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## **A new species of *Mops* (Molossidae) from Pemba Island, Tanzania**

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The bats of Pemba are poorly known, but recent surveys have provided material to critically examine the species that occur on this island, roughly 50 km off the coast of Tanzania. A new species of *Mops* (Molossidae) is described from Pemba and aspects of its distinguishing characteristics from other molossids and habitat are discussed. This new species differs from the type of *M. brachypterus* by lacking basisphenoid pits. The form *brachypterus* needs critical review.

*Key words:* Molossidae, *Mops*, new species, morphology, habitat, Pemba Island, Tanzania

## **Variation of mitochondrial DNA in the *Hipposideros caffer* complex (Chiroptera: Hipposideridae) and its taxonomic implications**

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The Afrotropical leaf-nosed bat *Hipposideros caffer* has been traditionally regarded as a complex of populations, currently pertaining to two recognized cryptic species, *H. caffer* and *H. ruber*. Extent of distribution and morphological variation of these bats has raised concerns over whether the current perception of the complex reflects true phylogenetic relationships and taxonomic diversity. Our phylogenetic analysis of nucleotide sequences of the mitochondrial cytochrome *b* gene challenged the hypothesis of two cryptic species. Instead of the two reciprocally monophyletic lineages expected, corresponding to the two species, we recovered four distinct lineages with deep internal divergences. Two sister clades within a lineage of bats of *H. caffer* represent respectively the nominotypical form *H. c. caffer*, restricted to Southern Africa, and *H. c. tephrus*, inhabiting the Maghreb, West Africa and the Arabian Peninsula. Geographical isolation and deep genetic divergence suggest species status of both the forms. Another lineage comprises specimens of both morphotypes from West and East Africa. It probably represents a distinct species but its taxonomic assignment remains obscure. A Central African lineage of *H. ruber* comprises two sister clades, which become sympatric in Cameroon. Their status has to be clarified with additional evidence, since nuclear gene flow might be taking place. A further divergent lineage with *H. ruber* morphotype, most probably representing another distinct species, is restricted to West Africa. Although all three genetic forms of *H. ruber* may correspond to named taxa, their proper taxonomic assignment has to be assessed by comparison with type material.

*Key words:* Africa, *Hipposideros caffer*, *H. ruber*, leaf-nosed bats, cryptic species, cytochrome *b*, molecular systematics, phylogeny

## **Genetic diversity and phylogeography of the greater mouse-tailed bat *Rhinopoma microphyllum* (Brünnich, 1782) in the Levant**

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The greater mouse-tailed bat (*Rhinopoma microphyllum*) possesses a large geographical range, covering most of the arid and warm areas of the Old World. We studied the genetic variability of this species using two mitochondrial markers (the cytochrome *b* gene and the control region), from several Israeli colonies and from over most of the species' range. Our results show that the cytochrome *b* sequences, unlike those of the control region, are too conserved to separate among *R. microphyllum* populations. Based on the control region sequences, a high level of sequence similarity was found within the Israeli population. Three clades were observed over the species' range: Oriental, Intermediate and Palaeartic. This division supports most of the traditional taxonomy of the species. The Israeli population, which belongs to the Palaeartic clade, was found to be isolated from the Oriental and Intermediate clades. We suggest that the colonization of the greater mouse-tailed bat in the Levant occurred from African populations during the late Pleistocene, when many Saharan plants and animals penetrated the northern part of the Great Rift Valley.

*Key words:* genetic diversity, mtDNA, *Rhinopoma microphyllum*, Levant

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## **A new species of tube-nosed bat *Murina* (Vespertilionidae, Chiroptera) from Vietnam**

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A new species of *Murina* is described from Lam Dong province, Vietnam. The new form is a very small tube-nosed bat with a forearm length less than 30 mm. Externally it looks similar to *Harpiola isodon* from which it is well differentiated by teeth shape. From other small *Murina* species the new species can be defined by pelage coloration and texture, longer nasal tubes, dark skin on muzzle and smaller anterior upper premolar. Provisional analysis of mitochondrial DNA sequence also supports its species status. This species is known only from mountainous forests of the Da Lat plateau.

