Deutsches Treffen für Fledermausforschung 2020

Bild: Sönke von den Berg

Abstract booklet

Long talks

10/01 – 19:05

Babbling, an extraordinary vocal practice behavior during ontogeny

Fernandez, A.A. [1,2], Knörnschild, M. [1,2,3]

[1] Museum für Naturkunde Berlin, Leibniz Institute for Evolution and Biodiversity Science
[2] Freie Universität Berlin
[3] Smithsonian Tropical Research Institute, Panama

Keywords: Babbling, Vocal ontogeny, *Saccopteryx bilineata*

Babbling – an exploratory behavior during vocal ontogeny – demarcates the transition between basic infant vocalizations and the complete adult vocal repertoire. While babbling is undoubtedly important during the vocal ontogeny of human infants, it is surprisingly rare in other animals. Babbling is found in species that learn vocalizations based on the auditory input of conspecifics (e.g. songbirds) and in species that do not learn their vocalizations (e.g. pygmy marmosets). Therefore, cross-species comparisons are needed to infer commonalities among babbling species with and without vocal production learning (VPL). During my dissertation I investigated the babbling behavior of the bat *Saccopteryx bilineata*. Pups show a conspicuous 7-week long phase of vocal exploratory behavior during which part of the adult vocal repertoire is acquired through VPL. By comparing babbling bouts of bat pups and human infants, I could demonstrate that both are characterized by similar features, e.g. rhythmicity, repetitiveness, and vocal overproduction. Moreover, the vocal ontogeny of bat pups is influenced by social interactions (vocal and non-vocal), as it is the case for speech acquisition in human infants. During my post-doc I am going to conduct neurogenetic studies on *S. bilineata* pups to investigate the regulation of specific genes, such as FoxP, in the brain during babbling. Moreover, I am going to raise pups in controlled acoustic environments to test their ability for learning con- and heterospecific vocalizations. Combining behavioral studies on wild and captive bats with neurogenetics is a promising way to understand the functional significance of babbling in bats and other taxa.

11/01 – 09:00

Processing of naturalistic acoustic streams in a fronto-auditory cortical circuit of the bat *Carollia perspicillata*

García-Rosales, F. [1], Koessl, M. [1], Hechavarria, J.C. [1]

[1] Institute for Cell Biology and Neuroscience, Goethe University, Frankfurt am Main

Keywords: *Carollia perspicillata*; auditory cortex; frontal auditory field; electrophysiology; natural sounds; coherence

A large number of animals rely on acoustic information for survival. However, the mechanisms in the central nervous system underlying acoustic processing and auditory-guided behaviour remain poorly understood. We tackled the question of auditory processing in the mammalian brain by investigating the encoding of temporal structures present in natural sounds in the cortex of the bat *Carollia perspicillata*. We focused on the representation of temporal features in the auditory cortex (AC), considering two prominent electrophysiological signals: spikes and local-field potential (LFP) oscillations. Further, we addressed a circuit putatively essential for the orchestration of auditory-guided behaviour. Specifically, we examined functional connectivity between AC and a frontal area which also receives auditory afferents: the frontal auditory field (FAF). In the AC, low-frequency oscillations participate with neuronal spiking in the encoding of temporal modulations present naturalistic acoustic streams, in a layer-specific manner. The FAF-AC circuit was intrinsically coupled by means of low-frequency oscillations, with strongest phase-synchronization between structures confined to deep layers of the AC, where spontaneous LFP-spiking coherence was also the strongest. This “default” mode of low-frequency synchrony was not significantly altered during passive listening, although strong high-frequency synchrony emerged after sound presentation without a clear laminar specificity. Altogether, our results highlight that interactions of oscillatory and spiking activities in the AC boost the coding temporal structures present in naturalistic sound streams. Moreover, our data suggest a functional connection between frontal and auditory areas in the bat cortex which may be key for the appropriate coordination of behaviour based on audition.

12/01 -09:00

Vorstellung des F+E Vorhabens "Umsetzung der Naturschutzforschung am Windtestfeld an Land" (NatForWINSENT II)

Happ, C. [1], Lüdtke, B. [2], Reers, H. [3]

[1] UMIT - Private University for Health Sciences, Medical Informatics and Technology GmbH, Austria
[2] FrInaT, Freiburg Institute for Applied Animal Ecology GmbH, Germany
[3] OekeFor GbR, Germany

Keywords: Windenergie, Fledermaus, Kollisionsrisiko, Vermeidemaßnahmen

Die Erkenntnis, dass Fledermäuse durch Windenergieanlagen (WEA) gefährdet werden, entwickelte sich bereits in den 1970er Jahren in den USA und Australien, als dort mit dem gezielten Ausbau von Windparks erste Kollisionen von Fledermäusen registriert wurden. Zum heutigen Zeitpunkt ist bekannt, dass Interaktionen mit WEA eine der häufigsten Todesursachen weltweit für Fledermäuse darstellen. Vor diesem Hintergrund soll die durch das BfN geförderte fledermausbasierte Naturschutzbegleitforschung am Windtestfeld (NatForWINSENT II) auf der Schwäbischen Alb das Verständnis über das Fledermausvorkommen und insbesondere deren Verhalten an WEA steigern. Das Windtestfeld mit seinen zwei Forschungs-WEA mit jeweils zwei Messmasten eröffnet neue Möglichkeiten räumlich aufgelöste Daten zum Fledermausverhalten über lange Zeiträume zu erfassen. Hierzu setzen wir im Rahmen des laufenden F+E Vorhabens bestehende Systeme wie akustische Detektoren ein, entwickeln aber gleichzeitig auch neue Methodiken: Neue Systeme zur zeitlich und räumlich aufgelösten Erfassung von Insektenabundanzmustern sollen den Zusammenhang zwischen Fledermausauftreten und Insektendichte in Gondelnähe der WEA beleuchten. Parallel entwickeln wir ein System zur dauerhaften, dreidimensionalen Verfolgung von Fledermausflugbahnen im Rotorbereich, mit dem sich Flugverhalten quantitativ und qualitativ untersuchen lässt. Akustische Detektoren, die in verschiedenen Höhen der WEA sowie der Messmasten und in der Umgebung des Windtestfelds installiert sind, erlauben eine Höhenstratifizierung der Fledermausaktivität an mehreren Orten im Windtestfeld. Diese umfassenden Daten ergeben zusammen mit den räumlich feinaufgelösten Umweltdaten neue Perspektiven, um das Konfliktfeld Fledermaus/WEA mit seinen bestehenden Hypothesen zu verstehen. Weiter sollen neue Ansätze für Vermeidungsmaßnahmen, wie die Berücksichtigung der aktuellen Fledermausaktivität für eine Echtzeit-Abschaltung der Anlagen, im Windtestfeld überprüft werden.

11/01 – 13:30

New perspectives on bat behavior: highlights from proximity sensing in the wild

Ripperger, S.P. [1,2,3]

[1] The Ohio State University
[2] Smithsonian Tropical Research Institute
[3] Museum für Naturkunde Berlin

Keywords: Biologging, Proximity Sensing, Social Behavior, Social Bonds, Social Networks

Recent advances in animal tracking technology have ushered in a new era in biologging. This opens up new avenues of research, in particular in the field of animal behavior. Next-generation proximity sensors allow us to study contacts between individuals of entire social groups in great detail. I used this novel technology to resolve long-standing questions in bat biology: How do naïve juvenile bats learn where to roost? By tagging mothers and offspring from maternity colonies of common noctule bats and by tracking their associations while on the wing I revealed that mothers guided their young to new roosts, a novel mechanism of maternal care. Are cooperative relationships in common vampire bats robust to dramatic changes in the social and physical environment? I answered this question by releasing individuals after two years of captivity back into the wild, where bat-borne proximity sensors created high-resolution social networks. I found that the released bats maintained their relationships by associating stronger with their tightest captive cooperation partners than with other formerly captive or wild bats. Individuals that had been born in captivity associated with their wild relatives in this entirely unknown environment, providing first evidence for unfamiliar kin recognition in bats. In the next step, I will incorporate further dimensions of vampire bat sociality into my work by simultaneously tagging cattle and bats and by studying social dynamics in predator-prey networks. These highlights from my current and future research illustrate the sheer unlimited potential of proximity sensing in wild bats.

Short talks

11/01 – 14:00

Non-invasive acoustic monitoring of swarming bats

Bergmann, A. [1], Knörnschild, M. [1]

[1] Museum für Naturkunde - Leibniz Institute for Evolution and Biodiversity Science

Keywords: autumn swarming, Myotis, echolocation calls, acoustic monitoring

During autumn, temperate zone bats gather in front of potential hibernacula for an activity called swarming. One of the largest swarming and hibernation sites in Northern Germany is the Kalkberg cave, which is predominantly inhabited by Natterer's bats and Daubenton's bats. In front of the cave, I recorded echolocation calls of large groups of swarming bats in multiple nights during the swarming season from August to November.
As the swarming site is highly frequented, echolocation calls overlap considerably. Thus call differences become subtle, which makes it nearly impossible to differentiate species by using merely classical acoustic parameters. Therefore, in addition to the measurement of the average peak and end frequency of call sequences, I extracted acoustic features based on linear-frequency cepstral coefficients (LFCC). LFCCs are spectral-based representations of entire signals, thus making the need to analyse single calls obsolete.
Using these parameters and a set of reference data, containing identified echolocation calls of *Myotis daubentonii* and *Myotis nattereri*, a discriminant function analysis classified the echolocation call sequences based on the predominance of either species. The classification revealed a seasonal activity pattern that corresponds to the ecology of both species. Furthermore, the two predominant species separate their swarming activity spatially.
This non-invasive technique for monitoring species abundance during autumn swarming provides a tool to describe the phenology over the swarming season without the disturbing impact of net captures. As European bats tend to swarm where they hibernate, the acoustic monitoring can also predict species assemblage during hibernation.

10/01 – 20:45

How do nectar-feeding bats track a changing environment?

Chidambaram, S. [1], Nachev, V. [1], Kacelnik, A. [2], Winter, Y. [1]

[1] Humboldt Universität zu Berlin
[2] University of Oxford

Keywords: Glossophaga, decision-making, tracking

The environment of a foraging animal is not static, and resources such as food sources can change in quality and quantity. The acquiring of new information about resource quality can be very important to animals if the resource in question changes, and changes in a predictable way. If the environment changes very infrequently, the cost of gathering information, such as increased risk of predation, losing out on a known rich resources, etc. might outweigh the benefits. If the environment changes very frequently and unpredictably, there might be little benefit to gathering information as learning from that information is not possible. Thus tracking a changing environment could yield the most returns when the change occurs at a moderate rate. Nectar-feeding bats are mobile, and feed on a food sources that is stationary: flowers. Experiments were done to examine the animals' ability to track the changes in their environment by giving them a choice between a option with a fixed output of reward volume, and an option whose output volume varied by a sine wave function. The animals' foraging strategies were then modelled.

11/01 – 11:00

Insights into tropical torpor used by *Carollia perspicillata*

Fasel, N. [1], Genoud, M. [1], Vullioud, C. [2], Christe, P. [1]

[1] University of Lausanne
[2] IZW Berlin

Keywords: Aging, Alternative Reproductive tactics, Endotherms, Polygyny, Thermoregulation, Torpor

Torpor is a state of controlled reduction of metabolic rate (M) and body temperature in endotherms. Assigning measurements of M to torpor or euthermia can be challenging, especially in species using shallow torpor. All current techniques available to distinguish between those two states have their limitations and are at least partly arbitrary. Here, we firstly present a new R package (torpor) enabling distinction of torpid versus euthermic M measured in stable environmental conditions. Functions are based on the variation in M measured along varying ambient temperatures. Secondly, we used this package to test whether use of torpor and M are adjusted to male reproductive tactics in the Seba's short-tailed bat (*Carollia perspicillata*). As our model species can reach more than 10 years in age, we further controlled for any potential effect of age on torpor use.
This study firstly provides a rare analysis of the potential links between social status and patterns of thermal energetics in a bat species, which are paramount to understand the maintenance of resource polygyny. Then, the "torpor" package provides an objective method to assign measurements of M to euthermia and/or torpor, and to predict M values at any given Ta below the thermoneutral zone. Ultimately, the use of this package should improve the standardization of respirometry analyses in heterotherms.

11/01 – 20:30

Do bats compensate for weather-induced variations in sound attenuation to maintain detection distance?

de Framond, L. [1], Reininger, V. [1], Goerlitz, H.R. [1]

[1] Acoustic and Functional Ecology Research Group, Max Planck Institute for Ornithology

Keywords: echolocation, atmospheric attenuation, detection distance

Atmospheric attenuation, the absorption of sound energy by the air, causes a fading of acoustic signals with distance. This phenomenon depends on weather parameters, such as temperature and humidity, as well as on sound frequency. Therefore, variations in temperature and humidity affect atmospheric attenuation on a seasonal and a daily basis. For animals that rely on sounds for foraging, such as echolocating bats, these changing conditions modify the maximum distance over which they can detect their prey. However, echolocating bats can vary the acoustic parameters of their calls, which they constantly adapt to their spatial and social environment and the task they perform. We hypothesized that bats maintain a constant prey detection distance to optimize foraging success, despite changing weather conditions. We propose that bats adapt the frequency, duration, and amplitude of their calls to the ambient atmospheric attenuation. To address this question, we recorded wild pipistrelles *Pipistrellus pipistrellus and Pipistrellus nathusii* during thirty nights in spring and summer, with a four-microphone array. We analyzed the frequency and energy of their echolocation calls, as a function of the natural seasonal and daily variations in atmospheric attenuation. Our results suggest that bats do not compensate for the decrease in detection distance induced by weather variations. Nevertheless, they seem to modify their call parameters according to atmospheric attenuation and their reaction is species dependent.

