

A new genus and species of vesper bat from West Africa, with notes on *Hypsugo*, *Neoromicia*, and *Pipistrellus* (Chiroptera: Vespertilionidae)

RAINER HUTTERER^{1,4}, JAN DECHER¹, ARA MONADJEM^{2,3}, and JONAS ASTRIN¹

¹*Zoologisches Forschungsmuseum Alexander Koenig, Adenauerallee 160, D-53113 Bonn, Germany*

²*Department of Biological Sciences, University of Eswatini, Private Bag 4, Kwaluseni, Eswatini*

³*Mammal Research Institute, Department of Zoology & Entomology, University of Pretoria, Private Bag 20, Hatfield 0028, Pretoria, Republic of South Africa*

⁴*Corresponding author: E-mail: r.hutterer@leibniz-zfmk.de*

We describe a new species of vespertilionid bat from Guinea and Liberia, West Africa. In this context we evaluate previously described taxa from West Africa assigned to *Pipistrellus*, *Neoromicia*, and *Hypsugo*. Based on genetics, morphology and ecology we conclude that the taxon *Pipistrellus eisentrauti bellieri* should be elevated to species level, and that the taxa *bellieri*, *crassulus*, *eisentrauti* plus the new species form a monophyletic clade for which a new genus name is proposed. The new genus occurs in forested regions south of the Sahara from Senegal to Ethiopia and Somalia, from where further taxa remain to be described.

Key words: Guinea, Liberia, morphology, molecular systematics, new genus, new species

Molecular phylogeny and systematics of the sheath-tailed bats from the Middle East (Emballonuridae: *Taphozous* and *Coleura*)

MAREK UVIZL^{1,2,3}, JIŘÍ ŠMÍD^{1,2}, TATIANA AGHOVÁ^{1,2}, ZUZANA KOTYKOVÁ VARADÍNOVÁ^{1,2},
and PETR BENDA^{2,1}

¹*Department of Zoology, Faculty of Science, Charles University, Viničná 7, 128 44 Praha, Czech Republic*

²*Department of Zoology, National Museum (Natural History), Václavské náměstí 68, 115 79 Praha, Czech Republic*

³*Corresponding author: E-mail: marek.uvizl@gmail.com*

The family of sheath-tailed bats (Emballonuridae) constitutes a considerable part of the bat fauna of the Middle East. This region on the crossroad of three biogeographical realms represents the sole significant extension of the family range into the Palaearctic, otherwise the family is distributed mostly in the tropics. Three emballonurid species occur in the Middle East, *Coleura afra*, *Taphozous perforatus* and *T. nudiventris*, each with a number of morphology-based subspecies reported from the region. For this study, we assembled a dataset of more than hundred samples that covers the Middle Eastern parts of the ranges of the respective species. We generated sequences of up to three mitochondrial and five nuclear markers and reconstructed a time-calibrated phylogeny of the family to infer the evolutionary history of emballonurids in the Middle East and to revise their intra- and interspecific taxonomy. The populations of *Coleura* from southern Arabia and the Red Sea coast of Africa show a low genetic structure, although as a lineage are well separated from other *Coleura* populations of Africa and the Indian Ocean islands. We suggest this Afro-Arabian lineage to represent a separate taxon which could be regarded as a species of its own, *C. gallarum*. Similarly, low genetic structure across the study area we revealed in *T. perforatus*; this indicates that only one taxon of this bat is present in the Middle East and adjacent areas that should be co-identified with the nominotypical form. On the contrary, *T. nudiventris* presents two clearly separated clades; one of them comprises the nominotypical form of north-eastern Africa and southern Arabia, as well as the eastern Arabian populations assigned to *T. n. zayidi*, which is thus unjustified, and the latter name to be considered a junior synonym of *T. n. nudiventris*. On the other hand, the analysis did not resolve satisfactorily the phylogenetic position of the large body-sized Mesopotamian populations of *T. nudiventris*, which thus remains to be regarded as a subspecies *T. n. magnus*. Finally, the position of *Liponycteris* as a separate subgenus of *Taphozous* was not found to be justified, while the traditional divisions of the family into the subfamilies Taphozoinae and Emballonurinae and the latter into the tribes Emballonurini and Diclidurini were supported by the analysis results.

Key words: Chiroptera, mitochondrial DNA, molecular genetics, nuclear DNA, southern Palaearctic

Distinct patterns of genetic connectivity found for two frugivorous bat species in Mesoamerica

LAURA TORRES-MORALES^{1,4}, ANTONIO GUILLÉN², and EDUARDO RUIZ-SANCHEZ³

¹*División de Posgrado, Instituto de Ecología, A.C., Carretera Antigua a Coatepec 351, El Haya, Xalapa, Veracruz 91070, Mexico*

²*Instituto de Ecología A.C., Carretera Antigua a Coatepec 351, El Haya, Xalapa, Veracruz 91070, Mexico*

³*Departamento de Botánica y Zoología, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Camino Ing. Ramón Padilla Sánchez 2100, Nextipac, Zapopán, Jalisco 45200, Mexico*

⁴*Corresponding author: E-mail: arualtm@hotmail.com*

Sturnira parvidens and *Sturnira hondurensis* are two frugivorous bat species distributed throughout the Mesoamerican region. *Sturnira parvidens* inhabits tropical lowland forests and *S. hondurensis* montane cloud forests. Their populations are respectively separated by the intervening highlands or lowlands. We used mitochondrial DNA control region sequences to compare genetic structure among the populations of these two species in the region of the Gulf of Mexico. We also measured genetic connectivity among their populations and assessed the distribution model for each species. We found high genetic diversity in both species: the F_{ST} comparisons values were low to high in *S. hondurensis* and low in *S. parvidens*. For *S. hondurensis*, we found isolation by landscape resistance (IBR) where the highland habitat heterogeneity may have restricted gene flow among the populations of the Sierra Madre Oriental, Sierra de Los Tuxtlas, Chiapas and Guatemala. For *S. parvidens*, the isolation is explained by geographic distance rather than by landscape heterogeneity.

