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A potent anti-inflammatory response in bat macrophages may be linked to extended longevity and viral tolerance

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Bats are unique among mammals given their ability to fly, apparent tolerance of deadly viruses and extraordinary longevity. We propose that these traits are linked and driven by adaptations of the innate immune system. To explore this hypothesis we challenged macrophages from the greater mouse-eared bat, *Myotis myotis* and the house mouse, *Mus musculus* with toll like receptors (TLRs) ligands, lipopolysaccharides, LPS and polyinosinic-polycytidylic acid, Poly(I:C). Macrophages from both species presented a high level of mRNA induction of inferon β (*INF-β*), tumor necrosis factor (*TNF*) and interleukin-1β (*Il-1β*). However, in bat macrophages, this antiviral, proinflammatory response was balanced by a sustained high-level transcription of the anti-inflammatory cytokine *Il-10*, which was not observed in mouse, potentially resulting from adaptive regulation in bats. Additionally, phylogenomic selection tests across the basal divergences in mammals (n = 39) uncovered bat-specific adaptations in six genes involved in antiviral and proinflammatory signalling. Based on this pilot study, we put forward a hypothesis that bats may have evolved unique anti-inflammatory responses to neutralize proinflammatory stimuli resulting from flight. This in turn may drive their extraordinary longevity and viral tolerance by limiting inflammation driven ageing and infection-induced immunopathology. Further data from other individuals and bat species are required to advance this intriguing hypothesis.

Key words: longevity, bat, viral response, phylogenetics, immune system evolution

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Host-parasite relationships between a Malagasy fruit bat (Pteropodidae) and associated bat fly (Diptera: Nycteribiidae): seasonal variation of host body condition and the possible impact of parasite abundance

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We studied variation in the Body Condition Index (BCI) of a Malagasy frugivorous bat, *Rousettus madagascariensis* (Pteropodidae), in relation to the abundance of ectoparasite flies, *Eucampsipoda madagascarensis* (Nycteribiidae). The study site was a cave in northern Madagascar that was visited three times during the dry season (September 2014, 2015, and 2016) and two times during the wet season (January 2015 and 2016). Two measurements were taken from all captured *Rousettus* to evaluate their BCI: forearm length and body mass. In total, we sampled ectoparasites from 1,030 *R. madagascariensis* during the five visits. The BCI of sampled bats showed statistical differences when compared by season and segregated by different age and sex classes, with generally the higher mean values during the wet season and lower values during the dry season. In most cases, the abundance of *E. madagascarensis* for each of the different bat age and sex classes did not differ between seasons. A weak positive relationship was found for most seasonal visits between host BCI and nycteribiid abundance, specifically in adult males, and sub-adult males and females; such a relationship was not observed for neonates. On the basis of a GLM analysis, our results support the hypothesis of a positive relationship between ectoparasite abundance and host BCI. The seasonal variation in host BCI was not related to nycteribiid abundance, but rather some other factor associated with host physical condition, such as the availability of fruit and correlated shifts in body mass.

Key words: body condition index, *Eucampsipoda madagascarensis*, fruit bat, Nycteribiidae, parasite abundance, *Rousettus madagascariensis*

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Diet determined by next generation sequencing reveals pest consumption and opportunistic foraging by bats in macadamia orchards in South Africa

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Recent studies have documented the economically significant impact of bats as predators of agricultural pest insects. We used Next Generation Sequencing (NGS) of the cytochrome oxidase I gene to elucidate the diet of six species of bats based on faecal pellets collected from individuals and roosts in macadamia orchards at Levubu, Limpopo Province, South Africa. For five of these species, we compared the molecular data with published results from microscopic analysis of faecal pellets, culled parts and stomach contents. We provide the first description of the molecular diet of the large African molossid bat, *Mops midas*. Expectations from skull morphology and a single limited study of stomach contents were that this species should be a beetle-specialist. However, NGS revealed that the diet of *M. midas* contained a much higher prevalence and diversity of lepidopteran (81 taxa from 17 families) compared to coleopteran (two taxa) prey. While this result is predicted by the allotonic frequency hypothesis for a bat species with low echolocation frequency, it could also be explained by unequal PCR amplification, a constraint of amplicon sequencing. Apart from the above-mentioned species where our sample was probably unbiased (24 pellets from multiple roosts and occasions), sample sizes of the other five species were very low and therefore potentially biased (1–6 pellets). Nevertheless, these samples revealed for each bat species surprisingly many prey taxa spanning several insect orders, indicating that individual bats were capable of consuming a wide diversity of prey during one or two nights of foraging. Contrary to expectations, bats of all foraging groups (clutter, clutter-edge and open-air) fed opportunistically on mostly-flightless cockroaches (Order Blattodea). About one third of all faecal pellets tested from five species of bats of all foraging groups contained DNA from the significant macadamia pest species, *Nezara viridula* (Order Heteroptera), indicating the value of intact bat communities in the biological control of pest stink bugs in macadamia orchards. Contrary to the general expectations of the allotonic frequency hypothesis, all six bat species studied fed predominantly on tympanate versus non-tympanate species of moths (57–75% of lepidopteran prey taxa), even those 'non-allotonic' bat species having intermediate echolocation peak frequencies that encompass the frequency sensitivity of hearing (tympanate) moths.