12/01 -11:15

Catching aerial prey: the hunting behavior of *Lonchorhina aurita* (Phyllostomidae)

Gessinger, G. [1,3], Denzinger, A. [2], Page, R.A. [3], Tschapka, M. [1,3]

[1] Ulm University
[2] University of Tübingen
[3] Smithsonian Tropical Research Institute

Keywords: echolocation, feeding buzz, sensory ecology

Detecting, localizing and catching prey imposes many challenges on the echolocation system of bats. Gleaning bats specialized on passive listening for prey-generated sounds use echolocation mainly for orientation. Signals are short and broadband (FM). Gleaning bats do not emit a feeding buzz when approaching stationary prey. In contrast, edge space foragers emit signals with a narrowband (QCF) component and long feeding buzzes comprised of numerous short calls at high repetition rates when catching airborne prey. *Lonchorhina aurita* belongs to the subfamily Lonchorhininae. It has very large ears, like gleaning Phyllostominae, and was long considered to be a passive listening gleaning bat. However, *L. aurita*'s echolocation call design is different from that of other species of this family and shows additionally CF and CF-FM calls that are more similar to calls of edge space aerial insectivorous bats. We, therefore, predicted that *L. aurita* would be adapted to catch aerial prey. Further, we expected that *L. aurita* would show echolocation behavior similar to edge space foragers, including a feeding buzz at the end of the approach. To test our hypotheses, we recorded *L. aurita* hunting free-flying moths within a flight cage. Bats spontaneously hunted flying moths while ignoring motionless insects. Just prior to a capture attempt bats emitted a feeding buzz of variable length. Our results suggest that the echolocation system of *L. aurita* was adapted to hunt aerial prey and evolved to fit the demands imposed on the sensory system by the foraging niche.

11/01 – 09:45

Mutual information and redundancy maps in the bat auditory midbrain in response to natural sound streams

González-Palomares, E. [1], García-Rosales, F. [1], López-Jury, L. [1], Hechavarria, J.C. [1]

[1] Institute of Cell biology and Neuroscience, Goethe University, Frankfurt am Main

Keywords: inferior colliculus, topography, mutual information, echolocation, communication sounds

The auditory midbrain (inferior colliculus, IC) plays an important role in sound processing acting as hub for acoustic information extraction and for the implementation of fast audio-motor behaviors. IC neurons are topographically organized according to their sound frequency preference: dorsal regions encode low frequencies while ventral areas respond better to high frequencies, a type of sensory map defined as tonotopy. Tonotopic maps have been studied extensively using artificial stimuli (pure tones) but our knowledge of how these maps represent information from natural, spectro-temporally rich sounds is sparse. We studied this question by conducting simultaneous extracellular recordings across IC depths in awake bats (*Carollia perspicillata*) that were listening to sequences of natural communication and echolocation sounds. The hypothesis was that information about these two sound types is represented in different IC depths since they exhibit large differences in spectral composition, i.e. echolocation covers the high frequency portion of the bat soundscape (> 45 kHz), while communication sounds are broadband and carry most at low frequencies (20-25 kHz). Our results showed that mutual information linking acoustic stimuli to neuronal responses, and response redundancy in pairs of neurons recorded simultaneously increases exponentially with IC depth. The latter occurs regardless of the sound type presented to the bats (echolocation or communication). Taken together, our results indicate the existence of mutual information and redundancy maps at the midbrain level whose response cannot be predicted based on the frequency composition of natural sounds and classic neuronal tuning curves.

11/01 – 20:00

Technological approaches to study sensory aspects of foraging behavior in wild bats

Greif, S. [1,2], Stidsholt, L. [3], Johnson, M. [3,4], Goerlitz, H.R. [2], Madsen, P.T. [3], Yovel, Y. [1]

[1] Tel Aviv University, Israel
[2] Max Planck Institute for Ornithology, Seewiesen
[3] Aarhus University, Denmark
[4] University of St Andrews, Scotland

Keywords: sensory ecology, foraging, echolocation, GPS, accelerometer

New technologies enable us to record the location (GPS), movement (accelerometer) and acoustic behavior (microphone) of bats while they are behaving freely in the wild. Here, we present a case study where we used these technological advances to assess different aspects of bat foraging.
We analyzed the foraging behavior of greater mouse-eared bats (Myotis myotis) in Northeastern Bulgaria with small on-board tags. GPS tracks informed us on the nightly, stereotypical foraging routes and large-scale strategies that these bats employ. The analysis of body movement and echolocation behavior gave fine-scaled insights into the actual foraging behavior of individual captures. Our acoustic recordings described the dynamics of this species' echolocation when listening for prey-generated sounds and hunting airborne prey. Finally, we could not only distinguish between different foraging modes (aerial vs. ground capture), but also evaluate the attack success rate and possible prey type. This kind of data can inform us on important basics of foraging and thereby open up possibilities to estimate optimal foraging strategies.

12:01 – 11:30

Bat – Bat Fly Interactions in Central Panama: a network analysis

Hiller, T. [1,2], Vollstädt, M.G.R. [3], Brändel, S.D. [1,2], Page. R.A. [2], Tschapka, M. [1,2]

[1] Institute of Evolutionary Ecology and Conservation Genomics, University of Ulm, Germany,
[2] Smithsonian Tropical Research Institute, Balboa, Panamá
[3] Agroecology, Department of Crop Sciences, University of Göttingen, Germany

Keywords: Bats, Bat Flies, Parasitism, Networks

Network analyses provide important information about the structural and functional organization, as well as about the dynamics of species interactions. Common model systems for network studies cover seed dispersal, pollination networks, and also parasite interactions. Bat flies (Diptera: Streblidae, Nycteribiidae) are obligate blood-sucking ectoparasites of bats. Resource partitioning allows multiple fly species to co-occur on a single host individual, making them an ideal model system for network analyses. During a large-scale bat biodiversity project between 2013 and 2015 in Central Panama 6528 bats from 53 species were checked for the presence of bat flies. A total of 6077 bat flies belonging to 52 species were collected. The resulting interaction network showed a significantly higher specificity (H2'=0.97) and modularity (Q=0.78) than expected by chance, indicating a very high host specificity of the bat flies. We investigated parasite interactions in context to host size, abundance and roosting preferences. The majority of our identified modules were associated with bats using persistent roosting structures. Hereby, neither host size nor host abundance appeared to affect module structure. Further, module structure appeared not to be host phylogeny driven, instead modules were often composed of species known to share roosting structures.

11:01 – 14:45

Handheld measurements of three-dimensional directivity patterns for playback experiments

Hochradel, K. [1], Hubancheva, A. [2]

[1] UMIT - Private University for Health Sciences, Medical Informatics and Technology GmbH, Austria
[2] MPI - Max Planck Institute for Ornithology, Acoustic and Functional Ecology Group, Germany

Keywords: sound-field, directivity, acoustic measurements

Playback experiments are common tools for evaluating behavior changes of bats during flight under varying acoustic stimuli. Often playback sounds origin from the bats' natural environment but playback in the flight room is realized through speakers. Comparison of the directivity pattern of the deployed speaker and the origin of the acoustic signal is rarely done by researchers. Determining sound field patterns with a high spatial resolution is not straight forward and, especially in the field, nearly impossible. We present a self-localizing microphone that allows handheld measurements of directivity patterns of stationary periodic acoustic signals with high spatial resolution. We used the system to determine the directivity pattern of the bush cricket *Ruspolia nitidula* and compared it to patterns produced by the speakers of the flight room. The entire system is battery powered and can be used without external computers. It consists of two ultrasonic microphones of the type SPU1410LR5H by Knowles and the tracking camera T265 by Intel. Up to now we used the system for purely qualitative comparisons, however we are planning to extend the system with the possibility to measure absolute sound pressure levels.

11/01 – 10:00

An analysis of temporal integration in bat vocal communication

Hörpel, S.G. [1], Baier, A.L. [1], Wiegrebe, L. [2], Firzlaff, U. [1]

[1] TU München
[2] LMU München

Keywords: Temporal processing, Social communication, time integration

Vocal communication is a key feature of vertebrate behaviour, especially in birds and mammals. Vocalizations carry information that can trigger a range of vital behaviours in the receiver, e.g. in the context of mating, foraging or predation avoidance. Therefore, correct interpretation of the often very complex signals is crucial, calling for detailed auditory analysis by the receiver. Currently, it is still being debated whether such an analysis depends more on the short-term acoustic spectrum or on the slow modulation envelopes (i.e. the temporal code). Here we study the temporal integration time that may underlie species-specific communication in the bat Phyllostomus discolor. Combining formal psychophysics and neurophysiology, we compare behavioural thresholds to responses of single neurons in the bat auditory cortex. We use bats' vocalizations from different social contexts and manipulate the spectro-temporal information content. Inside a short window, the phase of the signal is randomized, i.e. spectral information remains while temporal information is lost. Our study will give novel insights into auditory processing of social communication signals under different contexts, helping us to better understand temporal integration times that might underlie species-specific communication.

11/01 – 11:15

Are hibernation patterns of Noctule bats (*Nyctalus noctula*) in artificial winter roosts driven by ambient temperature?

Kordges, C. [1], Kugelschafter, K. [2], Farwig, N. [1], Eitzinger, B. [3]

[1] Philipps-Universität Marburg
[2] ChiroTec Lohra
[3]Albert-Ludwigs-Universität Freiburg

Keywords: Noctule bat, hibernation, temperature, light barrier

Climate change might shift bats phenology. We therefore studied the activity at artificial roosts during hibernation of Noctule bats (*Nyctalus noctula*) from 1998 to 2018 (19,645 days of observation) in Germany. Monitoring took place via light barrier to detect arousal pattern, continuous periods of hibernation, overall activity and the onset and end of hibernation. We found that the mean ambient temperature for arousals was -3.1 °C and therefore, 6 °C lower compared to days without arousals. Low ambient temperatures in general caused a reduction in flight activity for the continuous periods of hibernation and for overall activity. The duration of continuous periods without light barrier registrations increased with decreasing ambient temperature. The longest period without exit registrations was 88 days at a roost with 80 bats. The cluster survived even though bats had no access to food or water. With increasing ambient temperature overall activity of bats increased also. Some rare flights at extremely low temperatures of -10 °C and below have also been observed. We found not change in the onset or end of hibernation even though, the median date for the 90 % threshold of emigration was the 20th of March, and therefore seven days earlier than previously released. In general, these findings show that Noctule bats react to ambient conditions, especially temperature during hibernation. Flight activity increased with rising temperature while low temperatures led to prolonged periods without flight activity, but occasionally triggered arousals to prevent freezing at extreme conditions.

11/01 – 15:15

Automated bat species identification from images using deep neural networks

Krivek, G. [1], van Schaik, J. [1], Schöner, C. [1], Kerth, G. [1]

[1] University of Greifswald

Keywords: bat population monitoring, camera trap, deep learning, winter phenology

Reliable and cost-effective monitoring of bat population trends and community composition are fundamental requirements for efficient wildlife management decisions and biodiversity conservation. Camera traps have been used for bat population monitoring at hibernation sites in Germany in the past decade, generating a large volume of digital data that exceeds the capability of manual species identification by humans. However, the use of large image datasets with the latest advances in machine learning technologies has the potential to enable automatic image-based species identification. Deep learning methods have shown outstanding performance in object detection and classification tasks, therefore we have been training a deep convolutional neural network for automatic identification of European bat species. Once developed, we will compare the performance of the automatic species classification method with expert and non-expert human identification speed and accuracy. Ultimately, automatically identifying large camera trap image datasets from all over Germany will allow us to assess accurate hibernation assemblages and compare winter phenology of different species over a latitudinal climatic gradient.

12/01 – 09:45

Saisonale Aktivitätsverläufe von einheimischen Fledermäusen an ihren Winterquartieren

Kugelschafter, K. [1]

[1] ChiroTEC

Keywords: Winterquartiere, Monitoring

tbs

12/01 – 09:30

WTimpact – teaming up with citizen scientists to investigate urban habitat use on large scale

Lewanzik, D. [1], Straka, TM. [1]*, Markgraf, L. [1], Lorenz, J. [1], Schumann, A. [1], Brandt, M. [1], Voigt, C.C. [1,2]

[1] Leibniz Institute for Zoo and Wildlife Research
[2] Freie Universität Berlin
*current affiliation: Technische Universität Berlin

Keywords: citizen science, bats urbanization, biodiversity

Some bat species cope well with urban habitats or even thrive there. In Berlin, for instance, 18 bat species have been recorded. Yet this number is misleading, since the urban bat community is usually dominated by only very few species while others occur only occasionally and in low numbers. Unfortunately, systematic monitoring across entire cities has been lacking to date. Thus, it is not yet known whether the low numbers of some species are representative for the entire city, of if the species, which are supposedly rare in urban habitats, are in fact very active in local hotspots such as urban green spaces with particular environmental characteristics.
As part of the collaborative citizen science project WTimpact, we systematically record bat activity at 600 transect points on six nights each. We investigate how species-specific activity is affected by the level of impervious surface, canopy cover, and artificial light at night and by the distance to water bodies, while controlling for temperature and time after sunset. We predict that effects of these variables are dynamic, i.e. that they differ between seasons. Results of this study are going to be of high relevance for conservation measures, as we will be able to predict which combination of environmental variables is necessary for urban green spaces to function as refuge for rare bat species.

