort-outcome relationships are a type of causal evidence used to increase the strength of causal inference. The aims are to evaluate evidence of management effort-outcome relationships and assess evidence for diminishing returns and accelerated losses. Relative support for a relationship between efforts and outcomes is evaluated using three models in an experimental study of rodent control and crop yield. Two models, the logarithmic and inverse models, assume diminishing returns and accelerated losses and one model, the linear model, assumes no diminishing returns and no accelerated losses. There was limited statistical support for diminishing returns and accelerated losses in the rice-rodent control analyses. The result may be an artefact of study design and small sample size. However, in comparable non-rodent studies there was widespread support (highest Akaike weights) for diminishing returns and accelerated losses. The results show there is no one “best” model of the relationship between management efforts and outcomes, so support for alternative models should be evaluated using model selection regression analyses. The effort-outcome relationship should be estimated more frequently, ideally using randomised regression-design experiments and diminishing returns and accelerated losses evaluated as part of causal inference.

Managing overabundant rodents

Improving rodent trap success using information decoys

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Interacting with traps or detection devices is critical for effective wildlife management but relies entirely on animals themselves deciding to interact. Too often, wary animals won't engage because they don't value attractants or baits highly enough, leading to ineffective control and poor detection rates. But because decision making is cognitively taxing many animals use heuristic short cuts to make their choices when weighing risks versus rewards. These heuristic decisions should also be influenced by perceptions of opportunity costs (i.e. what animals are missing out on), which can be vulnerable to misinformation to alter decision making. Here we tested whether manipulation of choice architecture that acts on perceptions of missed opportunities, can improve device engagement rates for two globally significant pest species, the black rat, *Rattus rattus*, and the house mouse *Mus musculus*, by altering their perceptions of missed opportunities. Placing a phantom decoy (highly desirable yet unavailable food option) at the entrance of tracking tunnels in bushland habitats increased rat engagement rates (not simply attractance rates) by 83% for tunnels with low-quality baits (n=271 independent tunnel locations). Placing the same decoys at wheat-baited box traps improved trap success for mice by 96% compared to wheat-baited traps without decoys (1530 traps nights in total). Decoys appeared to work in the same way as the 'sold-out effect' and 'price anchoring' works in behavioural economics for humans ie. unavailable options increase the perceived value of available options (bait in devices). These results suggest that simple information decoys to nudge animal decision-making can make meaningful improvements in wildlife detection and pest control where bait quality is not sufficient to entice animals to engage with a device.

Managing overabundant rodents

Population dynamics of the non-native house mouse (*Mus musculus*) in pasture–cropping systems, New South Wales, Australia

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The house mouse (*Mus musculus*) is an invasive species in Australia that sometimes increases to high densities, causing substantial impacts to agriculture and human health. In 2021, a severe house mouse plague affected an area of 180,000 km^2 in northern and western New South Wales (NSW), Australia. Observations by farmers suggested that the plague began in pasture habitats before spreading to crops. Given that livestock grazing accounts for 68% of NSW's land use and includes a diverse mix of non-crop habitats, it is essential to understand how these non-crop habitats influence mouse population abundance, survival and recruitment. We studied the population dynamics of house mice at four properties in central-west NSW during 2022–2024. At each property, two live-trapping grids were established ~100 m apart, one in pasture and one in crop. Mouse numbers increased significantly during the 2022/2023 summer and autumn, with the highest density estimated at 330 individuals per hectare in April 2023, and then declined to low densities for the remainder of the study. On average, mouse densities were higher in pasture than in crop. Per-capita recruitment was lower in pasture than in crop and declined with increasing rainfall. However, apparent survival was higher in pasture (0.38) than crop (0.25). Some tagged mice moved between pasture and crop grids. Motion-sensitive trail cameras were used to quantify predator activity around the mouse trapping grids. Predator detection rates varied between properties, with red foxes dominating at one property and feral cats at the other three properties. There was not a strong effect of predator detections on mouse survival. These results indicate the importance of pasture habitats for house mouse populations in the mixed grazing-cropping agricultural landscape of central west NSW.

Managing overabundant rodents

Population dynamics of rodents in Southeast Asian rice fields and their association with rainfall changes

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The battle against rodent pests is one of the main challenges for Southeast Asian rice farmers. The losses caused by rodents are higher during occasional rodent outbreak years. Outbreaks could be related to asynchronous planting followed by extreme weather events (flooding/drought). Evidence-based understanding of how rodents respond to environmental factors that influence the population dynamic is lacking. This study aimed to assess the long-term general patterns of rodent population dynamics in rice fields and identify the possible bottom-up regulation effect of rainfall and rainfall anomaly (deviation in precipitation from long-term monthly/annual means) on rodent pest species. Available trapping data from previous rodent population studies and published papers were compiled through an extensive literature review and personal interviews. The annual and monthly rainfall and rainfall anomaly data were used to test the relationship between rainfall parameters and rodent abundance. In total, twenty years of rodent population data of *Rattus argentiventer* (112 trapping sessions) in Indonesia and sixteen years of *R. tanezumi* (176 trapping sessions) in the Philippines were used for the meta-analysis. The population abundance of both *R. argentiventer* and *R. tanezumi* was higher in some years, however this did not result in a clear multi-annual pattern. Higher *R. argentiventer* populations in Indonesia were related to less rainfall whilst *R. tanezumi* populations in the Philippines were higher in response to higher rainfall and rainfall anomaly. Both rainfall and rainfall anomaly could be useful in predicting high rodent population years in rice cropping systems. This information could provide input in the development of rodent population forecast models, which in turn could help farmers to apply early rodent preventative measures.

Managing overabundant rodents

Evaluating the effectiveness of relative abundance techniques (RATs) for monitoring rodent abundance and predicting rodent damage in rice agroecosystems in the Philippines

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Rodent pest outbreaks in rice agroecosystems pose a significant threat to rice production, prompting effective monitoring tools for timely pest management actions. Relative abundance techniques (RATs) offer a cost-effective approach to monitoring rodent abundance in rice fields, yet their applicability for rodent species and local conditions in Southeast Asia remains underexplored. This study aimed to evaluate the effectiveness of several RATs, including chew cards, wax blocks, active burrow counts and giving-up density (GUD) trays, in monitoring rodent abundance and predicting rodent damage in rice fields. The effectiveness of RATs in monitoring rodent abundance (in relation to adjusted trap success) and damage (% of cut rice tillers) was evaluated in rice fields in Laguna and Nueva Ecija, Philippines (2017-2018). The optimal number of GUD stations was also assessed in Laguna and Iloilo, Philippines (2018–2021). Data were collected during the seedling, early tillering, maximum tillering, and post-harvest stages of each rice cropping season. Results indicated that rodent abundance fluctuated between crop stages, often peaking during the maximum tillering stage, preceding the reproductive phase of the rice crop. Among the RATs evaluated, GUD indices showed the strongest association with rodent abundance and tiller damage, especially during the early and max tillering stages, which would enable proactive and ecologically-based management of rodent pests, such as trapping, hunting and habitat management. Further optimization revealed that deploying eight GUD stations per field (~1ha) provided the most reliable assessment of rodent abundance and predictor of damage. While GUDs show promise as a practical monitoring tool and predictor of rodent damage, further evaluation and refinement involving the participation of both extension agents and farmers is still needed.

Managing overabundant rodents

A comparative study on the trapping efficiency of five different types of traps for rice field rodents in Sri Lanka

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Rodents pose a significant threat to rice cultivation in Sri Lanka, causing substantial yield losses. Therefore, implementing effective rodent management strategies is crucial to ensure sustainable rice production. Trapping is an environmentally friendly and sustainable method of rodent control. The present study aimed to evaluate the efficiency of five different traps: Trap type 1 (Single capture live traps), 2 (Snap traps), 3 (Small snap traps), 4 (Modified trap 1), 5 (Modified trap 2) and to identify the most effective trap for use in rice fields to control rodents. The experiment was carried out in 2023 across three distinct climatic zones: dry, intermediate, and wet. At each site, 1 ha was selected, and a total of 250 traps were arranged in five lines, with 50 traps per line. Within each line, traps were placed at 2 m intervals following a Randomized Complete Block Design (RCBD), and the five lines were considered as replicates. Rodents captured over three consecutive nights were recorded, and capture rates were expressed as percentage values. The data were arcsine-transformed and analyzed using ANOVA in SAS. In the dry zone, **Trap type 4** showed the highest trapping efficiency (37%) followed by **Trap type 5 (23%).** T**rap type 1** and 3 were the least effective (10%), followed by T**rap type 2** (20%). In both the wet and intermediate zones, **Trap type 4 (Intermediate- 42%, wet- 44%) and 5** (33% in both zones**)** showed the higher capture rates, followed by Trap type 2 **(Intermediate- 16%, wet- 15%)**. Trap type 1 **(Intermediate- 5%, wet- 4%)** and 3 **(Intermediate- 4%, wet- 4%)** showed the lowest efficacy. Based on the results, it can be concluded that t**rap types 4 and 5** are the most effective for controlling rodent populations in rice fields across different climatic zones in Sri Lanka and their effectiveness, coupled with the advantage of being non-toxic and reusable, positions them as environmentally sustainable options for managing rice field rat populations.

Managing overabundant rodents

Understanding the behaviour of black rats: year-round diel activity pattern and trap responses on a livestock farm

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Rodents such as brown rats (*Rattus norvegicus*), black rats (*Rattus rattus*), and house mice (*Mus musculus*) are known vectors and reservoirs of livestock diseases. In Japan, rodent control on livestock farms is mandatory, but black rats—the dominant species—pose particular challenges due to their climbing ability, neophobia, and the limited understanding of their ecology and behaviour. This study aimed to clarify the ecological and behavioural traits of black rats to improve management strategies grounded in natural behaviours. We conducted two surveys at a livestock farm in Ibaraki, Japan: (1) year-round camera trap monitoring to analyze diel activity patterns, and (2) behavioural observation of responses to live-capture traps, assessing the effects of trap location, season, and developmental stage. Camera traps were installed in storage rooms, barns, entrances, outdoor feed boxes, and pastures. Live traps were placed at selected sites, and 2-minute videos were recorded to assess rodent responses to traps. Individuals were classified into three developmental stages based on relative body size observed in the footage: post-weaning (smallest-sized, recently independent), juvenile (intermediate-sized), and adult (largest-sized). Black rats exhibited primarily nocturnal activity, but diel patterns varied by season and developmental stage, except in summer when patterns remained consistent. Post-weaning individuals were mostly observed in storage rooms in May–July and November–December and rarely entered traps. Juveniles interacted more frequently with bait, especially in pastures, while adults, although present across all locations, rarely touched bait or entered traps. Trap responses were influenced more by location and developmental stage than by season. The overall trap entry rate for black rats was around 30%, which was lower than the approximately 70% entry rate observed for house mice. These findings reveal behavioural variation across life stages in black rats and emphasize the importance of age- and species-specific approaches in rodent management on livestock farms.

Managing overabundant rodents

Outbreak mechanisms and prevention methods of a subterranean rodent in the eastern margin of Qinghai-Tibet Plateau

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The plateau zokor (*Eospalax baileyi*) is a typical subterranean rodent species endemic to the Qinghai-Tibet Plateau. Due to human activities and climate change, they occur in high densities in degraded grassland habitats, accelerating the process of grassland degradation and severely affecting animal husbandry production, ecological security, and regional development on the Qinghai-Tibet Plateau. Understanding the mechanism of such negative impacts of an endemic species is fundamental to developing effective management strategies. We have found that climate change significantly affects the potential distribution of the plateau zokor population. The decreased foraging cost and increased relative proportion of preferred foods after grassland degradation, coupled with environmental changes resulting from the simplification of ecosystem structure, are external factors contributing to the outbreak of the plateau zokor on the eastern margin of the Qinghai-Tibet Plateau. Changes in population characteristics and disturbance of inherent reproduction regulation by human rodent control operations have led to a decrease in the proportion of non-breeding individuals. Changes in population genetic characteristics and density-dependent spatial genetic regulation are internal factors contributing to their outbreaks. Based on these findings, we investigated the following aspects that are relevant to zokor management: 1) Effect of livestock grazing on zokor mound building. Grazing patterns significantly influence the succession of plateau zokor mounds, and by evaluating the impact of the grazing system on the mounds, the ecological control of plateau zokors can be optimized; 2) Response of zokors to predator odours. Predator odours significantly affect the behaviour, physiology, and gene expression of the plateau zokor, such information can be used for its biological control; 3) Fertility control. We analysed the antifertility effect of EP-1 and its components on plateau zokor under laboratory conditions and their fertility control efficiency on plateau zokor. The development of these novel, green prevention and control technologies provides support for the integrated management of the plateau zokor.

Managing overabundant rodents

A study on Bg 403 rice variety as a trap crop on the management of *Bandicota bengalensis* (Lesser Bandicoot Rat) in rice cultivation, Sri Lanka

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Rats, primarily *Bandicota bengalensis*, pose a significant threat to rice cultivation in Sri Lanka, leading farmers to use rodenticides despite environmental and non-target effects. Trap cropping is an environmentally sustainable pest management strategy recognized globally. A previous study at Rice Research and Development Institute, Sri Lanka, identified Bg 403 as the most preferred rice variety by *Bandicota bengalensis* under both net-house and open field conditions. This study aimed to evaluate the effectiveness of Bg 403 as a trap crop in rice fields. A field of 10 ha was divided into four blocks (2.5 ha). In each block, Bg 403 was planted early, in a 100 m² plot along the field borders allowing its panicle initiation to occur three weeks before that of a main variety: Bg 352, Bg 366, and Bg 300. From each main variety, 100 m² plot was demarcated in each block for data collection. The number of damaged and regenerated tillers was recorded for each treatment, seven days after panicle initiation, following the standard protocol for stratified random sampling of rodent damage in rice. Damage percentage data were arcsine-transformed for ANOVA in SAS, with mean comparisons performed using Tukey's test at $p<0.05$. This procedure was repeated over three consecutive rice growing seasons. There were significant differences among seasons ($F_{2,36} = 8.47$, $p = 0.0010$). Tiller damage percentage in Bg 403 was significantly higher in all three seasons (94%, 91%, 92.75%) than Bg 352 (11.5%, 5.75%, 9.25%), Bg 366 (3.5%, 1.75%, 5.25%), and Bg 300 (4%, 2%, 5%). Rats that colonized in the trap crop can be captured using appropriate trapping methods and either released to forest areas or culled. In conclusion, Bg 403 is an effective option for planting in fields before the season begins, as a trap crop, serving as an eco-friendly strategy for rat management in rice cultivation.

Managing overabundant rodents

From traps to maps: Integrating optimized habitat and distribution modelling to advance ecologically rodent based management in the Philippines, with special reference for *Rattus* species

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Effective pest management is increasingly challenged by climate and land-use changes, complicating control strategies for rodent species. Species Distribution Modelling (SDM) offers a cost-effective tool to predict how environmental variables influence species distributions. While SDM has been widely applied for various pest management globally, its use in managing *Rattus* species in the Philippines remains limited. Therefore, this study assessed the applicability of MaxEnt, the most widely used SDM, in generating predictive maps to support and optimize Ecologically Based Rodent Management (EBRM). Specifically, we addressed two critical factors that could influence SDM reliability: survey bias and sample size requirements. To address survey bias, we applied spatial background restrictions including documented islands with occurrence, IUCN range maps, road distance, and observer access limits, and evaluated their impact on *Rattus* species' model performance. Additionally, we compared random and biased background point selection methods to assess their influence on model improvement. Model accuracy was further evaluated by determining the required sample size for *Rattus* species using subsets of occurrence data representing varying sample sizes for selected *Rattus* species. Results showed that spatial background restrictions significantly influenced model accuracy. Road distance improved performance, while overly narrow buffer areas reduced it by failing to capture environmental heterogeneity. Random background sampling consistently outperformed biased methods. For reliable national-scale predictions, native *Rattus* species required at least 80 records, while invasive species models benefited from sample sizes exceeding 100 occurrences. These findings highlight the importance of correcting survey bias and ensuring adequate sample size of *Rattus* species in SDM. Optimizing these parameters enhances model reliability, facilitates the identification of high-risk areas requiring immediate intervention, and strengthens the implementation of EBRM strategies in response to ongoing environmental and climate changes. This approach may provide a scalable framework for integrating habitat-based statistical data into rodent pest management programs in the Philippines.

Managing overabundant rodents

Foraging behaviour of rice-field rats (*Rattus argentiventer*) in the presence of barn owls (*Tyto alba*) in Aceh, Indonesia

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In Indonesia, rice field rats, *Rattus argentiventer*, are a significant cause of pre-harvest rice loss. Rat damage to rice occurs annually and poses a threat to farmers throughout Indonesia, including in Aceh province, and to national food security. In an effort to reduce rat damage, communities in Aceh, have introduced barn owls (*Tyto alba*), a natural predator of rice field rats, and provided nest boxes for their shelter. The aim of this study is to investigate whether the presence of introduced barn owls has an effect on the foraging behaviour and relative abundance of rice field rats, as well as on the level of rat damage to the rice crop surrounding the owl nest boxes. The study will be conducted during two crop growth stages in the dry rice cropping season in Pidie Jaya, Aceh, in 3 sites with owls and 3 sites without owls. Each site is at least 1 km apart. In each site, rodent foraging behaviour and the perceived risk of predation in a rice field will be assessed using giving-up densities (GUDs) involving trays of sand containing pieces of coconut at 4 different distances from the field edge. In addition, rodent relative abundance will be assessed using tracking tiles and active burrow counts, and rat damage assessments will be conducted by assessing the percentage of cut rice tillers along transects. Trapping will be conducted at the end of the study to confirm the rodent species present. The study is ongoing, thus the final results along with key conclusions will be presented during the conference.

