Rodent Behaviour – Session 1

Individual movement: personality–dependent spatial ecology of free-ranging bank voles

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Personality-dependent space use and movement is an emerging topic in current ecological research, but mainly concerned with large-scale movements. Individual variation in movement and space use on local scales, within the confinements of a habitat, and its ecological consequences are so far studied only sparsely. The main aim of the present study was to test whether inter-individual differences in boldness and exploration influence space use, movement patterns and microhabitat choice in free-ranging bank voles (*Myodes glareolus*, n=21). Individuals were captured and marked from three different subpopulations in North-East-Germany and inter- individual differences in boldness and exploration were quantified directly in the field with repeated standardized tests. Subsequently, space use and movement patterns were monitored via automated VHF telemetry for a period of four days, yielding on average 384 locations per individual. We found evidence for personality-dependent space use and movement in free-ranging bank voles. Bolder bank voles occupied larger home ranges and core areas, estimated via kernel density analysis, moved longer distances and spatially overlapped less with conspecifics. Furthermore we found that bold and shy individuals occupied different microhabitats (based on vegetation cover), leading to a non-random distribution of behavioural types within the habitat. Exploration only had an effect on movement distance, individuals that were quantified as thorough explorers in the personality test did not cover as much distance in their natural habitat compared to those determined by the test as superficial explorers. Taken together our results indicate the segregation of behavioural types into individual ecological niches in bank voles. Thus, results strongly hint towards inter-individual differences having relevant ecological consequences which might be greatly important for ecological interactions within-and between species and the shaping of local biodiversity.

Rodent Behaviour – Session 1

The effect of animal personality on virus transmission in *Mastomys natalensis*

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Consistent differences in behaviour between individuals (i.e. animal personality) can affect fitness in a wide variety of species, including susceptibility to parasitism and pathogen infection. Indeed, individuals with a certain personality type could have a disproportional effect on the transmission dynamics. Studying the effects of animal personality on pathogen transmission is useful for epidemiological models and, in case of zoonotic diseases, for human health as well. Thus, good knowledge about the behavioural ecology of personality is required. Here, we used multimammate mice (*Mastomys natalensis*), a common pest species in sub-Saharan Africa and host for several zoonotic pathogens, such as *Lassa* virus, as a model system. Data were collected in Morogoro, Tanzania, between May and October 2017 in three 0.5 ha enclosures. During this period, we repeatedly recorded the behaviour of 207 individuals using the hole board test. We found that *Mastomys natalensis* expressed two personality traits: exploration of the holes in the arena (R=0.22, 95% CI: 0.15–0.27) and a jumping-grooming continuum (R=0.41, 95% CI: 0.36–0.44). These two personality traits where independent of each other and did not form a behavioural syndrome. However, both traits where significantly correlated with population density, where individuals became more explorative when density increased and spend less time grooming. There was no significant effect of individual differences in plasticity, suggesting that each individual reacts similar to these changes. Interestingly, home range size was not affected by these personality traits, but home range overlap was: individuals that consistently groomed more often had a larger overlap than those that did not. This may suggest these individuals may have a higher probability to come into contact with other individuals and infected excretions and hence become infected themselves. All together, these results may be important to understand changes in the transmission of infections when population size fluctuates.

Rodent Behaviour – Session 1

Movements and spatial overlapping of rodents in natural environment

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Abundance, distribution, movement patterns and habitat selection of reservoir species influence the dispersal of pathogens. The objective of this study is to determine the daily movements of small rodents inhabiting two natural protected areas of central-east Argentina. Movement estimators and qualitative characteristics of rodent paths were determined by means of a spool and line device (102 tracks) and radiotelemetry methods (10 tracks). Tracking was conducted from November 2011 to December 2012 in Otamendi Natural Reserve and from June to October 2017 in Pre Delta National Park. All captured species were tracked in Otamendi, while only *Oligoryzomys flavescens*, reservoir of the etiologic agent of Hantavirus Pulmonary Syndrome in the region, was tracked in Pre-Delta. Movement patterns varied according to species, sex, reproductive season, and body size. *Akodon azarae*, reservoir of a hantavirus genotype not associated to human disease, had an intermediate linearity index, moved randomly and shared paths with all the other species. *Oligoryzomys flavescens* made an intensive vertical use of the habitat, had the most linear paths and did not share paths with other species possibly due to its scansorial habits. The mean linear distance traveled by this species was 107 m and the mean area was 5,477 m^2. Individuals of this species overlapped 32% (range: 0-99.5%) of their home range with conspecifics. All species, with the exception of *Oligoryzomys flavescens*, overlapped their paths at an interspecific, intraspecific, intrasexual, and intersexual level. The tunnel-like paths below the vegetation cover had signs of frequent use by one or more species of rodents. The sharing of space among rodent species probably results in an increase in the frequency of encounters among individuals and it could favour the direct and indirect transmission of diseases.