Key words: Chiroptera, macadamia, stink bugs, Limpopo Province, South Africa

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Small scale habitat preferences of *Myotis daubentonii*, *Pipistrellus pipistrellus*, and potential aerial prey in an upland river valley

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Distribution and abundance of two temperate-zone insectivorous bats, Daubenton's (*Myotis daubentonii*) and common pipistrelle (*Pipistrellus pipistrellus*), and their potential prey were studied along an altitudinal river gradient in relation to environmental variables including air temperature, wind speed, water surface state, and presence or absence of bank-side trees. Using a Latin square design at ten different habitat combination types, ultrasound recordings and insect sampling were carried out to quantify bat habitat preferences and potential prey abundance and classification. *Myotis daubentonii* and *P. pipistrellus* activity was significantly higher over smooth water river sections with trees on either or both banks while cluttered and rapid water sections were avoided. Conversely, insect abundance was not related to water surface condition or the presence or absence of bank-side trees. Nematoceran dipterans made up 98% of insect numbers, with small numbers of brachycerans and cyclorrhaphans. The most common insect families were Chironomidae and Ceratopogonidae. There was no correlation between bat activity and aerial insect activity, suggesting that aerial prey availability is not the sole driver of bat habitat choice. Bat and insect abundance were each correlated positively with night-time air temperature. No bat passes or flying insects were recorded at temperatures < 4°C. At 5°C, only *M. daubentonii* were observed foraging, and at 6ºC there were more *M. daubentonii* present than any other bat species. No correlation was found between number of bat passes hr^{-1} and wind speed, moon visibility, moon phase, and percentage cloud cover. Rain did not affect *M. daubentonii*, but *P. pipistrellus* preferred to forage on dry nights. Bats were predicted to forage preferentially where aerial insect abundance was highest but this was found to not be case, and other aspects such as detection of prey against clutter may have an important role to play in habitat choice.

Key words: Daubenton's bat, common pipistrelle, insects, habitat preferences, temperature, riparian, echolocation constraints

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Species richness, functional diversity and assemblage structure of insectivorous bats along an elevational gradient in tropical West Africa

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Rising global temperatures cause severe changes to the environment resulting, for example, in shifts in biomes and assemblages to higher elevational ranges. Therefore, it is integral to understand how species and assemblages will respond to this threat. Elevational gradients present a useful framework to measure potential changes to diversity due to climate change and human land use. Most studies focus on taxonomic diversity, and ignore functional diversity which provides a measure of the ecological roles of species within ecosystems. The aim of this study was to investigate taxonomic and functional diversity of as well as variation in assemblage structure of the insectivorous bat communities along the Mount Nimba elevational gradient. We predicted that both taxonomic and functional diversity would be negatively correlated with elevation, and that bat assemblages would show a nested pattern along the elevational gradient. Taxonomic diversity was calculated using species richness. Functional diversity of univariate and multivariate traits was calculated using two diversity indices: mean pairwise distance and mean nearest taxon distance. As predicted, species richness of bats was significantly negatively correlated with elevation. Functional diversity however, decreased significantly only at the highest elevation (and this may even be a sampling artifact given high human activities there in recent times). Contrary to predictions, metacommunity analyses revealed quasi-Gleasonian structuring of bat assemblages, indicating weak structuring forces along the elevational gradient. These results suggest that bat assemblages shifting in response to climate change along elevational gradients may change taxonomically but stay largely intact functionally.