Physiology

Physiology

Gut microbes mediate rodent responses to environmental change

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Currently, Earth is facing significant challenges due to climate change. Animals must adjust their physiological, behavioural, reproductive and survival strategies to adapt to environmental change. Like humans, animals also harbour a diverse array of gut microbes. Observation of the association between gut microbes and disease in humans, first revealed that gut microbiota plays a crucial role in maintaining various physiological functions. The loss or decline of specific beneficial microbes can lead to physiological or behavioural dysfunctions in the host. It has been demonstrated that gut microbes can influence the host through multiple pathways, such as the gut-brain axis, gut-testis axis, and gut-liver axis. Therefore, it is hypothesized that gut microbes may mediate the responses of animals to environmental change. In this study, we report recent advances which reveal the roles of gut microbes in mediating the responses of Brandt's voles (*Lasiopodomys brandtii*) to photoperiod-induced seasonal breeding and density-dependent aging processes. Specifically, short photoperiod exposed microbiota suppresses seasonal reproduction in voles by elevating melatonin levels, which in turn inhibit the HPG axis and the hypothalamic Kisspeptin/GPR54 system. In addition, high-density stress increases the relative abundance of pathogenic bacteria, which upregulates the NF-κB and COX-2 pathways, leading to elevated DNA oxidative and inflammation, thereby accelerating aging of voles. Our results underscore the important role of gut microbiota in facilitating animal adaptation to a changing environment and highlight the need for further research into studying associations and mechanisms between environmental change and gut microbes in small rodents.

Physiology

Dietary shift caused dramatic diversity loss and instability of gut microbiota in Brandt's vole

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Environmental disturbances are known as key drivers of biodiversity decline and ecosystem destabilization; however, the fundamental mechanisms governing these ecological responses remain elusive, primarily stemming from a paucity of comprehensive temporal datasets with sufficient resolution to capture dynamic system behaviours. This study employed the gut microbiome of Brandt's vole (*Lasiopodomys brandtii*) as a model ecosystem to investigate how dietary transition-mediated environmental disturbances influence ecological succession dynamics over a 60-day longitudinal monitoring period. Our findings revealed that dietary transitions to nutritionally distinct diets precipitated rapid deterioration in temporal stability and α-diversity, concurrent with marked proliferation events of opportunistic pathogens, specifically during the critical 10-day transition phase following dietary modification. In contrast, diet types exerted a defining influence on the composition of gut microbiota during non-transition periods. During the transition phase, dietary shifts induced the depletion of diet-specific antagonistic microbial populations, which subsequently triggered abrupt population expansions of some opportunistic species and a decline in non-diet-specific taxa. The host's gut immunoglobulin A (IgA) level exhibited a significant upregulation shortly following the proliferation of opportunistic microbial taxa. Our findings suggest that environmental perturbations can precipitate a loss of microbial biodiversity, thereby facilitating the expansion of opportunistic species. Concurrently, the host's immune mechanisms, particularly IgA-mediated regulation, play a critical role in restoring microbial diversity and temporal stability by suppressing the overgrowth of these taxa. Our study offers novel insights into the population and community dynamics within gut microbial ecosystems, with implications for mitigating health risks in animals and humans by modulating gut microbiota in response to the frequent and accelerated dietary shifts induced by environmental change.

Physiology

Profiling the microbiota of wild rodents through high-throughput single-cell analysis

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The gut bacterial microbiota is essential for animal physiology. To comprehensively understand how the microbiota contributes to animal physiology, the composition of the microbiota should be accurately characterized. We have developed a method named BarBIQ (Barcoding Bacteria for Identification and Quantification), which classifies single bacterial cells into taxa—named herein cell-based operational taxonomy units (cOTUs)—based on cellularly barcoded 16S rRNA sequences with single-base accuracy and quantifies the cell number for each cOTU in the microbiota in a high-throughput manner. BarBIQ opened a new window to visualize both the microbiota characterization and individual constituent bacteria including unknown bacteria, which is a basis for further understanding of the mechanism of microbiota-host interactions. Thus, BarBIQ is extremely suitable to study the gut microbiota of wild animals (i.e., non-model animals) which usually have many unknown bacteria. Using BarBIQ, we accurately profiled the gut microbiota of several wild rodents (e.g., *Rattus tanezumi*, *Niviventer confucianus, Apodemus draco, Tscherskia triton*) and established significant associations between microbial diversity patterns and host phylogenetic distances. In total, we revealed approximately 8,000 bacterial 16S rRNA gene sequences, with > 90% lacking matches in established microbial databases (e.g., SILVA), indicating substantial undocumented microbial diversity in wild animal hosts. The bacteria identified in various rodent species have different 16S rRNA gene sequences, but they are closely related through phylogenetic tree analysis. This phenomenon suggests that rodent microbiota predominantly co-evolve with their hosts, implying ancestral origin from a common phylogenetic lineage with evolutionary dynamics primarily constrained within host species boundaries. Interestingly, our preliminary analyses revealed significant covariation between Bray-Curtis dissimilarities of rodent gut microbiota and log-transformed genetic distances calculated from hosts' mitochondrial genome sequences.

Physiology

Fuel source shift or cost reduction: Context-dependent adaptation strategies in closely related *Neodon fuscus* and *Lasiopodomys brandtii* against hypoxia

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Oxygen is essential for most life forms. Insufficient oxygen supply can disrupt homeostasis and compromise survival, and hypoxia-induced cardiovascular failure is fatal in many animals, including humans. However, certain species have adapted and evolved to cope with hypoxic environments and are therefore good models for studying the regulatory mechanisms underlying responses to hypoxia. Here, we explored the physiological and molecular responses of the cardiovascular system in two closely related hypoxia-adapted species with different life histories, namely, Qinghai voles (*Neodon fuscus*) and Brandt's voles (*Lasiopodomys brandtii*), under hypoxic (10% O_2 for 48 h) and normoxic (20.9% O_2 for 48 h) exposure. Kunming mice (*Mus musculus*) were used for comparison. Qinghai voles live in plateau areas under hypoxic conditions, whereas Brandt's voles only experience periodic hypoxia. Histological and hematological analyses indicated a strong tolerance to hypoxia in both species, but significant cardiac tissue damage and increased blood circulation resistance in mice exposed to hypoxia. Comparative transcriptome analysis revealed enhanced oxygen transport efficiency as a coping mechanism against hypoxia in both *N. fuscus* and *L. brandtii*, but with some differences. Specifically, *N. fuscus* showed up-regulated expression of genes related to accelerated cardiac contraction and angiogenesis, whereas *L. brandtii* showed significant up-regulation of erythropoiesis-related genes. Synchronized up-regulation of hemoglobin synthesis-related genes was observed in both species. In addition, differences in cardiometabolic strategies against hypoxia were observed in the rodents. Notably, *M. musculus* relied on adenosine triphosphate (ATP) generation via fatty acid oxidation, whereas *N. fuscus* shifted energy production to glucose oxidation under hypoxic conditions and *L. brandtii* employed a conservative strategy involving down-regulation of fatty acid and glucose oxidation and a bradycardia phenotype. In conclusion, the cardiovascular systems of *N. fuscus* and *L. brandtii* have evolved different adaptation strategies to enhance oxygen transport capacity and conserve energy under hypoxia. Our findings suggest that the coping mechanisms underlying hypoxia tolerance in these closely related species are context dependent.

Physiology

GDF15 Up-regulation in Brandt's voles hippocampus under acute hypoxia: driving metabolic reprogramming

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The hippocampus, a crucial structure within the limbic system, plays a pivotal role in learning and memory. Energy metabolism homeostasis is fundamental for maintaining its normal physiological functions. However, the hippocampus is highly sensitive to hypoxia in mammals. Under hypoxic conditions, insufficient energy supply can lead to neuronal dysfunction and subsequent cognitive decline. Growth differentiation factor 15 (GDF15), a stress-responsive cytokine, drives metabolic reprogramming through multiple mechanisms, thereby influencing adaptive changes in energy metabolism. Brandt's voles (*Lasiopodomys brandtii*) have evolved remarkable hypoxia tolerance. However, whether its neuroprotection under hypoxia relies on GDF15-mediated metabolic reprogramming remains unclear. Brandt's voles were exposed to acute hypoxia (7.5% O_2 for 6 h or 5% O_2 for 6 h) in a normobaric hypoxia chamber. Spatial learning and memory were assessed using the Morris water maze before and after hypoxia exposure. Hippocampal morphology was evaluated via Nissl staining, NeuN immunofluorescence, and GFAP immunofluorescence. Key regulatory factors in hypoxia-induced neuroprotection were identified through reference-based transcriptomics. To study GDF15 function, we generated Brandt's voles GDF15-overexpressing HT22 cells and analyzed metabolic reprogramming using molecular approaches. Following acute hypoxia (7.5% O_2, 6 h), Brandt's voles exhibited no significant changes in spatial learning/memory or hippocampal neuronal damage. However, under more severe hypoxia (5% O_2, 6 h), cognitive decline and neuronal injury were evident. Notably, both conditions activated reactive astrocytes. Transcriptomic analysis revealed that the 5% O_2 group uniquely up-regulated genes linked not only to hypoxia response and immune regulation but also to learning/memory modulation. Among these, GDF15 was significantly elevated at both mRNA and protein levels. In *vitro*, GDF15 overexpression in HT22 cells under 1% O_2 hypoxia activated the PI3K/AKT pathway and upregulated key glycolytic enzymes (HK2, PFKM, LDHA), promoting metabolic reprogramming (reduced pyruvate, increased lactate and ATP). This enhanced glycolytic flux conferred neuroprotection, improving cell viability. Under acute hypoxia, hippocampal GDF15 up-regulation in Brandt's voles activates the PI3K/AKT pathway, driving metabolic reprogramming toward glycolysis to sustain energy production. This mechanism underpins their hypoxia-tolerant neuroprotection.

Human-Wildlife-Diseases

Human-Wildlife-Diseases

Invasive species management strategies in a One Health system

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In the UK, the grey squirrel *Sciurus carolinensis* is an invasive species which threatens trees through bark stripping and wildlife through disease transmission and competition. Grey squirrels are of growing relevance to human health as reservoir hosts of both *Borrelia burgdorferi*, the agent of Lyme disease, and *Ixodes ricinus*, the tick vector which feeds on a range of animal species and people. Current strategies to manage grey squirrel populations require intense trapping and/or shooting. The impact of this control on the wider ecosystem is believed to be positive, in terms of trees and native species at least. However, the contribution of grey squirrels to the spread of Lyme disease is poorly understood and the removal of one host may alter the abundance and behaviour of other host species, thus having limited impact on the spread of ticks and disease. This project, based on a One Health approach, quantified the contribution of grey squirrels to tick and Lyme disease spread, and assessed the impact of grey squirrel removal on the disease prevalence, vector abundance and the abundance and behaviour of other potential hosts. Using camera trap surveys and blanket dragging in isolated woodlands in Cumbria, UK, we estimated grey squirrel and tick densities before and after three culling treatments: no cull, full traditional cull, and a simulated fertility treatment cull whereby only juvenile squirrels are removed from the population. Camera traps and autonomous recording units were used to assess the encounter rates and activity patterns of other vertebrate host species before and after the culling treatments. I will present the preliminary results on grey squirrel densities before and after culling treatments and the impact of grey squirrel control on the remaining vertebrate community.

Human-Wildlife-Diseases

Disease profiling of mouse populations in grain cropping regions of Australia

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Mice are reservoirs of many pathogens, including some with zoonotic potential. In Australia, house mice (*Mus musculus*) undergo irregular population outbreaks or 'plagues'. During these outbreaks, high mouse population density leads to a greater interface between humans and mice, increasing the risk of zoonotic pathogen exposure. Despite this, we have only a limited understanding of the potential pathogens mice carry in Australia, and whether pathogen profiles change before, during and after a mouse plague. Here we used meta-transcriptomics to discover novel and known pathogens of wild house mice in agricultural systems. Mouse samples were collected from Parkes, New South Wales during and after the 2021 mouse plague. We also sampled mice from sites in Victoria and South Australia when the population size was low to moderate. We investigated the difference in microbial compositions among organs (liver, gut, and lung) and temporal differences in pathogen presence in mice sampled from grain cropping regions. Bacteria were the most abundant super-kingdom among the samples. Of public health interest, *Leptospira*, *Rickettia*, *Salmonella*, and *Yersinia* species were identified in the wild mice. For eukaryotic pathogens, we found *Cryptosporidium* species, *Plasmodium* species, and *Toxoplasma gondii*. In gut samples, picornaviruses, retroviruses, and murine coronaviruses were the three most abundant virus groups. In liver and lung samples, retroviruses were more abundant than other viruses. Additionally, murine astrovirus, rodent protoparvovirus, rodent orbivirus, and lactate dehydrogenase elevating virus (LDV) were identified in liver and lung samples. Our findings indicate that Australian wild house mice carry a diverse range of potential pathogens. Further analyses are required to understand associations between pathogen read abundance and disease, and whether the pathogen profile could be used as an additional indicator to predict mouse population fluctuations.

Human-Wildlife-Diseases

Rodentgate: future rodent management for pig and poultry health

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Project RODENTGATE assessed rodent-borne pathogens, dispersal, and infection dynamics on pig and poultry farms while developing sustainable management strategies. Over two years, 675 rodents (mainly *Rattus norvegicus*, *R. rattus*, and *Mus musculus*) were trapped across partner countries (Belgium, UK, Germany, the Netherlands, Poland). Pathogen screening revealed *Lawsonia intracellularis, Brachyspira hyodysenteriae, Leptospira* spp., *Salmonella* spp., and *Campylobacter*, with prevalence rates ranging from 0% to 54.3% depending on farm type, country, and pathogen. A metagenomic study on a UK farm identified 2,300+ bacterial species, including *Chlamydia suis* and *Streptococcus suis.* Sampling confirmed *Salmonella* spp. as a key shared pathogen, with prevalence rates of 26.9% in pigs and 13.6% in rodents. Whole genome sequencing revealed monophasic *Salmonella typhimurium* dominated both populations, emphasizing rodents as reservoirs. Interestingly, *Brachyspira* and *Leptospira* were detected in rodents but not in pigs, indicating potential transmission barriers. Rodent movement was studied using capture-mark-recapture and Bluetooth loggers. Findings showed limited interaction between commensal rodents (confined to stables) and non-target rodents (in adjacent fields or forests), minimizing cross-species transmission. Rodents rarely moved between stable interiors, amplifying localized disease risks. A mathematical model simulated disease dynamics under various management strategies. Simulations showed that culling strategies, such as rodenticide use, could increase pathogen prevalence due to population rebounds and reduced immunity. Sanitation strategies, like restricting food availability, effectively reduced rodent populations and transmission, proving rodenticides unnecessary for effective control. RODENTGATE identified rodent-borne pathogens and their transmission routes in pig and poultry farms and supports targeted interventions and outbreak prevention. Innovative tools, like Bluetooth loggers and metagenomic sequencing, enhance pathogen monitoring and disease surveillance. The findings advocate sustainable, non-rodenticide strategies that reduce antimicrobial resistance and promote environmentally safe pest control, ensuring better livestock health, improved farm productivity, and strengthened public health resilience.

Human-Wildlife-Diseases

Cyclic common vole populations drive recurrent risk of tularemia in mediterranean farmland

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Wild rodents acting as zoonotic reservoirs share some predictable traits, such as small-bodies, fast life histories and synanthropic habits. Notably, many of their populations often exhibit extreme "boom-and-bust" fluctuations in abundance (outbreaks), which can be sporadic or regular (cyclic). Fluctuations in host density strongly influence disease prevalence and is a main biological feature explaining transmission and spillover risk in rodent-borne zoonoses. One such case in Europe is tularemia, the infectious disease caused by *Francisella tularensis*, a facultative intracellular gram-negative bacterium of extreme infectivity and listed as a Class A biothreat agent. Common voles (*Microtus arvalis*) are putatively key agents for this disease in NW Spain, where outbreaks of tularemia among humans are endemic in farming landscapes since 1997 (>1,600 cases). Voles are considered a main amplification-spillover agent of tularemia as epizootic and epidemic episodes coincide in time and space with vole outbreaks. However, there remains controversy on whether voles are sufficient, or even necessary, to maintain the epidemic cycle. Here I present long-term structured data to expand evidence of a temporal coincidence between vole outbreaks, prevalence of *F. tularensis* and clinical cases in humans hitherto based on one single vole outbreak. I show unprecedented field evidence on the level of lethality and of the lack of persistence of infected voles during 3 interepidemic periods. Prevalence of tularemia in cyclic voles recurrently increases during population peaks, depicting cyclic density-dependent pathogen-host dynamics. Seroprevalence in voles lags 8-months behind vole densities, implying that some individuals recover from tularemia infection. Approximately 1/3 of tularemia-infected voles may recover from infection. Data show recurrent epidemics in, and environmental contamination by common voles. Nevertheless, tularemia is not enzootic in voles, implying a role for other amplifying or non-amplifying host/reservoirs. Our work empirically confirms the pivotal role of *M. arvalis* in cyclically amplifying *F. tularensis* in NW Spain.

Human-Wildlife-Diseases

Rodents and their role in zoonotic disease transmission in a highly endemic European zone

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Rodents are important hosts for ectoparasites (ticks, mites and fleas) and are considered reservoir hosts of vector-borne pathogens causing zoonotic diseases. This study examined the prevalence and genetic diversity of tick-borne encephalitis virus (TBEV), *Borrelia, Bartonella, Rickettsia* and *Babesia* in rodents and their ectoparasites in a highly endemic European zone – Baltic countries. In total, 1,180 rodents (*Apodemus flavicollis*, *A. agrarius*, *Mus musculus*, *Micromys minutus, Clethrionomys glareolus*, *Microtus oeconomus*, *M. agrestis* and *M. arvalis)* were identified. Altogether, 1,261 ectoparasites were collected from these rodents, including 673 *Ixodes ricinus* and 127 *Dermacentor reticulatus* ticks, 550 mites of five species and 115 fleas of eight species. Conventional, semi-nested, nested and real-time PCR were used to amplify different genome regions of pathogens with sequence analysis. TBEV was detected in 74.8% of tested rodents (100% in *M. arvalis,* 77.6% in *A. flavicolli*s), and in 0.6% of *I. ricinus* and 0.4% of *D. reticulatus* ticks. *Borrelia afzelii* and *B. miyamotoi* were found in *M. arvalis* and *M. oeconomus* (4.7 %). All rodent species carried *Bartonella* (54.8%), including *B. grahamii, B. taylorii, B. tribocorum, B. coopersplainsensis, B. doshiae* and *B. rochalimae*. Among ectoparasites, *B*. *grahamii*, *B*. *taylorii* and *B.rochalimae* were detected in five flea species (29.1%), while *B. taylorii* and *B. grahamii* were also identified in mites (12.3%). *B*. *grahamii* was additionally found in *I. ricinus* ticks. The highest prevalence (28.3%) of *Rickettsia helvetica* was observed in *A. flavicollis, M. minutus* and *C. glareolus*. In addition to *R. helvetica, R. felis, R. monacensis, Rickettsia* sp. and rickettsial endosymbiont were detected in fleas (43.5%) and mites (9.3%). Only *R. helvetica* was found in *I. ricinus* ticks. *Babesia* was detected in 2.8% of rodents, circulating in *A. flavicollis, M. minutus, C. glareolus, M. oeconomus* and *M. agrestis*. Notably, the zoonotic *Babesia microti* 'Jena/Germany' strain, potentially pathogenic to humans, was identified in Lithuania with 1.6% prevalence.