11/01 – 9:30

Neuroethology meets Predictive coding: the bat brain has neural priors that favor echolocation processing

López-Jury, L. [1], Hechavarria, J.C. [1]

[1] Institut für Zellbiologie und Neurowissenschaft Goethe-Universität Frankfurt/Main Germany

Keywords: predictive coding, bat, brain, neuroethology, priors

It has been argued that brains are essentially “prediction machines”, in the sense that they constantly attempt to match incoming sensory inputs to so-called “predictions”. Making predictions is influenced by “prior” knowledge that can be formed through life (i.e. the sky is blue) or even genetically hardwired in the neural tissue. In this project, we establish a link between neuroethology (i.e. the study of animal behaviour and the neural mechanisms mediating it) and predictive coding theory. Linking these two study fields is key to understand how expectations influence sensory information processing in behaviourally relevant contexts. To tackle this question, we studied cortical auditory responses in bats to ‘unexpected’ and ‘expected’ sounds in two auditory contexts: echolocation and communication. We show that expectations in the communication context (i.e. hearing a communication sound after a communication sequence) strongly suppress neuronal activity. The latter does not occur in the navigation context, in which the occurrence of biosonar calls does not suppress responses to forthcoming biosonar sounds, as it would be expected from classic predictive coding theory and adaptation experiments in other animal species. In addition, responses to unexpected sounds are facilitated in the communication situation, but echolocation sequences facilitate responses to both unexpected and expected sounds. Our observations suggest that ethology shapes brain operations by providing neural priors that favour behaviourally critical sensory signals (i.e. echolocation in the case of bats). We propose that within the predictive coding framework, at least some of the top-down expectations are the product of evolution.

11/01 – 14:15

Towards a Radar-Assisted Bat Fatality Assessment at Wind Turbines: Numerical and Experimental Results

Mälzer, M. [1], Taremi Zadeh, A. [1], Beck, S. [1], Moll, J. [1], Krozer, V. [1]

[1] Goethe University Frankfurt

Keywords: Bat Fataility, Radar, Wind Turbine

An important tool to understand the influence of wind turbines on bats is the search for fatalities.
This method poses several problems: First the area around the wind turbine cannot always be searched completely because of the large search area and vegetation. Secondly, even cadavers that fall on searchable areas can be carried off by animals before they are found. In forests or offshore it can even be impossible to find cadavers, because they can get caught in trees or are washed away.
In this work, we propose a radar barrier as a novel approach to assist evidence-based assessment of bat mortality at wind turbines. Therefore, at least three 24 GHz radar systems are mounted one above the other on the tower of a wind turbine below the rotor blade tips. The system detects falling objects and determines the starting height using the mechanical equation of free fall. If the estimated height is within the range of the blades we can assume a collision, and trigger a manual search at the relevant search area. A decision tree is used to eliminate false positives. This contribution presents the results of a model experiment to show a proof-of-principle. Furthermore, a simulation environmental has been developed to better understand the behavior of the radar systems and to generate a comprehensive amount of test data for optimized classification.

10/01 – 19:35

The role of auditory feedback on the vocal development of normally hearing and hearing-impaired pale spear-nosed bats, *Phyllostomus discolor*

Mardus, E.S. [1], Lattenkamp, E.Z. [1], Linnenschmidt, M. [1], Wiegrebe, L. [1]

[1] Ludwig-Maximilians University Munich

Keywords: Auditory feedback, vocal development, vocal learning, deafening

Bats are highly social animals, which display a broad variety of social and vocal behaviours. In the past, several bat species have shown indications for vocal learning, i.e. the capacity to acquire new vocalisations through auditory experience. However, reports on vocal learning in bats are still sparse. As vocal learning is strongly dependent on auditory feedback mechanisms, we investigated the effect of hearing impairment on the development of vocalisations of the pale spear-nosed bat, Phyllostomus discolor. A comparison between vocalisations of three 2-year old bats, which were deafened shortly after birth, and three same-aged normally hearing control bats was conducted. Based on acoustic analysis of several vocalisation parameters, it was demonstrated that the pale spear-nosed bat does indeed rely on auditory feedback for normal vocal development. These results present an important contribution to the discussion of the status of P. discolor as a limited vocal learner and the role of this species for the study of vocal learning.

11/01 – 15:30

Lethal teeth anatomy in *Pipistrellus* – an single case? Radiological investigations in extant bats

Rabenstein, R. [1], Stiefel, D. [2]

[1] Forschungsinsitut Senckenberg
[2] Staatliche Vogelschutzwarte für Hessen, Rheinland-Pfalz und Saarland

Keywords: teeth anatomy, Pipistrellus, X-ray

In der Fledermaus-Literatur finden sich vereinzelte Hinweise zu altersbedingt stark abgekauten Zähnen oder geringfügigen Zahnanomalien (Verdoppelung oder Fehlen einzelner Zahnpositionen). Bei der Staatlichen Vogelschutzwarte für Hessen, Rheinland-Pfalz und Saarland in Frankfurt wurde 2019 ein bereits flügges Jungtier von Pipistrellus pipistrellus mit normalem Ernährungszustand, jedoch ohne sichtbare Zähne abgegeben. Nach dem Tod dieses Pfleglings sollte eine Röntgenaufnahme Auskunft über seinen Zahnstatus geben. Zum Vergleich wurden zwei weitere Pflegetiere aus den abgegebenen Totfunden des gleichen Jahres zufällig ausgewählt und ebenfalls geröntgt. Überraschenderweise war bei der „zahnlosen“ Zwergfledermaus das gesamte Gebiss entwickelt, aber nicht durchgebrochen, während bei einem der beiden Vergleichstiere Zähne fehlten.
Um das Auftreten solcher Zahnanomalien näher zu erfassen, wurde eine erweiterte Stichprobe von 39 Tieren (*P. pipstrellus* und *P. pygmaeus*) unterschiedlichen Alters geröntgt. Im 2D-Röntgenlabor am Forschungsinstitut Senckenberg wurden an einem Vollschutzgerät (Faxitron HP) Radiografien der Tiere auf digitalen Speicherfolien erstellt (50 kV, 3 mA, 60-90 Sekunden), die mit 7 µm Auflösung (16bit) mit einem Laserscanner eingelesen wurden.
Kein einziges dieser 39 Tiere zeigte Gebissauffälligkeiten. Eine weitere Serie von 25 Tieren unterschiedlichen Alters von einem Fundpunkt ist für die weitere radiologische Untersuchung bereits ausgewählt. Um Daten zum Vorkommen und der Verbreitung und Fragen nach den Ursachen (Kontaktgifte, genetische Disposition) zu klären, wollen wir die Teilnehmer um Informationen aus ihren Arbeitsgebieten bitten. Die Radiografien sollen weiterhin für die Lebensaltersbestimmung und die Todesursache (Frakturen etc.) ausgewertet werden. Alle Zwerg- und Mückenfledermäuse werden für weitere Untersuchungen (z.B. DNA) aufbewahrt.

11/01 – 10:45

Roosting outside the comfort zone – torpor at high ambient temperatures in a Malagasy bat

Reher. S. [1], Rabarison. H. [1], Dausmann, K.H. [1]

[1] Functional Ecology, Institute for Zoology, University of Hamburg, Germany

Keywords: Energy budgets, Thermoregulation, Tropics, Roost selection, "Hot" torpor

Mammals rest up to 23 hours per day so that the quality of their sleeping site can profoundly affect maintaining a balanced energy budget. This is particularly true for bats since their large flight membranes promote heat and water loss. Insulated roosts posing minimal energetic constraints should therefore generally be favoured. In Madagascar's dry forests however, *Macronycteris commersoni* roosts solitary in understory shrubs offering no protection from daytime extremes. This type of roost raises intriguing questions on energy management and microclimate choice in an environment where bats are potentially water- and energy-restricted. We related metabolic rate and skin temperature measurements to local environmental characteristics to track how *M. commersoni* physiologically responds. While completely exposed to high temperatures and low humidity during the day, the bats entered torpor. Skin temperatures sometimes even exceeded normothermia but metabolic rate was remarkably low, suggesting metabolic inhibition despite hyperthermia. By accumulating heat instead of dumping it, no water is "wasted" via evaporative cooling, which is the only option for actively regulating body temperature at ambient temperatures exceeding normothermia. Other tropical species might cope with their local environment and weather extremes in a similar way. However, high body temperatures might be misleading and mask possible hypometabolic states, which underlines the necessity of further investigation in "hot" torpor using techniques that are independent of temperature.

12/01 – 11:45

The masked seducers: Lek courtship behaviour in the Wrinkle-faced bat *Centurio senex* (Phyllostomidae)

Rodríguez-Herrera, B. [1], Sánchez-Calderón, R. [1], Madrigal, V. [1], Rodríguez, P. [1], Villalobos, J. [2], Hernández, E. [2], Zamora, D. [3], Gessinger, G. [4,5], Tschapka, M. [4,5]

[1] Universidad de Costa Rica
[2] Universidad Nacional Autónoma de México
[3]Estación de Investigación Miguel Alfaro, Hotel Villablanca, Costa Rica
[4] University of Ulm, Germany, [5] Smithsonian Tropical Research Institute, Panama

Keywords: Phyllostomidae, reproduction, behavior, echolocation, bioacoustics

Centurio senex is an enigmatic phyllostomid bat characterized by facial modifications that deviate far from the general New World Leaf Nosed Bat morphology. The species has a bizarrely wrinkled face and the nose leaf is absent. Throughout its distribution from Mexico to Northern South America it is rarely captured and only scarce information is available. *Centurio senex* is frugivorous, and one of the few bats documented to consume also hard seeds. Interestingly, the species shows a distinct sexual dimorphism: Adult males have more pronounced facial wrinkles and a fold of skin under the chin that can be raised to cover the lower part of the face in style of a mask. We report on an aggregation of *Centurio senex* males in Costa Rica that provided the first opportunity to observe the mating behavior of the species using combined audio and video recordings. Over a period of 6 weeks up to 56 males were observed during the same night on perches with an average height of 2.35 m. Over long time the masked males moved just their wing tips, while vocalizing in the ultrasound range. Approaches of other individuals resulted in the male beating its wings and emitting a very loud, audible whistling call. Following such an encounter we recorded a copulation event. The observed aggregation of adult *C. senex* males is consistent with a lek courtship, a behavior described from only few other bat species.

10/01 – 20:20

Landscape structure influences social foraging behaviour in noctule bats

Roeleke, M. [1,2], Blohm, T. [2], Hoffmeister, U. [2], Marggraf, L. [2], Schlägel, U.E. [1], Teige, T. [2], Voigt, C.C. [2]

[1] University of Potsdam
[2] Leibniz Institute for Zoo- and Wildlife Research

Keywords: gps, eavesdropping, movement, ultrasonic recordings

Aerial insectivores are often confronted with variable spatial distribution of prey in anthropogenic landscapes. Yet, their high mobility may allow them to adjust their foraging strategy to different resource distributions.
We asked if aerial-hunting common noctules, *Nyctalus noctula*, vary in foraging strategies when hunting above two anthropogenic landscapes differing in structural diversity: one dominated by farmland and one dominated by forests.
We tracked flight paths of noctule bats in north-eastern Germany using GPS loggers equipped with an ultrasonic microphone that recorded foraging activity and the presence of conspecifics.
Above farmland, common noctules hunted mainly during bouts of highly tortuous and area restricted movements (ARM). Hunting activity was triggered by conspecific presence. In the forested landscape, common noctules hunted both during ARM and during straight flights, irrespective of conspecific presence. Common noctules that foraged above the forested landscape had a lower feeding rate and encountered overall more conspecifics than common noctules above farmland.
We propose that patchy prey distribution above farmland restricted common noctules to hunt in insect rich patches which were found by eavesdropping on hunting conspecifics. In contrast, structural diversity of the forested landscape at small scales possibly led to less patchy prey distribution on the landscape scale, thus enabling bats to find sufficient food without the need to eavesdrop on conspecifics. This suggests that social interactions among predators depending on ephemeral prey are required to forage successfully above structurally poor landscapes.

11/01 – 11:45

Bats, flies and haemosporidians: co-phylogeography of a host, a parasite and a pathogen

van Schaik, J. [1], Rosskopf, S.P. [2], Matuschewski, K. [2], Schaer, J. [2]

[1] University of Greifswald
[2] Humboldt University

Keywords: Myotis, basilia, polychromophilus, population genetics, host-parasite

Bats host a high diversity of malaria parasites, including the genus Polychromophilus, which is exclusive to bats and vectored by different species of bat flies (Nycteribiidae). One species, *Polychromophilus murinus*, has been recorded from several European vespertilionid bats, but range wide genetic diversity remains unknown. Here we investigated the range wide phylogeography of the Bechstein's bat, *Myotis bechsteinii*, its bat fly, *Basilia nana*, and the prevalence and genetic diversity of Polychromophilus infection across populations. Additionally, a subset of other bat fly species/genera from *Myotis spp*. were also screened for Polychromophilus infection. We found three distinct genetic lineages in *M. bechstenii*, corresponding to the Iranian, Caucasian and European populations. Contrastingly, genetic diversity of B. nana shows evidence for more recent dispersal between host subpopulations. Finally*, P. murinus* infections were detected in flies of every sampled region, comprising two sets of highly distinct haplotype clusters. In addition to this deeper split, haplotypes of *P. murinus* recovered in *B. nana / M. bechsteinii* diverged strongly from those found on other bat/fly associations, pointing to long-term host-specific associations between P. murinus and its various host species.

