

A new cryptic species of *Rhinolophus macrotis* (Chiroptera: Rhinolophidae) from Jiangxi Province, China

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A cryptic species of the big-eared horseshoe bat (*Rhinolophus macrotis*) was identified in Jiangxi Province, China, based on significant differences in echolocation frequencies and morphology. Consistent with the bimodal distribution of body sizes of *R. macrotis* specimens obtained from the same cave, we now consider this population to be comprised of two putative species; a large and a small form, with dominant echolocation call frequencies of 49 kHz and 65 kHz, respectively. Cytochrome *b* sequences of these two phonic forms diverged by 3.16–3.25%, a similar level of divergence to that between the large form and the outgroup, *R. rex* (3.33–3.77%). These differences strongly suggest that the two phonic forms are distinct species. We also found that the wing loading and aspect ratio of the small form was much lower than that of the large form, suggesting that the small form is capable of foraging in denser forest. Without dietary evidence, the ecological significance of the observed difference in echolocation call frequency between the two forms (16 kHz) remains unknown.

Key words: Chiroptera, *Rhinolophus*, genetics, cytochrome *b*, morphology, echolocation frequency

The systematic position of *Pteropus leucopterus* and its bearing on the monophyly and relationships of *Pteropus* (Chiroptera: Pteropodidae)

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Pteropus is the most speciose genus in Pteropodidae, currently comprising 65 species in 18 species groups. Here we examine whether *Pteropus* as currently understood is monophyletic. We sequenced three nuclear genes (RAG-1, RAG-2 and vWF) totalling c. 3.0 kbp from 18 species of *Pteropus* representing 12 species groups, plus *Acerodon celebensis* and megachiropteran outgroups representing all other subfamilies and tribes. Separate and combined parsimony and maximum likelihood analyses recovered a clade containing *Acerodon* as sister to all *Pteropus* species to the exclusion of the Philippine endemic taxon '*P. leucopterus*', rendering *Pteropus* paraphyletic. We propose the revalidation of *Desmalopex* Miller, 1907, an available generic name for *leucopterus*, adopting the name combination *Desmalopex leucopterus* (Temminck, 1853). We discuss implications of this result and anticipate further modifications of the classification of *Pteropus*.

Key words: Philippines, *Desmalopex leucopterus*, *Pteropus*, Megachiroptera, phylogeny

Phylogeography and predicted distribution of African-Arabian and Malagasy populations of giant mastiff bats, *Otomops* spp. (Chiroptera: Molossidae)

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Otomops martiensseni is sparsely distributed throughout sub-Saharan Africa and southwestern Arabia (Yemen). *Otomops madagascariensis* from the dry portions of Madagascar is widely recognised to be a distinct species. Based on mitochondrial DNA sequences of the cytochrome *b* gene (1,004 base pairs; $n = 50$) and the control region (D-loop, 290 base pairs; $n = 52$), two Oriental outgroup species (*O. wroughtoni* and *O. cf. formosus*) formed a monophyletic clade that was the sister group to the Afro-Malagasy taxa, composed of *O. martiensseni* and *O. madagascariensis*. Within the Afro-Malagasy clade, we discovered three well-supported but genetically similar clades (inter-clade genetic distances of 3.4–4.4%) from 1) north-eastern Africa and Arabia, 2) African mainland except northeast Africa, and 3) Madagascar. Taken together, haplotype networks, estimated divergence times, regional species richness and historical demographic data tentatively suggested dispersal from Asia to Africa and Madagascar. To understand ecological determinants of phylogeographic, biogeographic and genetic structure, we assessed the potential distribution of *O. martiensseni* throughout sub-Saharan Africa with ecological niche modelling (MaxEnt) based on known point localities ($n = 60$). The species is predicted to occur mainly in woodlands and forests and in areas of rough topography. Continuity of suitable habitats supported our inferred high levels of continental gene flow (relatively low genetic distances), and suggested that factors other than habitat suitability have resulted in the observed phylogeographic structure (e.g., seasonal mass migrations of insects that might be tracked by these bats). Based on a Bayesian relaxed clock approach and two fossil calibration dates, we estimated that African and Oriental clades diverged at 4.2 Mya, Malagasy and African clades at 1.5 Mya, and African clades 1 and 2 at 1.2 Mya. Integrating phylogenetic, phylogeographic, population genetic and ecological approaches holds promise for a better understanding of biodiversity patterns and evolutionary processes.