Human-Wildlife-Diseases

Drivers of host-pathogen community assemblies in European forests and urban green spaces

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Major advances in the understanding of infectious diseases have been achieved in the last decades. However, the persistence and re-emergence of pathogens from wildlife continue to raise public and veterinary health concern. This study investigates the relationship between biodiversity and rodent-borne diseases in Europe, focusing on the impact of habitat alterations and concomitant biodiversity loss. We present recently collected host-pathogen data from 21 temperate forest sites and eight urban green spaces throughout five European countries, environments where rodents are abundant and human/domestic animal–wildlife interactions are likely to occur. Specimens (n=3,766) were analyzed during the period from 2020 to 2022 comprising 15 different small mammal species. Samples were screened for bacteria by either 16S rRNA sequencing or specific PCR, and for viral antibodies using immunofluorescent assays. Various pathogens from several genera including *Bartonella*, *Borrelia*, *Mycoplasma*, *Anaplasma*, *Neoehrlichia*, *Leptospira*, Orthohantavirus and Orthopoxvirus were detected at non-negligible prevalence in 11 host species. Host community composition shifted along the anthropization gradient, with more urban adapters in anthropized sites. Pathogen richness increased with an increase in host species diversity, following the “host-diversity begets parasite-diversity” hypothesis. The absence of some vector-transmitted parasites in urban areas suggests a shift in pathogen community along the anthropization gradient. Host species and host intrinsic factors were dominant explanatory variables for endoparasitic *Mycoplasma* species and Sarcocystidae, while extrinsic environmental and climatic factors were influential in explaining variations in occurrences of several vector-transmitted pathogens. The wood mouse, *Apodemus sylvaticus*, and the bank vole, *Clethrionomys glareolus*, were important connector host species in urban green spaces and temperate forests respectively. Increased host diversity, but not anthropization, correlated with a richer pathogen community. These results ultimately lead to an improved understanding of the complex host-pathogen system at the local landscape that can aid future management decisions and support the public health sector.

Human-Wildlife-Diseases

Rodent-borne pathogen dynamics and control in agricultural environments: an eco-epidemiological modeling approach

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Rodents pose a significant challenge in livestock farming, not only through structural damage but also by serving as reservoirs and vectors of pathogens that threaten both animal and human health. With increasing restrictions on rodenticide use, it is critical to explore alternative, sustainable control strategies. We present an eco-epidemiological model that couples rodent population dynamics with pathogen transmission in agricultural settings such as pig and poultry farms. The model incorporates different pathogen life-history traits, including transmission modes (direct vs. environmental) and immune responses (short-lived vs. long-lasting immunity). Grounded in empirical contact data collected from real farms, the model captures realistic host movement and interaction patterns, enhancing its applicability for practical management decisions. We compare the effectiveness of three non-chemical rodent control strategies: environmental sanitation, population culling, and fertility control. Our framework uniquely integrates both direct and environmental transmission pathways and evaluates how each strategy influences rodent abundance and pathogen prevalence. Results reveal that while transmission mode has little effect on overall outcomes, the immune response duration significantly alters control strategy performance. Sanitation proves most effective when immunity is long-lasting, whereas culling is possible when immunity wanes rapidly. Our findings underscore the importance of accounting for both host ecology and pathogen life history when designing integrated pest and disease management strategies in farming systems. This approach offers practical guidance for reducing rodent-borne disease risks in an era of declining rodenticide use.

Human-Wildlife-Diseases

Ecological and zoonotic impacts of *Rattus rattus* in Madagascar: evidence from repeated trapping across diverse habitats

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The introduction and spread of invasive rodents, particularly the black rat (*Rattus rattus*), results in significant economic, wild animal and public health threats in Madagascar. *R. rattus* has successfully colonized a wide range of habitats, including intact and degraded natural forests, where its presence is associated with declines in endemic Nesomyine rodents. In addition to ecological impacts, *R. rattus* is a known reservoir for multiple zoonotic pathogens, including *Yersinia pestis* (plague), *Leptospira* spp., and various viruses such as hantaviruses and astrovirus, thereby increasing risks of disease transmission to both wild animals and human populations. Limited ecological data and socioeconomic constraints often hinder efforts to fully assess these impacts and to identify effective control strategies. Here, we present data from repeated live-trapping sessions conducted across anthropogenic habitats, crop fields, several forest sites, and show that high-frequency of *R. rattus* trapping significantly reduces their abundance. We also provide data on potential disease transmission pathways in rural populations. Transmission risks are compared across personal networks built from different types of connections, including spatial proximity, shared land use, and name-generating surveys, where respondents identify individuals based on specific relationships, to estimate the potential for pathogens to be spread through close contact or environmental exposure. Our findings also underscore the role of invasive rodents in the rural area and their contribution to the spread on zoonotic disease.

Human-Wildlife-Diseases

Environmental risk factors and hotspot identification for rat activity in Singapore

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Rats and the spread of rat-borne diseases represent significant public health challenges faced by major cities worldwide. In Singapore, proxies of rat activity, including rat burrows, public feedback, and live rat sightings, are used to prioritize vector management. Investigating the environmental factors influencing these proxies can enhance targeted response strategies and enable proactive mitigation measures. Here, we investigated environmental determinants of rat activity across Singapore using machine learning. We created Random Forest models using the three proxies and a comprehensive set of environmental factors, including waste management, weather variations, urban population and infrastructure and vegetation indexes. SHAP (SHapley Additive exPlanations) values were then employed to determine the magnitude and direction of risk factors of each rat-activity proxy. Consistently occurring key predictors of rat activities were number of dining establishments (ranging from certified restaurants in shopping centres through to canteen food stalls in schools), improper refuse disposal, compromised bin chutes and mean age of public housing. Using these key predictors, we also identified hotspots of rat activity in Singapore, providing a robust foundation for targeted field studies to inform operational interventions, policy refinement, and optimized resource allocation. Our study provides actionable insights into factors influencing relative rat activity in a tropical urban setting, which can guide targeted strategies to mitigate rat nuisances.

Human-Wildlife-Diseases

Urban rats, hidden threats: direct genotyping of *Leptospira* using a multi-locus sequence typing approach

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Leptospira are pathogenic bacteria that can cause severe illness in humans and animals, leading to significant economic burden and public health challenges. Urban rats are important reservoirs of *Leptospira*, and the urine from infected rats can contaminate the environment - soil, water sources and surfaces - facilitating the transmission to humans and animals. While Singapore maintains high standards in sanitation and healthcare systems, the risk of rat-borne diseases remains relevant due to the challenges posed by a densely populated urban environment, tropical climate with frequent rainfall and persistent rat populations. A previous study carried out in Singapore found that approximately 42% of sampled rats were carriers of either pathogenic or intermediate *Leptospira*. However, the lack of detailed information on species and serogroups presents a knowledge gap that hinders the understanding of disease transmission dynamics. This study evaluates a culture-independent approach to enhance *Leptospira* surveillance and shorten turnaround time by using Multi-Locus Sequence Typing (MLST) for direct genotyping from rat kidney tissues. This method uses Polymerase Chain Reaction (PCR) to amplify seven *Leptospira* housekeeping genes. MLST analysis from a full seven-gene sequences provides the high-resolution that allows *Leptospira to be assigned to different* serogroups. The results confirmed the presence of *Leptospira interrogans* serogroup Bataviae and *L. borgpetersonii* serogroup Javanica in the Singapore rat population, consistent with regional reports. This approach demonstrates that MLST allows reliable *Leptospira* genotyping, providing possible serovar identification with short turnaround time. This is crucial during outbreak investigations to streamline the diagnostic process and establish source attribution.

Human-Wildlife-Diseases

Zoonotic risk at the edge: plague and leptospirosis in rodent populations in rural Madagascar 2022 - 2024

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Rodents are known to be reservoirs for zoonotic diseases, including plague and leptospirosis. Transmission to humans usually occurs through bites of infected fleas for plague and via contaminated environments for leptospirosis. In Madagascar, plague remains a major public health concern, with cases reported each year. In contrast, despite the presence of both native and invasive small mammal populations carrying pathogenic *Leptospira*, the leptospirosis burden is likely underestimated due to a lack of access to diagnostic tests. This study aimed to assess the distribution of plague and leptospirosis among rodent populations across different habitats. Small mammals were captured three times per year between 2022 and 2024 in Ambohitrakoho, a rural area of Madagascar, to monitor their abundance and disease prevalence. Blood, spleen and kidney samples were collected. Serological, bacteriological and molecular analyses were performed to detect *Leptospira* and *Yersinia pestis* infections. A total of 472 small mammals were captured: 146 *Mus musculus*, 274 *Rattus rattus* and 52 *Suncus murinus*. Of these, 234 small mammals were tested for *Leptospira* using qPCR targeting *16SrRNA* and *lfb1* genes. For plague, 290 individuals were tested using Rapid Diagnostic Test (RDT) for *Y. pestis* antigen and 413 by ELISA for anti-F1 antibody. Overall, 34.6% tested positive for *Leptospira* with the highest prevalence observed in *M. musculus* captured in rice fields. The circulating strains were identified as *Leptospira interrogans* and *L. borgpetersenii*. Regarding plague, 2.8% of the individuals, all *R. rattus*, tested positive by RDT, while 4.8%, primarily *M. musculus*,were seropositive. Co infections of *Y. pestis* and *Leptospira* were detected in three individuals: two *M. musculus* and one *R. rattus*. This study highlighted the role of the ricefield as a high-risk habitat for zoonotic diseases. *M. musculus* and *R. rattus* were the most abundant species in these areas with infected individuals predominantly found outdoors. These findings highlight the need to reconsider current rodent control strategies by expanding surveillance beyond village perimeters.

Human-Wildlife-Diseases

Structure of small mammal communities in agricultural land and communally protected forest within a plague focus in Karatu District, Tanzania

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Habitat degradation and biodiversity loss can increase disease risk by allowing competent reservoir species to dominate. Hence, maintaining healthy ecosystems with diverse communities can be a natural buffer against zoonotic disease emergence. We studied small mammal community structure in Rhotia village within Karatu District, northern Tanzania, to find out the spatial-temporal variation in species abundance, composition, diversity, richness and accumulation curves within maize crop fields and communally protected forest in the study area. We captured 1,534 individuals through Capture-Mark-Recapture techniques from October 2023 to March 2025. They comprised seven rodent species and one insectivorous species. *Mastomys natalensis* was the most abundant rodent species across study sites, mainly in the protected forest (597) as compared to maize crop fields (384), and *Graphiurus* species was the rarest (3). The forest had higher abundance (total:1060), diversity (Simpson's Diversity: 0.6362), evenness (0.6432), and also species accumulation curves indicated the possibility of detecting more species in the future, especially in the forest. There were fluctuations of abundance according to maize crop growth stages and substantial declines of all studied parameters during the dry season in the maize crop fields, however, there was less variation of the same parameters observed in the forest. Hence, the communal forest might be ideal place for small mammal gene propagation and it could aid in plague control in the area through dilution effects.

Human-Wildlife-Diseases

Mapping the harms of urban rats: a scoping review of social, economic and health impacts

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Urban rats are a growing global concern contributing to public health risks, infrastructure degradation, and vulnerabilities in the food system. This scoping review synthesises findings globally from over 50 peer-reviewed and grey literature sources to examine the breadth of harms associated with urban rat presence. Using the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) framework, we categorised reported harms into three domains: individual health impacts, economic losses (particularly in the food and housing sectors), and under-explored social harms such as stigma and fear. The most commonly studied species were *Rattus rattus* and *Rattus norvegicus*, with zoonotic disease transmission, particularly leptospirosis, emerging as a dominant concern across geographic contexts. Despite the frequency of health and economic framing, few studies offered actionable interventions, and even fewer integrated community or policy perspectives. These findings highlight a pressing gap between academic understanding and real-world management, underscoring the need for transdisciplinary, solution-oriented research on urban rodents.

Emerging technologies

Emerging technologies

Toward translation of the world's first murine gene drive: from laboratory proof-of-concept to island deployment

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Invasive rodents have notoriously devastating impacts on island ecosystems, where conventional methods of control are often costly, can harm off-target species, and may sometimes fail to eradicate problem populations. Genetic biocontrols, wherein pest animal genomes are manipulated to impact normal reproduction, offer potential alternatives that are species-specific, and in the case of gene drive, highly efficient due to mechanisms that cause biased inheritance of the drive elements. Demonstration of the first mammalian proof-of-concept gene drive (t_{CRISPR}), which leverages a natural meiotic drive in house mice (*t*-haplotype), represents a key empirical breakthrough. However, there is a critical need for ecological, behavioural, and population genetic research to progress this technology from the laboratory to a field-ready tool. Here we discuss a framework for effective translation of this technology, and present recent experimental progress using controlled crosses to transfer the t_{CRISPR} construct for laboratory lines into a wild house mouse background, evaluate competitive ability of drive-bearing mice using mating trials, and validate biased transmission of the construct. We discuss essential next steps in this research program, including plans for the first caged trials of the t_{CRISPR} mechanism.

Emerging technologies

Evaluating the eradication potential of gene drives in invasive mice and rat populations

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Engineered gene drives can suppress or eradicate populations by spreading costly genes through biased inheritance. While most research has focused on developing gene drives in mosquitoes, recent advances have shown promise in rodent models. Rodents significantly impact biodiversity, contributing to global extinctions—particularly on islands, where approximately 75% of known extinctions have occurred. Although rodenticides have been used to eradicate rodent populations on islands, these chemicals can harm non-target species and often fail on larger islands. Consequently, there is growing interest in assessing the efficacy of gene drive–based suppression in rodents. Using spatially explicit computer simulations, we demonstrate that a recently developed gene drive in mice, t_{CRISPR}, can achieve complete eradication on islands by spreading female infertility through the population. We extend this model to non-isolated mainland populations that receive ongoing immigration from neighboring areas. In this context, we evaluate the drive's potential to mitigate mouse plagues, which are a significant economic and environmental concern in Australia. Additionally, we explore the eradication potential of a newly proposed two-target Homing Rescue (HR) gene drive in rats, using recent empirical data on germline gene conversion in this species. Our results suggest that even modest gene conversion rates could achieve population eradication, offering new opportunities for gene drive development in rats.

Emerging technologies

Mouse surveillance case study using an autonomous sensing platform

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Ever since the introduction of the house mouse (*Mus musculus*) to Australia, the country has been experiencing cyclical surges in its populations. High mouse numbers cause significant economic loss particularly in the agricultural sector. Accurate monitoring of mouse populations remains a challenging task that is both resource-intensive and laborious. A device that regularly and reliably measures mouse activity will support conservation farming practices and enable more effective population management. Such a device needs to be low-cost, low-effort and suitable for deployment in a farm environment. CSIRO has developed a sensor platform for harsh environments, offering high autonomy in a relatively small package. The platform emerged from developing sensor systems for various applications with similar recurring requirements. It has been integrated into a device developed for remote monitoring of mouse activity, using a power tool battery, capacitive sensors and a camera. This device was tested in both a laboratory and in the field using wild house mice. To evaluate the device's performance in detecting house mice in the lab trial, a machine learning model was fine-tuned and applied to video footage from the trial. Data from the lab and a subsequent field trial indicate that the device detects mice in both environments, demonstrating its potential for improving ecological survey practices. This presentation will showcase the functional requirements and design of the Remote Monitoring Device for mice, the results of the lab and field trials and how the results were validated. We will also discuss a variant developed for rat monitoring in a piggery and other future use cases for the sensor platform. The successful applications of the autonomous sensor platform highlight the prospects of ecological autonomous remote sensing.

Emerging technologies

Advancing the registration of norbormide as an alternative to broad-spectrum rodenticides

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Rodent control and eradication is dependent on anticoagulants such as brodifacoum which is highly effective but bioaccumulative leading to secondary poisoning. To register an alternative rodenticide that could reduce reliance on brodifacoum requires commitment. Norbormide is an older agent which is rapidly metabolised and has unique attributes. It is 100 to 150-fold more toxic to rats than to birds, most other mammals, including humans, and justifies this investment. Its contractile effect on rat peripheral arteries and the lack of this effect in other species explains why this compound is uniquely toxic to rats. A historical database circa 1965 in over 50 species demonstrated species specificity. However, these early studies were not carried out in accordance with recent Organization for Economic Cooperation and Development (OECD) test guidelines. New studies completed in accordance with current test guidelines that enable hazard and risk classifications by regulatory agencies will enable the registration and use of norbormide for rodent management. These studies have focussed on data-gaps in chemistry, genetic toxicology, non-target toxicity, general ecotoxicity and environmental fate. Norbormide has been shown to lack genotoxicity in, *in-vitro* cell culture toxicity studies (OECD 471, 487 and 490), indicating no carcinogenic potential. Acute dermal toxicity (OECD 402) in rats is low and no dermal toxicity occurred in mice. Norbormide was shown to be non-irritant in studies in rabbits and guinea pigs (OECD 404, 406 and 407). Acute toxicity studies in rats and mice (OECD 207 and OECD 487) yielded results consistent with historical data that reported LD_{50} ranges, following oral administration for Norway rats, between 5.3 and 15.0 mg/kg. The lack of toxicity (i.e., LD_{50} > 1,000 mg/kg) previously reported in five bird species and numerous mammalian species, including rhesus monkeys has been further confirmed by ecotoxicology studies in birds, earthworms, fish and Daphnia (OECD 223, 207, 202 and 203). Field efficacy data, generated with baits containing a consistently palatable form of norbormide and results from safety testing will be presented. These studies on norbormide all demonstrate very low or no risk to human and environmental health.