*Key words:* *Murina*, new species, Vietnam, taxonomy, skull morphology

**A taxonomic review of *Rhinolophus stheno* and *R. malayanus*  
(Chiroptera: Rhinolophidae) from continental Southeast Asia: an evaluation  
of echolocation call frequency in discriminating between cryptic species**

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The taxon *Rhinolophus microglobosus* is elevated to specific rank on the basis of clearly defined morphometric and acoustic characters which differentiate it from *Rhinolophus stheno*. It is recorded from Cambodia for the first time. *Rhinolophus malayanus* exhibits considerable geographical variation in echolocation calls, with apparently two phonic types: a northern population with lower frequency calls and a predominantly southern population with higher frequencies. However, this acoustic divergence is not reflected in any morphometric divergence, and the taxonomic status of the two phonic populations remains unclear. Discriminating characters of all three species are given, together with distribution data and short ecological summaries. The value of echolocation as an indicator of cryptic species and the zoogeographical implications of the study are briefly discussed.

*Key words:* *Rhinolophus microglobosus*, *R. malayanus*, *R. stheno*, taxonomy, echolocation, zoogeography, Southeast Asia

## **Systematic review of small fruit-eating bats (*Artibeus*) from the Guianas, and a re-evaluation of *A. glaucus bogotensis***

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We studied molecular and morphological variation in small fruit-eating bats (*Artibeus*) in northern South America to establish species boundaries, evolutionary relationships, and distributional limits. Although this is a speciose genus with some of the most common bats in Neotropical forests, resolution of taxonomy and their identification has been difficult. Our molecular phylogeny based on Bayesian and parsimony analyses of cytochrome *b* variation includes a well supported topology of *A. glaucus glaucus* sister to a clade of *A. gnomus* and *A. glaucus bogotensis* indicating that *A. glaucus* is a paraphyletic amalgam. A re-assessment of morphology corroborates differences between *A. g. bogotensis* from the Andean valleys of Colombia east into the Guianas and *A. g. glaucus* from western Amazonia. Thus, we recognize *A. bogotensis* and *A. glaucus* as distinct and allopatrically occurring species. Based on a Kimura-2 parameter model of substitution for cytochrome *b*, there was 1.2% sequence divergence within *A. bogotensis*, and 9.5% sequence divergence between *A. bogotensis* and *A. glaucus*. Compared to *A. glaucus*, *A. bogotensis* has prominent white facial stripes, a less hirsute interfemoral membrane, less robust orbitorostral region, and also lacks a small third lower molar. Within the Guiana region, there are three species with overlapping distributions (*A. bogotensis*, *A. cinereus*, and *A. gnomus*), however, they are sympatric only within the interior lowland forest near savannas. All other habitats including coastal forest, lowland forest, savanna, and highland forest have only two sympatric species, one of which is relatively more abundant (> 70%).

*Key words:* cytochrome *b*, Guyana, morphometrics, Phyllostomidae, Suriname

## **Taxonomic history of the genus *Anoura* (Chiroptera: Phyllostomidae) with insights into the challenges of morphological species delimitation**

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A surge in new species descriptions must be accompanied by an equal amount of healthy skepticism. Herein, we critique the current approach to species delimitation for the genus *Anoura* and assess the methodology used in these studies. It is not uncommon for studies committed to the delimitation of species to incur in a mismatch between their underlying epistemological perspective and the nature of species as real entities or ontological individuals. This is the reason why these studies must capitalize on the statistical paradigm to ascertain the degree of vagueness upon their particular approximation to real or purportedly real species. It is common for species to have fuzzy boundaries and numerous sources of variation. Furthermore, as multi-organismal entities, species deserve a more cautious action to their delimitation than purely verbal descriptions from the point of view of a single observer. We highlight the need for quantifiable methods that provide clear perspectives on the magnitude of overlap and variability within and among species. We argue that the delimitation of complex entities as evolutionary species must be framed under the paradigm of hypothesis testing and measurable and concrete estimates of character states. Quantitative hypothesis testing should be a requirement for the practice of systematics, taxonomy and species delimitation. Species are not mind constructs but complex ontological individuals awaiting discovery by means of precise statements of uncertainty.