Key words: *Otomops*, mitochondrial DNA, phylogeography, Africa, Madagascar, ecological niche modelling

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Phylogeography of the Mediterranean horseshoe bat, *Rhinolophus euryale* (Chiroptera: Rhinolophidae), in southeastern Europe and Anatolia

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The mitochondrial genetic differentiation of the Mediterranean horseshoe bat, *Rhinolophus euryale* Blasius, 1853, was investigated in southeastern Europe and Anatolia. Mitochondrial DNA tRNA-proline and control region sequences were used for the analyses. As a result of the phylogenetic analyses, two reciprocally monophyletic clades were found with very high support. The results suggested that secondary contact after allopatric differentiation in separate glacial refugia, and subsequent range expansion was the best explanation regarding the evolutionary history of this species in the region. The geographical distribution of the haplotypes also suggested that the Balkans and the Black Sea could be representing refugia from which the region was populated. There also was evidence for population expansion following a pattern of isolation by distance, with geographically more distant samples also being genetically more differentiated.

Key words: Anatolia, Chiroptera, D-loop, ice age, mitochondrial DNA, phylogeography, *Rhinolophus*

**Wing morphology, echolocation calls, diet and emergence time of
black-bearded tomb bats (*Taphozous melanopogon*, Emballonuridae)
from southwest China**

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We studied the wing morphology, echolocation calls, diet and emergence time of the black-bearded tomb bat (*Taphozous melanopogon*) from May to October 2006 in Guangxi Province, southwest China. *Taphozous melanopogon* has wings with high aspect ratio, high loading and pointed wing-tip shape-characteristics associated with fast flight in open space. This species usually produces low-intensity, low frequency, and frequency-modulated (FM) calls usually containing up to four harmonics, with most energy in the second (or sometimes third) harmonic. The diet of this species consists mostly of Lepidoptera and Hemiptera. Timing of evening emergence is correlated with the time of sunset. This is the first study to describe the flight and echolocation behavior of this species in China, and opens the way for future studies of its biology.

Key words: flight morphology, echolocation calls, diet, emergence time, *Taphozous melanopogon*, southwest China

Habitat selection by Geoffroy's bats (*Myotis emarginatus*) in a rural Mediterranean landscape: implications for conservation

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Most of the little information available on the foraging ecology of the threatened Geoffroy's bat *Myotis emarginatus* refers to areas outside the Mediterranean Basin. In this study, we analysed habitat selection by this species in a typical Mediterranean landscape. We radio-tracked a breeding colony (adults and juveniles) in the Iberian Peninsula and analysed habitat selection patterns. Although we confirmed the species' preference for forest, olive groves also appeared an important foraging habitat for both adults and juveniles. Juveniles proved to be less mobile than adults, moving on average 1.6 km less than adults in displacements to foraging sites and preferred more accessible habitats. We highlight here the importance of traditionally managed olive groves as foraging sites for this threatened bat. The ripping-up of ancient olive groves and their replacement by intensively managed cropland, urban areas or shrubland represents a significant threat for this vulnerable species in Mediterranean landscapes.

Key words: *Myotis emarginatus*, Mediterranean, traditional farmland, juveniles, foraging, olives

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Swarming of *Myotis mystacinus* and other bat species at high elevation in the Tatra Mountains, southern Poland