Emerging technologies

Application of seasonality in designing and optimizing the data acquisition framework for rodent pest monitoring and early warning

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Accurate prediction of rodent damage in the current and the coming year has extremely important application value in rodent damage prevention and management. Time series models are highly suitable for predicting rodent damage with periodicity in a particular area. In time series data, seasonality means the existence of variations occurring at specific regular intervals shorter than a year. The occurrence range and density of rodents are crucial for damage forecasting and evaluation. Although intelligent monitoring technology has developed rapidly, it is still a difficult task to obtain such data quickly. To improve the efficiency and accuracy of rodent monitoring, it is crucial to design and refine an appropriate data collection framework and select the necessary data collection time points. We therefore analysed and compared the seasonality of reproductive activities in Brandt's voles (*Lasiopodomys brandtii*), yellow steppe lemmings (*Eolagurus luteus*) and brown rats (*Rattus norvegicus*). Seasonal indices were calculated using monthly data on pregnancy rate and gonadal developmental features in both females and males. Although different species or different geographical populations of brown rats exhibit distinct patterns, the seasonal indices of their reproductive activity can clearly reveal the starting time, the duration of rodent population breeding, and the strength of seasonality. Correlation analyses with environmental factors normalized by seasonal indices indicate that the reproductive activities of Brandt's voles and brown rats in high-latitude areas are more correlated with photoperiod changes than with temperature. The reproductive activity of yellow steppe lemmings, a species living in desert grasslands, changes synchronously with the growth of the habitat vegetation. These results provide an important basis for designing and enhancing data collection frameworks based on time series models in line with the seasonality of reproduction in a geographical population.

Emerging technologies

Application of intelligent monitoring technologies for wild rodents in agro-pastoral ecosystems in China: current status and development trends

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Wild rodents present persistent and destructive threats to agricultural and grassland ecosystems, leading to significant crop damage, rangeland degradation, and ecological imbalances. Their rapid reproduction, mobility, and unpredictable population dynamics pose challenges for effective control strategies. Conventional rodent monitoring methods, such as field surveys and manual trapping, are labour-intensive, limited in scope, and lack proactive management capabilities. Recent advancements in artificial intelligence (AI) have transformed pest surveillance with automated scalable systems. AI-driven rodent monitoring technologies focus on their potential in agro-pastoral landscapes. Applications, including computer vision for image analysis, deep learning for behaviour tracking, acoustic signal processing, and drone-mounted thermal imaging, have improved detection accuracy and operational efficiency in various environmental conditions. Integrating multiple sensor inputs, such as visual, thermal, acoustic, and environmental data, with AI-driven decision models enhances system resilience in challenging outdoor environments. By merging AI with the Internet of Things (IoT) and edge computing, real-time, low-latency, and energy-efficient monitoring systems can be developed for widespread deployment in remote agricultural and rangeland areas. Here, we present our research progress utilizing machine vision and deep learning techniques for assessing rodent monitoring and damage. Through a two-year survey involving a total of 10-individual-working days each year, we analysed the population fluctuations of yellow stepped voles (*Eolagurus luteus*) in a 10,000-hectare core area within a pasture in Wusu county. This data serves as a foundation for further research and management strategies. Additionally, we have developed a series of equipment utilizing machine vision and deep learning methods to detect and quantify the densities or biomass of plants, rodents, and raptors in grasslands. Through the integration of monitoring points, we aim to investigate the threshold of rodent population density required for ecological balance in grassland ecosystems.

Emerging technologies

Nano-encapsulation of fertility control agents: a game-changer for long-term oral contraception in rodents

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Traditional rodent control methods largely depend on rodenticides, which, while effective, have several limitations. Fertility control is emerging as a promising and sustainable solution, targeting rodent populations by reducing their birth rates. Several sterilization approaches, including plant-based compounds, steroid hormones, and immunocontraceptive vaccines, have been explored. Plant-derived antifertility agents and steroids show promise due to their oral effectiveness, but often exhibit temporary effects due to their rapid breakdown, which limits their bioavailability. Achieving effectiveness typically requires high or repeated oral doses, increasing the risk of side effects. To overcome these limitations, the development of a safe, non-toxic, and efficient delivery system capable of bypassing the body's first-pass metabolism is essential. To address these limitations, our research aimed to develop a safe, effective, and sustainable fertility control strategy using advanced drug delivery systems. We formulated novel antifertility baits by encapsulating papaya seed extract into solid lipid nanoparticles. These formulations were incorporated into a bait for oral administration (for 15 days) at 5 and 10% concentrations. The bait was developed for post-rodenticide application to maintain long-term population suppression. The innovative nanoparticle-based baits demonstrated extended antifertility effects lasting up to 105 days in male rodents under laboratory conditions. Additionally, no adverse effects were observed on body weight, vital organs, or liver function, affirming the safety of the formulations for target species. This study marks a breakthrough in sustainable rodent management. By combining advanced nanotechnology with natural and hormonal antifertility agents, we offer a non-lethal, long-term solution that reduces dependency on toxic rodenticides. However, before recommending its widespread use by farmers, large-scale field evaluations are essential to assess its efficacy under diverse agricultural conditions, determine any potential residues, and evaluate possible effects on non-target species. The development of these user-friendly, effective contraceptive baits represents a significant advancement in eco-friendly rodent control, particularly suited for agricultural and high-infestation environments.

Emerging technologies

Tiny particles, big impact: extended reproductive suppression via Quinestrol nanobait

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Rodents cause significant economic and ecological damage, yet conventional rodenticides are limited by non-target toxicity, resistance and environmental concerns. While hormone-based fertility control offers a promising alternative, existing methods lack longevity and ready-to-use, field-deployable solutions. This study develops a ready-to-use quinestrol (Q) nanoparticle-based bait for effective and long-lasting rodent fertility control. This study aimed to evaluate the long-term contraceptive effects, tissue-level changes, and safety of ready-to-use bait containing quinestrol-loaded Poly(lactic-co-glycolic acid) (PLGA) nanoparticles (QNP) in female *Bandicota bengalensis*. Female rats were orally administered bait containing either bulk quinestrol (100 ppm) or quinestrol nanoparticles (10 ppm) for five consecutive days. Animals in each group (n=6 each) were examined at 15, 45, and 75 days post-treatment. Reproductive tissues were assessed histologically, and liver enzyme levels were analysed to determine potential toxicity. Breeding trials were conducted with untreated males to assess reproductive potential. Histological examination revealed a significant increase in atretic follicles and a reduction in normal ovarian follicles in treated groups, along with pronounced uterine glandular proliferation. These effects were most persistent in the QNP group, with tissue structural alterations maintained through to day 75. Liver enzyme levels (ALT, AST, ALP, ACP) remained within normal limits, indicating no hepatic toxicity for either formulation. Breeding trials showed that QNP-treated females produced significantly fewer or no pups for up to 75 days of observation periods, compared to controls, confirming reduced reproductive capacity. The QNP formulation achieved these effects with one-tenth the dose of bulk quinestrol, demonstrating enhanced efficacy and sustained delivery. This study presents a safe and ready-to-use quinestrol nanoparticle bait that induces long-lasting contraceptive effects in *B. bengalensis*. Before recommending its use by farmers, large-scale field evaluation, residue analysis, and assessment of non-target effects are needed. If proven effective, this nanoformulation could offer a promising tool for the sustainable, non-lethal management of rodent pests in agricultural settings.

Social attitudes

Social attitudes

Recognising the multiple, interrelated human and social impacts of an Australian mouse plague

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The human and social impacts of Australian mouse plagues are not well documented despite their periodic occurrence. In 2023, two years after a significant mouse plague passed through NSW, a team of social and behavioural scientists visited several regional towns to hear from communities about their experiences of the 2021 plague event. Using a series of interviews, informal conversations and focus group discussions with farmers, householders, businesses and community organisations, the research uncovered a broad range of human and social impacts. These included personal, interpersonal, physical, psychological, social and economic. Often interrelated, and extending beyond the farm, these impacts revealed a complex system of drivers and outcomes on individuals, families, businesses and communities. While regional communities accept plague events to be a part of country life, we found residents in these communities to be fatigued, frustrated and in many cases in need of additional support for recovery, especially since residents were also recovering from drought and the COVID-19 pandemic. Our findings suggest improved coordination and capacity across government and non-government services is needed, to aid regional communities in the lead up to and following catastrophic plague events. Residents with mobility challenges and those who are isolated are particularly vulnerable to harm and injury during plague events and require targeted and timely support. All residents who participated in our research experienced levels of human, economic, and social impacts with many of these affecting community resilience and wellbeing.

Social attitudes

A model of psychosocial impacts during the 2021 NSW mouse plague

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In 2021, New South Wales faced a severe mouse plague that significantly impacted farmers and regional communities. In this analysis, we empirically investigate the perceived severity of social impacts from the plague and identify key influencing factors. An online survey (N = 1,691) assessed psychosocial impacts, including emotional states (depression, disgust), personality traits (neuroticism), perceptions of social impacts (response costs, attitudes, perceived control), and support (social, governmental). Participants were regional NSW residents from the most affected areas, recruited via a research panel (representative sample) and geo-specific social media posts (random sample); 18% identified as farmers. Descriptive results indicated that 71% of respondents reported moderate to severe impacts, and 65% agreed that controlling the mice required substantial effort, time and money. Emotional disturbance was notable, with approximately 36% of participants experiencing at least moderate depressive symptoms, which is atypical. Farmers perceived more social impacts than non-farmers, though the effect size was small, suggesting minimal differences between farmers and other members of the community. A hierarchical regression analysis revealed a robust psychological model, explaining 58% of the variance in perceived severity of impacts. The three most influential factors were *perceived response costs* (time, effort, money), *emotional disturbance* (depressive symptoms), and *disgust* associated with the smell of mice. Age was the only demographic factor influencing perceived severity of impacts, albeit weakly, with older participants reporting greater perceived severity. This behavioural model highlights the most influential factors affecting individuals within a community during the 2021 mouse plague. Results offer insights for designing future social impact and assistance programs to support regional communities during similar catastrophic events.

Social attitudes

The economic impact of the 2021 NSW mouse plague

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Mouse plagues are known to occur periodically in Australia, due to favourable environmental conditions exacerbated by climate change, with the most recent plague occurring in New South Wales, and spanning Queensland and Victoria in 2021. Although mouse plagues occur sporadically in Australia, their economic impact on Australian communities remains under studied. Consequently, to understand the economic impact, as well as consider the optimal mouse control methods, economic data (N = 1,691) were collected in New South Wales, using probabilistic and convenience sampling techniques. Cost analysis was then conducted to estimate the economic impact of the 2021 mouse plague on households (n = 1,691), farms (n = 306), and businesses or facilities (n = 183). Furthermore, optimization techniques were used to identify the optimal crop damage abatement level. The total cost of the mouse plague was found to be Australian dollar (A$) 100,620,695 with crop yield losses and value of labour spent by households cleaning after the mess made by the mice comprising 39.3% and 16.5% of the total cost, respectively. The societal cost was estimated to be A$ 660,106,860 when only crop yield losses in the entire state of New South Wales and government expenditures were considered. Moreover, the study revealed that use of more efficient mouse control options was needed as it resulted in cost savings. Considering the high impact of the mouse plague on farm production, the study recommends the need for more rigorous mouse control and damage predictions to reduce the likelihood of mouse plagues and forestall the wider economic impact in the future.

Social attitudes

Living with mice: perspectives on mice and mouse management from a South Australian community case study.

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Living with mice can be challenging. For centuries, the house mouse has thrived alongside humans, contributing to pre- and post-harvest losses in agriculture and the spread of disease. House mice have accompanied us on travels far outside their native ranges, where they have caused immeasurable damage to native biodiversity and continue to hamper efforts to protect and restore threatened ecosystems. In response, we have developed diverse tools and strategies to manage mouse populations, including exclusion fencing, simple traps, poisoned baits, and biological controls. Additionally, genetic biocontrol methods, such as gene drives, and higher concentration ZnP baits are actively being researched and may be on the horizon. Considering these ongoing impacts and developments, this presentation examines community perspectives on current and future mouse management. Drawing from interviews and focus groups with diverse members of the community across differently mouse-affected regions of South Australia, I present findings about how participants experience and manage mice as pests, and their preferences for future mouse management. The results go beyond elucidating attitudes towards individual management methods and offer perspectives on decision making and community-level practices. These insights from South Australian community members inform specific recommendations for novel and existing mouse management strategies, including novel gene drive design and implementation. The findings also highlight critical directions for future community engagement efforts that can help align mouse management with societal values, expectations, and concerns.

Social attitudes

Pestilence and power: rat control, identity formation, and statecraft across Bermuda, Virginia, and New York City

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This research traces how rat infestations have served as flashpoints for identity formation, state authority, and ideological cohesion across four case studies: 17th-century Bermuda, early 20th-century Virginia, 18th-century Virginia, and 21st-century New York City. "Tempest of Pestilence" examines how Bermuda's ecological crisis in the 1610s fueled a colonial identity rooted in Puritan theology, survivalist governance, and interpretations of divine judgment. "The Pied Piper's Patriots" analyzes early 20th-century Virginia's anti-rat campaigns, revealing how public schools became tools for embedding civic nationalism, blending public health messaging with wartime propaganda. Ongoing research into 18th-century Virginia investigates economic, labor, racial, and regional dynamics surrounding the College of William & Mary, the Bray School, and the revolutionary ideologies of the period. Particular attention is given to how institutions like the Bray School sought to persuade enslaved students to accept their circumstances as divinely ordained, linking pest control discourses to the broader construction of the social "other." Here, the figure of the pest parallels how enslaved individuals were positioned within colonial hierarchies of value, exclusion, and identity formation, continuing trajectories explored in earlier work. Current case studies of 21st-century New York City focus on the city government's response to rat infestations, analyzing how official rhetoric, public health initiatives, and infrastructural policies frame questions of environmental justice, urban inequality, and civic belonging. Across these contexts, pest control campaigns—whether framed through religion, nationalism, or public health—emerge as powerful instruments for reinforcing authority, unifying communities, and transforming ecological threats into vehicles for cultural and political consolidation. By centering nonhuman actors within colonization, capitalism, and urbanization histories, this project contributes to broader discussions on multispecies history and the socio-political dimensions of environmental crises.

Social attitudes

Walking towards EBRM within poor urban settings: a comparative analysis of knowledge, attitudes and perceptions on rodent issues in Benin, Madagascar and Niger

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Rodents are well known for being major agricultural pests and/or reservoirs of zoonotic pathogens and as such, they represent a major issue in terms of management especially in urban contexts of developing countries. Here we present, in a comparative way, KAP (**Knowledge, Attitudes and Perceptions)** results obtained in three different African countries, that aim at exploring opportunities and constraints for Ecologically-Based Rodent Management (EBRM) in African cities, with special emphasis on slums. KAP data were collected through individual surveys and focus groups and analyzed using gtsummary R-package. Firstly, we found that, in terms of respondents' profile, females largely dominated (81.07%, $p<0.001$) the sample. Across the three countries investigated, the presence of rodents in human dwellings was reported in 94% of the responses on average (range 90 - 100%) while 55% found that, when present in houses, they are mainly associated with waste and livestock. However, 86.9% of the respondents considered rodents as major pests causing damage on food stocks, clothes, infrastructure and other valuable items including bank notes. In contrast, significant differences between countries were observed concerning the respondents' awareness of health problems associated with rodents. Indeed, in Madagascar almost 98% of the respondents know that plague risks are associated with rodents whereas in Benin and Niger there was no mention of the link between rodents and health problems. A large majority of respondents (94.6%) were in favour of the need to control rodents. Among rodent control methods recorded across the three countries, the use of poison seems to be the most common (61.8%), far ahead of use of traps (27.3%) and predators (10.9%). Considering that rodents are believed to be a permanent nuisance by these African cities' inhabitants, community-based actions against rodents could be well accepted for future experimental EBRM implementation in these cities.

Behavioural ecology

Behavioural ecology

Black rats generalise across olfactory cues of different birds

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Black rats (*Rattus rattus*) are prolific nest predators and major contributors to avian population declines worldwide. As dietary generalists, black rats exploit a wide range of prey, yet in regions where they are introduced, local prey are often novel. How rats locate unfamiliar prey species remains poorly understood. Black rats rely heavily on olfaction to detect prey, but must navigate information-rich environments with limited cognitive capacity. One adaptive strategy that may facilitate their invasive success is odour generalisation—the ability to respond similarly to chemically similar cues—allowing them to overcome initial naivety toward novel prey. Odour generalisation has broad conservation implications, helping to explain the success of invasive mammals and underpinning management strategies such as olfactory misinformation, which depend on predators generalising between deployed odours and the scent of prey. In this study, we tested whether wild black rats generalise olfactory cues associated with bird nests across different bird species. We deployed nesting material from two bird species familiar to black rats, pigeons (*Colomba livia domestica*) and Japanese quail (*Coturnix japonica*), and two species evolutionarily novel to them, budgerigars (*Melopsittacus undulatus*) and zebra finches (*Taeniopygia castanotis*), across bushland and urban areas in Sydney, Australia. We had 20 replicates per bird species (half in bushland and half in urban areas), each deployed for 7 nights. We then measured the time to first visit by black rats to each nest type. Our results showed no significant difference in detection time among the bird species, indicating that black rats generalise across the olfactory cues of different birds. This rapid generalisation likely aids their foraging success in novel environments and suggests that black rats may be particularly susceptible to olfactory misinformation approaches aimed at reducing avian nest predation by invasive rodents.