*Key words:* *Anoura*, morphology, species descriptions, species boundaries

## **Analysis of twinning in flying-foxes (Megachiroptera) reveals superfoetation and multiple-paternity**

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Published records of twinning and superfoetation in monotocous wild mammals are rare. Flying-foxes (Pteropodidae, Megachiroptera) occasionally produce twin offspring, fraternal twins, as well as superfoetation twins. Superfoetation occurs where a foetus is conceived when there is a foetus already developing. The resultant twins may be months apart in developmental stages so that one twin is usually born prematurely. Here, we review the current literature available on twinning and superfoetation in flying-foxes, and describe nine occurrences of multiple conceptions in Australian *Pteropus* species. Differences in sex and age of offspring clearly showed that most resulted from simultaneous or serial ovulations, not zygote splitting, thus excluding monozygous twinning. Additionally, an example of superfoetation is genetically analysed using six highly polymorphic microsatellite loci, to show multiple-paternity of superfoetation twins. Multiple births by flying-foxes are rare, leading the authors to conclude that the polyovulation constraint theory, found in the Microchiroptera, is not applicable in flying-foxes. The rare occurrence of additional ovulations do not usually produce additional live offspring. Post-ovulatory constraints, including the extra energetic demand twins place on a female flying-fox, are implicated in preventing successful production of multiple offspring.

*Key words:* superfoetation, flying-foxes, *Pteropus*, twins, volant mammal

## **Diet and prey selection in Mehelyi's horseshoe bat *Rhinolophus mehelyi* (Chiroptera, Rhinolophidae) in the south-western Iberian Peninsula**

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We studied diet and prey selection in Mehelyi's horseshoe bats *Rhinolophus mehelyi* in the south-western Iberian Peninsula, during the breeding seasons of 2003, 2006, and 2007. Faecal pellets were collected individually and arthropod fragments identified to family level, where possible. Arthropod availability was assessed using Malaise traps. Selection analyses were performed using Compositional Analysis and a Chi-square goodness-of-fit test. The bulk of the diet of *R. mehelyi* consisted of Lepidoptera, representing more than the 80% of the consumed volume on average (excluding juveniles), and more than 90% of the average percentage occurrence. This pattern was consistent across localities. Neuroptera and Tipulidae were locally abundant. Other important prey categories were Chrysomelidae, Brachycera, and Chironomidae. ANOVA tests showed that there were no significant differences between males and females in consumed prey categories, whereas juveniles consumed significantly less Lepidoptera than adults. Lepidoptera was the first prey category in the preference rank, followed by Myrmeleontidae, Chrysopidae and Tipulidae, and all of these were consumed more than expected by chance. This work shows that *R. mehelyi* is a moth specialist and suggests that juveniles may acquire this strategy while gaining hunting experience. Given the similarities in echolocation call characteristics and diet in the sibling *R. mehelyi* and *R. euryale*, they may compete for trophic resources in sympatry. Nevertheless, subtle differences in wing morphology between both species are probably large enough to permit spatial resource partitioning.

*Key words:* *Rhinolophus mehelyi*, diet, prey selection, Lepidoptera, south-western Europe

## **Fishing behaviour in the long-fingered bat *Myotis capaccinii* (Bonaparte, 1837): an experimental approach**

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To study the fishing behaviour of *Myotis capaccinii*, we performed an experiment in a flight tent containing an artificial pond. We recorded the behaviour of two groups of bats — eight individuals from two different roosts — using IR video camcorders and ultrasound detectors, and evaluated diet by analyzing faeces. Nightly, increasing amounts of fish were released in the pond. Our data show that *M. capaccinii* is able to exhibit fishing behaviour when fish occur in high densities in shallow waters, gaffing live fish from the water using their hind feet. They were attracted neither by dead fish floating, nor by ripples made by fishes feeding on the water surface. Bats showed a specific fishing behaviour with two main foraging patterns: A) long series of circular flights, skimming along the water and dipping in softly twice or three times in each roundabout; B) long figure-eight loops with bats flying faster and higher, swooping down on the centre of the pond, where they snapped their hind feet hard into the water. Compared with the echolocation calls used to catch insects from the water's surface in the wild, terminal buzzes were incomplete during the dips made to fish. Buzz II were always lacking, and buzz I had much longer inter-pulse intervals. This suggests that they were not pursuing specific targets but dipping randomly. We propose a scenario in which fishing behaviour occurs in the wild, linked to the seasonal drought of small ponds, marshes, or channels where large numbers of small fish become readily available and thus a profitable resource.