Key words: Chiroptera, elevational gradient, functional diversity, metacommunity, Mount Nimba, species richness

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Ecomorphological diversity in the Patagonian assemblage of bats from Argentina

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Patagonian bats are represented by only insectivorous species, five vespertilionids and one molossid species. They constitute an interesting assemblage of temperate species that remains poorly studied. Here we uncover ecomorphological patterns of Patagonian bats using craniodental morphology, aerodynamic measurements, and external bodily characters. Multivariate analysis was applied to characterize morphometric variation of each dataset separately and in combination. We explored the segregation of species in morphospace, and the importance of phylogeny in the assemblage organization. We used a phylogenetic comparative method to evaluate historical effects on the morphofunctional structure. Our results indicated that the species of the Patagonian assemblage segregate in dimensions of morphospace by size and morphology, which would be related to prey selection (trophic differences) and habitat use (different styles of flight). We also demonstrated the impact of different cladogenetic events of the evolutionary history of species on the structuring of the Patagonian assemblage, with the successive addition of non-overlapping, well-defined morphofunctional types imported from other South American regions, and whit speciation events that resulted in species-level endemisms (*Myotis chiloensis*, *Histiotus magellanicus*, and *Lasiurus varius*).

Key words: ecomorphology, Vespertilionidae, Molossidae, Patagonia, morphospace

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Spatial heterogeneity of fruit bats in a primary tropical lowland evergreen rainforest in northeastern Luzon, Philippines

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In the Philippines, little is known beyond the most basic information on the ecology and biogeography of fruit bats. This is aggravated by the increasing risks on their populations, particularly in primary lowland forests, the most threatened habitat in the country, which these species inhabit and also where chiropteran diversity is highest. In this study, the spatial heterogeneity of fruit bats within a primary lowland forest in Palanan, Isabela, northeastern Luzon was investigated. In addition, habitat partitioning patterns were compared with wing morphology variations. Mist nets were used to sample two vertical strata and three forest landscapes. Wing loading and aspect ratio were measured for all species captured. A total of 1,243 fruit bats representing eight species were caught from a sampling effort of 398,736 $m^2 \cdot h$. All species were captured in the canopy, while only six species were captured in the understory. All species were also captured along ridges and forest edges, while only seven were captured along streams. Based on permutational MANOVA, a significant difference was found between the species assemblages in the understory and canopy, but not among ridges, streams, and forest edges. At the population level, Kruskal-Wallis tests were performed on capture rates per species. All eight species exhibited strong preference for the canopy, while only two species were observed to have significantly different capture rates across forest landscapes. Wing morphology patterns based on wing loading and aspect ratio did not show consistent association with vertical strata preference. The varying capture rates of bats along ridges, streams and forest edges may have been influenced by their feeding behavior. This study demonstrates the spatial heterogeneity of fruit bats across vertical strata and across forest landscapes, the most significant of which is the preference for the canopy. Possible factors that could explain these patterns include fruit availability, a cluttered habitat, and tree species distribution, which should be assessed in future studies.

Key words: Pteropodidae, Philippines, landscape ecology, vertical stratification, habitat partitioning

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How do young bats find suitable swarming and hibernation sites? Assessing the plausibility of the maternal guidance hypothesis using genetic maternity assignment for two European bat species

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In many temperate zone bat species, large numbers of individuals aggregate in autumn at potential hibernacula such as caves, mines, and cellars, for a behaviour known as swarming. This autumn swarming probably serves two functions, the achievement of matings and the assessment of potential hibernation sites. Even though this remarkable behaviour has attracted a lot of research during the last decades, several central questions regarding the autumn swarming of temperate zone bats remain unanswered. One of them is how juvenile bats (defined here as young of the year) are able to find swarming sites, which are typically dozens of kilometres away from the maternity colonies where they had been born. In this study, we used a combination of field data and population genetic tools to assess whether the juveniles are likely to learn the location of swarming sites from their mothers. To obtain non-destructive wing-tissue samples for DNA-based maternity assignments, 170 *Myotis daubentonii* and 195 *Myotis nattereri* were captured during the swarming seasons in two subsequent years, at a large hibernaculum in Germany. Based on 14, respectively 13, highly polymorphic microsatellite loci, maternity assignment tests were conducted for all captured adult females and juveniles that had been born in the two respective years. For *M. daubentonii* we found four assigned mother-offspring pairs, whereas in *M. nattereri*, eight mother-offspring pairs could be assigned with high certainty. Moreover, among the latter species, in seven pairs the mothers and the assigned offspring were caught within ten minutes of one another on the same night. Using a simulation, we show that for *M. nattereri*, significantly more juveniles than expected are caught together with their mothers at the hibernacula. We discuss the implications of our findings with regard to understanding autumn swarming behaviour in temperate zone bats, as well as for the conservation of bats that depend on swarming sites for mating and hibernation.

