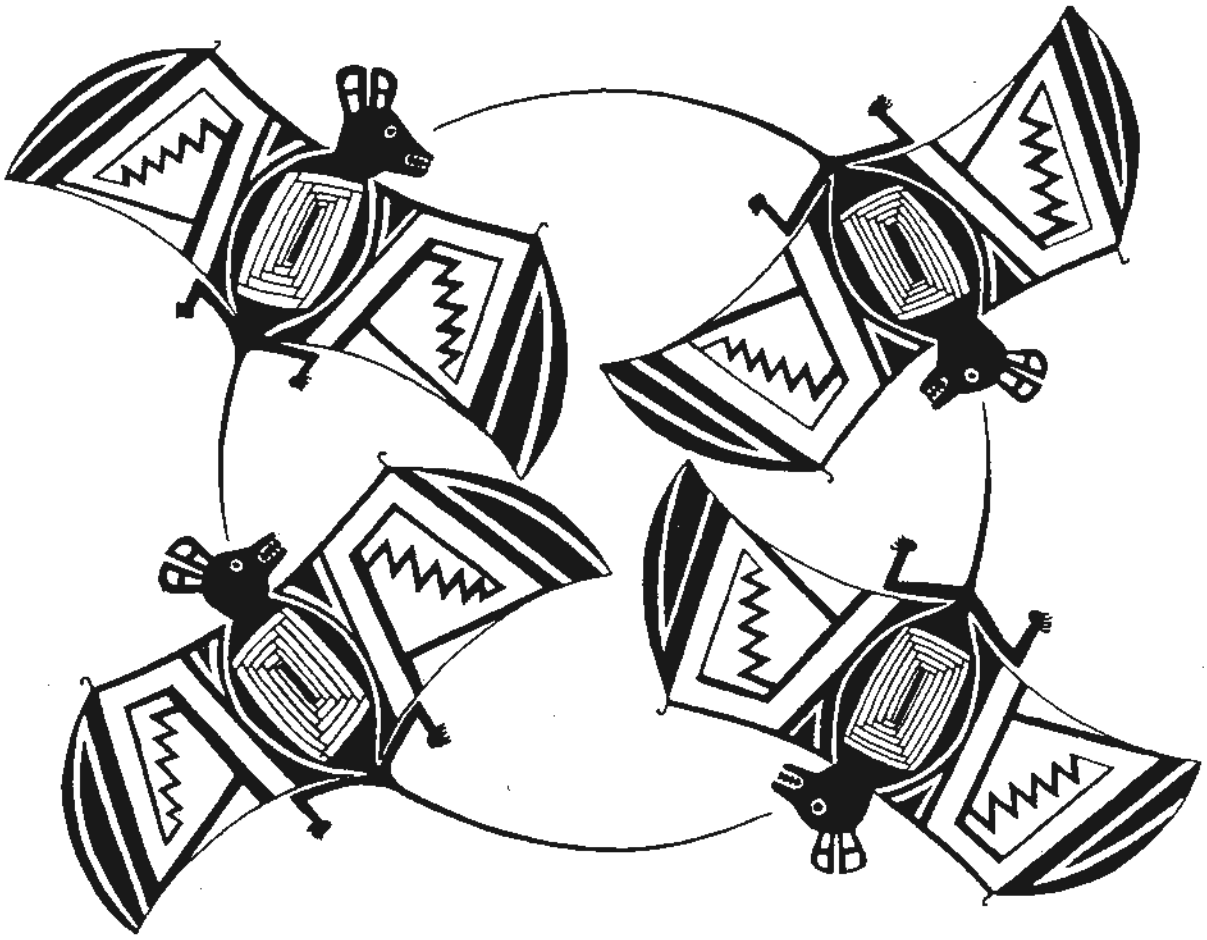
BAT RESEARCH NEWS



Volume 37: No.1 Spring 1996

BAT RESEARCH NEWS

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Subscriptions to institutions are $ 25.00 per volume(year).

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Bat Research News is: ISSN 0005-6227
United States Internal Revenue Service tax exemption number 16-1356633

Bat Research News is printed and mailed at:
Potsdam College of the State University of New York,
Potsdam, NY, 13676, U.S.A.

BAT RESEARCH NEWS

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Front Cover

The front cover is the logo used for the Four Corners Regional Bat Conference adapted from a pre-Columbian Indian motif.

BAT RESEARCH NEWS

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Original Issue Compiled by Dr. G. Roy Horst, Publisher and Managing Editor of *Bat Research News*, 1996.

Bat Research News is ISSN # 0005-6227.

BAT RESEARCH NEWS

Volume 37: No. 1 Spring 1996

A NON-LETHAL METHOD OF TISSUE SAMPLING FOR GENETIC STUDIES OF CHIROPTERANS

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ABSTRACT

The most common methods of obtaining samples for genetic studies of chiropterans, (blood sampling, toe clipping and muscle biopsies) have a number of ethical and technical disadvantages. Here we describe a biopsy punch technique for sampling wing and tail membrane from chiropteran species. This method yields sufficient good quality, high molecular weight DNA for most standard molecular genetic analyses based on polymerase chain reaction (PCR). The technique is quicker and simpler than traditional methods, can be easily carried out in both field and captive environments and is applicable to all chiropteran species regardless of size.

Genetic techniques have proven valuable for addressing questions in population, evolutionary and conservation biology. Recent technical advances (particularly the development of the polymerase chain reaction, or PCR) have reduced the amount of tissue required to provide sufficient template DNA, and non-destructive sampling methods can now be used.

For the study of chiropterans, a method of sampling wing and tail membrane has now been developed. This method has been used in genetic studies of at least eight species of microchiropterans, which range in size from the 5 g pipistrelle bat *Pipistrellus pipistrellus* (Barrett et al.'95) to the 150 g ghost bat *Macroderma gigas* (Worthington Wilmer et al.,'94) and five species of megachiropterans. Other microchiropteran species sampled using the new method include the noctule bat *Nyctalus noctula* (Mayer, '95), the mouse eared bat, *Myotis myotis* (Petri, et al., '95), the whiskered bat, *Myotis mystacinus* Nemeth and von Helversen, '93) the brown long-eared bat, *Plecotus auritus* (T. Burland, pers. comm.), the orange horseshoe bat, *Rhinonicteris aurantius*, (Worthington-Wilmer) and the greater horseshoe bat, *Rhinolophus ferrumequinum*, (G. Jones and R. Ransome pers. comm.). Those megachiropterans sampled are four species of *Pteropus: P. vampyrus* - the large fruit bat, *P. hypermelanus* - the island fruit bat, *P. rodricensus* - the Rodrigues fruit bat and *P. pumilus* - the little golden-manteled fruit bat and 1 species of *Cyanopterus: Cyanopterus brachyotis* - the dog faced fruit bat (K. Clark, pers. comm.). The method has been licensed by the Countryside Commission for Wales, the British Home Office, English Nature and Scottish Natural Heritage, under the provisions of the U.K. Wildlife and Countryside Act, 1981.

Tissue biopsies are taken from the plagiopatagium and tail membrane (uropatagium) using a sterile punch (Stiefel Laboratories). The diameter of the punches available ranges from 2mm - 8mm, the size used is determined by the size and wing area of the bat species being studied. For example, Barratt et al. ('95) used a 3mm punch for the pipistrelle work, while Worthington Wilmer et al. ('94) used a 5mm to sample ghost bats, *Macroderma gigas*. In some species, the plagiopatagium can contain a number of parallel muscle bundles - the plagiopatagiales muscles - which run vertically through the wing (Yalden and Morris, 1975). In these cases the biopsy site is selected from a region of the plagiopatagium that contains few or no visible blood vessels and, if they are present, the muscle strips. Sampling over the muscle strips will increase the final yield of DNA. (Of all the examples cited in this paper the ghost bat, *Macroderma gigas*, was the only bat species where these muscles were visible. The vespertilionid and rhinolophid species were sampled through membrane only. The wing is spread over a firm surface until the membrane is taut, the biopsy is then taken by pressing down the punch. For species which have fine wing membranes, such as *Pipistrellus pipistrellus*, this will be sufficient for taking the biopsy. For other species that have thicker

and stronger wing membranes, such as *Macroderma gigas* and pteropids, twisting the biopsy punch may be necessary to aid in taking the sample cleanly. If the biopsy site is chosen carefully, avoiding any veins, then no bleeding will occur. A single biopsy is taken from each wing of each bat. The biopsy punches are placed in a 1.5 mL tube containing 1 mL of tissue preservative buffer comprising 20% DMSO (dimethyl sulphoxide) solution saturated with salt (6M NaCl) and can be stored at room temperature (Amos and Hoelzel, '91). The sample will either be left on the cutting surface or be pushed up the punch cylinder (in this instance, it can be easier to remove the sample if the punch is first dipped in the tissue buffer). Collect the sample with a pair of fine forceps and place in the storage tubes.

To avoid cross contamination, use a new punch for each bat. The cutting surface onto which the biopsy is taken should also be swabbed with ethanol between each bat, as should all instruments used to handle the tissue. Not only do these precautions prevent cross contamination of the samples, but have the added advantage of reducing the risk of passing infection between bats.

Genomic DNA is extracted from the wing punches by first finely chopping the tissue with scalpel blades. The chopped tissue is then placed in 500 µl DNA extraction buffer (50 mM Tris-HCl, pH 8.0; 100mM NaCl; 5mM EDTA) containing 25 µl 20% SDS (sodium dioceyl sulphate) and 25 µl 10 mg/mL proteinase K and then incubated overnight at 55°C. DNA is then isolated from this using either the standard procedures of phenol-chloroform extraction and ethanol precipitation (Berger and Kimmel, '87) or salt-chloroform extractions (Müllenbach et al., '89). The amount of DNA that can be extracted from these wing punches will vary according to the size of the biopsy taken. For example, the average yield of genomic DNA from two 5mm punches taken from a ghost bat was approximately 47 µg. While Petri et al. ('95) recorded that one 3mm punch from the tail membrane of Myotis myotis yielded approximately 15 µg of genomic DNA. Pemberton and Robinson ('89) have also extracted DNA from tail membrane samples from a dead serotine bat (*Eptesicus serotinus*). Sample sizes ranged from 1mm2 to 8mm2, with yields of 0.08µg to 33µg DNA, respectively.

Many bat species have been caught in the wild with large tears in the wing membrane, without any observable impairment of flight capacity. Holes resulting from biopsies taken in the manner outlined above have been observed to heal with 4 weeks in a number of bat species: *M. gigas* (Figures 1A - 1E), *P. auritus* and *R. ferrumequinum*. In the case of *R. ferrumequinum*, complete healing occurred, for some of the juveniles samples, within two weeks during the summer (G. Jones and R. Ransome pers. comm.) Sampled *Macroderma* and *Rhinolophus* have been observed the following season in the same roost sites and reproductive behavior does not seem to be inhibited. For examples, a female *P. auritus* sampled in May was observed subsequently in July completely healed and with healthy offspring (T. Burland pers. comm.).

On the basis of extensive experience and collected evidence, we do not believe this technique to be detrimental to the welfare of the bats and in comparison to more traditional sampling methods such as toe clipping and muscle biopsies (e.g. Wilkinson and Chapman, '91) is simpler, quicker and more humane. One factor that must be taken into consideration when sampling temperate-zone bats is that the wing's healing capacity is reduced just prior to hibernation and so punch holes may be slow to heal. It is therefore recommended that for temperate zone bats, if tissue healing is to be rapid, the preferred sampling time be between April and September. Furthermore, depending on the license conditions, it is advisable to use great care when sampling heavily pregnant females or those with newborn offspring.

ACKNOWLEDGMENTS

We would like to thank Gareth Jones, Roger Ransome, Tamsin Burland, Barbara Petri and Freider Mayer for kindly providing information about their field sampling experiences. We would also like to thank Les Hall, Gareth Jones and Tamsin Burland for helpful comments on the manuscript.

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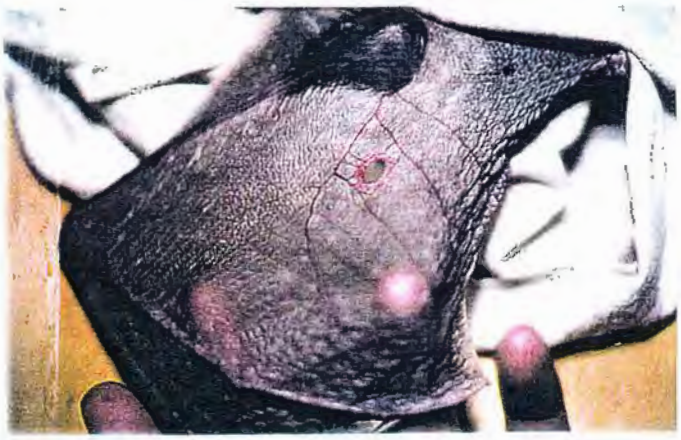
A.

B.

C.



D.

E.

Figures 1A - 1E. Photo series showing the healing process of *Macroderma gigas* wing following sampling using the biopsy punch method. 1A - Immediately after the sample has been taken. 1B - 1E the biopsy site 1, 2, 3 and 4 weeks respectively following sampling. Note that by week 4 the hole was completely healed.

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Helminth Parasites of Bats from the Neotropical Region of México

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Introduction

México is considered to be "megadiverse" because of the species richness of its flora and fauna. This richness is the result of the convergence of two biogeographical zones in this region--the Nearctic and Neotropic--together with a variety of ecosystems resulting from a complex topography and geological history. Méxican territory possesses 10% of the 4,332 extant species of mammals (Arita and León, 1993). Considering only chiropterans, 15.1% (136) of the 900 species worldwide are found in the country (Ramírez-Pulido and Castro -Campillo, 1993). However, helminth parasites of this group of organisms have been scarcely studied, and the few papers available deal mainly with a few species inhabiting the tropical part of the country, below the Neovolcanic Transverse Axis. In this paper, we compiled, updated, and analyzed the information available on helminth parasites of bats from the Neotropics of México.

Methods

To accomplish the goal of this paper, we made an extensive bibliographical search, looking for reports about helminth parasites of bats from the Méxican Republic. In addition, we used an earlier summary (Lamothe et al., 1996) of information found in the Colección

Helmintológica, Instituto de Biología, Universidad Nacional Autónoma de México .

Results and Discussion

To date, 32 species of helminth have been reported from 16 species of bats (Table 1). It is remarkable that 12 of the 13 papers that have been published about this topic deal exclusively with the taxonomic description of a particular species of helminth and do not indicate the complete helminth fauna associated with different bat species. Interestingly, bats studied were collected at localities in 12 of the Méxican states found in the Neotropics. Nematodes and digeneans were best represented, with 17 and 13 species, respectively; the digenean genus *Prosthodendrium* (Lecithodendriidae) reached the highest species richness with five collected from four bat species. One of these helminths, *P. macnabi*, has a Nearctic distribution, and the other four are endemic to the Neotropics of México. This high percentage of endemism is also noticeable when we consider all helminth species recorded from bats from Neotropical México; 40.6% (13) of the helminths are endemic, 31.2% (10) have a wider Neotropical distribution, 9.3% (3) have primarily a Nearctic distribution, and 6.2% (2) inhabit the entire American continent and other parts of the world.

The diversity of this helminth fauna, as we said before, must be the result of the mixture of populations due to the convergence of both biogeographical zones. The variety of habitats in the Méxican territory and the establishment of permanent and isolated populations of chiropterans in this area, together with the high proportion of endemic invertebrate species that serve as intermediate hosts for helminths, may have contributed to speciation events in nine of the 17 genera.

The richest helminth fauna was found in two bat species--*Tadarida brasiliensis*, harboring five species (four digeneans and one nematode; Caballero, 1940, 1942a, 1943a), and *Natalus stramineus* (=Natalus mexicanus), harboring nine species (four digeneans and five nematodes; Caballero, 1942, 1943a; Chitwood, 1938). We assume that these bat species were studied more widely (records in each case were from at least three different localities) and more intensively (probably because of the larger number of hosts examined). Studies on helminths of bats from México are very scarce, as we mentioned previously; helminths from only 17 of the 136 species of bats recorded in the entire country (12.5%) have been reported. Considering the high chiropteran diversity of México, we still are far from knowing how many species of helminths parasitize them, and there likely are many undescribed species. In this paper, we report an average of almost two helminth species per bat species. Thus we can hypothesize that, if all species of bats in the country (136) are examined for helminths, we might find approximately 272 species. If the same proportion of endemism continues (40.6%), there could be 109 undescribed species of helminths. This emphasizes that biodiversity studies should include members of the microfauna, if a complete inventory is to be produced.

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Table 1. Helminth parasites of bats from Neotropical México. Abbreviations for helminths are D=Digenea, C=Cestoda, and N=Nematoda; an asterisk indicates an endemic species. Localities are given as Mexican states or districts, such that D.F.=Distrito Federal, Edo. Mex.=Estado de México, and S.L.P.=San Luis Potosi.

Host	Helminth Species	Locality	Reference
EMBALLONURIDAE			
Balantiopteryx	*Prosthodendrium paeminosum* (D)*	Puebla	Caballero, 1943b
	Prosthodendrium tetralobatum (D)*	Puebla	Caballero, 1943b
	Rictularia nana (N)*	Puebla	Caballero, 1943c
MOLOSSIDAE			
Tadarida brasiliensis	*Ochoterenatrema labda* (D)	D.F.	Caballero, 1940, 1943a
	Prosthodendrium scabrum (D)*	D.F.	Caballero, 1940
	Urotrema scabridum (D)	Edo. Mex.	Caballero, 1942a
	Paralintoshius tadaridae (N)*	D.F.	Lamothe et al., 1996
MORMOOPIDAE			
Pteronotus davyi	*Vampirolepis elongatus* (C)	Jalisco	García-Vargas et al., 1996
	Capillaria sp. (N)	Jalisco	García-Vargas et al., 1996
Pteronotus parnellii	*Limatulum gastroides* (D)	Jalisco	García-Vargas et al., 1996
	Maxbraunium tubiporum (D)	Hidalgo	Caballero y Zerecero, 1942
	Websternema parnelli (N)	Jalisco	García-Vargas et al., 1996
NATALIDAE			
Natalus mexicanus	*Limatulum limatulum* (D)	Edo. Mex.	Caballero, 1943a
	Ochoterenatrema labda (D)	Edo. Mex.	Caballero, 1943a
	Plagiorchis muris (D)	Edo. Mex., D.F.	Caballero, 1943a
	Prosthodendrium emollidum (D)*	D.F.	Caballero, 1943a
	Urotrema scabridum (D)	D.F.	Caballero, 1942a
	Capillaria martinezi (N)*	D.F.	Caballero, 1942b
	Seuratum cancellatum (N)*	Yucatán	Chitwood, 1938
	Tricholeiperia caernegiensis (N)*	Yucatán	Chitwood, 1938
	Tricholeiperia pearsei (N)*	Yucatán	Chitwood, 1938
PHYLLOSTOMIDAE			
Artibeus jamaicensis	*Vampirolepis elongatus* (C)	Jalisco	García-Vargas et al., 1996
	Bidigiticaudata vivipara (N)*	Yucatán	Chitwood, 1938
	Litomosoides sp. (N)	Yucatán	Chitwood, 1938
	Litomosoides sp. (N)	Jalisco	García-Vargas et al., 1996
Artibeus lituratus	*Bidigiticaudata vivipara* (N)*	Guanajuato	Lamothe et al., 1996
	Litomosoides sp. (N)	Jalisco	García-Vargas et al, 1996
Artibeus phaeotis	*Vampirolepis elongatus* (C)	Veracruz	Gracía-Prieto, 1986
Artibeus toltecus	*Litomososides brasiliensis* (N)	Veracruz	Lamothe et al., 1996
Carollia perspicilliata	*Litomososides carollidae* (N)	S.L.P.	Caballero, 1944
Desmodus rotundus	*Biacantha sp* (N)	Colima	García-Márquez, 1985
	Biacantha desmoda (N)	Jalisco	García-Vargas, 1996
Glossophaga soricina	*Litomosoides hamletti* (N)	Yucatán	Chitwood, 1938
	Linustrongylus pteronoti (N)	Jalisco	García-Vargas, 1996
Macrotus waterhousii	*Limatulum limatulum* (D)	Oaxaca	Caballero and Barvo, 1950
	Limatulum aberrans (D)*	Oaxaca	Caballero and Barvo, 1950
	Litomosoides leonilavazquezae (N)*	Guerrero	Caballero, 1939
Micronycteryx megalotis	*Capillaria sp.* (N)	Yucatán	Chitwood, 1938
Trachops cirrhosus	*Tricholeipeira leiperi* (N)	Chiapas	Lamothe et al., 1996
VESPERTILIONIDAE			
Lasiurus cinereus	*Prosthodendrium macnabi* (D)	D.F.	Caballero y Zerecero,1951
	Prosthodendrium scabrum (D)*	D.F.	Caballero, 1943a

Helminth Parasites of Bats (Mormoopidae and Phyllostomidae) from the Estación de Biología Chamela, Jalisco State, México.

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Introduction

The region of Chamela, in southwestern México, represents a biological reserve in which the Biology Institute of the National Autonomous University of México (U.N.A.M.) has a field station with a protected area of 16 km^2. Seventy species of mammals have been recorded in the reserve, and 23 of them are members of the order Chiroptera (Ceballos and Miranda, 1986). During an ecological study of seed-dispersion by small mammals in the area, those organisms that died during the capture procedures were analyzed for parasites. The goal of this paper is to report the helminth species found during that survey and to discuss briefly their presence in different bat species, with respect to the host feeding habits.

Methods

The Estación de Biología Chamela is a reserve of tropical deciduous and semi-deciduous forest, located at approximately 19° 30' N, 105° 03' W, less than 2 km from the Pacific coast, in the municipality of La Huerta in the State of Jalisco (Bullock, 1986). A total of 31 bats, representing six different species, was captured between March 1993 and May 1994, using mist nets set in both deciduous and semi-deciduous forest. Bats were dissected, and their organs (liver, spleen, lungs, stomach, and intestine) and body cavity were examined for helminths. Helminths recovered were processed with routine techniques for taxonomic determination. Digeneans and tapeworms were stained with Delafield's hematoxylin and mounted on slides using Canada balsam. Nematodes were cleared with Amman's lactophenol and mounted on semi-permanent slides. Representative helminth specimens were deposited in the Colección Helmintológica, Instituto de Biología, U.N.A.M. (Table 1), and chiropteran skins and skeletons, in the Colección Mastozoológica of the same Institute.

Results

Six bat species belonging to two families were examined--*Pteronotus davyi* and *P. parnellii* (Mormoopidae), and *Artibeus jamaicensis, A. lituratus, Desmodus rotundus,* and *Glossophaga soricina* (Phyllostomidae). We collected 122 helminths, representing 7 species, from the intestine and body cavity of 10 of the 31 bats analyzed. These consisted of one digenean (*Limatulum gastroides*), one tapeworm (*Vampirolepis elongatus*), and five nematodes (*Websternema parnelli, Biacantha desmoda, Linustrongylus pteronoti, Capillaria sp.* and *Litomosoides sp.*). The most abundant helminth was *V. elongatus,* with 64 specimens. Three bat species (*Pteronotus davyi, P. parnelli,* and *Artibeus jamaicensis*) harbored two helminth species each, whereas the other three bat species harbored only one (Table 1).

Discussion

The tropical deciduous and semi-deciduous forests of Chamela represent new locality records for all helminth species mentioned herein. Four of these helminth species are recorded for the first time from México (*L. gastroides, W. parnelli, B. desmoda,* and *L. pteronoti*). Previously, García-Prieto (1986) described the presence of *V. elongatus* in *Artibeus phaeotis,* from the tropical rain forest of Los Tuxtlas, in Veracruz State. Four species of *Litomosoides* have been described previously from various sites in México (Chitwood, 1938; Caballero, 1939, 1944; Lamothe et al., 1996). In addition, Caballero (1942) described *Capillaria martinezi* from *Natalus mexicanus* and Chitwood (1938) found *Capillaria sp.* in *Micronicteryx megalotis* from Yucatán. We were unable to assign our specimens of *Litomosoides* or *Capillaria* to species because we collected few of them, and they were in very poor condition. This is the first extensive survey of helminth parasites of bats from México, and all helminths recovered are taxonomically determined. Whether these species represent the entire helminth community of each bat species, or only a subset of it, should be determined by further research. We recommend examining a larger number of hosts and doing this at different times during all seasons (dry and wet).

Feeding habits have been mentioned as one of the main factors that determine parasite

diversity and abundance in different host species. In our work, we found that the insect-eating bats (*Pteronotus davyi and P. parnelli*) harbored two helminth species, whereas the bats that did not consume insects generally had one. We considered the presence of the cestode *V. elongatus* in the fruit-eater *Artibeus jamaicensis* an accidental infection, because we only found three specimens of this worm in the intestine of *A. jamaicensis*; we assumed that the bat became infected when it fed upon some fruit with an insect moving on it. The 64 specimens of this same cestode in *P. davyi* suggested that this worm may be more common in insect-eating bats, but obviously, more work is needed to confirm this.

Acknowledgments

We thank Miguel A. Briones and Julia Pérez, Laboratorio de Mastozoología, Instituto de Biología, U.N.A.M., for collecting and providing us the hosts for this study. We would also like to thank Felipe Noguera, Chief of the Estación de Biología, for his permission to collect at the station. Funds for this research were provided in part by the program PAPIIT-UNAM (No. IN201593) to GPPL.

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Table 1. Helmith fauna of bats from the tropical deciduous forest of Chamela, Jalisco, México. Numbers following the names of the bats indicate the number of individuals examined over the number infected. Numbers following helminth names indicate the total number of helminths recovered. Accession numbers refer to specimens deposited in the Colección Helmintológica at the Instituto de Biología, U.N.A.M.

Host	Helminth	Site of Infection	Accesion Number
MORMOOPIDAE			
Pteronotus davyi (3/1)	Vampirolepis elongatus (64)	Intestine	002623
	Capillaria sp. (1)	Intestine	002616
Pteronotus parnellii (4/2)	Limatulum gastroides (4)	Intestine	002613
	Webstermema parnelli (10)	Intestine	002615
PHYLLOSTOMIDAE			
Artibeus jamaisencis (10/1)	Vampirolepis elongatus (3)	Intestine	002622
	Litomososides sp. (2)	Body cavity	002621
Artibeus lituratus (1/1)	Litomosoides sp. (2)	Body cavity	002624
Desmodus rotundus (10/5)	Biacantha desmoda (12)	Intestine	002617
Glossophaga soricina (3/1)	Linustrongylus pteronoti (4)	Intestine	002614

A Source of Error in Measuring Temperature of Tree Roosts

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Introduction

Temperature has a pervasive effect on growth, reproduction, and other energetic parameters, and consequently, it is the most frequently measured, environmental variable. Published work on the temperature of bat roosts predominantly focuses on colonial species occupying either buildings or cavelike structures. This undoubtedly is related to the ease of locating such structures, as well as the ability of biologists to enter the roosts along with the bats. However, there is an increasing amount of study on bats living in tree hollows or under bark--roosts that are essentially inaccessible to humans (Barclay and Brigham, 1996). Recording temperatures within these natural roosts often requires positioning the sensing end of a thermocouple (or thermistor) in the roost area and then stretching the remaining wire, down the surface of the trunk, to a more accessible recording unit. Unlike equipment within sheltered attics or barns, these thermocouples are now potentially exposed to solar radiation.

Christian and Tracy (1985) point out that exposing the sensing junction of a thermocouple to direct solar radiation results in an erroneous reading, and they also show that this error can be minimized by covering the sensing junction with white paint. Inserting the sensor inside a tree cavity or hiding it beneath exfoliating bark could, of course, take care of this problem as well. Baaken and Kunz (1988), however, suggest that errors may arise even though the sensing junction itself is adequately shaded; they note that if the rest of the thermocouple is exposed, the wires theoretically could be warmed by solar radiation and the resulting heat passed to the shaded sensing junction by conduction. The purpose of the present study is to quantify the effects of solar heating on thermocouple wires and to determine whether painting the wires, beyond the sensing junction, can reduce any error that might be present.

Methods

Type T thermocouples were made from a single spool of 20-gauge wire (EXPP-T) purchased from Omega Engineering (Stamford, CT), a common North American supplier. The external insulation on this wire was made from polyvinyl and was dark blue in color. The sensing junction was made by twisting the bare ends of the copper and constantan wires together for 5 mm and soldering the joined ends. The sensing junction and the adjacent 0, 15, 30, or 45 cm of insulated wire were then sprayed with a flat, white paint (Zynolyte, Speed-E-Namel).

To simulate actual conditions, I measured the temperature of three pieces of dry, barkless wood--a cedar post, a pine post, and a split piece of elm wood. After drilling a 2.5-cm-deep hole into the wood, I inserted the thermocouple and sealed it in place by filling the remaining space with a white latex caulk (Macco, Super Caulk) that was allowed to dry before proceeding. Twenty different thermocouples, equally divided among the four treatments (different lengths of paint), were used with each piece of wood; this resulted in 60 temperature measurements overall. The position of the thermocouples along the length of the wood was randomly determined, as was the order of measurement. Thermocouple leads were connected to a digital thermocouple thermometer (Omega Engineering, HH-25) for the actual temperature measurements.

Temperature measurements were made in early August, on three different days, one for each piece of wood. On each day, measurements were delayed until there was no discernible wind or cloud cover; consequently, measurements commenced at 1150, 1200, and 1620 hours for the cedar, pine, and elm, respectively. Ambient temperatures on these days varied from 30 to 31.5 °C during the measurements.

Data were subjected to a two-way analysis of variance (wood type and painted length), followed by a multiple comparison test on the main effect of interest--length of paint (Duncan's Multiple Range Test; 0.05 protection level). The main effect of "wood type" was used simply to minimize the error term, by controlling for inherent differences among the blocks of wood, as well as variation caused by differences in time of day and ambient temperature.

Results

The analysis of variance (mean square error = 0.48) indicated significant differences

among wood types ($F=97.58$; d.f.=2, 48; $p<0.0001$) and among treatments ($F=76.12$; d.f.=3, 48; $p<0.0001$), but there was no significant interaction ($F=1.91$; d.f.=6, 48; $p=0.10$). The multiple comparison test revealed that thermocouples without paint had the highest temperature. There was no significant difference among the 15, 30, or 45 cm treatments, but all painted thermocouples read significantly lower than the unpainted group. The main-effect mean for unpainted thermocouples was 42.1 °C; main-effect means of the painted thermocouples were 38.9, 39.1, and 38.9 °C, for 15, 30, and 45 cm of paint, respectively. Means and errors terms for each treatment are given in Table 1.

Discussion

My results indicate that exposing thermocouple extension wires to direct sunlight can affect the resulting temperature reading, even though the sensing junction itself is shielded. There is as much as a 4 °C difference between mean temperatures of painted and unpainted thermocouples within wood types (Table 1), and such large differences would significantly impact one's estimates of metabolic rates and other energetic parameters. My results also show that such errors can be minimized by covering at least 15 cm of the wires adjacent to the sensing junction with white paint.

Nevertheless, it is important to realize that the magnitude of these errors is likely dependent on a number of factors that will vary from situation to situation. Type, color, and thickness of insulation, as well as gauge of the wire, could affect the final reading. Angle of the sun (time of day and year), cloudiness, and wind velocity are also likely to play a role, and consequently, the magnitude of the error will not be constant over time. Investigators that intend to monitor roost temperatures behind bark, in tree cavities, or in similar exposed situations should consider performing a pilot study to determine the extent of these errors and possible remedies that are specific to their equipment and location. In addition, infrared radiation may have effects that were not considered in this study.

Acknowledgment

This study was partly funded by Eastern Michigan University, through a Graduate School Research Support Award to A. Kurta and R. Foster.

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Table 1. Temperatures recorded by thermocouples painted for varying lengths. Each mean was based on measurements from five thermocouples.

Block	Painted Length (cm)	Temperature (mean, S.E. °C)
Pine	0	42.7, 0.23
"	15	39.3, 0.34
"	30	40.4, 0.23
"	45	39.7, 0.44
Elm	0	43.4, 0.07
"	15	40.0, 0.37
"	30	40.1, 0.48
"	45	39.5, 0.27
Cedar	0	40.9, 0.40
"	15	37.4, 0.16
"	30	36.9, 0.21
"	45	37.5, 0.22

A New Longevity Record for *Myotis yumanensis*

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In late June 1995, 17 eager students of biology had the privilege of studying the behavioral ecology of bats and nocturnal birds under the direction of Brock Fenton, Mark Brigham, and Robert Barclay, with occasional, but valuable, cameo instruction from James Fullard. The course was held at the University of British Columbia Geology Field Station, in the Okanagan Valley, British Columbia.

On the evening of 30 June, while mist netting near the south weir of McIntyre Bluff, close to Oliver, B.C. (49° 10' N, 199° 37' W), we captured 76 bats, most of which were female and many of which were pregnant or lactating. Two of these were banded female bats: a *Myotis lucifugus* with a red band and a *Myotis yumanensis* with a yellow band. No numbers were visible on the red band. However, on the yellow band the numbers 023 could be made out with confidence. These colors and numbers correspond to the banding protocol of a study conducted on these two species, in this area, in 1982 (Herd and Fenton, 1983). Both bats were lactating and were released shortly after capture.

Upon consultation with Robert Herd (pers. comm.), we learned that these bats were originally banded after being caught in a Tuttle trap. The *M. yumanensis* was from a colony roosting within the wall of a cabin at the Gallagher Lake Motel, not far from our own capture site (R. Herd, pers. comm.). Unfortunately, we could read only three of the four numbers on the band of the *M. yumanensis*, so the condition under which it was originally banded was unknown. From what is known, this bat must have been born in 1981 or earlier, making her at least 14 years old! The longevity record of 34 years for *Myotis lucifugus* (Davis and Hitchcock, 1995) remained untouched by these recaptures, but the previous record of 8 years for a female *M. yumanensis* (Cockrum, 1973) can be replaced by this new record of 14 years.

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Letters to the Editor

Editor's Note. Unlike technical articles, letters are not peer-reviewed, but they are edited for grammar, style, and clarity. Letters provide an outlet for opinions, speculations, anecdotes, and other interesting observations that, by themselves, may not be sufficient or appropriate for a technical article. Letters should be no longer than two manuscript pages and should be sent to the Feature Editor. This is an area where the editors would like to see a much greater rate of communication. We are especially interested in short communications about a single noteworthy event or observation which of itself would not be the basis of a publication. If you have a modification of some more widely used technique, or suggestions about how to make some process more efficient, pass it along to us so that all of us might share in its benefits. We will even on occassion, even accept a "sounding off" letter about how something is being done, including constructive comments about Bat Research News. GRH

Fur-clipping Prior to Radiotransmitter Attachment

As with any study asking questions about the natural behavior of animals, it is always important to assess the impact of attaching or implanting devices used to measure such behavior. It is thus important to conduct studies like that of Dobkin et al. (1995) that assess the effect of fur-clipping before radiotransmitter attachment. Their study recently appeared in Bat Research News (36:18-20).

I am writing because I feel that some extra caution may be needed in the manner that their results are interpreted. I agree with the authors general assertion that the results must be viewed with caution in light of their low sample sizes. However, Dobkin et al. state, "The data clearly indicate that gluing transmitters directly to fur does not preclude extended retention". Given the low sample sizes and the fact that there were no statistical differences in retention time between clipped an unclipped bats, such a statement is premature. I encourage them or others to continue such studies and provide more definitive evidence.

Also, in regard to their interpretation of data presented in Brigham and Fenton (1986, Can. J. Zool., 64:1128-1133), several points need to be made. In a cursory look at papers published since 1986, it is true that most do not give information about whether or not the fur was clipped. This information would be useful in light of the data presented by Dobkin et al. In addition, although Fenton and I did not present the information in our paper, a preliminary study and previous work in the same lab (Geggie and Fenton, 1985, Can J. Zool., 63:263-267) suggested that clipping fur increased the time transmitters remained attached to *Eptesicus fuscus*. I surmise that this is for three reasons. First, the cement we used (Skin-Bond) is designed as a skin adhesive and as such should adhere best to skin. Dobkin et al., in contrast, used "eyelash cement" that may act differently. Second, fur that gets "frosted" onto the transmitter likely pulls on the bat's skin as the animal flies, potentially causing discomfort and alteration of natural activity patterns, and third, *Eptesicus* has relatively oily fur that makes the adhesive adhere less well.

This last point suggests that the best attachment technique may vary among species. I believe that the degree of oiliness of the fur, fur length, and perhaps fur thickness may influence whether clipping should be done or not. *Antrozous* has short (about 6 mm) interscapular hairs that may make clipping less necessary. *Plecotus* (now *Corynorhinus*) has longer hairs (8-9 mm), but they are very fine, woolly, and dry. In contrast, *Eptesicus* has long (8-9 mm) hairs that are thick and oily, as mentioned. The density of fur on *Antrozous* also appears to be much less than that of the others, although this has not been quantified. In short, there are interspecific differences that need to be evaluated when deciding to clip or not to clip.

Suggesting that the time it takes to clip the fur is a significant reason not to do so may be a "red herring." If, in some species, attachment time does prove to be longer after fur is clipped, then the 2 - 3 minutes that clipping takes is probably time well spent. I usually hold

bats at least 30 minutes for processing and waiting for the glue to dry, and several, extra minutes is unlikely to have a significant impact. Forcing a bat to carry a transmitter for days or weeks is much more likely to have a negative effect on the animal than the short time it takes to attach the transmitter.

In conclusion, a thorough study of this question would be useful. However, until that study is done, I feel that suggesting an avoidance of fur-clipping for all species, may be a bit premature.

I gratefully acknowledge Dave Nagorsen (Royal British Columbia Museum), who provided me with the descriptions of bat fur.