*Key words:* fishing behaviour, foraging, evolution, bats, *Myotis capaccinii*

## **Fringe for foraging? Histology of the bristle-like hairs on the tail membrane of the gleaning bat, *Myotis nattereri***

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Many bats are specialized to detect and capture arthropods from vegetation. As echoes from sitting arthropods and vegetation background overlap strongly, it is difficult for those bats to detect prey by echolocation alone. Within the largest genus of bats, *Myotis*, at least three species from different sub-clades show a characteristic fringe of hairs on the trailing edge of their uropatagium. All three species are capable of gleaning arthropods from vegetation with this tail membrane. Phylogenetic analyses strongly suggest that these specializations evolved convergently. Therefore, one can hypothesize that the hairs at the rim of the tail membrane have an important tactile and/or mechanical function for gleaning prey from substrate. To assess this question, we used light microscopic techniques to investigate the morphology and innervation of the bristle-like hair fringe, and for comparison, the structure of sensory mystacial vibrissae in *Myotis nattereri*. The results revealed that the fringe possesses two types of hair: larger guard hairs and smaller vellus hairs. Both hair types are well innervated underneath their sebaceous glands. They are encircled by a piloneural complex, which functions as a stretch and tension receptor. Although the bristle-like hairs are clearly not vibrissal follicle-sinus-complexes, their position, morphology and innervation strongly support a sensory function for prey detection and capture. An additional mechanical function, e.g., brushing prey off substrate, is plausible.

*Key words:* convergent evolution, follicle-sinus complex, guard hairs, musculus uropataginalis, *Myotis nattereri*, uropatagium, vellus hairs, vibrissae

## **The aerodynamics of big ears in the brown long-eared bat *Plecotus auritus***

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Wings are the most obvious adaptation bats have for powered flight and differences in wing morphology are known to correlate with flight behaviour. However, the function(s) of ancillary structures such as the ears and tail, which may also play an important role during flight, are less well understood. Here we constructed a simplified model of a bat body with ears based upon morphological measurements of a brown long-eared bat (*Plecotus auritus*) to examine the aerodynamic implications of flying with large ears. The forces and moments produced by the model were measured using a sensitive 6-component force and torque balance during wind tunnel testing. The large ears of the model bat produced positive lift as well as positive drag of the same order of magnitude. At small ears angles (0° to 10°), increasing the angle of the ears resulted in an increase of the lift-to-drag ratio. At higher ear angles (> 10°) separation of the flow occurred which caused a large decrease in the lift-to-drag ratio produced. To maximise the benefit from the ears (i.e., lift-to-drag ratio) our model predicts that a horizontal free flying *P. auritus* should hold its ears at an approximate angle of 10°. The results of the pitching moment coefficient are inconclusive in determining if the large ears are important as flight control structures. The additional drag produced by the ears has consequences for the foraging behaviour of *P. auritus* with reductions in its flight speed and foraging range.