Rodent Behaviour – Session 1

Personality drives interactions with wildlife detection devices, based on perceptions of risk and reward

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Effective wildlife surveys rely on the assumption that all individuals are equally detectable. However recent studies into trapping success have determined that trap misses and avoidances are surprisingly common. One reason for this bias is the presence of personality within wildlife populations. As individuals vary in their behavioural responses to environmental cues, they are expected to make similar trade-off decision in their willingness to interact with and enter novel devices. We investigated this phenomenon for wild populations of black rats (*Rattus rattus*) interacting with different, experimentally manipulated wildlife management devices. We hypothesised that bolder type individuals would interact sooner and with greater frequency compared to shyer individuals, who may actively avoid detection. Populations of black rats were trapped across 32 spatially independent peri-urban bushland sites in Sydney, Australia. We uniquely marked 129 individuals for later identification on cameras and ran rapid behavioural assays to test for personality traits relating to boldness and docility. We then measured the behavioural responses of our rats to novel devices with varied perceived risk and reward. Tracking tunnels left open-ended (low risk) or with one end sealed off (high risk) represented device-associated risks while a high reward attractant (100% peanut oil), low (100% vegetable oil) or medium attractant (50:50 peanut:vegetable oil) provided a gradient of rewards. We present how rats with different personality traits responded to devices with differing risk and reward. Understanding how a personality-driven bias affects detection rates will help strengthen the accuracy and reliability of wildlife surveys and effectiveness of control programs.

Rodent Behaviour – Session 1

Individual variation in cognitive styles affects foraging and anti-predatory strategies in a small mammal

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Balancing foraging gain and predation risk is one of the most fundamental trade-offs in the life of animals. Among-individual variation in cognition might affect how individuals balance these conflicting necessities, but the processes underlying individual differences are still unclear. Here we empirically assessed direct consequences of cognitive styles for fitness-determining behaviours, such as foraging and risk-taking behaviour, using a semi-natural setting. We exposed fast/inflexible (N = 21) and slow/flexible (N = 18) learners of bank voles (*Myodes glareolus*) to enclosed landscapes with different risk levels at two food patches. We quantified foraging behaviour, individual giving-up densities for food (a measure for perceived predation risk), and vigilance behaviour, which in a species with high predation pressure directly relate to fitness. Fast learners consumed up to 20% more food than slow learners in the high-risk area, increasingly exploited both food patches, and spent up to 75% of their visit foraging. Slow learners progressively avoided the high-risk area and spent approximately 50% of their visit exercising vigilance even in the low-risk area. Our results indicate that among-individual differences in cognitive styles are indeed reflected in different foraging and anti-predator strategies, providing insights into fitness consequences and differential selection pressures based on individual differences in cognition.

Rodent Behaviour – Session 1

Problem predators: can odour habituation reduce impacts of "rogue" rats on birds nests?

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Introduced rats are amongst the world's worst invasive predators and cause the ongoing decline of endangered birds throughout the world. Not all individuals within a predator population are likely to consume rare prey species however, and some individuals are more likely to cause a disproportionate impact on prey populations than others. Decoupling the learnt association between a bird odour and a valuable food reward through olfactory pre-exposure has been demonstrated to reduce rat predation on birds' nests by up to 62% (Price and Banks 2012 PNAS), however whether this technique targets those highly motivated, and most damaging individuals within a predator population remains unclear. Using individually marked wild black rats in bushland in northern Sydney, Australia, we explored behaviours, such as search image development, that allow some individuals to first find, and then target birds' eggs (domestic quail) using avian olfactory cues (domestic quail feathers and faeces). We then tested whether a simple technique to induce habituation using unrewarded exposure to bird odours offers protection to rare prey. Our results provide a better understanding of the behavioural and learning mechanisms that underpin the predatory effectiveness of invasive rats, as well as insight into ways that olfactory learning in rodents can be exploited to protect vulnerable prey species or to meet other management aims.

Rodent Behaviour – Session 1

Domestic cats and dogs create a landscape of fear for pest rodents around rural homesteads

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Using domestic predators such as cats to control rodent pest problems around farms and homesteads is common across the world. However, practical scientific evidence on the impact of such biological control in agricultural settings is often lacking. We tested whether the presence of domestic cats and/or domesic dogs in rural homesteads would affect the foraging behaviour of pest rodents. We estimated giving up densities (GUDs) from established feeding patches and estimated relative rodent activity using tracking tiles at 40 homesteads across four agricultural communities. We found that the presence of cats and dogs at the same homestead significantly reduced activity and increased GUDs (i.e. increased perception of foraging cost) of pest rodent species. However, if only cats or dogs alone were present at the homestead there was no observed difference in rodent foraging activity in comparison to homesteads with no cats or dogs. Our results suggest that pest rodent activity can be discouraged through the presence of domestic predators. When different types of predator are present together they likely create a heightened landscape of fear for foraging rodents.