12/01 – 10:00

New information about the distribution of the Western Barbastelle in Swabia (Bavaria) and findings concerning their behavior according to LED light

Schewe, A. [1]

[1] Hochschule Anhalt

Keywords: Barbastelle, LED, distribution, Swabia (Bavaria)

Although it seems to be known among bat workers, that the Western Barbastelle is well-distributed in Swabia (Bavaria), published recordings are fragmentary. For the official "Spezielle artenschutzrechtliche Prüfung" (Special species protection examination) in Bavaria it is usual, that only "officially" distributed species are considered. That implicates, that the Western Barbastelle sometimes does not get the necessary attention in building projects. To help along that problem a large-area spot-survey was done with the result that the species could be found more often than expected, also nursery roost. Additionally we developed and tested a study design to investigate the species behavior according to LED light.

10/01 – 19:50

Stability of roosting patterns in a laboratory colony of *Carollia perspicillata*: neighbors matter!

Schmidt, S. [1], Gérard, S. [1], Spreen, C. [1]

[1] Institut für Zoologie, Stiftung Tierärztliche Hochschule Hannover, Germany

Keywords: social network analysis, preferred associations

Social systems of animals are crucially shaped by the distribution of individuals in space and time which reflects their mating system, and sets the framework for individualized interactions. To test for sociality, rather than mere aggregation, in a laboratory colony of *C. perspicillata*, we explored roosting patterns focusing on group composition and its temporal stability, and related them to body condition, sex and age of the individuals involved. A social network analysis was performed on roosting data of the 23 to 25 bats of the colony monitored over eight months in the animal facility, using SOCPROG 2.8 to determine dyadic half weight association indices, to test for preferred or avoided associations, and to fit models based on standardized lagged association rate. The bats perched in stable, non-randomly associated groups of an adult male with several reproductive females (harems), of associated bachelors, of a group of two adult males with two females, and a group consisting mostly of juveniles of both sexes. Stability of groups varied considerably; a "constant companions and casual acquaintances" model explained data best. Bats older than one year showed more stable associations than younger animals, had higher association rates, and were associated with more strongly associated individuals. This correlated with a higher "forearm-mass-index" as proxy for body condition. In contrast, the fact that females showed more stable associations than males was not correlated to differences in body condition. In sum, the bats displayed a complex and dynamic social structure in captivity.

12/01 – 11:00

Echo-acoustic traits of moths in response to predation pressure by bats

Simon, R. [1], Leroy, H. [1], Berg, M.P. [1], Halfwerk, W. [1]

[1] Ecological Sciences, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands

Keywords: bats, moths, predator-prey interaction, echolocation, acoustic camouflage

Camouflage is one of the predominant anti-predator strategies of animals that face a strong predation pressure. Moths are a prime example of a heavily predated group as they are hunted by birds during the day and by bats throughout the night. As counterstrategy to diurnal predators many species are visually camouflaged when resting on vegetation. The nocturnal evolutionary arms race between bats and moths has also led to a whole arsenal of anti-predator strategies. One recently discovered strategy is acoustic camouflage. Specialized wing scales and thoracic fur can absorb ultrasound, thereby reducing detection of moths by echolocating predators. Here we show that such acoustic camouflage through prolonged and dense fur is widespread among different moth families and is not only limited to non-hearing moths. We used high resolution acoustic imaging and measured ultrasound echoes of 44 moth species belonging to eight families. For some species we also conducted an experiment where we repeated the echo measurement after we removed their thoracic and abdominal fur. We found a strong correlation between size and weight of the moth and their overall target strength (TS). Species with less hair (mainly Geometridae), where generally smaller and lighter, but had higher TS than species of the same size that where hairy. The fur-removing experiment revealed that absence of fur leads to and increased TS, which shows that the detection distance would be higher if moths would not exhibit this fur. We conclude that thoracic and abdominal fur might be especially important for larger species.

11/01 - 20:15

Spatial and temporal sensory trade-offs in *Myotis myotis* bats echolocating in the wild

Stidsholt, L. [1], Greif, S. [2,4], Johnson, M.P. [3], Macaulay, J. [3], Goerlitz, H.G. [4], Madsen, P.T. [1]

[1] Aarhus University
[2] Tel Aviv University
[3] University of St Andrews
[4] Max Planck Institute for Ornithology

Keywords: Echolocation, on-board tags, echogram, sensory volumes

Echolocating animals face a sensory tradeoff between spatial and temporal information acquisition: to receive echoes from longer distances, call rate must be reduced to avoid call/echo overlap. For bats this tradeoff is apparent when comparing commuting flight over large spatial scales with catching prey during fast and close encounters. To accomplish these different tasks, bats can change the output level, directionality and repetition rate of their calls. However, little is known about how such changes are implemented in the wild. Here, we equipped wild greater mouse-eared bats (Myotis myotis) with small on-board tags, recording movement, calls and returning echoes. We hypothesized that (1) the ensonified sensory volumes are larger (i.e. higher output levels), (2) the temporal resolution lower (i.e. reduced call rate) and (3) the overlap of ensonified volumes smaller (i.e. reduced call rate per flight distance) during commute flight compared to aerial captures.
We show that ensonified sensory volumes vary by up to 50 m3 between the loudest and weakest calls, and levels of spatial overlap change from 0 to 100 % between sensory tasks. These changes directly translate into large variations in the sensory scenes returning to the bat. During prey capture, bats decreased their sensory volume, which simplifies the auditory scene to mainly comprise prey echoes with high update rates easing sensory stream segregation for optimal timing of prey interception.
This study quantifies and visualizes how bats balance the acquisition of spatial and temporal sensory information during different operational modes in the wild.

12/01 – 10:15

A question of trust and beliefs? Understanding emotions and cognitions of interest groups involved in the green-green dilemma in Germany

Straka, T.M. [1], Fritze, M. [1], Voigt, C.C. [1]

[1] Department of Evolutionary Ecology, Leibniz Institute for Zoo and Wildlife Research, Berlin

Keywords: Conservation social sciences, interest groups, wind turbines

The development of wind turbines in Germany is a controversially discussed topic. While wind turbines promise to contribute to climate conservation goals in this century, the ongoing negative impact of wind turbines on some wildlife is undeniable. Understanding the views of involved stakeholders around the ongoing development of wind turbines is of value in this so called green-green dilemma. We undertook an online survey with five different stakeholder groups, i.e. representatives from the wind turbine sector, consultants, nature conservation authorities, scientists and volunteers from environmental NGOs. In our survey instrument, we investigated stakeholder groups' value orientations about human-nature relationships, emotions towards bats and wind turbines, beliefs about the benefits of wind turbines and trust in each other about the decisions made around the green-green dilemma. In total, we received 537 responses from all groups. We found that consultants and wind turbine developers strongly believed that wind turbines are important while volunteers held stronger beliefs about the importance of species protection. Further, we found that how respondents felt about bats and wind turbines was a stronger underlying predictor for these beliefs than their value orientations. Lastly, we found that trust in each other's decisions strongly varied among stakeholder groups. Understanding potential discrepancies in trust but also about the beliefs in relation to the green-green dilemma can be a useful base for further discussions and to move forward in finding a potential consensus in the green-green dilemma.

11/01 – 15:00

Receiver Directionality in Echolocating Bats *Phyllostomus discolor*: A Novel Reconstruction Technique

Umadi, R. [1], Baier, A.L. [1], Wiegrebe, L. [1]

[1] Ludwig-Maximilians-Universität München, Department Biologie II

Keywords: Directionality, Receiver, Emitter, Echolocation

Echolocating bats sequentially sample space while exercising control over the width and directionality of their sonar beam - a decisive process resulting from the processing of the returning echoes. The directionality of an echolocation system, however, is the product of sender and receiver directionality. While the latter is easily obtained from anesthetized or dead animals (the head-related transfer function, HRTF), awake and behaving bats make fast ear movements and –deformations which render classical HRTF methods impossible To understand the operational correlation between the receiver and emitter directionalities, we propose a novel approach using a 45 channel array of microphones and loudspeakers, and in-ear microphones. The microphones and co-located speakers are used to generate virtual echo-acoustic scenes wherein bats, for instance, have to find a single deviant object among many equal standard objects (like e.g. an edible fruit among inedible leaves). Further, all speakers continuously emit an individual signature sound that is picked up, together with the virtual echoes, by the in-ear microphones. By searching for the different signature sounds in the recordings from these microphones, we can determine how good the transmission of each of the speakers to each of the ears was. This allows the reconstruction of allocentric HRTFs. Moreover, by doing this reconstruction in fine temporal bins, as small as 10 ms, we can track ear directionality, together with emitter directionality changing over time while the bat is engaged in a well-defined echo-acoustic task.
We also discuss the various technical challenges expected in this approach and possible solutions.

11/01 – 11:30

Energy intake and sugar concentration discrimination in the nectar-feeding bat *Leptonycteris yerbabuenae*

Walter, M.H. [1], Verdong, A. [1], Olmos, V. [1], Weiss, C.C. [1], Vial, L.-R. [2], Putra, A. [1], Müller, J. [1], Schnitzler, H.-U. [1]

[1] Animal Physiology, Institute for Neurobiology, University of Tübingen
[2] Neuroethology, Institute for Neurobiology, University of Tübingen

Keywords: Intake response, Food choice, Phyllostomidae

All nectar-feeding animals are confronted daily with a challenge during foraging: they must find and select flowers that provide nectar with adequate amounts of dissolved sugar to cover their very high energy needs. To understand this decision-making process it is crucial to know how accurate different sugar concentrations can be discriminated. In a controlled laboratory setting we presented twelve individuals of the nectar-specialist lesser long-nosed bat, *Leptonycteris yerbabuenae*, the choice between sugar solutions of different concentrations in a two-alternative free choice test. We offered them solutions across the range of concentrations found naturally in bat-pollinated plants. Confirming a previously conducted study with wild conspecifics we found that physiological constraints limit their energy intake when feeding on dilute nectar. The capability to discriminate different sugar concentrations outperformed any other nectar-feeding animal studied to date. At sugar concentrations below 10%, these bats can discriminate solutions differing by only 0.5%. This fine-tuned ability helps the bats to select nectars with reward qualities that provide them with sufficient energy.

10/01 – 20:05

Formation of social patterns in a newly assembled group of Sowell's Short Tailed Bats (*Carollia sowelli*)

Weymann, J. [1], Bosia, T. [1], Engels, L. [1], Schmidt, S. [1]

[1] Institut für Zoologie Stiftung Tierärztliche Hochschule Hannover

Keywords: gregariousness, preferred associations, socio-positive interactions

Group-living is a typical feature of bat ecology. The present study aims at factors that drive aggregation and the formation of social patterns by studying a newly assembled group of *Carollia sowelli* in two observation periods, shortly after capturing the individuals, and six weeks later. Based on focal sampling, videos were recorded for three hours after dusk to capture physical contacts and social interactions of bat dyads. Using SOCPROG2.8, dyadic contact rates were analysed in terms of individual-based gregariousness, as well as of individual preferences for specific associates, and compared with the number of socio-positive interactions in bat dyads. In both observation periods, gregariousness and individual preferences for specific associates were predictors of physical contact rates. The number of socio-positive interactions, namely allogrooming, greeting and sniffing, was significantly higher in the second observation period compared to the first. Moreover, the number of socio-positive interactions, and the individual preferences for specific associates, were positively and significantly correlated in the second period, only, indicating a formation of individualised relationships. In contrast, individual gregariousness did not differ between observation periods and was negatively correlated with the number of socio-positive interactions in the second period, confirming that higher interaction rates were not a simple consequence of increased physical contact. In sum, the present study provides evidence that individualised relationships were established in a newly assembled group of *C. sowelli* within six weeks.

Batty talks

The mating song of the katydid *Ruspolia nitidula* may jam bat sonar

Hubancheva, A. [1,2], Dimitrova, K. [3], Goerlitz, H.R. [1]

[1] Max Planck Institute for Ornithology
[2] Institute of Biodiversity and Ecosystem Research
[3] Trinity College Dublin

Keywords: predator-prey interactions, echolocation, jamming, bush crickrets, bats

During the night, male katydids *Ruspolia nitidula* sing for long periods of time to attract females. Here, we describe previously unknown ultrasonic components in the mating song of this insect ranging from 40 kHz up to 110 kHz. We hypothesize that the continuous, ultrasonic, and high-duty cycle mating song can jam the echolocation signals of both gleaning and aerial-hawking bats flying close to the katydids. We performed a series of behavioural and molecular experiments and observations in the lab and the field. In a playback experiment, *Myotis blythii* showed strong predatory response towards an *R. nitidula* song broadcasted from loudspeakers, and the bats readily ate offered live katydids. However, the DNA of this insect was not found in faecal samples of wild *M. blythii* and *M. myotis* – the two bat species known to forage on katydids in Europe. In another experiment, M. myotis was trained to catch tethered mealworms placed 1 m away from a loudspeaker array. Our preliminary results show a significant difference between bat predation success in the presence of a high-pass *R. nitidula*'s song, a low-pass *R. nitidula*'s song, and a full-spectrum *R. nitidula* song in comparison to foraging in silence. Our study suggests that mating signals can interfere with sensory perception by echolocation. The calling katydid will be protected from bat attacks as the bat's orientation in shrub habitat will be impaired. In addition, not only the sender but also close-by aerial prey species might be protected.

Modelling active sensing in groups: (what) do bats hear in the cocktail party nightmare?