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Demonstrating Echolocation: a New Tool for Educators

For many years, the bat detector has been a useful teaching aid that allows one to passively demonstrate the existence of the ultrasonic calls of bats. However, with the use of an ultrasonic mobility device for the blind, such as the Sensory 6, an audience can actually be given an opportunity to transmit ultrasonic waves and to avoid objects by detecting the pattern of waves that return. Unlike bat detectors, these ultrasonic devices, allow people to experience echolocation from the bat's point of view. The Sensory 6 comes with a rechargeable battery and a base unit that houses the device's electronics. The transmission frequency is a steady 50 kHz. The range can be set for short or long distances, depending on the size of the area that one is working in. For example, the short range is 1-6 feet, and the long range is 1-12 feet. The detection pattern is 25 degrees horizontally and 15 degrees vertically. The weight of the equipment is an important consideration, especially when working with children, but for the Sensory 6, it is a mere 300 grams.

The standard Sensory 6 comes with a stereophonic headset, as well as transmitters and receivers that are mounted on eyeglasses. However, if a single instrument is to be used by a large number of people, it is best to request that the manufacturer modify the unit so that the transmitters and receivers are mounted on the base unit. Such a modification eliminates the possibility of transmitting bacteria or viruses ("pink eye") that may become associated with the glasses. It also eliminates an uncomfortable weight that must be carried on the head and makes it easier to "blind" the subject by placing a dark, cloth sack over the head.

The purchase price for the device, with transmitters and receivers mounted on the base unit, is $895 U.S. However, the price will be reduced to $845 U.S. if 5-9 devices are ordered at one time and $795 U.S for 10 or more. If you are already interested in purchasing the Sensory 6 from having seen its demonstration at the 10th IBRC in Boston, or if you wish additional information, please contact me by telephone: (404) 624-5618, FAX: (404) 627-7514, or e-mail: pszoode@prism.gatech.edu.

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NEWS From Texas Tech University, Lubbock, TX

Robert D. Owen and his lab are currently working on various bat research projects. The main focus of his research involves an intensive survey of the mammals and their ectoparasites from temperate-subtropical Paraguay, a project funded by NSF with Michael R. Willig as co-PI. He is also working with Cornelio Sánchez-Hernández and Ricardo López-Wilchis on a survey of mammals and their zoogeography in Michoacán, México, also funded by NSF. Several of the people working in Dr. Owen's lab have research projects ongoing with bats.

Dr. Javier Juste-B. is a post-doctoral associate from Spain who is starting his second year of a grant from the Spanish government. His research at Texas Tech will focus on patterns of fluctuating asymmetry, size, and sexual dimorphism in *Rousettus, Eidolon,* and *Myonycteris* populations from the islands of the Gulf of Guinea in western Africa. Other research interests include systematics, evolution, and conservation of bats from west and central Africa and southwest Europe. Contact Dr. Juste-B. via internet email (BCJJB@ttu.edu).

Lorinda Gordon is involved with the Michoacán project, surveying Phyllostomid bats and their parasitic spinturnicid mites. She is identifying parasite-host associations and correlating these associations with biogeographic and abiotic factors using GIS applications.

Stephen Kasper is mainly concerned with the morphometrics and phylogenetic analysis of the bat tribe *Myotini*, and with a study of the morphometric systematics of North American *Tadarida brasiliensis*. Also, two other research projects, coordinated by Dr. Owen and in collaboration with Dr. Wieslaw Bogdanowicz of the Mammal Research Institute in Poland, include: a landmark-based morphometric study of evolutionary shape change in the bat family Hipposideridae; and a discrete-state phylogenetic analysis (based on morphological and karyotypic characters) of the bat tribe *Plecotini*, which was presented at the recent International Bat Research Conference.

Cilia López-González is in Paraguay until August conducting field work for the survey portion of the Paraguay project. Upon her return, she will be working on the zoogeography of these mammals and their ectoparasites, and she will use GIS applications to analyze the relationships among the mammals. Celia is also analyzing aspects of fluctuating asymmetry in the documented hybrid zone of *Uroderma bilobatum* from Central America.

Steven Mezik is working with meiotic karyotypes of mammals. He is investigating the utility of this type of karyotype as a tool for mammalian systematics.

Michael R. Willig and his lab are currently involved in several field projects dealing with bats from various localities in Latin America. An extensive survey of bats and their associated ectoparasites is currently being conducted in Paraguay in collaboration with Robert D. Owen. An intensive study of the population biology and community ecology of bats in the Reserva Mbaracayu of eastern Paraguay is planned also. The effects of deforestation on bat community composition is under investigation in the state of Pará, Brazil (Florista Nacional de Tapajos). The last three summers have been spent conducting an extensive survey of Puerto Rico to determine the distribution and status of *Stenoderma rufum*, which is under consideration for listing as a sensitive species. The results of this work will also produce a book on the distribution, ecology, systematics, and conservation of Puerto Rican bats in collaboration with Michael Gannon and Armando Rodriguéz-Duran. Current museum projects include: systematics of the *Tonatia bidens* complex, microgeographic morphological variation of the bats of Puerto Rico, and various aspects of sexual size dimorphism in bats from Brazil. Several research projects are currently incorporating simulation analyses to evaluate latitudinal correlates of alpha and beta diversity, geographic range size, and higher order taxonomic units such as genera and families. Lastly, a collaborative study addressing the comparative analytical biogeography of Caribbean bats is being conducted with Hugh Genoways.

(news from Texas Tech continued)

Steven Cox, a doctoral student, is evaluating site fidelity of *Stenoderma rufum* in the Luquillo experimental forest in Puerto Rico. His primary research interests are in functional diversity.

Michael J. Cramer, a masters student, currently is involved in assessing the applicability of risk sensitive foraging theory to two nectarivore species, *Monophyllus redmani* and *Erophylla sezekorni*, in Puerto Rico. He is also interested in the factors that structure mammalian communities in sand shinnery oak habitats of West Texas.

Brian Croyle, a masters student, currently in involved in a survey addressing the distribution of bats and their ectoparasites in the karst (Magotes) region of Puerto Rico. His primary research interest concerns community ecology of macrobenthic organisms.

Marcos Gorresen, a masters student, is presently preparing a research proposal addressing landscape structure and its effects on bat community composition. Specifically, he is comparing intact Atlantic moist forest and areas converted to pasture. The study will be carried out in the Reserva Mbaracaytu and neighboring areas in eastern Paraguay. Prior to the initiationof this project, he will be conducting field work for the ongoing mammal and ectoparasite survey in Paraguay.

Dawn Kaufman has recently completed her masters thesis entitled "Latitudinal patterns on mammalian diversity in the New World". She is currently working on her Ph.D. at the University of New Mexico with James H. Brown.

Kate Lyons has recently finished her masters as well. It is entitled "Aereography of New World Bats and Marsupials". She is currently working on her Ph.D. at the University of Chicago with Bruce D. Patterson.

Steven Presley, a doctoral student, is currently in Paraguay collected data for his dissertation which will address ectoparasite assemblages associated with common species of bats in Paraguay. He also has been involved in a study in Puerto Rico evaluating the utilization of forest gaps by bats.

Richard Stevens recently has concluded a masters project evaluating the role of environmental variationon the degree to which competitive interactions structure New World bat communities. He also is studying sexual size dimorphism in wing morphology of Brazilian bats. He will be traveling to Paraguay in June to evaluate the ecomorphological structure of the bat community of Mbaracayu.

Donald A. Yee, a masters student, currently is working on the biology of *Peropteryx macrotis*. His interests include behavioral and foraging ecology of New World bats.

For more information on these projects or any programs in the department, contact Dr. Robert D. Owen or Dr. Michael Willig, Department of Biological Sciences, Texas Tech University, Lubbock, Texas 79409-3131
internet e-mail for Willig, "CMMRW@ttacs.ttu.edu" for Owen, "BCRDO@ttacs.ttu.edu"

So, dear readers, now you know what's going on at Texas Tech. Why don't you tell us what's going on with you??

Send your news items to Bat Research News, Dr. G. R. Horst, Department of Biology, State University of New York, Potsdam, NY 13676

RECENT LITERATURE

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ANATOMY

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Four Corners Regional Bat Conference

On January 25 to 27, 1996 The Colorado Bat Society sponsored the Four Corners Regional Bat Conference held at the Red Lion Inn in Durango, Colorado. The conference was organized by Rick Adams, Mike Bogan and Kirk Navo. Bat Research News is grateful to the Colorado Bat Society and the conference organizers and participants for the opportunity to reproduce the abstracts of the presentations for our readers interest and use. GRH

TROUBLES IN CAMELOT?
BOULDER COUNTY BATS SHOW SKEWED SEX RATIOS

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The diversity of habitats and available roost sites for bats in Boulder County is seemingly high. The foothills of the Rockies provide myriad roost sites for the ten bat species known to occur in the area and protected public lands around Boulder maintain a healthy native fauna despite high public use. A 1995 census of Boulder County bats resulted in a high number of captures of bats in the foothills which at first suggested stable and healthy bat populations. Further analyses of data, however, showed most captures to be males. Females and juveniles were rarely caught even in areas where population density was high. These data suggest that disturbance of maternity roosts may be occurring in the area.

NEW MEXICO'S BAT/ABANDONED MINE PROGRAM:
AFTER FIVE YEARS THE CHALLENGES AND UNANSWERED QUESTIONS

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Since this program was started over 500 inactive mines have been evaluated for bat use and over 50 bat-compatible closures have been installed or are scheduled for construction. Limited post-closure evaluation has demonstrated population increases or increases in use in several instances and no instances of population decline or negative impact as a result of the bat-compatible closures. Although some of the requirements which make an abandoned mine suitable bat habitat have been determined, the ability to fully assess the suitability, or utilization, of abandoned mines as bat habitat by external evaluation is not yet possible. A major factor which contributes to this is the near impossibility of determining internal configuration and interconnection of openings in many mines without internal evaluation. Geothermal heating appears to add a large measure of unpredictability and our limited understanding of even some of the most basic components of bat biology is illustrated repeatedly by unexpected discoveries of bats using abandoned mines. A very high proportion of abandoned mines probably provide suitable habitat for some species of bat at some time. In a time of limited funds for bat-compatible closures and increasing pressure to close abandoned mines, a major challenge to the long term success of this program is to determine the significance of a particular kind of mine use to the long term needs of a particular bat species. Another is to develop low person/hour technological solutions to evaluation programs.

REPRODUCTIVE BEHAVIOR IN
THE CALIFORNIA LEAF-NOSED BAT, *Macrotus californicus*

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Wing-flapping and vocalizations by male California leaf-nosed bats (*Macrotus californicus*) have been observed in most months of the year. In September and early October, these behaviors are performed with increased vigor. Males have preferred display roosts in abandoned mines, with color-banded males returning to the same roost on sequential nights. These mines may be the same as the day roost, or they may be used only at night. The females enter the mine in groups after dark, and after some deliberation, a female might

land next to a displaying male or allow a male to land next to her (without the female flying away). He then will attempt to wrap his wing around her as the prelude to a successful copulation. Often other males in the area will fly between a courting pair. Males were observed "boxing" with each other and flying into one another in apparently aggressive displays. This establishment and defense of temporary territories for the purpose of attracting a mate is equivalent to lek behavior reported in the Old World hammer-headed bats (*Hypsignathus*). *Macrotus* exhibits delayed development and the babies are not born until May or June. In summer maternity colonies, small clusters of females with their young are usually "guarded" by a displaying male. Other males entering the area are driven away by the "harem" male.

FORAGING ACTIVITY OF ADULT FEMALE PALE BIG-EARED BATS (*Corynorhinus townsendii pallescens*) IN EAST-CENTRAL NEVADA

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Fifteen female *Corynorhinus* were fitted with 0.67 gm radio transmitters and followed through a two-week period in mid-August, 1995, to discern foraging habitat, home range, roost habits and foraging strategies. Two to three biologists equipped with radio-receivers, compasses and two-way radios collected synchronized location data from dusk to dawn nightly through the two-week period. Thirteen of 15 bats yielded location data. *Corynorhinus* foraged strictly in forested habitats (pinyon/juniper, pinyon /juniper-sagebrush steppe ecotone, mountain mahogany, white fir/mahogany and riparian deciduous forest). Of the over 500 total locations, none were found in the dominant habitat type of the area, the sagebrush/grassland steppe. *Corynorhinus* displayed a high fidelity for one and sometimes two specific foraging territories and reappeared at these sites on numerous consecutive nights. Foraging territories were from 0.5 to 4 miles from maternity roosts. Emergence from maternity roosts was generally between 2000 and 2030 hr and return was between 0300 and 0500 hr PST. Feeding bouts lasted all night for most individuals and appeared to be shortened only when winds increased or air temperatures decreased. *Corynorhinus* showed great fidelity for their maternity roosts. However, some individuals displayed a working knowledge of alternate roost site locations, using caves sometimes 3.5 miles away from their maternity roosts as temporary night roosts.

OLD-GROWTH FOREST STRUCTURE AND THE BAT COMMUNITY: THE PHYSICAL NATURE OF VERTICAL FOREST HABITAT AND ITS IMPORTANCE IN SHAPING BAT SPECIES ASSEMBLAGES

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Recent work on forest dwelling bat species has stimulated interest in how the composition of these faunas is derived and maintained. Resource limitation and competition do not appear to be important, but forest structure may be a primary influence in the shaping of bat communities. Old-growth forests differ from younger forests in that they exhibit greater structural heterogeneity and can be viewed as a volume of habitat with discrete layers, each with its own peculiar structural characteristics. For flying bats, rapid movements into different microhabitats should be possible by vertical shifts between forest layers. From this it is assumed that vertical structural complexity may be an important habitat characteristic for forest dwelling bat species. I quantified forest structure by determining foliage density profiles. Increasing foliage density, represents increasing degrees of physical interference which a flying bat must negotiate. Small interspecific differences in wing and body morphology have important implications for maneuverability and agility. This may be expressed through interspecific differences in microhabitat selection. Hence, predictions, based on wing morphology and foliage density, were made regarding vertical microhabitat selection within old-growth forest. Predictions were tested using ultrasonic detectors and mist nets set at three heights, corresponding to the canopy, understory, and shrub layers. The study sites were located within three forest types and two biogeoclimatic zones on Vancouver Island. Preliminary results from this ongoing study will be discussed and future work outlined.

SEASONAL ROOST PREFERENCE OF THE CALIFORNIA LEAF-NOSED BAT, *Macrotus californicus*

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The California leaf-nosed bat (*Macrotus californicus*), the most northerly representative of the Phyllostomatidae, remains active yearlong in the deserts of California and Arizona. Since *Macrotus* cannot lower their body temperature for either daily torpor or hibernation, they require warm roosts, especially during the winter. Bell et al. (1986) found no special physiological adaptations in *Macrotus* for a desert existence and concluded that behavioral adaptations such as roost selection and foraging methods were important for their year-round activity. Geothermally-heated mine workings in the California desert provide a stable environment for this species, and may have contributed to their range expansion in the last century since natural caves are rare. Since 1964, a long-term banding study in California has been conducted to answer questions concerning population dynamics, movement, roost selection, and longevity in *Macrotus*. The regular recapture of many of the over 17,000 *Macrotus* banded during this time has demonstrated that this species exhibits strong roost fidelity, and may occupy different roosts on a seasonal basis. Winter roosts typically contain males and females, and are found in warm (>26° C), deep mines (horizontal or vertical) usually in areas without ventilation that capture warm air, such as bald-headed raises. In contrast, the maternity roosts that form during the spring and summer are frequently located near the entrance of a mine with multiple openings that promote the flow of warmer outside air through the roost. In the low desert in the summer, temperatures in the maternity colony may exceed 32° C. During this season, males may form bachelor colonies in shallow mine workings, or they may remain in the winter sites. During the warmer months, both sexes utilize short prospects for night-roosting between foraging bouts, leaving culled insect remains and guano as evidence. Some mines with large guano deposits appear to be used only in the fall for courtship behavior, and therefore are very important in the social system of *Macrotus*. An October survey of over 50 mine workings at Planet along the Bill Williams River, showed that lek behavior was concentrated in 3 adits that were occupied infrequently by the bats at other times of the year. Land management agencies need to be aware of the importance of different seasonal roosts in the natural history of *Macrotus*, and other southwestern bats. Project-driven inventories of bats need to be conducted at several times during the year to identify critical roosts. Current threats to *Macrotus* throughout their range include mine closures for reclamation, hazard abatement and renewed mining, and recreational mine exploration by the public. An understanding of roost requirements could aid in the creation of new roosts when historic colonies are displaced.

THE EFFECTS ON BATS OF RENEWED MINING IN HISTORIC DISTRICTS: IMPACTS AND MITIGATION

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Many traditional cave-roosting bats in the western United States now live in abandoned mines. Bats disturbed in natural cave roosts by recreational exploration, commercialization and vandalism have often found a safe refuge in historic mines. Now the closure of mines for hazard abatement, reclamation or renewed mining can have profound impacts on bats, especially highly colonial species. Contemporary mining operations usually occur in historic mining districts. In open pit mining, the existing adits and shafts are often destroyed. Occasionally underground techniques are employed, but only if a high quality ore is located deep beneath the surface. This method usually enlarges or destroys the original drifts. Even when historic workings on a mine's property are not directly affected by new operations, they are often targeted for closure as part of reclamation plans. In some current underground operations, future roosting habitat for bats can be created. For example, in the Cargo Muchacho Mountains, the American Girl Mining Joint Venture will leave some of the recently-mined underground areas open when they finish, and gate the entrances. Other historic mines in the vicinity have already been gated to provide undisturbed roosts for the California leaf-nosed bat (*Macrotus californicus*). This is a viable option to closing abandoned mines as part of reclamation activities. Removal and relocation of bats prior to renewed mining, identification and protection of alternate roost sites, monitoring the success of relocation, and basic research to identify habitat requirements are some ways in which mining companies can and have mitigated for impacts to bats.

RECOVERING HABITAT FOR BATS

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Old growth forests provide habitat for bats in snags, deep crevices, hollows, and brooms. However, with the rapidly shrinking old growth resource, these habitats are correspondingly disappearing. Second growth, even-aged stands, while providing timber resources for the future, provide poor habitat for bats and many other species because of the relative lack of tree-form heterogeneity. We believe that thoughtful habitat development using mechanical means to create tree-form heterogeneity (wildlife trees) will markedly improve the chances for recovery of endangered and threatened species. Rather than destroying habitat, chain saws can be wielded to enrich habitat. We demonstrate that by sculpturing bark slits and flanges, cave-starts and snags, heterogeneous tree-forms are produced which invite bat singles or colonies by providing alternatives to diminishing "natural" habitats.

RADIOLOGICAL HAZARDS AT ABANDONED RADIOACTIVE MINE AND MILL SITES

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During the compilation of the National Park Service (NPS) inventory of abandoned mineral lands (AML), park managers in the Colorado Plateau physiographic province raised concerns over the issue of radiation at abandoned uranium mine and mill sites. The Colorado Plateau has been mined for radioactive ores such as radium, vanadium, and uranium since 1900, and particularly from 1948-1970 when uranium procurement programs of the U.S. Atomic Energy Commission were in effect. Other federal land management agencies, particularly the Bureau of Land Management and U.S. Forest Service, have many more radioactive AML sites than the NPS. These sites are potentially hazardous due to the possibility of elevated radioactive emissions. Currently there are no federal regulations that address the management of AML sites for radioactive emissions, but guidelines are available for each agency to establish its own regulations and policies for permissible exposures to employees and the general public using these lands. Individuals who routinely work at these sites should understand the fundamental concepts of radioactivity, possible pathways of personal exposure, monitoring equipment available and its uses, and how to interpret radiological data. Permissible exposures depend on the level of radioactivity present and the duration of personal exposure anticipated.

REDEFINING THE RANGE OF THE GREATER-WESTERN MASTIFF BAT IN ARIZONA

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The greater western mastiff bat (*Eumops perotis californicus*) is the largest bat in the United States and has only been documented in Arizona at several locations. Based on published data, its range extends southward from Kingman, Phoenix, and Morenci with one specimen being collected in Flagstaff. A sonogram record for this bat at Point Sublime and an unconfirmed capture record at Columbine Falls (both in Grand Canyon National Park) suggests that the accepted range should be adjusted. This paper will review the occurrence records of *E. p. californicus* in Arizona and discuss the results of our capture records and how they expand the known range of this species.

BAT SPECIES COMPOSITION AND ROOST USE IN PINYON-JUNIPER WOODLANDS OF NEW MEXICO

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Bat species composition and structures used for colony roosts were investigated in pinyon-juniper habitats of the Cibola National Forest. Ten sites across five mountain ranges were mist netted for four nights during summer 1995. Of the sixteen species captured overall, nine species accounted for over 95% of the total captures. Total captures and combinations of species at each site are reported. Radiotelemetry was used to study maternity roost use by three Federal Category 2 candidate species (Species of Concern).

Three *Myotis thysanodes*, one *M. evotis*, and two *M. volans* colony roosts were located. *M. thysanodes* and *M. volans* roosts with 30 to over 200 bats were found in ponderosa pine snags and live ponderosa pine with long, vertical cracks. These roosts were found in isolated ponderosa pine stands in the drainage bottoms of pinyon-juniper woodlands or at the interface of ponderosa pine and pinyon-juniper habitats. One colony of lactating *M. evotis* roosted in the hollow trunk of a partially dead juniper. From mid-July on, radio-tagged lactating *M. volans* and *M. evotis* were not found in large colonies, but were found alone or with 1-2 other bats in roosts that changed on a daily basis. *M. evotis* continued to use the same types of roosts (junipers) as earlier in the season. However, *M. volans* roosted under the sloughing bark of pinyon snags instead of the crevices in ponderosa pine that served as maternity roosts earlier in the season.

THE USE OF ACOUSTICS IN THE IDENTIFICATION OF MICROBATS

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Modern instrumentation makes it fairly easy to detect the echolocation calls of free-flying microbats and to produce visual displays of their call characteristics. It would be nice if these "acoustic signatures" were species specific, permitting reliable identification of the bats producing them. In reality, most bats vary the calls they produce according to their surroundings and there may be substantial individual variation as well. Most species produce calls which closely resemble those of other, sympatric species. The determination of which species can be distinguished acoustically, and how, will depend on the development of a thorough understanding of the acoustic behavior of all of the species which might occur in the area of interest. An emphasis needs to be placed on the documentation of variation, rather than on detailed analysis of supposedly "typical" calls. The success of bat identification is greatly enhanced if visual as well as acoustic cues are employed, and the development of a broader-based, more natural-history oriented identification strategy should be seen as essential to the establishment of criteria for identification from acoustics alone. These points are illustrated by looking at problems in the identification of bats of the Point Reyes area in California, with emphasis on the value of using real-time ANABAT displays in conjunction with visual observations.

HABITAT SELECTION BY BATS IN FRAGMENTED AND UNFRAGMENTED ASPEN MIXEDWOOD STANDS OF DIFFERENT AGES

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To determine if bats prefer certain ages of aspen mixedwood forest for roosting and foraging, and to predict the impacts of logging on bats, I compared relative abundances and foraging activity of bats in young, mature and old stands in 1993 and 1994, using bat detectors. In 1994, I also assessed post-logging bat abundances in two of the mature and tow of the old stands. I tracked radio-tagged *Myotis lucifugus* and *Lasionycteris noctivagans* to roost tress, which I measured and compared to a random sample of wildlife trees. Mean total activity of all bats was significantly greater in old than in young or mature stands. It also appeared greater in unfragmented than fragmented stands, but not significantly so. All 27 roost trees were found in old forests. Bats preferred tall (mean: 22.0m), newly dead *Populus spp.* with heart rot and low leaf cover (mean: 27%). Tree-roosting colonies were small (4-63 bats) and transient. Bats likely select trees large enough to house colonies and provide suitable temperatures and these trees are only available in old stands. Roost preference likely explains observed activity patterns. To sustain bat populations in these forests, old stands must be retained, and roost sites preserved by managing the forest at the stand level.

HABITAT USE AND ROOSTING ECOLOGY OF BATS INHABITING THE SOUTHERN BLACK HILLS OF SOUTH DAKOTA: A PROGRESS REPORT

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Field work was conducted during the summer of 1995 in a continuing effort to understand the distribution, frequency and roosting ecology of the 10 bat species known to inhabit the Black Hills region.

The study is acooperative venture between National Park Service and National Biological Service. General capture data will be presented, as well as the preliminary results of a radio-telemetry roosting study. Two species were successfully marked with radio transmitters and followed to their daytime retreats. These species were *Myotis volans* and *Myotis thysanodes pahasapensis* (a subspecies endemic to the Black Hills region). Both sexes of each species were tracked. Males of both species were found roosting solitarily in small rock crevices and changing roosts frequently. A tagged female *M. volans* was found roosting in a mature ponderosa pine snag. Reproductive female *M. thysanodes pahasapensis* were all (n=6) found communally roosting in rock crevices. These crevices were located in a variety of situations ranging from boulders on the ground to outcrops on limestone rock faces. Colony size ranged from 2 to 23 individuals and, with one exception, the colonies changed roost crevices daily. Evidence suggests that the colony maintains some form of social integrity during roost changes. Furthermore, old (>1 year) guano was present in all roost crevices examined, suggesting repeated use. Avenues of future research will be presented.

A PROGRESS REPORT ON THE NATIONAL BIOLOGICAL SERVICE'S BAT POPULATION STATUS AND TRENDS DATABASE

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The National Biological Service initiated a project this fall to compile, review, and synthesize existing information on the status of bat populations in the United States and Territories. The resulting database from this project will serve to provide a national baseline for future research, identify major information gaps, and highlight conservation needs. Meta-analyses will eventually be conducted to statistically analyze for trends using those data sets gathered with similar methodologies. Our initial efforts focused on designing a database using the relational database management system Access. This database was designed to revolve around observations of colony size through time, but other observation types are anticipated inputs. We began an extensive literature search on bat research, focusing mainly on those past projects documenting numbers and population estimates (hence the focus on colonial species). We are highlighting the Four Corners states to develop a prototype for gathering information. The current database structure along with results from preliminary analyses will be presented. Future products anticipated from this project also will be discussed.

A COMPARISON OF CHARACTERISTIC FREQUENCIES AND HAND-MEASURED LOW FREQUENCIES AND WITH A DISCUSSION OF THE RESULTS FROM A SURVEY OF ANABAT USERS

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ANABAT is a cost effective and potentially simple method of identifying echolocation sequences from free-flying bats. Essential to the identification of free-flying bats is the identification of intraspecific characteristics from reference sequences of known species. Historically, a primary character for species identification has been the "low frequency" of a call note or sequence. ANABAT calculates a "characteristic frequency" for each sonograph. Characteristic frequency is intended to estimate low frequency for a call note or sequence. I tested the accuracy of characteristic frequencies by comparing them to "hand measured" low frequencies. Preliminary data shows that for call notes with a strong constant frequency component, characteristic frequency is a consistent and accurate measure of low frequency. In call notes with steep frequency modulated components ANABAT is occasionally fooled into miscalculating the characteristic frequency. Statistical significance will be tested and reported. In addition, I recently distributed a survey and test to 15 ANABAT users. The 31-question survey focuses on the background of individual researchers, their experience with ANABAT and their opinions on ANABAT as an analysis tool. The test, 10 unmarked sequences of known bat species, was mailed to each participant for identification and comments. The results, which are forthcoming, will be reviewed and future objectives of ANABAT research and researchers will be discussed.

NEW MEXICO BAT SURVEY: CAPTURE AND ACOUSTIC RESULTS, 1994-1995

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A five-year survey of the bats of New Mexico was begun in 1994. The purpose of the survey was to use mistnets to confirm historical records and sample new localities. An additional goal was to conduct acoustic surveys to record species-specific ultrasonic vocalizations from free-flying bats. The ANABAT ultrasonic detector was used to detect bats and their calls which then were recorded either onto tape or a laptop computer. ANABAT analysis software was used to generate sound spectrograms. With respect to mistnet capture data, 712 bats were netted during the first two years of the survey. Six new county records and at least one new site of syntopy for two long-eared *Myotis species* have been noted. The most numerous species encountered during the survey were *Eptesicus fuscus, Antrozous pallidus, Lasiurus cinereus, Lasionycteris noctivagans,* and *Myotis yumanensis.* Insofar as the ANABAT sound recordings are concerned, of 26 species known from New Mexico, seven have been verified as "known," nine species characterized provisionally, and the remaining species have not yet been recorded successfully. Calls that are "known" (verified) are made from bats that were first captured in mistnets, held for other data collection, and then released and tracked by a spotlight and ANABAT recording system. It is planned that this survey will continue through 1999 so that a verified call library for most of New Mexico's bat species can be produced. Other information on parasitology, ecology, morphology, taxonomy, and behavior has also resulted from this survey. Tbis work was sponsored principally by the New Mexico Department of Game and Fish Share with Wildlife program, the U. S. Forest Service, the Bureau of Land Management, and the Museum of Southwestern Biology at the University of New Mexico.

BATS AND BOY SCOUTS

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For over 30 years Brigham Young University has sponsored a Boy Scout Merit Badge Pow Wow in November where over 5,000 young men can earn three merit badges over a three-week period of Saturday morning workshops. A mammal study merit badge has been a traditional offering earned hy strict adherence to the merit badge manual. This year (1995), however, we chose to place special emphasis on bats and have the boys become involved in a public awareness program with the communities of central Utah. This program consisted of having each scout administer questionnaires to eight different heads of households designed to reveal levels of enlightenment about bats. The next week each scout provided to each person interviewed a fact sheet on bats that gives general information and that requests information on urban bat colonies. At the completion of the Pow Wow each scout was provided a poster of the Spotted Bat by the Utah Division of Wildlife Resources and was allowed to see and touch live bats. This program bas as its first and major objective the education and, hopefully, conversion of nearly two-hundred young men to bats and bat conservation. Second, since eacb boy administered eight questionnaires, 1600 citizens became informed and more aware. Finally, the scouts became active participants in informing bat biologists about the whereabouts of bat colonies. Evaluation of questionnaires will dictate the nature of future fact sheets and follow-up telephone conversations with scouts and those they interviewed will suggest the direction of future efforts and the reliability of information on colonies.

BUILDING AND USING THE CONFINED SPACES BAT TRAP

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Bat biology studies often require the capture of wild bats. "Harp traps" or "Tuttle traps" provide a convenient method of capturing bats, particularly at the usually confined entrances to mines, caves and buildings. Often less injurious to the bats than mist nets, an escape resistant trap also requires less continuous monitoring, allowing the biologist to work several sites simultaneously. But, traditional trap designs are often too bulky to set inside small roost entrances. Heavy traps may he difficult to carry across broken terrain and difficult to set up in awkward situations. Furthermore, these traps require a high degree of skill to manufacture when made with welded aluminum. Fixed dimension traps of PVC pipe can be fragile

or difficult to set up in a wide variety of situations. Bats may have to be funneled to the trap with an elaborate set up involving tarps or nets. To address these problems, we have designed a modular, height adjustable, aluminum harp trap that can be constructed at home with ordinary tools and modest building skills. Designed to fit within confined spaces, the trap can be set in the flyway with ease. The carefully dimensioned, escape resistant bag allows several traps to be employed simultaneously. A selection of accessories allows the trap to be set in a variety of configurations. Designed for convenience, the trap is easily set up under widely various conditions, it is field repairable, and it is lightweight and portable. This report outlines construction of the trap and its use.

COLORADO'S BATS/INACTIVE MINES PROJECT: OVERVIEW OF THE FIRST FIVE YEARS

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Colorado's rich mining history has resulted in more than 20,000 inactive or abandoned mines scattered throughout much of the state. While the Colorado Division of Minerals and Geology is currently closing many of these mines to safeguard the public, many of the mines provide important roost habitat for some of Colorado's 18 species of bats. Mine habitats are especially important for sensitive species, such as *Plecotus townsendii*, that are highly dependent on underground roost sites. In 1991 the Colorado Division of Wildlife initiated a project in an attempt to identify mines that provide significant bat habitat. Important roost sites are recommended for a bat gate closure to prevent the permanent loss of habitat. Using techniques that include microclimate pre-surveys, bat detector and visual bat activity surveys, internal and bat capture surveys, the Bats/Inactive Mines Project (B/IMP) has performed bat roost evaluations at 659 sites. This includes 909 detector or capture surveys, 345 external microclimate surveys, and 78 internal surveys. Additionally, data from 111 external microclimate and 58 internal surveys has been collected for future analysis of the predictive value of various mine characteristics. Sixty-four *Plecotus* roosts, and roosts of 7 other species have been identified. To date, 77 sites have been recommended for bat gates, and approximately 50 are expected to have been installed by the end of 1995. Although the primary function of the project is roost protection, much information on bat roosting requirements, distribution, habits and effectiveness of gate designs has been obtained. This information will assist wildlife managers in the conservation of bats in the west.

CHIROPTERAN DIVERSITY STUDIES - LECHUGUILLA CAVE, CARLSBAD CAVERNS NATIONAL PARK

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Since its discovery in 1985, most interest in Lechuguilla Cave has centered on its unique speleothems, insights into speleogenesis, and potentially revolutionary new microbiology. Little attention has been given to faunal studies. This presentation will address the Chiropteran diversity and population counts of osteological specimens found in Lechuguilla Cave. Also presented, will be a brief history of previous bat population occupations at the entrance and events leading to the discovery of the "new" sections of Lechuguilla Cave. In addition, speculations regarding the high quantity of accidental or non-cave dwelling bats observed and the significant numbers of *Myotis ciliolabrum* found in the cave will be discussed.

INTRASPECIFIC VARIATION IN TREE ROOST SITE SELECTION BY MALE AND FEMALE LITTLE BROWN BATS (*Myotis lucifugus*)

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In a recent review of roost fidelity in bats, Lewis (1995) suggests that species that show intraspecific variability in roost site selection and fidelity can provide insight into questions regarding the costs and benefits of site fidelity. Roost site selection and fidelity are likely affected by sex and reproductive con-

dition, however few data address intraspecific variability in these behaviors. In 1994, as part of a larger study which examined tree roost site selection by big brown bats (*Eptesicus fuscus*) in Cypress Hills, Saskatchewan, we collected data on roost site selection, fidelity and behavior of 2 male and many female little brown bats (*Myotis lucifugus*). Selection of roost sites varied both between and within sexes. One adult male exclusively roosted in stumps while the other male roosted in snags and cavities in live and dead trembling aspen trees. Females were found roosting in buildings and live aspen trees. Female bats which roosted in buildings displayed higher site fidelity than the other male and females roosting in tree cavities. There was variation in the use of torpor. These observations show that there can be considerable intraspecific variation in roosting behavior and that we should be wary of presenting a simplified picture of the roosting behavior of a particular species.

AN EVALUATION OF BAT USE OF TEXAS HIGHWAY STRUCTURES

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The Bats and Bridges study is an ongoing study designed to determine how bats are using highway structures in Texas. We will discuss engineering aspects of bat use of highway structures, the position of Texas DOT in relation to the project, and methods being used to evaluate highway structures for bat use. These methods include; a comparison study, a state wide evaluation, and retro-fitting highway structures with artificial roosts. In the comparison study, characteristics of 80 bridges located in central Texas were compared in bat-occupied versus unoccupied bridges. Characteristics of bridges utilized by *Tadarida brasiliensis* were matched with the nearest unused bridge of similar design for a paired comparison study. Multiple regression analysis was used to screen 80 characteristics for significance. Ninety-four percent of central Texas bridge crevices that are 30 centimeters or deeper and between 1.9 and 2.5 centimeters wide with closed tops are occupied by T. brasiliensis. A statewide evaluation of bat use of highway structures is being used to determine geographic distribution of highway structure use by bats. Designs for retro-fitting bridges to create roosting habitat for bats are also being evaluated.

SUMMER AND WINTER ROOST SELECTION IN ABANDONED HARD ROCK MINES BY THE TOWNSEND'S BIG-EARED BAT (*Corynorhinus townsendii*)

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The reclamation of abandoned, underground hard rock mines is underway throughout the western U.S. Conservation of bat species that roost in such mines requires careful evaluation of mines as potential habitat for bats prior to their closure. A list of the precise characteristics of abandoned mines preferred by roosting bats remains elusive, yet these data would be most useful to reclamation agencies. We attempted to identify those characteristics of abandoned mines that are important to the Townsend's big-eared bat (*Corynorhinus townsendii*) as it selects summer roosts as well as winter hibernacula. Two surveys of abandoned mines were conducted in southern Utah in cooperation with the Utah Division of Oil, Gas and Mining's Abandoned Mine Reclamation Program: a summer survey of 65 adits in Silver Reef, Washington County; and a winter survey of 29 adits in Bullion Canyon, Piute County. In early September 1995, 34 of 65 adits surveyed in Silver Reef showed evidence of roosting bats; 15 of these contained one or more individuals of C. townsendii. A second survey of 29 adits in Bullion Canyon in late October-early November yielded 12 adits that contained hibernating *C. townsendii*. Each adit surveyed was characterized as to: 1) the extent of the stopes, raises and other cavernous formations present (EXTSTOPE), 2) the extent of the crevices present (EXTCREV), 3) the presence or absence of multiple levels (MULTILEV), 4) the presence or absence of airflow at its portal (AIRFLOW), 5) the total length of the adit, including drifts (LENGTH), 6) the average measure of relative humidity within the adit (HUMIDITY), and 7) the average air temperature within the adit (TEMP). Multiple logistic regression was used to examine the relationship between these seven explanatory variables and a variable denoting the presence or absence of bats or bat sign in the adits (OCCUPIED); analyses of the summer and winter data were conducted separately. Five variables (EXTSTOPE, EXTCREV, MULTILEV, AIRFLOW, and LENGTH) had statistically significant relationship with the roosting of bats during the summer months. None of the variables had a significant relationship with the use of the adits by hibernating bats during the winter season.