Key words: conservation, Chiroptera, hibernacula, information transfer, maternity assignment, maternal guidance hypothesis, swarming behaviour

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Male resource defence behaviour strengthens harem size in promiscuously mating fruit bats

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Mating success in group forming animals largely depend on the ability of same-sex competitors (usually males) to monopolize local resources that are spatially limited and are of importance to their sexual partners. Across taxa, this resource defence behaviour (RDB) is predicted to maximize male reproductive success. Although RDB is widely observed in polygynous societies, its significance as an alternative male mating strategy among randomly mating individuals (i.e., promiscuous) is a less explored topic in ethology, especially within Chiroptera. In this study, we elucidate the relationship between RDB (measured here as male tent defence behaviour) and the harem size associated with adult males of *Cynopterus sphinx*. From 12 independent resident male removal experiments, we found that inter-male aggressive combats often exclusively occur while defending foliage tents in mating seasons. Further, our harem census data of usurper males (during usurpation) and resident males (post release), suggests a significant bias among females to preferentially roost with the resident males. This preferential association between harem females and the resident males that almost always recovers the foliage tent from the usurpers, suggests that *C. sphinx* harem males use RDB as an alternative mating strategy to monopolize roosting resources and maintain large harems. However, further research is required to identify the direct effects of RDB on individual male reproductive success.

Key words: *Cynopterus sphinx*, resource defence, aggression, alternative mating tactics, intra sexual mate competition, promiscuity

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Foraging and roosting behaviour of the fringe-lipped bat, *Trachops cirrhosus*, on Barro Colorado Island, Panamá

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The Neotropical fringe-lipped bat, *Trachops cirrhosus*, is a generalist predator that hunts frogs and insects by homing in on their mating calls. Although research has examined cognition and prey preferences of bats in captivity, little is known of the foraging or roosting behaviour of this species in the wild. We radio tracked six *T. cirrhosus* individuals on Barro Colorado Island, Panamá. Bat day roosts were all in hollow cashew trees, *Anacardium excelsum*, in mixed sex groups of three to five *T. cirrhosus* individuals, with frequent roost switching. Radio tracked individuals flew an average of 218 ± 227 m from their day roosts to 12.0 ± 10.17 ha foraging areas (50% utilization distribution [UD] kernels = areas where bats spent 50% of their time as estimated from a probability distribution). These 50% UD kernels were less than 10% of their average total range use, but larger than previously reported for *T. cirrhosus*. Radio tracked individuals overlapped in 50% UD kernel foraging areas by only 2.1 ± 5.9 % on average. Foraging behaviour consisted predominantly of short sally flights of less than one minute, indicating bats were likely perch hunting. Bats were more frequently in flight, and had longer flight durations, at the beginning of the night and just before dawn than throughout the rest of the night. These data provide insight into the foraging behaviour of *T. cirrhosus* in the wild, that is a species fast becoming a model system of cognition in captivity.

Key words: Barro Colorado Island, Chiroptera, Brownian bridge, movement ecology, roosting behaviour, telemetry, *Trachops cirrhosus*, social learning

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Flight activity of Noack's round-leaf bat (*Hipposideros* cf. *ruber*) at two caves in central Ghana, West Africa

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Noack's round-leaf bat *Hipposideros* cf. *ruber* is widely distributed in sub-Saharan Africa. Here, we present some aspects of its ecology from two caves in central Ghana. Our main objective was to assess the nightly and annual flight activity and to examine the influences of ambient temperature on flight activity. We tested the hypothesis that flight activity of the species is concentrated at certain periods of the night and the year using mist-netting data from 2,712 captured bats. We found no evidence for annual fluctuations in flight activity, probably due to no distinct seasonal limitation of food resources, no migration, and the lack of extreme environmental conditions in the study area. Our hypothesis of concentrated nightly flight activity was confirmed for one cave but not for the other. Flight activity was concentrated early in the night (20:00, 21:00 and 22:00 hours) at one cave, possibly to take advantage of locally available early active prey insects, while it was uniformly distributed throughout the night at the other. Lastly, we found a reduction in the flight activity of *H.* cf. *ruber* when there was a distinct drop in temperature over the night. We therefore suggest the reduction in flight activity may result from the direct effects of temperature on prey abundance as the bats responded by reducing activity to avoid excessive prey search costs.

