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Effects of Risk and Fear on Animal Behaviour

Potsdam, Germany, 26st – 28th of February 2018

Abstracts

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FOREWORD

The 13th meeting of the Ethological Society takes at the University of Potsdam from February 26th to 28th of February 2018. The topic of 2018 “Animal Behaviour under Risk and Fear” covers the key processes that have shaped animal behaviour in evolutionary time frames. Animals have adapted their behaviour and time allocation to predation risk while mating or foraging, and to risks associated with inbreeding or disease transmission. Landscapes of fear can thus be comprised of many different risk qualities.

Prof. Dr. Jana Eccard

All abstracts are printed as submitted.

PLENARY TALKS

Plenary

Ecology of Fear, Landscapes of Fear, and other scary topics

BROWN JOEL S.

Moffitt Cancer Center, Tampa, Florida, USA

Predator's both kill and frighten their prey. Here I will define fear, not by its proximal mechanisms, but as an adaptation by which organisms assign a fitness cost to engaging in risky activities; usually in the context of food-safety tradeoffs. Prey manifest non-lethal effects through habitat selection, patch use behaviors, vigilance and herd size. Predators manifest injury risk by modulating derring-do and prey selection. Theory shows how behaviorally responsive prey bend the vegetation's, prey's and predator's isoclines in ways that alter abundances and stability properties. Fierce carnivores can be rare. They can positively influence prey and vegetation abundances without actually killing many prey. For management this can lead to questions such as "Does Chicago have too many deer or too fearless deer?". Food-safety tradeoffs augment biodiversity such as that seen in fox squirrels and grey squirrels, even when the squirrels themselves do not feed and support the predators whose fear is needed for coexistence. Prey fear responses may enhance predator biodiversity such as the predator facilitation experienced by snakes and owl preying upon gerbils, or "hulky and bulky" versus "fragile and agile" seen in systems with jaguar and pumas. Landscapes of fear allow us to overlap the non-lethal effects of predators onto more traditional vegetation and physical landscapes. As can be seen in springbok and in striped mice of South Africa, spatial variability in predation risk and food availability create habitats that are: 1) core for the prey (safe and productive), 2) refugia (safe but unproductive), 3) unsuitable (risky and unproductive) and core for their predators (risky and productive). What emerges from all of this? Fear matters. Fear can and should be incorporated into metrics and concepts of behavior, predator-prey foraging games, and predator-prey dynamics. Finally, food-safety tradeoffs manifest strongly in cancers and tumor ecosystems – for many of us this has been and shall be the scariest ecosystem of all.

Plenary

Risk in human altered habitats

EAST MARION L.

Leibniz Insiture for Zoo and Wildlife Research (IZW), Berlin, GERMANY

The Earth has entered the ‘anthropocene’: a geological era in which human activities worldwide have a more profound impact on the loss of biodiversity than other processes. Given that the human population and its demand for resources are predicted to continue to rise in the coming decades, the scale and pace of human induced environmental change is also set to increase. Wildlife species differ considerably in their ability to cope with these rapid environmental changes. The current alarmingly high rate of biodiversity loss in terms of reduced and fragmented wildlife communities, the extirpation of populations and extinction of species, indicates that wildlife is mostly failing to adapt to human altered environments. Even so, there are species that are so well adapted to specific environments created by humans they persist at higher densities than in more natural settings. Within the conference theme of ‘risk and fear’ my talk will focus on the level and type of ‘risk’ confronting wildlife in human altered environments, the behavioural, physiological and genetic changes these risks favour, their outcome in terms of measures of Darwinian fitness and the actions needed to mitigate the detrimental outcomes of human activities.

Plenary

Cooperative foraging in group-living spiders

SCHNEIDER JUTTA M.

University of Hamburg, GERMANY

Group living often evolved to minimize mortality risks, a benefit that generally increases with group size. However, among other trade-offs, food competition also increases with group size. Yet, cooperation in the acquisition of food may diminish food competition through diverse associated benefits. One such benefit of social foraging is particularly evident in predators as they can increase their prey spectrum through hunting as a group.
Spiders are a megadiverse group of predators but sociality has evolved only rarely and, if so, is largely restricted to web building clades. One of the few exceptions are Australian crab-spiders of the genus Australomisidia. These spiders do not use silk to capture prey but build communal nests from Eucalyptus leaves. Groups mainly consist of offspring from a single female although non-related intruders are common and generally tolerated. We show that group living benefits these spiders by lowering their mortality risk, and by increasing their capture success in general and in particular of prey that is too large for a single spider. In experimentally manipulated group compositions, we investigated how relatedness as well as sex affects capture success, prey sharing and growth. We further examined task specialization in A. ergandros and detected consistent differences in individual propensities to catch and share prey (producers) or to mainly scrounge on prey supplied by others. We quantified foraging interactions within groups using social network analyses and found that connectivity relates to genetic relatedness, body size and sex of group members.

Plenary

Proto-cooperation in billfishes

KRAUSE JENS

Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) & Humboldt University Berlin, GERMANY

Relatively little is known about group-hunting in marine predators. In terrestrial species group-hunting is often associated with individual recognition of group mates and tightly controlled group membership. We studied different species of billfishes and identified simple mechanisms that provide novel benefits for hunting in groups and do not require complex cognitive abilities. Among other things we propose that behavioural diversification is more likely to evolve in group-hunting predators (compared to solitary ones) because they can develop individual-level specialisation without the cost of greater predictability to their prey. Mechanisms of pro-cooperation occur in a wide variety of contexts and could help explain the evolution of group-living.

ORAL PRESENTATIONS

SESSION RISK AND FEAR I

Mammal communities under fear: Perceived predation risk shapes prey diversity

TECKENTRUP LISA[1], KRAMER-SCHADT STEPHANIE [2], GRIMM VOLKER [2], JELTSCH FLORIAN [1]

[1] Plant Ecology and Nature Conservation, University of Potsam, GERMANY
[2] Leibniz Institute for Zoo and Wildlife Research, Berlin, GERMANY
[3] Helmholtz-Centre for Environmental Research (UFZ), Leipzig, GERMANY

To date, most studies on behavior-mediated effects of predators on their prey either focused on specific behavioral adaptations on the level of single individuals or on consequences for other trophic levels. However, consequences of fear on the prey community itself are largely unknown despite their importance concerning conservation and management. In this study, we investigated how risk effects modifying animal behavior scale up to the community level shaping prey community structure and composition, hence biodiversity patterns.
We used an individual-based, spatially-explicit modelling approach to investigate the consequences of landscapes of fear on prey community metrics. The model scales up from risk effects on individual foraging behavior to consequences on prey community structure and composition. We explored how different behavioral strategies in interaction with the configuration of the landscape of fear and food distribution affect prey community metrics.
Our results reveal that adaptations in prey space use due to perceived predation risk scale up to the community level leading to shifts in body mass distributions and affecting prey diversity. The interaction between behavioral strategies under fear and the availability of safe patches were identified as two driving mechanisms shaping community responses to perceived predation risk. Furthermore, we show how landscapes of fear modify effects of habitat loss and fragmentation on animal communities.
Our modelling approach allows to link individual animal behavior to patterns on the community level and to identify underlying mechanisms driving community responses.
An understanding of these mechanisms and their consequences is highly needed to assess the impact of current changes in landscapes of fear due to the loss of apex predators or human modifications in many ecosystems.

Spatial response of a red deer population to an experimental gradient of wolf urine intensity

BECKER MARCEL[1], BUBNICKI JAKUB[2], CHURSKI MARCIN[2], VAN GINKEL ANNELIES[2], KUIJPER DRIES[2]

[1] Friedrich Schiller University, Jena, GERMANY
[2] Mammal Research Institute - Polish Academy of Sciences, Białowieża, POLAND

Besides direct effects on prey population size through predation, predators can shape their prey´s population dynamics through behaviourally-mediated effects. Recent studies in closed forest systems in Europe showed that wolves have non-lethal, fear-driven effects on their ungulate prey species. Vigilance levels of deer increased and foraging time decreased in the presence of the scent of their main predator (wolf scats). This risk-effects were demonstrated to operate at a local scale. In the present study we experimentally tested whether scent of a large carnivore can affect the spatio-temporal distribution and group sizes of red deer at a large scale. Scent could potentially be used to create an artificial landscape of fear as an application in deer management.
We examine changes in a population of red deer containing around 450 individuals after establishing a set of 105 locations with wolf urine in the centre of a fenced forest enclosure of 3.300 ha near the Belarusian part of the Bialowieza Forest. The density of urine was decreased from the core towards the edges of the studied area. A fixed grid of 50 camera traps was used to cover the whole area before and during the urine treatment - the distribution of deer depicted by the daily trapping rates. We test for changes in the population distribution in relation to the intensity of wolf urine and expect a decrease of red deer trapping rate and group size with proximity to an increasing density of the artificial predator cues. First results will be presented.