Key words: habitat heterogeneity, refuge, humid forest, *Sturnira hondurensis*, *S. parvidens*

Not all *Molossus* are created equal: genetic variation in the mastiff bat reveals diversity masked by conservative morphology

LIVIA O. LOUREIRO^{1,2,5}, MARK ENGSTROM^{1,2}, BURTON LIM², CELIA LÓPEZ GONZÁLEZ³,
and JAVIER JUSTE⁴

¹*Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, ON M5S 3B2, Canada*

²*Department of Natural History, Royal Ontario Museum, Toronto, ON M5S 2C6, Canada*

³*Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional (CIIDIR) Unidad Durango, Instituto Politécnico Nacional, Calle Sigma 119, Fraccionamiento 20 de Noviembre II, Durango, 34220 Mexico*

⁴*Estación Biológica de Doñana, Consejo Superior de Investigaciones Científica (CSIC), 41092 Seville, Spain*

⁵*Corresponding author: E-mail: livia.loureiro@mail.utoronto.ca*

The genus *Molossus* of the free-tailed bat family Molossidae is morphologically conservative and the level of genetic divergence is also low among many species, which has masked the actual species diversity in the genus. We analyzed the evolutionary relationships among species within *Molossus* using three mitochondrial (*COI*, *Cytb*, and *16S RNA*), and two nuclear genes (*RAG2* and *β -fib*) from more than 400 specimens across the Neotropics. We also investigated the genetic integrity of currently recognized species, especially those with broad geographic distributions and controversial taxonomic arrangements. Maximum likelihood and Bayesian phylogenetic reconstructions show that some recognized species are not monophyletic. The use of combined mitochondrial and nuclear genes as well as the use of only mitochondrial markers revealed more robust phylogenies than those for individual data sets and those restricted to the two nuclear genes. We recovered the recently described *M. fentoni* and *M. alvarezii*, validated *M. milleri* and *M. verrilli* as distinct species relative to *M. molossus*, and confirmed that the name *M. barnesi* should be considered as a junior synonym of *M. coibensis*. Additionally, *M. rufus* appears to be a complex of cryptic species, showing that the broadly distributed genus *Molossus* is more diverse than previously reported.

Key words: molecular systematics, genetic diversity, phylogeny, *Molossus*

Hypophysis size evolution in Chiroptera

NICOLÁS REYES-AMAYA^{1,3} and DAVID FLORES^{1,2}

¹*Unidad Ejecutora Lillo, CONICET-Fundación Miguel Lillo, Miguel Lillo 251, T4000JFE - San Miguel de Tucumán, Argentina*

²*Instituto de Vertebrados, Fundación Miguel Lillo, Miguel Lillo 251, T4000JFE - San Miguel de Tucumán, Argentina*

³*Corresponding author: E-mail: nrreyesa@unal.edu.co*

The hypophysis influences biological functions in mammals at various levels, and its volumetric variation in Chiroptera is recently well known. We explored the relation of the hypophysis size as a whole (Hyp) and its separate components, adenohipophysis (Adh) and neurohypophysis (Neh), from 96 species of bats (Yinpterochiroptera and Yangochiroptera), with social (roosting association), reproductive (testes mass, mating system, female promiscuity), body size (body mass) and foraging (diet) variables (when available for the sampled species), through ANCOVA and linear regressions analyses. We also explored the phylogenetic legacy of the volumetric changes of Hyp, Adh and Neh over a well-resolved phylogenetic tree, through Phylogenetically independent contrasts analysis, phylogenetic signal, and character optimizations. Hyp, Adh, Neh volumes and testes mass showed significant relation with body mass. When body mass effect was excluded, Hyp, Adh and Neh showed no significant relation with testes mass nor significant differences within roosting association, mating system and female promiscuity variables. However, Hyp, Adh and Neh volumes showed a pattern with diet, probably related to the regulatory role of the hypophysis at the endogenous protein metabolism in Mammals. The significant phylogenetic effect at linear regressions of Hyp, Adh and Neh volumes against body mass suggests the hypophysis volume and the body mass has coevolved, which was also supported by the significant phylogenetic signal and the optimizations considering body mass. Optimizations excluding body mass also showed significant phylogenetic signal, demonstrating that the volumetric changes bear phylogenetic information beyond body size. Our results suggest that the hypophysis size variations in bats are rather explained by phylogenetic legacy, as phylogenetic inertia linked to the ecology of the ancestors of the different clades, than current ecological aspects related to the natural history of the extant species.