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This paper reports a study of the visitation of bats to Great Litworowa Cave (1,907 m a.s.l., Tatra Mts., southern Poland) during summer and autumn 1999–2005. A total 5,608 bats representing 11 of Poland's 25 species were captured. *Myotis mystacinus* predominated. Its activity at all times was high. However, the species composition and number of other bats changed seasonally. Swarming activity lasted between July and November, peaking in late July and August. Nightly activity peaked between 22.00 and 02.00 hrs and then gradually decreased toward dawn. Strong male bias was observed. *Myotis mystacinus* showed regular changes in sex and age ratios. Rare species such as *M. bechsteinii*, *M. emarginatus*, and *Vespertilio murinus* were recorded. This cave is the highest locality of *M. bechsteinii* and *M. brandtii* in Europe. Some behavioural observations including copulation, drinking and daylight activity were recorded. The role of swarming activity is discussed in light of the findings. Some observations suggest that this activity of bats is connected with mating; some other observations provide evidence that the function of swarming is also to facilitate the location of mates and/or to assess suitable hibernacula.

Key words: elevational distribution, mountains, *Myotis*, Poland, swarming

Roost selection by non-breeding Leisler's bats (*Nyctalus leisleri*) in montane woodlands: implications for habitat management

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We investigated roost selection by Leisler's bat (*Nyctalus leisleri*) before and after hibernation in 2005 in a mountain area of southern Switzerland. The study area is dominated by deciduous trees and characterised by the presence of previously managed chestnut (*Castanea sativa*) orchards that are now partly abandoned. In March–May and August–October, 15 radio-tracked bats (seven males and eight females) used 28 roost trees. We analysed roosts used by *N. leisleri* at three different levels: (i) micro-scale: features of roost cavities; (ii) meso-scale: characteristics of selected roost trees and (iii) macro-scale: structure of woodland surrounding roost trees. Selection at meso and macro-scales was obtained comparing characteristics of roost trees and surrounding woodland with potentially available trees and woodlands. Bats roosted mainly in live chestnut trees, with large diameter and absence of vegetation near the entrance. Roost trees were located closer to streams, in woodlands with a higher percentage of sweet chestnut trees and a lower tree density than random trees. Multifunctional forest management in abandoned chestnut stands, comprising recreation (chestnut harvesting) and preservation of a semi-natural habitat and its related biodiversity, would recreate the traditional woodland features – in particular an open forest structure with low tree density and presence of ancient chestnut trees – and provide suitable roosting sites to migratory *N. leisleri*.

Key words: *Nyctalus leisleri*, chestnut stands, forest composition, roost selection, Switzerland

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Roosting requirements of white tent-making bat *Ectophylla alba* (Chiroptera: Phyllostomidae)

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Roosting ecology and its correlates are among the major forces driving the evolution of bats. However, roost ecology remains one of the most poorly understood topics on the basic biology of bats. *Ectophylla alba* is endemic to Central America with a very small distribution. This species generally modifies leaves of a certain size within the genus *Heliconia*. Here we explore this species' habitat preferences for the construction of its roosts. We identified three variables as the requirements of a suitable tent-building habitat: canopy coverage, understory coverage between 0–1 m of height, and density of *Heliconia*. Our results show that the process of habitat selection for roost construction is highly specialized to an intermediate stage of secondary succession, which in turn, makes *Ectophylla* even more vulnerable to extinction than previously believed.

Key words: Costa Rica, *Ectophylla alba*, habitat selection, Phyllostomidae, bat roost ecology, tent-roosting bats, conservation

Rediscovery, ecology, and identification of rare free-tailed bats (Chiroptera: Molossidae) in Costa Rica

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Five new specimens of the poorly known Sanborn's bonneted bat, *Eumops hansae* (Chiroptera: Molossidae), are reported for Costa Rica's central and northern Pacific lowlands based on a subadult male collected in 1990 and four adult females collected in 2003. We also report the second known specimen of *Eumops underwoodi* from Costa Rica and additional specimens of *Cynomops mexicanus*, *Eumops glaucinus*, *Molossus molossus*, and *Molossus pretiosus*. Most of the females captured in August and April were either lactating or pregnant, suggesting that parturition in these molossids occurs in the late dry season and the early to middle rainy season, periods when insects are especially abundant in this dry forest. Characters used previously to distinguish between the similar-sized *E. hansae* and *E. nanus* are evaluated, and external and cranial measurements for the specimens of *E. hansae* are provided. The best single character for distinguishing the two species is size and shape of the upper incisors. In *E. hansae*, the upper incisors are thin and recurved, whereas they are thick, straight, and slightly procumbent in *E. nanus*. The six sympatric species of free-tailed bat found in the gallery forest along the Río Enmedio vary in size, jaw thickness, and wing shape suggesting coexistence through resource partitioning in this molossid bat assemblage.