Long-term memory of artificial predators in common ravens (*Corvus corax*)

BLUM CHRISTIAN, BURGNYAR THOMAS, FITCH TECUMSEH

University of Vienna, AUSTRIA

Mobbing is a form of anti-predator behaviour common among birds. Learning about novel threats allows individuals to adapt this response to new predators. Previous studies showed wild American crows to be capable of remembering newly introduced artificial predators on a long term basis. We used a similar approach on another member of the corvid family, the common raven. Two groups of captive non-breeders (n=16) were exposed to masked humans subsequently walking past the aviary. The "predator mask" was carrying a dead raven, while the "control mask" was not. After four initial training presentations all following presentations were conducted without the dead raven over a time span of five years. We were interested in i) how quickly the ravens would start to mob the predator mask, ii) how long they would display mobbing selectively and iii) how their performance might be influenced by social dynamics. Our results indicate a quick learning process and a long-term fidelity. Type of raising, kin and dominance status influenced the birds' participation in mobbing.
In a second study, we investigated the mobbing performance of a group of naïve ravens (n=10) that arrived one year after the initial training phase. The aviary layout permitted the new arrivals to observe the group response of their trained neighbours, providing valuable information on both masks and giving opportunity for cultural transmission. Similarities and differences in mobbing responses between trained and naïve birds will be discussed.

Predatory threat related intra-specific aggression mediates benefits of first- and second order sociality in a cooperative breeder

FROMMEN JOACHIM[1], GROENEWOUD FRANK[2], JOSI DARIO[1], TANAKA HIROKAZU[1], TABORSKY MICHAEL[1]

[1] University of Bern, SWITZERLAND
[2] University of Groningen, THE NETHERLANDS

Group living generates many benefits, including increased protection from predators. However, living in groups and colonies also entails costs such as competition for limited resources, which may involve aggressive interactions. Thus, group members face trade-offs for instance between increased predator protection and higher intraspecific aggression. This may drive within-group and between-group social interactions, which can crucially affect fitness returns. So far the interplay between predation risk, inter-individual aggression and social structure has been largely neglected. Here we report on a study of predation risk and intraspecific aggression in eight distinct colonies of the cooperatively breeding cichlid fish Neolamprologus pulcher. We recorded intra-group and inter-group interactions, estimated group size and distance to the nearest neighboring group as a measure of first- and second order sociality, and we monitored reproductive success in each of these groups. Within-group aggressive interactions were low under high predation risk, while high colony density correlated with enhanced levels of between-group conflict. In populations with low predation risk, reproductive success was highest in large groups with distant neighbors and in small groups with close-by neighbors, indicating that protection by either own group members or by neighbors boosted reproductive success. In contrast, under high predation risk the groups characterized by a combination of both a large number of members and close vicinity to neighbors yielded the highest reproductive success. Apparently, with low predation pressure the costs of intraspecific competition outweigh the benefits of high local density, whereas with high predation risk individuals living in large groups and dense colonies do best. These results demonstrate the importance of trade-offs between predator protection and intra-specific aggression in dependence of ecological conditions, highlighting the importance of predation risk for the evolution of complex social systems.

Giving-up densities as a measure of perceived predation risk in the common vole, *Microtus arvalis*

HALLE STEFAN

Friedrich Schiller University, Jena, GERMANY

The method of measuring perceived predation risk by giving-up densities (GUD) was developed for small rodents in arid and semi-arid habitats. We applied the method for common voles living in semi-natural habitat patches of dense meadow vegetation. We found a distinct difference in GUD between the patch interior and the open matrix and a clear gradient at the habitat edge, indicating a much higher perceived predation risk in habitats without vegetation cover. There was no consistent difference between day and night.

The response to threat – fixed stimulus response or state-dependent?

HOFFMEISTER THOMAS S.[1], ROITBERG BERNARD D.[2]

[1] University Bremen, GERMANY
[2] Simon Fraser University, Burnaby, CANADA

Foragers may encounter cues about threats while foraging on patches. When such patches provide valuable yet depletable resources foragers may decide to trade off threats versus benefits from foraging. If they do so, we would predict to find conditions under which the benefits from foraging might outweigh the risk to get killed and lead to continued foraging, and reverse, conditions under which the costs may outweigh the benefits and foragers escape. Using predictions from state-dependent theory for conditions under which foragers will abandon patches following encounters with threats, we will show theoretically and experimentally whether sensitivity to threats is dynamic i.e. depending upon both, information-state and perception of danger.

SESSION RISK AND FEAR II

Secrets of success in a landscape of fear: Urban wild boar adjust risk perception and tolerate disturbance

STILLFRIED MILENA[1], GRAS PIERRE[1], BÖRNER KONSTANTIN[1], GÖRITZ FRANK[1], PAINER JOHANNA[2], ROELLIG KATHLEEN[1], WENZLER MORITZ[3], HOFER HERIBERT[1], ORTMANN SYLVIA[1], KRAMER-SCHADT STEPHANIE[1]

[1] Leibniz Institute for Zoo and Wildlife Research (IZW), Berlin, GERMANY
[2] University of Veterinary Medicine Vienna, AUSTRIA
[3] Humboldt University, Berlin, GERMANY

In urban areas with a high level of human disturbance, wildlife has to adjust its behavior to deal with the so called "landscape of fear." This can be studied in risk perception during movement in relation to specific habitat types, whereby individuals trade-off between foraging and disturbance. Due to its high behavioral plasticity and increasing occurrence in urban environments, wild boar (*Sus scrofa*) is an excellent model organism to study adjustment to urbanization. With the help of GPS tracking, space use of 11 wild boar from Berlin's metropolitan region was analyzed: we aimed at understanding how animals adjust space use to deal with the landscape of fear in urban areas compared to rural areas. We compared use vs. availability with help of generalized linear mixed models. First, we studied landscape types selected by rural vs. urban wild boar, second, we analyzed distances of wild boar locations to each of the landscape types. Finally, we mapped the resulting habitat selection probability to predict hotspots of human-wildlife conflicts. A higher tolerance to disturbance in urban wild boar was shown by a one third shorter flight distance and by an increased re-use of areas close to the trap. Urban wild boar had a strong preference for natural landscapes such as swamp areas, green areas and deciduous forests, and areas with high primary productivity, as indicated by high NDVI (normalized difference vegetation index) values. The areas selected by urban wild boar were often located closely to roads and houses. The spatial distribution maps show that a large area of Berlin would be suitable for urban wild boar but not their rural conspecifics, with the most likely reason being a different perception of anthropogenic disturbance. Wild boar therefore showed considerable behavioral plasticity suitable to adjust to human-dominated environments in a potentially evolutionarily adaptive manner.

Annoying disturbers: effects of recreation on the reproductive behaviour of great tits (*Parus major*)

HUTFLUSS ALEXANDER, DINGEMANSE NIELS

Ludwig Maximilians University Munich, GERMANY

Recreational pressures have led to increasing numbers of humans in forests and national parks, resulting in more contact between humans and wildlife. Observed negative effects of this "human disturbance", e.g. birds avoiding areas frequented by visitors or deserting their nests, might be induced by humans being perceived as potential predators. One key outstanding question is whether human recreation affects reproductive behaviour and other life-history traits. We used a 8-year data set, collected within 12 nest box populations of great tits in Germany, consisting of nest site selection data, clutch size, and reproductive success, as well as (bi)weekly counts of numbers of human visitors. We hypothesized that intensity of recreation negatively affected reproductive success for birds breeding close to paths and thus tested how the intensity of recreation affected various life-history decisions in interaction with the distance to the source of the disturbance (path). We found that birds preferred nest boxes further away from paths, especially in plots with more visitors during the breeding season. Birds in more disturbed conditions laid fewer eggs and produced fewer fledglings. Interestingly, also birds breeding far away from paths had smaller clutches. We are currently investigating, whether this finding is due to differences between individuals with different personalities in their response to humans. Our findings contribute to the field of human disturbance and show that humans affect behaviour and reproductive success of cavity breeding birds. Potentially, we will also be able to show if negative impacts of recreation are differing between individuals, depending on their behavioural types.

How does human behaviour affect hantavirus infection risk?

REIL DANIELA[1], IMHOLT CHRISTIAN[2], ULRICH RAINER G. [3], SCHLINKMANN KRISTIN M.[4], JACOB JENS[2], ECCARD JANA[1]

[1] University of Potsdam, GERMANY
[2] Julius Kühn Institute, Münster, GERMANY
[3] Friedrich Löffler Institute, Greifswald-Insel Riems, GERMANY
[4] Governmental Institute of Public Health of Lower Saxony, Hannover, GERMANY

The Puumala orthohantavirus (PUUV) is widely distributed across Europe. It is most commonly transmitted by bank voles (Myodes glareolus) and an infection can cause mild to severe courses of nephropathia epidemica in humans. Infections occur predominantly through inhalation of virus contaminated aerosols, which originate from urine, faeces, or saliva shed by the rodent reservoir.
The number of human PUUV infections is highly correlated to rodent host abundance in the present year as well as to beech seed production in the previous year. Beech fructification strongly promotes bank vole abundance by providing enhanced food supply. In turn, PUUV dynamics are connected to multi-annual and seasonal fluctuations of host populations.
Even though beech mast driven rodent host dynamics have been identified as the main driver for human PUUV infection risk, the transmission of PUUV remains complex and further parameters may matter. The risk of humans being infected depends mainly on the exposure to aerosols in bank vole habitats and thus differs strongly between individuals. Nevertheless, studies have shown that there is an increased occupational risk of infection for workers in forestry or farming. More particularly, activities like cleaning rodent infested places but also leisure activities, which extend the possible exposure to rodents like camping or visiting a forest, were identified as relevant risk factors. Further, smoking has been reported as a major risk factor for PUUV infection. Human exposure to PUUV may therefore differ because of variation in risk related human behaviour.
Current activities of the RoBoPub research consortium aim to investigate these challenging issues. This is highly relevant because vaccination is not available and therefore raising awareness and taking preventive measures (including avoiding risk related behaviour) should be given priority to minimise human infection with hantavirus and possibly other rodent-borne pathogens.