Key words: bats, ecology, evolution, pituitary gland, size

High throughput bioacoustic monitoring and phenology of the greater noctule bat (*Nyctalus lasiopterus*) compared to other migratory species

TOMÁŠ BARTONIČKA¹, NIKOLA MIKETOVÁ², and PAVEL HULVA^{3,4}

¹*Department of Botany and Zoology, Faculty of Science, Masaryk University, Kotlářská 2, 602 00 Brno, Czech Republic*

²*Department of Biology and Ecology, University of Ostrava, Chittussiho 10, 710 00 Ostrava, Czech Republic*

³*Vertebrate Zoology Research Group, Department of Zoology, Charles University, Viničná 7, 128 42 Prague, Czech Republic*

⁴*Corresponding author: E-mail: hulva@natur.cuni.cz*

Conventional monitoring tools are seldom effective for studying the ecology of rare and elusive mammals. In the present study, we use automated ultrasound detectors to provide information about seasonal activity of the greater noctule bat (*Nyctalus lasiopterus*), the largest and one of least known European bats. We selected localities within Central Europe with diverse geomorphological contexts, including rivers of different sizes and mountain passes. The study demonstrates the capability of the automatic recording approach to achieve bioacoustic discrimination of this species, but also pointed to the persistent need of integrating results from automatic classification software applications with the feedback from manual approaches. The high throughput capacity of the assay proved to be efficient, and the regular occurrence of the species was identified at two localities. These locations are associated with two known and intensely used migratory corridors of winged animals going through Vltava River valley and Červenohorské Saddle in Jeseníky mountains, as illustrated also by the activity patterns of other migratory species. Together with the occurrence of spring and autumn peaks in activity, these findings are in concordance with the plesiomorphic condition in pipistrelloid bats, showing also migratory behavior, and represent further indirect evidence of migration of the greater noctule. This pattern could be facilitated by the trophic niche of the species, involving predation of migrating songbirds. Differences in phenology of migratory species observed at particular sites likely mirror position of the locality in relation to migration flyways, seasonal and geographic variation in prey availability and energy demands etc. Further application of bioacoustic monitoring and other tools is necessary to obtain detailed information about the range and movement ecology of the species in higher latitudes.

Key words: migration, automated detectors, central Europe, greater noctule, *Nyctalus lasiopterus*, SonoChiro, Vltava River valley, Červenohorské Saddle

Long-term monitoring of the effects of weather and marking techniques on body condition in the Kuhl's pipistrelle bat, *Pipistrellus kuhlii*

ANDREA G. LOCATELLI^{1,4}, SIMONE CIUTI², PRIMOŽ PRESETNIK³, ROBERTO TOFFOLI⁴,
and EMMA TEELING^{1,5}

¹*Laboratory of Molecular Evolution and Mammalian Phylogenetics, School of Biology and Environmental Science, University College Dublin, Belfield, Dublin 4, Ireland*

²*Laboratory of Wildlife Ecology and Behaviour, School of Biology and Environmental Science, University College Dublin, Belfield, Dublin 4, Ireland*

³*Centre for Cartography of Fauna and Flora, Klunova 3, 1000 Ljubljana, Slovenia*

⁴*Chirosphera, Associazione per lo Studio e la Tutela dei Chiroterteri e l'Ambiente, Via Tetti Barbieri 11, Santena, Turin, Italy*

⁵*Corresponding author: E-mail: emma.teeling@ucd.ie*

Bats are one of the most widespread and speciose orders of mammals. Despite their huge biodiversity, little is known about the natural behaviour and ecology of many species given the difficulty in monitoring and studying them. *Pipistrellus kuhlii* is one of the most common bats of the Mediterranean biome but its ecology remains ambiguous given the scarcity of longitudinal studies. Such basic information is urgently needed to predict the shift of species distribution range under climate change scenarios. Here, we analysed the effects of weather variables (namely temperature, precipitation, wind speed and air humidity) on the body conditions of *P. kuhlii* monitored in five maternity roosts in Southern Europe over more than a decade (17 years). Using linear mixed-effect models, we disentangled the impact of weather predictors on body condition variations in 347 individuals. Our results revealed species-specific sensitivity to variations in the monitored four main weather parameters. Through the modelling analysis, we show how weather seasonal variables recorded prior to the capture period had a substantial role in driving bat body condition. A combination of warmer spring-summers and cooler winters was found associated with optimal body condition in *P. kuhlii*. Our analysis also showed that *P. kuhlii* bats were favoured by higher spring humidity combined with intermediate precipitation and humidity levels recorded during the summers prior to the capture. The latter parameters (precipitation and humidity) were arguably linked with the proliferation of entomofauna on which bats feed. Additionally, we assessed the body condition of 45 bats that were previously captured and tagged either with bands or PIT-tags, two of the most widespread marking techniques for bats. We showed that bats carrying a ring (band) or a PIT-tag had a body condition that did not differ to that expected for untagged bats. This suggests that transponding bats has no significant effect on body condition, enabling new opportunities for passive monitoring and large-scale long-term longitudinal studies for these animals.

Key words: bats, bat ringing, linear mixed-effect models, passive integrated transponder PIT, principal component analysis, scaled mass index, bat banding

Population size and survival of the Malagasy fruit bat *Rousettus madagascariensis* (Pteropodidae) in Ankarana, northern Madagascar

OLIVA S. NOROALINTSEHENO LALARIVONIAINA^{1,2,5}, FANEVA I. RAJEMISON^{1,2}, RIANA V. RAMANANTSALAMA^{1, 2},
ARISTIDE ANDRIANARIMISA^{1,3}, and STEVEN M. GOODMAN^{1,4}

¹*Mention Zoologie et Biodiversité Animale, Domaine Sciences et Technologies, Université d'Antananarivo, BP 906, Antananarivo 101, Madagascar*

²*Association Vahatra, BP 3972, Antananarivo 101, Madagascar*

³*Wildlife Conservation Society, BP 8500, Antananarivo 101, Madagascar*

⁴*Field Museum of Natural History, 1400 South Lake Shore Drive, Chicago, IL 60605, USA*