Beleyur, T. [1], Goerlitz, H.R.[2]

[1] Acoustic and Functional Ecology, Max Planck Institute for Ornithology

Keywords: echolocation, active sensing, cocktail party nightmare

Echolocation research over the past fifty years has unravelled how bats echolocate as individuals. Bats emit loud calls and listen for faint returning echoes. However, when many bats echolocate together, they might mutually jam each other. The loud calls from neighbouring bats will tend to mask returning echoes, and masking is expected to get worse with increasing group size. This problem is called the cocktail party nightmare for echolocating bats. Despite this problem, many bats echolocate in groups and roost socially in the field.

Here, we present a biologically parametrized framework to quantify echo detection in groups. Incorporating known properties of echolocation, psychoacoustics, spatial acoustics and group flight, we quantify how well bats flying in groups can detect each other despite jamming. A focal bat in the center of a group can detect neighbors for group sizes of up to 100 bats. With increasing group size, fewer and only the closest and frontal neighbors are detected. Neighbor detection is improved for longer call intervals, shorter call durations, denser groups and more variable flight and sonar beam directions. Our results provide the first quantification of the sensory input of echolocating bats in collective group flight, such as mating swarms or emergences. Our results further generate predictions on the sensory strategies bats may use to reduce jamming in the cocktail party nightmare. Lastly, we suggest that the spatially limited sensory field of echolocators leads to limited interactions within a group, so that collective behavior is achieved by following only nearest neighbors.

Posters

#9 Echolocation

Peeking through the foliage - Biosonar range resolution

Baier, A.L. [1,2], Wagenhäuser, P.A. [1], Wiegrebe, L. [1]

[1] Department Biology II, Ludwig Maximilians University Munich, Großhaderner Str. 2, 82152 Martinsried, Germany
[2] Chair of Zoology, Technical University Munich, Liesel-Beckmann-Str. 4, 85354 Freising-Weihenstephan, Germany

Keywords: echolocation, psychophysics, spatial resolution, depth, clutter

Many echolocating bats forage close to vegetation - a chaotic arrangement of prey and foliage where multiple targets are positioned behind one another. Bats excel at determining distance: they measure target range by the delay between outgoing call and returning echo. In their auditory cortex, neurons are arranged by the specific delay they respond to, forming a topographic map. This would suggest that bats can resolve echoes of multiple targets along the range axis - a skill crucial for the forage-amongst-foliage scenario. We explicitly tested this hypothesis combining an auditory virtual reality with formal psychophysics: We simulated a prey item embedded in two foliage elements, one in front of and one behind the prey. The simulated spacing between “prey” (target) and “foliage” (maskers) was defined by the inter-masker delay (IMD). We then trained Phyllostomus discolor bats to detect the target in the presence of the maskers and systematically varied both loudness and spacing of the maskers. We show that target detection is considerably impaired when maskers are closely spaced (IMD < 1 ms), but remarkably improves when the spacing is increased: the release from masking is about 5 dB for intermediate IMDs (1-3 ms) and increases to over 20 dB for large IMDs (≥ 9 ms). These results suggest that prey would enjoy considerable acoustic protection from closely spaced foliage, but also that the range resolution of bats would indeed let them “peek into gaps”. Our study puts target ranging into a meaningful context and highlights the limitations of computational topographic maps.

#17 Ecology

Functional Diversity and Community Structure of Bats along an Elevational Gradient in the Himalayas

Chakravarty, R. [1], Radchuk, V. [1], Voigt, C.C. [1]

[1] Leibniz Institute for Zoo and Wildlife Research

Keywords: elevational gradient, Himalayas, functional traits, acoustic sampling

Climate change is one of the greatest threats faced by the natural world. Recent studies show that animals respond to climate change in several ways such as shifts in phenology, changes in breeding cycles, and range expansions to higher latitudes or elevations. Range shifts are increasingly common but little is known about the effects that range-shifting species have on established native communities that have shaped over hundreds and thousands of years of interactions. Elevational gradients provide a particularly suitable framework for understanding both how contemporary communities are structured and how they may change in the future. Bats - a taxonomically and functionally diverse group of vagile mammals that are sensitive to environmental perturbations - present interesting opportunities to study community ecology in montane environments. In the first part of this ongoing study, we sampled 150 bats from 26 species from 1400m above sea level (asl) to 3500m asl at Kedarnath Wildlife Sanctuary in the Indian Himalayas between March and June 2018 and 2019. Specifically, we used passive acoustic monitoring to investigate nocturnal activity patterns of co-occurring bats. Additionally, we mistnetted bats to collect data on functional traits related to wing morphology and echolocation characters. Here we present preliminary results on functional diversity, activity patterns and community structure of bats across elevations. In the long run, this study is intended to improve our understanding of the impacts of climate change on Himalayan fauna and will provide a framework for assessing the future impacts on vulnerable montane species all over the world.

#14 Echolocation

Behavioral responses of acuminate horseshoe bats to sexually dimorphic echolocation calls

Chang, Y. [1,3], Bumrungsri, S. [2], Lewanzik, D. [3], Soisook, P. [2], Goerlitz, H.R.[3]

[1] Evolution, Ecology and Systematic, Ludwig-Maximilians-Universität München, Martinsried, Germany
[2] Faculty of Science, Prince of Songkhla University, Thailand
[3] Acoustic and Functional Ecology, Max-Plank Institute for Ornithology, Seewiesen, Germany

The time-frequency structure of bat echolocation calls is highly adapted to navigating and foraging in the darkness. Less understood is its function for conveying social information. Several bat species have sexually dimorphic peak call frequencies, but usually the range of peak frequencies overlaps between the sexes. Our study confirmed that a strong sexual dimorphism in echolocation call frequencies exists in *Rhinolophus acuminatus*, an understudied species, in southern Thailand. The peak frequency is inversely correlated with forearm length, where females are smaller and call at frequencies above 90 kHz while males are larger and call below 90 kHz. In addition, sex itself has a significant effect on call frequency, which does not interact with the effect of body size. Hypothesizing that the bats' responses might depend on the caller's sex and frequency, we broadcasted playbacks to free-living *R. acuminatus* in the roost and audio-video recorded ear movements and the calls' duty cycle and received level. Bats of both sexes showed stronger responses to female than male playbacks. Moreover, females reduced their duty cycle and received level with increasing call frequency of male playbacks. We also documented previously undescribed social behaviors, namely face-approaching behavior with associated calls during aggressive encounters, and hooked calls emitted when one bat approaches another one. Our findings highlight the diverse acoustic and behavioral repertoire in *R. acuminatus*, suggesting that these bats recognize sex through echolocation calls and probably differentiate their response based on conspecific call frequency.

#18 Ecology

Tent-roosting Bats and where to find them: Roost site selection of tent-roosting bats across a lowland rainforest island system in Panama

Cvecko, P. [1, 2], Brändel, S. [1, 2], Hiller, T. [1,2], Page, R.A. [2], Tschapka, M. [1, 2]

[1] Institute of Evolutionary Ecology and Conservation Genomics, University of Ulm, Ulm, Germany
[2] Smithsonian Tropical Research Institute, Balboa , Panama

Keywords: roosting ecology, tropical bats, habitat fragmentation, bat-plant interaction

Fragmentation of natural habitat is worldwide one of the major losses of species diversity. The responses of forest-dwelling animals to fragmentation may vary widely, especially within bird and bat communities. Particularly the diverse group of Neotropical leaf-nosed bats (Phyllostomidae) provide important ecosystem services such as pollination, seed dispersal and predation on herbivorous insects. Adequate roosting sites are essential for these animals, limiting the occurrence and population size of the species. These limits may even affect species known to be quite flexible in roost site choice, including species that modify leaves into tents. Host plant species preferences and potential roost resource availability for this group of bats are still largely understudied.
The objective of this study was to understand how tent-roosting bats respond to the availability of roost resources in a fragmented landscape. We investigated factors driving roost site and plant species preferences of tent-roosting bats and quantified availability of roost plants along 72 transects in continuous forest and island sites in the Panama Canal area. In total, we counted over 9000 leaves of which 163 were modified into tents. Data on roost preferences and availability were then linked to species occurrences from a recent bat survey.
We observed a preference towards roosts in larger-leaved plant species and identified the microhabitat variables relevant for the bats. Although tent-roosting species occurred on the islands, number of tents declined drastically, showing negative effects of isolation and fragmentation on roosting options.

#19 Ecology

Penis morphology facilitates identification of cryptic African bat species

Fasel, N.J. [1, 2], Mamba,M. [3], Monadjem,A. [3,4]

[1] Department of Ecology and Evolution, University of Lausanne, Biophore, Lausanne, Switzerland
[2] Leibniz Institute for Zoo and Wildlife Research, Alfred-Kowalke Strasse 17, Berlin, Germany
[3] Department of Biological Sciences, University of Eswatini, Private Bag 4, Kwaluseni, Eswatini
[4] Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Private Bag 20, Hatfield 0028, Pretoria, South Africa

Africa hosts an high number of bat species; however, this diversity remains poorly investigated. Among African vesper bats (Vespertilionidae), some species are morphologically similar, hampering identification in the field. Consequently, basic information on these species' population dynamics, distributions or behaviors is vague and/or incorrectly documented. Among some Vespertilionidae, variation in flaccid penis shape enables species identification. This variation in morphology is thought to have resulted from sexual selection operating on the erected penis. Furthermore, in the context of strong post-copulatory competition, divergence in sperm traits between closely related species may have evolved. These male reproductive characters have hitherto not been investigated in southern African vespertilionid bats. In this study, we present the morphology of flaccid penis, erected penis and sperm of six small vesper species, based on the prediction that these characters have sufficiently evolved towards different optima to allow species discrimination. Species identification based only on penis shape and hairiness entirely matched species identification based on traditional (craniodental) characters. We illustrate penis morphology of these species to assist with future field identifications for ecological, conservation or behavioural studies in the future. Sperm morphology was sufficient to discriminate between the different genera, but could not reliably separate Neoromicia nana, N. zuluensis and N. capensis. Hence, we demonstrate that these difficult to identify species can be readily distinguished based on traits directly observable on the field and on living animals, which we hope will lead to more focused field studies on these cryptic species.

#10 Echolocation

Comparison of the echolocation behaviour of *Rhinolophus pusillus* and *Hipposideros grandis* when foraging for prey

Fleischer, J. [1], Schöppler, D. [1], Schnitzler, H.U.[1], Denzinger, A. [1]

[1] Animal Physiology, Institute of Neurobiology, University of Tübingen

Keywords: echolocation, bats, flutter detection, foraging

Rhinolophidae, Hipposideridae and the mormoopid bat *Pteronotus parnellii* belong to the guild of narrow space flutter detecting foragers. Long CF-FM echolocation calls, high duty cycle, Doppler shift compensation and an auditory fovea are adaptations to evaluate the amplitude and frequency modulations in the echoes, which are generated by the moving wings of insect prey. The echolocation behaviour of flutter detecting foragers during approach has so far only been studied when approaching stationary targets in lab but not during foraging and prey catching in the natural habitat. In this study, we will describe the echolocation behaviour of the rhinolophid *Rhinolophus pusillus* and the hipposiderid *Hipposideros grandis*, which were recorded in Vietnam when foraging at the same time in a swampy area between bushes. We will compare signal pattern and parameters, such as call duration, pulse interval, duty cycle, CF duration, FM duration and bandwidth, and how these parameters change during the approach. Finally, we will discuss the adaptive value of the different echolocation behaviour between families with respect to the foraging niche.

#11 Echolocation

Biosonar adjustments to masking in echolocating Daubenton's bats

Foskolos, I. [1], Pedersen, M.B. [1], Stidsholt, L. [1], Uebel, A.S. [1], Brinkløv, S. [1,2], Beedholm, K. [1], Madsen, P.T. [1,3]

[1] Section for Zoophysiology, Department of Bioscience, Aarhus University, Denmark
[2] Sound and Behaviour Group, Institute of Biology, University of Southern Denmark, Denmark
[3] Aarhus Institute of Advanced Studies, Aarhus University, Denmark

Keywords: bat, echolocation, biosonar, masking

Echolocating bats navigate and track their prey for capture via active sensing. To do so, they need to operate on a favorable echo-to-noise ratio (ENR) that allows them to discern target echoes from background noise and clutter. Early studies using wire experiments have demonstrated high resilience to masking in free-flying bats, but whether this is explained by spatial release from masking or complex auditory signal detection in noise remains unresolved. To test the hypothesis that bats in masking noise defend a certain ENR by increasing source levels, we trained four Daubenton's bats to approach and land on a spherical hydrophone (TS of approx. -15 dB) that also acted as an omnidirectional noise source at four different noise levels (NL, white noise from 20-90 kHz, 60-90 dB re: 20 µPa in 10 dB steps). Behind the hydrophone, an array of seven microphones was used to localize the bats during the approach and to estimate source level (SL) from received level (RL) and range. Compared to the no-noise treatment, bats substantially increased their SL by 6 dB at a NL of 60 dB re: 20 µPa, and more so at higher noise levels, ending up with a SL around 130 dB re: 20 µPa at NLs of 90 dB. We show that bats are sensitive to masking when they cannot employ spectral, temporal or spatial means to reduce such auditory interference and that they can produce very high source levels in the lab to defend ENRs good enough to perform echo-guided landings.