Fearful or bold? How a generalist predator affects the foraging strategies of fruit flies and parasitoids

MIGANI VALENTINA, HOFFMEISTER THOMAS S.

University of Bremen, GERMANY

The risk of predation can alter prey foraging behaviour and this in turn may have consequences at the prey population level. When looking for resources, foragers evaluate the patch they are currently searching and make decisions accordingly. Detecting the presence of a predator may influence a forager´s decision making, for example, by reducing the time the forager spends within the patch. The reduction of patch residence time, in turn, may reduce the forager's reproductive success. To understand the patterns that fear of predation generates at the population level it will be necessary to also clarify the mechanisms of response to fear. We report on a study in which we investigated the effect of the weaver ants, a generalist predator of insects, on the reproductive success of two potential prey, i.e. fruit flies and parasitoids. In particular, we investigated whether the presence or absence of the weaver ants affect the number of eggs laid by the fruit fly and parasitoids, respectively, and the mechanisms through which the ants affect the foraging behaviour of the fruit flies and the parasitoids.

SESSION SOCIAL BEHAVIOUR

How do individuals integrate personal and social information in a simulated predator detection task?

NOVAES TUMP ALAN, PLESKAC TIMOTHY, KURVES RALF

Max Planck Institute for Human Development, Berlin, GERMANY

A powerful approach to increase decision accuracy is to not only rely on personal information but to incorporate information provided by others, so called social information. Individuals in a group can, for example, decrease their predation risk by observing escape initiations of conspecifics. During such collective escape manoeuvres, individuals are both emitters and receivers of social information and have to integrate personal and social information to make optimal decisions. This gives rise to complex collective dynamics that are generally poorly understood. A key reason of why such processes remain poorly understood is that a mechanistic model of evidence accumulation on an individual level is lacking. To unravel the mechanistic basis of collective decision making in groups, we performed a simulated predator detection task using human groups and modelled their behaviour using the drift diffusion model (DDM). The DDM describes the evidence accumulation over time until a decision is made in a binary decision task and can predict both choices and response times (RTs). The model assumes that each decision maker starts with a preference based on its personal information. During the social decision making process, the decision maker aggregates social information by observing the choices of others. When an individual gathered enough evidence (and exceeds the decision threshold), the decision is made. The system is highly dynamic and the outcome is influenced by early responders and the initial preference distributions of group members. Our results indicate that humans weight social information as a linear function of the size of the majority for a particular option. Further, our results indicate that individuals expressing a high confidence start close to the decision threshold and therefore show fast RTs. In combination, both factors can explain the emergence of self-organisation in groups.

Genetic risk predicts cortisol levels, risk-taking, and social bonding behavior of male Assamese macaques

SCHÜLKE OLIVER[1], GUTLEB DARIA[1], HEISTERMANN MICHAEL[2], NOLL ANGELA[2], ROOS CHRISTIAN[2], OSTNER JULIA[1]

[1] University of Göttingen, GERMANY
[2] German Primate Center, Leibniz Institute for Primate Research, Göttingen, GERMANY

The genetic underpinnings of phenotypic variation are well explored in humans, but have not gained much attention in studies investigating individuality in wild animal populations. Non-human primates show individual differences in cortisol levels, aggression, and social strategies, which have mainly been attributed to variation in dominance rank, personality, and external factors. In this study, we combined behavioral and endocrine measurements of wild male Assamese macaques (*Macaca assamensis*) with multi-locus genotype data on 159 single nucleotide polymorphisms in 22 genes associated with the hypothalamic-pituitary-adrenal-axis. During a one-year period, 2511 hours of focal animal data and 366 urine samples were collected from 25 adult males in four wild groups in their natural habitat at Phu Khieo Wildlife Sanctuary, Thailand. We calculated the proportion of missense variants an individual carries as a genetic risk score and found it to be a) positively related to immunoreactive urinary cortisol levels, b) negatively to risk-taking behavior, c) positively to the strength of a male's closest relationships, particularly with higher-ranking partners, and d) positively related with how responsible males were for the maintenance of these bonds. Our results suggest that possibly a considerable proportion of inter-individual variability may have a genetic basis and thus cannot only be explained by variation in other individual attributes such as dominance rank or by environmental influences.

Social tool use in chimpanzees (*Pan troglodytes*)

SCHWEINFURTH MANON[1], DETROY SARAH E.[2], VAN LEEUWEN EDWIN J. C.[3], CALL JOSEP[1], HAUN DANIEL B. M.[2]

[1] University of St. Andrews, UNITED KINGDOM
[2] University of Leipzig, GERMANY
[3] Max Planck Institute for Psycholinguistics, Nijmegen, THE NETHERLANDS

Most social animals show a range of strategies to deal with group members in both cooperative and competitive situations. One such strategy is social tool use in which an individual physically uses others to receive selfish benefits. Here, we provide evidence for the occurrence of such social tool use behaviour in chimpanzees (*Pan troglodytes*). We presented an experimental device to a semi-wild group of chimpanzees. The device consisted of two buttons that, if pressed, released juice at a distant fountain. Hence, the juice could not be obtained by pushers, but only by others near the fountain. An adult male developed a strategy consisting of the retrieval of juveniles, pushing them towards the buttons and occasionally gesturing by reaching out. The "social tools" pressed for him in most of the cases. We recorded 146 events, the largest dataset on social tool use recorded among non-human animals so far. With this behaviour, the social tool user increased his juice intake 10-fold. Surprisingly, the social tools did not avoid the user over time, which might be explained by the social play that was associated with the social use. Manipulating others as social tools repeatedly may qualify as a form of Machiavellian intelligence.

Vocal intervention: Group leaders terminate social conflicts via vocalisations

SCHEUMANN MARINA[1], RÖPER KATHRIN[1], ZIMMERMANN ELKE[2]

[1] Stiftung Tierärztliche Hochschule Hannover, GERMANY
[2] Zoo Hannover, GERMANY

Vocal intervention is a triadic social interaction, where a third party vocally responds to a conflict of group members, which ends most conflicts. It is a suitable behavioural strategy to intervene by minimizing costs of aggression. Proboscis monkeys live in harem and bachelor groups. It was hypothesised that vocalisations of the harem male are uttered in response to vocalisation-associated agonistic conflicts between group members, calming down the conflicts. To test this hypothesis, we analysed (1) vocal responses of the harem holder to agonistic vocal exchanges within the harem group and (2) context and conflict partners related to these vocal events.
In the first study, audio recordings of 17 free-ranging groups living in the Kinabatangan Wildlife Sanctuary, Borneo, were scanned for Bray vocalisations of the harem holder and for Shriek vocalisation associated with agonistic conflicts. We found that Bray vocalisations of the harem holder occurred significantly more often after Shriek vocalisations than expected by chance. Thereby, Bray vocalisations terminated vocalisation-associated agonistic conflicts in 54% of the cases.
In the second study, we video- and audio-recorded 5 groups of habituated proboscis monkeys at feeding platforms in the Labuk Bay Rescue Center. Vocalisations of the harem male occurred more often after vocalisation-associated female-female conflicts than after immature-immature conflicts.
Thus, our study provided first empirical evidence that vocalisations of the harem holder function as vocal intervention signal to calm down agonistic conflicts between adult females of his group. Our findings point to the previously neglected role of vocalizations for governing conflict resolution in complex societies and suggest that vocal intervention in human societies is rooted phylogenetically deep in primate ancestry.

SESSION FORAGING

Ecology of fear in the Zebra Finch

IMMER ANIKA[1], DALL SASHA[1], GRIFFITH SIMON[2].

[1] University of Exeter, UNITED KINGDOM
[2] Macquarie University, Sidney, AUSTRALIA

Fear drives many decisions that animals make over their lifetime, as foraging activities. Zebra finches are extensively studied in captivity and are commonly described as colonial birds. Little is known about zebra finch foraging activity in captivity and even less in the wild. Zebra finches are native to a highly unpredictable environment: the Australian desert. There, foraging takes place in a wide range of group sizes and environmental conditions. We suggest two main factors to be important for a zebra finch to feel safe: 1) the spatial location of a food patch and 2) the number of birds feeding in a same patch. To explore what drives zebra finch foraging decisions, a series of experiments were done under laboratory conditions and in the wild.