Key words: prey, insects, temperature, caves, flight activity, *Hipposideros* cf. *ruber*

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Phenology of emergence by Mediterranean sympatric cave-dwelling bats during their breeding period

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The emergence of cave-dwelling bats can be influenced by multiple variables, such as diurnal predator evasion, energetic requirements, and prey abundance. This work aimed to determine emergence patterns of cave-dwelling bat species from roosts over the April–July 2013 period in the Valencian Community (East Spain) by infrared camera and acoustic recordings. We observed that *Miniopterus schreibersii* left earliest followed by the *Myotis myotis*/*blythii* group and *Myotis capaccinii* and finally *Myotis escalerai*. This pattern of emergence was observed in four roosts with no significant differences. *Miniopterus schreibersii* tended to display quicker flight in open areas, compared to the *Myotis* genus. Moreover, the *M. myotis*/*blythii* group and *M. capaccinii* were larger in size and had a greater wing loading than *M. escalerai*. Therefore, variations in emergence times may be due to differences in predation pressure by diurnal and crepuscular predators, which would enable large and fast bats like *M. schreibersii* to leave earlier, and thus, perhaps take advantage of insect abundance peaks. Another finding was that bats in general left earlier in relation to sunset in summer (particularly in June) than in spring. Differences between months could be attributed to the presence of lactating females in May and June in the genus *Myotis*, which have higher energetic demands than other reproductive classes and may need to forage for a longer time or travel to further distances. Different results were obtained for *M. schreibersii*, indicating different ecological pressures for this species.

Key words: *Myotis myotis*, maternity roosts, activity patterns, emergence timing, *M. blythii*, *M. capaccinii*, *M. escalerai*, *Miniopterus schreibersii*

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Winter activity of bats in Mediterranean peri-urban deciduous forests

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Although the Vespertilionid bats typically hibernate during the winter to minimize energy expenditure in the cold months, in the temperate regions torpor breaks can be rather frequent. The aim of our study was to conduct a preliminary characterisation of the winter bat activity patterns in Mediterranean peri-urban deciduous forests of North Portugal. Echolocation calls were recorded between November and February, and bat activity was regularly detected on warm evenings, with sun set temperatures above 4.6°C during the night sampling, mostly in November (89.9%), only rarely in December (3.7%) and February (6.4%) and without activity detected in January. The most commonly recorded species were *Pipistrellus pygmaeus*, *P. pipistrellus*, and *P. kuhlii*. Socialization activity was mostly concentrated in November (96.8%), only with rare records in February (3.2%) and absent in December and January. Regarding the best fitting average model, obtained by the Multi-Model Inference (MMI) method to explaining the variation of bat passes, the main positive influencing factors are related with the night period of the monitoring process and temperature, and the negative influence with the precipitation recorded in the last 48 hours before surveys. The MMI results for the variation of social calls revealed as significant positive influences the humidity, temperature and wind speed and as negative influence the precipitation recorded in the last 48 hours before surveys. We outline our study as a promising baseline to the studies of winter bat activity, demonstrating how the present and past weather conditions can play a major role in bat torpor breaks. Therefore, for conservation purposes, further winter acoustic research efforts should be consider mandatory for full understanding the bat activity patterns facing the potential impacts of global climatic changes expected to occur in the Mediterranean region.

Key words: bat activity, winter acoustic monitoring, North Portugal, Mediterranean forests

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Bat activity at high altitudes in the Central Alps, Europe