⁵*Corresponding author: E-mail: olivasantarni@gmail.com*

Population size and survival are crucial factors to understand population dynamics of a given species, especially those that have long life spans and delayed sexual maturity, such as Pteropodidae bats. We studied the population size and apparent survival of individuals at a day roost site of an endemic cave-dwelling Malagasy fruit bat, *Rousettus madagascariensis*, in relation with age and sex. 1,801 individuals were captured and tagged over the course of four years in the Grotte des Chauves-souris, Réserve Spéciale d'Ankarana, northern Madagascar. The Cormack-Jolly-Seber model and the POPAN model in the program MARK were used to analyze mark-recapture data and to estimate apparent individual survival and population size. The apparent survival of individuals ranged from 0.46 to 0.60, but exhibited significant variability associated with age, sex, and time. Apparent survival is lower in adults compared to sub-adults ($\Phi_{\text{adult}} = 0.49$; $\Phi_{\text{sub-adult}} = 0.63$). For adults, the apparent survival of males was higher ($\Phi_{\text{male}} = 0.50$; $\Phi_{\text{female}} = 0.47$), and conversely for sub-adults, it was in favor of females ($\Phi_{\text{male}} = 0.55$; $\Phi_{\text{female}} = 0.70$). Population size ranged from 1,245 (CI: 268–3,050) to 5,868 (CI: 3,520–10,601) and was significantly higher during the wet season as compared to the dry season. The survival rate in this population is strongly influenced by mortality and secondarily by dispersal. We found that the apparent survival of individuals has a positive impact on population growth but less than birth rate. Thus, the health and sustainability of the population relies heavily on individual survival.

Key words: dispersal, *Rousettus madagascariensis*, population size, fruit bat, apparent survival

Seasonal variation in diurnal cave-roosting behavior of a Malagasy fruit bat (*Rousettus madagascariensis*, Chiroptera: Pteropodidae)

RIANA V. RAMANANTSALAMA^{1,2,4}, OLIVA S. NOROALINTSEHENO LALARIVONIAINA^{1,2},
ACHILLE P. RASELIMANANA^{1,2}, and STEVEN M. GOODMAN²

¹*Mention Zoologie et Biodiversité Animale, Université d'Antananarivo, BP 906, Antananarivo 101, Madagascar*

²*Association Vahatra, BP 3972, Antananarivo 101, Madagascar*

³*Field Museum of Natural History, 1400 South Lake Shore Drive, Chicago, IL 60605, USA*

⁴*Corresponding author: E-mail: rianaval@yahoo.fr*

This study examines seasonal behavioral activity in a cave day roost of an endemic Malagasy fruit bat, *Rousettus madagascariensis* (Chiroptera: Pteropodidae). Activities of both sexes (male and female) classified by age (neonate, sub-adult, and adult) were filmed in the cave using an infrared camcorder during the wet and dry seasons. Analyses of the videos were used to calculate the proportion of time spent conducting predefined behavior types during different 10 min periods. Measurements taken from captured individuals were employed to calculate the body condition index (BCI, ratio of body mass to forearm length) for the different age and sex classes. The results indicate that cave-roosting behavior changed as according to season. During the dry season, roosting individuals spent more time in 'rest' and 'consume ectoparasites' behaviors and limited 'move' (flight and crawl) and 'groom' activities. Further, the BCI was lower during this period, as compared to the wet season, and this shift is presumably related to food availability or quality. During the wet season, 'groom' behavior frequency was higher and individuals formed a more dispersed roosting group configuration. The threshold for the shift to 'tight' group configuration and less grooming activity is correlated with climatological variables, specifically when the average temperature outside the cave was $\leq 25.3^{\circ}\text{C}$, the mean temperature inside the cave was $\leq 24.0^{\circ}\text{C}$, and the average relative humidity was $\leq 68.2\%$. In contrast, the presence of solitary roosting individuals and 'loose' group configuration were more common when the average temperature outside the cave was $\geq 27.1^{\circ}\text{C}$ and the average temperature and relative humidity inside the cave was $\geq 25.0^{\circ}\text{C}$ and $\geq 93.4\%$, respectively. Future studies should examine aspects of thermoregulation in cave-roosting pteropodids living in tropical areas, combined with measures of food availability and quality, and the relationship of these variables to reproduction.

Key words: behavior, body condition index, group configuration, relative humidity, seasonal variation, solitary, temperature, Madagascar

Roost composition and sexual segregation in a lowland population of Daubenton's bats (*Myotis daubentonii*)

DANIELLE M. LINTON^{1,2} and DAVID W. MACDONALD¹

¹*Wildlife Conservation Research Unit (WildCRU), Department of Zoology, University of Oxford, The Recanati-Kaplan Centre,
Tubney House, Abingdon Road, Tubney, OX13 5QL, United Kingdom*

²*Corresponding author: E-mail: daniellemlinton@gmail.com*

Using data from 1100 day roosts containing a minimum of 9424 *Myotis daubentonii* bats, we compare the distribution of adult males, adult females, and juveniles, within SchweglerTM box roosts distributed across 394 ha of woodland adjacent to a river corridor in lowland England. Five social groups, containing both males and females (each comprising 55–230 adult bats per annum, using 37–127 known roosts per colony), occupy discrete roosting areas to which individuals show high inter-annual fidelity. Natal philopatry is also high, compared to between colony movements, for both sexes in our study population. Despite considerable spatial overlap and variability in roost composition over the summer (April to October), related to temporal changes in reproductive status, there is sexual segregation within day roosts. Bachelor (adult male dominated) roosts are situated significantly further from water than maternity (adult female or juvenile dominated) roosts on average. This spatial partitioning between maternity and bachelor roosts operates within rather than between colony home roost ranges, however, with adult males from some social groups found roosting closer to water than are adult females from adjacent colonies. The co-occurrence of maternity and bachelor groups roosting in close proximity, including extensive spatial overlap in roosts occupied, and temporal overlap during roost sharing between the sexes, provides novel insights into social organisation and potential drivers of sexual segregation and mating strategies for this widespread and common species within lowland habitats.