Ecological speciation in African weakly electric fish (genus Campylomormyrus): The influence of gravel size on species-specific feeding behavior

AMEN RAHMA

University of Potsdam, GERMANY

Weakly electric fishes are characterized by their ability to generate weak electric organ discharges (EODs) from a specific organ called electric organ. These fishes use EODs mainly for navigation, electrolocation, and electrocommunication. Recent studies have shown that the divergence in the morphology and EODs of African weakly electric fish (genus Campylomormyrus) are the two main factors that promote its adaptive radiation. For instance, the snout morphology, as an ecological trait, is apparently under disruptive natural selection and may play a role for niche specialization. The divergence of EODs is presumably acting as prezygotic isolation mechanisms, but may be related to feeding behaviour as well.
Apart from EOD divergence, species exhibit morphological differences in their trophic apparatus - an elongated trunk-like snout used for grasp-suction feeding - which varies among the different species in length, thickness, and curvature. In this study, we hypothesize that the morphological diversity of weakly electric fish corresponds with different diets and feeding habits. Feeding behavior and stomach content analyses of two Campylomormyrus species will be used to verify this hypothesis. Currently, dichotomous choice feeding experiments are being conducted to show behavior differences among different substrates, including different gravel sizes and sand. Nocturnal video recordings and EOD trains are sampled, encoded, and further processed. Preliminary results show that at these two Campylomormyrus species with significantly different snout morphologies correspondingly associate with different substrates and gravel size. Though still preliminary, our study provides initial evidence that the diversification in the trophic apparatus found in the radiation of these electric fish may be an adaptation to feeding on different substrate.

SESSION FREE TOPICS

Adaptive shaping of behavioural and neuroendocrine phenotypes during adolescence

ZIMMERMANN TOBIAS D.

University of Münster, GERMANY

Environmental influences during prenatal and early postnatal life can profoundly shape an individual's phenotype, thus adjusting it to prevailing or predicted future conditions. More recently, adolescence has been recognised as another crucial phase during which phenotypic development may be adaptively shaped in response to environmental stimuli. We have shown in previous studies that male guinea pigs living in large mixed-sex colonies develop a low-aggressive phenotype as part of a queuing strategy that is adaptive for integrating into large unfamiliar colonies. By contrast, males living in mixed-sex pairs during adolescence become highly aggressive towards strangers, which prevents integration into groups of unfamiliar conspecifics. In the present approach, we examined whether the high-aggressive phenotype is adaptive in situations with a limited number of competitors for access to females. For that purpose, we established groups of one pair-housed male (PM), one colony-housed male (CM) and two females after both males had reached late adolescence and examined their social behaviour, endocrine responses and reproductive success. PMs were found to direct more aggression towards the male competitor and more courtship and mating towards females than CMs. In consequence, PMs attained the dominant position in most cases and sired significantly more offspring. The high-aggressive strategy of PMs was accompanied by substantially elevated cortisol levels and significantly higher testosterone concentrations compared with CMs, which probably promoted the enhanced aggression while mobilizing necessary energy. Combining these findings with our previous results, we provided the clearest evidence to date for adaptive shaping of the phenotype by environmental influences during adolescence.

Shaping and reshaping of biobehavioural profiles beyond adolescence - A study in guinea pigs

MUTWILL ALEXANDRA M., ZIMMERMANN TOBIAS, RICHTER S. HELENE, KAISER SYLVIA, SACHSER NORBERT

University of Münster, GERMANY

Phenotypic plasticity describes the ability of individuals to change phenotypic traits in response to the environment. After focusing on pre- and postnatal development as sensitive phases, recently adolescence has been identified as another time window for phenotypic adjustment in mammals. Using male guinea pigs as a model system, the aim of the present study was to investigate in which way biobehavioural profiles are shaped by different social environments and whether they are reshaped after transfer to another social condition in early adulthood. To test this, a low and a high individual number situation were explored. After weaning, males were either kept together with one female each in pairs (P) or in large mixed-sex colonies with a graduated age structure (C). From an age of 120 days on, individual cortisol and testosterone responsiveness to novelty was assessed on a monthly basis. At 240 days of age, males of both conditions were transferred to a P-situation with an unfamiliar female. One month later, hormonal responsiveness to novelty was assessed again. Before transfer, P-males were shaped for a high cortisol responsiveness and low testosterone levels, whereas C-males showed a low cortisol responsiveness and high testosterone levels. After transfer to a P-situation in early adulthood, biobehavioural profiles of C-males were reshaped towards low testosterone levels and a high cortisol responsiveness resembling the profile of P-males. P-males themselves maintained their original endocrine profile. The present study clearly showed that shaping and reshaping of biobehavioural profiles is possible beyond adolescence, suggesting that plasticity can be preserved also in early adulthood.

SESSION COMMUNICATION

Does overnight temperature influence the singing behaviour in wild great tits, *Parus major*?

STRAUß AURELIA F., DINGEMANSE NIELS .

Ludwig Maximilians University, Munich, GERMANY

Birdsong, as an example of acoustic communication, transmits information and is mainly used to defend territories and attract mates. These two purposes are crucial for survival and reproduction success. But singing is also costly due to trade-offs with other behaviours and potentially increased energetic costs. Changes in singing behaviour might therefore be caused by variation in environmental factors that affect an individuals' condition.
The aim of the study was to investigate effects of overnight temperature on the singing behaviour of wild great tits due to increased energy consumption during cold nights. Thus, we expected a decrease in song rate with lower overnight temperatures because more energy would be required for thermoregulation during these nights. Furthermore, we predict this effect to reduce with increasing time between sunrise and singing because of more time available to refill energy reserves by foraging.
To test this hypotheses an eight year data set, collected in 12 nestbox populations in Bavaria, was used. Song rate, alarm rate and the approach distance to the intruder were measured during artificial intrusion experiments in two different breeding stages, egg laying and incubation. Overnight temperatures were taken from a weather station in the centre of the study area. As expected song rate decreased with lower overnight temperature, while the alarm rate increased. Furthermore, a reduction in alarm calls was found with ongoing time from sunrise. All traits were expressed differently in the two breeding stages.
Our findings indicate that colder nights result in a reduced song output and instead an increased alarm rate. This supports the hypothesis that singing is costly, and thus energetically challenging environments affect acoustic communication. Moreover, vocal output differs between breeding stages and this is also due to environmental changes.

‘Bird song metronomics’: Isochronous organization of zebra finch song rhythm

NORTON PHILIPP, SCHARFF CONSTANCE

Freie Universität Berlin, GERMANY

The human capacity for speech and vocal music depends on vocal imitation. Songbirds, in contrast to non-human primates, share this vocal production learning with humans. The process through which birds and humans learn many of their vocalizations as well as the underlying neural system exhibit a number of striking parallels and have been widely researched. In contrast, rhythm, a key feature of language and music, has received surprisingly little attention in songbirds. Investigating temporal periodicity in bird song has the potential to inform the relationship between neural mechanisms and behavioral output and can also provide insight into the biology and evolution of musicality. Here we present a method to analyze birdsong for an underlying rhythmic regularity. Using the intervals from one note onset to the next as input, we found for each bird an isochronous sequence of time stamps, a ‘signal-derived pulse’, or pulse^{S}, of which a subset aligned with all note onsets of the bird’s song. Fourier analysis corroborated these results. To determine whether this finding was just a byproduct of the duration of notes and intervals typical for zebra finches but not dependent on the individual duration of elements and the sequence in which they are sung, we compared natural songs to models of artificial songs. Note onsets of natural song deviated from the pulse^{S} significantly less than those of artificial songs with randomized note and gap durations. Thus, male zebra finch song has the regularity required for a listener to extract a perceived pulse (pulse^{P}), as yet untested. Strikingly, in our study, pulses^{S} that best fit note onsets often also coincided with the transitions between sub-note elements within complex notes, corresponding to neuromuscular gestures. Gesture durations often equaled one or more pulse^{S} periods. This suggests that gesture duration constitutes the basic element of the temporal hierarchy of zebra finch song rhythm, an interesting parallel to the hierarchically structured components of regular rhythms in human music.

Isochronous rhythm in vocalizations of the greater sac-winged bat

BURCHARDT LARA SOPHIE

Freie Universität Berlin, GERMANY

Rhythm is an essential component of our speech and music. Surprisingly little is known about rhythm in animal vocalizations, even though this might give valuable insight into the evolution of rhythm and music. Using a method developed for zebra finch song, we found a regular, isochronous rhythm in three vocalization types of the neotropical bat *Saccopteryx bilineata*. As input we used multisyllabic vocalizations of different individuals. Inter-syllable-onsets were used to fit a signal-derived-pulse, pulseS. For all individuals and vocalization types (echolocation call sequences, territorial songs, isolation calls) pulseS frequencies were predominantly lying around 7.5 Hz - 20 Hz. For echolocation call sequences, we expected pulseS frequencies of 7.5 - 15 Hz because the production of echolocation calls is strongly coupled with wingbeat/respiration during flight, which are at approximately 7.5 Hz for S. bilineata. Surprisingly, we found pulseS frequencies similar to echolocation call sequences in social vocalizations, even without coupling between respiration and wingbeat. Territorial songs and isolation calls were uttered when bats were perched in the day-roost and, in case of isolation calls, when individuals were not volant yet. At present, we can only speculate about the reasons for this unexpectedly steady rhythm in bat vocalizations. Nevertheless, comparative studies on different echolocating and/or singing species may help to understand the evolution of rhythm and music, because animal vocalizations might be more rhythmic than previously thought.