STATEWIDE INVENTORY OF CAVES AND ABANDONED MINES TO DOCUMENT AND PROTECT BAT ROOSTS IN WYOMING

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The status of bat populations and location and status of bat roosts in Wyoming was mostly unknown before 1994, except for 32 adits and shafts identified during abandoned mine reclamation projects. Utilizing federal/state cost-share projects, a statewide survey to identify bat roosts in caves and abandoned mines was begun in May 1994. Since that time 91 caves and 80 abandoned mines have been evaluated. Fifty-six caves (61%) were utilized by bats, 52 as night roosts, 11 as day roosts, 10 as hibernacula, and 3 as maternity roosts. Sixty-two abandoned mines (77%) were used by bats, 55 as night roosts, 17 as day roosts, 11 as hibernacula, and 1 as a maternity roost. Some caves and abandoned mines were used as more than one roost type. *Corynorhinus townsendii* was present at 30 night roosts, 17 day roosts, 16 hibernacula, and 3 maternity roosts and was the bat species most commonly observed. *Myotis ciliolabrum* was the second most common, occurring at 29 night roosts, 5 day roosts, and 15 hibernacula. Nine bat species were observed at night roosts, 5 species at day roosts, 4 species at hibernacula, and 2 species at maternity roosts. *C. townsendii, M. ciliolabrum, Myotis septentrionalis,* and *Eptesicus fuscus* occurred most often in abandoned mines, while *Myotis lucifugus, Myotis volans, Myotis evotis, Myotis thysanodes,* and *Antrozous pallidus* were observed more often in caves. Three maternity roosts of *C. townsendii* totaled an estimated 275 females, and one *M. lucifugus* roost had an estimated 200 females. Hibernacula in 15 caves and 23 abandoned mines harbored an estimated 143 *C. townsendii*, 41 *M. ciliolabrum*, 11 *E. fuscus*, and 3 *M. lucifugus*. Data collected has resulted in installation of bat gates at 26 abandoned mines, and plans are underway to modify cave gates at 3 locations to allow bat passage.

ROOST SITE CHARACTERISTICS FOR Antrozous pallidus , Eptesicus fuscus, AND Myotis occultus IN A CENTRAL ARIZONA PONDEROSA PINE FOREST

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Roost site characteristics for forest-dwelling bats are relatively unknown in the Southwest. Information on the habitat selected by these bats for roosting and foraging is imperative for appropriate management of bats in forested ecosystems on federal lands. Pallid bats (*Antrozous pallidus*), big brown bats (*Eptesicus fuscus*), and Arizona Myotis (*Myotis occultus*) were radio-tracked to roost sites during three different sampling periods from late May through July of 1995. Pregnant, lactating, post-lactating, and non-reproductive females, and one male were banded, affixed with radio transmitters, and tracked to day roosts. A total of nine maternity roosts were located for all three species. Two of these were pine snag roosts used by four of the Arizona *Myotis* tracked, two were pine roosts (a snag and a live tree) used by three of the big brown bats tracked, four were Arizona white oak trees used by one female pallid bat, and one was a ponderosa pine tree used by a pallid bat. Six other roosts located and thought not to be maternity roosts included a house, fence-post, power pole, and a Gambel's oak snag. The male used a ponderosa pine tree and an alligator juniper. Maternity roosts ranged in size from 4 bats to 322 bats. Non-maternity roosts ranged from 1 to 53 bats. A second year of study will take place during the summer of 1996. Both years of study are also addressing habitat selection during foraging, but only roost site results will be presented at this time.

HISTORY, DEVELOPMENT AND IMPLEMENTATION OF A BAT CONSERVATION POLICY: AN EXAMPLE FROM UTAH'S ABANDONED MINE RECLAMATION PROGRAM

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With the passage of the Surface Mining Control and Reclamation Act (SMCRA) in 1977, safeguarding the public from the hazards associated with abandoned mines became the number one priority of states with SMCRA Abandoned Mine Reclamation Programs (AMPS). Conflicts have arisen between the concerns for public safety and other considerations such as compliance with the Endangered Species Act and the Nat-

-ional Environmental Policy Act. This has encouraged states to develop policies that accommodate bats and their habitat needs while at the same time protecting the public. The Utah AMRP began the process of developing a bat policy in 1992. In 1992 and 1993, bat sensitive closures were utilized in projects on US Forest Service (USFS) and National Park Service (NPS) administered lands. In 1993, bat gate designs were evaluated and vandal tested in the field, yet no clear policy or sampling protocol existed. In 1994, the USFS began to survey for bats in mines scheduled for closure on USFS administered lands. By 1995, 29 bat-sensitive closures had been installed in a variety of mine settings, and the closure designs continued to evolve. As significant as this previous action was, it was not until 1995 that a policy with a clear bat sampling protocol was implemented. It was developed in cooperation with the state Division of Wildlife Resources and biologists from Utah State University. This policy provides for an internal survey in summer and winter implemented prior to any abandoned mine closure work. To date, internal surveys have been initiated at two significant mining districts in Utah that are slated for reclamation in 1996.

THE VIRTUAL BAT FAUNA OF THE HENRY MOUNTAINS, UTAH

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A survey of the mammal fauna of the Henry Mountains, south-central Utah, was begun in the summer of 1993. Surveys for bats have relied primarily on use of mist nets and have provided new distributional and elevational records for 15 of the possible 18 species of bats in the Henry Mountains. Our work has provided the first records for the mountains of 10 species, including several species of *Myotis*, *Euderma maculatum*, *Idionycteris phyllotis*, and *Plecotus townsendii*. In the period since field work was initiated, the jurisdictional status of some of the bat species potentially occurring there has been changed by both state and federal agencies. Some changes preclude the taking of voucher specimens. The impact on the credibility of this and similar studies resulting from the loss of this traditional means of documenting locality records is discussed. The continued importance of good science and alternative means of documentation also are presented.

GENETIC DIVERSITY IN THE BIG BROWN BAT (Eptesicus fuscus) BASED ON RAPD-PCR FINGERPRINTING

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We are investigating the use of Random Amplified Polymorphic DNA (RAPD) fingerprinting to compare the amount of genetic diversity within and between populations of *Eptesicus fuscus*. Four summer roost colonies were selected for study; two from Delaware County, Indiana; one from Vigo County, Indiana, and; one from Coconino County, Arizona. Forty µl blood samples were extracted from five randomly -chosen adult females from each colony. Polymerase chain reaction (PCR) amplification of DNA using ten randomly chosen oligonucleotide primers is expected to yield individually unique DNA banding patterns (fingerprints) following electrophoresis on 1.5 % agarose gels. Direct visual comparisons of individual banding patterns and computer analyses will be used to estimate the degree of genetic diversity and to develop phenograms. Additionally, we hope to gain data which can be used to estimate the current fitness of this species, possibly gain insight into its recent genetic history, and further our knowledge of breeding patterns. Perhaps, more importantly, we are evaluating the use of RAPD-PCR fingerprinting as a quick, inexpensive, and non-invasive method to estimate the genetic diversity of rare and endangered mammals.

OBSERVATIONS OF GROUND ROOSTING BEHAVIOR BY Myotis Eevotis IN ARIZONA FORESTS

T. E. Morrell, M. Rabe, H. Green, J. Devos, and K. Yasuda. Dept. of Biology, Ball State University, Muncie, IN 47306, (MR, JD) Arizona Game and Fish Dept., 2221 W. Greenway Rd., Phoenix, AZ 85023, (HG) U.S. Forest Service, Mormon Lake Ranger District, 4373 Lake Mary Rd., Flagstaff AZ 86001, and (KY) Lane Community College, Eugene, OR 97405.

During the summers of 1993-1995 we documented 9 cases of *Myotis evotis* roosting during the day in

small- to medium-sized rocks on the ground. Ground-roosting bats were located by attaching 0.45 - 0.78 g radio-transmitters to pregnant/lactating females that were captured with mist nets. The smallest rock structure bats used for roosting was 14 cm tall and 46 cm wide (widest point), the largest was 53 cm tall by 96 cm wide. During 1995 we observed multiple bats (2-8) exiting rock roosts in the early evening. Moreover, in one instance a young bat was observed exiting a rock and ascending the nearest tree suggesting that rock roosts may be used by maternity colonies. In most cases transmittered bats were solitary roosters using a ground roost site for only 1 day before moving to another site. However, we also observed instances where groups of bats would use a roost up to 3 days before moving to a different ground roost site. Eleven (55%) of the transmittered *M. evotis* were located roosting in tree snags only.

NAME THAT TUNE: THE PROBLEMS WITH AUDIBLE BAT SURVEYS

Kirk W. Navo. Colorado Division of Wildlife, 0722 S. Rd.1E, Monte Vista, CO 81144.

Resource managers have recently become more involved in bat conservation issues in the west. As managers initiate distributional surveys and project clearance work that includes bats, survey techniques become a critical issue. In the west, some bats that will require surveys are known to have audible echolocation calls. This has led to the recognition that audible bats can be surveyed without having to capture the bat. Surveys are being conducted based on the assumption that there are only a few audible bat species to contend with, and in most parts of the west, the only audible bat expected is Euderma maculatnm. In the west there are at least 6 species known to vocalize at least some of the time, within the audible range. These include *Euderma, Nyctinomops, Tadarida, Idionycteris, Eumops,* and *Antrozous.* In Colorado, audible bat calls are heard throughout western and southern parts of the state, especially in late summer. There is no available library of recorded calls of various species which managers can use as a reference for determining species identification. Some species, although known to sometimes vocalize within the audible range, are not commonly considered by bat researchers to be "audible" bats. However, this information is not generally known within the management community. Managers, not typically experts in the physics of sound analysis, cannot communicate clearly with one another about sound and echolocation. Problems associated with multiple audible species, variations of calls within species, poor hearing abilities of surveyors, and confusion over the communication of field results between managers can all lead to erroneous conclusions. There is a need for guidelines or protocols on how to survey for audible bats, a depository of recorded calls of audible bats, and research on equipment needed to best record, document, and utilize for surveys of audible bats.

BAT GATE DESIGNS FOR *Plecotus townsendii* AT ABANDONED MINES IN COLORADO

Kirk W. Navo, Judy Sheppard, and Tom Ingersoll.
Colorado Division of Wildlife, 6060 Broadway, Denver, CO 80216.

As part of an ongoing cooperative project involving the survey and protection of mines for bats, the Colorado Division of Wildlife is gating and monitoring some mines that have been scheduled for closure. As mines are determined to be used by *Plecotus* as roost sites, they are recommended to the Division of Minerals and Geology to receive a bat gate as the preferred closure method. Due to a lack of funding and a concern for public safety, experimental gate designs have been used at some roosts. These experimental designs, called "windows", were installed and then monitored by return visits and infra-red monitors/counters to determine the acceptance of the gate design to *Plecotus* and other species of bats. To date, 15 window gates have been installed. Preliminary results indicate that bats do not abandon the mines after installation of a window gate, and return to use the same roost the following year. Internal temperature data loggers were used to document temperature fluctuations at gated hibernacula. Temperatures within the first 75 feet remained very stable over the winter. Eight species have been documented using the window designed gate, but current data are inadequate to evaluate any potential changes in populations using theses mines. Surveys of one site indicate that a nursery colony of *Plecotus* did not change the year after gate installation, and may have increased slightly. Monitoring of these sites is continuing to verify the acceptance of the window design at various types of roosts, as well as for other species.

AGUA CALIENTE CAVE: PROTECTING THE FUTURE

Debra C. Noel, Tim Snow, and Shawn Castner.
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In 1994, the Arizona Game and Fish Department, under a Right of Entry Permit from the State Land Department, placed bat gates on three entrances at Agua Caliente Cave. This cave had been a popular recreation site for at least 25 years. It also contained a maternity roost of about 100 Townsend's big-eared bats (*Plecotus townsendii*) and a winter roost of about 50 California leaf-nosed bats (*Macrotus californicus*). Research results had shown that the maternity colony had experienced a 50% decline culminating in a complete reproductive failure in 1994. This presentation will review the events that led to this situation, the actions taken, and the hope for the future at this site.

PREVALENCE OF RABIES IN INSECTIVOROUS BATS SUBMITTED FOR FLUORESCENT RABIES ANTIBODY TESTING: COLORADO, 1977-1995

John W. Pape. Disease Control and Environmental Epidemiology Division, Colorado Department of Public Health and Environment, 4300 Cherry Creek Drive South, Denver, CO, 80222-1530.

Since 1980, 13 of the 26 human rabies cases reported in the U.S. were determined by monoclonal antibody studies to be infected by bat variants of rabies virus. Eight of the 13 cases have occurred since 1993. In Colorado, bats have been the only endemic rabies reservoir since 1977. The increase of bat-virus associated human rabies cases prompted a review of bats submitted for testing to the Colorado Department of Public Health and Environment (CDH) and Colorado State University Diagnostic (CSU) labs from 1977 -1995. During this period, 4210 bats were tested, representing 33% of the 12,697 animals tested and 98% of rabies positive specimens. Of the 4210 bats, 680 were reported as positive for rabies by fluorescent rabies antibody (FRA) technique. The mean annual positive rate was 15% (range 13-19%). Three species, *Eptesicus fuscus, Lasiurus cinereus,* and *Lasionycteris noctivagans* accounted for 3077 (73%) of bats submitted, 538 (79%) of FRA positive specimens and 152 (70%) of bats involved in human exposure. Two hundred-seventeen (5%) of all bats and 68 (10%) of rabid bats were involved in human exposure. Temporal and geographic distribution, transmission to other species, monoclonal antibody testing patterns and species-specific trends are reviewed.

BAT SPECIES AND ROOST SITE SURVEY OF THE CLOUDCROFT DISTRICT OF THE LINCOLN NATIONAL FOREST, NEW MEXICO

Travis Perry, Steve Davenport, and Michael A. Bogan. National Biological Service, Department of Biology, University of New Mexico, Albuquerque, NM 87131.

A primary factor limiting bat abundance and distribution is the availability of roost sites. During the summer of 1995 we began a bat species and roosts site survey of the Cloudcroft District of the Lincoln National Forest. To date, we have captured a total of 358 bats of 13 species at 10 localities. *Lasiurus noctivagans* was the most abundant species followed by *Myotis lucifugus occultus* and *Myotis volans* respectively. The most note-worthy captures include 5 lactating female *Euderma maculatum*. These 5 females represent a new mountain range locality for this species in New Mexico. We used radio telemetry to locate eight roost sites for three bat species: *Myotis lucifugus occultus, Myotis volans,* and *Eptesicus fuscus*. Preliminary data strongly suggest that mature, dead or dying *Pinus ponderosa, Pinus edulus, Pseudotsuga menziezii* and *Quercus gambelii* with loose bark or cavities are important for solitary and maternity roosts of these 3 bat species. This work was funded by the Lincoln National Forest, U. S. Forest Service.

TECHNIQUES FOR SAMPLING BAT DIVERSITY: THE BAT COMMUNITY IN THE SACRAMENTO RIVER DRAINAGE OF NORTHERN CALIFORNIA

Elizabeth D. Pierson and William E. Rainey. 2556 Hilgard Avenue, Berkeley, CA 94709.

Effective sampling of species diversity in bat communities requires a combination of techniques, due to the ecomorphological diversity among bat species and the differing advantages and limitations inherent in

each technique. A five-year study of the bat community in the Sacramento River drainage of northern California allowed us to evaluate the usefulness of various sampling methods. In this relatively mesic habitat, by mist netting over water (i.e., river and tributary streams) we captured 15 of 17 species identified in the area. There was, however, no one site at which all species were captured, and it generally took at least three nights of netting effort per site before the cumulative number of species captured approached an asymptote. Sampling of night roosts, particularly at bridges, proved to be the most effective method for locating a number of species, yet some of the forest and cliff dwelling species (8 of the 17) were never found in bridge or building night roosts. Surveys of day roosts, particularly during the maternity season should only be undertaken with the greatest caution, and should avoid, if possible, entry into the roosting area. However, certain species (particularly cave/mine dwelling taxa like Corynorhinus townsendii), could be located most reliably by surveys of potential day roosts. While acoustic surveys can be the most efficient method for comparing levels of bat activity across sites and/or seasons, and, in this study, allowed us to identify two otherwise difficult to detect species (i.e.., *Eumops perotis* and *Euderma maculatum*), species identification based on call characteristics generally presents considerable analytical challenges. Which species appeared to be most common varied with the sampling method used, suggesting that assumptions about relative abundance should not be made based on a single sampling method.

THE PARASITES ASSOCIATED WITH BATS FROM NEW MEXICO AND CALIFORNIA, USA, AND BAJA CALIFORNIA SUR, MEXICO

D.T. Scott, A.R. Deans, and W.L. Gannon.
Department of Biology, University of New Mexico, Albuquerque, NM 87131.

Bats were collected from New Mexico and California as well as Baja California Sur (Mexico) between May and October 1994 and May and September 1995. Over 800 bats were examined for ectoparasites; additionally, their fecal samples were examined for *Coccidia* (Protozoa:Apicomplexa). A subsample of 100 bats was examined for intestinal helminths. The prevalence and mean intensities of the ectoparasites may provide information about bat ecology such as roost choice and roost size. For example, *Lasiurus cinereus*, a solitary tree-roosting species, has a low ectoparasite prevalence (0/84). Meanwhile, *Antrozous pallidus*, a colonial-roosting species has a high ectoparasite prevalence (107/111). Currently there are no more than five Eimeria (*Coccidia*) species known from New World bats. We have found at least four new species of *Eimeria*. Although still awaiting identification, the intestinal helminths may provide information about prey selection by the bats. For example, cestodes with known intermediate hosts will provide us with information about the diet of the bats.

STATUS AND TRENDS OF BAT POPULATIONS IN THE JEMEZ MOUNTAINS AT BANDELIER NATIONAL MONUMENT AND LOS ALAMOS NATIONAL LABORATORY, NEW MEXICO

Jason Sexton, Stephen Davenport, Michael A. Bogan, and Thomas J. O'Shea. National Biological Service, University of New Mexico, Albuquerque, NM 87131 and (TJO) Midcontinent Ecological Science Center, 4512 McMurry Avenue, Fort Collins, CO 80525.

There is a continuing need to obtain basic information on bat populations, such as species of occurrence, habitat use, distribution, natural history, and population trends. Eleven species of bats in New Mexico are listed as species of special concern and some bat populations in the United States are known to be declining. In 1995, the National Biological Service, in cooperation with the National Park Service and Los Alamos National Laboratory, initiated a multi year study on bats of the Jemez Mountains in Bandelier National Monument, Sandoval County, and Los Alamos National Laboratory, Los Alamos County. During late summer 1995 we captured a total of 189 individuals of 13 species at Bandelier National Monument. Captures at Bandelier included two lactating, and one post-lactating, female *Euderma maculatum*, the first captures of this species for the monument. At Los Alamos National Laboratory we captured 35 individuals of 7 species. Species lists and relative abundances for the two areas will be presented.

SURVEYS OF HABITAT AND ANALYSIS OF SUCCESS OF GATING PROJECTS FOR CATEGORY 2 DESIGNATED SPECIES IN UTAH

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Little is known about the habitat requirements of many Category 2 species of bats found in Utah. To better understand the habitat requirements of these C2 bats, the U.S. Forest Service initiated surveys in May 1992. Initially, surveys focused on abandoned mine resource sites. Over time, survey efforts have broadened to include buildings, caves, and bridges. Abandoned mine sites identified as bat habitats have been gated by the Utah Division of Oil, Gas and Mining. To collect population data, each roost site identified is added to a general monitoring "pool" and is surveyed twice per year. It is anticipated that by continuing to monitor these sites over time, we will gain valuable information about migratory trends, population numbers and pioneering behaviors. This study represents a combined effort among the U.S.D.A. Forest Service, Utah Division of Wildlife Resources, Utah Division of Oil, Gas and Mining, Bureau of Land Management, U.S. Fish and Wildlife Service, Brigham Young University, and several private mining companies. Preliminary results indicate that discrete habitat requirements may be identifiable for Plecotus townsendii pallescens. Adequate sample sizes are not yet available to make any inferences regarding the other C2 species of bats found in Utah.

SPOTTED BAT FORAGING AND ROOSTING HABITAT N THE KAIBAB PLATEAU IN NORTHERN ARIZONA

Melissa S. Siders, Richard Miller, Debra C. Noel, Michael Rabe, Shawn V. Castner, Tim K. Snow, and Dan Garcia de la Cadena. Arizona Game and Fish Department, (Non-Game Branch, SVC, TKS, DCN; Research Branch, MR) 2221 W. Greenway, Phoenix, AZ 85023, Arizona Game and Fish Department, Region 2, (RM) 3500 S. Lake Mary Rd., Flagstaff, AZ 86001, and (MSS, DGC) North Kaibab Ranger District, Kaibab National Forest, Fredonia, AZ 86022.

The Kaibab Plateau of north-central Arizona is a high elevation, limestone plateau, bisected with small canyons on the northern edge of the Grand Canyon. Bat surveys conducted in 1994 and 1995 have shown the Kaibab Plateau to have a great diversity of bats species, with twenty different species caught. Spotted bats (*Euderma maculatum*) appear to be more numerous on the Kaibab Plateau than in other locations, with audible echolocation calls heard in many areas of the forest even when bats were not captured. Spotted bats were trapped on the Kaibab Plateau between August 1 and August 22, 1995. They were fitted with 0.5 -0.7g transmitters and tracked until the battery died (7-10 days) or radio signals were no longer picked up for several days. The main purpose of this study was to locate spotted bat maternity roosts, and document foraging behavior. Six spotted bats were radio tracked: four lactating females, one non-lactating female, and one adult male. An attempt was made to locate day roosts during the daytime, however no daytime signals were detected. Limestone in the canyons was probably interfering with the radio signals, making daytime locations extremely difficult to detect. Nighttime radio signals were easily detected and could be followed for some time before the bats were lost due to difficulties in road access and the speed at which the bats were flying. Spotted bats appeared to forage extensively in long meadow stringers in mixed conifer forest within approximately five miles of their original trap site. They appeared to have approximately the same foraging patterns each night, enabling trackers to pick up the bats for several nights and follow them a little farther into the evening. One day roost was located in a cliff face, but the specific site was not determined. There appeared to be one night roost located, that was used by one female on several consecutive nights from approximately 2300 to 0100 hrs.

REVIEW OF THE ARIZONA BAT MANAGEMENT PROGRAM'S ABANDONED MINE SURVEYS

Tim K. Snow, Shawn V. Castner, and Debra C. Noel.
Arizona Game and Fish Department, 2221 West Greenway Road, Phoenix, AZ 85023.

The Arizona Game and Fish Department recognizes that abandoned mines have become one of the most important resources for bats. Over half of the 28 species occurring in Arizona use abandoned mines.

Renewed mining and hazard abatement has resulted in the displacement of unknown bat colonies. This presentation will focus on the AGFD Bat Management Program's abandoned mine surveys including safety precautions, other wildlife uses, and renewed mining and hazard abatement issues.

THE NORTH AMERICAN BATS AND MINES PROJECT: A COOPERATIVE APPROACH FOR INTEGRATING BAT CONSERVATION AND MINE LAND RECLAMATION

D.A.R. Taylor. Bat Conservation International, Inc., P.O. Box 162603, Austin, TX 78736.

Abandoned underground mines have become essential habitat for more than half of North America's 44 species of bats. This includes some of the largest remaining populations, and all that are listed as endangered. Tens of thousands of abandoned mines have been closed across North America without consideration for bats, and thousands more are slated for closure. Available evidence suggest that millions of bats have already been lost. The continued closure of abandoned mines without first conducting biological surveys could endanger even currently abundant species. This threat to bat survival is cause for serious concern. The North American Bats and Mines Project (NABMP) is a partnership effort between BCI and the USDI Bureau of Land Management created to address this critical conservation issue. Already in its second year, the NABMP is providing national coordination and leadership among federal, state, and private agencies and the mining industry to minimize the loss of bats living in mines. This is being accomplished by 1) educating the public and natural resource managers on the importance of mines to bats, 2) providing training on mine assessment and closure methods that protect both bats and people; 3) providing assistance to agencies and industry to protect existing mine-roosting bat populations, 4) facilitating the development of partnerships and cooperative efforts between agencies, industry, and individuals involved in abandoned mine management and wildlife conservation, and 5) assisting the mining industry to develop cost-effective techniques for the creation of new bat habitat during active mining and mine land reclamation efforts.

ROOSTING ECOLOGY AND ROOST-SITE PREFERENCES OF REPRODUCTIVE FEMALE *Eptesicus fuscus* AND *Lasionycteris noctivagans* IN THE PEND D'OREILLE VALLEY IN SOUTHERN BRITISH COLUMBIA

Vonhof, M.J. Department of Biology, York University, North York, ON, Canada M3J 1P3.

During the summers of 1993-94 I characterized the trees used by bats as roosts in the West Arm Demonstration Forest in the southern interior of British Columbia. Bats exhibited a strong preference for tall trees in areas with low percent canopy closure, and short distances to other available trees. The bats also preferred western whit pine (*Pinus monticola*) in intermediate stages of decay. During the summer of 1995 I focused on the roost-site preferences of female big brown bats (*Eptesicus fuscus*) and silver-haired bats (*Lasionycteris noctivagans*) in the Pend d'Oreille valley, located just north of the U.S. border in southern British Columbia. Tree roosting sites were located by attaching radio-transmitters to pregnant and lactating female bats and tracking them to their roosts. Once tree roosting sites had been located I measured a range of tree- and tree-site characteristics. I found approximately 15 roost trees used by each species. With only two exceptions, all roosts were in abandoned woodpecker cavities. The majority of big brown bat roosts were in trembling aspen (*Populus tremuloides*), but silver-haired bats were commonly found in both trembling aspen and Douglas-fir (*Pseudotsuga menziesii*). Bats of both species switched roosts regularly, even while lactating, and subsequent roost trees were generally located within a relatively small area. I made comparisons between the roost trees used by the two bat species, and between roost trees and randomly-selected available trees from both the immediate vicinity of the roost trees and other areas of the same stand. The results of these analyses will be discussed.

New Video Available

Bat-free Belfries: A Guide to Bat-proofing

No other mammals live as closely with humans but are as misunderstood as our northeastern bats. This video explores the role of bats in northeastern ecosystems and highlights the need for their protection and management. The video also gives detailed guidelines on dealing with a single bat or a colony of bats in a building, identifying bat entrances, sealing buildings to prevent bat access, and providing alternative roosts or bat boxes, for displaced maternity colonies to occupy. The program is intended for homeowners seeking solutions to a bat problem as well as for county extension agents, pest control operators, and wildlife conservation officers confronted with bat nuisance complaints.

Program content was developed by Lisa M. Williams-Whitmer, Wildlife Extension Assistant, and Margaret C. Brittingham, Associate Professor of Wildlife Resources, School of Forest Resources, Penn State University.

This video is available from:

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P.O.Box 10, Scoharie, NY 12157
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The purchase price is $35.00 plus $4.00 shipping and handling, and includes the 23 minute video and the 22 page booklet; **A Homeowner's Guide to Northeastern Bats and Bat Problems.**

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The 26th Annual North American Symposium on Bat Research

will be held

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Detailed information will appear in successive issues of Bat Research News.

Ed. note[see, I really have retired! GRH]

BAT RESEARCH NEWS

Volume 37: Nos. 2 & 3 Summer - Fall 1996

BAT RESEARCH NEWS

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Subscriptions to individuals are $15.00 [US funds] per volume(year). All issues are sent surface mail, postage paid by ***Bat Research News*** to all addresses world-wide. Special arrangements have been made to serve European and Australian, and New Zealand subscribtions via air mail for an additional $5.00 per year.

Subscriptions to institutions are $ 25.00 per volume(year).

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Bat Research News is : ISSN 0005-6227
United States Internal Revenue Service tax exemption number 16-1356633

Bat Research News is printed and mailed at:
Potsdam College of the State University of New York,
Potsdam, NY, 13676, U.S.A.

BAT RESEARCH NEWS

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Front Cover

The front cover is the logo of the VII European Bat Research Symposium kindly provided by Peter Lina.

BAT RESEARCH NEWS

Volume 37: Numbers 2 & 3 **Summer and Fall 1996**

Original Issue Compiled by Dr. G. Roy Horst, Publisher and Managing Editor of *Bat Research News*, 1996.

Bat Research News is ISSN # 0005-6227.

BAT RESEARCH NEWS

Volume 37: No. 2 & 3 Summer - Fall 1996

Unusual Foods of the Lesser Spear-Nosed Bat, *Phyllostomus discolor*

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Phyllostomus discolor is a phyllostomid bat with a wide distribution, occurring from southeastern Mexico to southwestern Brazil. This species rests in several types of roosts, such as hollow trees and tree holes, caves, culverts, and buildings (Eisenberg, 1989; Nowak, 1991). The diet of *P. discolor* appears very diverse. Although considered by some authors to be primarily frugivorous (Gardner, 1977), *P. discolor* feeds also on pollen, nectar, and insects (Gardner, 1977; Nowak, 1991). Fleming et al. (1972) analyzed the food of *P. discolor* in Costa Rica and Panama and found 99% insects and only 1% fruit. On the other hand, Heithaus et al. (1975) reported that pollen predominated in the stomach contents of lesser spear-nosed bats in Costa Rica; in addition to pollen, those authors also found insects, but no seeds. *Phyllostomus discolor* is an important flower visitor, pollinating several species of plants (Sazima and Sazima, 1977; Dobat and Peikert-Holle, 1985). In contrast to the other reports, Willig (1983) suggests that *P. discolor* is omnivorous, and in captivity, *P. discolor* eats meat (McNab, 1969), although it does not display the predatory behavior that is typically observed in the larger *P. hastatus* (Eisenberg, 1989).

In the following note, we present data on items of food found under a roost of the lesser spear-nosed bat and collected in March 1994, in the urban area of Crato (07° 13' S, 39° 24' W), State of Ceará, northeastern Brazil. The remains were found on the floor of a church tower (Catedral da Sé), in which a colony of *P. discolor* roosted. We identified seeds of *Cecropia sp.* (Cecropiaceae), wing fragments of hydrophilid beetles, and the leg of a frog (*Leptodactylus ocellatus*: Leptdactylidae) among the remains discarded under the roost.

Phyllostomus discolor is known to feed on many plant species (Dobat and Peikert-Holle, 1985; Gardner, 1977). However, we are unaware of previous references to the use of *Cecropia* infructescences as a food item by *P. discolor*. *Cecropia* infructescences are also eaten by the larger *P. hastatus* (Gardner, 1977).

Leptodactylus ocellatus is a large frog (120 to 140 mm in body length) with terrestrial habits (Cei, 1980), and its predation by the lesser spear-nosed bat suggests that this bat is able to recognize and capture live prey on the ground and carry it to the roost. According to Duellman and Trueb (1986), predation on anuran amphibians is known from only two bat genera: the Old World Megaderma (probably only *M. lyra*---Nowak, 1991) and the New World species *Trachops cirrhosus*, a phyllostomid that is smaller than *P. discolor* (Ryan et al., 1982; Tuttle and Ryan, 1981; Tuttle et al., 1982). Nevertheless, *Chrotopterus auritus*, another New World bat, also feeds on frogs (Sazima, 1978). Our report, however, is the first record of predation on amphibians by *P. discolor*, and we suspect that *P. hastatus* also include frogs in its diet, since it is known to feed on small vertebrates, such as lizards, birds, mice, and other bats (Gardner, 1977).

Acknowledgments

We thank Drs. Franco de Assis G. de Mello, Ivan Sazima, Jorge Jim and Nelson Bernardi for reading the manuscript, and Drs. João Vasconcellos-Neto and Jorge Jim for identification of the seeds and the frog, respectively.

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Noteworthy Records of Some Bats from Michoacán, México

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The state of Michoacán contains about 51% of the bat species that are known from México. However, it was not until 1949 that Hall and Villa published the first annotated list for the state. Since that time, few additional studies have been conducted. The best studied region is the coast (Alvarez, 1968; Polaco and Múñiz-Martínez, 1987; Sánchez et al., 1985), whereas inland areas have been little worked (Huerta, 1989; Lechuga, 1993; Uribe et al., 1981). For this reason, in 1994, the authors of the present report joined with Robert D. Owen and Ricardo López Wilchez to begin a survey in the state, consisting of intensive field work and examination of mammal collections in México and the United States. In this paper, we report new locality records for bats in Michoacán and include descriptive information, including body mass (in grams) and external and cranial measurements (in millimeters). Specimens reported herein are deposited in the mammal collection at the Facultad de Ciencias Biológicas, Universidad Michoacána de San Nicolás de Hidalgo (UMSNH).

Myotis auriculacea apache Hoffmeister and Krutzsch, 1955

An immature male was captured in the city of Morelia, in a building of the Universidad Michoacána de San Nicolás de Hidalgo, in September 1978 (UMNSH 117). This specimen represents the first record for the state. The closest previous records are from 10 mi NNE de Pihuamo, Jalisco, 3500 ft (Genoways and Jones 1969), and Cueva Plaza de Gallos, 10 km NW Ixcateopan, Guerrero (León and Romo, 1993). The area surrounding the University is covered by short grasses with some trees. However, the city of Morelia has many old buildings that may give refuge to these bats.

The tips of dorsal hairs are cinnamon-buff, and the bases are blackish; the tips of ventral hairs are pale brown, with the bases black. The ears, wings, and interfemoral membrane are blackish. External measurements are: total length, 83; length of tail, 43; length of hind foot, 10; length of ear, 20; and length of forearm, 38.5. Cranial measurements are: greatest length of skull, 16.7; braincase breadth, 9.6; zygomatic breadth, 9.8; width of least postorbital constriction, 4.0; length of maxillary toothrow, 6.5; length of mandibular toothrow, 8.1; and mandibular length, 12.7.

Myotis carteri LaVal, 1973

Some authorities consider this taxon a subspecies of *Myotis nigricans* (Koopman, 1993). We examined two males (UMNSH 1710 and 1711) from SE of Tirio, municipio of Morelia, captured in November 1992. This locality is 220 km S of a previously reported site at 6 mi NE of Tamazula, Jalisco (Hall, 1981). The dominant vegetation in the area of Morelia is temperate forest. The dorsal hairs of the specimens were about 8 mm in length. The base of each dorsal hair is black, and the tip is brown or pale brown, resulting in a speckled appearance; underparts are paler, with the base of each ventral hair blackish. Membranes are blackish.

External measurements of the two specimens, respectively, are: total length, 65, 62; length of tail, 25, 32; length of hind foot, 7, 7; length of ear, 10, 11; and length of forearm, 34.4, 34.3. Body mass was 4.0 and 3.6, respectively. Cranial measurements are: greatest length of skull, 14.1, 13.8; braincase breadth, 6.7, 6.5; width of least postorbital constriction, 3.7, 3.6; length of maxillary toothrow, 5.3, 5.3; length of mandibular toothrow, 6.4, --; and mandibular length, 10.0, --.

Nyctinomops laticudatuus ferrugineus (Goodwin, 1954)

Five specimens were captured in a building at the Escuela Superior Forestal de Uruapan (ESFU), in the city of Uruapan, in April 1980. The capture locality is 310 km from a previously reported site at 2 km SE of Alpuyeca, Morelos (Álvarez and Ramírez, 1972). The dominant vegetation in the area is temperate forest. Specimens include four females and a male (UMNSH 325, 326, 457, 494, and 823). All were

sexually immature at the time of capture. Average external measurements of the females and the single male are: total length, 112.2 (99-117), 99; length of tail, 39.7 (38-43), 42; length of hind foot, 8.7 (8-10), 7; length of ear, 19.5 (17-21), 17; length of forearm, 45.5 (44.6-46.1), 44.6; and weight (females only), 112.5 (12-13). Average cranial measurements of the females and the single male are: greatest length of skull, 19.3 (19.0-19.3), 19.2; condylo-incisive length, 17.0 (16.8-17.3), 17.0; zygomatic breadth (three females), 10.4 (10.4 10.5), 10.4; braincase breadth, 8.8 (8.4-9.0), 8.9; width of least postorbital constriction, 3.7 (3.6-3.8), 3.7; length of maxillary toothrow, 7.2 (7.0-7.2), 7.1; length of mandibular toothrow, 8.2 (8.108.4), 8.1; and mandibular length, 13.6 (13.4-13.8), 13.7.

Acknowledgments

We thank the authorities of CONACyT for their support of the project "Mamíferos Silvestres del estado de Michoacán" (400-355-5-1361-N), awarded to Cornelio Sanchez H., and the National Science Foundation for their support of the project "The Mammals of Michoacán, México, Zoogeography in an Area of Endemism and Biotic Interface," awarded to Robert D. Owen.

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Myotis volans in Morelos, México

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As part of a survey conducted in the Corredor Biológico Chichinauitzin, a protected area of México city and Morelos state, two *Myotis volans* were collected, from different localities in Morelos, and represent the first records for the state. The closest previous record is from the slope of W Popocatépetl, km 15 of the Amecameca-Tlamacas Highway, 3,220 m (Ceballos and Galindo, 1984, Mamíferos silvestres de la cuenca de México, Limusa, México, D.F., 299 pp.). Both specimens were deposited in the mammal collection at the Facultad de Ciencias Biológicas, Universidad Autónoma del Estado de Morelos (UAEM).

The first bat (UAEM 0611) is a male with inguinal testes that were 1x1 mm in size. This bat was caught in March 1995, at 1.5 km NE San Juan Tlacotenco, municipio of Tepoztlán (19° 01.07' N, 99° 05.07' W), 2,570 m, in a net set around a small pond. The vegetation at this site is oak forest (*Quercus* spp.) and cultivated lands. In the same net, *Lasiurus borealis* and *Dermanura azteca* were caught.

The second specimen (UAEM 0648) is also a male, captured in April 1995, at 1.5 km SW Santo Domingo Ocotitlàn, municipio of Tepoztlán (18° 59.79' N, 99° 03.62' W), 1,890 m, in a net set near a cave. This area is covered by second-growth vegetation and pine forest (Pinus spp.). At the same site, we caught *Artibeus jamaicensis, Leptonycteris nivalis,* and *Chiroderma salvini.*

External measurements (in mm) and weight (in g) of the specimens 0611 and 0648, respectively are: total length, 75, 77; tail length, 38, 33; hindfoot length, 6, 6; ear length, 12, 11.5; forearm length, 32.7, --; weight 4.0, 4.0. Cranial measurements (in mm) are: length, 13.6, 13.7; braincase breadth, 12.0, 12.0; interorbital constriction, 3.2, 3.3; interorbital breadth, 4.2, 3.9; maxillary toothrow, 5.1, 5.3; mandibular length, 9.2, 9.6; and length of mandibular toothrow, 6.1, 6.0.