Rodent Behaviour – Session 1

Behavior of *Rattus rattus* (Linnaeus, 1758) around self-resetting traps

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Invasive ship rats (*Rattus rattus*) are the major threat to the native species and ecosystem of Goat Island (9.3 ha), New Zealand. In December 2015 a grid of 8 kill traps (DOC200s) was installed across the island to manage rat numbers. In June 2016 we extended the trapping grid with 10 self-resetting traps (GoodNature A24s), monitored with motion-activated cameras and trigger counters. All devices were checked approximately monthly until November 2017. Data on rat abundance from the kill trapping devices before, during and after the self-resetting trap study showed no significant difference among years, and were consistently low. In contrast, the videos reveal high rat activity on the island, which reduced over time, with the highest number of interactions happening in the first months after installing the self-resetting traps. The number of animals killed by the self-resetting traps varied among months and peaked in mid-summer. The rats showed interest in the self-resetting traps and interacted with them, resulting in deaths, but along with the kill traps (i.e. two devices per hectare) the number of rats killed was insufficient to offset intrinsic population growth and reinvasion from the adjacent coast, and hence achieve eradication on the island. Size selectivity is potentially an issue for both traps as young rats were not observed being killed. Self-resetting devices at one per hectare did reduce rat numbers in an area where kill trap maintenance was time and cost intensive, but maintaining very low rat numbers or achieving eradication requires additional refinement of the system (e.g. a combination of different tools or a higher density of devices).

Rodent Behaviour – Session 1

Influence of predator and plant chemical cues in the exploratory behaviour of the house mouse

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Foraging behaviour and avoidance of predators cover basic needs for self-maintenance and survival. These basic behaviours are triggered by internal and external sources of information like blood glucose levels and olfactory cues. Plant olfactory cues are valuable for rodents as the house mouse because they can inform about the ripening state of fruits and risks associated to unripe or rooted fruits. Our research found that ethanol as olfactory cue elicited avoidance and decreased locomotor activity in mice, these results highlighted the relevance of ethanol as a probable cue for fruit ripening, in the wild, this chemical cue could convey primordial information about the ripening state of fruits. Olfaction has also a main role in predator avoidance by mice, avoidance of physical encounters with the predator species, increases highly chances of survival. In another study, we found that mice avoided significantly olfactory cues from domestic ferrets (*Mustela furo*), which probable ancestor is the European polecat (*Mustela putorius*), natural predators of rodents. Future research should consider the interactions of predator and plant olfactory cues as they are part of the same olfactory dimension, and motivations for feeding and avoidance of predators are tightly linked.

Rodent Behaviour – Session 1

Communicating fear: the role of alarm pheromones in a bank vole

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Predation involves more than just predators consuming prey. Indirect effects, such as fear responses caused by predator presence, can have consequences for prey life history. Laboratory experiments have shown that some rodents can recognize fear in conspecifics via alarm pheromones. Individuals exposed to alarm pheromones can exhibit behavioural alterations that are similar to those displayed by predator-exposed individuals. Furthermore, mice alarm pheromone may be biochemically related to predator-produced scent cues and both contain similar sulfur-containing volatiles. Yet the ecological and evolutionary significance of alarm pheromones in wild mammals remains unclear. We investigated how alarm pheromones affect the behaviour and fitness of wild bank voles (*Myodes glareolus*) in several experiments conducted either in the lab or under semi-natural conditions in large outdoor enclosures. Specifically, we have compared the effects of exposure of voles to a second-hand fear cue, which in this case was transmitted via bedding material used by predator-exposed voles. Control animals were exposed to bedding used by voles with no predator experience. We have also compared alarm pheromone effects to real predator odor. Besides that we have studied the gross generational effects of predation risk emitted either via real predator odor or alarm pheromone. The first results show for instance a double increase in litter size in the group exposed to the alarm pheromone compared to control odor. Furthermore, female voles seems to be attracted to bedding that had been used by predator-exposed male voles. In a subsequent experiment female reproduction was also enhanced in the alarm pheromone treatment. In contrast males were repelled by conspecific male alarm pheromone. Our results suggest that predation risk can exert population-level effects through indirect alarm cue by prey individuals having experienced and escaped a predator attack.