Key words: Costa Rica, Molossidae, bonneted bats, identification, *Eumops hansae*

The advertisement song of *Pipistrellus nathusii* (Chiroptera, Vespertilionidae): a complex message containing acoustic signatures of individuals

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Males of *Nathusius' pipistrelle* (*Pipistrellus nathusii*) are well known for their complex acoustic advertisement behaviour performed either as songflight (SF) or sedentary display (SD). We analysed phonologic, syntactic and semantic characteristics of these calls based on 2,924 acoustic records obtained from individual males repeatedly occupying 33 roosts in southern Bohemia from 1999 to 2006. Both SF and SD calls are composed of three main phonologically contrasting motifs (A, B, C) and under specific contexts often supplemented with two accessory motifs (D, E). Besides the major syntagmatic string ABC we recorded further 15 syntagms containing the main motif A and 10 syntagms without this motif. At the peak of the mating season and with the SD, the complexity of the vocalisation increases (increased variation in syntagmatic structure and syllabic composition of particular motifs, as well as in length of syntagmatic strings). The motif A corresponds to advertisement calls of congeneric species and is related to agonistic vocalisation, and B, C, D are specific for *P. nathusii*. B and C exhibit the largest between-individual but low within-individual variation, and their combination provides an acoustic signature of an individual and uniquely identified each particular male. Motif D corresponds to calls of mother-young communication and shows the largest syllabic variation. Motif E is a series of steep FM signals evocative of the act of landing. The message of a complete advertisement call (ABCED) could be thus: '(A): Pay attention, here is a *P. nathusii*, (B, C): I am male X, (E): land here, (D): we share a common social identity and common communication pool'. The individual characteristics of the performance of B, C, and D motifs were found to be invariant both within a season and over a series of successive years.

Key words: *Pipistrellus nathusii*, advertisement calls, individual recognition, vocalisation behaviour, phonology, semiotics

Identification of bat species in Greece from their echolocation calls

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Bats are the second most speciose order of mammals and are under significant threat throughout the world. Survey and monitoring of bats for conservation are severely hampered by the lack of a reliable and user-friendly method of identifying bats from their echolocation calls. We recorded and described time-expanded echolocation calls from 23 bat species in the National Park of Dadia-Lefkimi-Soufli, Greece. We compared the performance of quadratic and linear discriminant function analysis (DFA) of calls as a means of identifying species. Quadratic rather than linear DFA has been used by several researchers because of the violation of the method's basic assumption (homogeneity of variance-covariance matrices). However, when linear DFA was applied for the classification of recorded species in this study, correct classification rate was identical to the quadratic functions (82.4%) and linear models did not misclassify bats to the species with the greatest dispersion, the main problem caused by violation of the homogeneity assumption. The advantage of linear DFA is that it provides discriminant function coefficients. The linear combination of these coefficients and parameters from calls from unidentified bats can be used for species identification without access to the original data sets, an option not provided by quadratic analysis. When separate models were developed for *Myotis* species and for FM/QCF species, correct classification rates increased to 84.8% and 93.4%, respectively. DF coefficients thus provide a reliable identification tool, but intraspecific geographic variation must be taken into account.