*Key words:* Chiroptera, flight, ear, aerodynamics, *Plecotus auritus*

## **Roosts and activity areas of *Nyctinomops macrotis* in northern Arizona**

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Female big free-tailed bats *Nyctinomops macrotis* have been captured over water in northern Arizona in high elevation (> 2,400 m) forests and low elevation (1,500 m) desert scrub vegetation. We hypothesized that roost sites were in vertical walls of cliffs that were up to 25 km away from capture sites given the flight capability of these bats. During summer 2005 we captured eight females over ponds and attached radio transmitters to locate day roosts. We also identified locations used during nightly movements from 1 to 6 nights of radio tracking. We found three day roosts for seven bats; average distance ( $\pm$  SE) from a capture site to a roost was  $12.1 \pm 3.0$  km. Roosts were small maternity colonies used by  $\geq$  four *N. macrotis* in cracks or crevices in upper portions of vertical cliffs and faced south or southeast. Average dimensions for ponds where we found *N. macrotis* were  $24 \times 46$  m, larger than the average pond size ( $14 \times 19$  m) where we did not capture this species. We identified 73 night locations for five *N. macrotis* and for one individual with 32 night locations calculated a 95% activity area (minimum convex polygon method) of 29,590 ha. Straight line distance between successive locations averaged  $5.1 \pm 0.8$  km. Maximum distance detected from roost averaged  $25.3 \pm 4.9$  km. We conservatively estimated a maximum flight speed of 61 km per hour. Most locations were in desert scrub vegetation but three bats moved to higher elevations, using pinyon-juniper (*Pinus edulis-Juniperus* spp.) woodland and ponderosa pine (*Pinus ponderosa*) forest. The maternity roosts we located for *N. macrotis* were remote, difficult to access, and within protected areas (national parks) in northern Arizona; however, foraging areas and ponds used for drinking are managed by different public or private agencies. These features are not as well protected and could be critically important in this arid environment.

*Key words:* Arizona, big free-tailed bat, minimum convex polygon, movement, *Nyctinomops macrotis*, radio telemetry, roost

## **Bats select buildings in clearings in Białowieża Primeval Forest**

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Species dominance structure and selection of buildings by bats were studied during the breeding season in areas surrounding the well-preserved stands of Białowieża Primeval Forest (BPF), potentially offering an abundance of tree cavities. Searches for bats were carried out during daylight hours and at evening emergence. Thirty eight of the 238 buildings surveyed from May to August, 2002 were used by 708 bats. Only three of the 12 resident species of bats occupied buildings, amongst these *Vespertilio murinus* and *Eptesicus serotinus* were the most common, found in 16 and 15 buildings, respectively. *Pipistrellus pygmaeus* was located in two buildings. This suggests that limited access to old-growth forests (potentially rich in tree cavities) may not be a crucial factor leading to the occupation of buildings by those species. Selection of buildings by bats was further investigated by comparing 14 characteristics of those buildings occupied by bats to those unused. Six of these characteristics were shown to have a significant influence. Using Akaike's Information Criterion (AICc), the most important categories for selection were roof lining and building size. This would suggest that the criterion for the selection of buildings by these species is based not only on its location but on these key structural attributes.

*Key words: Eptesicus serotinus, Vespertilio murinus, roost selection, conservation*

## **The influence of riparian vegetation on the distribution and abundance of bats in an African savanna**

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Riparian habitats are known to be important for bats across the world, however this is largely unstudied in Africa. We investigated the community structure of bats in riparian areas and the surrounding savanna landscape in Swaziland's lowveld using mist nets and a harp trap. We found riparian sites overall had higher bat activity, diversity, species richness and abundance. One species (*Epomophorus wahlbergi*) accounted for 52.6% of captures. Seasonality had no effect on overall captures, nor did distance from nearest riparian habitat for savanna sites. Echolocation guilds were correlated with vegetation characteristics, with CF (constant frequency), FM (steep frequency-modulated) and FM-QCF (broadband FM) bats more frequently captured at sites with denser undergrowth than QCF (quasi-constant frequency or narrowband FM) bats; conversely, QCF bats were more frequently caught at sites with lower canopy cover than other bats. Our findings suggest that although bats discriminate between microhabitats, they do not respond to larger-scale habitat features in the way that other taxa, such as birds, are found to. In conclusion it appears that riparian areas are important foraging sites for bats within African savannas.