Behavioural ecology

Revealing burrow secrets: a short-term study of social organisation in free-living house mice

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Social interactions are central to shaping individual fitness and often reflect non-random associations based on kinship or familiarity. In highly adaptable species such as the house mouse (*Mus musculus*), social flexibility allows individuals to form associations that reduce competition and enhance reproductive success, even in variable environments. In Australian grain growing systems, house mouse populations undergo irregular outbreaks, with social organisation increasingly recognised as a key mechanism influencing population dynamics. This study explores fine-scale social organisation in wild populations. Using passive integrated transponder (PIT) tag monitoring across two non-crop seasons, we tracked burrow visits and applied social network analysis to infer associations from repeated co-occurrences at burrows. These patterns were integrated with live-capture data on sex, age class, and relatedness to assess whether demographic factors shape social structure during the breeding season. We found that mice displayed non-random burrow use, and were more interconnected than expected by chance, with mice repeatedly using the same burrows as familiar conspecifics. Our findings provide new insights into the demographic and spatiotemporal organisation of house mouse populations and highlight the value of automated remote monitoring for inferring social organisation in small burrowing species.

Behavioural ecology

The maintenance mechanism of spatial memory in hibernating food-storing rodents: a case study of the Siberian chipmunk

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Lipid-storing hibernators survive solely on pre-hibernation fat reserves without feeding. In contrast, food-storing hibernators store food near their nests and periodically awaken to consume it. The Siberian chipmunk (*Tamias sibiricus*), a food-storing species, disperses food near its nest before hibernation and retrieves it during interbout arousal periods. Accurate spatial memory is critical for locating these caches effectively. In Shandong, the Siberian chipmunk has an average of 23 ± 7.0 hibernation bouts, with each bout lasting 3.44 ± 0.45 days and interbout arousal periods averaging 22.08 ± 3.26 hours (n=6). During deep hibernation, body temperature approximates ambient winter temperatures, and metabolic rate declines sharply. Behavioural experiments confirm precise spatial memory retention before, during, and after hibernation. 16S rDNA sequencing and metabolomics analyses reveal significant changes in caecal microbial structure and function during hibernation. Short-chain fatty acid levels decrease during torpor but rebound rapidly during interbout arousal. Serum neurotransmitter concentrations also increase and recover quickly during arousal. Proteomics studies suggest protection against myocardial ischemia-reperfusion injury. Golgi staining and Sholl analysis show increased dendritic spine number, length, and density during interbout arousal, approaching pre-hibernation levels. Transcriptomics data indicate enriched genes and pathways associated with spatial memory in the hippocampus during arousal compared to torpor. The rapid restoration of hippocampal function during interbout arousal likely underpins the Siberian chipmunk's precise spatial memory, essential for efficient food retrieval, successful hibernation, and transition into reproduction.

Behavioural ecology

Behavioural drivers of responses of introduced rats to management devices: effect of rat origin and bait station construction material

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Invasive rodents such as black rats (*Rattus rattus*) are major drivers of biodiversity loss, and mitigating their damage remains a primary conservation goal. Bait stations are widely used in suppression and eradication programmes, but these devices often reduce bait uptake. This problem largely stems from bait stations being designed with the safety of non-target species and ease of deployment in mind, rather than considering the behavioural responses of rats. To investigate potential drivers of neophobia towards bait stations, we tested whether rat responses were affected by the material of the bait station or by rat origin and prior experience. We conducted enclosure trials with 34 wild-caught black rats from urban sites with a history of control, and bushland sites without such history. Individual rats were exposed to three bait stations constructed from different materials (plastic, wood or metal) but otherwise identical in design. Using camera footage, we quantified the latency of rats to approach, interact with, and enter the bait stations. We also conducted behavioural assays to test whether an individual's response to a novel object correlated with their response to the bait station. While there was no difference in the likelihood of rats approaching or interacting with the bait station, bait station material significantly affected entry likelihood. Compared to standard plastic bait stations, rats were more likely to enter wooden bait stations and least likely to enter metal bait stations. Notably, of the ten rats that entered only one type of bait station, nine entered the wooden one, suggesting that wood may be more attractive to recalcitrant individuals. We observed a trend that bushland rats were more likely to enter bait stations than urban rats, but this was not significant. This research has implications for pest management by highlighting the potential for material choice to improve bait station efficacy.

Behavioural ecology

Multimodal information use by foraging rodents – if, when, why?

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Decisions - about foraging or anything else - are rarely based on a single piece of information. If a single smell or sound is not a wholly reliable indicator of prey availability or quality, a predator should seek additional information to decide whether to keep searching. Information-rich natural landscapes are complex, and predators will use the sensory cues available to them to hone in on prey. Using information from multiple modalities, sequentially or simultaneously, has been shown to be vital for learning about predation risk and mate recognition, but how multimodal information might influence foraging decisions is not well studied. For example, black rats, *Rattus rattus,* are a pervasive predator of nesting birds that emit visual, auditory and olfactory cues, but most experiments have only targeted olfactory cues to date. Understanding the sensory drivers of predation risk to nests and chicks would assist with developing more effective pest management strategies. I will discuss theoretical predictions for if, and then when, rodents should integrate multimodal information about prey, outlining why understanding these processes could provide new explanations for rodent foraging ecology and behaviour as well as pest impacts. I will present data from pilot studies that have aimed to develop new techniques for testing whether black rats use sound cues on their own or in combination with odour cues to find artificial nests. Understanding multimodal information use with ecologically realistic techniques has proved challenging, primarily as high-quality playback equipment for field deployment remains limited but is an important first step to developing multimodal sensory tactics for protecting vulnerable prey from rodents.

Behavioural ecology

Using game cameras to monitor Norway rat foraging and nesting behaviour in apartment buildings

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Norway rats (*Rattus norvegicus* Berkenhout) are an important pest in cities. In the northeast of the U.S., rodent control services represented 36% of the total revenue of pest management professionals (n=281 surveyed) in 2024. Rat control is difficult due to many factors. Among them is the lack of understanding of how they move inside buildings and where they nest. We aim to understand the rat movement inside buildings and their nesting behaviour. We placed multiple game cameras in basements and crawl spaces of apartment buildings in New York City, U.S. Rats were frequently found in basements and crawl spaces in the studied buildings. Rats' nesting sites included dirt floors in basements or crawl spaces, inside garbage chutes, and hollow walls. They are generally more active during the nighttime than the daytime, even though the lights are on 24 hours a day. Rats avoided contacting snap traps and bait stations placed in compactor rooms and other rooms most of the time. When offered a choice of various baits, rats preferred blank rodent bait to various rodenticide baits. They also showed preferences among the various rodenticide baits. Sealing the pathways disrupted rat movement patterns. We conclude that game cameras are a very effective tool for detecting the presence and levels of rat activity in buildings. Results are instrumental for designing location-specific rat management strategies in buildings, including eliminating pathways of movement, proper placement of traps or baits, and using alternative tools and materials to speed up the elimination process of rat infestations in buildings.

Behavioural ecology

Ultrasonic vocalizations in adult Taiwan voles (*Alexandromys kikuchii*)

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Acoustic signals are vital in animal communication, yet ultrasonic vocalizations (USVs; >20 kHz) in wild rodents remain under studied outside a few taxa (e.g., *Peromyscus*, *Microtus*). This study presents the first comprehensive description of USVs in the Taiwan vole (*Alexandromys kikuchii;* formerly *Microtus kikuchii*), a socially monogamous and genetically structured species endemic to Taiwan's alpine ecosystem. Between 2021 and 2024, we live-captured the voles and recorded their USVs in two settings (alone, accompanied by a conspecific). The portable recording chamber (30×30×30 cm) was sound-insulated and equipped with a u384 ultrasound microphone (Pettersson Elektronik AB, Sweden). We identified six distinct call types from 321 calls (out of a total of 927 calls) for which the spectrograms (viewed in Raven Pro) were clean enough for visual inspection and categorization (i.e., flat, upward, downward, chevron, complex, and frequency steps), all of which are reported in other rodent species. Adult voles were highly vocal in the presence of a conspecific, with females producing significantly more calls than males regardless of companion sex, suggesting that USVs play key roles in social interactions. Acoustic properties, analysed using Raven Pro based on 762 calls (out of a total of 927 calls) for which there was no clipping, varied significantly among phylogenetic groups, but these differences did not align with genetic or geographic distances, implying a potential role of local adaptation or plasticity. Our findings reveal both inter- and intra-population variation in USVs in Taiwan voles, and suggest these vocalizations may be involved in their social bonding or mother-pup communication. This study contributes to ongoing efforts to investigate the evolutionary and ecological significance of USVs in wild, non-model rodents.

Behavioural ecology

Vocalisation library development for nine rodent species in Mpumalanga, South Africa

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Bioacoustics has gained increasing attention in wildlife conservation as a reliable and relatively low-cost technique for monitoring biodiversity. To date, acoustic monitoring has typically been used for the identification of bats, birds, and frogs. Studies using acoustics are limited for terrestrial small mammals, especially within the Southern Hemisphere. On Telperion Nature Reserve (Mpumalanga, South Africa), there are 23 species of small mammals. We have developed vocalisation libraries for nine rodent species (family: Muridae), that are found on the reserve. We captured rodents, using live traps, and kept them for 24 hours in a field laboratory. Using ultrasonic and audible range recorders in an anechoic chamber, we collected vocalisations from the animals. Since most species did not make vocalisations in the audible range, we only present results from recordings of vocalisations in the ultrasonic range. We generated spectrograms in the programs Kaleidoscope Pro and DeepSqueak to visualise, characterise, and measure twelve metrics for all of the ultrasonic vocalisations (USVs). As a result, we developed call libraries for each species and were able to identify and describe species-specific vocalisations. Our study demonstrates the potential for using USVs to distinguish morphologically similar species. We also undertook a pilot study, testing whether acoustic recorders can capture vocalisations of free roaming terrestrial small mammals. The initial results show that we can record vocalisations of rodents in the field, confirming the potential for acoustically monitoring small terrestrial mammals. This study will serve as a catalyst for the use of acoustic monitoring to investigate distribution and occupancy of terrestrial small mammals. If successful, our methodology developed during this study could be repeated for small mammal species, that emit USVs, elsewhere in the world.

Evolutionary biology

Evolutionary biology

Integrative taxonomy reveals diversity of commensal rodents and their co-occurrence with non-commensal small mammals in urban and agricultural habitats in the eastern Free State

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A few species of murid rodents in the genera *Rattus* and *Mus* are among the most destructive pests in urban and peri-urban communities and farms and are reservoir hosts of zoonotic diseases. Little is known about the species composition and genetic diversity of commensal rats and mice or their interactions with native rodents in the study area. The study aims to determine the species composition and genetic diversity of small mammals across four distinct habitats. Rodents were trapped using 90 Sherman traps per habitat, placed 10 m apart in a 30 x 3 grid and were baited with a mixture of peanut butter and oats. In urban homesteads and buildings on farms, locally-made wire walk-in live traps were set opportunistically to collect *Rattus* individuals. PAST software was used to investigate the usefulness of skull measurements to distinguish local species of commensal and non-commensal rodents. MEGA 12 was used to analyse cytochrome-b sequences obtained from the study. A total of 42 commensal pests were trapped. Captures from urban homesteads were dominated by *R. norvegicus*, but included 14 striped mice (*Rhabdomys dilectus chakae*). In urban-edge habitats, commensal rats (*R. tanezumi* based on a single bar-coded individual) were trapped alongside striped mice. Predominantly commensal rats and striped mice are exclusively from urban homesteads and buildings on farms, whilst the striped mouse was the most frequently collected. Results demonstrated co-occurrence of two species of commensal rats with native striped mice in urban, urban-edge and agricultural habitats, suggesting an increased risk of zoonotic spillover of rodent-borne diseases.

Evolutionary biology

Spread of a single anticoagulant resistance *Vkorc1* haplotype in Asian house rats across China

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The Asian house rat, *Rattus tanezumi*, originally distributed in areas south of the Yellow River, has expanded northward into North China over the past 20 years. Anticoagulant resistance has been reported in *R. tanezumi* populations across China, significantly reducing the effectiveness of anticoagulant rodenticides. The *Vkorc1* gene is targeted by these anticoagulants, but the *Vkorc1* polymorphism in most *R. tanezumi* populations in China has remained unclear. Given the hybridization between *R. tanezumi* and *Rattus rattus*, it is hypothesized that resistance *Vkorc1* mutations in *R. tanezumi* may have been introgressed from *R. rattus*. In this study, we sequenced mitochondrial *Cyt b*, *D-loop*, and *Vkorc1* genes across 24 sampling sites and found that all *Vkorc1* and mitochondrial genes originated exclusively from *R. tanezumi*. Further analysis identified two resistance mutations, Tyr139Cys and Ala26Thr in the *Vkorc1*. The Tyr139Cys mutation was present in populations from South, Central, and North China, while the Ala26Thr mutation was restricted to the Tianmen population in Central China. Population dynamics analysis of the D-loop region revealed a dynamic population expansion in Central China, which may have facilitated the spread of *R. tanezumi* carrying Tyr139Cys. Most (32/34) resistant rats carried the same *Vkorc1* haplotype with Tyr139Cys, suggesting its spread from South to North China. The Ala26Thr originated from a separate *Vkorc1* background, suggesting it evolved independently as a *de novo* mutation. Our findings provide critical evidence that anticoagulant resistance is spreading across China through the transmission of target-gene resistance mutations, while *de novo* mutations are evolving in different *Vkorc1* haplotype backgrounds. These results highlight the resistance evolutionary patterns in *R. tanezumi* and the importance of considering *Vkorc1* resistance mutations when optimizing house rat management strategies.

Evolutionary biology

The reproductive biology of Australian hydromyine rodents

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Australia has a diversity of native mammalian species. The marsupials largely evolved on the supercontinent Gondwana whereas the rodents mainly evolved in the northern hemisphere. Approximately 60 species of native rodents occur in Australia with several species having become extinct during the last century. There are two major groups of extant native rodents: eight species of *Rattus* and approximately 50 species of hydromyine rodents. Using cell biology, this talk will summarize the basic reproduction of the hydromyines, with particular emphasis on the Hopping Mouse (*Notomys alexis*) and Plains Mouse (*Pseudomys australis*), both of which are arid zone species. Studies on the reproductive biology of sexually mature male hydromyine rodents have demonstrated that, in most cases, the relative testes mass is 1 to 3 percent of body mass. However, in most adult *Notomys* species, it is only 0.1 to 0.2 percent of body mass which suggests a monogamous breeding system. Most hydromyine rodents possess a complex spermatozoon with the head having a hook as well as two ventral processes. These ventral processes stabilize the spermatozoon during egg coat penetration. *Notomys alexis,* however, has a sperm head that is highly variable, lacks the ventral processes and has a very short apical hook. In most female hydromyines, the pregnancy length in nonlactating individuals is approximately 32 days which is around 10 days longer than that of *Mus* and *Rattus*. Hydromyine females have only four teats, which limits the number of young that can be suckled simultaneously, but in Hopping Mice periodic suckling takes place enabling up to six young to be successfully reared in the one litter. Clearly the hydromyine rodents exhibit a diverse array of reproductive biological traits that differ from introduced mice and rats. Every effort should be made to conserve these species and the habitats in which they occur.

Evolutionary biology

Failed mouse eradication on Sand Island: a case of novel rodenticide resistance?

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Anticoagulant rodenticides (ARs) are an important tool for managing invasive rodents and protecting vulnerable insular biodiversity. Despite hundreds of eradications worldwide using ARs, some efforts fail to eliminate target populations. These failures require costly re-baiting and prolong environmental impacts from both rodents and the intervention itself. One possible contributing factor is genetic mutations that confer resistance to ARs. Resistance is commonly linked to nonsynonymous single nucleotide polymorphisms (SNPs) in *Vkorc1*, a gene involved in vitamin K recycling and blood clotting. While documented in mainland mice, resistance remains untested in island eradications. On Sand Island (Kuaihelani/Midway Atoll NWR), house mice began depredating nesting adult mōlī (Laysan Albatross, *Phoebastria immutabilis*) in 2015. The U.S. Fish and Wildlife Service and Island Conservation attempted an eradication in 2023 using brodifacoum. Despite multiple rounds of bait application, the eradication failed, raising questions about why—and the potential role of rodenticide resistance. To assess whether resistance was at play, we analyzed *Vkorc1* and its paralog *Vkorc1l1* in mice collected before and after the attempt. Preliminary results from pooled whole genome sequencing of pre-eradication mice revealed four novel nonsynonymous SNPs in exon 1 of *Vkorc1*, segregating at low allele frequencies (<10%) near known resistance mutations. We also observed one non-synonymous SNP in *Vkorc1l1*—the first reported mutation in this gene for wild house mice. Sequencing is ongoing to evaluate changes in allele frequency of these SNPs in post-eradication samples, which would be consistent with selection for resistance following AR exposure. This is the first genetic assessment of resistance in a failed island eradication, emphasizing the need for genetic screening beforehand. On islands with past AR use, screening could refine eradication strategies and inform alternative measures. Rodenticide resistance also has broader implications for agriculture, infrastructure, and public health, highlighting the importance of understanding resistance in wild rodent populations.