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The occurrence of bats in mountains at high altitudes above 2300 m has not been investigated in the Alps until recently. In other European mountains, only a few studies on bats in high regions e.g., in the Pyrenees or in Switzerland at the Col de Bretolet had been conducted. Here we report a study carried out between 2012 and 2016 at several high-alpine sites at altitudes ranging from 2250 m up to 2761 m in the mountains of the Hohe Tauern, Salzburg, Austria. In spite of extreme climatic conditions, a surprisingly high bat activity and diversity of bat species was recorded. Eleven bat species were detected by different methods. Species identified by echolocation calls were: *Barbastella barbastellus*, *Eptesicus nilssonii, Nyctalus noctula*, *N. leisleri*, *Pipistrellus pipistrellus*, *P. pygmaeus*, *Myotis daubentonii*, and *Vespertilio murinus*. Additional findings were the species pairs *Myotis mystacinus*/*M. brandtii* and *Pipistrellus nathusii*/*P. kuhlii* as well as the genus *Plecotus*. The presence of most of these species was confirmed by capturing individuals with mist nets. Permanent monitoring of ultrasound calls was undertaken throughout the active period of bats at the site located at 2315 m above sea level. A total of over 30,000 series of bat calls were recorded and the activity period lasted from the end of March to the beginning of November. Long-distance migratory bat species were recorded in spring under wintry conditions and much more prominently from August to October. Presumably these individuals were crossing the Alps on their way between summer and winter roosts. Sedentary bats used the high alpine zone for foraging during summer. At these altitudes bats were active at high wind speeds of up to 13.9 m/s as well as at low temperatures around freezing point and down to -5.8°C.

Key words: Chiroptera, Austria, phenology, climatic conditions, National Park Hohe Tauern, migration

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High-resolution MaxEnt modelling of habitat suitability for maternity colonies of the barbastelle bat *Barbastella barbastellus* (Schreber, 1774) in Rhineland-Palatinate, Germany

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The barbastelle bat *Barbastella barbastellus* (Schreber, 1774), probably one of the rarest of western European bat species, has suffered from substantial population declines over the last several decades. In fact, it was believed to be extinct within the federal state of Rhineland-Palatinate (western Germany) until the discovery of a maternity colony in 2004. More reproduction sites have since been found, which demonstrates a substantial knowledge gap about the actual distribution and abundance of the species in Rhineland-Palatinate. Suitable habitats for maternity colonies are crucial for the survival of a population and knowledge of their location is critical for conservation. We modelled the suitability of habitats for use by maternity colonies in Rhineland-Palatinate based on high-resolution data of the forest structure and roosting sites of maternity colonies, using the presence-only machine learning approach MaxEnt. In addition to statistical tests of the model performance, we analysed general occurrence surveys from the last few years for evidence of barbastelle and conducted an in-situ survey on one of the sites identified as highly suitable by the model, but for which no occurrence records exist. On this site, we discovered a new maternity colony. Analysis of third-party surveys resulted in two recently discovered colonies, which shows the barbastelle's range is not restricted to the area south of the Moselle River. The results of our study along with the scattered pattern of potentially suitable locations for maternity colonies in the region challenge previous assumptions of the geographic distribution of barbastelle in Rhineland-Palatinate. This study demonstrates the potential of habitat suitability modelling in conservation ecology and the results may provide a basis for future preservation strategies in the region.

Key words: species distribution modelling, barbastelle bat, *Barbastella barbastellus*, MaxEnt, conservation

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Natural history of the Caatinga endemic Vieira's flower bat, *Xeronycteris vieirai*

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Xeronycteris vieirai is an endemic bat species described by Gregorin and Ditchfield in 2005 only five specimens of which have been collected to date. It is considered Data Deficient by the IUCN Red List. There is little information about this species, so its ecological requirements are poorly known although its diet has been speculated to be nectarivorous. *Xeronycteris vieirai* apparently has a distribution restricted to the semi-arid Brazilian Caatinga, a habitat that has been highly degraded. We present here the first information about the natural history of *X. vieirai*, obtained through a large research project aiming at the ecology and conservation of bats in the Caatinga of the states of Rio Grande do Norte and Pernambuco, northeastern Brazil. From June 2014 to October 2015 we captured 62 individuals of *X. vieirai* at five sites, which represent new records and expand its known distribution, establishing the northernmost record. *Xeronycteris vieirai* feeds on nectar of at least nine species of plants belonging to six families, and mainly on the columnar cactus *Pilosocereus pachycladus*. The species has peak activity at 1830 h and shows an apparently seasonally monoestrous reproductive cycle (June–December). Adult females have longer forearms than adult males and are significantly heavier; there is no bias in the sex ratio. A colony of approximately 20 individuals was observed in a well-ventilated cave with natural lighting, representing the first documented roost for the species. Finally, ectoparasites of the genus *Trichobius* were found on 85.7% of the individuals examined, with no difference in parasite load between males and females.