Key words: landscape, philopatry, occupancy, colony, fidelity, maternity, male, social

Do activity patterns and the degree of foraging specialization enable niche partitioning in nectarivorous bats?

ALICIA CHÁVEZ-ESTRADA¹, ALEJANDRO SALINAS-MELGOZA^{1,2,3}, and YVONNE HERRERÍAS-DIEGO^{1,2}

¹*Laboratorio de Vida Silvestre, Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo, Avenida Francisco J. Múgica S/N, Ciudad Universitaria, 58030 Morelia, Michoacán, Mexico*

²*Laboratorio de Análisis y Síntesis Ecológica, Programa de Laboratorios Nacionales CONACyT, Antigua Carretera a Pátzcuaro 8701, Col. Ex Hacienda de San José de la Huerta, 58190 Morelia, Michoacán, Mexico*

³*Corresponding author: E-mail: cuixmaloso@gmail.com*

Niche partitioning is a strategy that favors the coexistence of sympatric species and prevents resource competition. Resource partitioning not only occurs along a temporal and spatial axis, but also within the niche breadth. The lesser long-nosed (*Leptonycteris yerbabuena*) and the Pallas's long-tongued (*Glossophaga soricina*) bats are sympatric throughout much of their distribution range. Both species can be found in the Mexican tropical dry forest and co-occur during the winter in the Pacific coast of Michoacán. These bats have similar requirements but differ in morphological characteristics associated with their particular methods for obtaining food. We evaluate whether these species exhibit niche partitioning in diet and activity patterns during their period of coexistence. Bats were sampled each month from April 2016 to March 2017, and mist-nets were set up at ground level from 19:00 to 03:00 h in Lazaro Cardenas, Michoacán. Diet was determined by taking pollen samples from bat fur and feces, and patterns of daily activity were analyzed. We found greater abundance of bats during November to January, which corresponds to the dry season. This abundance may be associated with a greater availability of floral resources in the study area. Bats fed on nectar from plants of the families Bombacaceae, Fabaceae, Convolvulaceae, Apocynaceae, Cactaceae and Rosaceae. We found no evidence that the diet of the species changes in relation to the presence of potential competitors. However, we found niche partitioning in daily activity patterns of *G. soricina* related to a high density of *L. yerbabuena*.

Key words: competition, foraging behavior, *Glossophaga soricina*, *Leptonycteris yerbabuena*, tropical dry forest

Activity of aerial insectivorous bats in two rice fields in the northwestern Llanos of Venezuela

YARA AZOFEIFA^{1,2}, SERGIO ESTRADA-VILLEGAS^{3,4,5}, JESÚS MAVÁREZ^{6,7}, and JAFET M. NASSAR^{1,8}

¹*Centro de Ecología, Instituto Venezolano de Investigaciones Científicas, Aptdo. 20632, Carretera Panamericana km 11, Caracas 1020-A, Miranda, Venezuela*

²*Escuela de Ciencias Biológicas, Universidad Nacional, Heredia, Aptdo. 86-3000, Costa Rica*

³*Department of Biological Sciences, Marquette University, P.O. Box 1881, Milwaukee, Wisconsin, 53201-1881, USA*

⁴*Smithsonian Tropical Research Institute, Apartado 0843-03092, Balboa, Ancón, Panama*

⁵*Programa para la Conservación de los Murciélagos de Colombia PCMCo. Carrera 10 # 65 - 63 - Oficina 201-3, Bogotá, Colombia*

⁶*Laboratoire d'Ecologie Alpine, UMR UGA-USMB-CNRS 5553 Université Grenoble Alpes, CS 40700 38058 Grenoble, cedex 9, France*

⁷*Departamento de Ciencias Biológicas y Ambientales, Universidad Jorge Tadeo Lozano, Carrera 4 #22-61, Bogotá, Colombia*