#6 Conservation

With F.U.N. into the wild - Combining science and citizen's education

Fritze, M. [1], Schöner, M. [1], Post, M. [1], Schöner, C. [1], Koch, R. [2], Kerth, G. [1]

[1] University of Greifswald,
[2] Nature reserve Nossentiner/Schwinzer Heide

Keywords: citizen science, bats, education, conservation, data analysis

Using bats as focal organisms, 'F.U.N.' aims to combine three components into one project: 'Forschung' (=research), 'Umweltbildung' (=environmental education) and 'Naturschutz' (=nature conservation). The project is based on two fundaments - an online platform and a citizen science station in a German nature reserve (Nossentiner/Schwinzer Heide). Citizens from all age classes are invited to participate in bat research projects via the website and field excursions in the nature reserve to learn about bat conservation. Getting online (www.fledermausfun.de), citizen scientists can get involved into academic research by working on real bat data. In addition, schools are invited to use tutorials and teaching materials for school teaching in different age cohorts. Teachers can download school material for free which was especially designed by co-workers with the respective educational and scientific background. In addition to using the online platform, school classes, citizens and students can register for visiting the citizen science station in the nature reserve to see applied bat conservation measures such as artificial bat hibernacula and bat boxes in the forest. The area is also the place where scientific data is collected which is then used for scientific projects on the online platform.
With our project we aim to improve scientific understanding of citizens by increasing their knowledge about bat conservation and actively involving them into scientific work.

#1 Behaviour

Behavioral response of bats to light intensity variation

Hermans, C. [1], Koblitz, J.C. [2], Visser, M.E. [1], Spoelstra, K. [1]

[1] Department of Animal Ecology, Netherlands Institute of Ecology (NIOO-KNAW), Wageningen, The Netherlands
[2] University of Konstanz, Germany

Keywords: light pollution, microphone arrays, habitat loss, landscape connectivity

Artificial light is a major threat for ecological communities, especially for nocturnal species like bats. Our knowledge on how bats alter their behavior in response to lit environment is however limited. In order to establish effective mitigation measures, for instance by keeping illumination intensity below the disturbance threshold, it is essential to know how the response of bats to light depends on light intensity. Previous studies have shown that changes in activity vary with light color, and that red lights have the least effect on bat activity. We expect therefore that the threshold light intensities at which species avoid the lit parts of their habitat or stop using commuting routes also vary with the spectral composition of light.
The aim of this study is to assess a dose-response relation of bat activity with light intensity for different spectra, and to use this knowledge to prevent habitat loss and habitat fragmentation. In the context of habitat loss, we will estimate bat activity and behavioral shifts at the vicinity of streetlights with the use of microphone arrays. We will carry out this experiment in the Netherlands at experimentally illuminated transects set up for the long-term study on the impact of light at night. In addition, experimental illumination of landscape corridors (linear water bodies and treelines) combined with acoustic tracking methods will allow us to measure consequences of light on landscape connectivity.

#27 Neurobiology

Mapping vocalization-related immediate early gene expression in the brain of Seba's short-tailed fruit bat, *Carollia perspicillata*

Holtz. S. [1,2], Geesdorf, M. [1], Knörnschild, M. [1,2], Scharff, C. [1]

[1] Freie Universität Berlin
[2] Museum für Naturkunde Berlin

Keywords: *Carollia perspicillata*, vocal production, social vocalization, echolocation, immediate early gene expression, brain activity

The production of learned social vocalizations in songbirds and humans requires the concerted activation of cortical and subcortical neural substrates. Some bat species also use learned social vocalizations but their neural substrates are not known. Other bat species use social vocalizations that need not be learned, which is also the case for the calls used during echolocation. We compared brain activity patterns related to echolocation calls or to social calls in Seba's short-tailed fruit bat, *Carollia perspicillata*, a species for which there is no evidence of vocal production learning. We visualized mRNA expression of the immediate early gene EGR-1 in brain sections of males after the emission of echolocation calls or of social calls. Our results are consistent with the mammalian pattern of neural activation during vocal production and auditory processing. Interestingly, the anterior cingulate cortex, previously considered relevant for all vocalizations in mammals expressed EGR-1 only during echolocation call emission. In contrast, the lateral mammillary body and the premammillary nucleus were only active during the emission of social calls. Finally, we found evidence for the involvement of the striosomal patch compartment in bat vocalizations. These pilot data will need to be confirmed in a larger sample. Comparing and contrasting the neural substrates underlying different vocalization types, echolocation and social, the latter either learned or not learned, across bat species will open the window towards understanding the evolution and neural mechanism of different vocalization types in mammals.

#21 Ecology

Bushcrickets may adapt bat predator avoidance behaviour to predator threat levels and age

Hubancheva, A. [1,2], Chobanov, D. [2], Goerlitz, H.R. [1]

[1] Acoustic and Functional Ecology, Max Planck Institute for Ornithology, Eberhard-Gwinner-Str. 11, 82319 Seewiesen, Germany
[2] Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Tsar Osvoboditel 1, 1000 Sofia, Bulgaria

Male bushcrickets (Orthoptera: Tettigoniidae) attract females by species-specific ultrasonic calls, which are also exploited by eavesdropping predators such as bats. Therefore, in many bushcricket species males are under strong pressure to constantly trade-off singing for mate attraction with ceasing singing for avoiding predation. Here, we hypothesized that male decision making changes over the lifespan to optimize reproductive success. We predict that with increasing age, male bushcrickets will accept higher levels of predation risk while singing, effectively prioritizing mating opportunities over survival.
To test our hypothesis, we conducted a series of behavioural playback experiments with wild caught male *Tettigonia viridissima* (n=8) in controlled lab conditions. In a large dark flight room, we placed individual bushcrickets within a mesh cage. We then presented the tested bushcricket with acoustic stimuli: bat echolocation calls with different intensities and repetition rates mimicking different predation threat levels. We tested the experimental animals twice during the mating season, once at the beginning of the mating season (two weeks after the first singing attempts of the bushcrickets), and a second time one month later. We analysed the duration of song cessation in response to the different treatments and as a function of male age.
Our preliminary results suggest that under bat attack male bushcrickets resume singing more quickly when they are younger, suggesting that decision making in bushcrickets is adapted to their age.

#22 Ecology

What bats should know to catch a moth

Hügel, T. [1], Goerlitz, H.R. [1]

[1] Max Planck Institute for Ornithology

Keywords: predator-prey interaction, moths, lepidoptera, bat predation

Even though recent findings might question how closely moths and bats evolved together, one thing is still for sure: Bats depend on moths as a major food source. This is why the pressure is high on moths to avoid attacking bats. We studied how moths avoid being eaten by bats using evasive flight manoeuvres. Here we want to share two of our major findings:
(1) Each species reacts differently! Using a force-transducer to record tethered moths of seven different species, we demonstrated that different moth species react in a species-specific way, even though they were all exposed to the same, bat-like stimulus. As moths occur in mixed-species groups this makes it especially hard for bats to predict evasive flight manoeuvres as they likely cannot distinguish between moth species.
(2) Evasive flight is elicited at high echolocation call levels! Using the same force-transducer we recorded behavioural audiograms of moths. These audiograms reveal that in reverence to the two auditory neurons of our species tested behavioural thresholds show the same frequency-dependency like, and are 0-20dB above neuronal thresholds. For bats this means if they can stay below that threshold, they likely won't elicit evasive flight in moths.

#23 Ecology

Fluctuating activity of *Myotis* and *Pipistrellus* bats in stables

Koplitz-Weißgerber, A [1], Zahn, A.[2]

[1] LMU Munich
[2] Koordinationsstelle für Fledermausschutz Südbayern

In Central Europe, several bat species forage in stables. Telemetry studies e.g. in Geoffroy's bats showed considerable differences between individuals and across seasons (Krull et al. 1991, Zahn et al. 2010). To investigate the general use of stables as hunting habitats throughout the year and under varying weather conditions, automatic sound recordings have been made in a cowshed and a horse stable in Upper Bavaria between April and November 2019.
The data was collected every fortnight, over a minimum of two nights, using BatCorders (ecoObs GmbH). Ambient temperature in the stables was recorded simultaneously. Ambient weather data were taken from meteorological stations 19.5 and 22 km away, respectively. Bats hunted regularly in both stables. By now, *Myotis brandtii/mystacinus*, *Myotis emarginatus*, and *Pipistrellus pipistrellus* could be identified. Further analyses of more call sequences may prove the presence of more species.
First evaluations show considerable variations in foraging activity in both stables between seasons. First records could be taken in April.
The numbers increased until the beginning of May. From then on intensive foraging activity was observed until the middle of October.
A continuous importance of stables as hunting habitat during the activity period of bats is apparent.
The influence of weather conditions on the activity and the differences between species still have to be analysed.
My study is an important step to clarify the relevance of stables as hunting habitats for native bat species.

#2 Behaviour

TBA

Kravchenko, K.A. [1,2], Vlaschenko, A.S. [3,4], Lehnert, L.S. [1,2], Courtiol, A. [1], Voigt, C.C. [1,2]

[1] Leibniz Institute for Zoo and Wildlife Research
[2] Institute for Biology, Freie Universität Berlin
[3] Bat Rehabilitation Center of Feldman Ecopark
[4] Ukrainian Independent Ecology Institute

Keywords: migratory behavior, stable isotope analysis, demography, range shift, climate change

Today, wildlife species have to adjust to various anthropogenic challenges in order to survive in an ever changing environment. Among the many species affected by anthropogenic challenges, migratory species are of particular concern because they depend on a series of habitats for their annual life cycle. Here, we studied if and how a European migratory bat, the common noctule (*Nyctalus noctula*), has changed its migratory behavior over the past two decades. Several papers showed that starting from the turn of the last century this species shifted its wintering areas to higher latitudes. Over a period of 12 years, we collected fur samples from migrating and hibernating common noctules in the Kharkiv area in the Ukraine to identify possible changes in the summer origin of bats over time. Based on stable hydrogen isotope ratios in fur keratin (□2Hf), used as a proxy for the geographical summer origin of individuals, we documented a decrease in the proportion of migratory individuals during both the migration and hibernation period, suggesting that over a period of more than a decade a significant proportion of the local population of common noctules stopped migrating, and instead remained in the Kharkiv area throughout the whole year. Our results shed light on changes in the migratory behavior of common noctule bats, most likely related to global warming, and the recent expansion of the wintering range of this species towards the north in Eastern Europe.

#31 Physiology

Comparative hearing in eleven neotropical bat species

Lattenkamp, E.Z. [1,2], Nagy, M. [3], Drexl, M. [4], Vernes, S.C. [2], Wiegrebe, L. [1], Knörnschild, M. [3]

[1] Ludwig Maximilians University Munich
[2] Max Planck Institute for Psycholinguistics
[3] Leibniz-Institut für Evolutions- und Biodiversitätsforschung
[4] German Center for Vertigo and Balance Disorders (IFB)

Keywords: Hearing thresholds, auditory brainstem responses, social calls, echolocation, sexual dimorphism

Our senses are our interface with the environment and different species make use of their sensory systems according to the ecological niche they inhabit. Although sensory systems undergo species-specific adaptations, the general principles are often analogous for closely related taxa. By means of auditory brainstem responses (ABRs), we investigated the peripheral auditory encoding of loudness across frequencies in eleven neotropical bat species. ABRs are minimally invasive recordings of acoustically evoked summary potentials. The frequency-dependent sound levels that create a significant ABR provide an estimate of an individuals' audiogram. Furthermore, the growth of the ABR with increasing loudness provides information about loudness encoding in the auditory periphery. We found that the audiograms of the investigated bat species are similar at first sight, but reveal species-, and even sex-specific specialisations. Across all species, we found that the growth of the ABR with increasing loudness is steeper and saturates earlier at lower frequencies, mainly corresponding to social call frequencies. At higher ultrasonic frequencies, corresponding to echolocation call frequencies, ABR growth is much shallower and saturation is rarely encountered in the tested loudness range (up to 110 dB SPL). Our data suggest that reliable loudness coding is more important for echolocation, where loudness is a cue for echoacoustic target distance and size. For social calls, absolute auditory sensitivity is equally good, but loudness coding is less flexible. Despite species-specific differences in audiogram shape, this general principle for loudness coding was found in all measured bat species and may extend to other mammals.

#3 Behaviour

Insectivorous bats integrate social information about species identity, conspecific activity and prey abundance to estimate cost–benefit ratio of interactions

Lewanzik, D. [1], Sundaramurthy, A.K. [1,2], Goerlitz, H.R [1]

[1] Acoustic and Functional Ecology Research Group, Max Planck Institute for Ornithology, Seewiesen, Germany
[2] Faculty of Biology, Ludwig-Maximilians-University, München, Germany

Animals can use Inadvertent Social Information (ISI) to improve fitness-relevant decisions. Since bats emit high-amplitude species-specific echolocation calls when flying, they provide a constant flow of ISI. Of particular interest is the feeding buzz rate – characteristic call sequences preceding any prey capture – which correlates with insect abundance. Our goal was to systematically test which ISI bats integrate when eavesdropping on others and how this integration affects space-use and interactions, respectively.
We used a community-wide approach and investigated the effects of a broad range of playback feeding buzz rates and conspecific activity on eavesdropping responses in 24 bat species combinations in the wild.
For the first time, we reveal that finely graded and density-dependent eavesdropping responses are not limited to particular foraging styles or call types, but instead are ubiquitous among insectivorous bats. All bats integrated ISI about calling species identity, prey abundance, and conspecific activity to estimate the cost-benefit ratio of prospective interactions, yet in a species-specific manner. The effect of buzz rate was multifaceted, as bats responded differently to different buzz rates and responses were additionally modulated by heterospecific recognition. Conspecific activity had a negative effect on the eavesdropping responses of all bats.
These findings can explain the inconsistent results of previous studies and advance our understanding of the complex nature of con- and heterospecific interactions within bat communities. A comprehensive understanding of how bats incorporate social information into their decision-making will help researchers to explain species distribution patterns and eventually to unravel mechanisms of species coexistence.