An Abnormal Pregnancy in the Indian Fruit Bat, *Rousettus leschenaulti*

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While studying growth-related embryonic morphology of the Indian fruit bat, *Rousettus leschenaulti*, we discovered that one female, collected from an abandoned manganese mine, at Kandri Mines, Nagpur, on 23 February 1984, showed an unusual pregnancy. When the uterine lumen and vagina were opened, it was observed that the conceptus, which appeared like a lump of flesh, occupied not only the uterine lumen but extended into the vagina up to the vulvar opening (Fig. 1, left). The lump was divided into two portions; the smaller part occupied the uterine lumen, whereas the larger part occupied the vagina (Fig. 1, middle). The cup-shaped chorioallantoic placenta, with the yolk-sac gland abutting its fetal surface, was present at the normal site, towards the mesometrium. One end of the short umbilical cord was attached to the fetal border of the placenta, whereas the other end appeared to arise form the top of the smaller portion of the lump (Fig. 1, right).

Careful examination under a dissecting microscope revealed that the lump was actually an embryo with apparently stunted growth, because *Rousettus* embryos collected on this date are usually in an advanced stage of development. The larger portion, which occupied the vagina, was actually the head of the embryo, and the smaller portion, lying in the uterus, was the body. The embryo faced dorsally.

Further observation indicated that, in addition to stunted growth, the embryo showed a number of abnormalities. The compressed head was thrown to one side and was smaller in size than the head of a normal embryo of this stage. The skull had soft, fleshy jaws with no teeth, the mouth was not bounded by

proper lips. Both eyes appeared on the lower side of the snout. Although both nostrils were present, one was continuous with the upper lip. Ear pinnae were small and triangular, and only the right wing possessed fleshy claws, including a minute claw on the index finger, which is characteristic of the Megachiroptera. The stunted hind limbs showed five fleshy claws on each limb, but the foot appeared bifurcated into two parts--one part with two fleshy claws and the other with three. A short tail-bud and a protruding penis also were observed. Embryos from seven different families of Chiroptera have been observed in our laboratory during the last four decades, but this is the first report of an unusual pregnancy, with abnormalities, in an embryo of *Rousettus leschenaulti* collected from a wild population.

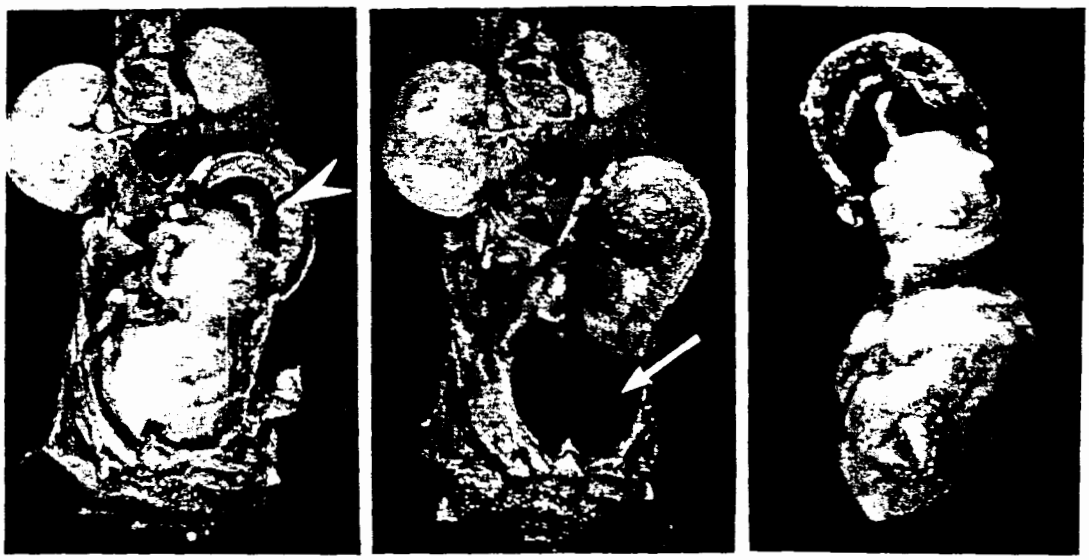

Figure 1. Abnormal fetus of *Rousettus leschenaulti*. The left photograph (x 2) shows that the lumplike conceptus is comprised of a small portion occupying the left uterine corner and a larger portion occupying the vagina, up to the vulvar opening. The placenta lies towards the mesometrium (white arrowhead), and the black arrow points towards the right ovary and uterus. The middle photograph (x 2) shows the larger portion of the conceptus lifted to reveal the vaginal lumen (arrow). The right photograph (x 5) is a close -up of the embryo, along with its umbilical cord, yolk-sac gland, and placenta. The larger portion is the head of the embryo, and the smaller portion is the body. The arrow points toward the claws of the hind limb.

Bats in Military Service: United States Naval and Marine Corps Aviation

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In the 33rd volume of Bat Research News, Horst (1992) featured an insignia of the Naval Sea Combat Systems Engineering Station at Norfolk, Virginia, which depicted a "Seabat," an anatomically correct drawing of a bat carrying an anchor. Horst (1992) stated that "apparently this is the only official military ensignia (sic) that carries the likeness of a bat." This comment stimulated us to look further into the subject, and since then, we have compiled a data base of military aviation units that use bats, in one form or another, as a heraldic device in their unit's insignia or as the namesake of a particular weapon.

In this paper, we present general information on the use of bat-related insignias and weapons, used by units of the United States Navy and Marines. A future paper will provide similar information for units of the United States Air Force and the Royal Air Force of Great Britain. We encourage anyone with further information (sources and corrections) dealing with bats and squadron heraldry to contact the senior author so that we may add to this growing data base.

History

Official and unofficial aviation insignia began to flourish during World War One (WWI), and many of the WWI designs are in use today. The first semi-official organizational insignias for the U.S. Navy began to appear in the fledgling Naval Aeronautical Organization in the early 1920s. Official insignias were placed on squadron aircraft, equipment, stationery, and the aviator's prized leather flight jacket. (A squadron is an organization established to perform a specific mission or task). By the beginning of World War Two (WWII), all Army Air Corps and Naval/Marine Aviation squadrons and aircraft carriers had official, distinctive insignias. New designs, both official and unofficial flourished during WWII and were placed on aircraft, ships, submarines, and even army tanks and vehicles.

In the past, insignias of the United States were most often in caricature form, in contrast to Great Britain and its associated military forces that used a more formal, heraldic design. However, since the 1970s, official insignias of U.S. military aviation units have become more formal in size, design, and shape, conforming to regulations that shy away from caricatures and politically incorrect designs. Nevertheless, unofficial insignias still appear in squadrons, often displaying irreverent humor (Nelsen and Parsons, 1990; Roberts, 1995).

In most cases, squadron insignia depicted the various functions or missions of the unit, and squadron heraldry was often shared among sister squadrons in the same air group or combat wing. These insignias were often transferred after the unit received a nomenclatural (administrative) redesignation, taken on by another squadron after the original squadron was disbanded, or sometimes maintained even though the mission of the squadron changed (e.g., from fighter to attack squadron).

Nomenclature

A brief overview of squadron and aircraft designations may assist the reader. With respect to naval aviation, a squadron's designation is comprised of a series of letters. The first letter--V, Z, or H--designates a squadron equipped with heavier than air vehicles (fixed wing), lighter than air vehicles (blimps), or helicopters, respectively. The second letter reflects the mission of the squadron such that O, S, P, F, T, and B designate Observation, Scouting, Patrol, Fighter, Torpedo, and Bomber aircraft. The second letter in Marine squadrons is always M followed by the same mission designators used by the Navy. For example: "VP-4" translates into Patrol Squadron Four," operated by the United States Navy, whereas "VMFA(AW)-242" translates into "Fighter/Attack Squadron (All-weather) 242," operated by the United States Marine Corps.

Bats in Uniform

The earliest, if not first, use of bats in insignia of U. S. Naval squadrons is found in Observation Squadron VOS-3S, circa 1923. Ironically, their scout aircraft were so poorly suited to observation duties that both pilots and the observers complained of being "blind as bats." During this time, observation squadrons, which often flew out of Guantanamo Bay, Cuba, specified a "Cuban bat" (perhaps *Artibeus*) to represent their "blind" status. The logo stuck, and was used by the squadron as its designation changed to VS-5S, VS-5B, VCS-2, and finally VS-6S (Table 1), before it was disbanded in 1937.

Despite this unfortunate introduction into military service, bat insignia soon came to dominate emblems carried by nightfighter, patrol, and observation squadrons because of the remarkable ability of bats to navigate in the dark. The rationale for including a bat in the "official" insignia of a squadron varied, and what follows is an unedited sampling of those reasons, which were obtained from the records of the Tailhook Association (San Diego, CA). "Radar is the third eye of the all-weather night pilot." "[Bats] embody the qualities of ferocity, determination, and aptitude in the use of all airborne weapons." "The bat is a predatory creature who hunts his prey at night using a natural detection system to locate, identify, track, and strike, not unlike the Grumman A-6 Intruder attack aircraft." "The bat represents Beelzebub, the Prince of Demons in Milton's Paradise Lost."

Without question, however, the most intriguing explanation came from Torpedo Squadron 27, based in the South Pacific during World War Two. They chose a flying fox (apparently *Epomophorus*) because it " . . . is a large fruit eating mammal indigenous of the area in which VT-27 had most of its battle experience. It's night flying proclivity is also indicative of the squadron's success. The wile and cunning of the fox are well known and desirable characteristics for naval aviators. The flying fox in the last extremity serves as food for the lost pilot."

Bats were never quite able to compete with the "pin-up girl" nose-art that graced many aircraft during WWII, though the Vargas-like pin-up figures of Batgirl used by Patrol Squadron VP-24 and Nightfighter

Squadron 103 are fine efforts. It is of interest that in today's politically correct Navy, VP-24's Batgirl is the sole survivor of a long lineage of officially sanctioned, but less-than-correct, insignia (Fig. 1).
Bat caricatures were the clear choice of squadrons that carried the Bat glide bomb (see below), and Walt Disney even got into the act and drew up bat cartoon figures for Night Torpedo Squadron VT(N)-90 and the lineage of squadrons named "Hell Razors" (sic): VB-81, VA-13A, VA-134, VF-174, and VA-174 (Fig. 3). Disney studios went on to produce some 1,200 military insignia of all types during WWII (Rawls, 1992).

A Bat Bomb--Project X-Ray

Couffer's (1992) enjoyable book, "Bat Bomb," is a great story about an idea that wasn't. The following quote from McCracken's correspondence with R.A. von Doenhoff of the United States National Archive concerning Project X-Ray (McCracken, 1990) briefly summarizes this debacle.

"Project X-Ray was an experiment undertaken by the Department of the Navy to determine if incendiary devices attached to bats would be useful if they were released form aircraft over major Japanese cities. The theory was that the bats would be released just before dawn with incendiary devices with timers attached to each bat. As daylight approached, the bats would head for dark recesses of wooden Japanese houses. When the bats were safely asleep, the incendiary devices would ignite, thus producing a conflagration of unprecedented proportions. A test run of this theory was carried out in the southwestern United States. However, the advent of the atomic bomb rendered this experiment moot."

The Other Bat Bomb

Despite the failure of Project X-Ray, a lesser-known weapon system named Bat did, in fact, exceed expectations and was active in the arsenal of the United States Navy from 1945 through 1953 (Buford and Boyd, 1953; Huff, 1950; Van Vleet et al., 1981). Indeed, the Bat air-to-surface missile (ASM-N-2: Special Weapons Ordinance Device--SWOD Mk 9) was the first fully automatic guided-missile to be used operationally by any of the combatants during WWII. Once launched, the Bat went solo, guided to its target by an early S-band radar unit, developed by the Bell Telephone Laboratories. There were many wire-, radio-, and television-guided bombs, either gliding or self-propelled, that were used by the Germans and Americans during the war (e.g., Henschel Hs-293, GB-4); however, the Bat was the very first, fully-automatic weapon system, the archetype of what we now term "fire-and-forget" weaponry.

The ASM-N-2 Bat was a relatively simple glide bomb (12.3-feet long with a 10.0-foot wingspan), with a gross weight of 1,700 pounds, including its 1,000-pound charge (Fig. 4). Though primarily an anti-shipping weapon, it was also used as a gunnery target. Two of the 2580 ASM-N-2 Bat airframes that were built remain intact; one can be found at the Planes of Fame Museum (Chino, California), and the other at the Admiral Nimitz State Historical Park (Fredricksburg, Texas).

The aircraft that carried the Bat was the Consolidated PB4Y-2B Privateer patrol bomber, though the Navy also experimented with the much smaller Vought F4U-4 Corsair (Davis, 1987; Huff, 1950; Sullivan, 1994; Van Vleet et al., 1981). The first operational use of the Bat occurred on April 23, 1945, when Privateers of VPB-109 launched two Bats against Japanese shipping near Borneo. VPB-109 had been the first squadron to be equipped with the Bat, but was followed soon thereafter by VPB-123 (European Theater of Operations) and VPB-124 (Pacific Theater of Operations). Immediately after the war, VP-24 and VP-25 took over the job of carrying this weapon system but were redesignated VP-104 and VP-115 in 1946 (Van Vleet et al., 1981). Without an enemy, post-war Privateer crews were forced to maintain their proficiency with the Bat by attacking icebergs in the North Atalantic. In 1953, an upgraded version of the Bat (ASM-N-2A) made its appearance, but it was removed from naval inventory soon thereafter.

Acknowledgments

We acknowledge the assistance of J. Jacobs of the Tailhook Association, R. Grossnick, J. Walters, and W. Baker of the Navy Historical Center, R. Ferrin (ret.) and A. Wagner (ret.) of VP-24, C. Krus of VQ-1, J. Rabine of VMFA(AW)-242, M. Atherton of Mesotech Systems Ltd., E. Brown of the "Crosswind"--NAS Whidbey Island, F. Mormello and B. Reed of the Planes of Fame Museum, A. Krueger of the Admiral Nimitz State Historical Park, and finally, the staff of the Seattle Public Library Aerospace Archives for their help, good humor, and patience during this undertaking. I greatly appreciate the editorial services provided by A. Kurta of Eastern Michigan University. A very special thanks goes to J. Clark of the University of Washington, H. Reed of the National Archives and Records Administration, and S. Gindes of Visual Image Presentations for their photographic services.

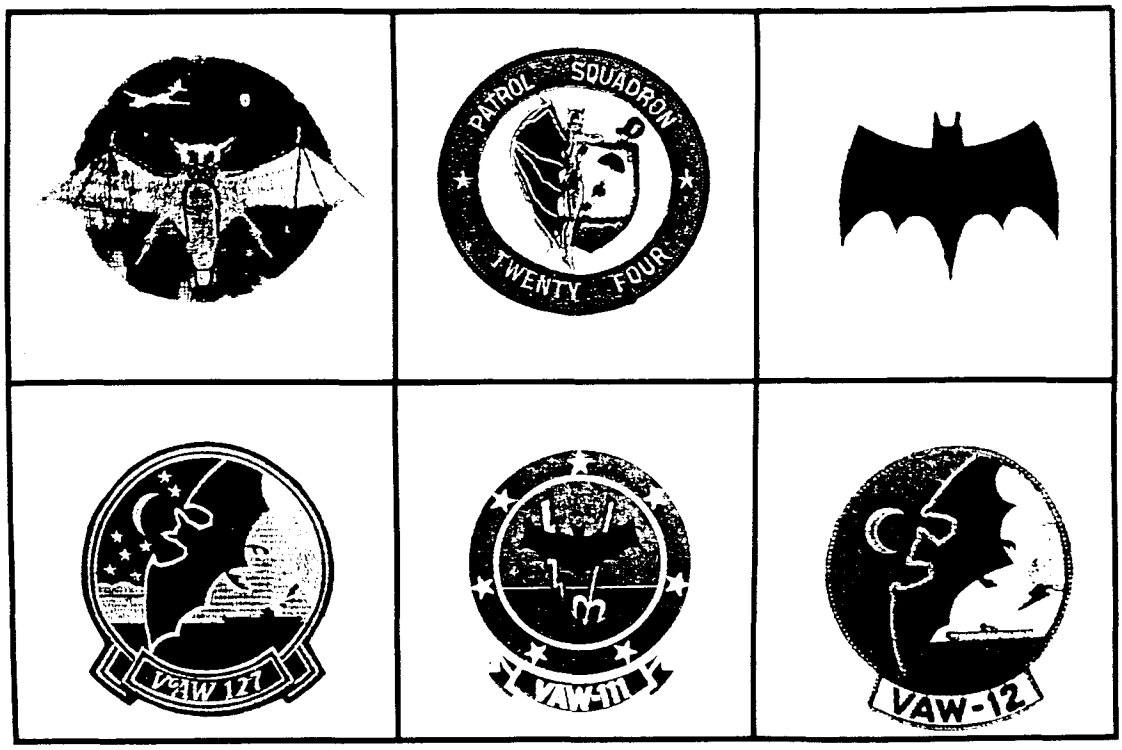

Figure 1.—US Navy Patrol and Early Warning Squadrons: Clockwise from upper left, VP-HL-4, VP-24, VP-24 (Variant), VAW-12, VAW-111, VAW-127 (note re-use of VAW-12 insignia).

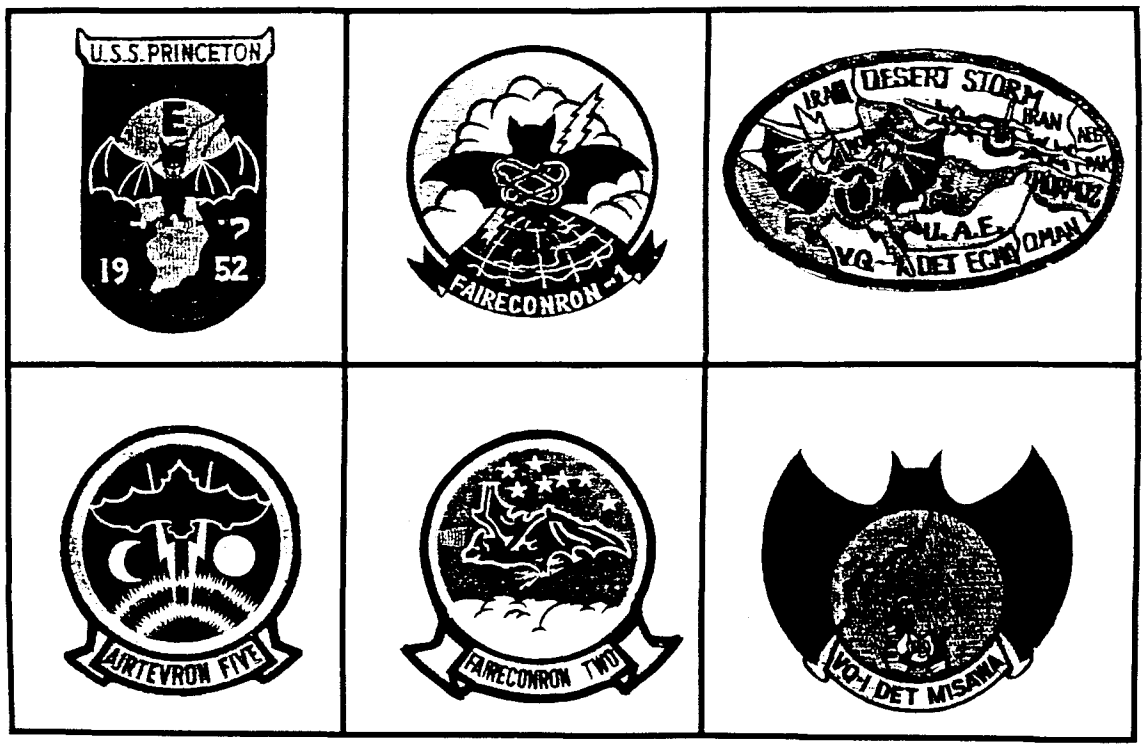

Figure 2.—US Navy Early Warning Squadrons (continued): Clockwise from upper left, VC-35, VQ-1, VQ-1 (Det. Echo), VQ-1 (Det. Misawa), VQ-2, VX-5 Test-Evaluation Squadron.

Figure 3.—US Navy Fighter and Attack Squadrons: Clockwise from upper left, VF-174 (Walt Disney), VMFA-312 USMC, VMFA(AW)-242 USMC, VAH-13, RVAH-13, VA-127.

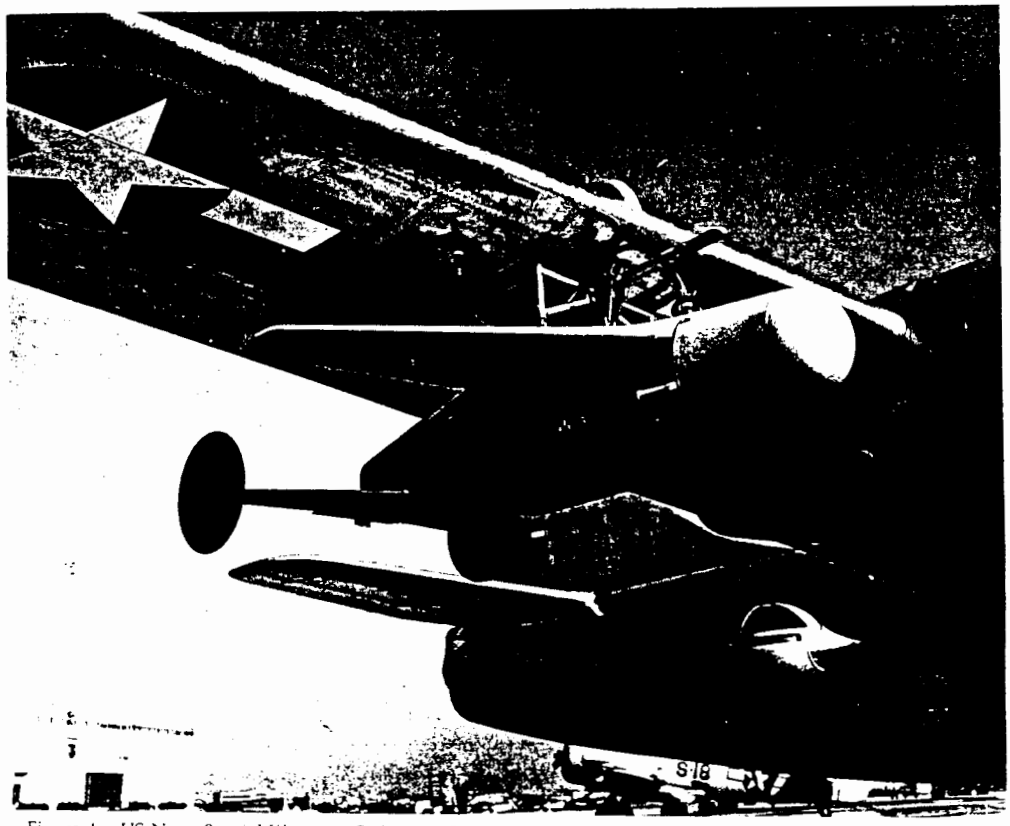

Figure 4.—US Navy Special Weapons Ordinance Device - SWOD Mk 9, ASM-N-2 (USN photo 80-G-701606).

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Editor's note: While the preceeding article is not about bat biology or bat research, it does concern the role that bats have played in history, and presumably many will find it interesting. We anticipate several critical letters from our readers, which will be a welcome change from our usually very silent readership.

BOOK REVIEW

Faune de Madagascar, vol. 84, Chiroptères

Paris: Muséum national d'Histoire naturelle (1995). Pp. 204. Price 300F

†R. L. Peterson, J. L. Eger, and L. Mitchell.

In the late 1960s, Randolph Peterson commenced work on the bats of Madagascar, and this remained his major research project for the rest of his life. Unfortunately this work remained unfinished at the time of his death in 1989. However, this has now been completed by Eger and Mitchell. Though the work was originally written in English, the published version is entirely in French, without an English summary. I am indebted to Judith Eger for sending me a draft of the original.

The first seven pages give a brief historical survey of the literature, ecological regions of Madagascar, abbreviations and measurements used, statistical methods, and acknowledgments. Most of the remainder is taken up with accounts of the seven families, 17 genera, and 29 species that are recognized (a few doubtfully) from Madagascar. For each taxon, there is a diagnosis and often other information. For each species, there is also a synonymy, distribution in Madagascar, systematic variability, "biology," and remarks. There is also a drawing or photograph (the former more informative) of the dorsal, ventral, and lateral views of the skull and usually several external views of the head. Keys to species are given where appropriate. The work concludes with a list of references, gazetteer, and systematic index.

Peterson was a numerical pheneticist, which I am not, so there are extensive measurements for various OTUs, multivariate analyses and phenograms. Peterson was interested in determining relationships of the bats of Madagascar to one another and also with relatives elsewhere. In some cases he has come up with novel taxonomic arrangements. Thus, *Rousettus obliviosus* of the Comoro islands is treated as a subspecies of *R. madagascariensis*, *Nycteris madagascariensis* as an endemic species, *Triaenops auritus* as a species distinct from *T. furculus* and *T. rufus* from *T. persicus*. A new subspecies of *Eptesicus somalicus* is described (*E. s. malagasyensis*), and of the four species of *Miniopterus* in Madagascar, three are considered endemic (*manavi*, a species distinct from *M. minor*; *majori*, a species distinct from *M. schreibersii*; and a new species, *gleni*, treated as distinct from *M. inflatus*). In the Molossidae, *leucogaster* is treated as a species distinct from *Tadarida pumila* (which is also recorded from Madagascar, but not sympatrically); also *leucostigma* is considered as a species distinct from *T. condylura*. *Otomops madagascariensis* is treated as an endemic species more closely related to *O. formosus* of Java than to the African *O. martiensseni*, in which it has been placed.

One species of Malagasy bat is left unidentified, a small *Pipistrellus*, which Dorst had previously referred to the African *P. nanus*. I have seen the only specimen that Peterson was able to study, a skull at the Museum of Comparative Zoology. I agree with Peterson that the specimen agrees best with *P. nanus* (= *africanus*), among the African *Pipistrellus*, but is too large and differs in some other characters. While it clearly cannot be referred to any known African species, it will be necessary to compare it with species of southern Asia, since several of the other Malagasy bats show this geographical relationship.

While some will not agree with Peterson's methods or taxonomic conclusions, this work is clearly far superior to any previous treatment of the bats of Madagascar. Any future work on the bats of this large island, as well as work on related forms, will have to take Peterson's work into account.

Karl F. Koopman, Dept. Mammalogy, American Museum of Natural History, New York, NY 10024-5192.

RECENT LITERATURE

Authors are requested to send reprints of their papers to the Editor (Tom Griffiths, Dept. of Biology, Illinois Wesleyan Univ., Bloomington, IL. 61702-2900, U.S.A.) for inclusion in this section. If reprints are scarce, please send a complete citation (including complete name of journal and author mailing address) to:

tgriff@titan.iwu.edu by e-mail.

Receipt of reprints is preferred at it will facilitate complete and correct citation. Our Recent Literature section is based on several bibliographic sources and for obvious reasons can never be up-to-date. Any error or omission is inadvertent. Voluntary contributions for this section, especially from researchers outside the United States, are most welcome.

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The Abstracts of Papers and Posters Presented at the VII European Bat Research Symposium Veldhoven, The Netherlands 12 - 16 August, 1996

Ed. note: Many of the manuscripts were contributed by authors whose first (or even second or third) language is not English. Some of these have been edited for grammatical corrections or more appropriate phraseology to render them into more easily understood English. In a few cases this was a rather difficult undertaking, but in no case did we intend any change of meaning or alterations of concepts. Any changes which resulted in an impression not intended by the authors, is inadvertent, and the editors apologize sincerely. Peter Lina and Roy Horst

The Effectivness of Various Survey Methods for Bats in Biscay (Basque Country, Northern Iberian Peninsula)

J.R. Aihartza, E. Imaz, M.J. Totorika & E. Bernedo

Animali Biologia eta Genetika Saila. Unibertsitatea. 644 p.k. 48080-Bolbo. Basque Country (Spain)

Biscay is a 2,348 km^2 region in the northern part of the Iberian Peninsula. From December 1993 onwards, an intense survery has been carried out to determine the distribution of bats. Different survey methods have been used such as visits to potential roosts (caves, mines, churches...), the use of mist-nets, ultrasound detectors and others. We have obtained 281 records(106.2 records/1,000 km^2) of 17 species, of which eight were recorded for the first time in the territory. Results obtained with different survey techniques are compared. Records of presence, species detected, and effort are used to estimate the effectiveness of each method in such a distribution survey. The detectability of the various species using each technique is shown as well.

Bat Fauna of Moldavian Underground Shelters

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In 1995 and 1996 summer and winter studies of the bat fauna have been carried out in Moldavian underground shelters. 58 undergrounds have been investigated, 10 of these being natural grottoes and caves, 17 hand-exploited mines and 31 machine-exploited limestone mines. The mines are more numerous and larger, with a total length varying from a few metres to more than 50 km. The undergrounds are inhabited by 12 species of bats: *Rhinolophus ferrumequinum, Rh. hipposideros, Myotis blythii, M. bechsteinii, M. dasycneme, M. daubentonii, M. nattereri, M. mystacinus, M. ikonnikovi, Plecotus auritus, Barbestella barastellus,* and *Eptesicus serotinus. Myotis nattereri* and *Rh. ferrumequinum* were found only in the summer period, *M. bechsteinii* only in the winter period. The most frequent species are: *Rh. hipposideros, M. blythii, M. daubentonii* and *Plecotus auritus.* Less frequent are *M. dasycneme, M. mystacinus* and *E. serotinus.* Very rare species are: *Rh. ferrumequinum, M. nattereri, M. bechsteinii* and *B. barbastellus.* The most numerous are the colonial species: *Rh. hipposideros, M. daubentonii, M. blythii* and *E. serotinus.* the least numerous species are *Rh. ferrumequinum, M. nattereri* and *M. bechsteinii.* During the last 20 years the number of species has shown a decreasing trend.

A Comparision of Cadmium Levels in Greater Horseshoe Bat Droppings, Atmospheric Precipation and Soil Samples

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Greater Horseshoe bat *Rhinolophus ferrumequinum* droppings from a maternity roost at Stackpole and Slebech in West Wales were collected during 1995 for cadmium analysis. Samples collected at Stackpole in April, May, august, and September showed cadmium levels of 2.63, 1.42, 1.48, qnd 1.67 mg/Kg respectively. Fresh droppings collected from Slebech in August showed a relatively a low level of cadmium, 0.63 mg/Kg. These findings confirm the difference in cadmium levels at Stackpole and Slebech and the pattern of overall incremental rise from May to September as reported by Harries, but our study also shows an April cadmium level which is greater than any reported previously by Stebbings. We also

observed a high level of cadmium in Lesser Horseshoe bat, *Rhinolophus hipposideros* droppings from north Wales. Atmospheric precipitation, estimated from vaseline-coated tiles placed near the roosts at Stackpole and Slebech, showed low levels of cadmium in the range 0.08-0.31 mg/Kg. In comparison, cadmium in soil samples taken at the edge of the top pond at Stackpole were 1.43 mg/Kg at pH 7.48. Although cadmium in this soil was relatively high, it was below the statutory limit of 3 mg/Kg at pH 5.0 or more. In comparison, there was no cadmium in any soil samples near Slebech at pH 3.14. We suggest that the source of cadmium in the Stackpole bat colony may be partly from the aquatic larval stage of insects, which retain cadmium after emerging in the foraging area of the Stackpole roost.

The Influence of Weather on the Survival and Fecundity of a Colony of 55 KHhz. *Pipistrelles* in West Wales

Peter T. Andrews[1], Robin G. Crump[2] & David J. Harries[3]

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Annual survival and fecundity figures have been deduced from exit counts of a *Pipistrellus pipistrellus* colony made weekly from 1984 to 1994. The bats were of the 55 kHz echolocation type, with approximately 500 individuals in the colony. Annual variations in fecundity and survival were strongly correlated, which indicates that the changes in both quantities were caused by the weather. The data were analysed to reveal any dependence on temperature or rainfall. Both survival and fecundity were found to depend on the monthly average maximum temperatures in the early part of the season, with the March temperature having the greatest effect. Survival and fecundity were high in years when the maximum temperatures in March and April were low. The bats leave from hibernation during March and April and the results are interpreted as showing that survival was highest and pregnancies were most likely to come to term when hibernation was prolonged. The number of insects emerging in early summer is limited and the insect density is higher in years when the insects first become active after March. Hunting by flying bats is most profitable in these years and their survival and fecundity is above average.

Bats on Postage Stamps: a Centenary Survey

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The first postage stamps showing bats were issued in 1894 bv the Imperial Chinese Post: a small red 1-candarin and a large green 9-candarin have a round central design with five bats, which stands for "five-fold fortune". In 1941 Hong Kong issued a set of six stamps with small bats in the margin. Up to now, 79 stamps with stylized bats have been issued in China, Spain (Valencia's coat of arms), Commonwealth Islands, etc. In 1948, Chile issued the first real bat stamps: 3 *Sturnira lilium*. By the end of 1994, 133 stamps depicting 56 bat species, including one fossil bat (*Paleochiropteryx tupaiodon*), were available. Most of these (81.2%) were issued since 1980. The largest number of stamps comes from post-offices in Oceania, the Antilles, and even Indian Ocean islands; the smallest number is from continental Asia. Consequently, Pteropodidae are dominant (49.3% of the issues), well above Phyllostomidae (22.0%) and Vespertilionidae (I 0.3%). Only I I families have been illustrated on stamps. Some of these are underrepresented such as Rhinolophidae (130 species, only 13 stamps), whereas some others are overrepresented such as Noctilionidae (2 species, 4 stamps). The great interest in the latter family is due to the dietary preference of *Noctilio leporinus* . Specialized diets (piscivory or sanguinivory) are, in proportion, more often depicted than common ones (insectivory, and frugivory): 4, 3 versus 6, 9 stamps. About the other life history traits, most pictures are hardly informative. Bats are mainly portrayed alone (79.7%), flying (58.6%) or hanging by their feet (36.8%), but always with open eyes. Roosts are more often depicted for tree-dwelling species (40 stamps) than for cave-dwelling ones (9 stamps); the human habitat is utterly ignored. Nocturnal habits are only shown on 19 stamps, reproduction or echolocation on 3 stamps, and rabies on one stamp.

Function of *Pipistrellus pipistrellus* Social Calls: Field Data and a Playback Experiment

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We aimed to determine whether or not the so called social calls that are produced by foraging bats of two phonic types of *Pipistrellus pipistrellus* do indeed serve a social function. First, the relationship between insect availability and the rate of production of social calls was measured at a foraging site of both phonic types. Second, playback experiments of social calls were conducted in the field to determine the response of foraging bats to these calls, and to determine whether the calls are used in communication within or between phonic types. Two hypotheses are suggested for the function of social calls: either that they may be used to attract other bats to a food patch, or in agonistic interactions between bats in defence of a food patch. At relatively low insect densities, the rate of social call production of both phonic types increased significantly as insect density decreased. When social calls of each phonic types were broadcast, there was a significant reduction in bat activity of the same phonic type. In contrast playbacks of social calls resulted in no change in activity of the other phonic type. The results supported the food patch defence hypothesis, that social calls are used to warn off other bats of the same phonic type when insects are scarce. The results also supported the hypothesis that the two phonic types are sibling species. Social calls were shown to serve a social function in intraspecific communication, but there was no communication between phonic types.

Morphological Diferences between Two Cryptic Species of *Pipistrellus pipstrellus*

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The abundant bat *Pipistrellus pipistrellus* is likely to exist in Europe as two cryptic species. *P. pipistrellus* occurs as two phonic types, one echolocating with maximum energy close to 46 kHz, the other at 55 kHz on average (Jones, G. & Parijs, S.M. van (1993). *Proc. Roy. Soc. Lond. 25 1 B: 119 -125*). We investigated differences in cranial and bacular morphology between the phonic types. Skull morphology of the two phonic types was remarkably similar, though a multivariate analysis of 7 skull parameters from 57 bats assigned 79% to phonic type correctly, with cross-validation included in the model. The length of the mandibular tooth row between the upper canine and third molar, and mastoid breadth were the most important parameters separating the two phonic types. Differences in bacular morphology exist between several cryptic bat species, and may function in reproductive isolation. The bacula of the two phonic types of *P. pipistrellus* were similar in gross morphology, but the angle between the shaft and the basal flanges may be a useful identification feature. We discuss the evolutionary significance of morphological conservatism and acoustic divergence in these bats.

Bat Boxes as a Possible Replacement for Problematic or Destroyed Roosts in Buildings

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Various bat species occasionally choose roller blinds and cavities in buildings as their roosts. However, these very often are likely to cause conflicts with people, especially where the bat colonies become large.Three examples illustrate how it has been possible to preserve problematic or destroyed roosts of *Nyctalus noctula* and *Myotis myotis* in a simple manner by means of bat boxes made of timber. Moreover, the boxes proved to be suitable for hibernation, each of the three boxes being used by about 100 to 200 hibernating *N. noctula.*

New Records of Greater Horseshoe Bats *Rhinolophus ferrumequinum* in the North of Switzerland

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In 1995 greater horseshoe bats were unexpectedly discovered in the north-central part of Switzerland,

which has been intensively investigated faunistically since 1988. In May a female leaving, a cave led, by means of radiotracking, to a nursery roost at 8 kilometres distance in the attic of a farmhouse. In the summer 6 to 10 adults and young animals were counted in this roost. In the following winter for the first time in over ten years a hibernating animal was found in a mine at a distance of 18 kilometres from the nursery roost. This evidence of local interest could indicate a tendency of slowly increasing numbers and an extension of the species' range.