⁸*Corresponding author: E-mail: jafet.nassar@gmail.com*

Even though agricultural lands provide abundant food to aerial insectivorous bats (AIB), our understanding of how spatio-temporal factors affect their foraging behavior in these habitats is limited and mostly restricted to temperate regions. In this study, we examined species richness, composition and patterns of activity of AIB in rice fields in the northwestern Llanos of Venezuela. Between 2013 and 2014, we conducted acoustic monitoring of AIB in two rice fields with contrasting forest cover, throughout three phases of the life cycle of this crop (vegetative, reproductive, and ripening), during the dry and rainy season. Out of 108 h recorded, we processed 12,630 files and identified 15 species and 10 sonotypes of AIB from families Molossidae, Mormoopidae, Vespertilionidae, Emballonuridae and Noctilionidae. *Molossus molossus* and *Myotis nigricans* showed the highest levels of feeding and general activity across species. The index of general activity (IGA) of AIB was higher above rice fields with more surrounding forest cover, during the dry season and throughout the entire life cycle of the plant. Relative feeding activity (RFA) did not change with respect to forest cover, season or crop phase, but a significant effect of the interaction of these factors was observed on this variable. The response of IGA and RFA to forest cover, season or crop phase was different between *M. molossus* and *M. nigricans* and among functional groups. Our results indicate that rice fields in the Venezuelan Llanos can be active feeding grounds for open space and edge-habitat foraging species of insect-feeding bats. Forest patches can promote AIB activity by favoring foraging of ‘edge’ species above rice fields. Higher general activity of most AIB species during the dry season suggests that rice fields are used more intensively when insect populations decrease in semi-deciduous forest patches around them. Overall, our results suggest that availability of abundant feeding areas to AIB, provided by the rice fields, together with presence of artificial and natural roosts to these bats, could ensure year-round permanence of a rich ensemble of AIB in the rice field-forest landscape in the northwestern Llanos of Venezuela. Some of these species could be the subject of field experiments to test their value in the control of rice’s insect pest populations.

Key words: echolocation, rice, Venezuelan Llanos, insectivorous bats, *Molossus molossus*, *Myotis nigricans*, Neotropics

Activity records of the endangered Paraguaná moustached bat, *Pteronotus paraguayensis*, in the main vegetation types of the Paraguaná Peninsula, Venezuela

ANGELA M. G. MARTINO¹, DULCE BORGES¹, and JAFET M. NASSAR^{2,3}

¹*Centro de Investigaciones en Ecología y Zonas Áridas, Universidad Nacional Experimental Francisco de Miranda, Aptdo 7506, Coro, Falcón, Venezuela*

²*Centro de Ecología, Instituto Venezolano de Investigaciones Científicas, Aptdo 20632, Carretera Panamericana km 11, Caracas 1020-A, Miranda, Venezuela*

³*Corresponding author: E-mail: jafet.nassar@gmail.com*

The Paraguaná moustached bat, *Pteronotus paraguayensis* (Mormoopidae), is one of the four species of bats endemic to Venezuela. Besides having a geographic distribution restricted to the Paraguaná Peninsula, it is currently classified as Endangered in the IUCN Red List of Threatened Species. Changes in land use, frequent human disturbance at diurnal roosts and poisoning with agropesticides from farming operations are some of the main threats that affect this species. Despite its conservation status and the pressing need to protect its feeding areas, habitat use of this species has not been well documented. The aim of this study was to record this bat's activity using acoustic monitoring to identify the vegetation types most frequently used throughout the year. We recorded echolocation calls over the course of eight months between 2015 and 2016, using walking transects distributed along the vegetation types most representative of the peninsula. Activity of *P. paraguayensis* differed significantly among vegetation types, reaching highest relative activity in thorn woodlands (45%), followed by premontane woodlands (20%), disturbed habitats (19%), thorn scrubs (11%), and columnar cactus forests (4%). Activity (mean number of bat passes/h) was comparatively higher in premontane woodlands (78.17 ± 49.82 SD) than in the other vegetation units (range: 4.39 ± 5.71 SD – 15.51 ± 16.11 SD) where this species was detected. This result is indicative that this species is mainly associated with forest habitats; however, it can also be present at lower frequency in disturbed lands. Our bat call recordings also help confirm that the Paraguaná Peninsula's isthmus represents an ecological barrier that precludes dispersion of *P. paraguayensis* to the mainland. Based on our findings, we highlight the need to focus conservation actions for this species on protection of the remnant patches of forest vegetation still present in the peninsula.

Key words: echolocation calls, endangered species, habitat degradation, Mormoopidae, *Pteronotus paraguayensis*

Microclimate of developing tubular leaves used as roost sites by bats

NATHALIA PÉREZ-CÁRDENAS¹, KATHERINE PORRAS-BRENES², LEYDI V. AUCCACUSI-CHOQUE^{3,4},
JOANNA J. SUÁREZ-TORRES⁵, ROSA M. BROOKS⁶, and GLORIANA CHAVERRI^{7,8,9}

¹*Instituto de Investigaciones en Ecosistemas y Sustentabilidad, Universidad Nacional Autónoma de México, Morelia, Michoacán, Mexico*

²*Escuela de Ciencias Biológicas, Universidad Nacional, Campus Omar Dengo, Heredia, Costa Rica*

³*Frankfurt Zoological Society - Perú, Entel Perú C-1, Wanchaq, Cusco, Peru*

⁴*Museo de Historia Natural de la Universidad de San Antonio Abad del Cusco, Parainfo Universitario (Plaza de Armas s/n), Cusco, Peru*

⁵*Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Camino Ramón Padilla Sánchez 2100 Nextipac, 45200 Zapopan, Jalisco, Mexico*

⁶*Centro Oriental de Ecosistemas y Biodiversidad, Santiago de Cuba, Cuba*

⁷*Recinto de Golfito, Universidad de Costa Rica, Alamedas, Golfito 60701, Costa Rica*

⁸*Smithsonian Tropical Research Institute, Apartado 0843-03092, Balboa, Ancón, Panama*

⁹*Corresponding author: E-mail: gloriana.chaverri@ucr.ac.cr*

Roosts are critical for the reproduction and survival of bats and many species spend a significant portion of their lives in them; thus, individuals should carefully select sites that reduce predation risk while providing ideal microclimatic conditions. Many studies have determined that bats select warmer and more humid roosts in temperate regions, but few studies have determined if roosts selected by tropical species also provide suitable conditions. In this study we compare temperature and humidity within and outside furled tubular leaves of plants in the order Zingiberales, which are used by several tropical species as roost-sites, to determine if these structures provide microclimatic advantages to bats. We found very small differences between the internal and external temperatures of tubular leaves, and the difference further decreased as leaves developed. However, we found large differences in humidity within the tubular leaf compared to external conditions, which were strongly dependent on a leaf's diameter and genus. The internal humidity was often 20% above the external, particularly when leaves were narrower, and tubular leaves in the genus *Heliconia* were more humid than those in the genus *Calathea*. Our findings suggest that, despite being fairly exposed structures, furled tubular leaves provide suitable microclimatic conditions for tropical species.