#4 Behaviour

What changes movement patterns in open-space foraging bats?

Mehl, C. [1], Pritsch, F. [1], Schlaegel, U. [2], Jeltsch, F. [2], Toledo, S. [3], Nathan, R. [4], Roeleke, R. [2], Mazzoni, C. [1], Eccard, E. [2], Voigt, C. [1]

[1] Leibniz Institute for Zoo and Wildlife Research
[2] University of Potsdam
[3] Tel Aviv University
[4]The Hebrew University of Jerusalem

Keywords: bats, competition, diet, movement

Inter- and intra-specific competition may influence individual behavior and fitness. At the same time, equalizing mechanisms act to minimize the fitness difference among competitors. The movement patterns of foraging insectivorous bats are influenced by factors such as resource distribution, prey selection and the competitive landscape. In this study, adult *N. noctula* were fitted with radio transmitters, allowing for the simultaneous tracking of multiple individuals with high temporal resolution using a reversed GPS approach. Mailaise traps were used to determine insect diversity and abundance within foraging sites and along flight paths. Further, scat was collected from artificial roosts occupied by tagged bats. This study aims to answer the following questions: (1) How does the presence of competitors influence the flight paths and foraging behaviour of *N. noctula*? (2) Do *N. noctula* favour certain prey items because of their availability or fatty-acid profiles, and how does this change with season? Competitive influence will be determined through the changes in flight path (eg. turning angles, step length, speed) in the presence of competitors. Metabarcoding will be used to identify prey items in scat samples. Insects will get identified with metabarcoding and fatty-acid profiles will get determined. Differences between insect availability and consumption will provide insight into seasonal changes in prey selection.

#32 Physiology

Switching off bat genes to study vocal learning

Mengede, J. [1], Devanna, P. [1], Hörpel, S.G. [2], Firzlaff, U. [2], Vernes, S.C. [1,3]

[1] Max Planck Institute for Psycholinguistics
[2] Technische Universität München
[3] Donders Institute for Brain, Cognition and Behaviour

Keywords: Vocal learning, FOXP2, knockdown, brain, genetic modification

Vocal learning is the ability to alter vocal outputs in response to auditory input and is a crucial characteristic of the plasticity of human speech. However, the genetic and neural mechanisms of vocal learning are not well understood in mammals. Apart from humans, only few mammal species have been identified as vocal learners (some bats, seals, elephants and toothed whales). Bats are the only animals within the group of vocal learning mammals that can be currently used for genetic manipulation studies, due to their small size, ease of handling and generation time. FOXP2 has been identified as a monogenetic cause for a severe language disorder in humans, showing its importance for normal language development. Studies on zebra finches in which FoxP2 was downregulated in areas that are involved in their song learning circuitry have also shown FoxP2 to be important for vocal learning. We are investigating the causative links between FoxP2 expression and vocal learning behaviour in a mammalian brain by downregulating FoxP2 in the brains of living bats (*Phyllostomus discolor*). This model will allow us to explore the consequences of FoxP2 loss, which will be studied at a molecular, neurobiological and behavioural level. In doing so, we will help to bridge the gaps between our knowledge on birds and humans, giving us a more complete view on the evolution of vocal learning and eventually, human speech.

#7 Conservation

Long-term population trends in Bavarian bats – still on the rise?

Meschede, A. [1], Hammer, M. [2], Pfeiffer, B. [2], Rudolph, B.-U. [3], Zahn, A. [4]

[1] Berlin
[2] Northern Bavarian Coordination Center for Bat Conservation, Division of Animal Physiology, Erlangen University, Erlangen
[3] Bavarian Environment Agency, Augsburg
[4] Southern Bavarian Coordination Center for Bat Conservation, University of Munich, Department Biology II, Planegg-Martinsried

Keywords: Bavaria, population dynamics, long-term study, TRIM

For the last 34 years the Bavarian State Ministry for the Environment is conducting a bat conservation programme. It includes censuses in hibernacula and summer colonies. Data have been collected by a large number of volunteer bat workers and researchers. We regularly analyse data by using the freely available software programme TRIM (TRends & Indices for Monitoring data) with respect to population trends in order to, among other reasons, monitor the success of conservation efforts.
Summer and winter roosts of *Rhinolophus ferrumequinum* and summer colonies of *R. hipposideros* show a strong increase in individuals with an average annual growth rate of 16% for *R. hipposideros*-colonies, indicating a population density still far below the habitat carrying capacity.
Winter populations of *Plecotus auritus, Myotis daubentonii, M. nattereri, M. bechsteinii, M. myotis*, *M. mystacinus/brandtii*, and *Barbastella barbastellus* strongly grew since the beginning of data collection, but show signs of a decelerating or even negative trend (e.g. *Plecotus*), possibly caused by limited environmental resources, such as food (due to the loss of landscape elements), and roost sites.
Plecotus auritus, *Myotis mystacinus/brandtii*, and *Barbastella barbastellus* summer colonies did not increase while *Myotis myotis*-colonies increased only during the first 10-12 years. The difference between winter and summer data for *M. myotis* suggests an increase in number of colonies rather than growing colony sizes. *Myotis emarginatus*-colonies are still moderately increasing compared to 1991 but show a decline starting 2003.
Species vulnerable to collision with wind turbines – e.g. *Nyctalus noctula, Pipistrellus pipistrellus* – are possibly moderately declining.

#12 Echolocation

Quantifying changes in echolocation call parameters of free-flying horseshoe bat groups

Mysuru, N. [1], Beleyur, T. [1], Krishna, A. [1,2], Goerlitz, H.R. [1]

[1] Max Planck Institute for Ornithology, Seewiesen
[2] Indian Institute for Science Education and Research, Mohali

Keywords: Horseshoe bats, Group echolocation, Call parameters

Echolocating bats fly in groups in many behavioral contexts like roosting, emergence and return to roosts, foraging and mating. When flying in groups, the probability of a bats' call getting masked by other bat calls or echoes is high. Some bats might change their call parameters when flying in group, to improve the detection of their own echoes. Most of what is known about changes in call parameters is from frequency modulating (FM) bats. Horseshoe bats on the other hand, emit long echolocation calls with a constant frequency (CF) component sandwiched between two frequency-modulated (FM) components. When many horseshoe bats fly together, their calls suffer greatly from temporal and likely spectral overlap rendering acoustic analysis of individual calls a challenge. Existing research on group echolocation in horseshoe bats is limited to lab-based experiments with small group sizes. Our study aims to fill this gap by studying group echolocation in horseshoe bats flying in their natural habitat. We used synchronized audio and video to record and obtain the number of single and multiple free-flying horseshoe bats. We measured call parameters like peak and minimum frequency and amplitude, independently from both CF and FM parts of the call. Our preliminary analysis shows that the inter-quartile-ranges of peak frequency and received call level were larger by about 1 kHz and 4 dB, respectively, during group flight compared to single animals. This suggests that horseshoe bats vary their call parameters when flying in groups. Our work presents a novel analysis workflow to parametrize long overlapping CF call recordings with multiple echolocating bats.

#13 Echolocation

Unplug my nose! – Nasal and oral call emission in Phyllostomid bats?

Negahdar, P. [1,2], Gessinger, G. [1,2], Brinklov, S. [3], Page, R. [2],Tschapka, M. [1,2]

[1] Institute of Evolutionary Ecology and Conservation Genomic, University of Ulm
[2] Smithsonian Tropical Research Institute, Panama City
[3] Institute of Biology, University of Southern Denmark

Keywords: Echolocation, Oral emission,Phyllostomidae

Species of the highly diverse Neotropical Leaf-nosed Bat family (Phyllostomidae) are characterized by a unique nose leaf that generally is assumed to play a role in shaping the echolocation beam emitted through the nostrils. Interestingly, recent studies have shown that some species fly consistently with an open mouth (Group A), suggesting at least some role of oral emission, while in others the mouth is always closed (Group B). Dependence on nasal emission thus seems to differ among these groups. The aim of this study was to compare how echolocation parameters (e.g., call intensity, frequency range, inter-pulse interval and number of calls) change in groups A and B, respectively, in response to the obstruction of sound emission through the nostrils. I hypothesized that exclusion of nasal sound emission should affect echolocation parameters of species of Group B more than those of Group A. In an experimental approach I temporarily obstructed the bat's nostrils. Bats were hand-released under standardized conditions into a flight cage while a high-speed camera synchronized with an ultrasound device recorded behavior and call emissions. Here we present our first findings, focusing on changes in acoustic parameters between manipulated and control bats from Group A and Group B.

#28 Neurobiology

Stimulus specific adaptation in bat echolocation

Pastyrik, J. [1], Firzlaff, U. [2]

[1] Technical University of Munich
[2] Department of Zoology

Keywords: SSA, Echolocation, Electrophysiology, Auditory Cortex

An echolocating bat navigating its environment is challenged with differentiating relevant from irrelevant sensory inputs. In subjective terms, a typically rare and interesting object (e.g. food items, predators or obstacles) should “sound” differently to the recipient compared to the rest of the environment. A possible mechanism on the neuronal level for the detection of rare objects could be Stimulus Specific Adaptation (SSA). SSA is a computational process, by which the neuronal response rate to a common stimulus is reduced in comparison to a rare one. We hypothesize that SSA is an important neuronal mechanism for the detection of rare objects in bat echolocation. To test this, we present streams of natural pulse/echo pairs to anaesthetized *Phyllostomus discolor* bats, while extracellularly recording from delay-tuned neurons in the auditory cortex. The streams consist of a frequently occurring stimulus (standard) and a sparsley occurring stimulus (deviant). Deviant and standard differ in either echo delay or echo attenuation. Preliminary results indicate SSA in delay-tuned neurons of the auditory cortex of *P. discolor*.

#20 Ecology

Microhabitat preferences of bats roosting in a multi-species assemblage in a hot cave

Rabarison, H. [1], Reher, S. [1], Dausmann, K. [1]

[1] University of Hamburg, Functional Ecology

Keywords: Bats, temperature, humidity, cave, microhabitat, Madagascar

Bats diurnal roosts range from foliage over tree holes to caves. Especially hot caves have distinct characteristics: they usually have a single small entrance, low air circulation, and constant year round ambient temperatures. In Tsimanampetsotsa National Park located in the South-west of Madagascar, a calcareous plateau offers varying caves owing to an underground stream system. Andranolovy cave is one of the caves in the park, a large hot cave, consisting of a complex system with three different chambers. In one chamber, three species of bats (*Macronycteris commersoni*, *Triaenops menamena* and *Paratriaenops furculus*) roost together year-round. Few studies examines microhabitat selection for coexistent bat species so that we aimed to determine whether there is a correlation between skin temperature pattern of the different species and climate characteristics (temperature and humidity). During the dry season, ambient temperature in each chamber was 23.15°C, 24.6°C, and 29.3°C, respectively, and the relative humidity was 67.6 %- 77.8 % and 77.9 %, respectively. Thus bats tended to choose the more humid and warmer chamber to roost year-round.

#25 Ecology

Ready for climate change? The importance of adaptive thermoregulatory flexibility for Malagasy bats

Remmers, S. [1], Reher, S. [1], Dausmann, K.H. [1]

[1] Functional Ecology, Institute for Zoology, University of Hamburg, Germany

Keywords: thermoregulation, roost selection, energy budget, tropics, "hot" torpor, bats

The animal's energy management is closely linked to the ecology, as they interact with their abiotic and biotic environment. That is, changes in the conditions of habitats can be challenging for every species and their physiology. For endothermic mammals, heterothermy is one of the most effective and successful strategies to survive during periods of energy shortage.
This study concentrates on the species *Triaenops menamena*, which is endemic to Madagascar and inhabits the drier regions. We measured the metabolic rate and skin temperatures of individuals from two *T. menamena* populations, both in the Tsimanampetsotsa National Park during the colder dry season. One population roosts in a cave with constant microclimatic conditions (~30°C, ~100% humidity), whereas the other population roosts in a sinkhole, which is more exposed to fluctuating ambient temperature and humidity.
Although, these two roosting sites are approximately only a hundred meters apart, the populations show different torpor patterns, which suggests a correlation between body condition and ambient temperature and metabolic inhibition, as well as an intraspecific physiological flexibility. Using torpor differently within a species as an adaptive strategy to maintain energy balance, even in unfavorable environmental conditions, might be beneficial regarding climate change. Further investigations of their physiological capabilities and roost selection is of great importance to reveal unknown functions of torpor and for developing conservation plans to ensure a long-term persistence of this species.

#8 Conservation

Spatial behaviour of common Noctule bats in relation to wind turbines

Reusch, C. [1], Kramer-Schadt, S. [1], Fritze, M. [1], Pelz, G. and Voigt, C.C. [1]

[1] Leibniz-Institut für Zoo- und Wildtierforschung (IZW) im Forschungsverbund Berlin e.V.

Keywords: *Nyctalus noctula*, spatial behaviour, interaction bat wind turbines, GPS logger

Recent studies suggested that some bats may get attracted to wind turbines (WT). However, the underlying causes for this attraction, including specific environmental stimuli, are still unknown. Identifying those environmental stimuli that are causative for the approaching of bats to WT as well as evaluating measures to avoid, reduce or compensate such an effect are the primary goals of our project. We selected common noctule bats as our study organisms, because previous work indicated some interactive behaviour of common noctules with WT (Roeleke et al. 2016) and because this species has the highest collision risk in Germany. Reducing possible attractants may not only decrease the fatality rates of bats at WT but also the commissioned mitigation schemes, such as elevated cut-in speeds, which translates into a higher energy yield of WT.