Status of *Myotis myotis* in the Czech Republic

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Because of its roosting strategy, *Myotis myotis* ranks among the species for which the data obtained by means of traditional techniques may reveal reliable information on patterns of distribution and abundance. In the Czech Republic, such type of data are available for quite a long period. In *M. myotis* they amount to about 4000 records. The present analysis of that material provided a detailed picture on (1) distribution of the species in different regions, (2) the factors affecting its local distribution, both in the summer and winter periods (in particular the climatic and hypsometrical aspects), and (3) trends in abundance during the last 30 years (estimated from results of continual censusing, both in hibernacula and breeding colonies). Most summer records come from medium altitude, whereas in the winter period, records in the mountain zone are quite frequent as well. *M. myotis* is apparently less abundant in cultivated lowlands than in a variegated landscape in which woodland areas and open country are equally represented. A strong population decline was observed in 1970 -1978 (with a decrease in abundance to ca. 50%), while a clear increase in numbers has taken place until recent time. In all regions, present abundances are higher than ever before (about 200% of those in 1970). Despite this, the former pattern of local distribution has not changed in any essential respect.

The Importance of Village Wells for Hibernating Bats: The Example of a Village in North-western Poland

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The studies were carried out in Rzecin, a small village ca. 75 km NW of Poznan, situated in a large clearing with a lake in the 70-year-old Notecka Pine Forest. Bats were observed in a well for the first time in 1992 by A. Gawlak. In 1994-96 the authors controlled all potential hibernacula in the village: 4 cellars, 15 brick cellars of a dugout type and 32 wells (9 brick, 23 built of concrete rings), 2.5-7m deep. Four species were recorded: *Myotis nattereri*, only in wells, *Myotis daubentonii*, almost exclusively .in wells, *Plecotus auritus*, equally in wells and in cellars, *Plecotus austriacus* only in cellars. In 22 shelters, 30-70 individuals per control were found. Wells constituted 54-77% of all occupied shelters, and bats wintering in wells constituted 60-84% of all recorded individuals. 13 wells (41 % of all controlled) were used as hibernacula: 5 concrete (only 22% of all concrete wells controlled, 38% of all inhabited wells), 8 brick (89% of all brick wells controlled, 62% of all inhabited wells). 18-46 individuals per control were found in wells. In concrete wells 1-4 (average 2) individuals, in brick 1-9 (average 4) individuals were observed per well. In wells *M. daubentonii* was the most abundant species (31-57%), *M. nattereri* made up 16-44% of all individuals and *P. auritus* 6-37%. It must be stressed that wells can be more important hibernacula in villages than cellars, especially in regions where brick wells remained.

Examination of the Settlement of *Myotis myotis* in a Mine

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Myotis myotis and *Myotis blythii* are among the most widespread and common bats in Hungary. They form nursery colonies consisting of 100-1000 animals. These colonies can usually be found in churches, but sometimes in mines or caves. Establishing a new roost means a high risk for bats as it does for other animals. Bats do not "know" whether the new roost can continously provide a peaceful place and the necessary climatic conditions. A need to occupy a new roost may arise in two typical cases. I called these active and passive criteria:

1 . Active criterion: The number of animals in a colony reaches an upper limit, at which the conditions of the roost or the quantlty of food prevent them from increasing further.

2. Passive criterion: If the roost or the nearbv hunting ground changes or disappears, the bats must look for a new roost.

If neither the passive nor the active criteria operate, the best strategy is to stay at the old, well-known roost. It may occur that a newly created potential roost has better climatic conditions, is safer or closer to the winter or summer roost, and therefore may be suitable for occupation without the two criteria mentioned above. I have studied the settling of *Myotis myotis* and *Myotis blythii* in a mine where exploitation had recently ceased. I found that this process took years; and the first step was to get acquainted with the circumstances (vagrant animals). A few years later large numbers of bats used the mine as a temporary roost. Finally the great mass of bats occupied the mine (summer roost). In the future, bats will probably stay there for the winter as well. Bats follow this sequence of stages for safety reasons. At present a nursery colony of 3000 bats lives and breeds in the mine.

International Aspects of Bat Conservation in Europe

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Introduction. General introduction will include the background to the Agreement and the role of Non-Government Organisations leading to Governmental action. Importance of the role of monitoring showing that bats migrate across national borders, and the implications for a population of a species or the species itself; bats' importance as "predictor" species for the ecological health of the environment.

Agreements and Conventions. General background to international environmental agreements and conventions, with specific reference to the Bonn Convention, and the place of the Bat Agreement within this historical and organisational context.

Bat Agreement. Obligations; geographical and political coverage; national action and international co-operation; role of the Secretariat; outcome of the first Meeting of Parties and follow-up by the Advisory Committee.

Noseleaf Structure, Echolocation and Foraging Behaviour in the Phyllostomidae

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To explore the possibility that facial morphology, echolocation and foraging behaviour are related in some species of bats, intra- and interspecific differences in noseleaf morphology were quantified by uni- and multivariate methods for 248 specimens representing 32 species in three subfamilies of the Phyllostomidae. The species showed a range of diets from mainly animals (Phyllostominae) to fruit (Stenodermatinae), and nectar and pollen (Glossophaginae), with the animal-eating species presumed to depend more upon echolocation to detect, locate and assess prey than frugivorous or nectarivorous species.

Stenodermatines are characterized by the most homogenous intraspecific noseleaf structure, glossophagines by the lowest interspecific variability, whereas phyllostomines show the highest level of interspecific variance and the most distinctive noseleaves. The variety of noseleaf structure in phyllostomines coincides with variation in diet but not with variety of echolocation calls.

The Dietary Consequences of What Bats Say and Moths Hear

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The allotonic frequency hypothesis suggests that some insectivorous bats prey on moths sensitive to echolocation calls by using frequencies outside the range of those heard best by the moths. This hypothesis predicts a significant correlation between the frequencies dominating the echolocation calls of some species of bats and the incidence of moths in their diets. We collected data on the morphology, echolocation calls and diet for 20 species of high-duty cycle echolocating bats (Rhinotophidae and Hipposideridae) and 23 species of low-duty cycle bats (Vespertillonidae and Molossidae) which take airborne prey. Our data support earlier findings for high-duty cycle bats, in that the frequencies dominating their echolocation calls are positively related to the incidence of moths in their diets ($r = 0.47$; $P < 0.01$). Low-duty cycle bats use a wider range of frequencies in their echolocation calls, and there is no significant correlation between the percentages of moths in the diet and the frequencies dominating the echolocation calls ($P >> 0.5$). In either group of bats, these frequencies correlate negatively with the bats' body size (typically $P < 0.01$). When controlled for body size (forearm length), none of the bats in our sample showed a significant relationship between diet (the incidence of moths) and echolocation ($P >> 0.05$). Overall, therefore, the frequencies dominating the echolocation of bats' calls depend more on morpholocy than on the hearing sensitivity of moths.

Foraging Areas and Habitat Use of a Mediterranian Nursery Colony of *Rhinolophus ferrumequinum* as a Reference to Studies of this species at the Border of its Distribution Area

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As a reference area to field studies in Central Europe, where the greater horseshoe bat is endangered, we chose the Mediterranean area of the Romagna in northern Italy, where the greater horseshoe bat is still considered common. The Romagna (1200 km^2) lies between Rimini and Bologna, half of it in the Apennin mountains and half of it in a plain with mainly intensively cultivated orchards. There are more than 40 actual sites (mostly winter sites) of the greater horseshoe bat known in this area, most of these in caves. Therefore, in caves the greater horseshoe bat is the most frequently observed bat species in this area, apart from *Myotis myotis/blythii* and *Miniopterus schreibersii*. The colonies of the greater horseshoe bat found during summer are usually small, with only a few to at most some dozens of individuals. The three known nursery colonies are about 10 km apart and have a maximum of 60 adult individuals. In May 1994 we radio-tracked 9 females and one male of a nursery colony during the first foraging bout. The nursery colony, situated in the first floor of an old unoccupied villa, had 40 adult individuals and has been known for several years. The roost is situated in a small village in a hilly area near the Apennin, 500 m from the river Montone and 10 km from the plain. The area was highly selectively used for night acitivities. The tracked bats used different flying paths to leave their roost. During one foraging bout they often changed their hunting areas and hardly ever stayed at one place for a longer period, except for perch-hunting. The radio-tracked bats hunted mostly in an area between 1500 m and 4000 m from the corresponding day roost, with a maximum distance of 5.5 km. All feeding areas where the radio-tracked bats foraged for a longer period, were situated near the river Montone, not more than 50 m from the river. These areas are mostly

covered with young deciduous forest with dense bushes and small trees. The intensively cultivated plain is protected against high water with embankments on each side of the river. The river bed in between (about 40 m) is covered with rich vegetation. These river courses seem to provide suitable foraging habitats for the greater horseshoe bats in the intensivly cultivated plain and are also used as flight paths. All radio-tracked bats which flew to the plain used the river as a flight path. Except for one animal hunting in an intensively cultivated orchard, the tracked bats were never observed hunting in the agricultural cultivated plain.

How Does Plant Cover on the Water Surface Affect Hunting Behaviour in Daubenton's Bat *Myotis daubentonii* ?

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Systematic counts show that Daubenton's bat avoids ponds that are covered with duckweed when hunting close to the water surface. By sampling insect densities at different amounts of duckweed cover, it appeared that insect density is not influenced by the duckweed cover. In a rectangular (2 x 3.1 m) wooden frame, floating on the water surface, bats were only able to detect mealworms when the water surface within the frame was only partly covered with duckweed. When the duckweed cover was augmented, the number of detected mealworms decreased, although the bats could freely gaff through the duckweed, indicating that duckweed forms no mechanical obstruction for catching prey. Experiments in which mealworms and tiny patches of duckweed were offered simultaneously revealed that Daubenton's bats have difficulties discriminating between these items and are thus impaired in detecting insects on the water surface when this is covered with duckweed.

Observations on the Female Genital Anatomy of Vespertilionid Bats

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A comparative morphological analysis of female genitalia was conducted for 23 species (11 genera) of plain-nosed bats (Vespertilionidae). All observed species possess a transverse vaginal opening, bicornuate (or nearly bipartite) uterus with the uterine horns fused to various degrees, a complete bursa ovarica, and medially recurving oviducts. Considerable diversity was observed in the shape of the vagina, in some cases corresponding to the peculiarities of postcopulatorv vaginal reactions. Besides, variation was found in the structure of the bursae ovaricae and in the development and disposition of the uterine and ovarian ligaments.The latter seems to reflect differences in the expansion of the uterus during gestation between mono- and polytocous species. None of the species studied, except *Miniopterus*, display morphological reproductive asymmetry (found in some other bat families), despite the right horn implantation dominance, found in many vespertilionids. Uterine vascularisation basically resembles that of other mammals, though differing considerably in adaptations towards antimesometrial implantation (antimesometrial uterine vein), which in turn is thought to sustain potential polyembryony except and plasticity in litter size. characteristic of many representatives of the family. In its origin the female reproductive tract of plain-nosed bats appears to be an offshoot of the generalized bipartite uterus, found among recent bats only in some representatives of the emballonuroid superfamily and seems to have evolved independently from that of molossids.

The Interdependence of Chiropteran Life Strategies

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The diversity within bat communities is formed not only by morphological divergence and niche speciation, but also by differences in life history strategies. The most important of these are foraging and reproduction, which comprise vital items of an organism's energetic budget and have been contemplated by the optimal foraging and r-K-selection theories, respectively. Theoretically, a higher reproductive effort (r -strategy) requires a more intense energy intake, which is easier to maintain when using patches with ad libitum food resources. The latter, however, are somewhat unpredictable. A lower reproductive effort (K -strategy) provides lower energetic demands and retains enough fitness to be able to use a less concentrated but more predictable resource. A comparison of the available data on reproductive patterns and trophic ecology of north-temperate Russian bat species suggests that there is some correlation between their reproductive and foraging strategies. Our preliminary studies indicate that relatively r-oriented species (e.g., *Nyctaliis noctula, Pipistrellus nathusii*), are more confined to habitats with patchy food resources (various insect aggregations), whereas K-strategists (e.g., *Plecotus auritus, Myotis brandtii*) can utilize more dispersed prey. Intersexual differences were observed in foraging tactics and habitats during the periods of pregnancy and lactation in *Myotis brandtii*. This may be due to intense intraspecific competition at the females' low-productivity foraging grounds.

Can Virological Methods Be Useful for Bat Research

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Viruses of at least 8 families (Flaviviridae, Coronaviridae, Reoviridae, Togaviridae, Bunjaviridae, Rhabdoviridae, Herpesviridae, Arenaviridae) and some non-classified viruses have been isolated from Chiroptera worldwide. Bats are the principal and sometimes unique hosts for manv viruses. With the help of molecular biology methods (monoclonal antibodies, polymerase chain reaction and others), a lot of new information about the variability of bat viruses has been obtained. Some antigenic or genetic virus varieties are closelv related with certain bat species, ecological groups or populations. The results of virological research have traditionally been discussed in connection with their medical or veterinary significance, their negative influence on bat populations due to mass bat collection for autopsy, on death -rates in bats, or on public opinion. These data have to be considered from another point of view. As a result of coevolution, viruses may serve as natural biomarkers in investigations of bat migration, world distribution, interspecies contacts, etc. The W. Eichler rules can probablv be used with some restrictions. An attempt at such an analysis has been made for two relatively well investigated virus genera - *Lyssavirus* (rabies and rabies-related viruses) and *Flavivirus* (,tick-borne encephalitis virus and others).

The Megachiroptera of the Island of Choiseul: An Example of the Need for Conservation in the Solomon Islands

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Choiseul is a small island in the Northern Solomon's chain, approx. 120 x 40 km in size, with a maximum elevation of 1060m at the highest point of its rugged interior. It is also currently one of the least disturbed islands in the archipelago although currently under immediate threat from logging. Choiseul was also ranked by the IUCN/SSC Chiroptera Specialist Group as having the fourth highest biodiversity of fruit bats in the Old World. It was against this background that the Choiseul 1995 team from Bristol University went to undertake a survey of the island's Megachiroptera, to estimate relative abundance, status of extant populations, and whether or not the I U C N grade I *Pteralopex anceps* was extinct as previously

suspected. The results included the fact that *P. anceps*, the Bougainville monkey-faced flying fox, is still inhabiting a very restricted area of the island and is under threat. Additionally, further threats were identified to the 'commonest' species of fruit bat in the region, *Pteropus rayneri*, which seems to have dramatically declined in the last decade. Some novel ecological observations were made on the behaviour of this species. One IUCN grade 3 species, *Pteropus mahaganus* was recorded on the island for the first time, and some new information on its diet is suggested, which would give it potential importance to the island's economy. Three out of five other previously recorded species of smaller fruit bat were netted on numerous occassions. The two species not accounted for predominantly live on small off-shore islands.

The Microchiroptera of Choiseul in the Northern Solomon's Chain; Including Seven New Records

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The 1995 Choiseul project had as its principal aim to survey the species of Megachiroptera present on the island. However, a biproduct of the methods used to do this, i.e. mist-netting and the exploration of some cave roosts, was that many species of Microchiroptera were recorded. Seven of these constituted new records for the island: *Emballonura dianae, Emballonura nigrescens, Hipposideros dinops, Miniopterus propitristis, Miniopterlis schreibersii,* and *Pipistrellus angulatus*. Additionally, the sixth specimen of *Anthops ornatus* ever recorded was netted and photographed for the first time. Some taxonomic difficulties were highlighted in the field identification of two closely related species of *Hipposideros* and the localised distribution of the little known *Chaerephon solomonis* is suggested.

Transient Roost of Young Noctules *Nyctalus noctula* in a Motorway Bridge Turns Out to Be a Trap

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From late August to the middle of September 1994, 121 emaciated individuals of the noctule *Nyctalus noctula*, mainly carcasses and some moribund, were collected in the abutment chamber of a motorway bridge across the river Rhine near Mannheim. Post-mortem examination of recently dead individuals (mean body weight 21.6 +/- 2.1 g, n=61) revealed some bacterial and helminth infections by opportunistic pathogens and one case of coccidiosis. Different laboratory tests for rabies yielded negative results (n= IO). High amounts of chlorinated hydrocarbon residues were found in all animals tested (n=26). However, the principal cause of the noctules' mass mortality at the bridge roost was not discovered at the time. In the same period of the following year (I 995), subsequently more than 500 noctules entered this place. On average every second day newly arrived, clustering bats were taken from the roost for health control and were released elsewhere or temporarily kept in captivity, if they were in a bad condition. Observations at the roost now gave evidence that the great majority of the noctules failed to find their way out of the bridge, which works - due to its type of construction - as an echolocation trap for this species. Age composition, sex ratio and reproductive status of the handled bats proved to be nearly identical in both years. According to several criteria, the transient groups consisted almost exclusively of young from the same year, 62% were females. Evidently, both sexes of this age category were already involved in mating activity, which was confirmed histologicaly in all tested individuals by either the presence of insemination (n=27 females) or sperm production (n=22 males).

The Use of Cave Galleries by Bats in the Sumava Region (SW Bohemia, Czech Republic)

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In 1992-1996 bats were netted at the entrances of different caves in two localities in the Sumava Mts. Region. The research was carried out in order to discover more details of the composition and dynamics of bat communities visiting different types of caves during, the reproductive season. Significant differences in species composition between localities as well as differences between different caves within one locality were found. The structure of the netted samples was changing in the course of the reproductive season. The total numbers of bats changed considerably and the individual species showed different seasonal changes in the use of the caves.

Population Structure of the Brown Long-earred Bat (Plecotus auritus) across North-East Scotland

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The brown long-eared bat, *Plecotus auritus*, is the second most common bat in Great Britain and one of two members of the genus *Plecotus* (family Vespertitionidae) found in the U.K. Scotland represents the western and northern limits of its range, and it is found across most of the mainland, but is absent from more exposed regions and offshore islands. During the summer *P. auritis* forms nursery colonies in which, unlike other U.K. bat species, both males and females are present. Ringing studies of both adults and juveniles in house roosts across North-East Scotland have revealed strong maternity roost site philopatry. Furthermore, no movement between known roost sites (even those >0.5 km apart) has been recorded. Using the nondestructive tissue sampling method developed for bats, 3 mm wing punches were collected for genetic analysis from ringed individuals occupying these roosts. Nuclear DNA markers are being used to test the hypothesis that *P. auritus* mates only with individuals from nearby roosts (within a 5 km region), which may lead to genetic structuring of populations. Preliminary results suggest that, at the least, gene flow occurs between roosts situated within I km of one another. Social Organisation of *P. auritus* within house roosts is also being investigated.

Insectivory in Two Species of Fruit Bat: *Pteropus livingstonii* and *P. rodricensis*

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Two fruit bat species of the genus *Pteropus*, Livingstone's fruit bat *P. livingstonii* and the Rodrigues fruit bat *P. rodricensis*, have been observed in captivity actively catching and eating insects. Both species adopt the same technique to trap flying insects, using their wings to envelop them. The capture position was assumed within 0.84 seconds (+/- 0.09) of the bat becoming aware of the insect, and its spontaneity indicates that the response is not an artefact of captivity. The behaviour was observed in captive-bred *P. rodricensis* which had no prior access to insects, suggesting that it is innate. A higher rate of successful captures was recorded for an older, wild-caught *P. livingstonii* female, indicating that the effectiveness of the technique used improves with age. Significant differences in the amount of time spent catching insects by males and females were evident in this species. This study supports suggestions that insects are eaten by some megachiropterans in order to supplement their protein intake, and has implications for the behavioural enrichment and nutrition of captive bats.

The Livingstone's Fruit Bat *Pteropus livingstonii* Captive Breeding Programme at Jersey Wildlife Preservation Trust

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One of the strategies being implemented to try and conserve one of the world's largest and most

endangered bats, Livingstone's fruit bat *Pteroptis livingstonii*, is an ex-situ captive breeding programme. The establishment of two founder colonies at Jersey Wildlife Preservation Trust has provided a safeguard against extinction of the species, as well as an opportunity to study the bats' biology. In particular, work to help understand their behaviour, especially social interactions and reproduction. Furthermore, research has provided information to help develop the most appropriate captive management regime. Twenty years previously, a similar captive breeding programme was initiated by JWPT for another western Indian Ocean Pteroptus species, *P. rodricensis*. Past studies of this species have provided many comparative data.

The distribution of the Great Evening Bat *Ia io* in the Indomaylan Region

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The great evening bat is one of the largest and rarest vespertilionids of the world. The species had hitherto been found in eleven localities and most of the captures were of single specimens only. Unfortunately, the published distribution maps of the species are incomplete and unreliable due to the difficulties in locating the Chinese geographical names. In recent years the species was collected from two more localities by the Southeast Asian expeditions of the Hungarian Natural History Museum:

1. One male mist-netted at the entrance of a cave in North Vietnam near , the Chinese border on November19,1993;
2. Four males and two females mist-netted on two occasions (October 12, 1994 and April 12, 1995) in Central Nepal in the same cave.

The Vietnamese specimen is the first known living animal from the country, since previously only bone remains had been found in a cave. In Nepal the bats were collected from a group of about thirty animals. This is the second evidence of a colony formed by this species; and this new locality is the westernmost point of the occurrence of *Ia io* known to date. Based on the descriptions of the former localities and the new records, it is evident that the great evening bat is an obligate cave-dwelling species of the subtropical limestone areas of Southeast Asia.

Projects on Bats as an Example for Education in Environmentl Issues

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In the research project "How bats use the "Philosophen-Forest" we did research on bats and started looking for ways of making our findings accessible to the public. The corner stones "learning in projects - bat conservation - children's needs" should be combined in activities for the public. The mythology of bats, their biology and their ecological role etc. offer a wide range of topics for projects with children. All projects are focused on finding out more about bats in their habitat. The habitats are the children's environment (villages, cities, forests). Having fun and doing something in a group are important elements of the projects. The teaching methods were geared to the particular groups and helped to develop the children's feeling for nature. Furthermore, the projects should foster the children's curiosity and their thirst for knowledge. By finding out how various aspects interact, the children should become aware of how their behaviour could have an impact on bat populations. Various projects with children and adolescents in the city, in the village, and in the forest are presented.

Conservation of House-Dwelling Bats in Hungary

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The Hungarian Bat Research Society was founded in 1991. The main aim of this society is to organize and co-ordinate bat conservation and research activities in Hungary. Our main tasks are the following: mapping bat colonies, and identifying and halting the processes endangering the colonies. We are working for the preservation of forest-, cave-, and house-dwelling bat colonies. As far as is known at present, the house-dwelling colonies are the most vulnerable, and so need most attention. The house-dwelling colonies mainly occur in castles and church towers. We have surveyed 2,000 churches and castles so far. We registered the number of animals, the species composition, and the presence, or absence, of some other

species of animals having an impact on bats (owls, martens, pigeons, etc.). We also recorded important characters of the roosts - such as size, quality of entrance holes, roof cover, etc. Using these data, we can statistically analyse the factors influencing the survival of the bat colonies.

Survey of Cave-Dwelling Bat Colonies in the Rumanian Bihar Mountains

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The Hungarian Bat Research Society, together with local cavers and students (members of the Federatia Romana de Speologia - Rumanian Caving Society) started a programme in 1995 in order to protect the bat colonies living in the Bihar mountains and the Kiraly forest. There are roughly 2,000 caves in the Bihar mountains, and some of these are optimal sites for bat colonies. We have surveyed 60 major sites so far. We have worked on both wintering and breeding colonies. Some of these colonies are potentially endangered by human impact (mining, tourism). We attempt a detailed examination of such threats in order to minimize their harmful effects. The species recorded most frequently are *Rhinolophus ferrumequinum, Rhinolophus hipposideros, Rhinolophus euryale, Myotis myotis* and *Miniopterus schreibersii*. By recapture of bats banded in Hungary we have shown that the breeding colonies of *Rhinolophus ferrumequinum* in the Eastern Hungarian lowland migrate to hibernate in the caves of the Kiraly forest. The distance between the breeding and the wintering sites is 44-60 kilometres, but in some cases we recorded migration routes up to 320 kilometres long.

Determining the Location of Bat Roosts and Bat Roost Densities Using a Questionnaire Survey

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Locating bat roost sites and establishing their density in an area can be a difficult and time-consuming task. A novel approach to this problem is described: the use of a questionnaire survey to locate bat roosts. The questionnaire was designed to obtain as much valuable information as possible, while maximising response rates. It was distributed to all inhabited buildings in a 25 km^2 rural study area in central England. There was a good response rate (47%) and, with follow-up investigations, the survey revealed a high density of previously unrecorded roosts. The technique can dramatically increase roost records and complements other methods, such as bat detector survey work. Questionnaires are a cost-effective way to locate roosts and at the same time raise public awareness of bat conservation.

Savi's Pipistrelle *Pipestrillus savii* in Britain

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In February 1996, a bat was rescued from two cats in Wallasey, on the Wirral Peninsula, in north-west England. The bat was identified as a Savi's Pipistrelle, an identification confirmed bv Tony Hutson of the Bat Conservation Trust, and by Derek Yalden of Manchester University. At that time only two other records of Savi's Pipistrelle had been reported from Britain; a moribund animal that had crawled out of a punnet of nectarines, and a wet and exhausted bat found near Eastbourne, on England's south coast, in January, 1993. Enquiries within Britain have since resulted in at least one Savi's Pipistrelle having been confirmed from a group of Jersey bats sent for DNA testing. There is also the possibility that one or two animals previously thought to have been Northern bats *Eptesicus nilssonii* were in fact Savi's Pipistrelles. Identificational differences between the two species are discussed, with reference to material in the Natural History Museum, London. Savi's Pipistrelle is considered to be predominately a bat of southern Europe, but an accurate assessment of its distribution is hampered by lack of data and difficulties with identification. Here we request assistance from bat workers throughout Europe to help us more clearly assess its status. Is Savi's Pipistrelle a regular migrant to Britain, or was "Wallace" the Wallasey bat just a ship's stowaway?

The Significance of Tree Holes for Bats and Other Vertebrates

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Since 1992 the number and position of holes in trees and their users are recorded in the "Philosophen-Forest" in Giessen (Germany). The research area (20 hectares) is situated at the outskirts of the city, surrounded by housing areas and streets. The forest consists maintly of beech and oak, some trees are up to 250 years old. So far, 435 holes were found in 379 trees. More than 70% of these holes were made by woodpeckers. The others are mainly the results of natural rotting processes due to injuries. During the research period, 160-200 holes were used annualy by different species. A large part of these were used every year by some species. Furthermore, many cavities were used successively by different species. One hole, for example, was first used by noctule bats, then by hornets, then by the green woodpecker (*Picus viridis*) before the noctule bats returned in the mating season. Some trees with a number of holes were home for up to five different species at the same time. The successive utilization of a hole was only possible because successors like woodpeckers and starlings (*Sturna vulgaris*) clean out nest or honey combs. Furthermore, insects play an important part in this system(most significantly, larvae of Diptera which live on the faeces of bats) so that the holes can be used again by other species.

Foraging Activity of *Eptesicus serotinus* in Different Habitats

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Three of the seven largest breeding colonies of *Eptesicus serotinus* known in the Mazovian Lowland were studied in 1994 and 1995 during the period May-September. The time of the departures and arrivals of the bats was observed. Foraging activity was recorded at points located in different habitats within an area of up to 2.5 km from each roost. Eight types of habitat were distinguished: densely built-up areas, built-up areas with rich vegetation (villages and small houses with gardens), riversides and ponds, forest edges, forest, open areas (fields and meadows), and patches and lines of trees within open areas. *Eptesicus serotinus* does not seem to be very specific in its choice of foraging habitat. The species mostly hunts in sparsely built-up areas with rich vegetation and close to lines and patches of trees, but if there are places like a riverside or lamp-lit forest edge in the vicinity, feeding activity apparently concentrates there. The bats often forage at lit-up places, but this is more obvious in areas where such places are sparse and probably attract greater concentrations of insects.

OTON - Polish Society for Bat Protection

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OTON was established in December,1994 in Poznan. This nongovernmental Organisation has about 60 members so far. Main alms of our activities are focused on: (1) searching for summer and winter roosts, (2) creating new roosts and shelters (bat boxes, additional crevices in bridges and hibernacula), protection of roosts: - bringing the most important roosts under legal protection, - installation of approp--riate grilles in underground sites to prevent unauthorized human access. - promotion of non-toxic substances for timber treatment, (4) conducting long-term monitoring studies of bat numbers, (5) establishing a public authority for the conservation of bats. Current OTON projects are: *"Protection of the Most Important Bat Hibernation Sites in Poland"* and *"Conservation of Bats in Forests"*. If you would like to share your experience as far as bat protection in Poland is concerned, please contact us: OTON, Fredry 10, 61-701 Poznan, Poland; E-mail: wegiel@au.poznan.pl

The Influence of Extraneous Sounds on Prey Capture by the Echolocating Bat *Pipistrellus pipistrellus*

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Certain moths (Arctiidae) can produce clicks when they hear the echolocation calls of insectivorous bats. Among other things, the click could interfere with the bat's biosonar, causing it to miss the target and thus providing a survival advantage for the clicking moth. We attempted to test this hypothesis by training captive flying bats to catch catapulted prey targets. The volume in which the bats caught the prey was ensonified with pre-recorded click bursts (*Phragniatobia fuliginosa*) or bat signals (*P. pipistrellus*, early terminal phase). In some experiments we triggered the sound manually when the bat was near the catch volume. In other experiments the bat triggered the sounds when the interval between two successive echolocation signals was =<15.2 ms, corresponding to signal intervals within the approach phase. During an experiment we altered the sound trials. The trials were video-taped. The results were tallied from bats in the catch volume where the bat had a chance to capture the prey. Bat A caught between 83% and 95% of the prey items, bat B caught between 38% and 68%. There was no significant difference (2x2 contingency analysis, $P<0.05$) in catching success in sound trials compared to no-sound trials for bat A with manually triggered sound and for bat B with bat-triggered sound. Bat A caught significantly more prey in the presence of bat-triggered sounds but if moth clicks and bat buzzes were analysed separately, there was no significant difference in catching success in trials with moth clicks compared to trials with no sound. Bat A did, however, catch significantly more prey in the presence of bat buzzes. Bat B caught significantly less prey in the presence of manually triggered sounds. If moth clicks and bat buzzes were analysed separately, however, there was no significant difference in catching success using bat buzzes or moth clicks compared to no-sound trials. Neither bat buzzes nor moth clicks interfered with the bats' biosonar. In other settings the moth clicks could startle bats or warn them of distasteful prey.

Currant Status of the Study of Bats in the Polish Part of the International Biosphere Reserve"East Carpathians"

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Studies have been carried out for 5 years. Using net catches, detector monitoring,, lofts and underground controls, a list of bats occurring in the Polish part of the International Blosphere Reserve "East Carpathians" (Bieszczady Mts.) was prepared. 15 bat species were recorded, including 8 new for the area: *Myotis daubentonii, Myotis nattereri, Myotis mystacinus/ brandtii, Eptesicus nilssonii, Barbastella barbastellus, Myotis bechsteinii, Myotis emarginatus* and *Vespertilio murinus*. The presence of 7 species was confirmed: *Rhinolophus hipposideros, Myotis myotis, Pipistrellus pipistrellus, Nyctalus noctula, Eptesicus serotinus, Plecotus auritus* and *Plecotus austriacus*. 20 new sites were found.

Flower-visiting Bats and Their Role as Pollinators in the African Rain Forest

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The pollination of flowers by bats (chiropterophily) is wide-spread in the tropics and subtropics of both hemispheres. In contrast to America and Asia, few field observations have been carried out in Africa. Our studies of the biology and pollination ecology of rain forest trees and lianas are presented from Cameroon. Their flowers - variable in morphology and blooming strategy - are characterized by a typical feature syndrome attractive to bats. Several fruit bat species (Pteropodidae) are found to pollinate them. The bats differ profoundly in their ability to utilize these flowers (e.g. in terms of their activity and behaviour in the trees, at the flowers, and in their diet), including large and middle-sized species of the genus *Eidolon, Rousettus* and *Micropteropus*, which have more or less frugivorous feeding habits, as well as the tiny longtongued *Megaloglossus woermanni*, the only highly specialized flower-bat in Africa, but still poorly known.

Structure of a Bat Community Hibernating in the Kaunas Theriological Reserves

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Studies of bats hibernating in a fortress in Kaunas City were carried out in 1995 and 1996. The main goal was to narrow the gap of information about the distribution and species diversity of this bat community. It was found that 8 species were hibernating in 14 fortification buildings. Eleven of these buildings are called theriological reserves. We made a visual census of the bats. 90% of the bats were found in the four richest theriological reserves. *Myotis daubentonii* was the dominant species, making up at least 50% of the hibernating animals. Comparing the results of the 1995 and 1996 seasons, it was found that the number of bats had increased from 1211 to 1543) (27.4%). The density of bats had increased in the underground shelters with a high humidity. This can be explained by the change of microclimatic conditions in the reserves brought about by the cold winter. A very remarkable increase in bat numbers (78.7%) was observed in the theriological reserve of Rokai. The cause of this could be the large number of shelters with a high humidity. Estimating the index of species diversity for different theriological reserves, we are convinced of its dependence on the variety of microclimatic conditions and on the number of suitable shelters.

Foraging Habitats of the Lessor Mouse-eared Bat *Myotis blythii* in Eastern Switzerland

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We present some preliminary results of a study of the habitat selection of hunting *Motis blythii* in the Rhine valley, eastern Switzerland. In 1994 three adult females were marked with radiotransmitters, to locate their foraging areas. The tracking sessions were also conducted to determine relevant hunting habitats for further investigations on prey selection (see Lustenberger & Güttinger). The general aim of the study is to get a broader insight in the feeding ecology of this bat in a man-made landscape. In his detailed studies of the feeding ecology of *M. blythii* and *M. moytis*, Arlettaz clearly demonstrated that *M. blythii* is a typical hunter of larae-sized insects which seem to be caught strictly in open areas. As our study area is strongly dominated by intensive agriculture, we expected that hunting individuals of *M. blythii* would select more traditionally managed grasslands, which usually offer a higher abundance of larger insects than intensively cultivated meadows. Indeed, we found a pronounced selection for such grasslands; undisturbed or not completely degraded wet meadows (e.g. *Molinion, Filipendulon*) were the preferred hunting habitats in the study area.

The Bat Fauna of Luxembourg - Results of a Five-Year Study

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From 1991 to 1995, the summer distribution of bats in Luxembourg was investigated on behalf of the National Museum of Natural History of Luxembourg. The methods applied included the use of an ultrasound detector (model D - 980, Pettersson Elektroniks, Sweden), mist-netting and the control of potential summer roosts, i.e. all church lofts potentially suitable for bats. Until now, 18 bat species have been found. Nursery roosts or other proofs of reproduction were found for 12 species. The distribution, abundance and status of all species is shown and factors influencing their distribution patterns are explained as far as possible.

The Life Project "Protection of Bat Winter Roosts in Western Central Europe"

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The Transboundary Association for Bat Protection was founded in 1992 in Luxembourg and includes the following regions and countries: Luxembourg, Wallonie (Belgium), Limburg (the Netherlands), Champagne-Ardenne, Lorraine and North-Alsace (France), Saarland, Rhineland-Palatinate and Westfalia

(Germany). The LIFE project mentioned above was developed by the Transboundary Association and handed in to the EC with the assistance of the Ministry of Environment of Saarland, Gemany. The contract signed in December 1995 is valid from January 1996 until August 1998, then a second term of three years can be approved by the EC. This contract requires that the national or regional ministries of environment of the member countries commit themselves to paying half of the costs in their country (excluding the Netherlands). The other half will be given by the EC. Our project aims at protecting the main winter roosts of bats, especially of those appearing on appendix 11 of the Fauna and Flora Habitat Directive, and laying within the borders of the member countries. The situation of the winter roosts should form a grid in which migrating bats can find secure roosts. Protection will mainly be implemented by buying or renting the objects and securing their entrances. Further points are the future legal protection of the chosen roosts and their management, an accompanving scientific research and control of the success and, finally, public relations work to enhance the knowledge and acceptance of bats among a broad public.

The Worldwide Importance of Trees to Bats

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Worldwide, all species of bats depend upon trees in one way or another. Trees provide roost sites for some and are host to much of the insect food for others. In both, the Old and New World, tropical bats feed on fruit and nectar provided by trees. Tree lines are the essential features without which many species of bats cannot navigate to, or from their feeding areas. Old trees are especially important as standing deadwood, as they are the breeding ground for a vast insect biomass and can be easily worked by woodpeckers, which thus make roost sites. Throughout the developed world, these trees are often considered dangerous or untidy and cut down. They are felled in large numbers to make way for development or agriculture. When felled, the potential food supply is diminished and the number of available roost sites decreases. There is competition from many other species of animals for these sites and bats come off worst. Their decline is speeded up. This is a plea for the people of Eastern Europe not to destroy their old trees as we in the West are doing. Leave old trees standing.

Holocene History of the Mid-European Bat Communities

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At the first sight, the Holocene central European fossil record of bats is very rich. However, most of the material comes from mass bone assemblages in the surface of cave deposits which, of course, provide almost no stratigraphical information and are of limited value only for a detailed analysis of community development. Reliable information can be obtained from material coming from continuous sedimentary sequences. The present paper deals primarily with such type of data, obtained from 28 series (amounting to about 33O species records). Repeated evidence indicates the Late Vistulian appearance of several species (*Eptesicus nilssonii, Eptesicus serotinus, Myotis nattereri, Plecotus auritus*). In contrast to the Pannonian basin, in the Western Carpathians and the Bohemian Massif almost no changes in bat communities appeared during the Preboreal, whereas major faunal rearrangements took place during the Boreal stage. Some of the elements, apochoric to Holocene in the regions under study, such as *Pipistrellus pipistrellus* and *Rhinolophus hipposideros*, first appeared in that time. In contrast, the other species of this group, viz. *Myotis myotis* and *Plecotus austriacus*, did not appear before historical time. In agreement with the information derived from mass cave assemblages, the present data suggest that *Myotis bechsteinii, Myotis nattereri, Plecotus auritis, Barbastella barbastellus* (but also *Nyctalus noctula, Vespertilio murinus* and/or *Eptesicus serotinus*) formed the core of the central-European chiropteran communities throughout most of the Holocene, including a considerable part of the post-neolithic period.