Evolutionary biology

The genetic structure of semi-commensal rodents in urban areas (an example of the common hamster)

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Urbanization is increasingly encroaching upon various regions globally, leading to the destruction of existing natural habitats and native species. However, certain species that find the urban environment conducive to their survival are able to persist. There are three potential pathways for autochthonous species to establish themselves in urban areas: 1) species that have existed within the urban environment for a long time (commensal species); 2) species that have relatively recently colonized these environments (semi-commensal species); and 3) species that have been incorporated into urban environments as a result of urban expansion. The first case includes true commensals (mice and rats). The second and third cases include semi-commensals, which typically inhabit green spaces, including parks, gardens, squares, and cemeteries. All these species may present epidemiological risks or cause damage to residential structures. In each case, distinct mechanisms of adaptation to novel conditions are expected. The objective of this study is to investigate the settlement patterns and genetic structure of the common hamster in urban areas across three cities in Russia (Moscow, Simferopol, and Kislovodsk) and one city in Kazakhstan (Astana), using microsatellite, mtDNA and MHC markers. The presence of common hamster populations has been documented in Moscow, Simferopol and Kislovodsk for more than 100 years. Our findings indicate that the Moscow population now consists of a small dems with reduced genetic diversity in both mtDNA and microsatellite markers with the presence of one unique mitochondrial lineage. In contrast, the genetic diversity in Simferopol and Kislovodsk, where the density of the species is higher than in Moscow, remains higher. The situation in Astana is radically different. The city was colonized by the common hamster approximately 15 years ago, following significant urban transformations. Currently, only one mtDNA lineage has been identified there, with no differentiation observed in nuclear markers. The hamster population is now expanding from the city to the surrounding rural areas. This study illustrates multiple scenarios for a species' persistence in urban environments and gives clues to the underlying genetic structural changes needed to facilitate urban adaptation.

Evolutionary biology

Genetic structure and parasitic load of striped field mouse (*Apodemus agrarius*) in a megacity

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Monitoring environmental changes in cities is important to ensure their sustainable development. Habitat fragmentation is prevalent in urban areas. The evolutionary consequences of this may include genetic drift, accumulation of harmful mutations, reduced genetic diversity, and the ability to adapt to new environments. *Apodemus agrarius* is a semi-commensal species that inhabits many cities in Europe and Asia. The purpose of our study was to comprehensively assess the genetic state of this species in five Moscow parks using (1) neutral markers (cytb gene and 12 microsatellites) to assess the genetic diversity of urban populations and (2) adaptive MHC (DRB1) genes to assess the parasitic load. We found that the *A. agrarius* population inhabiting the central park (Neskuchny Park) represents the most isolated genetic cluster. The average values of allele richness and expected heterozygosity were highest in Bitsevsky Park (AR=4.906; He=0.721), located on the outskirts of the city, and lowest in Neskuchny Park (AR=3.768; He=0.607). The maximum genetic distances were between Neskuchny and other parks (8.0% - 10.4% with a geographical distance of approximately 30 km), whereas the genetic distance between suburban populations located more than 100 km from each other did not exceed 4.2%. The diversity of alleles of the DRB gene, corresponding proteins, and unique alleles was also greatest in the least urbanized area and was connected with rural populations (Bitsevsky), which may indirectly indicate the maximum parasitic load in this area. However, the effect of positive selection on DRB allele diversity was most pronounced in *A. agrarius* living in Neskuchny Park. We assume that the discovered patterns in *A. agrarius* inhabiting Moscow will be valid for other rodents inhabiting cities and will allow us to assess the speed and direction of their urban evolution.

Evolutionary biology

Ectoparasite communities of small mammals from different habitats in the eastern Free State, South Africa

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Small mammals are important maintenance hosts of ectoparasites as well as reservoir hosts for many arthropod-borne pathogens. South Africa has a rich diversity of small mammals of which several are hosts to different ectoparasite species of veterinary and human importance. However, data on ectoparasite diversity associated with small mammals are limited in South Africa. Hence, to address this lack of knowledge, the current study aimed at providing an inventory list of ectoparasites infesting small mammals in the eastern Free State. Species diversity and factors that influence the abundance and mean intensity of ectoparasites were investigated and the ectoparasites were identified using the available taxonomic keys. A total of 416 rodent species were captured from four habitats using Sherman traps and oats with peanut butter as bait. The trapped small mammals belonged to 10 genera (*Rattus*, *Rhabdomys, Gerbillicus, Mysorex, Suncus, Crocidura, Otomys, Mastomys, Mus*, and *Dendromus*). The ectoparasites were removed by small tweezers and by massaging through the rodent's fur using fingertips. The results showed that about 68% of small mammals were infested by ectoparasites with an average of 8 individual ectoparasites per host. A total of four taxa of ectoparasites (ticks, mites, fleas, lice) were identified. The identified ticks were of genera *Rhipicephalus, Haemaphysalis*, and *Hyalomma,* the mites were from family Laelapidae. One polyplex individual was also identified, while fleas consisted of *Xenopsylla, Pulex, Ctenocephalides*, and *Dinopsyllus*. Mites were the most prevalent ectoparasites occurring with a prevalence rate of 52.3% followed by fleas (45.2%) and the least louse (0.3%). *Rhabdomys* was the most abundant and most infested small mammal. Males were the most parasitized group in the study. Some species of fleas and ticks that occur in this study are also important vectors of some zoonotic diseases for many animal species, including humans. Zoonotic disease control strategies should be implemented.

Evolutionary biology

Genetic differentiation and interspecific gene introgression in Myospalacinae: a study from grassland ecosystems on the Qinghai-Tibet Plateau

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The high-altitude plateau zokors (*Eospalax baileyi*) and the low-altitude Gansu zokors (*E. cansus*) are sympatrically distributed in the grassland ecosystems of the Qinghai-Tibet Plateau (QTP). The high population density of these two species has caused damage to the grassland, severely affecting agricultural and pastoral production in the QTP region and the ecological security barrier construction of China. The unique subterranean lifestyle and distribution pattern of these two species provide a model for understanding the genetic diversity characteristics and adaptive evolution of subterranean rodents. By combining molecular marker and whole-genome sequencing technology, we analyzed the genetic diversity characteristics of QTP endemic species, plateau zokor, and investigated whether there is gene introgression between it and Gansu zokor. The results are as follows: (1) both mitochondrial DNA and microsatellite markers implied substantial genetic diversity of plateau zokor; there was significant correlation between geographical distance and genetic distance among the five populations. The population of plateau zokor had experienced recent expansion events, which was highly consistent with glaciation events, and its differentiation direction was from north to south in the eastern margin of QTP. (2) Gene introgression had occurred between plateau zokor and Gansu zokor in the two sympatric distribution areas. A number of genes related to the development of the cardiovascular system, lung development, and calcium ion transport were found in the positively selected genes introgressed into Gansu zokor from plateau zokor. These genes, which are very relevant to hypoxic adaptation, may play a pivotal role in the adaptation of the Gansu zokor to the plateau environment. Our results are of great scientific significance to the understanding of the formation and maintenance mechanism of biodiversity on the QTP and the understanding of biological adaptation model, as well as to the integrated control and management of zokors.

Ecology and conservation

Ecology and conservation

Broad-scale climate change drives population dynamics of rodents

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During the past century, the earth has been experiencing continuous climate warming and intensified human disturbances, which have caused serious ecological crises such as species extinction, biological invasion, disease transmission and resource depletion in the world. Rodents are sensitive to environment change because they own a high capacity of reproduction and dispersal. Previously, particularly before 1990's, the impact of climate change on small rodents was mainly examined at a local scale, and the role of broad-scale climate (e.g. climate warming, ENSO, NAO) was ignored. Entering the 21th century, we have seen highly disruptive impacts of climate warming and extreme climate episodes on ecosystems. At the same time, range shifts, population declines or disruption of population cycling of some small rodent species have been frequently reported and may be associated with the global change. In this study, we report our recent advances about associations of population dynamics of small rodents with climate warming, human disturbances and extreme climate events based on meta-data analysis using literature as well as our field observations. Our study highlights the role of broad-scale climate factors in explaining population dynamics of small rodents.

Ecology and conservation

Minimally invasive data collection techniques for long-term monitoring of ecosystem health using free-ranging southern African rodents as biological indicators

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Ecological studies on wildlife using minimally invasive techniques can elucidate the impacts of anthropogenic disturbance on the welfare of indigenous species and their ecosystems. These techniques inflict minimal pain on sentient individuals, ensure relatively quick recovery from induced stress, and, consequently, a rapid release of animals after sampling and long-term monitoring of biological indicator species as a measure of ecosystem health. This study assessed the effectiveness of minimally invasive research techniques by investigating the effects of anthropogenic disturbance on population dynamics, stress-related glucocorticoids, and diet selection of native rodent assemblages in the Magaliesberg Biosphere, South Africa. Population dynamics were monitored through capture-mark-recapture (CMR) using live traps, after which captured animals were weighed, sexed and identified to species level. For the investigation of stress-related endocrine correlates in rodent species, faecal samples were collected from traps for analysis. Hair was collected from captured individuals for stable isotope analysis (SIA) to assess the diet selection of rodents. The study monitored rodent species and elucidated their community structure in the Magaliesberg using CMR techniques, determining that low and intermediate levels of disturbance on natural ecosystems allow for greater biodiversity. Additionally, the study established minimally invasive methods for monitoring stress-related endocrine correlates by identifying a common enzyme immunoassay (5α-pregnane-3β,11β,21-triol-20-one) that can detect and quantify faecal glucocorticoids in six rodent species studied. Hair samples were analysed, and carbon and nitrogen stable isotope ratios were compared with local vegetation to investigate rodent diet selection. Overall findings show that minimally invasive data collection techniques allow rodent species to be efficient long-term biological indicators of ecosystem health. This ensures repeatable, long-term ecological data collection towards elucidating the impacts of anthropogenic activities on wildlife populations and their natural environments through sustainable research.

Ecology and conservation

Rodents in the Anthropocene: the importance of temporal niches

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The rapid expansion of anthropogenic activities, such as urbanisation, poses a growing threat to the functioning of natural ecosystems. Urbanisation introduces spatial disturbances such as habitat transformation, and temporal disruptions such as artificial light at night (ALAN) and the accelerated increase in ambient temperatures. Rodents are essential components of all ecosystems, and they contribute significantly to several important ecosystem services. It is generally believed that rodents are relatively resilient to changes in their environments, however the flexibility to adapt to changing environments varies with species. Our initial focus was to assess the similarity between laboratory and field results. In addition, we evaluated the response capacity of rodents to temporal environmental changes. We monitored the locomotor activity of rodents with temporal niches ranging from strictly nocturnal to diurnal, with infrared motion detectors. The animals were subjected to diverse environmental treatments, both in the laboratory and in semi-natural conditions. Nocturnal and diurnal animals typically displayed distinct responses. Diurnal animals were less active in the laboratory than in natural environmental conditions, whereas nocturnal animals showed the opposite trend. In the laboratory, simulated twilight shortened the active period of nocturnal animals, while diurnal animals showed no response. Nocturnal and diurnal animals differed in their responses to ALAN. Nocturnal animals significantly decreased their activity in an intensity-dependent manner, whereas diurnal animals showed varied, more subdued responses. Increased ambient temperatures led to increased activity in both groups. Overall, diurnal animals demonstrated more flexibility in their behaviour, whereas nocturnal animals were more affected by change. Evidently, the behaviour of animals is not dependent on a single environmental factor, but rather a complex integration of environmental and physiological traits. Some species are dependent on their temporal niches, and disruptions thereof could have fitness and biodiversity implications for wildlife.

Ecology and conservation

Reimagining small mammal monitoring: a non-invasive approach using footprint identification technology

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Small mammals, such as mice, shrews, and sengis, are vital bioindicators for biodiversity monitoring and environmental assessments in southern Africa. As integral components of terrestrial ecosystems, they reflect ecological shifts due to their small home ranges, habitat specializations, and sensitivity to environmental change. Community composition offers valuable insights into factors such as habitat complexity, productivity, and disturbances including overgrazing, trampling and the presence of invasive species. Species richness and diversity patterns across successional stages further reveal habitat integrity, with generalists dominating early and late stages, and specialists emerging in climax conditions. Indicator species also appear or disappear along this gradient. Traditional live-trapping methods are effective but resource-intensive. In pursuit of a viable alternative, we piloted Footprint Identification Technology (FIT) in South Africa as an innovative and non-invasive method. This technology uses artificial intelligence (AI) and morphometric analysis to identify small mammals by their footprints, eliminating the need to capture and handle animals. We created reference libraries for a range of small mammal species to identify tracks produced via track plates placed in the field. This study (1) strengthens the hypothesis that small mammals serve as indicators of habitat integrity, drawing on two long-term studies from the Kalahari, and (2) presents progress in FIT development for distinguishing footprints among a diverse range of captive mice, shrew, and sengi species. Results demonstrate FIT's ability to detect elusive or trap-shy species and differentiate morphologically similar taxa. We conclude that FIT offers a promising, cost-effective, and scalable alternative for monitoring small mammal communities, with significant potential for ecological research and conservation.

Ecology and conservation

Effects of habitat characteristics on the diversity and abundance of rodents in the forest ecosystem of Mt. Mingan, Dingalan, Aurora, Northern Sierra Madre, Philippines

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Studying the factors that shape mammal occupancy is essential for informing conservation and management strategies. Habitat features such as tree cover and water availability have been identified as key determinants of species abundance and diversity. These environmental variables play a crucial role in structuring communities, emphasizing the importance of habitat composition in maintaining ecosystem function and biodiversity. Therefore, this study aimed to determine the effects of various habitat characteristics on the diversity and abundance of rodent populations in Mt. Mingan, Northern Sierra Madre, Philippines. Environmental and climatic variables were assessed to determine their influence on the population of rodents in the study area near the Langawan River which measures approximately 19has; however, the study method involved establishing cage traps along a transect 1.5km to 2km in length within the 19has. Habitat disturbances such as open-dumping, tourism, land conversion (agroforestry), recreational activities, charcoal, and slash-and-burn activity in the area were also noticed. The study recorded 23 individuals belonging to three genera of *Rattus*: *Rattus everetti; Rattus tanezumi; and Rattus exulans*. The study composed of four different sampling points; Sampling Point 1 (112 meter above sea level) was agroforestry. Sampling Point 2 (119 meter above sea level) was also agroforestry. Sampling Point 3 (123 meter above sea level) was a secondary forest. Lastly, Sampling Point 4 (207 meter above sea level), a Lower Dipterocarp Forest. All four sampling points exhibited high canopy cover, indicating a well-vegetated landscape ranging from semi-open agroforestry areas to dense, mature forests. Despite varying land use, sites shared common conditions such as stable tropical temperatures, high humidity, and a combination of native and non-native tree species. This consistent canopy provides shelter and food sources, such as fruit-bearing trees. The vegetation diversity creates microhabitats that support foraging, nesting, and movement, making the area well-suited for sustaining the populations of three *Rattus* species despite different disturbance levels. On the other hand, the study revealed a strong negative relationship between *Rattus* species abundance and distance to water, their abundance increased with closer proximity to water sources. Similarly, species evenness showed a strong negative correlation with air temperature, suggesting that higher temperatures may reduce evenness, possibly due to heat stress. Overall, habitat characteristics such as forest type, elevation, proximity to water, humidity, temperature, and tree presence were found to significantly influence species richness, abundance, and distribution of three *Rattus* species in the study area.

Ecology and conservation

Small-mammal community structure in disturbed landscapes in upland Central Cordillera, Luzon Island, Philippines

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The small non-flying mammal fauna of Luzon Island, one of the largest and oldest islands in the Philippines, includes native species that exhibit tolerance to disturbance and presence of non-native species. However, we are only beginning to understand the effects of disturbance and pests on the Philippine native fauna in degraded systems. We wanted to describe small-mammal community structure in three disturbed landscapes in upland areas in the Central Cordillera region on Luzon Island. In each landscape, we employed live trapping techniques at each of three adjacent habitat types (remnant montane forest, pine stand, and agricultural area) that vary in structure and disturbance levels. After over 10,500 trap nights, set over a 2-month survey, we recorded five native species (*Apomys abrae, A. musculus, Bullimus luzonicus, Chrotomys whiteheadi,* and *Rattus everetti*), all endemic to the Philippines, and three non-native species (*R. exulans, R. tanezumi,* and *Suncus murinus*). In each landscape, native and non-native species were always present, with the latter always the most abundant. Overall and between groups (native and non-native) species assemblage, species richness, and relative abundance varied across the three landscapes and among the three habitat types. Measures of small-mammal diversity did not differ greatly across the landscapes, but at the habitat level, the highest diversities were in pine stands, and lowest in agricultural areas. These measures suggest a variable small-mammal community structure among disturbed landscapes and across habitat types. We show that degraded systems with remnant forest patches support native species, and differences in habitat structure and/or level or form of disturbance associated with a habitat type influence small-mammal community structure. Any plans to conserve endemic species should consider the role of various habitat types, especially remnant montane forest patches, and the presence of pest species in the recovery of degraded systems.

Ecology and conservation

Differential use of a keystone plant resource by small rodents in the sub-tropical Brazilian Atlantic Forest

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The araucaria pine (*Araucaria angustifolia*) is a keystone species in the Araucaria Forest of the Brazilian Atlantic Forest. Its large, energy-rich seeds (pinhões), produced in large quantities during the colder months (autumn and winter), are a key resource for many animals when other food sources are scarce. Small rodents are among the main consumers of pinhões, and seed availability is thought to influence their abundance. However, most studies treat rodents as a single functional group, limiting our understanding of interspecific dietary differences and resource use. In this study, we examined the dietary relevance of *A. angustifolia* seeds for three wild omnivorous sigmodontine rodents—*Akodon paranaensis*, *Oligoryzomys flavescens*, and *Oligoryzomys nigripes*—in the subtropical Atlantic Forest of southern Brazil. We hypothesized that the increase in pinhão consumption would lead to reduced dietary niche breadth, greater interspecific niche overlap, and increased rodent abundance during the seed production period (April–July). Rodents were live-trapped over 10 months, covering both the seed production (April–July) and non-production periods (October–February). Dietary habits were analyzed through stomach content examination, and resource availability (pinhões, other seeds and fruits, invertebrates, and plant material) was assessed in the field. Food items were grouped into five categories: pinhões, other seeds/fruits, invertebrates, plant matter, and fungi. Invertebrate consumption was higher during the non-production period for all species, particularly *for A. paranaensis*. Conversely, *Oligoryzomys* spp consumed more pinhões and showed population peaks during the fruiting period. Contrary to expectations, overall trophic niche overlap (Pianka's index) was higher than expected by chance during the non-production period only. During seed production, *Oligoryzomys* species reduced their niche breadth (Levins' index), while *A. paranaensis* expanded its diet. Our findings indicate that the studied rodents respond differently to pinhão availability, with *Oligoryzomys* spp. showing greater dependence on *A. angustifolia* seeds than the more insectivorous *A. paranaensis*.