Key words: disc-winged bats, evaporative water loss, humidity, temperature, thermoregulation

Bat folivory in numbers: how many, how much, and how long?

ADRIANA DUQUE-MÁRQUEZ¹, DAMIÁN RUIZ-RAMONI^{1,2}, PAOLO RAMONI-PERAZZI^{1,3},
and MARIANA MUÑOZ-ROMO^{1,4,5}

¹*Laboratorio de Zoología Aplicada, Departamento de Biología, Facultad de Ciencias, Universidad de Los Andes, Mérida 5101, Venezuela*

²*Current address: Universidad Nacional Autónoma de México, Departamento de Paleontología, Instituto Geología, Cd. Universitaria, Circuito de la Investigación, Del. Coyoacán, C.P. 04510, Ciudad de México, México*

³*Current address: Laboratório de Ecologia e Conservação de Mamíferos, Programa de Pós-Graduação em Ecologia Aplicada, Universidade Federal de Lavras, CEP 37200-000, Lavras, MG, Brazil*

⁴*Current address: Smithsonian Tropical Research Institute, Apartado 0843-03092, Balboa, Ancón, República de Panamá*

⁵*Corresponding author: E-mail: munozml@si.edu*

Folivory in bats has been described as chewing bits of leaves to extract the liquids, and then discarding the remaining fibers in form of oral pellets. At least eight species of Neotropical fruit-eating bats have been reported to use folivory as a strategy potentially to provide bats with vitamins, micronutrients and proteins usually scarce in fruits, as well as secondary metabolites that stimulate or inhibit reproductive processes, or even as a supply of water. All reported cases of folivory in bats consist of short, descriptive natural history notes with few supporting details. In depth understanding of leaf consumption by bats is lacking. To bridge this gap, we studied two colonies of *Artibeus* living under different conditions in the Venezuelan Andes: an urban colony (*A. lituratus*) and a forest colony (*A. amplus*) whose individuals exhibited folivorous habits. We hypothesized that bats: (1) feed on leaves from many plant species, and more frequently eat certain plant species over others, (2) show monthly variation in leaf consumption, (3) eat specific parts of each leaf and discard the rest, and (4) within a plant species, eat the same part of each leaf. We collected leaves found below the roosting site of the colonies of both species and analyzed digital images of each leaf to quantify the consumed area. All leaves ($n = 1,188$) were classified and quantified in terms of the pattern of observed consumption (apical, basal, other). We found that both species of bats fed on leaves from certain plant species over others, showed monthly variation in leaf consumption, and on average consumed less than 50% of the leaf, equivalent to an area of 5–7 cm² ($n = 655$). Maximum consumption of leaves was observed in both species in the weeks immediately prior to males exhibiting scrotal testes and females becoming palpably pregnant. Results from our study provide the first systematic and detailed assessment of folivory in bats, showing the use of leaves all year long by two bat species. Future research should investigate whether males and females consume leaves to the same extent, and on the chemical properties of consumed plant species.

Key words: Chiroptera, forest, Phyllostomidae, behavior, feeding habits, Venezuela, leaves, Stenodermatinae

Vocal development of Horsfield's leaf-nosed bat pups (*Hipposideros larvatus*)

TINGTING CHI¹, MUXUN LIU¹, XIAO TAN¹, YU LI¹, YANHONG XIAO¹, KEPING SUN¹, LONGRU JIN^{1,2},
and JIANG FENG¹

¹*Jilin Provincial Key Laboratory of Animal Resource Conservation and Utilization, Northeast Normal University,
Changchun, 130024, China*

²*Corresponding author: E-mail: jinlr915@nenu.edu.cn*

Bats are an appealing animal for investigating the biological basis and evolution of speech-related traits in wild mammal systems. We investigated vocal development in Horsfield's leaf-nosed bat pups, *Hipposideros larvatus*. We found that newborn bats emit many types of isolation calls, including downward frequency modulation (DFM), arched frequency modulation (AFM), upward frequency modulation (UFM), and others. The gradual decrease of Euclidean distance measurements revealed that pup isolation calls (DFM, AFM, UFM) gradually change into adult social calls. Furthermore, one of the isolation call types (UFM type) encoded an individual signature. By contrast, we report that early echolocation calls and isolation calls develop in parallel. As pups develop, early echolocation calls gradually mature and transform into adult-like echolocation calls. The interval and duration of echolocation calls decreases, while the peak frequency and bandwidth of frequency modulation increases.