Evolutionary Divergence in the Lessor Horseshoe Bat

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Geographical populations of the lesser horseshoe bat vary in the diploid number of chromosomes. The

56-chromosome form has been reported from the species' European range, the 58-chromosome form from Asia Minor and the Near East, and the 62-chromosome race from southern Kirghistan in central Asia. Amorphological comparative analysis of these karyotypic races has been conducted, and systematic implications of the evolutionary divergence are suggested.

Ectoparasites of Bats in Biscay (Basque Country, Northen Iberian Peninsula)

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During a distribution survey of bats in Biscay, 12 species have been examined for ectoparasites, We looked for batflies (Diptera: Nycteribiidae and Strebliidae) in 150 individuals throughout the year. Mites (Acari, Gamasida, Spintumicidae and Macronyssidae), ticks (Acari, Ixodida: Ixodidae and Argasidae) and fleas (Siphonaptera: Ischnopsyllidae) have been sampled in 135 potential hosts from January to June. Ectoparasites were removed with pincers and stored in ethylacetate prior to identification. We recorded a total of 55 batflies, 543 mites, 36 ticks and 20 fleas. The survey reports the associations between hosts and parasites.

Distributional Status of the *Rhinolophus* Species in Bulgaria

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Current data on the distribution of the five *Rhinolophus* species known from Bulgaria - *R. ferrumequinum, R. hipposideros, R. blasii, R. euryale* and *R. mehelyi* are presented using a UTM grid of 10x10 km. Preliminary information on roost types and colony size is given.

Bat Protection in Bulgaria - Current Statement

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The Bulgarian Bat Research & Protection Group (BPPG) was formed as a working group at the NGO "Green Balkans - Sofia" in 1989. The main aims of BRPG are a thorough investigation of bats in Bulgaria, the creation of public awareness of the importance of their conservation, the study of bat -threatening human activities, as well as direct protection of bats, their habitats and roosts. In the period 1994-1996 the status of colonies of cave-dwelling species has been studied by the members of the Bat Research and Protection Group. About 50 Bulgarian natural and artificial caves were recognized as very important bat roosts. The human activities endangering the colonies were identified. The main conservation problems were outlined and suggestions for solving these were developed.

Habitat Use and Feeding Strategy by the Parti-colored Bat in Western Switzerland

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Eight parti-coloured bats(*Vespertilio murinus*) of a breeding colony in western Switzerland were radio-tracked in 1994 and 1995. Their hunting grounds were exclusively located over the areas of shallow water and natural shores of a large lake. The use of these habitats was greatly influenced by wind orientation and spatial distribution of insects. Despite their high availability around the colony, other habitats (i.e. urban areas, forests and cultures), were avoided by the bats. According to faecal analyses and trapping, parti -coloured bats fed opportunistically on small swarm-living aquatic insects. Wetland could be a habitat of prime importance to parti-coloured bats during the breeding season. This could therefore explain the patchy distribution of *Vespertilio murinus* in central Europe.

Dolichole Levels in the Liver of Selected Bat Species

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Liver samples taken from eleven bats from the ISEZ PAN collection in Cracow were studied. The animals had been caught between 1902 and 1962. The animals studied belong to 8 species (numbers between brackets give the number of individuals) *Myotis emarginatus* (1), *Myotis myotis* (1), *Eptesicus serotinus* (2), *Eptesicus nilssonii* (2), *Vespertilio murinus* (1), *Miniopterus schreibersii* (1), *Plecotus auritus* (2), *Nyctalus leisleri* (1). The presence of dolichols in the bats' liver was confirmed for the first time. Dolichols represent a huge group (a few hundreds of thousand known so far) of natural substances biosynthesized from the activated five-carbon unit of mevalonate/isopentenylpyrophosphate. In the liver of most of the eleven bats a complex mixture of dolichols was found. The long chain of polyisoprenoid alcohols form a complex of two families of components with 2 prenologues: C 95 or C 100 and C 11O or C 115 as the dominating compounds. Significant variations in dolichol contents in different individuals were reported. However, the total contents of unsaponifiable lipids was approximately the same in all samples (between 0.7 and 1.7 mg); only the level of dolichols belonging to the group of unsaponifiable lipids changes (from under 2 micrograms/g in *Myotis* and *M. emarginatus* up to 70 microcrams/g in *N. leisleri*). Changes of dolichol contents in liver tissue could be the result of differences between species as well as the age of the individual. Defining the contents and type of dolichol in bat tissues may be of significance for establishing the relationships and systematic position of the species.

Forest Habitat Preferences of Nathusius' Pipistrelle *Pipistrellus pipistrellus* in Northen Poland

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Investigations of Nathusius' pipistrelle were conducted in 1993 and 1994 in the forest on the Vistula sand bank (southern Baltic coast). The preference for different types of forest was studied by measuring the bats' activitv along a line transect and by checking bird boxes. Features of the artificial roosts that influenced box occupation were considered as well. Nathusius' pipistrelle preferred to forage in the pine forest close to the lagoon, and avoided the mixed forest close the road. The highest variability in activity during the season was noticed in pine forest. The number of bats found in boxes in this particular habitat was influenced by humidity. However, both in 1993 and 1994 high numbers of males were found in the pine forest. The choice of boxes with different entrance exposures also depended on weather conditions and was different in 1993 and 1994. One of the important factors influencing usage of the boxes was the type of entrance. 61% of the bats were found in boxes with a long narrow entrance, which constituted only 4 - 28 % of all boxes present in the different types of forest.

Complex Social Sounds used by *Eptesicus serotinus* during Intraspecific Aerial Encounters

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During field work on echolocating *Eptesicus serotinus*, we have regularly observed one bat pursuing another. In connection with such "chases" we have often heard chattering sounds (social sounds) which we never heard in other situations. Therefore, we investigated the acoustic behaviour of this species during aerial encounters, using 3 Brüel & Kjaer 1/4" microphones. The microphones were attached to a 15 m high mast constructed of 7 telescoping sections. Signals were recorded simultaneously on a high-speed tape recorder (Racal Store 4). Recordings were made at 2 locations in Denmark. In order to relate the sounds to the individuals in the chase, we compared the delays in relative arrival times to the microphones, using a special cross-correlation programme. During a chase one bat significantly changed some parameters in its echolocation signals, which became distinctive (t-test, $p < 0.05$) from those of the other bat. The second bat showed only minor changes in its echolocation sionals, or none at all. We recorded 3 types of social

sounds during a chase. These were always emitted by the bat that did not significantly change its echolocation. One type of social sound was an audible "chitter". It consisted of amplitude modulations (pulses) repeated at a rate of 3000 - 6000 modulations/sec. In the sonagram it appears as a multiharmonic signal, in which each harmonic is separated by the modulation rate. The carrier frequency within the pulses sweeps from 50 - 30 kHz over the entire signal and is the most dominant harmonic in the sonagram. Of the two other types of social sounds, one is an FM (frequency modulated) signal shaped like a reversed J, with a terminal frequency of around 45 kHz. This is 20 kHz above the terminal frequency in the echolocation signals (shallow FM signals). The third sound is an FM - CF (constant frequency) signal that ends in a pulsed sound with the CF part at 45 kHz. The social sounds of *E. serotinus* are complex and varied. Amplitude-modulated sounds have not previously been described for the serotine bat, but are commonly used bv dolphins and killer whales as communication signals. The function of the social signals described here could be territorial, since they were only heard in connection with aerial chases. We do not know which bat emits the social sound: the chaser or the chased.

The Functional Ecology of Emergence Time in Echolocating Bats

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We proposed that echolocating bats time their evening emergence in relation to the benefits of maximising feeding success, and the costs associated with predation risk (Jones, G. & Rydell, J. (1994)@ Phil. Trans. R. Soc. Lond. ' 46B: 445-455). In accordance with this theory, the fastest flying species (presumably those best able to avoid predation by raptorial birds) emerged earliest, and species that fed on prey other than crepuscular small dipterans emerged late. We extend our theories that predation risk and foraging strategy influences emergence time in echolocating bats by testing the following predictions:

1. The fastest flying species emerge at the highest light intensities.
2. Bats should emerge later on moonlit nights.
3. Bats should emerge earlier when they are energetically stressed. Hence lactating females should emerge before pregnant bats, and bats should emerge earlier when they are starving.
4. Juvenile bats, with less adept flight performance, should emerge after adults.
5. Bats should emerge from sheltered roost sites earlier than from exposed ones. These predictions are tested bv analysis of roost observations and radio-tracking data from a range of European bat species.

Dynamics of *Myotis nattereri* and *M. daubentonii* Observed during the Hibernation Season as an Artifact in Some Types of Hibernacula

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The dynamics of hibernating bats of *Myotis nattereri* and *Myotis daubentonii* were studied. It is widely known that these species during hibernation prefer places offering a high degree of protection. The work was carried out in one of the bunkers in western Poland (Poznan, Fort 1). The study was made in two ways: 1) visible bats were counted every week by using artificial light (during the 3 hibernation seasons 1991 to 1994), 2) bats were caught in mist-nets put in front of the exit of the bunker. They were netted four times a week, during 5 hours after dusk (during the late winter and early spring of 1992, 1993 and 1994). Results of counting *M. nattereri* and *M. daubentonii* :peaks were observed in the second half of November and in December (M.n.) or in November (M.d.); during the following winter months downward tendencies (M.n.) or distinct drops (,M. d.) in numbers were observed. Generally, numbers of netted M. nattereri and M. daubentonii were higher (nearly 2 times in some years) than numbers of bats found inside the bunker at the beginnig of netting. Based on the above results, one can suppose that drops in the numbers of bats following autumn peaks were caused by the animals moving to the places in which they were better protected (and less visible). Departure from the hibernaculum during the winter was probably of little importance.

The Role of Active Bats in Awakening Hibernating Animals in Fort I in Poznan

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A study was made in Fort I in Poznan, in one of the hibernacula where the density of bats was relatively high. The work was carried out during November, January and March in the hibernation seasons 1992/93 and 1993/94. The two species studied *Myotis nattereri* and *Myotis daubentonii* mainly hibernated in 1200 small regular shafts (cross-section ca. 3 x 4 cm, lengths ca. 2 m). Special plastic stakes (I cm high) were put in 391 shafts (4 cm from their edges). The lower end of each stake was filled with plasticine. The stakes were put in such a way that the bats had to overturn them when entering or leaving the shafts. The positions of the overturned stakes indicated, inter alia, which shafts were visited by active bats. In "visited" shafts torpid bats could be disturbed and even awakened bv active ones. Displacements were a measure of the activity of hibernating bats. Frequencies of displacements of *M. nattereri* and *M. daubentonii* which hibernated in "visited" shafts were higher than in "not visited" ones. It was calculated that in *M. nattereri* about 18% and I2% of torpid individuals were awakened by active bats during January and March, respectively (in November this species has barely arrived). In *M. daubentonii* about 5%, 17% and 15% of torpid bats were awakened by active individuals during November, January and March, respectively.

Swarming Behaviour *Myotis nattereri* and *Myotis daubentonii* at a Large Hibernaculum

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In an old fortress "Spandauer Zitadelle" a maximum of 200 Daubenton's bats *Myotis daubentonii* as well as 200 Natterer's bats *Myotis nattereri* hibernate visibly in underground areas. At regular nettings in autumn, from August to November, nearly 15,000 "swarming" bats have been captured here. More than 4,500 Daubenton's and 6,000 Natterer's bats have been banded since 1991. The banded bats came back several times in each swarming period and in subsequent years. So the proportion of marked individuals showed a constant increase to nearly 80 % in October and November 1995. Estimates of population size, based on mark-recapture techniques, make plain that about 3,500 Daubenton's bats and about 7,000 Natterer's bats visit the hibernaculum every year. The sex ratio for these estimates is nearly 1:1. Banded individuals of both species were found in summer colonies more than 60 km away from the hibernaculum. The swarming period of both species is divided into two phases: The first swarming phase ("*period of exploration - Erkundungsphase*") begins two months before hibernation. In the second phase ("*period of settlement - Einwanderungsphase* "), body mass of swarming bats increases and the first hibernating bats can be observed. Daubenton's bat first appears in the beginning of August at the hibernaculum, Natterer's bat can be seen one month later, in the beginning of September. Hibernation of Daubenton's bat begins in the first half of October, whereas Natterer's bats hibernate at the earliest from the beginning of November.

Bats and Landscape: Small-Scale Distribution Patterns of Bats as a Reference for Area Planning, Nature Conservations and Development Policy

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One of the main tasks of Dutch Provincial Authorities is area planning, including the implementation of national area policy on a regional level. To support policy-making in the province of Noord-Holland, a nature-survey programme has been carried out since 1978, mainly covering birds and vegetation. In recent years this programme has been extended with a bat-survey, carried out in cooperation with many volunteers. The bat-survey included several methods, of which the use of bat-detectors was the most important, since this is the first and only method that enables us to cover an area systematically and exhaustively. The bat-survey has revealed many data. What can we do with this knowledge? Do bats provide any added value to our existing knowledge of natural assets and often traditional way of policy-making? The answer is yes. Bats prove to be good indicators for landscape quality and coherence. Both are vague and abstract terms which, however, are often used. Bats may render these terms more concrete and tangible. Some examples will be given of the connection between bats and landscape: distribution patterns,

habitat use, and species diversity. In general, data are more valuable for the process of policy-making and thus more widely applied when they are more detailed and when ecological relations are better known. It is argued that data on 'bats and landscape', when available during the preparation phase of area planning, landscape development and conservation, are essential to provide a basis for the adequate conservation of bats.

Decline of a Popultion of *Nyctalus noctula* near Haarlem, 1930-1995, Based on a Method of Simultaneous Counts, and the Prospects of Recovery

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The preparation stage of area planning and policy-making depends on the availability of information on the values of landscape and natural assets. Data on species distribution and population size are important to rate areas according to these values. Current data on bats make up part of this information. In general, the size of a bat-roost is determined by counting all departing bats after sunset. However, the population size within a certain area cannot simply be assessed by summing up the sizes of all roosts known within the area, since bats often change roosts, which may lead to double-countings. This holds true especially for tree-dwelling species. During a survey programme of bats between 1987 and 1993 in the province of Noord-Holland, many roosts of noctules *Nyctalus noctula* were found, mainly in hollow trees in old woodlands. Population size of noctules (and Daubenton's bats *Myotis daubentonii*) could be assessed by simultaneous counts, a method not practised on bats before. Such counts were organised in four contiguous areas of woodland. The population size of noctules in one of these regions, near Haarlem, were assessed in 199') and in 1996. For this area, historical data are available as well: population numbers in the thirties and fourties can be deduced from the very well-kept ringing data collected by Leo Bets, who started a study on noctules near Haarlem 50-60 years ago. A short film of his work in 1940 wiII be shown. A comparison shows that the population of noctules has decreased with by least 50% in 50 years, probably much more. It is argued that changes in landscape-character especially, as well as the coherence of woodlands is reponsible for this decrease. However, new plans may offer new chances for this species.

The Bat Fauna Settled in Bird Nest Boxes in Tuchola Forest in North Poland

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During 1991-1994, a study of species composition, numbers and degree of utilization of bird boxes by bats was carried out in the largest coniferous forest complex (Bory Tucholskie) in northern Poland. 3,590 wooden nest boxes (W) with an entrance of 30 - 35 mm in diameter were checked, as well as 287 sawdust -concrete boxes (SW), Graczyk design, with an entrance diameter of 32 mm, Bats were found in 8% of the W-boxes and a 12.5% of the SW-boxes. Totally, bats or their droppings were found in 29.8% of the W-boxes and 31.4% of the SW-boxes. In spite of the fact that sawdust-concrete boxes were less numerous (7.9% of all boxes), as much as 32.4% of all bats were found in these. 1397 bats belonging to seven species were found. Altogether, the proportions were as follows: *Pipistrellus nathusii* 37.2%, *Myotis daubentonii* 35.8%, *Myotis nattereri* 16.2%, *Plecotus auritus* 10.6%, *Nyctalus noctula* 0.1%, *Eptesicus serotinus* <Θ. 1 %, *Pipistrellus pipistrellus* <O.. I %. *Pipistrellus nathusii* showed a strong preference for wooden boxes, *Myotis daubentonii* on the other hand preferred sawdust-concrete boxes. *Myotis nattereri* and *Plecotus auritus* were found in both types of boxes in similar proportions.

Population Structure in the Bechstein Bat *Myotis bechsteinii*

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Female Bechstein's bats form groups during the summer to raise their young. Such maternity colonies consist of 20-80 females, which regularly split into subgroups of variable individual composition and which use a variety of different roosts. We analysed the mitochondrial DNA of 370 bats by using three polymorphic markers (including one new mitochondrial microsatellite). We compared the variability of

these markers within and between 17 colonies in forests of northern Bavaria, Germany. We found little variation within each colony, whereas most colonies were clearly distinct by colony-specific mitochondrial types of their members. From these results we conclude that maternity colonies of Bechstein's bat consist of maternally closely related females and are socially closed societies. Some of the solitary males, however, leave the area where they were born and settle close to the roost of a foreign, normally neighbouring colony, whereas other males stay for years in the area of their native colony. The population structure of Bechstein's bat is therefore characterized by extreme female philopatry and local male dispersal. Possible implications of this population structure on the social system of Bechstein's bat are discussed.

Activity Patterns and Foraging Areas of a *Plecotus austriacus* Colony

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In 1994 and 1995, we investigated the activity patterns of a nursery colony of Plecotius austriacus which inhabits a church loft in the Nahe Valley (Germany). We found lactating females with their offspring, non-lactating females, and single males inhabiting the loft at the same time. Eight females and one male were radio-tracked. In addition, we recorded the weekly activity pattern of the colony in relation to temperature by sampling pellets below preferred resting sites within the loft. Like *Myotis myotis*, grey long-eared bats select their hiding places according to changes in temperature conditions of different microhabitats. Most bats were hanging free, but almost always single individuals were hidden in holes and crevices of beams. There are special places of cluster formation in spring, summer, and autumn. *Plecotus austriacus* also utilizes the church loft and clock tower as a winter roost, and maybe as a mating site. 61 nights of radio-tracking provided information on hunting sites: mainly orchards, meadows, street-lamps, hedges, forests, and single standing trees. Most hunting areas were situated close to the roost, within a distance of less than 2 km. However, the maximum hunting distance was about 5 km. During a night, individual bats first visited nearby hunting grounds before they approached more distant ones. Most animals changed their foraging areas several times a night.

Distribution and Abundance of *Plecotus austriacus* in the Nahe Valley, Germany

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In the Nahe Valley (Germany), *Plecotus austriacus* is a widespread species. In 200 church lofts that were checked for bats since 1988, we found 30 nursery colonies of the grey long-eared bat. In addition, in 80 lofts single specimens or small groups of animals were found. Most colonies consisted of about 30-50 females (lactating and non-lactating ones), in two cases we found between 60 and 80 bats. One colony, however, consisted of 180 animals including juveniles. Since 1994 we have marked 294 individuals in five colonies with coloured rings. In about 100 cases we recorded marked and unmarked bats when regularly checking the lofts for bats during winter and summer. Using mist-nets, we recaptured 104 banded bats in the close vicinity of the lofts. However, we never found an exchange of individuals between colonies. Most banded bats were recaptured at their colonies of marking. Only females that were less than one year old were recaptured outside their colonies: One was found 7 km away as a traffic casualty, a second was found hibernating at 15 km distance in an old mine, and a third was hanging outside a house, 30 km from its colony of birth.

Ecology and Energetics of Hibernating Daubenton's Bat *Myotis daubentonii*

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Measurements of the oxygen consumption of Daubenton's bats at 5'C were carried out by respirometry in October-December 1993 in the Department of Zoology, University of Aberdeen. The bats were taken from three populations (Central Scotland N=11, Central Wales N=9 and NE Scotland N=2). They were housed in the flight room exposed to a natural photoperiod and to the ambient temperature. The average forearm length (FL) of the bats was 37.21(SD= 1.28, N=22, R= 35.15-39.50). A negative correlation was found between oxygen consumption (ml/min) and forearm length ($r=-0.72$, $F=10.86$, $df=10$, $P<0.008$). There was no significant relationship between oxygen consumption and body mass ($r=-0.10$, $F=0.11$,

df=10, P<0.75), age (F=3.89, df=10, P<0.08) and sex (F=0.56, df=10, P<0.47). Field observations of weight decrease in hibernating Daubenton's bats were made in the "Nietoperek" bat reserve (W. Poland) (November-March) in the winter seasons 1990/91 and 1991/92. The average forearm length (FL) of hibernating bats was 38.17 (SD=0.98, N=581, R=34.25-40.70). Three size classes were distinguished (FL<36.45, 38.56>FL>36.45, FL>38.58) and regression equations were calculated for these classes. The greatest weight decrease was observed in the largest (0.0236g/day) and smallest size classes (0.0233g/day). The lowest decline in weight was observed in middle-sized ' bats (0.0195g/day). The difference between laboratory and field conditions is probably caused by the energy costs of spontaneous arousals, which are higher for large animals. The small bats start foraging earlier (February-March) (weight decline stopped) than other classes.

Energy Balance of *Myotis myotis* Hibernating in Two Localities: A Study with a New Tobec Instrument

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The energy balance of bats hibernating in two places in Poland: a semi-natural cave at Miedzianka and in the forts of the city of Poznan, was calculated from changes in fat contents estimated with ACAN-2, an instrument applying a non-invasive TOBEC method for the analysis of body composition. In both places measurements were performed four times (December, January, February, and March-April). The number of animals analysed during each of the trials was between 16 and 28, 25% to 70% of the individuals were retrapped. During the long and cold winter of 1995/96, the temperatures in the Poznan forts, and the bodv temperatures of the bats hibernating there, were 2'C to 4'C lower than in Miedzianka cave. At the beginning of hibernation the weights of the bats (BM±SD) and estimated fat contents (FM) were higher in Miedzianka (BM=29.3±2.3 g, FM=8.5±1.7 g) than in Poznan (BM=28.3 ±2.9, FM=8.1±2.3g), but at the end of hibernation the values were lower in Miedzianka (BM=24.4±2.0 g, FM=3.4±1.2 g) than in Poznan (BM=24.8±2.2 g, FM=4.1±1.4 g). On average, the bats hibernating in Miedzianka were using 1.5 kJ/day from their fat reserves, which amounts 230 kJ or 5.9 g fat for the entire hibernation period (5 months). Hibernation in the Poznan forts was less expensive: 1.3 kJ/d, which amounts to 198 kJ or 5.1 g fat for 5 months. The result is consistent with the theoretical prediction that energy expenditure during hibernation is lower at lower ambient temperatures.

Comparative Morphology and Functional Analysis of Sternum and M. Pectoralis

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Our research of the thorax and its individual elements in representatives of 12 families of bats has shown substantial differences in shape of the thorax as a whole and of its elements, in particular the sternum. We have established that in bats having their thorax compressed dorsoventrally, there is no keel on the corpus sterni, whereas a keel is present in bats with the thorax having a rounded shape. The detailed studies of morphology of thorax, proximal elements of thoracic limbs, and pectoral muscules in representatives of the Vespertitionidae and Rhinolophidae have revealed regularities in the formation of the ventral elements. We conclude that both the keel on the corpus sterni and the ventral process of the manubrium sterni are the result of the action of the pectoral muscules, having the shape formation character. The degree of development of these structures correlates with the value of the angle of the pectoral muscle fibres to the plane of the sternum, which, in its turn, depends upon disposition of proximal links of the thoracic limbs relative to the thorax as well as on thorax shape.

Hibernation of Bats in Wells

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Very little information on hibernation of bats in wells has been published. In Poland the first observation was made in the Notecka Forest (Bernard & Gawlak, Bat News 1994); and now has been observed in four places in Poland. Studies on the ecology of bat hibernation in wells was carried out in Górzno-Lidzbark Landscape Park (central Poland). During two winters about 3O wells were controlled in the first part of December and the first part of February (four controls). The highest number of bats was observed in December 1994 (227 individuals). Four species were found (*Myotis myotis, M. nattereril, M. daubentonii,* and *Plecotus auritus*), but *M. myotis* was recorded only once (in December 1994). *M. daubentonii* dominated in all controls. Each well was divided into three equal parts: upper, middle and lower. In December the bats equally distributed over these sections, but in February about 70% of the bats was in the upper part of the well. All species preferred the upper part, but in December *M. daubentonii* was numerous in both the upper and lower part. The majority of the bats was hidden in fissures and this preference was more obvious in February. In the same area bats hibernating in cellars were investigated. The species composition in these two kinds of hibernacula was different. In cellars *P. auritus* and *Barbastella barbastellus* dominated. The above-mentioned two small *Myotis sp.* were observed rarely here. Because small numbers of bats were found in cellars (max. 53 individuals in one control), the authors are of the opinion that in this area wells are more important for bat hibernation than cellars.

Aspects of Bat Activity During Transient Periods(Spring and Autumn) in Poland

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In order to study the species composition of migrating bats, mist nets were installed in front of the entrances to selected caves in Betkowska Valley in the Jura Landscape Park in southern Poland. Bats were caught in autumn (September-October) 1995 and spring (April-May) 1996. The data were compared with those from the winter count of bats hibernating in the same valley in the Nietoperzowa Cave, the largest bat hibernaculum near Cracow. Considerable differences were found in species composition between the bats hibernating in caves and those occurring nearby during migration. In winter the dominant species were Mouse-eared bat, *Myotis myotis* and Lesser horseshoe bat, *Rhinolophus hipposideros*, in autumn Natterer's bat, *M. nattereri*, Daubenton's bat, *M daubentonii* and Lesser horseshoe bat, *R. hipposideros*, and in spring Geoffroy's bat, *M. emarginatus* and Lesser horseshoe bat, *R. hipposideros*. Up to now Geoffroy's bat, *M. emarginatus* has been considered very rare or nearly extinct in this part of Europe. Within the last few years, only a few individuals of this species were found hibernating in caves of Southern Poland. As many as 18 individuals of Geoffroy's bat were caught during. one night in spring 1996 (31 May), and 25 during the whole study. The results indicate that Geoffroy's bat is far more numerous than previously thought. Neither the areas of their summer activities nor the places of hibernation are known. During the present study, the bats were most probably caught on migration.

Structure of the Central Russian Bat Community: Ecomorphological Data

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The bat fauna of Central Russia (north of the forest-steppe zone) includes 12 species of 6 genera (family Vespertilionidae). 17 indices based on body, wing and skull measurements were used to divide these species into ecological groups. We measured from 7 to 22 specimens of each species. Proportions of wings and jaws were interpreted as indicators of feeding strategy. In spite of the poverty of this community, all main ecological groups of insectivorous bats can be found (though the members of these may be less specialized than in tropical communities). The following ecological groups can be defined. The first consists of fast, non-maneuverable aerial insectivores with narrow wings and adaptated to larger prey (3 species of *Nyctalus* and *Vespertilio murinus*), provisionally regarded as obligate users of patch resource. The second group includes species with a fast, maneuverable flight (*Pipistrellus nathusii, P. pipistrellus*), that feed mainly in the space around the canopy. 3 species of *Myotis* and *Eptesicus nilssonii* form a cluster

of maneuverable aerial insectivores, using a homogeneous food resource, that mainly hunt in open areas. The last group consists of the most specialized element - *Plecotus auritus* (adapted to perch-hunting and gleaning). *Myotis nattereri*, with its adaptation to gleaning, occupies an intermediate position between the two latter groups.

Difference in Wing Shape Between Species of Whiskered Bat *Selysius*

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The wing of a bat is influenced by strong selection pressures, and so its shape and proportions are greatly modified in accordance with the hunting behaviour of this or that species. We investigated three species which are closely related systematically and, probably, ecologically: *Myotis mystacinus, M brandtii and M. ikonnikovi*. Skeletal wing elements were measured of specimens from different parts of the distribution area. A comparatively low coefficient of variation of some wing skeleton elements and a high correlation between the lengths of metacarpals and forearm were demonstrated. In accordance with this, among these species a clear difference in wing shape exists, the forest species, *M. brandtii* having a slightly smaller arm wing part than *M. mystacinus*, which prefers more open areas. At least among non-European forms of *M. mystacinus*, practically no difference in wing proportions is found; this is more noticeable among the two races of *M. brandtii*. Sexual dimorphism was not found. In spite of this difference in wing shape, direct identification of these species by the measurements of wing elements cannot be considered exact

The "Levensauer Bridge" near Kiel: the Largest Hibernaculum of Noctule Bats *Nyctalus noctula*

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Although the hibernaculum "Levensauer Bridge" had been known since 1971, the number of hibernating noctule bats *Nyctalus noctula* has been significantly underestimated. According to recent estimates, at least 5,000 individuals hibernate in the southern part of the bridge. At a height of 15 metres the bats form large clusters using the dilatation joints (up to 150 cm deep and 8 cm wide) on both ends of the bridge. Whereas the counting of hibernating bats is based on video-recording of animals leaving the bridge between the end of February and March 20, 1994, flight activity of the noctules has been continuously recorded by passive ultrasound-sensors ever since 1993. The data show that the bats use the bridge not only in winter, but also in late summer. Mainly in August there is a peak of activity, with hundreds of noctules visiting the bridge. They stay only a couple of hours and leave the bridge again later in the same night. The immigration into the hibernaculum lasts from the middle of November until the middle of December. Except for phases with temperatures clearly below zero, there was always flight -activity throughout the winters of 1993/94 and 94/95. Due to the long period of frost in the last winter, there was hardly any flight-activity until the second week of April, when departure started. This was almost four weeks later than in the previous years. Nevertheless, only a very few indivdiuals were found dead in the bridge.

The Influence of Weather Conditions on the Departure of Bats from Bad Segeberg Cave

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The limestone-cave in Bad Segeberg, 70 km north of Hamburg, is one of the largest hibernacula of bats in central Europe, with 12-15,000 hibernating bats. The number was recorded by means of a special light-barrier system, which has been implemented since August 1992. During the winter the limestone-cave accommodates a number of different bat species, first of all Daubenton's bat *M. daubentonii* and Natterer's bat *M. nattereri*. There are, however, also small numbers of *M. dasycneme, M. brandtii,*

M. bechsteinii, M. myotis and *P. auritus*. Between 1993 and 1995 the numbers of departing bats increased during March. At the turn of the month a peak was reached. In the second week of April the number started to decrease. The last bats always left in the last week of April. The number of departing bats ranged from some individuals when it was cold and windy, to more than 1,500 animals per night when the weather was favourable again after an unfavourable period. Single cold nights with temperatures below zero did not significantly influence the departing dynamics. However, the 1996 data suggest that long cold spells considerably delay the departure of the bats. Then, however, they leave within a shorter period of time, so that again the last bats leave at the end of April. When comparing the departure patterns over the years, it seems that weather conditions play a minor role and that the departures are predominantely endogenously determined.

A New System for Monitoring and Counting Bats

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By means of an automatic monitoring device, bats entering or leaving their cover or flying into their roost sites can be recorded and the data evaluated later. The system makes it possible to monitor bats all year round and thus revealing new insights into the utilisation of hibernation as well as breeding sites. So far, this system has been successfully implemented as a monitoring device in several hibernacula. Probably the best known of these is the limestone cave of Bad Segeberg/Germany, where monitoring started four years ago. In order to record bats entering or leaving, a two-way light-barrier system has been developed. To ensure a reliable recording of even small species and at the same time prevent counting insects, the flight direction is determined by an integrated hardware logic-filter. A certain order of light interruptions, means, for example, that a bat has entered; bats circling at the entrance are not counted. Flight activitiy is recorded by means of the ultrasounds emitted by the bats. Ultrasoundsensors pick up the echolocation pulses and send a signal to the computer. Since whether or not the bats are active is the only fact of interest to us, the sensors can only be activated every thirty seconds. Otherwise the amount of data would be enormous without providing more information. The fact that the bats are active as well as the exact time are recorded. The data are then available for research on various aspects of flight activity.

Bat Lyssaviruses and Arboviruses in the Territory of the Former Soviet Union(Assumed Data up to 1995)

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Up to 1995, a total of 2,617 bats were examined for rabies in the territory of the FSU. 13 Lyssavirus strains were isolated and 2 strains from humans who had died after bat bites. Some of the strains were studied using monoclonal antibodies and identified as serotypes I (Siberia), and 4 (Ukraine and European part of Russia). One strain from Aravan (Kyrghyzstan) was significantly different from the other serotypes. Large numbers of bats were examined for arboviruses. The tick-borne encephalitis virus had been isolated in many places including locations where it was not found in "field" ticks, rodents and birds (Central Asia, Southern Kazakhstan, some points of Eastern Siberia). This may be regarded as evidence of an isolated circulation of the tick-borne encephalitis virus among bats as had been demonstrated earlier for lyssaviruses. Also, one member of the Flaviviridae - Sokuluk virus - was isolated from bats and their parasitic arthropods in the Central Asia. Among other arboviruses occurring in bats are members of the Bunyaviridae:Issyk-Kul virus (epidemiologically significant in many places in Central Asia), Tyaginya (Tadjikistan) and Uzunagach (Southern Kazakhstan) viruses.

Bat Embryology and the Evolution of Flight

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The existing hypotheses concerning flight evolution in chiropterans are based mainly on the data provided by palaeontology and comparative anatomy. Embryological data are scarce though some onto-

genetic recapitulations are well known. We have carried out a comparative investigation of the development of locomotion organs in chiropterans *Nyctalus noctula* and dermopterans *Galeopithecus volans*. The latter species is known as the best glider among mammals; its embryos were kindly provided by the Hubrecht Laboratorium (Utrecht University, the Netherlands). An evident similarity in the development of the flying membrane between chiropterans and dermopterans was demonstrated, supporting the hypothesis of flight evolution through the gliding stage.

Monitoring and Conservation of Bats in the Malé Mountains, Slovakia

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Until recently the Malé Karpaty Mts. were relatively little studied in chiropterological respect, despite the presence of numerous suitable shelters for bats. Since 1993 a group of volonteer conservationists called Miniopterus, part of the Slovak Union of Nature and Landscape Conservators with its headquarters in Bratislava, has been working in this area. Recently, it also organizes and coordinates the research and conservation of bats in the West Slovak region. Due to the activities of this group, the Malé Karpaty are now among the best explored mountains in the Slovak republic. We carry out counts of bats in summer colonies, autumn nettings and winter counts in hibernation sites. We have recorded 30 summer and 42 winter localities with bats. The members of "Miniopterus" are also involved in management for the conservation of endangered species or localities. We often make up for the lack of activities of state organizations for nature conservation. We present the results of monitoring, development trends, evaluation of biotopes, evaluation of the importance of localities, the conservation status of individual species and photographic documentation.

Foraging Areas of *Eptesicu serotinus* and *Nyctalus noctula* in River Valleys

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Bats were counted on transacts in 3 broad river valleys in Poland (Biebrza, Bug, Vistula), each in a different way transformed by agricultural land-use and urbanization. D 100 detectors were used to record bats and to determine the species. The 2 km long transacts (situated an increasing distance from the river) represented a variety of habitats: riparian, open meadows or arable fields, built-up, the edge of a forest on the border of each valley and forest interior. Prefered habitats of foraging bats differed between the two species, but were similar in all valleys under study. *Nyctalus noctula* foraged much higher (usually > 15 m above ground level) than *Eptesicus serotinus* (usually < 10 m above ground level). The main foraging areas of the former species were distributed in riparian habitats, where it reached the maximum relative density - 44 records/count (Bug valley). Inside a forest *Nyctalus noctula* appeared rarely and only over big glades. It was also observed in low numbers between the river and the forest edge. Those parts of the valley were probably only passed by bats flying to preferred foraging areas near the river. *Eptesicus serotinus* was less frequently observed along the river, mainly in places close to a built-up area. Forest roads were preferred by this species, mainly up to 1.5 km from villages. The maximum relative densities of *Eptesicus serotinus* in all valleys reached similar values - 20 records/count (Vistula valley), 18.3 records/count (Biebrza valley), 17.7 records/count (Bug valley). Variations in total bat densities in comparable parts of the three valleys under study were small. Relative densities were highest in the part between the river and the forest. This part of Biebrza valley was characterized by a bat density 2-3 times lower than in other valleys. The total abundance of *Eptesicus serotinus* increased with increasing anthropogenic changes, and was highest in Vistula valley, lowest in the Biebrza valley. As for *Nyctalus noctula*, its abundance was lower in the Vistula valley as compared to other valleys.

Systematic Knowledge of the Distribution and Abundance of Bats as a Basis for Bat Conservation

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In order to develop and implement effective conservation strategies for bats in Europe, a number of

conditions have to be fulfilled. General conservation policies as well as concrete conservational measures need a legal basis and have to be accepted by society, both on a national and international level, to be able "to do something". Ecological requirements of bats have to be known or studied in more detail, to know "what to do". Distribution and abundance of bats have to be known in detail, to know "where to what". In Europe numerous examples of successful efforts to improve the legal status or public awareness, of good research on bat ecology, directed at specific sites, species or phenomena, can be given. At the same time many European or national distribution maps do not necessarily represent true distribution, and a sound assessment of the abundance and status of individual species is hardly possible. Selectivity of individual survey methods and uncoordinated survey activities of (volunteer) observers lead to a fragmented and selective knowledge. Conservation efforts based on such knowledge too often concentrate on conspicuous species at conspicuous sites. To be able to gain a more profound knowledge of the distribution and abundance of bats, the area should be systematically and actively surveyed using a combination of all available survey methods (detectors, netting, bat boxes, visual inspection of potential roosts etc.), thus optimizing the detection chance for each species. Although not perfect, the results of the Dutch nationwide bat survey demonstrate that better possibilities for bat conservation may arise from a systematic large-scale bat survey. Examples drawn from this project will hopefully stimulate conservation authorities and bat workers in other countries to give priority again to "basic" bat survey work.