Vocal repertoire ontogeny of the neotropical bat species, *Saccopteryx bilineata*

FERNANDEZ AHANA AURORA, KNÖRNSCHILD MIRJAM

Freie Universität Berlin, GERMANY

Human Language acquisition is characterized by several key features (e.g. vocal imitation, subsequent developmental speech stages) which are universal. Infant language development is composed of different stages, each determined by different characteristics, "canonical babbling" being probably the most prominent. Babbling is seen as a crucial step in language acquisition therefore, a comparative approach investigating non-human animals with a complex vocal repertoire regarding vocal ontogeny and possible babbling behavior would be revealing. So far, babbling has been described in several songbirds (plastic song) but only rarely in mammals (primates). A promising species to investigate vocal ontogeny is the highly social bat species, *Saccopteryx bilineata*. This species is capable of vocal learning (at least one adult song type is acquired through vocal learning) and owns a complex vocal repertoire (i.e. 24 distinct adult syllable types; combination of distinct syllable types into multisyllabic calls and two song types). The vocal repertoire is acquired by a conspicuous vocal practice in form of babbling bouts, reminiscent of the "canonical babbling" in human infants. Babbling bouts in S. bilineata are defined as sequences of syllables, composed of adult-like syllable types and one "transition" syllable type which is not part of the adult vocal repertoire. With our study we want to elucidate whether there are universal babbling characteristics among species with a complex vocal repertoire. During two consecutive field seasons we recorded and analyzed babbling behavior during pup ontogeny (range 10-12 weeks) in two genetically different S.bilineata populations (Costa Rica & Panama, N=20 pups, 8 colonies). Results revealed that babbling is composed of three subsequent stages, each defined by different features. Interestingly, aggressive adult-like syllable types were acquired earlier in ontogeny in contrast to affiliative ones. Furthermore, babbling bouts were dominated by repetition of syllable types, reminiscent of the "canonical babbling stage" in infants. Moreover, first analyses showed that the transition probability among the adult-like syllable types is not random, i.e. babbling bouts are following simple phonological syntactical rules. To summarize the first results babbling behavior in S.bilineata is characterized by following features which are shared with the other babbling species: babbling bouts do not occur during a certain context (meaningless), they are dominated by repetitions (repetitiveness), they contain non adult forms (i.e. "transition" syllable type) and the acquisition of the adult syllable types does not follow a linear accumulative pattern (comparable to human infants).

Individual recognition of distressed social group members in bats

KNÖRNSCHILD MIRJAM, NAGY MARTINA

Freie Universität Berlin, GERMANY

The ability to recognize conspecifics individually plays a crucial role in shaping animal societies and is considered to be cognitively more advanced than class-level recognition (e.g. discriminating familiar vs. unfamiliar conspecifics). Under natural conditions, individual recognition has only been studied in few taxa. Here, we present experimental evidence that wild bats, *Saccopteryx bilineata*, can recognize individual group members using voice cues in distress calls. Bats produce distress calls when being caught by a predator, and distress calls often attract conspecifics. Distress calls of S. bilineata differ significantly between individuals. To test whether the individual differences in distress calls are meaningful for social group members, we conducted a playback experiment in direct vicinity of the bats' day-roost. During the playback experiment, we simulated predation events that were either congruent or incongruent by using a modified violation-of-expectation paradigm. Bats approached the speaker broadcasting distress calls of group members only when the simulated scenario was congruent (when the stimulus donor had already left the roost), but never when the simulated scenario was incongruent (when the stimulus donor was still perched among the focal bats). Thus, distress calls only elicited a relevant behavioral response (phonotaxis) when the expectation about the signaler's position was not violated. The lack of responsiveness when conflicting information was presented (i.e. the physical presence of an individual in one place and its voice in another place) strongly suggests that S. bilineata is capable of recognizing individual conspecifics based on voice cues in distress calls. Moreover, our study shows that experiments with a modified violation-of-expectation paradigm are a promising approach for studying the communicative and cognitive abilities of free-living bats.

Predation risk and high temperature in exposed day roosts shape the mating strategy of male Proboscis bats

NAGY MARTINA[1], GÜNTHER LINUS[2], WILDE LUKE[3], KNÖRNSCHILD MIRJAM[1]

[1] Freie Universität Berlin, GERMANY
[2] Natural History Museum, Berlin, GERMANY
[2] Gonzaga University, Spokane Washington, USA

Day roosts play a crucial role for the ecology and evolution of bats. They are the sites where social interactions, mating and the rearing of young take place and where bats find shelter from adverse weather and predators. Yet, our understanding on how roosting habits may shape the social organization and mating systems of bats remains scarce. Proboscis bats form cohesive multi-male-multi-female groups and inhabit unusually exposed day roosts (e.g. tree trunks, vines, buildings). During the mating season males can be observed to defend females directly. However, the identity of the dominant male depends on the current roosting site in the day roost and, thus, male mating strategy can best be described as a form of site specific dominance. The clumped social organization during day and the fact that dominant males permit the presence of other males in the social group is probably the result of strong selection for crypsis due to high predation risk in the day roost. Proboscis bats possess not only cryptic coloration but also behavioral adaptations to remain cryptic during motion. Our results show that regular relocations of the whole group between different roosting sites (i.e. male territories) in the day roost are related to high roost temperatures; relocations were more frequent when temperature in the preferred roosting site reached the upper limit of the thermoneutral zone (30° - 35° C). Taken together our data suggest that predation risk and thermoregulatory needs in an unusually open day roost have shaped and maintain a male-mating strategy that contains elements of both, resource defense and direct female defense.

The impact of odour on parent-offspring recognition in zebra finches

CASPERS BARBARA

University of Bielefeld, GERMANY

The capability to recognise parents from hatching on seems to be absent in alricial birds. However, the ability of chicks to recognize parental odours has been completely neglected. Here we investigated whether day-old Zebra Finch chicks (*Taeniopygia guttata*) are capable of identification of parental odours. In the first experiment, chicks begged significantly longer in response to the genetic parent compared to the scent of an unfamiliar adult individual. In a second experiment, we cross-fostered eggs and tested the response of hatchlings to the scent of a genetic vs. foster parent. Chicks from cross-fostered eggs responded significantly more to the odour of their genetic mother than their foster mother, but did not discriminate between odours of their genetic or foster fathers. This is, to our knowledge, the first evidence that birds are capable of early recognition of parental odour and demonstrates that recognition of the genetic mother does not require familiarity.

Multiple processes determine responsiveness to heterospecific alarm calls in African herbivores

MEISE KRISTINE[1], FRANKS DAN[1], BRO-JORGENSEN JAKOB[2].

[1] University of Liverpool, UNITED KINGDOM
[2] University of York, UNITED KINGDOM

Heterospecific alarm calls may provide crucial survival benefits shaping animal behaviour. Multi-species studies can disentangle the relative importance of the various processes determining these benefits, but previous studies have included too few species to quantitatively assess alternative hypotheses. In a community-wide study of African savanna herbivores we here partition alarm responses according to distinct aspects of the signaller-receiver relationship and thereby uncover the impact of several concurrent adaptive and non-adaptive processes. Stronger responses were found to callers who were vulnerable to similar predators and who were more consistent in denoting the presence of predators of the receiver. Moreover, alarm calls resembling those of conspecifics elicited stronger responses, pointing to sensory constraints, and increased responsiveness to more abundant callers indicated a role of learning. Our findings suggest that mammals can respond adaptively to subtle variation in the information content of heterospecific alarm calls, but within the constraints imposed by a sensory bias towards conspecific calls and reduced learning of less familiar calls. The study thereby provides new insights central to understanding the ecological consequences of interspecific communication networks in natural communities.

POSTER PRESENTATIONS

Nesting behavior of the European hedgehog (*Erinaceus europaeus*, Linnaeus, 1758) under direct anthropogenic influences

BARTHEL LEON M. F.[1], OLTMANN FEONA[2], BERGER ANNE[1]

[1] Leibniz Institute for Zoo and Wildlife Research (IZW), Berlin, GERMANY
[2] Van Hall Larenstein University of Applied Sciences (VHL), Leeuwarden, THE NETHERLANDS

In an urban environment, animals have to cope with increased direct and indirect human influences on their habitat. Beside indirect influences like light pollution or climate change, there are also a lot of direct changes which occur within days or weeks and, thus, affect the animal's daily life. The reaction to those changes of habitat is important for the survival of the individual or species. Related to this framework, we investigated the effect of a festival on the nesting behaviour of European hedgehogs in an urban park. As a nocturnal insectivore species, hedgehogs rely on their nests during the day to sleep.