Key words: roosts, nectar-feeding, ectoparasites, reproduction, geographic range, Caatinga

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Bioacoustics as an important complementary tool in bat inventories in the Caatinga drylands of Brazil

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The Caatinga of northeastern Brazil is considered one of the most species-rich dry forests in the World. The area may harbor nearly 100 species of bats and correctly accessing such richness is a scientific challenge. Bat inventories have been usually based solely on mist netting, which is biased in drylands, where nearly half of the species are open-space insectivores flying high above nets, or species able to better detect and avoid nets. Here, we used mist netting and acoustic inventories in three protected areas in the Caatinga, so species richness could be compared based on both techniques. After an effort of 1,010 net.hours and 1,941 minutes of recordings, we recorded 29 species with nets, 27 on recordings, and five with both techniques. Acoustic sampling resulted in more species in 44% of nights sampled, and two nights had species recorded solely based on their echolocation calls. Species recording differed between techniques, and the driest the site, the lowest the captures with nets, while records based on echolocation remained constant. Based on species estimators, netting achieved 51% of the expected richness, acoustics achieved 87%, and both techniques achieved 70%. Using acoustic sampling we recorded ca. of 42% of the insectivorous species expected for the entire Caatinga and 20% solely on netting. Moreover, in our study bioacoustics indicated that some species were more abundant and widespread than expected. Therefore, studies using solely netting or bioacoustics will produce different results and, in Neotropical dry forests like Caatinga, for a more complete scenario on the local bat species richness a combination of both techniques is essential.

Key words: acoustic inventory, Chiroptera, dry forests, echolocation, species inventories

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Recent surveys of bats from the Andaman Islands, India: diversity, distribution, and echolocation characteristics

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We studied the chiropteran diversity of Andaman Islands between July 2012 and January 2016 from 38 different localities spread throughout the islands. Our surveys revealed the presence of 17 species of bats. One species — lesser bamboo bat *Tylonycteris pachypus* — reported earlier could not be found during the present study. Our study adds four new species records (Andersen's roundleaf bat *Hipposideros pomona*, diadem roundleaf bat *Hipposideros diadema*, Indian pipistrelle *Pipistrellus coromandra*, and greater bamboo bat *Tylonycteris robustula*) for the Andaman Islands. A brief review of each species including details on its distribution (earlier and present), and external and craniodental measurements is provided. We also provide a database of echolocation calls for the Islands' echolocating bat fauna, and confirm the reliability of acoustic monitoring as a method to non-invasively document chiropteran diversity there. This database allows comparisons with taxa from the mainland that are currently considered conspecific, but which show acoustic divergence, and deserve further taxonomic study.

Key words: call library, taxonomy, endemic species, FM calls, FM/QCF calls, CF calls, acoustics

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Inventory, features, and protection of underground roosts used by bats in Mexico

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The disturbance and loss of diurnal roosts is one of the major causes of decline in cave-dwelling bat populations, thus the identification and protection of these sites is essential to the implementation of effective conservation plans. We conducted a search for information on caves, mines, tunnels, and culverts used as roosts by bats in Mexico, in order to create an inventory and a database, as well as a list of priority sites for their protection. In total, 970 underground roosts have been reported: 73.7% are caves, 16.6% are mines, 5.2% are culverts, and 4.5% are tunnels. The roost sites are more commonly located in tropical deciduous forests (24%) and secondary vegetation modified by farming (18.5%). In 92% of underground roosts, the surrounding vegetation has been altered for several causes. Regarding internal disturbance, 46.6% of the 176 roost sites analyzed present little to no disturbance, 43.7% have moderate levels of disturbance, and 9.7% are highly disturbed. The use of underground roosts was documented for 88 bat species included in 44 genera and seven families. Of these, six species are endemic to Mexico and according to the IUCN Red List, three are listed as Near Threatened, three as Vulnerable and two as Endangered. Based on species richness and bat abundance, we considered 53 sites as having the highest priority for conservation of cave-dwelling bats in Mexico, and based on a Complementarity Analysis we identified 167 roosts that must be protected to maintain a greater diversity of bats in the country. It is urgent to implement actions to regulate visits to roosts in order to prevent structural and microenvironmental deterioration, in addition to preserving the foraging areas around roosts, so that conservation of cave-dwelling bats will be more effective at both a local and regional level.

Key words: underground roosts, cave-dwelling bats, inventory, disturbance, conservation, México