How Noctule Bats *Nyctalus noctula* Make Use of the Philosophen Forest, Germany in the Different Seasons

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The "Philosophen-Forest" is situated at the outskirts of the city of Giessen, Germany and is surrounded by housing areas and streets. The forest covers 20 hectares and consists mainly of oak and beech. The number of noctule bats *Nyctalus noctula* which use the forest all year round varies greatly. For recording the changes in the numbers of more or less stationary bats over the year, the bats leaving the forest in order to hunt were counted once every week. Because of the island-like structure of the forest, it was possible to place ten people around it, to record all noctules leaving the forest from the beginning of their departure (around 15 minutes past sunset) until it was completely dark. The number of noctules leaving ranges from between 400 individuals in spring and late summer to about 120 in mainly midsummer. Furthermore, there is a considerable number of noctules, which use the forest mainly as a roost. They arrive at night and leave again on one of the following nights. In August the hibernacula are predominantly used by large groups of mainly young noctules. Since they could not be trapped again in August, it may be assumed that they stay in the forest only a short period of time. Shortly after having been ringed, however, animals were found 50 and 120 km away from Giessen. The immigration of hibernating noctule bats clearly starts later, in the second part of November. The animals arrive during the night. So far, 11 hibernacula have become known. The largest of these accomodates at least 700 indivuduals every year!

Bat Research in Matsalu Nature Reserve in Estonia

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Matsalu Nature Reserve lies in Western Estonia. Sporadic observations of bats have been conducted here from the early sixties onwards, and ringing and hibernation surveys have been carried out from mid-seventies. For 3 years, bat detecting with an ultrasonic detector has been going on at two monitoring sites. In parks and islets of the reserve 7 species of bats (*Myotis daubentonii, Myotis dasycneme, Plecotus auritus, Pipistrellus pipistrellus, Pipistrellus nathusii, Eptesicus nilssonii,* and*Nyctalus noctula*) have been found. An inventory of cellars used for hibernation was carried out this winter. In the absence of caves, cellars are of vital importance in the region for the hibernation of bats. As compared to the mid-seventies, hibernating conditions have deteriorated due to the decay of cellars. Recommendations were made to improve wintering conditions. As the site is one of the main points on the East- Atlantic route of migrating birds, its significance for bat migration should also be investigated.

Prey Density Influences the Habitat Selection of the Greater Horseshoe Bat

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Habitat and food selection of greater horseshoe bats were studied in Valais, Swiss Alps. Information on habitat preferences were obtained by radio-tracking. This species selects diversified, well-structured and semi-open habitats, such as riparian forests or high orchards. Diet, determined by faecal analysis, was compared to prey availability, as assessed with light traps. Results show that the greater horseshoe bat does not select its prey, but mostly forages opportunistically. Little insects, such as Ichneumonidae or Tipulidae, are surprisingly massively consumed. But to compensate for the small energy intake per capture, horseshoes search for large swarms of insects. This work demonstrates that the occurrence of swarms determines habitat selection to a great extent. The relatively slow flight of the greater horseshoe bat constrains it to hunting in habitats with high insect densities. Other species, able to fly faster (for example *Nyctalus noctula* or *Tadarida teniotis*), are able to hunt in habitats offering fewer prey, or even in winter in the case of *Tadarida*. Their higher speed allows them to keep up an optimal rate of prey capture. One may attribute the decline of the greater horseshoe bat in central Europe to decreasing insect densities at low altitudes.

Diet and Diet Selection of the Lesser Mouse-eared Bat *Myotis blythii* in the Rhine Valley of Eastern Switzerland

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In the study area *Myotis myotis* and *M. blythii* are inhabiting the same roosts and form mixed colonies. Species-specific faeces samples were collected from free-living *M. blythii* in three colonies in 1994 and from two colonies in 1995 (one sample per month, from May to September, 10 individuals per sample). 16 prey categories from 196 faecal samples have been identified so far. Bushcrickets (Tettigonidae sp.), crane-flies (Tipulidae sp.), mole crickets (Gryllotalpa gryllotalpa) and cockchafers (Melolontha sp.) constitute the main prey items in the diet. Where in an agricultural landscape does the Lesser Mouse-eared bat find its favourite prey. To identify typical hunting habitats in the study area, three *M. blythii* from one colony were fitted with radiotransmitters in 1994. The aim of these tracking studies was to determine relevant habitats for estimating prey abundance. In 1995 semi-quantitative insect trapping was carried out in these hunting habitats and in corresponding control areas, to estimate prey abundance. Prey selection will be tested by comparing the seasonal variation diet (faecal analysis) with the seasonal prey availability (semi-quantitative insect trapping) in different habitat patches. Some preliminary results are presented.

An Analysis of Fossil and Subfossil Remains of Bats from Lazareva Pecina Cave in Eastern Serbia

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The excavation of fossil and subfossil material has been conducted simultaneously with theriological researches on the fauna of Lazareva Pecina Cave in the vicinity of the village of Zlot in eastern Serbia. Of the numerous remains of mammals, the majority is of cranial and postcranial bat skeletons. This paper shows comparative data on the recent bat fauna and the bat fauna of the past. It also surveys the sediment acidity in the geologic formation containing characteristic findings and its effect on the preservation of fossil remains.

Monitoring Bats with Bat Detectors in Estonia

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A modified transect census method was used to count bats flying in summer habtats. On 20 monitoring routes seven species of bats were counted, of which *Eptesicus nilssonii* was most abundant. Special monitoring indices were used to estimate the relative abundance of bats on each route. Maximum

densities of bats were recorded near water bodies, where the animals concentrated to feed. The highest level of Route's Monitoring Index (RMI) was found at Raepina, where 58.5 individuals and 19.5 groups of bats were recorded per 10 km. The Mean Monitoring Index (MMI), the mean of 20 routes studied in Estonia in 1993-1994, was 25.7 individuals and 7.2 groups of bats per 10 km.

A Method for Estimating the Value of Winter Quarters for Bats

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The method has been worked out in 1977-1978, during an investigation of hundreds of underground winter quarters (WQs) of bats in Estonia. The value of each WQ can be quantitatively expessed by the Index of Value (IV), which is calculated by using the following formula: IV = number of bats found times number of bat species found. The formula is sensitive to both number of bats and species richness. It could be used to quantitatively compare: 1) WQs situated in different places, 2) changes of conditions of a certain WQ during a time interval. In case conditions of a certain WQ and behaviour of bats remain constant, the IV level will characterize the status of bat populations in a certain area. Thus, IV can be used in bat conservation work as a quantitative monitoring index. IV has been used for bat conservation purposes in Estonia. A list of the most important WQs has been compiled, based on IV levels. Among artificial caves the IV levels can be as high as 7,500, while among cellars the highest IV levels reach 150. Similar formulas could be used to estimate changes in biodiversity in certain biotopes or in larger areas, nature reserves included.

Genetic Analysis of Bat Populations

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Recent developments in the field of molecular genetics provide a variety of genetic markers distributed throughout the nuclear and mitochondrial genome. Such polymorphic loci allow an approach of basic questions regarding bat behaviour by studying the allele frequencies among and between individuals, populations and species. The polymerase chain reaction (PCR) allows specific amplification of a single part of the genome. Thereafter the amplified sequence or its length can be analyzed. DNA sequence divergence, i.e. the number of mutations between two sequences, is time-dependent and can be used as a direct measure for genetic relationship. Repetitive DNA sequences, which are known to be variable in length due to a variable copy number of the repeated unit, are used in intraspecific studies. Examples of genetic-analysis on the individual, population and species level are given using microsatellites, i.e. tandem arrays of a short DNA sequence usually 2 to 4 base pairs in length, and sequence comparisons of mitochondrial DNA. Results on the phylogenetic relationships among European vespertitionid bats and genetic structure of nursing colonies of the noctute bat *Nyctalus noctula* are presented.

The Lessor Horseshoe Bat *Rhinolophus hipposideros* in Ireland: Distribution, Status and Conservation

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The lesser horseshoe bat is the only member of the Rhinolophidae to occur in Ireland, where it is at its western and northern distribution limits. It is confined to just six regions along the western Atlantic seaboard. The known population is approximately 5,000 bats, but it Is estimated that the total population could be between 10,000 and 12,000 animals. A survey took place during the mid- 980s, which resulted in over I 00 sites being recorded. Approximately 250 sites are known today. Large areas of the species' range have yet to be systematically surveyed. Existing legislation affords the species some protection, but is currently not an offence to disturb or destroy a roosting site during building, road construction or archaeological work. Nursery sites occur in the attics of old mansions, in farm buildings and small cottages. Hibernation sites occur in cellars, caves and underground passages. All the major nursery and hibernation sites are in private ownership. Nine underground sites have been grilled to prevent disturbance and the roofs and ceilings of five nursery sites have been repaired. At least three large nursery and hibernation sites have been lost during the past ten years. Conservation measures needed to secure the future of the lesser horseshoe in Ireland include: grilling vulnerable hibernation sites, negotiating habitat and site management agreements with private owners, and purchasing key sites as bat reserves.

Bats and Forest Management: a Research Project in Germany

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This research project has been initiated and is being funded by the Federal Agency for Nature Conservation in Bonn. The project started in December 1995 and will last for 30 months. The aim of the project is to formulate suggestions for the conservation and support of forest-living bats by characterizing bat communities occurring in different types of forests, evaluating the use of bat boxes, identifying forests of special importance for migrating bats, setting up an action plan for migrating forest-living bats, and formulating suggestions for forest management. Accordingly, the project comprises the following parts:

1. A comprehensive literature survey (bats in forests, habitat use, use of bat boxes, etc.)
2. Investigations focussing on ecological aspects such as spatial and temporal utilization of forest habitat structures (radiotracking of several bat species)
3. Investigations to identify bat communities in different types of forests (selected sites are chosen, ranging from lowland forests in the northern part of the country to montane forests in the Bavarian Alpes)
4. Observations of migrating bats, especially the Noctule bat *Nyctalus noctula*, during migration (a detailed observation and counting programme is being conducted at several selected spots in Germany)
5. Additionally, all study sites and areas known from the literature are being investigated by a forester, to obtain detailed information on actual management.

Conserving Greater Horseshoe Bat Feeding Areas: Part II. Environmental Prescriptions

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Conservation of greater horseshoe bat populations depends on both the protection of roost sites and the maintenance of feeding areas containing suitable insect prey and habitat features. The most critical areas are centered on maternity sites, where the density of hunting bats is greatest and their food requirements are highest. Generalised landscape management plans for critical areas were prepared by combining published data on foraging range and habitats with information from dietary studies. These plans will be put into effect through agricultural support mechanisms, which compensate farmers for adopting environmentally beneficial land management practices.

An Atlas of European Mammals

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The Societas Europaea Mammalogica was founded in Paris in 1988, primarily as a way of coordinating the production of mammal distribution maps, but also with the aim of improving contacts between European mammalogists and promoting the study of mammals in a European context. Since 1988, voluntary coordinators for countries and regions have contributed towards a draft atlas, based on 50 km UTM grid squares. A draft atlas will be available at the Symposium and the final atlas will be published by Academic Press in 1998.

Summer Activity of Bats in Their hibernacula

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Summer activity of bats in their hibernacula is a phenomenon which has occurred during the last IO years and up to now is not well understood. Therefore, we investigated bat activity so during the summer of 1995 in 3 hibernacula by automatic data-logging (Gerate und Anlagen für die biologische Forschung). Each detectable ultrasound was recorded as one signal and the number of signals per time was used as the measure for activity. Two investigated quarters were natural limestone caves on the Swabian Alb (Baden-Württemberg, Germany); one of these is mainly used by *Myotis myotis* (90%), the other by a mixture of

6 bat species (*Myotis myotis, M. mystacinus/brandii, M. nattereri*, M. *dubentonii, Plecotus auritus* and *Eptesicus serotinus*). Activity in both caves was low in mid-July, but increased by the end of July and was highest in August. At the end of August activity became lower during a cold period. In September activity increased once more, but to a lower level than in August. This period of activity lasted till the middle of October. All bat species which are known from the winter period use these caves also during summer. The third investigated bat hibernaculum was situated near Freyburg an der Unstrut in Sachsen-Anhalt, Germany, and formerly was an underground limestone quarry mainly used by *Rhinolophus hipposideros*. In the case of this species, activity occurred at a moderate level from the beginning of July to the end of August and then increased to a higher level from September to October. In all 3 quarters summer activity of bats was observed. The great variety of investigated species leads to the conclusion that the use of subterranean hibernacula during summer is a phenomenon which occurs in all bat species hibernating in such places. What the bats do there is not known. It is important for the conservation of bats that the hibernacula should also be protected during the summer.

Retinofugal Projections in the Vespertilionid Bats *Myotis myotis, Plecotus auritus* and *Nyctalus noctula*

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Retinal projections, cyto- and myeloarchitecture of the primary optic system have been studied in vespertilionid bats representing three clades, different in both phyletic and ecomorphological respects. Unilateral eye injections of horseradish peroxidase conjugates (HRP-WGA) and routine Nissl or myelin-staining methods were applied. Quantitative image analysis techniques were used to estimate the relative degree of retinal input into different primary visual nuclei. The retina was found to project bilaterally into the suprachiasmatic nucleus, the dorsal and ventral lateral geniculate nuclei, the pretectal area and the superior colliculus. In the pretectum, the nucleus of the optic tract, the olivary pretectal nucleus and the anterior and posterior pretectal nuclei were identified as receiving contra- and ipsilateral retinal innervation. The presence of a complete accessory optic system was confirmed. In addition, the lateral and anterior hypothalamic areas, the retrochiasmatic region, the laterodorsal thalamic nucleus and the basal telencephalon were found as receiving a sparse retinal input in all three species. In *Plecotus auritus* this also includes the medial habenula. The major retinal target was the lateral geniculate body (LG), which received almost 70% of the total retinal projection as compared to hypothalamic (0.5%) and mesencephalic structures (29.5%). Both the dorsal and ventral geniculate nucleus are well developed. The superficial layers of the superior colliculus are more or less collapsed to a single layer and their thickness and differentiation vary among the species studied. With the exception of the suprachiasmatic nucleus, the ipsilateral projections were remarkably weak (around 2% of the total retinal projection). The primary visual centres are moderately developed and, except for the superficial grey layer of the superior colliculus, lack a substantial reduction in their overall pattern.

Chiropterna Diphyly - Defintely a Past Question?

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Twenty years have passed since the hypothesis on chiropteran diphyly was first presented in full. Since then, it has been both rejected or supported several times, with various arguments. The latest major revival of the hypothesis was evoked by discoveries of differences between microbats and megabats in some neuromorphological characters, in particular those concerning the organization of the visual system. Although as a reaction a considerable amount of new contra-arguments have appeared and the neuromorphological evidence has been discussed in the light of repeated investigations, the essential question has still not been answered completely. The present paper is intended to survey the previous discussion; to reconsider aspects of some neuromorphological characters; and to discuss their validity and a possible phylogenetic significance of the differences predicted for both major clades of bats.

Reproductive Behaviour and Conservation Status of Nursery Colonies of Myotis myotis in Bulgariaa

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The distribution of the most important nursery colonies of *Myotis myotis* (Borkhausen) in Bulgaria is presented. The data obtained during 1991-1995 are compared with literature reports and concern the numbers of reproductive females in 22 summer roosts (caves and mines). Fourteen of these roosts, inhabited by hundred to thousands of bats, are protected by law. The birth period established for *M. myotis* in Bulgaria is from 18-20 May to 25 June. The main parturition in the colonies lasts 3-4 days. The forearm length and weight changes of the young were measured, to determine the postnatal growth rates. The maximum forearm length (about 95% of the adult value) was recorded in the seventieth week after birth.

Predation by Martens on Bats Wintering in the Nietoperek Reserve

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During two winter seasons (1995, 1996) observations of feeding activities of martens (Alartes sp.) in the Nietoperek Reserve (NW Poland) were carried out. Marten scats from three underground control sites were collected and their composition was analysed. The number of scats, killed bats and other tracks left by martens was much higher in 1996, probably the result of last winter's severe conditions. The quantity of bat remains found in scats was unexpectedly large and differed among control sites. The differences were connected with the presence of *Myotis myotis* clusters.

Mehely's Horseshoe Bat *Rhinolophus mehelyi* : New to the Yugoslavian Bat Fauna

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Mehely's horseshoe bat inhabits caves in southeastern European countries. It is the least known and least studied member of the family Rhinolophidae. It is considered rare and occurring in small numbers. Until recently, the species had not been recorded in Yugoslavia, even though it occurs in almost all Balkan countries. On 10 May 1996, at the entrance of Lazareva Pecina cave, village Zlot, East Serbia, an adult male was caught in a mist-net. The cave is permanently inhabited by the other 4 species of horseshoe bats (of which *Rhinolophus euryale* and *Rhinolophus blasii* form a large mixed hibernating colony), while 13 more species have sporadically been recorded in or near the same cave. This paper presents the measurements of body and skull, as well as the morphological characteristics of the specimen, which is preserved in the Mammal collection of the Natural History Museum in Belgrade.

A Revision of the Distribution and Status of *Rhinolophus euryale* and *R. blasii* in Yugoslavia, Based on the Discriminant Properties of Distinctive Morphological Characters

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This paper highlights some results of our bat fauna research in recent years. The data presented were compiled from two sources: (i) long-term stationary-site bat sampling in Eastern Serbia; and (ii) re-examination of specimens from the Federal Republic of Yugoslavia deposited in the bat collection of the Natural History Museum, Belgrade. We have analysed and identified over 280 specimens of *Rhinolophus euryale* and *Rhinolophus blasii* from Yugoslavia. In our data set we record the basic statistical parameters for three distinctive morphological characters which are reliable species indicators. We also present the results of discriminant analyses with their specific discriminant functions that allow a reliable species identification. Our results allow a more reliable survey of the distribution and status of these two species in Yugoslavia. This is particularly important for *Rhinolophus blasii*, as our results differ both qualitatively and quantitatively from the current state of knowledge.

Distribution Status and Protection of Bats in Lithuania

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The Lithuanian bat fauna includes 14 species. Two species, *Myotis bechsteinii* and *Rhinolophus hipposideros*, have been rejected from the list, because old references were not accepted as reliable. *Myotis daubentonii, Pipistrellus nathusii, Plecotus auritus* and *Eptesicus serotinus* are the most abundant and widespread species, although recently *P. auritus* has disappeared from some hibernacula. There are still abundant populations of *Myotis nattereri, Myotis brandtii,* and *Barbastella barbastellus* in hibernacula, while their status in summer is unknown. *Myotis dasycneme* is probably very rare and endangered. The status of *Myotis mystacinus* and *Nyctalus leisleri* is not clear, but they are most likely rare, because very few specimens have been found. So far little is known about the status of *Nyctalus noctula, Pipistrellus pipistrellus, Eptesicus nilssonii* and *Vespertilio murinus*, because these species are common only during the autumn bat migration along the Baltic Sea Coast. From what is known at the present time it can be concluded that: (1) the northern limits of the distribution of *B. barbastellus, E serotinus* and *V. murinus* reach the middle of Lithuania between 55°N and 56°N, which may also be the southern limit of abundance of *E. nilssonii*; (2) the wintering site with the largest numbers of bats in Lithuania are the vaults of the Kaunas fortress, where every year eight species are found hibernating in numbers estimated as follows: *M. daubentonii* 400-500, *M. nattereri* 200-300, *M. brandtii* 80-100, *B. barbastellus* 200-300, *P. auritus* 40-60, *M. dasycneme* 15-20 and a few *E. serotinus* and *E. nilssonii.* In Lithuania nine bat species have been protected by law since 1991, as species included in the Red Data Book, Also, eleven bat reserves have been designated in Kaunas fortress, to protect the most important hibernation sites in Lithuania.

Heart Nervous Apparatus of the Hibernating Bats *Myotis daubentonii* and *Eptesicus serotinus*

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So far the ability of hibernating bats to have heart rates of less than IO beats/min in the torpid state and more than 700 beats/min during arousal flights, have amazed biologists and cardiologists. It is admitted that the cardioaccelaration is a function of the intracardiac nervous system. Therefore, the aim of this study was to investigate the structural organization of heart innervation of *M. daubentonii* and *E. serotinus* during natural hibernation and to ascertain the morphological changes of the heart that would enable hibernating bats to rapidly adapt (on average 15-' 3O min) their heart activity to the needs of an euthermic or hypothermic animal. Ten *M. daubentonii* and four *E. serotinus* were sacrificed for electron microscopic studies of the heart. The animals were euthanised in euthermic and hibernating states. The main findings were as follows: (1) the ultrastructural heart innervation pattern of bats differs from that of other mammals. During the hibernation period: (2) the intercellular space in the sinoatrial node of *M. daubentonii* is filled with a dense substance that might act as a temporary barrier between conducting cardiomyocytes and nerve fibres; (3) acetylcholine vesicles were often aggregated in the nerve varices, and vesicle clusters were absent at the presynaptic membranes. Probably, the vesicle aggregation causes the decrease of cholinergic influence on the heart during hibernation; (4) the catecholamine vesicles were almost empty in the intracardiac nerve fibers. Therefore, a significant role of catechotamines in cardioacceleration during bat hibernation seems doubtful.

Long Distance Migration of *Pipistrellus nathusii* and *Nyctaslus noctula* Found or Banded in Latvia

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Long-distance seasonal movements by *Pipistrellus nathusii* and *Nyctalus noctula* : are known mainly as a result of banding activities in several eastern and northern European countries. This work summarizes the data on two species in Latvia. A total of 14,000 individuals of *P. nathusii* and 700 individuals of *N. noctula* have been marked. Most of these were trapped in 1985-1992 during their autumn migration, at the ornithological station Pape on the SW coast of Latvia (56.11 N 21.03 E), others were caught in their breeding colonies and in mating roosts in bird and bat boxes. Sixty recoveries of *P. nathusii* have been

received. Additionally, 7 *P. nathusii* with foreign rings have been found. The recoveries indicate that the hibernation sites of *P. nathusii* from northeastern Europe are spread over a wide area of western Europe includin Germany, the Netherlands, Belgium, France, Switzerland, Italy, Croatia and Czechia. The three greatest distances covered by this species were at least 1,820, 1,875 and 1,905 km. Nine specimens showed a mean migration speed from 42 to 79.7 km per day. For several years a *P. nathusii* male ringed at Pape has been found near Potsdam, Germany, during summer, which gives evidence of the differences in migration behaviour between sexes in this species. Three individuals of *N. noctula* banded in Latvia during the autumn migration have been found in Czechia (2) and in Slovakia (1), as far as 760, 800 and 930 km SW of their ringing places.

Bat Populations in Europe

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Very little is known about population size, population structure and gene flow in bats. The recent development of new molecular markers now allows us to circumvent some of the problems encountered when working with marked individuals and direct observations. These markers belong either to the mitochondrial genome or to the nuclear genome. Both genomes differ in their mode of inheritance. Mitochondrial DNA is transmitted exclusively by the mother to her offspring, whereas the nuclear genome is inherited biparentally. Therefore, the behaviour of females and males can be distinguished due to differences in the distribution of mitochondrial and nuclear genetic markers. Long-term banding studies of the noctute bat *Nyctalus noctula* have shown that it is a migratory species in which females are faithful to their nursing colony, whereas males seem to stay in the mating area they choose after their dispersal. This philopatric behaviour of the females would result in differences in the mitochondrial genome among populations. This hypothesis was tested by comparison of samples from nursing colonies from all over Europe, in order to find population-specific genotypes. As a first estimation of the gene flow caused by male dispersal, the population genetic structure of noctule bat populations at the nuclear level was assessed using microsatellites.

Analysis of Habitat and Feeding Areas of a Nursing colony of *Rhinolophus ferrumequinum* in Luxembourg: Results of a Radiotelemetric Study

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The Greater horseshoe bat *Rhinolophus ferrumequinum* is becoming one of the most endangered bat species in Europe. For this species only a single reproduction colony consisting of 90 adult animals, is known in the south-east of the country. Even if the population has apparently been stable for the last decade, the Greater horseshoe bat will only survive if an adequate programme for the protection of its summer and winter quarters, and particularly its hunting and feeding areas, will be carried out in Luxembourg. Hence, the knowledge of the feeding areas is of major importance for the implementation of such a conservation programme. During 1994 and 1995, a radiotelemetric study was made of the nocturnal habitats of the nursing colony. To avoid disturbance, part of the population (15 individuals) were caught on their flight paths; the marked bats could be radio-tracked from 2-11 days. The results show that the intensive vineyard monoculture in the Moselle valley forces *Rhinolophus ferrumequinum* to abandon areas close to the roost for more distant foraging sites. Greater horseshoe bats forage mainly in deciduous woodland and scrub during spring and early summer. About mid-June, the species hunts mainly in open habitats such as over pastures, along forest edges, small wetlands and brookland. During autumn the horseshoe bats were found feeding over cattle-grazed pasture and orchards bordered by hedgerows or woodland. Over 12 night-roosting sites could be found at 0.06-2.79 km distance from the maternity roost. These nocturnal satellite roosts, mainly in houses and barns, appear to be of major importance for the survival of this species. To estimate the importance of the various feeding habitats, prey availability in the hunting areas as revealed by radio-tracking will be investigated during 1996.

Bats and Teenagers

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Last year a poll was held among the pupils of the Secondary School in Sieradz (an agricultural region of central Poland) which contained 10 questions about bats in our country. 117 persons answered it. The results show clearly, that the pupils' knowledge of how and what bats eat is very limited. 36.4% of those polled thought that bats feed on mice, 11.4% thought that they feed on blood. Of the 117 persons, 38 did not know the answer at all. There were only 2 correct answers on the role of bats in ecosystems. There is no knowledge of the specific names of bats. Of 68 people who answered, 81.57% mentioned only *Plecotus sp.* 54.7% of those polled thought that vampires live in Poland. There were no problems with the classification of bats as mammals - 90.31% of those polled, and with indentifying the places where bats can be present - 98.3% of those polled. We conducted the poll to team the educational need of children and young people. The drawings used came from the exhibition prepared by children of 13 Nursery Schools in Gdansk.

Bats and Insects over Two Scottish Rivers with Contrasting Nitrate Status

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The abundance of foraging bats *Pipistrellus pipistrellus* and *Myotis daubentonii* and flying insects over two rivers in North-east Scotland (Dee and Ythan), differing eightfold in nitrate levels, were compared by paired samples over three ten-day periods in the summer of 1995, using ultrasonic detectors and insect suction traps. The cleaner of the two rivers, the Dee, supported higher densities of bats than the Ythan in June, but this may have resulted from between-river differences in weather conditions. In July and August/September, the abundances of the bat species did not differ significantly between the two rivers, but the density (i.e. abundance corrected for difference in river size) of pipistrelle bats was significantly higher over the Ythan (the smaller of the two rivers) in July. During the latter two sampling periods, the abundance of Chironomidae and Trichoptera, the main food of the bats, did not differ between the two rivers, although the Ythan showed a higher total insect biomass than the Dee, and also a much higher abundance of small Diptera, mainly Psychodidae and Cecidomyiidae, which probably originated from ditches draining the surrounding fertilized grassland and not from the main river. Although Ephemeroptera were observed flying over both rivers, they were most active early in the evening before the bats started to feed, and were seldom caught in the traps. Species of relatively pollution-sensitive Trichoptera were caught in abundance at both rivers. Thus the current level of eutrophication of the Ythan appears to have a positive effect on insect biomass, and bat activity, and may be related to an increased production of Diptera in the fertilized river valley.

Feeding Habits of Several Species of Bats in Four Areas of Portugal

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The preservation of feeding habitats is one of the fundamental objectives in bat conservation. Although the most important cave roosts are well known in Portugal, the knowledge of the main feeding areas is very limited or even zero. This study intends to overcome this situation, and our objective was the determination of the most important feeding biotopes of the bats present in the areas around four important cave roosts in the south of Portugal. During the summer of 1995 and 1996, all potential feeding biotopes in that region were prospected by transects with an ultrasound detector. Feeding buzzes and bat-passes were counted per species. Some vocalizations were identified with sound analysis software. Taking into consideration the number of bat-passes, number of species and their conservation status, the results reveal that natural and semi-natural biotopes are the most important feeding habitats. The only exception are the urban areas. Due to various reasons, natural areas, especially forested ones, have been progressively reduced in our country. Without recuperation, this situation may become restrictive both to the abundance and diversity of bats and their roosts in this region. Some practical measures to prevent this situation are discussed.

Bat Demography in the Main Landscapes of Eastern Transcaucasia

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The bat fauna of the typical landscapes in Eastern Transcaucasia is described on the basis of the authors research, literature and collection material. It has been established that the foothills and mountain steppes are very rich; here, 10 of the 23 recorded species are abundant and common (*P. pipistrellus, P. kuhlii, E. serotinus, R. ferrumequinum, R. hipposideros, M. blythii, M. mystacinus, R. mehelyi, M. schreibersii, P. auritus*). In mountain forests, 8 of 22 species are common (all the above mentioned species except the three last, plus *M. emarginatus*), in semideserts 5 of 18 (only *P. kuhlii* is numerous, *P. pipistrellus, E. serotinus, M. mystacinus* and *R. ferrumequinum* are common), in lowland and riparian forests 5 of 15 (all above mentioned except *P. kuhlii* plus *R. hipposideros*), in mountain meadows 1 of 8 (*P. pipistrellus*). Of 895 discovered places of bats the first three landscapes each account for nearly a third of the records: the lowland forests have 16.5%, and the montane grasslands 2%. The anthropogenous landscapes consisting of mountain xerophites and forests have the highest population densities (more than 1,000 bats per km^2).

Conserving Greater Horseshoe Bat Feeding Areas: Part I Dietary Studies

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Dietary studies were based on faecal pellets collected from beneath up to 5 maternity sites in 1986, 1988 and 1995, and from individuals from one site, which were caught on certain dates from 1990 to 1995. Bats were held in cloth bags soon after their return from dawn foraging. Despite the large distances between the various sites, July diets were very similar. In sites studied throughout the summer, key prey items changed as summer progressed in a pattern which is consistent among sites and years. They were Geotrupes sp. dung beetles (April/May); *Melolontha melolontha* (May/June); various moths (June-August); and *Aphodius rufipes* (August/September). Secondary prey items included tipulids, small diptera and an ichneumonid of the *Ophium luteum* complex. Pellets from individuals showed that single prey items (of key prey) are normally eaten during a single foraging bout (SFB) in favourable weather. In August the mothers and their young (aged over 28 days) normally feed on different prey; the former on moths, and the latter on *Aphodius rufipes*. Poor weather (e.g. cold; wet and windy; drought) leads to more prey items in a SFB, but more than 3 items rarely occur. This species is therefore a highly selective, conservative feeder.

Influence of Protective Grills on the Behaviour of Bats

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Roost disturbance seems to be one of the main causes of the decline of cave-dwelling bat species. To minimise the disturbance, several types of barriers to restrict the access of visitors to roosts have been used. Grills seem to be the most efficient but, even when well designed, may cause problems to bat populations. We speculate that those problems may be due to two factors: (i) reluctance of some species to fly through the grills, and (ii) increased predation caused specially by changes in flight patterns induced by the presence of the grills. This study attempts to evaluate the impact of these factors. Experimental temporary grills were installed at the entrance of roosts used by several species of bats. Their reaction to the presence of grills was analysed using video recordings of the emergence and return of the bats. We recorded several behavioural variables before and after installing the temporary grills (number of circular flying movements, flying height, flying speed). Other changes in behaviour that could be due to the installation of the grills were also recorded. For most species and roosts, the number of bats decreased after the installation of the grill. There were also significant changes in flight pattern: the number of circular flying movements increased, and the flying height and speed decreased.

Vampire Bat Feeding Options and Human Beings

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Experiences referring to feeding by vampire bats (*Desmodus sp.* and *Diphylla* sp.) on humans in the region of Angra dos Reis/RJ are presented. The haematophagous vampire *Desmodus rotundus*, is one of the most important vectors of the rabies virus in Latin America. It is found in large numbers in regions with an abundance of animals as well as adequate shelter. Transforming forests into pasture and the introduction of cattle may cause a population increase of these bats locally. When the food source is reduced, the vampire has to shift to the nearest alternative. In a region of the State of Rio de Janeiro, we found that, as a result of an abrupt removal of large quantities of domestic animals, haematophagous bats turned to feeding on other species, including humans. Decreasing the local vampire bat population by disturbing the animals, together with the netting of the houses visited most frequently, immediately resulted in a decrease of attacks on humans and in a smaller number of domestic animals being bitten. The risk of human death due to rabies transmitted by vampires has been restricted for this time. The effectiveness of these measures depends, however, on regular surveillance and healthy attitudes orientation.

Differential Use of Structural Features in Deciduous Woodland by Foraging Bats in Central England

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Fragmented deciduous woodlands form an important part of the English landscape. Management practices within these sites can affect the abundance and diversity of animals found there. Four small mature woods in central England were studied for bat abundance from April to September, 1995. Relative activity was estimated using bat detectors while walking line transacts several times throughout a night. Transects covered various structural features within woods such as glades, rides, edges, coppiced areas, etc. Results were analysed to reveal differences in the use of these features relative to availability. Between the four woodlands studied no significant difference was found in overall bat abundance along transacts. However, activity was often concentrated in certain areas. During most of the season small natural clearings were used more than expected by *Myotis* species and pipistrelles *Pipistrellus pipistrellus*. Woodland edges were avoided by all species throughout the season. Areas of dense vegetation were often avoided by pipistrelles. Insect availability was measured using several methods and was significantly correlated with relative bat numbers within woods. The effects of weather conditions such as humidity and temperature were also considered. Results from this study have practical implications for bat conservation when considering ways to improve bat-friendly areas in a predominantly agricultural landscape.

An Active and Systematic Approach in the Nationwide Bat Survey in Niedersachsen, Germany

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National and international conservation laws and policies require protection of important bat roosts and key habitats. However, because bats are difficult to observe and identify in the field, existing records at present do not necessarily represent true distribution. Aiming at producing more reliable distribution maps, a detailed survey of bat distribution and status in Niedersachsen, Germany is being organized. In this systematic survey, each grid block will be actively surveyed using a combination of all available survey methods (netting, detectors, bat boxes, visual inspection of potential roosts etc.), thus optimizing the detection chance for each species. The scheme relies upon regional bat groups for the recruitment of observers, and for the general organization and co-ordination of the survey work within their respective regions. For each survey method, a national working group will oversee the development of training for, and implementation of surveys using the required technique. Within this organization structure, the project group of the Naturschutzbund Deutschland (NABU) in Niedersachsen, which initiated the project as a whole, has already organized 20 bat detector workshops in 1994 and 1995. Over 300 bat workers were trained to

use bat detectors for species identification and roost finding. In the field work during these workshops, which concentrated on surveys in woodland, already 125 tree roosts and another 34 house roosts were located.

Ecology of Bats Hibernating in Small Fortifications in Podlasie Lowlands in North-eastern Poland

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Studies were carried out during the hibernation seasons from 1992-1996 Bats occupied several types of small fortifications, called "Molotows Line", which were built along the Bug river by the Red Army in 1940-41. About 60 fortresses were checked. The dynamics of bat numbers were investigated in three fortresses in 1994/95 and in six in 1995/96, near Siemiatycze (southern part of Bialystok region). Checks have been made once a month since 1994. No bats have been marked. A total of over 1,200 individuals were recorded, representing 8 species. Most numerous was *Barbastella barbastellus* (89%) followed by: *M. daubentonii* (3.3%), *E. serotinus* (2.7%), *M. nattereri* (2.1 %), *P. auritus* (I.3%), *E. nilssonii* (0.5%), *M. dasycneme* (0.3%), M. brandtii (0.08%) and indet (0.8%). In the "warm" season (1994/95), bat numbers were highest by the end of December and in the beginning of February, in the "cold" season (1995/96) in February and March. The preference for shelters was also investigated. 86% of the bats were recorded in drinking wells (inside fortifications). Most bats occupied either wells or lived outside, depending on seasonal temperature.

Bats and Tourism: A Posible Coexistance

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In order to contribute to a better knowledge of the relationship between bats and cave frequentation by people, the case of Onfeero Reserve is presented. The natural reserve of Onferno, in Gemmano Commune, 30 km from Rimini, is the first reserve in Italy instituted to protect a bat cave. Six species: *Rhinolophus ferrumequinum* and *R. euryale,* wintering, and *R. hipposideros, Myotis myotis, M blythii* and *Miniopterus schreibersii* hibernating and then establishing reproductive colonies totalling about 3,500 individuals. The cave was chosen for low-impact tourist use, and currently has about 13,000 visitors per year, with a very low light level and offering trips with an expert guide only. Many schools came to visit the cave. Bats are monitored to control the impact of cave use and each month the phenology, reproductive stage and temperature are registered. A very careful approach to the animals was chosen, in order not to have a direct impact on them. A review of the data collected is shown. After heavy stress on *M. schreibersii* in June 1991 as a result of natural causes (very rainy and cold May), the reproductive colony in '92 chose a site about IO metres from the visitors' path, and in '93 a lateral isolated chamber. In'94 and'95, however, the bats stayed 4 metres above the path without any signs of being disturbed. The number of young produced was good and very few fell to the ground during the visits. Apparently, a good level of coexistence can be attained by providing the visitors with sufficient information, by the use of indirect, low-level light only, and by not permitting the public to direct lights at the animals. With these visits a good didactic level was achieved, which will be raised with the new visitors' centre dedicated to the bats.

A Study of Roosting and Foraging Ecology of *Rhinolophus hipposideros* in the United Kingdom

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Rhinolophus hipposideros is confined to south west Britain. It selects roosts in areas of undulating countryside with hedgerows and tree lines. Roosts were located predominantly in the roof voids of 19th century buildings with stone walls and slate roofs, close to woodland and connected to it by hedgerows or tree lines. R. hipposideros foraged in woodlands, hedgerows and tree lines within 2-3 km of the maternity roost. It hunted close to vegetative clutter catching prey by hawking, gleaning and in late pregnancy by fly -catching, using hedgerows and tree lines as commuting routes between foraging areas and roosts.