Posters and speed talks

Poster and speed talks – Managing overabundant rodents

Rapid assessment of mouse abundance across Australia to predict house mouse outbreaks

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Feral house mice (*Mus musculus*) pose a significant challenge to Australian grain crops, with the ability to cause major economic damage throughout the crop-cycle, especially when numbers rise to plague proportions. We have reasonable ability to forecast mouse plagues at key sites with high quality mouse abundance data. However, we need to provide forecasts across the entire Australian grain growing regions in the absence of such data. Accordingly, we have developed a 'rapid assessment' survey protocol to monitor mouse populations over broad spatial scales. Rapid assessment involves the use of active burrow and chew card assessments to calculate an index of activity. These rapid assessment surveys now cover a significantly greater area than the live-trapping and Capture Mark Recapture gold standard, allowing spatially-explicit forecasts. These mouse monitoring surveys have been conducted three times a year since 2012 at key points in the crop cycle (Autumn, Winter and Spring). Since then, this method has expanded to 5 states of Australia, including three benchmark sites where live trapping is performed, and close to 200 rapid assessment sites, targeted mostly at cereal, oilseed and legume crops. This data is then used in newly developed near-term forecast models to warn growers about risk of mouse outbreak in their specific region via *Mouse Updates* that are issued and form the basis of communications and media releases. This project involves collaboration with a large network of farmers, agronomists, and Landcare groups which has evolved over the last 13 years, as well as partnerships with external contractors who complete monitoring in specific regions to improve coverage. This mouse monitoring project is a large exercise in communication, logistics and network building. The versatility of the data collection methods and strong relationships create an effective network for monitoring, plague forecasting and dissemination of information.

Poster and speed talks – Managing overabundant rodents

PESTMAP: Development of an Agent Based Model to simulate rodent movements in agricultural settings

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Rodents pose significant threats to agricultural productivity and biosecurity. In poultry production, a big threat is rodent-mediated spread of zoonotic pathogens such as Salmonella and Highly Pathogenic Avian Influenza (HPAI). This work presents an overview, details and description protocol for the development of an Agent-Based Model (ABM), PESTMAP: Pattern Evaluation and Simulation of Trajectories of Mammalian Active Pests. PESTMAP simulates rodent movement and factors such as habitat suitability, food availability, environmental and spatial dynamics in and around a poultry farm. Underlying ecological factors, including habitat types with high plant coverage, significantly influence rodent activity and behaviour, which in turn affects their interactions with livestock facilities. PESTMAP incorporates Geographic Information Systems (GIS) layers to develop spatial risk assessments based on management interventions that are founded in ecological perspectives on rodent dynamics. We hypothesize that this ABM's ability to account for behaviour of individual rodents, such as indirect competition for resources, improves the relevance of simulations of control effectiveness and disease transmission processes. This study illustrates the value of the adoption of ABMs as an effective methodology in agricultural pest management while emphasizing the critical need for understanding rodent behaviour in developing successful control strategies aimed at minimizing agricultural losses.

Poster and speed talks – Managing overabundant rodents

Preferred habitat and reproduction of introduced small mammals (*Mus musculus*, *Rattus rattus* and *Suncus murinus*) in rural villages of Analavory, highland of Madagascar

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Three species of rodent (*Mus musculus*, *Rattus norvegicus*, *R. rattus*) and two of shrew (*Suncus etruscus* and *S. murinus*) are introduced in Madagascar. These introduced rodents are considered among the most common threat to food production and human health on the island. An efficient strategy of control, based on their habitat and their reproduction, is necessary to reduce the damage due to these animals. We have undertaken live trapping studies across various seasons in nine villages of Analavory in the highlands of Madagascar and determined preferred habitats and reproductive status for three species (*Mus musculus*, *Rattus rattus* and *Suncus murinus)*. Live capture traps (BTS and Sherman) were placed in houses, in peri-domestic areas and in outside crop fields in nine villages. Embryos of pregnant females were counted to analyze their reproduction rate. In total, 2,085 individuals were captured. *R. rattus* were present in the highest number while *S. murinus* were the lowest. There was no significant variation in abundance of these species between seasons. The preferred habitat of *M. musculus* was mainly inside houses, *R. rattus* preferred the outside crop fields and S. *murinus* was found equally across the three habitats. The maximum number of embryos was 9 for *M. musculus,* 12 for *R. rattus* and 5 for *S. murinus*. Reproduction of these three species is highest during the hot-rainy season. Control efforts during the cold-dry season in fields outside of villages and continuous control inside houses could efficiently manage the population of these species.

Poster and speed talks – Managing overabundant rodents

Rodent mobility within vulnerable urban socio-ecosystems: a study in Antananarivo, Madagascar

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A large portion of Antananarivo city dwellers live in informal, unplanned settlements with limited access to basic services. These degraded socio-environments create ideal conditions for small mammals like rodents and shrews to thrive, posing risks to infrastructure, food supplies and public health. Despite numerous attempts, rodent control in urban areas has been largely ineffective. Among other issues, insufficient data on rodent movements within urban landscapes greatly limits the design of adapted control strategies due to poor knowledge of adequate intervention scales. In this study, fluorescent Rhodamine B-containing baits were used to document the straight-line distances traveled by rodents in various settings (e.g., slums, markets) of Antananarivo, Madagascar, and to explore the potential impact of some urban landscape features on movement patterns. Average straight-line distance covered by rats was 88 m, but much larger distances (up to 266 m and 250 m in *Rattus norvegicus* and *R. rattus*, respectively) were observed in many instances. Significant differences in straight-line travel distances were observed among age groups of *R. norvegicus*. Canals and paved roads did not seem to hinder rodent movements. In addition, movements between markets and their surroundings on the one hand, and between rice fields and nearby houses, on the other hand, were frequent. Overall, our findings suggest that rats regularly travel across quite long distances within the dense, complex and rather cluttered landscape of Antananarivo city. Such results provide new insights into urban rat ecology which have important implications in terms of urban rodent control within Global South urban areas, especially socio-environmentally disadvantaged ones.

Poster and speed talks – Managing overabundant rodents

Improving effectiveness in the management of Norway rats through adaptations of non-chemical alternatives

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Norway rats cause many problems by damaging infrastructure, eating or contaminating stored goods and transmitting pathogens to humans, pets and livestock. Management of rat populations in rural and urban areas is often necessary to minimise such problems. Bait with anticoagulant rodenticide is usually used for this purpose, but application can release toxins into the environment. Snap traps might be an environmentally friendly alternative to reduce the use of rodenticidal bait. This study aims to increase the effectiveness of snap traps through a field test of trap systems that considers optimal materials, entry size and transparency, to achieve the highest possible efficiency in trapping Norway rats in the farm environment that should benefit farmers, pest control operators (PCOs) and the environment. Image and video material of Norway rats were collected with camera traps before and after placing traps in and around locations on farms where rats were likely to be present. Preliminary results of ongoing fieldwork have shown that wood is not as an attractive material as previously assumed. Entry rate by rats in metal and plastic traps appeared to be higher, but this needs to be confirmed in further runs. The same is true for transparency and entry size where effects on trap access and latency are expected. A strong neophobic behaviour was observed, with the rats entering the traps after about 6-10 days after installation.

Poster and speed talks – Physiology

Variations in microbial function along density gradients in soil and the Brandt's vole gut

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The density of animals is influenced by extrinsic and intrinsic factors that determine their ecological role. Fluctuations in the density of Brandt's vole (*Lasiopodomys brandtii*) can influence their physiological role and gut microbiota. Brandt's voles interact with soil, potentially facilitating microbial exchange between their gut and the environment. The impact of rodent density on soil and gut microbial functions has been studied independently but their interaction is unexplored. Microbial functions were predicted from amplicon sequencing data of soil (n=10 per site) and gut of Brandt's voles (n=10 per site) across a density gradient in three sites; 200, 400, and 1200 burrows per hectare, low, medium, and high-density sites respectively. The soil and gut share 82% of pathways, with soil exhibiting a higher number of pathways (184) compared to the gut (155). Soil microbial functions are significantly correlated with available potassium ($P< 0.05$). In soil, the biosynthesis of secondary metabolites ($F = 3.98$, $P = 0.03$) and the metabolism of terpenoids and polyketides ($F = 4.35$, $P = 0.023$) were lower at sites with higher animal density compared to lower-density sites. The soil physicochemical factors explain 90.2% and 76.9% of the variation in soil and gut bacterial functions. Density on all three sites emerges as the primary driver of variation in both soil ($P = 0.04$) and gut ($P = 0.021$) microbial communities. The gut and soil bacterial functions were negatively correlated ($r > -0.5$, $P < 0.05$), particularly the metabolism of secondary metabolites, glycan and amino acid. The density has a positive effect on soil microbial functions (+0.17) and a negative effect on gut microbial functions (-0.02), while soil and gut have a direct positive effect on each other (+0.20). These results suggest the interdependence of soil and gut microbial functions, with population density acting as a key driver. Understanding these dynamics can provide insights into the influence of host density on soil and gut microbial functions, their mutual interactions, and implications for rodent management.

Poster and speed talks – Physiology

Gut microbiota are potentially involved in postnatal development and photo-refractoriness of gonadal activity under different photoperiodic exposure in male Brandt's vole, *Lasiopodomys brandtii*

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The gut microbiota plays a vital role in various animal physiological functions, including seasonal changes and photoperiod-induced testicular function. However, the influence of photoperiod on gut microbiota at different developmental stages and its involvement in the photorefractory response remain unclear. In this study, we analyzed the gut microbiota and gonadal activity of male voles (*Lasiopodomys brandtii*) born under long (LP) or short photoperiod (SP) using 16S rRNA sequencing at postnatal weeks 4 (PNW4; juvenile), 10 (PNW10; adult), and 19 (PNW19; photorefractory stage). We observed an increase in gut microbiota diversity during the development process, accompanied by distinct changes in microbiota species composition. Photoperiod influenced the gut microbiota of juvenile and adult voles, with a more pronounced effect on the latter. A significant correlation (Coef = 38.27, P = 0.001) was exhibited between gut microbiota and gonadal activity. Noteworthy shifts in gut microbiota were identified in male voles with different gonadal activity during the photorefractory stage, despite being subjected to the same photoperiod. The distribution of microbes revealed potential roles of Firmicutes (e.g., Lachnospiraceae, Ruminococcaceae) and Bacteroidetes in photo-refractoriness, while Rikenellaceae_RC9 and Acetatifactor may facilitate gonadal development leading to SP-refractoriness. Ruminococcaceae_NK4A214 may impede gonadal development resulting in LP-refractoriness. In conclusion, the study highlights the potential impact of photoperiod and developmental stage on gut microbiota, as evidenced by the significant correlation with gonadal activity, indicating a possible role of gut microbiota in modulating photorefractory responses.

Poster and speed talks – Physiology

Studies on the role of microglia in hypoxic injury of hippocampi of *Lasiopodomys brandtii*

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Oxygen is essential for sustaining life, and its reduced availability can adversely affect physiological functions. The brain, being highly sensitive to oxygen levels, is particularly vulnerable to hypoxia, which can result in hippocampal neuron damage and cognitive impairment. However, as a hypoxic-tolerant species, the extent of hippocampal damage and the adaptive responses of Brandt's voles (*Lasiopodomys brandtii*) under hypoxic conditions remain to be clarified. In this study, Brandt's voles were used as the research subjects and C57BL/6J mice as the control group. Behavioural and physiological approaches were employed to investigate the response patterns of hippocampal neurons and microglia under hypoxic exposure, in order to explore the hypoxic adaptation mechanism of the hippocampus in Brandt's voles. Our findings demonstrated that after C57BL/6J mice were treated with hypoxia (10% O_2 for 6 hours), their spatial learning and memory abilities exhibited a significant decline: latency and moving distance in the water maze increased significantly (n=12; P=0.007; P=0.007), number of platform traversals decreased significantly (P=0.006), spontaneous alternation rate of the Y-maze decreased significantly (n=12; P<0.0001), and new object recognition index decreased significantly (n=12; P=0.012). We also conducted immunofluorescence staining of the brain tissues after hypoxia. The results showed that after 6 hours of exposure to 10% O_2, microglia in C57BL/6J mice were activated, with an increase in Iba-1 fluorescence intensity (n=3; P=0.005). For Brandt's voles under the same hypoxic conditions, only the number of times they crossed the platform in the water maze and their new object recognition index decreased significantly (n=12; P=0.027; P=0.012). There were no significant changes in other behavioural metrics and the Iba-1 fluorescence intensity. However, after 6 hours of severe hypoxia with 5% O_2, Brandt's voles displayed significant cognitive impairment: latency and moving distance in the water maze increased significantly (n=12; P=0.004; P=0.0004), number of platform traversals decreased significantly (P=0.007), spontaneous alternation rate of the Y-maze decreased significantly (n=12; P<0.0001), and new object recognition index decreased significantly (n=12; P<0.0001). The Iba-1 fluorescence intensity increased significantly (n=3; P=0.003), indicating microglial activation. Our results confirmed that microglia were activated in C57BL/6J mice after hypoxia treatment (10% O_2 for 6 hours). However, only after more intense acute hypoxia exposure (5% O_2 for 6 hours), were the microglia of Brandt's voles activated, thereby improving their hypoxia adaptability. This indicates that Brandt's voles have better tolerance of hypoxia than C57BL/6J mice.

Poster and speed talks – Physiology

Molecular mechanism of Timp2 mediated liver hypoxia tolerance in Brandt's voles (*Lasiopodomys brandtii*)

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Hypoxia poses a serious metabolic challenge to the liver and will cause a series of physiological and biochemical reactions in cells resulting in damage. Brandt's voles experience intermittent hypoxia and tolerance, but the molecular mechanisms are not clear. Through the screening of liver hypoxia transcriptome data, it was found that gene Timp2, which is involved in the process of cell proliferation, differentiation, apoptosis and migration was highly expressed. At present, the role of the Timp2 gene in tolerance of hypoxia and its molecular mechanism requires further study. Brandt's voles (n=6) were exposed to hypoxia (10% O_2 for 12 h) in a normobaric hypoxia chamber. The correlations between the expression level of the Timp2 gene and liver morphological changes, cell apoptosis and cell proliferation caused by hypoxia treatment were detected and verified before and after hypoxia exposure. To study Timp2 function, cell lines with stable overexpression of Brandt's voles Timp2 gene were established in AML12 cells, and the differences in cell activity, apoptosis and migration ability of the overexpressed cells under exposure to hypoxia were determined. Finally, the molecular method was adopted to analyze the gene expression status of Timp2 involved in regulating possible related pathways. Brandt's vole liver cells have adapted to and are tolerant to the hypoxic environment (10% O_2 for 12 h) by regulating cell proliferation and apoptosis. Under hypoxic conditions (1% O_2 for 24 h or 1% O_2 for 48 h), the *in vitro* expression of Timp2 significantly ($P < 0.01$) increases cell activity, promotes cell migration, and inhibits apoptosis. The liver of Brandt's voles can adapt to the hypoxic environment by regulating the cell cycle and apoptosis through the Timp2 gene. Our study explored the physiological effects of hypoxia on the liver of Brandt's voles and preliminarily verified a role for Timp2 in the tolerance of hypoxia, providing data to support further study of the mechanisms of adaptation to hypoxia.

Poster and speed talks – Human-Wildlife-Diseases

Microbiome insights into zoonotic risk at wildlife-human interfaces in a transitioning landscape in Thailand

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Animal-human interfaces are critical hotspots for the emergence of zoonotic diseases, particularly in biodiverse regions experiencing rapid land-use change. In this study, we investigated the faecal microbiomes and potential pathogen transmission pathways among sympatric bats, rodents, and domestic dogs in a village of Nan Province, northern Thailand—a landscape undergoing transition from agriculture to reforestation. Rodents, known for their ecological flexibility, were present across all habitat types, from caves and forests to peri-domestic environments. Rectal swabs collected between 2021 and 2022 were analyzed using full-length 16S rRNA metabarcoding to profile bacterial communities at species level. We identified 2,142 bacterial taxa, of which 229 are potentially pathogenic to humans. Rodents exhibited the highest overall bacterial richness, particularly in village and reforestation areas. Bats harboured a greater number of potential human pathogens, despite notably high pathogen loads in *Menetes berdmorei*, a rodent species found in plantation and reforested sites. Rodents demonstrated significant shifts in microbiome composition between natural and human-influenced habitats, highlighting their role as ecological connectors at the wildlife-human boundary. To better understand the drivers of microbiome structure, we applied Hierarchical Modeling of Species Communities (HMSC), integrating host identity, habitat type, and spatial data. This approach identified rodents as key hosts for both environmental and anthropogenic microbial exchange. Our findings underscore the importance of monitoring microbiome dynamics across habitat gradients to anticipate potential zoonotic spillover risks. By focusing on microbial assemblages in ecotonal zones, this work contributes to a more nuanced understanding of pathogen ecology in changing tropical landscapes.

Poster and speed talks – Human-Wildlife-Diseases

Rickettsial diseases as an under-documented infectious risk in disadvantaged urban areas: a case study in an observatory site in Antananarivo, Madagascar

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Rickettsiae are obligate intracellular bacteria responsible for rickettsial diseases (i.e. typhus in humans). These pathogens are maintained by animal reservoirs, including rodents, and transmitted by arthropod vectors, including fleas. Once widespread and feared, rickettsioses are now neglected, and are currently considered as re-emerging worldwide. Despite this, they remain under-documented and virtually undiagnosed. In Madagascar, limited data indicate that rickettsiae circulate in reservoirs, vectors and humans. This study aimed to assess the sanitary risk associated with *Rickettsia* spp. in mammalian reservoirs and their fleas in Ankasina, a slum area of Antananarivo, Madagascar. Using targeted qPCR assays, we analyzed 527 introduced small mammals (328 *Mus musculus*, 134 *Rattus norvegicus*, 47 *Suncus murinus* and 18 *Rattus rattus*), their 685 ectoparasitic fleas (683 *Xenopsylla cheopis* and 3 *Ctenocephalides felis*) and 211 free fleas (154 *Pulex irritans*, 56 *C. felis* and 1 *X. cheopis*) collected inside house or their immediate surroundings. We found that 14% of the small mammals and/or their ectoparasitic fleas carry pathogenic *Rickettsia*, essentially *R. felis* and *R. typhi*. In addition, 14.2% of free fleas, among which mostly cat fleas *Ctenocephalides felis*, were also found to be infected by pathogenic rickettsiales, most of which were *R. felis*. Considering the omnipresence of small mammals within domestic spaces, our findings indicate that slum inhabitants are widely exposed to rodent- and flea-associated typhus. Notably, the widespread use of cats for rodent control may contribute to a largely overlooked sanitary threat in urban disadvantaged areas.