Our project aims to reconcile both goals, the conservation goal to protect endangered wildlife species and the environmental goal to fight climate change via the promotion of energy production from renewable sources.

We use miniaturized GPS loggers to document the spatial behaviour of common noctule bats in relation to WT. In our first field season in Brandenburg, we documented 43 flight tracks from 38 bats resulting in a total of 3,533 GPS locations in the vicinity of WT. Using a spatial modelling approach we aim at deriving specific habitat and WT parameter which may be relevant for an attraction of common noctule bats at WT.

This project is sponsored by the Deutsche Bundesstiftung Umwelt DBU.

#5 Behaviour

Bat in a Maze - an in-situ assay of exploration behavior

Schabacker, T. [1,2], Rizzi, S. [1], Hoffmeister, U., Teige, T., Voigt, C.C. [1], Snijders, L. [1]

[1] Leibniz Institut für Zoo- und Wildtierforschung
[2] Freie Universität Berlin

Keywords: migration strategy, exploration, behavior, personality, individual variation, isotopic geolocation

Many studies have highlighted the importance of migratory species in connecting different habitats, but also stressed the vulnerability of these species to changing environmental conditions. Insights into the processes mitigating animal migration are thus crucial to understand and protect migratory species and the key ecological roles they play.
A potentially important factor in migration is animal personality, i.e. individual differences in behaviour that are consistent over time and/or context. Nowadays, there is strong scientific evidence for animal personality in many species and for links between personality and important life-history traits. A link between specific personality traits and migration strategies would be especially relevant because the presence of personality differences usually implies that individuals are not completely flexible in their behavioral responses. Migrants might thus differ from their con-/heterospecific residents in their ability to cope with novel (environmental) stressors and changes.
We therefore investigate the potential link between migratory strategy and exploration behavior, an established personality trait in a wide variety of species, in partially migratory noctule (*Nyctalus noctula*) and fully migratory (*Pipistrellus nathusii*).
In our current study we will link differences in small-scale movement to variation in migration strategies, assessed by non-invasive isotopic geolocation.
Here, we will present our first findings.

#15 Echolocation

Echolocation and flight behavior of *Hipposideros armiger* catching fluttering insects

Schoeppler, D.S. [1], Schnitzler, H.U.S. [1], Denzinger, A.D. [1]

[1] University of Tübingen

Keywords: Flutter detection, CF-FM bats, high duty cycle, hipposiderid bat, prey catch

Hipposiderids use the flutter detection strategy to find and acquire fluttering insects even in dense clutter. Together with rhinolophids *and Pteronotus parnellii*, they belong to the guild of narrow space flutter detecting foragers. Long CF-FM echolocation signals, a high duty cycle, Doppler shift compensation, and an auditory fovea enable them to sense and analyze the rhythmical modulations in insect echoes which are caused by the moving wings.
Here we describe for the first time the flight and echolocation of a hipposiderid bat catching fluttering insects. With a synchronized audio and video system we recorded the search and approach behavior of two *Hipposideros armiger* when catching tethered desert locusts (*Schistocerca gregaria*) in a flight room. We reconstructed the position of the locusts, the 3D flight paths of the bats and analyzed the bats' echolocation behavior. Hipposideros armiger started to fly from a perch at the ceiling or wall to catch the fluttering locust from the string. We show how relevant parameters of the echolocation signals like pulse interval, duty cycle, relative amplitude relationship, and duration of the CF and FM components are adjusted during the search for and the approach to the fluttering prey.

#33 Physiology

Drag me UP! Influence of surface tension and viscosity on the feeding performance of the nectar-feeding bat *Glossophaga soricina*

Speidel, M. [1], Ahner,L. [1], Tschapka, M. [1,2]

[1] Institute of Evolutionary Ecology and Conservation Genomics, University of Ulm, Ulm, Germany
[2] Smithsonian Tropical Research Institute, Balboa, Panama

Keywords: Chiroptera, nectar, surface tension, viscosity, feeding, efficiency

For animals that live on a diet dominated by nectar, the efficiency to extract this resource from flowers is a key-determinant of fitness. The Neotropical family Phyllostomidae consists of two predominantly nectarivorous subfamilies, the Glossophaginae and the Lonchophyllinae. To extract nectar from flowers, both use elongated tongues. However, these differ vastly in morphology. Glossophagine bats have hair-like papillae at the tip of their tongue, functioning like a mop, whereas the lonchophylline bats have a hair-less tongue with distinct lateral grooves. Ultimately, these different morphologies result in strikingly different feeding behaviours, which for the lonchophylline bats is not yet understood. In order to untangle the factors affecting drinking performance of nectar-feeding bats, we designed a set of experiments to investigate the influence of physical properties of nectar, namely viscosity and surface tension, on nectar extraction efficiency (NEE). Based on an 18% (weight/weight) sugar solution, we prepared the following treatments: We (1) lowered surface tension from 72 mN/m to 42 mN/m by adding small quantities of soybean lecithin and (2) increased viscosity from 1.8 mPa*s to 15.4 mPa*s by adding small quantities of Hydroxyethylcellulose, an inert polysaccharide. We offered these treatments to six individual *Glossophaga soricina*. Bats fed readily on each experimental solution. By performing a linear mixed model analysis, we found a significant influence of surface tension on NEE. Future plans include to observe directly the influence of viscosity and surface tension on the feeding performance to get insights into the unique feeding behaviour of lonchophylline bats.

#26 Ecology

Do differences in ecological strategies influence heavy metals accumulation in two European bat species

Timofieieva, O. [1,2], Vlaschenko, A. [2,3], Swiergosz-Kowalewska, R. [1], Laskowski, R. [1]

[1] Jagiellonian University, Kraków, Poland
[2] Bat Rehabilitation Center of Feldman Ecopark, Kharkiv Region, Ukraine
[3] Ukrainian Independent Ecology Institute, Kharkiv, Ukraine

Keywords: bioaccumulation, trace metals, Chiroptera, *Nyctalus noctula*, Eptesicus serotinus, Ukraine

European bats are insectivorous and occupy the highest food web level, being thus particularly exposed to high input of both organic and inorganic pollutants. Heavy metals, belonging to the most important environmental pollutants, may impact the health of individuals, decrease their longevity and reduce the reproductive success of females, threatening such bat populations despite the efforts to protect their roosting sites and habitats.
Our study area is a highly urbanised region (Kharkiv city, northeastern Ukraine). Two bat species were used in the study: *Nyctalus noctula* – a forests-dwelling species and *Eptesicus serotinus* – the urban dweller. Tissues of this-year-born individuals were obtained for metal analysis (liver, kidney, lungs, forearm bones, wing membrane and fur). The samples were analyzed for metal contents (Pb, Cu, Zn, Cd) using atomic absorption spectrophotometer. To test whether the fur or wing membrane - two tissues that can be sampled from alive bats, can be used to monitor metal contamination of internal tissues, correlations between the metal concentrations in these two tissues and the four remaining tissues were calculated.
In *E. serotinus* significant positive correlations in metal concentrations were found for Pb between fur and lung, wing and lung, wing and kidney and additionally fur and liver. For Cd such correlation was found between fur and lung, for Cu between wing and liver and between fur and kidney. Metal concentrations in bone were not correlated with the concentrations found in the wing or fur. No correlations for metal's concentrations in the different tissues were found for *N. noctula*.

#29 Neurobiology

Neural oscillations in the fronto-striatal network predict vocal output in bats

Weineck, K. [1], Garcia-Rosales, F. [2,3], Hechavarria, J.C. [1]

[1] Auditory Computations Group, Institute for Cell Biology and Neuroscience, Goethe University, Frankfurt am Main, Germany

The ability to vocalize is ubiquitous in the animal kingdom but our knowledge of brain networks underlying vocalization production is sparse. Miss-coordination in vocalization neural networks affects the ecological success of species that rely heavily on acoustic information, such as humans and bats. This study aimed to link neural activity in the frontal cortex and dorsal striatum (caudate nucleus) to vocalization production. In humans, these brain regions are affected in conditions that involve language impairments, such as Parkinson disease, Asperger, Huntington, and Tourette syndromes. We used bats as experimental model to study fronto-striatal contributions to vocal production. This approach allows to assess the general aspects underlying vocalization in mammals (i.e. communication sound production) and the unique neural adaptations that enable active hearing during bat echolocation. The data collected indicates that before vocalization production, a precise control of high-gamma and beta neural oscillations (50-80 Hz and 12-30 Hz, respectively) takes place in the bat frontal cortex and dorsal striatum. Such precise fine-tuning of brain rhythms could allow bats to access sensory-motor programs required for echolocation and communication call production. Moreover, the functional coupling between frontal and striatal areas -occurring in the theta oscillatory band (4-8 Hz)- differs markedly at the millisecond level depending on whether the animals are in self-communication mode (i.e. producing echolocation calls) or trying to convey acoustic information to other individuals (communication mode). Overall, the data collected indicates that fronto-striatal oscillations mediate neural synchronization in canonical networks underlying communication call production in mammals and echolocation-based navigation in bats.

#30 Neurobiology

Auditory brainstem responses in the bat *Carollia perspicillata*: Threshold calculation and analysis of responses to amplitude modulated stimuli.

Wetekam, J. [1], Reissig, C. [1], Hechavarria, J. [1], Kössl, M. [1]

[1] Auditory computations group, Institut für Zellbiologie und Neurowissenschaft

Keywords: auditory system, cochlea, ABR, distortion-products, amplitude modulation, *Carollia perspicillata*

We present ABR hearing curves of the bat species *Carollia perspicillata* determined by an objective method based on a bootstrap analysis of the root-mean square (rms) amplitude of the measured signal (see Lv et al. 2007; Linnenschmidt and Wiegrebe 2019). The rms values and their significance for threshold determination depended strongly on the filtering of the signal. By using the minimum threshold values obtained at three different low frequency filter corner frequencies (30, 100, 300 Hz), ABR threshold curves were calculated. The course of the ABR thresholds was comparable to that of published DPOAE (distortion-product otoacoustic emission) thresholds based on a -10 dB SPL threshold criterion for the 2f1-f2 emission (Schlenther et al. 2014, frequency range 10-90 kHz). For the most sensitive part of the bat's audiogram (20-80 kHz) median ABR thresholds ranged from 10 to 28 dB SPL. In comparison, DPOAE thresholds in this area ranged between 10-23 dB SPL. At frequencies below 20 kHz (5-20 kHz) and above 80 kHz (80-120 kHz), ABR thresholds increased by 20 dB/octave and 45 dB/octave, respectively. Additionally, using amplitude modulated stimuli, an ABR following response up to the highest tested AM frequency of 1280 Hz could be demonstrated.

#16 Echolocation

Ortungsrufe von *Myotis*-Arten in unterirdischen Quartieren

Wimmer, B., Kugelschafter, K.

Keywords: echolocation-calls

Akustische Dauerbeobachtungsmethoden können an unterirdischen Quartieren rel. effizient und störungsarm eingesetzt werden. Für artspezifische Aussagen sind jedoch Kenntnisse über die Ortungsrufe der Arten in unterirdischen Quartieren erforderlich. Zur Nahorientierung nutzen Myotis-Arten kürzere, meist in einem höheren Frequenzbereich beginnende Rufe. In der echoreichen Umgebung von Quartieren kommt hinzu, dass die Rufe oft relativ leise sind. Für Freiland-Aufnahmen hilfreiche Unter- scheidungsmerkmale wie Ruflänge, Knicke und Rufabstand sind auf diese Situation i. d. R. nicht übertragbar. Mit Hilfe des Einsatzes von Licht- schranken, Fotofallen und Batcordern an den Eingängen unterirdischer Quartiere konnten Referenz-Aufnahmen von Myotis-Arten gewonnen werden.

#24 Ecology

Stables as foraging habitats of bats

Zahn, A. [1] , Lustig, A. [1], Gohle, D. [1], Kriner, E. [1], Gerges, M. [1], Brigitte, M. [1]

[1] Koordinationsstelle für Fledermausschutz Südbayern, LMU München, Department Biologie II

Keywords: Myotis, Pipistrellus, foraging, activity, stables, Bavaria

We studied bat activity by use of automatic sound recording systems (batcorder, Ecoobs) in 108 stables distributed over all 7 districts of Bavaria. Bat activity was recorded in 92,6 % of all stables.
Most common species were *Pipistrellus pipistrellus* (67% of all stables with bats), *Myotis brandtii/mystacinus* (55 %) and *Myotis nattereri* (48%). Activity of these species was recorded over hours in many stables.
Rarely recorded species were *Rhinolophus ferrumequinum* (1%), *Barbastella barbastellus* (1%), *Myotis myotis* (1%) and *Myotis bechsteinii* (2%). *Myotis emarginatus* was recorded in 21% of all stables.
Bats foraged in old "traditional" stables as well as in modern ones and there was no difference between organic and conventional farms. While *P. pipstrellus* was found more often in higher and larger "modern" stables, *Myotis emarginatus* and *Myotis nattereri* tended to use lower stables.
Horse stables were less frequented than stables for cattle. Final buzzes we recorded in *Myotis* species and *Pipistrellus* species as well.
All in all, stables proved to be important foraging sites for several species of bats in Bavaria.