Key words: spectral analysis, discriminant function analysis, Chiroptera, Greece

Precision and accuracy of flyout counts of the common bent-wing bat (*Miniopterus schreibersii*)

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Visual flyout count data for the common bent-wing bat *Miniopterus schreibersii*, collected by a team of observers over two seasons at a disused mine in the Kinglake National Park, south-eastern Australia, was compared with infra-red video footage, collected simultaneously, in order to quantify the precision and accuracy of the observer counts. Bayesian statistical models were used to evaluate the relationship between observer counts and the actual number of bats emerging from the cave, as determined by analysis of the infra-red video footage of the flyout. The accuracy of flyout counts was found to decline with increasing flyout rates, with observers' counts becoming increasingly negatively biased as the rate of bat emergence from the mine increased. In addition, there was evidence of inter-observer variation in the accuracy of the counts. Although the bias in observer counts was relatively small, caution needs to be exercised in interpreting the results of visual flyout counts. We conclude that the use of infra-red video footage for determining numbers is preferable to visual observer counts. The major difficulty in using flyout counts for monitoring is the considerable night-to-night variation in numbers of bats emerging, which could be attributed to variation in the proportion of bats emerging to forage, or to the use of alternative roosting sites by individual bats on successive nights. Both observer error and short-term temporal variation in numbers of emerging bats have the potential to bias population estimates of bats, and need to be properly accounted for if flyout counts are to be used as a tool for population assessment and monitoring.

Key words: Australia, Bayesian model, flyout count, insectivorous bat, *Miniopterus schreibersii*, population assessment, survey protocol, Vespertilionidae

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Evaluation of morphological indices and total body electrical conductivity to assess body composition in big brown bats

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Bat researchers have used both morphological indices and total body electric conductivity (TOBEC) as proxies for body condition in a variety of studies, but have typically not validated these indices against direct measurement of body composition. We quantified body composition (total carcass lipids) to determine if morphological indices were useful predictors of body condition in big brown bats (*Eptesicus fuscus*). We also evaluated body composition indirectly by TOBEC using EM-SCAN® technology. The most important predictors of body composition in multiple regression analysis were body mass-to-forearm ratio (partial $r^2 = 0.82$, $P < 0.001$) followed by TOBEC measurement (partial $r^2 = 0.08$, $P < 0.001$) and to a minor extent head length (partial $r^2 = 0.02$, $P < 0.05$). Morphological condition indices alone may be adequate for some studies because of lower cost and effort. Marking bats with passive integrated transponder (PIT) tags affected TOBEC measurements.

Key words: Chiroptera, body condition indices, body mass, Colorado, *Eptesicus fuscus*, fat, lipid deposition, TOBEC

Epididymal sperm storage in Rickett's big-footed bat (*Myotis ricketti*)

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Spermatozoa were present in the cauda epididymidis of male Rickett's big-footed bat, *Myotis ricketti*, from late September to early April but absent from the testes from mid November until late August. Males thus store spermatozoa in the cauda epididymidis for 4.5–6.5 months of the year. Assessments of sperm motility, movement pattern and computer-assisted sperm analysis (CASA) were carried out on spermatozoa which had been stored for over 3.5 months in the cauda epididymidis. The motility of sperm stored for the same period of time and taken from a male which died over 9 h before assessment was 86%. Four kinds of culture media were screened for their suitability for future studies of sperm motility, and a low calcium minimal capacitation medium and a hamster fertilization medium were selected. Serum testosterone (T) concentration increased dramatically in September and began to fall in October, before returning to baseline for the remainder of winter. These results indicate that high levels of T are required for spermatogenesis and spermiogenesis but not for sperm storage.

Key words: sperm storage, sperm motility, movement pattern, CASA, testosterone

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SHORT NOTES

**Use of leaves as roosts by the Gervais' fruit-eating bat, *Artibeus cinereus*
(Phyllostomidae: Stenodermatinae) and proposed modifiability index**

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Key words: Artibeus cinereus, roost, tent-making, leaf, Venezuela

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SHORT NOTES

Temperature and humidity differences between roosts of the fruit bat, *Rousettus aegyptiacus* (Geoffroy, 1810), and the refugia of its ectoparasite, *Afroscimex constrictus*

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Key words: Pteropodidae, *Rousettus*, Heteroptera, blood feeding, *Cimex*, habitat preference

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SHORT NOTES

Rudimentary finger claws in a flower-visiting phyllostomid bat

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Key words: evolution, Glossophaginae, *Lonchophylla robusta*, Pteropodidae, wing anatomy