*Key words:* community structure, riparian forest, savanna, Swaziland, Africa

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## **Bat diversity in tropical forest and agro-pastoral habitats within a protected area in the Philippines**

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Parks and other protected areas in tropical forests often include secondary forest, cropland, and pasture. Documentation of the impact of such anthropogenic disturbance is essential for effective management. We re-sampled bats within Mount Isarog Natural Park (MINP), a protected area in southeastern Luzon, Philippines, seventeen years after a survey in old- and second-growth forest and in agro-pastoral areas was conducted in 1988. By employing harp traps and a tunnel trap, in addition to mist nets as used in the earlier study, we aimed to document species previously undetected by mist netting alone. We documented 26 bat species, seven of which were captured exclusively in harp traps, and two that were only captured in a tunnel trap. This survey resulted in nine new records of bat species for MINP, bringing the total number to 30. We did not recapture four species documented in 1988, all of which were noted in that study as uncommon. Nineteen species were captured in agro-pastoral areas on the south slope, including two *Hipposideros* spp. not captured at the forested sites.

*Key words:* agriculture, altitudinal gradient, fragmentation, Hipposideridae, re-sampling, Rhinolophidae, Vespertilionidae

## **Long-term change in an assemblage of North American bats: are eastern red bats declining?**

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We examined changes in the assemblage of bats in southern Lower Michigan, USA, using results of paired netting surveys conducted with similar techniques but separated by 12–26 years. Species diversity declined by 18–35% and evenness decreased by 0–35% throughout the region and in two specific areas. Changes in diversity and evenness were attributed primarily to decreases of 44% or more in relative abundance of the foliage-roosting eastern red bat (*Lasiurus borealis*). Number of *L. borealis* captured per net-night decreased 52–85%. The decline in relative abundance of *L. borealis* suggested by mist netting was supported by a 10-fold decrease over 38 years in the proportion of *L. borealis* that were tested for rabies by the state health laboratory. The apparent decline in *L. borealis* is especially alarming in light of the recent upsurge in use of wind power and the large number of *L. borealis* that are killed at such developments. We recommend that other previously completed surveys in eastern North America be duplicated, as one way of helping to confirm or refute the trend that we have identified.

*Key words:* assemblage, bat, diversity, evenness, *Lasiurus borealis*, long-term change, Michigan

## **An experimental test of gating derelict mines to conserve bat roost habitat in southeastern Australia**

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Management of derelict mines to improve subterranean bat habitat and minimise safety risks to the unsuspecting public is occurring more frequently. Many caves and mines around the world have had gates placed at mine and cave entrances as a means of maintaining bat habitat and preventing human access, but there have been few replicated experiments to test their effectiveness. We experimentally tested a staged installation of a template gate at two mines while monitoring another two un-gated derelict mines in southeastern Australia. We recorded changes in numbers, behaviour and the relative species abundance of two bat species (*Rhinolophus megaphyllus* and *Miniopterus schreibersii*) before and after the gates were installed. The template gate (20 mm diameter plastic tubing) was installed in three stages, with the initial horizontal bar spacing at 450 mm, followed by a spacing of 300 mm and a final spacing of 125 mm. Bat numbers and behaviour were largely unaffected by bar spacings of 450 mm and 300 mm. The major findings were that immediately after the installation of bars at the final spacing (125 mm gap), numbers of bats declined significantly and a significant increase in the number of aborted exit and entry flights was observed. Detectors proved to be inadequate at quantifying changes in the relative abundance of species. Eleven days after the final installation there were no significant differences between the numbers of bats leaving gated and control mines, suggesting bats had learnt to negotiate the bars after a short period of time. However, flight behaviour was still affected after habituation, especially baulking at the structure when bats attempted to re-enter before dawn. The low replication of mines in the experiment warrants caution in extrapolating this result. Until further gating experiments are carried-out, we recommend site specific monitoring whenever mines are gated.

*Key words:* *Rhinolophus megaphyllus*, *Miniopterus schreibersii*, derelict mine, gates, experiment

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SHORT NOTES

**Flying-fox (Megachiroptera: Pteropodidae) flight altitudes determined via  
an unusual sampling method: aircraft strikes in Australia**

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*Key words:* altitude, flying fox, height, migration, wildlife strike

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SHORT NOTES

**Mistakes in the formation of species-group names for Neotropical bats:  
*Micronycteris* and *Sturnira* (Phyllostomidae)**

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*Key words:* *Micronycteris*, *Sturnira*, original spellings, nomenclature, Phyllostomidae