Festival took place on two days (+16 days of construction) having about 140,000 festival visitors. During the research period from August until September 2016, 17 hedgehogs (9 male, 8 female) were captured within the festival area and fitted with a VHF radio-transmitter. Daily controls of the nest use of every tracked hedgehog were carried out. Data were analysed with respect to the effect of the festival on the nesting behaviour comparing periods before and during the festival respectively construction work.

Survival analyses of the nest use show a different result for male and female. During the festival: male hedgehogs significantly decreased their time using the same nest, while, females did not change the nests more than before the festival. Taking into account that some of the tracked female hedgehogs did care for hoglets during that time could be an explanation why they were not able to change the nest.

It is not clear how the hedgehog population is or is not affected in the longterm or energy metabolism by those big events but further analyses in the project will investigate also the influence on the movement and the rhythmic structure of behaviour.

Risk pump in Gerbillus pyramidum: quality of rich habitats increases with more conspecifics

DE MENZES JORGE F. S., KOTLER BURT P., DIXON AUSTIN K.

Ben-Gurion University of the Negev, ISRAEL

Reducing predation risk is fundamental to many animals. Among those, social animals are studied for one type of anti-predator defense. They aggregate in certain habitats to dilute risk, share vigilance, defend each other, and reduce their chances of being attacked. However, this tendency is not necessarily unique: solitary animals may also benefit from the presence of conspecifics. Thus, we hypothesize that even solitary animals should aggregate whenever there is safety in numbers. Additionally, this tendency to aggregate should create a "risk pump", a positive feedback in aggregation because more individuals bring more safety, which brings more individuals. We also analyzed if they will aggregate in richer or poorer environment. Aggregation in a richer and thus crowded environment implies risk pump is a stronger mechanism than competition. To test the existence and direction of a "risk pump" in non-social animals, we compared habitat quality between patches at different distances and population sizes in two experiments with the most abundant gerbils of the Negev Desert: *Gerbillus andersoni* and *G. pyramidum*. Results supported the hypothesis of aggregation in the richer patch only for *G. pyramidum*. Meanwhile both species show aggregation in the poor patch. We discuss that this difference may be a result of the way gerbils compete. Their intraspecific competition is done mostly by exploitation instead of interference, decreasing costs of conflicts when aggregating.

Solar powered LED illumination impacts risk and fear in epigeal arthropods

ECCARD JANA[1], SCHEFFLER INGO[1], FRANKE STEFFEN[2], HOFFMANN JULIA[1]

[1] University of Potsdam, GERMANY
[2] Leibniz Institute for Plasma Science and Technology, Greifswald, GERMANY

Artificial light at night (ALAN) may transport a landscape of fear to nocturnal prey animals, increasing their visibility for predators. Advances in LED technology combined with solar, storable energy can bring light to places remote from electricity grids, but the impact on biodiversity and movement of animals is largely unknown. The importance of solar powered LED (SPLED) is expected to increase, since more than 1.3 billion people are living off-grid, often in developing regions of high insect biodiversity, but also in developed countries, where people use ornamental solar powered garden lights bringing light to the last refuges for wildlife in towns and cities: our gardens. SPLEDs are cheaply available, dim and often used to illuminate the ground. Little is known on their effects on ground living (epigeal) arthropods. In this study we used off-the-shelf outdoor SPLED lamps with a single LED, and measured illuminance, luminance, and spectral irradiance. SPLEDs had a cold white light with a colour temperature of 7250K. We experimentally investigated SPLED effects on attraction and nocturnal activity of ground beetles (Carabidae). We found two disparate, species-specific effects of SPLEDs. (a) Nocturnal, phototactic species, which were not reducing nocturnal activity under illumination. Attraction to lamps increased along a Lux gradient (local SPLED number), indicated by a >20 fold increase in captures of species that aggregate in lit areas so that lamps may become ecological traps. Further, these species are removed from nearby, unlit assemblages. (b) Nocturnal species, which reduced their mobility and activity under illumination. These species were not attracted to SPLED. Reduced activity under illumination may also have fitness effects. Both reactions offer mechanistic explanations on how outdoor illumination can change population densities of specific predatory arthropods, which may have cascading effects on epigeal arthropod assemblages. With SPLED use prognosed to rise in off-grid areas of the world, the technology may further impact insect biodiversity. Measures are needed to mitigate effects such as adjustment of light colour temperature and automated switch-offs.

Emotional contagion in common marmosets (*Callithrix jacchus*): does signalling about the presence of predators or food affect the behavioural and physiological responses in naive individuals?

GRABNER JULIA VICTORIA, ŠLIPOGOR VEDRANA, BUGNYAR THOMAS,

University of Vienna, AUSTRIA

An advantage of social life is that animals may use information provided by others. Hearing others announcing the presence of a predator, for instance, allows naïve individuals to appropriately respond without seeing the source of information, i.e. the predator, themselves. It is debated, however, what type of information is transmitted in such situations. Common marmosets (Callithrix jacchus) are cooperatively breeding neotropical primates that forage on a variety of fruits and insects. We here experimentally simulated the spreading of individual monkeys from their group and then tested how they respond to calls produced by their family group in a predatory as well as a food context. One individual of a group was visually but not acoustically separated while the group was confronted with either a predator stimulus or a food stimulus. We measured the separated individual's behavioural response during the test and change in salivary cortisol before and ten minutes after the test. We found that separated animals exposed to "socio-negative calls" (i.e. mobbing calls, alarm calls) from their group showed an increase in behaviours indicating stress and alertness. Furthermore, changes in the cortisol levels before and after the test indicated that being exposed to vocalisations not only changes the behaviour of marmosets but also their physiological state. We will discuss whether these responses are indicative of a mechanism termed emotional contagion.

Jamming Avoidance Response explains electric behavior in response to moving conspecifics in weakly electric fish

HLADNIK TIM, VIAL LISA-RUTH, BENDA JAN

University of Tübingen, GERMANY

Weakly-electric fish communicate with their electric fields. By modulating the frequency and/or amplitude of their highly periodic electric-organ discharges (EOD) they generate different types of electric communication signals. Recent behavioral and neurophysiological studies have primarily focused on so-called ”chirps”, brief (<100 ms) increases in EOD frequency emitted in the context of courtship and aggression.
The Jamming Avoidance Response (JAR) is another well researched modulation of the EOD frequency in the range of seconds and minutes. When the EOD frequencies of two conspecifics of the genus Eigenmannia differ by less than a few 10 Hz the JAR increases the frequency difference to improve both fish’s electrolocation abilities. In contrast, the closely related Apteronotus uses the JAR behavior to jam the other fish by decreasing the frequency difference.
Recently, it has been reported that Apteronotus respond with modulations of their EOD frequency to slow changes in a conspecific’s EOD amplitude that naturally occur during relative movement between individuals. These amplitude modulations are called ”movement envelopes”. We hypothesize that this behaviour is a direct result of the JAR to time-dependent changes in the amplitude of jamming signals.
We first characterized the temporal dynamics of the JAR in A. leptorhynchus in response to jamming signals with constant amplitudes by fitting two low-pass filters to the data. We then measured the behavioral responses to dynamic amplitude changes and compared these to predictions obtained from the low-pass filters. The predictions capture the measured behavior very well and we thus conclude that the JAR is sufficient to explain the reponses to movement envelopes.

Effects of artificial light at night on activity and space use of two small mammal species

HOFFMANN JULIA, ECCARD JANA, SCHIRMER ANNIKA

University of Potsdam, GERMANY

Natural light functions as an important zeitgeber in many animal species which use this external stimulus to adapt to predictable environmental changes throughout the day and the season. Besides the increasing spatial spread and intensity of nighttime illumination there is a shift towards new lighting techniques such as light emitting diodes (LEDs) that are characterized by a broad spectrum with a large proportion of blue light. This portion of the spectrum is known to most affectively suppress melatonin production and thereby influencing activity rhythms. What is missing are experiments under more natural conditions that clarify if laboratory results are applicable to animals in the wild and take into account possible effects of artificial light at night on species interaction and competition.

In this study, the effect of artificial light at night emitted by LEDs on the activity and space use of the bank vole (*Myodes glareolus*) and the striped field mouse (*Apodemus agrarius*) was investigated in semi-natural outdoor enclosures via automated radio telemetry. As both species have similar ecological requirements but, according to literature, differ in their activity rhythms possible variations in the effects of artificial light at night will be discussed.