Key words: bats, isolation calls, individual signature, echolocation calls, vocal development

Detection probability of bats using active versus passive monitoring

KATHERINE D. TEETS¹, SUSAN C. LOEB², and DAVID S. JACHOWSKI^{1,3}

¹*Department of Forestry and Environmental Conservation, Clemson University, Clemson, SC 29634, USA*

²*USDA Forest Service, Southern Research Station, Clemson, SC 29634, USA*

³*Corresponding author: E-mail: djachow@clemson.edu*

As technology has evolved, bat researchers have relied more heavily on using acoustic techniques to collect data on bat communities. Acoustic data can be collected actively, where the researcher is present at the sampling point and follows the bat with the detector, or passively, where the researcher is not present and the detector is set out by itself. Active sampling can yield longer, clearer calls, and is only conducted during part of the night (usually from sunset to about 02:00 hours) for short bouts (20 minutes). By contrast, passive sampling can yield lower quality calls, but procedures are easily repeatable and data can be used to measure temporal variation in activity throughout the night and detect individuals and species that are missed during active sampling. Researchers are increasingly attempting to monitor and compare bat communities over time, including sites where both active and passive sampling have occurred. However, these two techniques can yield different detection probabilities and the extent to which data collected using these two techniques can be compared is unclear. Thus, in July 2017 we simultaneously collected acoustic data actively and passively to compare detection probabilities of bats at the Savannah River Site, South Carolina, USA. Using Anabat Express detectors, we detected five species or species groups (*Eptesicus fuscus*/*Lasiurus cinereus*, *L. borealis*/*L. seminolus*, *Perimyotis subflavus*, *Myotis austroriparius*, and *Nycticeius humeralis*) using each method. Using single season occupancy modeling, we found that method (passive vs. active sampling) had a significant effect on detection probabilities of all species, and that passively sampling throughout the night yielded the highest detection probability for all species. As a result, if differences in detection probability are not taken into account, comparison of historical active datasets with current passive datasets could lead to different insights into habitat use by similar bat communities. Based on our findings, we recommend that researchers use passive sampling throughout the night when studying and monitoring bat communities.

Key words: acoustics, active sampling, clutter, passive sampling, occupancy probability

Going beyond a leap of faith when choosing between active and passive bat monitoring methods

JULIE FAURE-LACROIX^{1, 2, 5}, ANDRÉ DESROCHERS¹, LOUIS IMBEAU³, and ANOUK SIMARD⁴

¹*Centre d'Étude de la Forêt, Université Laval, 2405 rue de la Terrasse, Québec City, QC, G1V 0A6, Canada*

²*Present address: Département de Génie électrique et de Génie Informatique, Faculté de Sciences et de Génie, 1065 Avenue de la Médecine, Université Laval, Québec, G1V 0A6, Canada*

³*Centre d'Étude de la Forêt, Université du Québec en Abitibi-Témiscamingue, Institut de Recherche sur les Forêts, 341 rue Principale Nord, Amos, QC, J9T 2L8, Canada*

⁴*Ministère des Forêts, de la Faune et des Parc du Québec, Centre de la Science de la Biodiversité, 880 Chemin Ste-Foy, Québec City, QC, G1S 2L2, Canada*

⁵*Corresponding author: E-mail: julie.faure-lacroix.1@ulaval.ca*

The limiting trade-off between expediency and accuracy is well exemplified by the monitoring of bats, more specifically since the onset of the White-Nose Syndrome in North America. Acoustic detection is a way of circumventing the difficulties of catching bats, and monitoring is usually done either with transects or fixed recording points, the latter generally being assumed to be superior. However, little has been done until now to assess each method's ability to maximize the quality of recordings and the number of species detected, to account for the temporal variability of bat activity, and to account for the variability in habitats and the spatial patterns of bat activity. We tested whether transects could yield similar results as fixed points for every of those aspects of accurate and reliable bat monitoring. We found it to be true for recording quality and the detection of peaks of activity, but found that either method was little affected by weather and landscape attributes. We conclude that the use of transects is a valid choice for long-term monitoring, as it performs comparably to fixed recording points and maximizes the number of detections per sampling unit. However, transects tend to record a greater proportion of migratory bats than fixed recording points, a bias which should be considered in the assessment of the state of particular species' populations.

Key words: echolocation, Chiroptera, monitoring, call identification, activity, transects, passive

Isolation and characterization of hyper-xylanase producing *Bacillus* spp. from faeces of the Indian flying fox (*Pteropus giganteus*)

J. DHIVAHAR¹, AMEER KHUSRO², PAUL AGASTIAN², and S. SUTHAKAR ISAAC^{1,3}

¹Research Department of Zoology, St. John's College, Palayamkottai - 627002, Tamil Nadu, India

²Research Department of Plant Biology and Biotechnology, Loyola College, Chennai - 600034, Tamil Nadu, India

³Corresponding author: E-mail: isaacsuthakar@gmail.com

In the present study, hyper-xylanase producing novel bacterial strains were isolated from faeces of the Indian flying fox (*Pteropus giganteus*). Considering the qualitative assay, off 27 bacterial isolates, three strains were observed to be the hyper producers of xylanase. The potent isolates were identified using biochemical as well as molecular characterization tools, and were categorized under *Bacillus* spp. Further, the production of extracellular xylanase was quantified up to 72 h using standard methodology. The hyper production of xylanase was observed in the order of *Bacillus amyloliquefaciens* strain LAA64 (998.32 ± 17.6 U/mL) > *B. methylotrophicus* strain DLA64 (937.89 ± 16.1 U/mL) and > *B. velezensis* strain DLLA28 (910.46 ± 14.5 U/mL) at 48 h of incubation period. Evidently, these novel strains were identified as promising source for xylanase yield. Xylanase represents one of the most important groups of industrial enzymes and thus xylanases obtained from *Bacillus* spp. suggest their wide applications in diversified industries.

Key words: xylanase, molecular characterization, faeces, *Pteropus giganteus*