Poster and speed talks – Human-Wildlife-Diseases

Biodiversity changes in African forests and the emergence of infectious diseases: should we worry?

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Biodiversity in Afrotropical forests is declining dramatically due to deforestation and intensified bushmeat trade. At the same time there is an increased frequency of outbreaks of emerging infectious diseases (EID) that have a natural reservoir in wild small mammals. The effect of biodiversity changes on the risk of spillover of these EID to humans is not yet clear. Higher biodiversity may reduce transmission rates in the small mammal community ("dilution effect") or may facilitate it ("amplification effect"). The BIODIV-AFREID project explored these relations in different forest sites in Central Africa. We investigated a range of viral pathogens but with a focus on two contrasting EID that are of major concern: Monkeypox and Ebola virus. In areas where these EID have been reported before, we collect at sites with differences in forest degradation and bushmeat hunting and study the biodiversity of small mammal communities and the presence and prevalence of the viruses in these communities. At two field sites in the Democratic Republic of the Congo (DRC) (Boende and Kponyo) we collected 936 terrestrial mammals, 570 bats and 71 bushmeat samples. We also performed serosurveillance in local villagers who frequently contact these animals. Laboratory analyses revealed a significant diversity of paramyxoviruses (13% prevalence) across multiple rodent species. Coronaviruses were detected in 17% of bat samples and 0.5-7% of rodents and shrews, with notable genetic diversity in both alpha and beta coronaviruses. Although no active infections of Ebola or monkeypox were found, we detected anti-Ebola virus IgG antibodies in 13 bats and 38 rodents. Among the human participants, 120 individuals had IgG antibodies against at least one Ebola virus antigen, with 12 participants seropositive for two antigens of the same Ebola virus species despite no previous Ebola diagnosis. This indicates that a proportion of villagers may encounter Ebola-like viruses without experiencing severe illness.

Poster and speed talks – Human-Wildlife-Diseases

Improving urban rodent management through movement assessment in high-risk communities

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Rodent infestation remains a pressing challenge in both urban and rural settings worldwide, particularly in vulnerable settings of low- and middle-income countries. These settings often offer ideal conditions for rapid rodent proliferation, posing significant threats to public health, agriculture and infrastructure. Consequently, the implementation of effective control strategies is critical to mitigate the risks of disease transmission and economic losses associated with rodent infestations. Historically, rodent control efforts have frequently yielded suboptimal outcomes, partly due to an inadequate understanding of rodent ecology, particularly regarding the delineation of control units and appropriate bait spacing during interventions. Overlooking these ecological considerations often leads to excessive control efforts in targeted settings, followed by swift re-infestation from nearby untreated colonies. This highlights the need for a more systematic and evidence-based approach to defining control units during rodent management programs. As such, in this study, we evaluated the suitability of Rhodamine B (RhB), a non-toxic biomarker, for assessing rodent movement in a vulnerable urban community of Salvador, Brazil. We tracked rats over distances of up to 90 metres and examined whiskers of trapped rodents for the presence of RhB under a fluorescence microscope. Our results revealed that 27.9% of trapped rodents exhibited signs of RhB in their whiskers, with rodents moving up to 90 metres even in settings with abundant food, water and shelter. This innovative method offers a valuable alternative for investigating rodent movement, even in dense and complex urban landscapes. The information obtained from this study should be useful in guiding efficient rodent control programs in such communities, where traditional control efforts often lack a site-specific definition of control units. Our technique not only enhances the management of rodent infestation but also contributes indirectly to reducing the risks associated with rodent infestation, including rodent-borne disease transmission in vulnerable urban settings.

Poster and speed talks – Human-Wildlife-Diseases

From rat counts to risk counts: applying the Rat Risk Index to urban rodent management in Richmond, British Columbia

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Urban rat infestations present significant public health, environmental, and infrastructural challenges, yet municipal responses often rely on rat abundance metrics that overlook the real-world consequences of infestations. In Richmond, BC, traditional, complaint-driven pest management may be missing the areas most in need of intervention. The Rat Risk Index (RRI), proposed by Himsworth & Byers (2025), offers a framework to shift municipal focus from "rat counts" to "risk counts" by accounting for both rat presence and the harm they cause. While some cities track infestation reports, few incorporate contextual metrics such as socioeconomic vulnerability or critical infrastructure sensitivity. We explore the question: How can Richmond operationalise a harm-based rat management model that prioritises areas of highest consequence rather than just highest abundance? To answer this, we will:

- Overlay rat complaint data and environmental factors to estimate Rat Infestation Magnitude (RIM)

- Quantify health, economic and infrastructure losses caused by rat infestations

- Collaborate with the City of Richmond departments to validate, refine, and apply the RRI framework across selected control zones and across disciplines

- Use a qualitative approach to understand how different city departments interact differently with rats to create an interface that can be used in multiple capacities.

Unlike existing approaches, this model integrates public health, social equity, and urban planning into a proactive management strategy. By grounding rodent control in measurable harm, this work aims to support more equitable and effective municipal responses and offers a novel tool with multiple applications that Richmond can use to prioritise high-impact interventions.

Poster and speed talks – Human-Wildlife-Diseases

Plague in small mammals from an endemic focus of the Malagasy Central Highlands: a longitudinal survey with a special reference on black rats (*Rattus rattus*)

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Plague, a zoonotic disease caused by *Yersinia pestis*, remains a major public health threat in several parts of the world, including Madagascar. Factors underlying long-term persistence and emergence of the pathogen remain poorly understood. We implemented a longitudinal survey to provide insights into plague reservoir ecology within an endemic focus. Six trapping sessions were conducted in six different localities of the Ankazobe district from 2018 to 2020 in order to monitor small mammal communities. A total of 2,762 individuals of six species (*Rattus rattus*, *Rattus norvegicus*, *Mus musculus*, *Setifer setosus*, *Suncus murinus* and *Tenrec ecaudatus*) were caught over the six successive trapping sessions. *Rattus rattus* represented 88% of all captures, with the highest relative abundances observed during the dry season (June to August 2019). None of the micromammals tested positive for the presence of *Y. pestis*, neither with qPCR nor bacterial culture. However, 11 seropositive individuals (6 *R. rattus*, 2 *M. musculus* and 3 *S. murinus*) were retrieved following ELISA, thus leading to a global seroprevalence of 0.4%. Our study highlighted the significant influence of climatic data on the seasonal variations of *R. rattus* abundance and suggest that black rat control should be conducted before the dry season, that is, before the high reproduction period of rats, in order to reduce the number of reproducing animals and prevent subsequent increase in abundance. As three *S. murinus* and two *M. musculus* were identified as seropositive for plague in the present study, their potential role in plague eco-epidemiology in Madagascar should be explored further.

Poster and speed talks – Emerging technologies

Establishing a wild house mouse colony to support translational research for gene drive

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House mice (*Mus musculus domesticus*) are a very successful invasive species, particularly on islands where they impact sensitive ecosystems and threaten native species. Genetic biocontrols, including synthetic gene drive, offer a promising alternative to conventional methods of invasive species management. In collaboration with the University of Adelaide, the CSIRO genetic biocontrol team is undertaking essential translational research to advance a laboratory proof-of-concept gene drive mouse (t_{CRISPR}). To support this, a key step will be the establishment of captive populations to facilitate behavioural studies and validate gene drive transmission. Through controlled breeding in a captive setting, we aim to transfer the t_{CRISPR} genetic construct from lab mice (C57BL/6) into the genetic background of wild mice captured from an invasive island population (Thevenard Island, WA). The establishment of a wild-type captive breeding population poses several challenges, including initial transport, susceptibility to disease, and prolonged stress associated with human interactions that might all influence survival and reproductive success. To overcome these challenges, we looked at how we could promote captive breeding success in a wild-caught population of house mice and transfer a synthetic gene drive construct from laboratory lines into a wild-type genetic background. Individual body mass, female fecundity, and behavioural interactions in mating pairs were recorded and analysed as part of our initial mating trials to determine if wild mice could adapt to a captive environment and if a laboratory genetic construct could be successfully bred into a wild background. Having the capability to breed lines of crossbred mice with gene drive potential for genetic translational research and having the ability to maintain generations of these mice in a controlled environment is important for breeding mice for future potential deployment of t_{CRISPR} in the field.

Poster and speed talks – Social attitudes

Biological invasions of rodents in West Africa: Introducing the Wan@bi Network as a multi-stakeholder science-society interface tool

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Biological invasions are a growing global concern, exacerbating critical challenges such as biodiversity loss, food insecurity, and public health threats. Invasive rodents are among the most widespread and damaging invasive alien species (IAS), with substantial impacts on native ecosystems, agriculture, infrastructure, and human well-being. In West Africa, however, the ecological and socio-economic dimensions of rodent invasions remain largely underestimated by academic, political, and socio-economic actors. This work presents the West African Network on Biological Invasions (Wan@bi) as a collaborative, transdisciplinary platform designed to address the knowledge, awareness, and policy gaps surrounding (rodent) invasions in West Africa. Wan@bi, supported by the French National Research Institute for Sustainable Development (IRD), unites academic and operational institutions from France and four West African countries (Benin, Mali, Niger, and Senegal). The network develops joint research programs, capacity-building initiatives, and outreach activities targeting both academic and non-academic audiences. Rodents serve as a model group to explore broader dynamics of biological invasions. Since its creation, Wan@bi has implemented activities aimed at (i) raising awareness of the socio-environmental impacts of invasive rodents among diverse stakeholders, (ii) enhancing local scientific and technical capacity through workshops, lab training, and collaborative research, and (iii) promoting evidence-based practices and policies for the sustainable management of biological invasions. These efforts have led to stronger regional cooperation, increased visibility of IAS issues, and early-stage policy engagement. This was notably reflected in our network's contribution to the establishment of the first environmental surveillance platform at the Autonomous Port of Cotonou (Benin) — a multi-stakeholder initiative dedicated to the monitoring and management of invasive alien species. Wan@bi illustrates the value of an integrated, multi-actor approach to tackling biological invasions in underrepresented regions. By positioning invasive rodents as both a research model and a policy concern, the network contributes to building a robust science-society interface and a sustainable foundation for addressing IAS in West Africa.

Poster and speed talks – Evolutionary biology

From whiskers to DNA: unravelling *Rattus* diversity and its implications for urban management in Singapore

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This study presents the first comprehensive phylogenetic analysis of *Rattus* species in Singapore's urban environment, addressing the limitations of morphological identification of these important disease vectors. Morphological identification proves challenging due to characteristic variability throughout different developmental stages, natural intraspecific variation, and the presence of cryptic species that, while genetically distinct, appear morphologically similar. We analysed 147 rodent specimens collected between 2006 and 2024 using DNA barcoding techniques targeting mitochondrial genes (Cytochrome C oxidase subunit I and Cytochrome B). These specimens were initially classified morphologically as either *R. norvegicus* (n=37) or *R. rattus* (n=110). Molecular analysis confirmed the identification of *R. norvegicus* but revealed that specimens initially identified morphologically as *R. rattus* comprised three distinct species instead: *R. tanezumi* (n=1), *R. tiomanicus* (n=2), and *Rattus* R3 (n=107). This distinct *Rattus* lineage, designated as R3, aligns with previous molecular studies examining the Rattini tribe's taxonomy, where field-identified specimens, though initially classified as different species, were found to be genetically similar within the R3 clade. These findings highlight significant limitations of morphological classification and provide evidence for the presence of the cryptic *Rattus* lineage (R3) in Singapore, warranting formal taxonomic description. This improved understanding of *Rattus* species diversity in Singapore's urban environment has important implications for rodent control strategies and disease surveillance programmes, as different species may carry distinct pathogen profiles and exhibit unique ecological traits. Specifically, these findings can help to refine pathogen screening protocols by identifying species-specific disease risks. Furthermore, taxonomic insights gained from this study can support more targeted control strategies, as different *Rattus* species may differ in their nesting habits, movement pattern, feeding behaviour, and responses to rodenticides. These results contribute to the broader understanding of *Rattus* taxonomy in Southeast Asia and provide valuable insights for public health management.

Poster and speed talks – Ecology and conservation

Spatial ecology of endemic squirrels in Puerto Princesa Subterranean River National Park, Palawan Island, Philippines

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Puerto Princesa Subterranean River National Park in Palawan Island, Philippines, is a UNESCO World Heritage Site that is home to two squirrel species, the Northern Palawan Tree Squirrel (*Sundasciurus juvencus*) and the Palawan Flying Squirrel (*Hylopetes nigripes*), both of which are endemic to Palawan Island. This study presents the first ecological research focused on these two species. From March 2022 to March 2023, 30 camera traps were set up in different habitat types on the understorey stratum of the national park and 10 camera traps were set on the canopy stratum. All cameras were set without baits or lures and recorded data for 24 hours per day. Most cameras were set for 3-6 months and then moved to a different area, resulting in a total of 3882 trap-nights. There were 549 independent detections of *S. juvencus* on both the understorey and canopy strata and in a wide variety of habitat types. Meanwhile, there were only 6 independent detections for *H. nigripes*, occurring exclusively in the canopy stratum and only in forest habitat types. *S. juvencus* may be more abundant than *H. nigripes*, and *H. nigripes* may be exclusively arboreal and forest dependent. This study sheds light on the basic spatial ecology of these understudied endemic squirrels.

Poster and speed talks – Ecology and conservation

ObsMiCE, West African Observatory of small mammal indicators of environmental changes

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Formalized in 2015, ObsMiCE is based on long-standing collaborations between agents of the Institut de Recherche pour le Développement (IRD) from LPED (Laboratoire Population Environnement Développement) and CBGP (Centre de Biologie pour la Gestion des Populations) research teams, and partners from several West African countries. It aims to i) perpetuate temporal monitoring of small mammals in various ecosystems (cities and villages, agroecosystems and pastoral areas, natural habitats) initiated in the years 1970 to 2000; ii) gather, archive, analyze, and make available to the scientific community, managers and populations, the information collected; iii) develop a shared methodology for future monitoring and thus facilitate comparative studies, meta-analyses and research programs in partnership. The observatory thus provides data to answer a set of scientific questions, in connection with three priority themes, namely (1) bioinvasions, (2) the links between health (via the study of zoonoses) and environmental changes and (3) documentation of the effects of global changes on biodiversity. Other topics of interest have emerged more recently, related for example to the management of small mammal populations in agricultural and urban ecosystems. A major tool of ObsMiCE is the small mammal database hosted by the CBGP, whose summary data can be publicly accessed via http://BPM-CBGP.science.

Poster and speed talks – Ecology and conservation

Effect of bioturbation by plateau pika (*Ochotona curzoniae*) on soil carbon and nitrogen stocks in alpine meadows

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The plateau pika (*Ochotona curzoniae*), a keystone burrowing herbivore in alpine meadows of the Qinghai-Tibet Plateau, significantly influences soil nutrient cycling. A 2023 field experiment in the southeastern Qinghai-Tibet Plateau across 3 sites with 27 plots (35m×35m each) and 270 soil samples (5 replicates per plot at 0-20cm depth) systematically evaluated ecological impacts of plateau pika bioturbation across an active burrow density (ABD) gradient of 14-390 burrows/ha. By analyzing the effects of plateau pika activity on soil organic carbon (SOC), total carbon (TC), and total nitrogen (TN) in surface (0-10 cm) and deeper (10-20 cm) layers under varying ABD, results showed: SOC, TC, and TN concentrations initially increased then decreased with rising ABD, peaking at 240-330 burrows/ha. SOC and TN exhibited synchronized trends between soil depths, but deeper TC responses lagged behind surface layers. Surface soil C:N ratios decreased with higher ABD, while deeper layers showed an inverse pattern. Moderate bioturbation (ABD < 230 burrows/ha) optimized nutrient redistribution and stabilized stoichiometric relationships, whereas excessive disturbance (ABD > 330 burrows/ha) disrupted soil structure and accelerated carbon-nitrogen loss. Maintaining plateau pika populations below 230 burrows/ha effectively balances alpine meadow nutrient cycling and ecological stability. Compared to eradication strategies, science-based management of plateau pika density holds greater promise for preserving carbon sequestration capacity and ecosystem health on the Qinghai-Tibet Plateau.

Poster and speed talks – Ecology and conservation

Structural and functional responses of small mammal communities to land abandonment in a region of high biodiversity

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Small mammals are key components of many ecosystems, and being common in farmland, their communities are affected by agricultural practices. However, so far, no clear patterns have yet emerged, as the effect of farmland management varies across different spatial scales and geographic areas. We conducted small mammal live-trapping in two highly patched agricultural landscapes in south-eastern Transylvania (Romania). We aimed to assess whether the discontinuation of land cultivation and pasture grazing leads to significant changes in small mammal community structure and diversity. Our results revealed more diverse communities than similar studies in central and western Europe, with similar overall abundances. Abandonment of agricultural fields was positively related to species richness, taxonomic and functional (especially body size and reproduction) diversity and abundance, with most species showing a positive response. Its effect was stronger in pastures, where intensive grazing is a limiting factor for small mammals. Functional trait composition was also sensitive to fallowing and abandonment of grazing, which promote diurnal activity, broader niches and lower fertility. Our results highlight that small mammals benefit from the maintenance of uncultivated plots and low numbers of grazing livestock to support taxonomic and functional biodiversity with implications in ecosystem service functionality.

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