Age matters: effects of varying social experiences during different life phases on anxiety-like behaviour and hormonal stress response in male mice

KÄSTNER NIKLAS[1], RICHTER S. HELENE[1], BODDEN CARINA[1], PALME RUPERT[2], KAISER SYLVIA[1], SACHSER NORBERT[1]

[1] University of Münster, GERMANY
[2] University of Veterinary Sciences Vienna, AUSTRIA

Social experiences can have profound effects on an individual's level of anxiety. While various studies have addressed consequences of experiences of a specific type, e.g. social defeat, we recently investigated the impact of combinations of adverse and beneficial social experiences on anxiety-like behaviour of male mice. Quite surprisingly, mice exposed to benefits during early life phases followed by escapable adversity in adulthood displayed lowest levels of anxiety, even compared to individuals having experienced throughout beneficial conditions. In a follow-up study, we aimed to elucidate whether this phenomenon is restricted to these specific life phases or whether it also exists when all these experiences are made in full adulthood. For this purpose, we compared anxiety-like behaviour and hormonal stress response (i.e. determining of faecal corticosterone metabolite concentrations) of adult male mice exposed to escapable social adversity following beneficial social experiences to that of mice exposed to either throughout adverse or throughout beneficial social conditions. The animals' stress response was profoundly affected by current social conditions: escapable social defeat (adverse condition) led to an increase in corticosterone metabolite concentrations, whereas living with a female (beneficial condition) led to a decrease. Interestingly, however, in contrast to the previous study in younger animals, we found no effects of social experience on anxiety-like behaviour. Taken together, these studies highlight the importance of the time of social experience for affecting an individual's level of anxiety. On the other hand, the results demonstrate that anxiety and stress response can be affected separately by social experience during adulthood.

Using high-resolution movement data to derive diurnal behavioural patterns of red foxes (*Vulpes vulpes*) along an urbanization gradient

KIMMING SOPHIA ELISABETH, GRAS PIERRE, BÖRNER KONSTANTIN, RADWAINSKI JANINA, RADCHUK VICTORIIA, ORTMANN SYLVIA, BERGER ANNE, HOFER HERIBERT, BRANDT MIRIAM, KRAMER-SCHADT STEPHANIE
Leibniz Institute for Zoo and Wildlife Research, Berlin, GERMANY

The expansion of urban areas is one out of manifold aspects of continuously increasing anthropogenic pressures on the environment. This urbanization process creates challenges for wild animal species, because they have to constantly trade-off their needs versus risks imposed by humans to be able to survive and persist in such novel environments. Some generalist species like the red fox (*Vulpes vulpes*) can cope well and even reach high densities in the urban habitat. It therefore serves as an excellent model species to assess behavioural adjustments to anthropogenic pressures through space-use and movement analyses.
We here analyse the influence of urbanization on circadian movement patterns of urban red foxes. We hypothesize that human day- and night-time activities influence red fox behaviour. Respectively, we expect to find different circadian movement patterns in areas with varying degrees of urbanization. We predict that movement is less directional during diurnal than during nocturnal activity, especially in areas with high levels of urbanization. We further expect home ranges to be smaller during the day and larger during the night.
We used high-resolution GPS data (4min intervals) of four radio-collared foxes within the city of Berlin, sampled over six to eight weeks, to analyse movement, more precisely turning angles, with respect to daytime. The degree of urbanization was estimated based on the percentage of sealed area. We determine the home range sizes of foxes both, diurnal and nocturnal, using GPS data of six individuals applying minimum convex polygon (MCP) method, kernel density estimation (KDE) and a recently proposed auto-correlated kernel density estimator (aKDE).
Our analyses demonstrate that foxes adjust their movement pattern in response to the circadian change in human activity and reveal the plastic behavioural capacity of a successful mesopredator. This finding shows the role anthropogenic pressure has as external driver on urban wildlife.

Take a risk or better play safe? Implementing a touchscreen-based cognitive bias test for mice

KRANKENBERG VIKTORIA, GARCIA RODRIGUES LUIS, KÄSTNER NIKLAS, KAISER SYLVIA, SACHSER NORBERT, RICHTER S. HELENE

University of Münster, GERMANY

Information processing in the brain can be influenced by emotional states, a phenomenon referred to as cognitive bias. Thus, an individual's appraisal of an ambiguous cue can serve as an indicator of its underlying emotional state. A growing body of evidence suggests negative cognitive biases to be implicated in the aetiology of psychological disorders, such as anxiety disorders or depression in humans. Consequently, the development of appropriate methods to assess them in animal models has gained major importance, especially with respect to enhancing the translatability of results. Since mice are the predominantly used animal model in biomedical research, the aim of this study was to develop a cognitive bias task for this species, based on a translational touchscreen task.
In a discrimination task, mice were trained to distinguish between bars displayed at different positions (top and bottom) on a central field of a touchscreen. Dependant on the cue position ("positive" or "negative"), mice had to nose-poke a cross on a touch field left or right from the reference cue, resulting in the delivery of either a large or small reward. In the following cognitive bias test, mice were presented with ambiguous cues at three intermediate positions: "near positive", "near negative", or "middle". The judgements the animals made in response to these cues, i.e. a left or right side touch, were taken as a measure for their cognitive judgement bias.
As expected, the animals' interpretation of the three intermediate bar positions differed significantly. Bars resembling either of the previously trained cues ("near positive" and "near negative") were judged accordingly, while optimism scores for the middle cue reflected highest degrees of ambiguity. In summary, the here presented method constitutes a novel and promising approach to investigate cognitive bias in laboratory mice. Provided that the paradigm can be validated, it has the potential to considerably facilitate the assessment of animal emotion in neuropsychological research.

Personality and stress response in bank voles

MAZZA VALERIA

University of Potsdam, GERMANY

How an individual copes with stressful conditions has important fitness consequences. Among-individual differences in coping with stress encompass neurophysiological and behavioural reactions. The coping style model proposes two alternative response patterns to stressors that integrate both types of response. Many of the previous studies have considered artificially selected lines, and there is reason to believe that in natural populations this relationship may not be as straightforward as predicted. In the present study we tested the predictions of the coping style model in an unselected population of bank voles (*Myodes glareolus*). We measured the voles´ faecal corticosterone metabolite levels under three different stress conditions (indoor cage: N = 70, open field: N = 70, outdoor enclosures: N = 40). We tested the repeatability of the stress response and the possible connections with the proactive-reactive behavioural profile.
Proactive voles had significantly lower corticosterone levels than reactive conspecifics, but only in the two presumably less challenging conditions. Different personality-cognitive profiles were also shown to respond differently to the change from indoor to outdoor conditions. However, contrary to our expectations, we did not detect any effect of any measured trait on the endocrine response to the most stressful situation. Our results partially support the coping style model, but suggest a more complicated relationship between behavioural and physiological responses than was initially proposed. Determining whether or not the proposed model is generally true across species and/or environmental contexts will require further studies, more attention to natural population and wider adoption of repeated measures designs. Also, experiments conducted in what are supposed to be controlled and protected conditions should be validated with natural conditions; the sole fact of being confined might differentially affect the individuals and the responses they display.

Risky sex: old males of Argiope bruennichi suffer higher rates of sexual cannibalism but do not incorporate this in their mating decisions

METZINGER MICHELLE, CORY ANNA-LENA, SCHNEIDER JUTTA M. ,

University of Hamburg, GERMANY

Males of the sexually cannibalistic spider *Argiope bruennichi* can achieve a maximum of two copulations but more than 50% are cannibalized during their first mating. First copulations take between 5 and 30 seconds and sperm transfer as well as survival are functions of the duration of copulation. Males have a chance to survive the first copulation if they mate for less than 10 seconds and transfer less sperm. Surviving males can then mate with the same female again to secure full paternity by having securely plugged both of her paired genital openings. Alternatively, surviving males may leave and search for a second female risking sperm competition if this female mates again. There is a third option of a single long copulation with the first female that ensures transferring the complete sperm load of one of their two sperm-transferring organs, the pedipalps. This option secures between 50% and 100% paternity because not all females mate again. The latter tactic is less risky given that the attempt to survive copulation means to transfer only a proportion of the sperm load and still suffer a considerable mortality risk. We test the hypothesis that older males with a reduced body condition (males do not feed as adults) should select a low risk tactic with a higher probability than younger males that may have a better chance of escaping sexual cannibalism during their first copulation and gaining a second mating. We compared copulation duration and sexual cannibalism between young and old males. As predicted older males were less likely to survive their first copulation than younger ones. However, we did not find longer copulations by old males. Our data suggest that higher mortality of old males is more likely a consequence of their inferior body condition than of employing a low risk mating strategy.

The "tolerant chimpanzee" - towards the costs and benefits of sociality in female bonobos (*Pan paniscus*)

NURMI NIINA[1], SCHÜLKE OLIVER[2], DESCHNER TOBIAS[1], HOHMANN GOTTFRIED[1]

[1] German Primate Center, Leibniz Institute for Primate Research, Göttingen, GERMANY
[2] University of Göttingen, GERMANY

Food acquisition is an important determinant of reproductive success in mammalian females. Within-group contest competition is likely when dominance rank affects access to food. When food sources are not defendable, within-group scramble competition is expected to prevail. The relative strength of these competitive modes influences costs of gregariousness in different ways. While bonobos and chimpanzees have shared characteristic social traits, such as female dispersal and fission-fusion dynamics, the trademarks of female bonobos include high gregariousness and elaborate socio-sexual behaviours. We tested predictions from three socio-ecological hypotheses regarding the evolution of these latter traits using data on wild bonobos at LuiKotale, D.R.C. We quantified feeding behavior by recording intake and movement rates within food patches using a modified Focal tree protocol, and assessed energy balances via urinary C-peptide levels in 14 females. We found that across patch residency times of varying durations intake rates remained high, but females moved increasingly more within patches, indicating that food patches were depleting. Dominance rank did not strongly affect intake rates, but was negatively associated with movement suggesting that feeding efficiency increases with rank. However, these rank effects did not translate into variation in energy balance, suggesting that the effects are too weak or that subordinates compensate for reduced feeding efficiency. Therefore, female bonobos do not exhibit high levels of tolerance in food patches, but may be better able than chimpanzee females to compensate for the disruptive effects of contest competition.

Can the landscape of risk affect seed diversity? The effect of vegetation cover on rodent feeding activity and its impact on seed bank diversity

PEREDO ARCE ANDRÉS, ECCARD JANA

University of Potsdam, GERMANY

Rodent species show an active avoidance of open areas as a defensive strategy against avian predators, even when the birds of prey are not present. As a result, seed predation by rodents on the seed bank is higher in areas with greater vegetation cover. However, its effect on the seed bank diversity has been poorly studied.

Two pilot experiments were conducted to set up future research lines about this topic. Two spatial scales were defined for both experiments: a number of landscapes along a gradient of vegetation cover and a group of sites in each landscape. In each site a seed tray with an artificial seed bank was placed. The feeding activity was measured and the seeds left in each seed tray counted to determine the giving-up-Diversity: GUDiv.

A correlation between vegetation cover and feeding activity by rodents was found in both experiments. The feeding activity or vegetation hight affected the GUDiv at both scales. A negative correlation was found between feeding activity and seed diversity left at site scale (α diversity) and at landscape scale (γ diversity). β diversity reached its maximum values at intermediate levels of feeding activity while when the feeding activity was low or high the β diversity values were minimum. Effects of time spend in feeding sites and of vegetation cover will be discussed pertaining to the landscape of fear to the rodent consumer.

Natural electric communication behavior of weakly electric fish recorded in their neotropical habitats

RAAB TILL, SEHUANES JUAN FELIPE, BENDA JAN

Eberhard Karls University Tübingen, GERMANY

To understand animal behavior it is essential to study animals under natural conditions. While in laboratory experiments the simulation of natural conditions is limited, long-term observations of animal behavior in the wild is technically much more difficult and usually requires tagging of individual animals. We take advantage of the continuously generated electric fields (EOD – electric organ discharge) of weakly electric fish to track each individuals communication behaviors. The EOD together with electroreceptive neurons form an active electrosensory system that is used for navigation, foraging and communication. The frequency of the EOD is specific for individual fish and conveys social information about species, sex, and potentially hierarchical position and motivational status. Although the neurophysiology of the electrosensory systems of these fish has been studied in much detail, little is known about their natural behavior in the wild.

To close this gap we studied a population of weakly electric fish of the species *Apteronotus leptorhynchus* in a Neotropical stream in Colombia. Using 64 electrodes aligned in a grid we continuously recorded electric signals from this population for two consecutive weeks with minimal impact on the habitat. A tracking algorithm based on EOD frequency and the distribution of signal strength on all electrodes allows us to track individual fish and their electric behaviors without tagging or video recordings.

In this data set we detected many so called EOD frequency rises, electric communication signals characterized by a fast increase of EOD frequency follow by a slow decay back to the baseline frequency lasting up to several minutes. The role of these rises is so far very controversially discussed. Our large dataset on naturally behaving fish does not support rises to signal hierarchical status but rather hints to rises being an expression of density of the fish in a given microhabitat.

Personality dependent behavioural response to artificial light at night (ALAN) in bank voles (*Myodes glareolus*)

RÜSEN LINDA, HOFFMANN JULIA, SCHIRMER ANNIKA, ECCARD JANA

University of Potsdam, GERMANY

Behavioural antipredator responses of prey species can be influenced by both indirect environmental indicators for predation risk, like light intensity, as well as animal personality. Artificial illumination during night was found to have negative impact on fitness of small rodents as it facilitates avian predation and disturbs natural dark/light rhythms. However, since personality traits have been shown to affect behavioural responses to changing environments and the perception of risk, it is likely that they are also of importance in the context of human-induced changes like artificial illumination. In this study, personality dependent behavioural responses to ALAN were investigated in bank voles (*Myodes glareolus*, N = 26). Animals were subjected to different artificial light intensities during night in laboratory arenas and exploration and foraging behaviour as well as food intake were recorded. Personality was measured using an open field test. First results suggest that ALAN had a negative effect on exploration time and movement range in the arena, although measured food intake was unaffected by light conditions. Repeatable personality traits were revealed, however only a slight tendency for personality dependent responses to illumination was shown. Shyer and less active individuals reduced their exploration time and activity in the test arenas more compared to bolder, more active conspecifics. Overall, behavioural differences were mainly explained by light condition rather than personality traits. These findings suggest that vital energy supply is being maintained even when perceived predation risk is higher while subjected to ALAN, however exploring time and movement range are affected negatively by disrupted dark/light rhythms. This, for instance, may result in limited mating opportunities or territory size and therefore decreased individual fitness. If bolder/more active individuals actually have selection advantages over shyer/less active individuals when exposed to ALAN, loss of behavioural variation on population level could be a consequence in illuminated areas.

Personality dependent spatial ecology of free-ranging rodents

SCHIRMER ANNIKA[1], HERDE ANTJE[1], ECCARD JANA[1], DAMMHAHN MELANIE[2]

[1] University of Potsdam, GERMANY
[2] University of Greifswald, GERMANY

Theory suggests, that personality-dependent space use may be an important driver in shaping ecological interactions within and between species. However, whether and how inter-individual differences in behaviour translate into variation in movement and space use patterns, is not well known.
The main aim of the present study was to test whether individual differences in boldness and exploration influence space use, movement and occupation of microhabitats of differential cover in naturally co-occurring bank voles *(Myodes glareolus*, N=21) and striped field mice (*Apodemus agrarius*, N=15). We captured and marked individuals from three subpopulations in NE-Germany in situ. Individual differences in boldness and exploration were quantified with repeated standardized tests directly in the field. Space use and movement patterns were monitored via automated VHF telemetry over four days (mean 380 locations per individual) and analyzed via kernel density estimation.
We found that space use, movement, and microhabitat use were influenced by personality differences in both species. In bank voles, bolder individuals occupied larger home ranges, moved longer distances than shy conspecifics, and used microhabitats with lower maximum vegetation height but higher ground cover more often compared to shy individuals. In striped field mice, bolder individuals tended to move longer distances but showed no difference in home range size to shy individuals
Exploration had no effect on home range size in both species, but influenced path length in bank voles positively. Further, in striped field mice, more explorative individuals were less often recorded in areas of high vegetation height but more often in areas with high ground cover.
Overall, we found evidence for personality-dependent spatial ecology in free ranging small rodents but the extent of the influence is species specific. Thus, individual differences in behaviour might lead to non-random spatial interactions within- and between species and thus might contribute to shaping local biodiversity.

The smell of hunger: Norway rats provision social partners based on odour cues of need

SCHNEEBERGER KARIN[1], TABORSKY MICHAEL[1]

[1] University of Potsdam, GERMANY
[2] University of Bern, SWITZERLAND

Direct reciprocity can establish cooperation among unrelated animals. In such interactions, the amount of help provided should depend on the relative benefit for the receiver, as this may influence the latter's propensity to reciprocate the help. Norway rats (*Rattus norvegicus*) have been shown to apply direct reciprocity in dyads of unrelated individuals enabled to produce food for each other. Here we show that in such situation, rats assess the need of their partner by odour cues. In an iterated food exchange task, rats provide more food to hungry than to satiated partners. Remarkably, merely the odour from a hungry rat is sufficient to release help of the focal towards a stooge, even if the hungry rat is kept in a different room. We further found differences in several chemical components in the odour of hungry and satiated individuals, making these substances key candidates for olfactory cues of hunger in rats. Our results suggest some form of awareness in rats of the relative benefits of a helpful act to a social partner, which otherwise is known from humans. Furthermore, we provide evidence that rats use olfactory cues as honest signals to assess the need of a partner.

Behavioural consequences and animal welfare implications of experimental housing conditions and vaccinations against rabies in red foxes (*Vulpes vulpes*)

SCHÖLER VERENA

Friedrich Löffler Institute, Celle, GERMANY

The aim of this project is to investigate of short- and long-term effects of rabies vaccination on the behaviour and the locomotor patterns of single housed captive red foxes (*Vulpes vulpes*). Furthermore, will we try to assess and to improve welfare of captive foxes in such a laboratory setting using specific physical and probably cognitive enrichment. Until now less is known on the influence of different vaccination treatments against rabies on recipient behaviour and locomotor activity. Here we will present first data on the short-term effects of laboratory housing and experimental sampling routines on the individual behaviour of 23 captive red foxes, that are distributed on three experimental rabies vaccination groups, i.) parenteral application of the vaccination, ii.) oral application, and iii.) control sham-vaccination. Through analysis of video recordings of individuals (24 hours per day splitted 15 min interval) and automated motion detection devices we aim to estimate locomotion patterns. These first results will give first hints of the behavioural patterns over time of captive foxes and the effects in response to sampling routines the rabies vaccination treatments on these behaviours.

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