Foraging and Echolocation Behaviour of *Myotis brandtii* and *M. mystacinus* : Possibilities for Discrimination between Two sibling species

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The foraging and echolocation behaviour of *Myotis brandtii* and *M. mystacinus* were studied in the field in two forest areas in Niedersachsen, Germany. Detailed observations of hunting behaviour were made using a night vision divice and a strong torch. Echolocation sounds were recorded using time-expansion and heterodyning detectors. We were unable to discriminate between the two species on the basis of our data on hunting behaviour. Foraging flight and catching of prey showed similar patterns in both species. Catches by either species could be assigned to one of six categories. Sound recordings were assigned to five habitat categories, to account for intraspecific variation in echolocation behaviour resulting from differences in habitat structure. Maximum and minimum frequencies, frequency at maximum amplitude, lenght of pulse, rate of frequency modulation and pulse repetition rate were measured. *Myotis brandtii* and *M. mystacintis*, showed strongly significant interspecific differences in the rate of frequency modulation and the length of pulse. Comparison of time-expanded sound recordings of unspecified Brandt's/Whiskerd bats to our data enabled species.

Old World Fruit Bat Conservation at the Lubee Foundation, Inc.

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The Lubee Foundation, Inc. was founded by the late Luis F. Bacardi in 1990. The foundation is dedicated to the conservation of threatened and endangered species of Old World fruit bats. Its goals are to establish and maintain captive breeding populations and to promote basic research on these animals that will lead to new and improved knowledge for the betterment of both captive and wild populations. Investigators are encouraged to conduct research on animals housed at The Lubee Foundation, Inc. and in the field, which will contribute to improve conservation and sound management of wild populations. The goals of The Lubee Foundation, Inc. are as follows:

Promote basic and conservation research on captive bats as models for the conservation of threatened and endangered species.

Make the facilities and collections of animals housed at Lubee available to the scientific community for research purposes.

Promote the interaction and collaboration among members of the scientific and zoo communities to enhance conservation efforts.

Initiate and promote, when possible, in situ programs for the conservation of Old World fruit bats.

Utilize its animal collections to (1) work in conjunction with the American Zoo and Aquarium Association (AZA) member institutions to establish captive breeding programs under the guidelines of its Species Survival Plan (SSP) and the IUCN's Chiropteran Specialist Group, and (2) supply zoological parks and living museums with specimens for the purposes of education through exhibition.

The initiatives of The Lubee Foundation, Inc. are threefold: research, education and captive propagation. Lubee also maintains the world's largest and most diverse collection of Old World fruit bats, including *Pteropus hypomelanus, P. vampyrus, P. pumilus, P. rodricensis, Cynopterus brachyotis, Eidolon helvum* and *Epomophorus wahlbergi.*

Frombork, a New Hibernaculum of Bats in Northern Poland

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Our researches were conducted in Frombork - Northern Poland, in 1995 and 1996 on the position of hibernating bats in an artificial object: an old cellar made of bricks, in a ruined building. The microclimate of this environment is characterized by temperatures fluctuating from 2 to 5 C° (relatively cold), and a humidity from 65 to 75%. The number of hibernating bats is around 45. *Myotis nattereri, Myotis daubentonii* and *Plecotus auritus* hibernate regularly in this place. During severe weather conditions the cellar was visited by Barbastella barbastellus, a new species in this area, and up to now Frombork is the northernmost record of this species in Poland.

Status of the Lessor Horseshoe Bat in Austria

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The lesser horseshoe bat is widespread in Austria. It inhabits cultivated landscapes at elevations from 100 - 1700 m. The typical original distribution pattern was a dense web of many small colonies. The majority of records of maternity roosts are from rather cool (mean July temperature 16 - 18'C) and moist (mean annual precipitation 900-1,750 mm) areas, whereas in the hottest and driest parts of the country maternity roosts are very scarce. This seeming preference for a cooler and moister climate could be a secondary effect brought upon by a change of human land use after the end of the war, when in the Eastern lowlands, the large basins and alpine valley floors, livestock breeding was replaced by farming. The general population trend appears to be negative. But some local populations seem to flourish: A wintering population that had been counted regularly since 1945, after a steep decline in the late 60s, now shows a steady recovery and has increased to almost the same number of individuals as in 1945.

First Records of *Pipistrellus nathusii* in Norway, with Notes on Current Distribution, Sonar and Morphology

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The occurrence of *Pipistrellus nathusii* (Keyserling and Blasius, 1839) has now been documented for Norway. Records are described from four localities at the southwestern coast facing the North Sea. These observations are mainly of single foraging individuals, recorded by ultrasound detector, but one summer resident and a relatively high density in one locality may indicate a reproductive population, though neither mating calls nor females have been recorded as yet. In this locality, the species has been continuously recorded as yet between the beginning of May and late October. Echolocation calls show this species to have a peak sonar frequency at about 41 kHz and a range from 38 to 43 kHz, being distinct from the nearest summer resident population in Scandinavia. The characters of the two specimens collected are described, along with photographs showing one male.

Distributional Patterns in a Southwestern Norwegian Bat Community

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Due to its wide altitudinal and latitudinal range and oceanic character, three main climatic zones cover Norway. The mountainous southwestern Norway has ecotypes ranging from the mild but exposed Atlantic heather-covered hills, through sheltered rich deciduous and pine forests inside fiords, to montane tundra and glaciers, besides showing a mosaic of rivers, lakes, wetlands and other landscapes. These relatively diverse environmental factors clearly show restriction of the distribution of the region's bat species, both in space and time. Of the nine species recorded, six occur regularly and five are believed to have their northern distribution limits within or close to this region. Three species, *Myotis daubentonii*, *Pipistrellus pipistrellus* and *Eptesicus nilssonii* are the most common. Of all species, *E. nilssonii* shows the highest degree of adaptation and has been found in all habitats, from the exposed coastal cliffs to the high inland montain plateau. With the exception of *Plecotus auritus* and *M. mystacinus/brandtii*, most species show a close association with wetland and deciduous forest, which have the highest species diversity. Seasonal activity patterns show *M. daubentonii, P. pipistrellus, P. nathusii* and *E. nilssonii* do tolerate the cold climate in early spring and late autumn while hunting insects.

Distributional Correlates to the Variation in Echolocation Search Calls of Bats in Norway

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Distribution patterns of five species of bats were correlated to the variation in 10 frequency and time measures of their echolocation search calls in natural enviroruneuts in southern Norway: (i) *Myotis daubentonii,* (ii) *M. Mystacinus/brandtii,* (iii) *Eptesicus nilssonii,* (iv) *Pipistrellus pipistrellus* and (v) *P.*

nathusii. The variation coefficient showed correlation with each species' degree of habitat utilization and distribution. Within all species, most variation was found in initial frequency and prepulse interval, which indicates that these are the species' significant adaptive mechanisms. The peak and terminal frequency showed the least variation. Most variation was found in *E. nilssonii* which coincides with its adaptation to a wide variety of habitats and extensive distribution. Least variation was found in *M. mystacinus - brandtii*, which coincides with its limited distribution.

Systematics of the *muricola* and *mystacinus* groups ofthe Genus Myotis

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The goal of this study was to make a systematic review of the Myotis mystacinus and muricola groups based on dental non-metric characters and metric external and skeletal features. The analysis is based on a sample of 215 skulls of 26 taxa including the following subspecies:
M. mystacinus transcaspicus, M. m. sogdianus, M. m.nipalensis, M. m.przewalskii, M. brandtii gracilis, M. muricola moupinensis, M. m. caliginosus, M. m. nugax, M. m. browni. Myotis ozensis, M. yesoensis and *M. australis* were not included in this study because of lack of material. The *muricola* group shows large differences between the taxa. *Myotis ridleyi, M. rosseti* and *M. annectans* should be exluded from this group. *Myotis ater* is certainly a separate species. Also, *Myotis moupinensis* should be treated like a separate species. The *mystacinus* group is very homogenic. Most of the subspecies of *M. mystacinus* show no significant differences.

Ecological Requirements of *Rhinolophus ferrumequinum* in the Winter Period

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We carried out research in Abaliget cave (South Hungary), during the winter period of the last two years. The greater horseshoe bat *Rhinolophus ferrumequinum* has proved sensitive to changes of ambient temperature. These changes were also observed in the cave, and the colony followed the optimal climate conditions. The aim of our study was to determine these optimal values.

Fauna and Relative Abundance of Bats in the Russian Far-east

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There are 15 bat species in the Far East of Russia: 13 species occur the whole year round and 2 are found only in summer. During the spring-summer period, in the south of Primorye up to latitude 44° north, *Vespertilio superans* and *Myotis daubentonii* dominate numerically (49.5% and 38.5% respectively). In winter *Murina leucogaster* prevails in hibernation sites (caves) of this territory, with *Plecotus auritus* taking the second place. In more northern regions (from 44° to 49°) in the spring-summer period *M. daubentonii* ranks first in terms of relative abundance, and *V. superans* ranks second. In Khabarovskyi Region, north of 49° and in Amurskaya Province to the west, the mostspecies is *M. brandtii*. On Sakhalin the species with highest numbers is *M. daubentonii*, the second most abundant is *M. brandtii*. On Kunashir Island the most widely distributed and most numerous (relative abundance 56.1 %) species is *M. macrodactylus*. In winter, both in Khabarovskyl Region and Sakhalin Island, *P. auritus* prevails.

First Approach to the Ecology Bats in Biscay, Basue Country, Northern Iberian Peninsula

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Biscay is a 2,384 km^2 hilly area in the Iberian Peninsula, with altitudes ranging from sea level up to 1,481 m, and characterized by narrow valleys. The vegetation has been severely altered, and pine and eucalyptus plantations, pastures and arable fields have replaced the original deciduous forests, which remain only in isolated patches. During a survey carried out from December 1993 to determine the distribution of bats, we obtained 281 records of seventeen species in 355 localities. Each locality has been characterized by

ecological parameters such as altitude, vegetation, the amount of wooded area, patchiness and urban pressure. Relations between these parameters and the occurrence of various species are analysed to determine the bats' habitat preferences.

Newly Constructed Hibernation Quarters in the Province of Noord-Brabant, the Netherlands

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In the Netherlands a construction meant to be used as hibernation quarters by bats was first built in 1983. Since then, this initiative has been followed in many places. In the province of Noord-Brabant eight such structures have been newly constructed, three of which are used by bats. Reasons for constructing them are a lack of suitable places, so that five to seven species may more or less depend on their presence. Also, they offer an opportunity to monitor local populations. The following quarters have been constructed: Golfclub Oosterhout, constructed in 1993. Measuring 3.5x2.5x2.5 m; no bats have been found in it yet. Engelermeer, constructed in 1993, measuring 18x2.2x2.2 m; amphibians and butterflies have been found, no bats yet. At Boxtel, constructed in 1994, measuring 30x1.5x1.5 m; only mosquitoes up to now. Heempark Handel, constructed in 1994, measuring 8x8x2.5 m; butterflies and mosquitoes, no bats. Best, constructed in 1992, measuring 12x1.5x1.5 m; butterflies, mosquitoes and a hedgehog, no bats yet. Ekkerswijer, constructed in 1991, measuring 12x1.5x1 (front) to 2 (back) m; amphibians, butterflies, and during three winters one or two *Plecotus auritus*. Malpie, constructed in 1993, measuring 6Ox2.2x2 m: butterflies, amphibians and during three winters one to three *Plecotus auritus*. Asten, constructed in 1989, measuring 8.x8x2.2 m; butterflies, mosquitoes, and amphibians have been found, and three species of bats have used this structure. Three *Pipistrellus pipistrellus*, have been found, two of which were dead. *Myotis daubentonii* has been found once during the past winter. Up to twelve individuals of *Plecotus auritus* have used this structure since the winter of '93/'94, and very recently a small cluster was also found in summer.

Bat Colony Survey in Lofts in Slovakia 1994-1995

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The project of mapping and conservation of bat colonies in buildings in Slovakia in 1994 and 1995 was organized by the Bat Protection Group. This activity was supported by grants from the Global Enviromental Fund and the Slovak Environmental Agency. The aim of the project was to study the current status and the problems concerning the conservation of bat colonies in lofts in Slovakia. Creating public awareness was also an important goal of the project. From all lofts of 406 checked churches, castles, monasteries, other old buildings and forest cabins in several regions, in 250 localities (61.5%) the occurrence of 11 bat species was found: *Rhinolophus hipposideros, R. ferrumequinum, Myotis myotis, M. blythii, M. emarginatus, Eptesicus serotinus, Plecotus auritus, P. austriacus, Nyctalus noctula, Pipistrellus pipistrellus, Vespertilio murinus.* The species *M. myotis* and *M. blythii* were the most widely distributed and the most abundant. .They occurred (mostly in mixed colonies) in 83 localities, with colonies of up to 1000 individuals (103.7 individuals per check), followed by *P. austriacus* (76 localities; 9.1 individuals per check), *E. serotinus* (61 localities; 12.6 individuals) and *R. hipposideros* (48 localities; 28.5 individuals). Three species (*P. auritus* , 24 localities, 8 individuals; *R. ferrumequinum*, 11 localities, 29.2 individuals; and *M. emarginatus* , 9 localities; 119.9 individuals) were less common and their distribution patterns were geographically limited. Large breeding colonies of *M. emarginatus* (600 individuals) and *R. ferrumequinum* (250-300 individuals) were found. Other species (*N. noctula, P. pipistrellus, V. murinus*) were rare in lofts.

The Status of *Miniopterus schreibersii* in Slovakia

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In this paper the available literature and original data on the distribution of *Miniopterus schreibersii* in Slovakia are presented. These data were collected using standard chiropterological research methods (checks of underground sites, netting, detecting, osteological material and food analysis of predatory birds) and they are evaluated till 1996. Until now, the occurrence of Schreiber's bat was confirmed for 37 localities in 18 mountain units (26 squares of the 12.0 x 11.2 km Slovak fauna mapping grid, approx. 6.1 % of the territory under study). A long-term occurrence was limited to 6 parts of the Western Carpathians: the Small Carpathians, Stiavnické hills, Muráska plain, Driencansky karst, Slovak karst and Aksamitka cave in the Pieniny Mts. The altitudinal range of all records is 100 - 960 m a.s.l. Most localities (51.3%) are in lower altitudes (200-400 m a.s.l.). Winter records (14 localities) are mostly in caves with a large entrance and extensive underground system (85.7%), others are in old mines (14.2%) and one is in an abandoned railway tunnel (7.14%). The numbers of individuals in hibernacula were 1-9,000 (516.1 individuals per check). Summer records are of individuals netted in entrances of underground sites (62.7%), of colonies in caves or mines (29.4%) and of netting and/or detectoring above the water surface (5.8%). The numbers of individuals in summer colonies were 10- 1,100, average number per check 51 individuals. The decline in abundance and changes in the geographical distribution of the species in Slovakia are described. The species is classified as endangered. In the '90s, it occurred regularly in only three regions: the Small Carpathians, Muránska plain, and the Slovak karst.

Progress in Bat Conservation in Poland

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All bat species in Poland were given legal protection by the Species Protection Act of 1983. Six species are listed in the "Polish Red Data Book": *Rhinolophus hipposideros* (E), *Myotis bechsteinii* , *M. emarginatus* (E), *Vespertilio murinus* (R), *Eptesicus nilssonii* (R) and *Nyctalus leisleri* (R). Extremely endangered are *R. hipposideros* and *M. emarginatus*. Their populations decreased to about 1% of the original population during the last 40 years. There are about 500 bat hibemacula known in Poland. A small part of the old military tunnels in Western Poland, where about 30,000 bats of 12 species hibernate, is protected by law as the bat reserve "Nietoperek". A few other hibemacula have recently been protected, as places of ecological importance. Several other bat caves are protected because of their geological or archaeological importance.Several National Governmental Orgainzationss are involved in bat conservation in Poland. Several educational activities have been carried out, e.g., producing informative material, organizing meetings and trainings, and publishing articles in newspapers. The Polish Society for Bat Conservation, OTON, was established in 1994, to promote and coordinate conservation, research and education, with special emphasis on developing the public's awareness of bats. The society's newsletter will be circulated to all people interested in bats. The society's project *"Protection of Bat Hibrnacula in Poland"* is in progress now. The European Bats Agreement will be signed soon.

Functions of Vertical Landscape Elements for Bats: Indications for Their Use as Acoustical Landmarks

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1. We studied commuting and foraging bats near vertical landscape elements such as tree lines and forest edges, as well as near banks of canals and a lake.
2. Foraging *Pipistrellus pipistrellus* were observed almost exclusively close to tree lines and forest edges,

whereas *Eptesicus serotinus* more frequently crossed fields and meadows. Possible explanations are:

(i) pipistrelles hunt smaller insects,
(ii) pipistrelles are more sensitive to wind, and/or
(iii) as their sonar range is smaller, pipistrelles stay closer to the vegetation in order to maintain acoustic contact.

3. The presence of hunting areas of pipistrelles near tree lines was strongly related to the degree of wind shelter of the vegetation (height and porosity).
4. Detailed studies within hunting areas showed a preference of pipistrelles and of pond bats *Myotis dasycneme* for foraging in a restricted area close to tree lines and to lake banks, independently from insect distribution and wind shelter effects.
5. When passing over canals of increasing width, commuting pond bats increased the pulse durations and interpulse intervals of their signals. For bats flying halfway between the banks, the mean interpulse intervals were sufficiently long to prevent overlap of an echo from the canal bank and a new outgoing pulse.
6. The results indicate that bats, although they do not necessarily stay close to landscape elements all the time, they do maintain acoustic contact with vertical elements.

Causes of Death in Two Species of Bats, *Pipistrellus kuhlii* and *Hypsugo savi* in Urban Areas of North-Central Italy

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From 1992 onwards, the mortality of bats in urban areas has been monitored in three cities of northern Tuscany - Florence, Prato and Pistoia, by critically analysing the causes of death in more than 140 specimens, most of which were *Pipistrellus kuhlii* and *Hypsugo savii*. The majority of the specimens were kindly brought to us by inhabitants of the cities, while the remainder were located by checking roosts, particularly those used during the summer. The study has shown that:

I1. According to the specimens collected, *P. kuhlii* and *H. savii* seem to be the most abundant species in urban areas in northern Tuscany.

2. Other species, though rarely collected, are also present, as is shown by ultrasonic detection, mist-net captures and roost checks. Using these same methods, it was found that *Pipistrellus pipistrellus*, of which only two specimens were collected in our urban study area, is more frequent in peripheral zones less inhabited by man. Hypothetically, intraspecies competition might explain this distribution.

3. The age class of the specimens differs significantly between *P. kuhlii* and *H. savii*. Most *P. kuhlii* were young which were unable to fly, whereas most *H. savii* were juveniles which had just started to fly.

4. The cause of death differs significantly between the two species, In *P. kuhlii* most animals had fallen down in the nursery, in *H. savii* it was inexperience in flight of newly weaned juveniles and cat wounds in adults. The possible causes of these differences are discussed.

Conservation of Bats in Flanders, Belgium

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During the last decades the numbers of bats have declined throughout Europe. In Flanders this decline is even more pronounced than elsewhere. Lack of old woods and a highly fragmented landscape might be a possible explanation. Earlier, 18 species were found in Flanders, now only 15 are left: *Rhinolophus hipposideros, R. ferrumequinum* and *Barbastella barbastellus* probably became extinct. Except for *Myotis daubentonii, Pipistrellus pipistrellus, Eptesicus serotinus* and *Nyctalus noctula*, all species are rare or extre ely rare. This situation has led to the legal protection of all species on September 9,1992 (based on the Nature Conservancy Act of July 12, 1973) whereby it is forbidden to kill or catch bats and to damage their roosts. Despite this official protection, nothing has really changed for bats. In the past, research and conservation were mainly the work of nature associations. In line with execution of the Bat Agreement, which was ratified by the government in 1994, a two-year study is financed by AMINAL. The project started in February this year and has the following objections:

1. mapping the distribution of bat species with an indication of their numbers;

2. carrying out a survey of summer and winter roosts and formulating sidelines for their protection:
3. recommendations for a bat-friendly management of woods and reserves.

Main Features of the Bat Fauna of the North Adriatic Coast(Italian Border)

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A collection of old and recent distributional data, but especially a series of field researches with bat detectors and mist-nets in several localities of the North Adriatic Italian Coast may provide a first idea of the present status of the bat fauna in these habitats. The North Adriatic coast of Italy is principally low and sandy. Especially in the regions of Veneto and Emilia Romagna, there are some large holiday settlements alternating with natural or semi-natural forest; also, a number of humid areas (lagoons) and little islands may provide an interesting natural habitat for bats. The most common species are everywhere *Pipistrellus kuhlii* and *Eptesicus serotinus*, and *Hypsugo savii* is often present. *Nyctalus lasiopterus* seems particularly localized in the Venice lagoon area (museum material). In Venice_ The following bat species were recorded: *Eptesicus serotinus, Pipistrellus kuhlii, Pipistrellus pipistrellus, Pipistrellus nathusii, Hypsugo savii, Myotis blythii.* The coastal pine forests of Ravenna are inhabited by *Nyctalus lasiopterus* and especially *Nyetalus noctula*, and the "Pineta di Cervia" has one of the most interesting populations of these vespertilionids in Italy. Recent research in Comacchio (Ferrara) has revealed a scattered presence of *Barbastella barbastellus*. Some new localities with a significant presence of *Myotis daubentonii* were discoveredwith bat-detectors during the last years. In several natural parks on the coast *Rhinolophus ferrumequinum* is present in small numbers. During the last years two specimens of *Pipistrellus nathusii* were found in the North Adriatic Venice lagoon (Veneto) and the Grado lagoon (Friuli-Venezia Giulia). These bats were ringed in Latvia, which demonstrate the presence of a long-distance migratory route from NE Europe to the North Adriatic coast, passing along the East Italian border, which probably is also important for other migrant bat species, such as *Nyctalus noctula.*

The Costs of Harem Maintenance in Saccopteryx bilineata

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The Neotropical bat *Saccopteryx bilineata* is a species with a social pattern that can best be described as resource-defense polygyny. Up to 60 individuals may be found in a colony. The colonies are divided into subgroups, each consisting of one male and I to 9 females. Harem males perform a variety of social displays, including hovering displays, flight manoeuvres and song performances, when recruiting and retaining females in their harem. Because males differ in their physiological condition, I would expect individual differences in the time and energy budgets of harem males. In my study, I counted the number of social displays that are performed by males with different harem sizes. In addition, I determined the daily energy expenditure of harem males, using the doubte-labelled water technique. The mean harem size in the study colony in Costa Rica was 3 to 4 females. The time budget analysis showed a strong correlation between harem size and number of social displays. Non-harem males on the average made 8 hovering displays and 51 flight manoeuvres, whereas harem males on the average performed an additional 12 hovers and 30 flight manoeuvres per female. Preliminary data on the daily energy budget demonstrate that males have a higher daily energy expenditure than non-reproductive females, although males usually weigh less than females.

The U.K. National Bat Monitoring Programme: Designing Large-Scale Monitoring Schemes

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Trends in population numbers over time and in the structure of population abundances within geographic ranges are poorly understood for bats, yet of particular importance to bat conservation. In Britain, population trends for all but the two rhinolophid species are currently based on subjective estimates, due to a lack of reliable quantitative data. Although long-term counts carried out since the 1950s have provided evidence of population declines, changes in the methods used over time limits the level of

confidence in existing figures. A five-year UK National Bat Monitoring Programme was therefore commissioned by the Department of the Environment in 1996 to develop standardised monitoring methodologies, provide baseline population data and examine the ecological determinants of distribution and abundance of selected species of bats across Britain. To provide a reliable basis for monitoring bat population trends, the programme aims at testing three main monitoring strategies at a large scale: maternity colony counts, bat detector field surveys and hibernation site counts. For each method, a formal design of the sampling strategy is required which balances time, effort and cost against adequate coverage, such that the ability to detect population changes is maximised. This paper discusses the design approach taken to other large-scale surveys of bats.

The U.K. Bat Monitoring Programme: Effective Use of Volunteer Support

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The UK National Bat Monitoring Programme aims at monitoring seven selected species of bat throughout the UK over a five-year period. The programme is coordinated by The Bat Conservation Trust and the majority of the survey work will be carried out by volunteers. There are over 90 Bat Groups distributed throughout the UK and this network provides the structure for the project. Monitoring strategies are being developed which allow data to be used at a local level and to be merged to form a national dataset. Data collected nationally can be integrated with data from other surveys such as the River Habitat Survey, to strengthen conclusions on habitat preferences. The three monitoring strategies are based on 1) summer colony counts 2) hibernation counts 3) field surveys. This three-pronged approach allows participation by batworkers with a range of experiences. Field surveys using bat detectors will provide the bulk of data for some species and training is provided through a series of all-night workshops held throughout the country on weekends during the summer. Hibernation visits are already made by licensed bat workers and the use of standardised recording sheets and protocols will help standardise data collection. For many species summer roost counts can be made by relatively inexperienced volunteers or householders. Since there are relatively few skilled surveyors to cover a large land area, a sampling strategy has been devised to collect data in the most cost- effective manner to meet the programme objectives.

Chiropterological Information Center in Poland: 1993-1996 Activity Report

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The Chiropterological Information Centre (CIC) was established in May 1987 and is now a department in the Institute of Animal Systematics and Evolution PAS in Cracow. The main goal of the CIC is to put on line all information on bats in Poland, promote the systematic and biogeographical study of bats, and to consult and cooperate with the government and scientific institutions in the conservation of bats in Poland. Between 1993 and 1996 the CIC organized three winter bat censuses (DSN'94- DSN'96) in Poland in the first half of February. Since 1993 the CIC has organized or cooperated in the organization of three National Bat Conferences in Poland (VII'OKC - IX'OKC). Another area of the CIC activity is to yearly organize a chiropterological school for government personnel and non-govemment organizations involved in environmental protection as well as for amateur chiropterologists, in order to disseminate practical knowledge of bats and their conservation. During the past three years over 100 persons have participated in these courses. In the autumn 1995, the Chiropterological Information Centre organized for the first time the International Bat Night (IBN'95) on the 21st of September. The integration of the Chiropterologists' activities in Europe and in the world in the field of bat conservation, was the main aim of the action. The Second IBN'96 will be organized next September('96). The CIC edits two journals: The CIC Bulletin (twice a year) and a quarterly annex to the Polish monthly naturalist magazine "Wszechswiat" (The Universe), named "Wszechswiat Nietoperzy" (The Universe of Bats). Both are published in Polish. We are publishing occasional papers: "Publications of the Chiropterological Information Center". In 1994 a book "Results of the winter bat census in Poland, 1988-1992" was published in this series. A substantial proportion of research and organization activities of the CIC were realized by volunteers, the majority of whom are students and pupils of several Polish universities and colleges.

The System of Ecology Education as Carried out by the Chiropterological Information Center in Poland

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Ever since the Chiropterological Information Centre PAS (C.I.C.) in Cracow was established in 1987, the specialistic training of both chiropterologists and naturalists interested in environmental protection, has played an important part in our activities. During a couple of years a compact training system including a varied range of problems concerning chiropterology and as well as other aspects of environmental protection has been worked out. The system of ecological education by the C.I.C. has three levels:

1. A practical level

These are so-called "Courses of Practical Chiropterology". The courses aim at the chiropterological education of people active in the field of nature conservation at government departments, e.g. the regional nature conservators' personnel, the personnel of the national and landscape parks and the forest service, non-government organisations active in the field of environmental protection, as well as amateur chiropterologists. The training stresses the practical knowledge of bats and their conservation. Nine Courses of Practical Chiropterology, which trained over 200 people, have been accomplished so far.

2. A didactic level

Within which specialistic (monographic) lectures titled: "The Natural History of Bats" are conducted for students of the Biology and Earth Sciences Department at the Jagillonian Univeristy in Cracow. The lectures' main purpose is training future biology teachers in chiropterology combined with many other aspects of environmental protection. The course participants, during their work at school, will be able to pass on this knowledge to their pupils. Since the lectures started in the academic year 1992/93, more than 120 students have been trained.

3. An academic level

Carried out as "The Chiropterological Seminar" conducted by the @C.I.C. for (as well as by) students preparing their master's and doctor's degrees at the C.I.C.. The Chiropterological Seminar is the most specialised and professional form of training. Dunng the seminar the results of recent research are reported and the latest developments of Polish and world chiropterology are discussed.

Bats in the Dutch Mammal Monitoring Projeect

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From 1982-1992 the distribution of mammals in the Netherlands was mapped by many volunteers and professionals. The resulting atlas based on finds and sightings was published in 1992. The atlas based on field observations of bats with ultrasound detectors will be published in spring 1996. The present distribution of mammals being now fairly well known, it was felt that more information is needed on the developments in population size of many species. After a feasibility study (November 1994), the Dutch Mammal Monitoring Project (Zoogdiermonitoring) was started in 1995. It is a project of the Dutch Mammal Society and funded by the National Statistical Service and the Ministry of Agriculture, Nature Management and Fisheries. The main aims are to have an early warning and control system and to detect factors affecting mammal populations. Such a system should warn us if species are about to become threathened or extinct. By combining its results with the gathered knowledge of underlying factors, it should enable us to propose protective measures. If these are carried out, the system should also be able to determine their effects (early control). Field work is carried out by volunteers and professionals. So far we have run four different schemes on bats.

I. Counts of hibernating bats. Originally started in 1943, these have extended to about."300 hibernacula with 8500 bats of several species. Older data are currently under review. Counts of maternity colonies in June. Started in 1995 as a proper scheme. So far we have received results from 180 roosts with well over 9,000 bats. Roosts of 10 species were recorded, but most were common pipistrelles and serotines.

3. Counts of advertising mates of common pipistrelle, Nathusius' pipistrelle and noctule bat. Started in 1990 with 2 transacts and slowly extended up to 23 transacts with 338 'territories' in 1994 (results of 1995 are underway).

4. Transect counts of passing bats. Started in 1990 with 2 transacts and slowly extended to 10 in 1995. In 1995 a total of 1682 presences of 9 species were recorded.

Population Development of Attic-Dwelling Bats in Southern Bavaria, Germany

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The Koordinationsstelle für Fledermausschutz Südbayern" (agency for bat protection in Southern Bavaria) monitors the colony sizes of the attic-dwelling bat species *Myotis myotis, Myotis emarginatus* and *Rhinolophus hipposideros* in Southern Bavaria (Oberbayern, Niederbayern, Schwaben). By 1995 one nursery colony of *R. hipposideros* (25 adults), nine nursery colonies of *M. emarginatus* (average size about 100 adults plus juveniles) and 122 nursery colonies of *M. myotis* (average size about 200 adults plus juveniles) had been observed. The size of the *R. hipposideros* colony has doubled since 1991 when it was first discovered. The six colonies of *M. emarginatus* already known in 1991 have increased by 40% since that year. Of the colonies counted in at least two succeeding years since 1991 the population of *M. myotis* rose by 17% between 1991 and 1992 (28 checked colonies) and by 16% between 1992 and 1993 (42 checked colonies). The population decreased by 13% (72 checked colonies) between 1993 and 1994 but increased again by 7% (104 checked colonies) between 1994 and 1995.

Notes on the Chiropterofauna of Calabria, Southern Italy

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Since 1992 the authors have been involved in the qualitative study of the chiropterofauna of Calabria, Southern Italy, looking for roosts, mist-netting and detecting bats by means of electronic devices. In this preliminary note historical data from museums and private collections as well as published reports are evaluated and new records are given. The following species have been found so far: *Rhinolophus ferrumequinum, R. hipposideros, R. euryale, Myotis nattereri, M. capaccinii, M. emarginatus, M. myotis, M. daubentonii, Pipistrellus pipistrellus, P. nathusii, P. kuhlii, Hypsugo savii, Eptesicus serotinus, Nyctalus lasiopterus, Plecotus austriacus, Barbastella barbastellus, Miniopterus schreibersii* and *Tadarida teniotis.* Our two records of *Nyctalu lasiopterus* (Pineta di Fago del Soldato, Sila Grande, Cosenza, and Verzino, Crotone) are the first of this species in Calabria. UTM maps of the distribution of the eighteen species of bats so far recorded for the Region are also provided.

New Distribution Data of the Italian Chiropterofauna

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During numerous field excursions in the last three years in Northern, Central and Southern Italy, the authors and their collaborators have investigated the bat faunas of several protected areas chiropterologically unknown, by means of mist-nets and electronic devices. In particular, the following species have been found to be present in the following areas:

Elba Island

R. ferrumequinum, R. hipposideros, P. pipistrellus, P. nathusii, P. kuhlii, H. savii, E. serotinus, P. austriacus, B. barbastellus, T. tentotis.

Tremiti Islands

P. pipistrellus, P. kuhlii, N . leisteri.

Parco dell'Alto Appennino Reggiano

P. pipistrellus, H. savi, N. noctula, P. auritus, M. schreibersii.

Parco dell'Alto Appennino Modenese

R. hipposideros, P. pipistrellus, H. savii.

Parco del Como alle Scale
P. pipistrellus, P. kuhlii, H. savii.
Parco del Delta del Po
M. bechsteinii, P. pipistrellus, P. nathusii, P. kuhlii, E. serotinus, N. noctula, N. lasiopterus, P. austriacus, B. barbastellus.
Parco Nazionale dei Monti Sibillini
R. ferrumequinum, P. pipistrellus, P. nathusii, P. kuhlii, H. savii, P. austriacus, E. serotinus, B. barbastellus, M. schreibersii.
Parco Nazionale del Gran Sasso-Monti della Laga
R. ferrumequinum, P. pipistrellus, P. kuhlii, H. savii, E. serotinus, P. auritus, B. barbastellus.
Parco Nazionale detla Majella
R. ferrumequinum, R. hipposideros, M. blythii, P. pipistrellus, P. kuhlii, H. savii, P. auritus.
Parco Nazionale del Gargano
R. ferrumequinum, R. hipposideros, R. euryale, P.pipistrellus, P. kuhlii, H. savii, N. leisleri.
Parco Nazionale Cilento-Valle Diano
R. hipposideros, R. euryale, M. schreibersii, M. nattereri, M. capaccinii, M. myotis, M. blythii, P. pipistrellus, P. kuhlii, H. savii, E. serotinus, T. teniotis.
Parco Nazionale del Pollino
R. hipposideros, M. capaccinii, M. myotis, M. schreibersii, P. pipistrellus, P. kuhlii.
Lago di Como
R. ferrumequinum, M. nattereri, M. mystacinus, M. daubentonii, M. capaccinii, P. pipistrellus, P. nathusil, P. kuhlii, H. savii, P. austriacus, B. barbastellus.
Val Camonica
P. pipistrellus, P. kuhlii, H. savii, N. noctula, P. auritus, B. barbastellus)
Val Seriana
P. pipistrellus, P. kuhlii, N. noctula.
Piana di Magorno, Montesano sulla Marcellana, Salerno
P. kuhlii, H. savii, N. lasiopterus.

Daubenton's Bat's Nocturnal Activity in a Southern Hungarian Cave

Szabolcs Závoczky
Department of Ecology and Zoogeograpy, Janus Pannonius University, 7601 Pécs, Ifjúságútja 6, Hungary

This research was carried out during the period 1989-94, in a limestone cave in southern Hungary. I caught about 700 Daubenton's bats and ringed all animals. The research period was always August 20-30. I compared the activity of Dauberton's bat from night to night. Daubenton's bats were very activite during the early night, between 21:00 and 23:00 h., and at early dawn from 04:00-05:00 h. The bat's weight was lowest between 23:00 and 04:00 o'clock, when activity was lowest.

Differentation of chondrocytes and Growth of the Pectoral Extremity skeleton in the Noctule Bat *Nyctalus noctula*

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Dept. of Cytology and Histogenesis, Institute of Zoology,
National Academy of Science, B. Khmelnitski str. 15, 252030, Kiev, Ukraine

A study was made of the cellular mechanisms of development of the skeletal phalanges during pre- and postnatal ontogenesis. To evaluate the reproduction and metabolism of chondrocytes, 3H-thymidine 35S-sodium sulphate, 3H-glucose and 3H-glycine were used. The growth of skeletal phalanges proceeds by different rates of division and terminal differentiation of cells in the growth cartilages. These structures of the radius, basidigital bones and phalanges show an increase in the number of proliferating chondrocytes and the size of zones during prenatal ontogenesis, which influences the transverse growth and remodeling of the bony shaft. Division and terminal differentiation of cells in the growth cartilages are so interrelated, that in zones of proliferation there is an increased concentration of chondrocytes, an intensification of glycosaminoglycans biosynthesis, acceleration of maturation and hypertrophy of cells. With similar index values of 3H-thymidine-labelled chondrocytes, these peculiarities ensure more intensive and prolonged,

growth of the phalanges. Thus, the unique length of autopodium bones is achieved due to a growth mechanism, being universal in the extremity skeleton of vertebrates; however, during ontogenesis of Chiroptera the evolutionary-programmed growth of these skeletal phalanges is ensured by a different intensity of manifestation of the basic features of the cells' reproduction and differentiation.

Principal Trends in the Evolution of the Chiropteran Digestive System

Natalya F. Zhukova

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15 B. Khmelnytski Str., Kiev - 252030, Ukraine

A great number of trophic specializations within the order Chiroptera is caused, in our opinion, by the omnivorous diet of ancestral bats. Perhaps, the common ancestral features which are preserved in the digestive system of representatives of different trophic groups have restricted its evolutionary possibilities. At the same time, these features seem to possess such initial multifunctional properties as to allow chiropterans to occupy the largest number of trophic niches among mammals. The digestive system of each trophic group is characterized by a number of specific features at the macro- and micromorphological and biochemical level, reflecting specialization on a certain type of food. The highest degree of specialization has been reached by the digestive system in sanguinivorous bats. Along with this, specialization of the digestive organs in sanguinivorous and phytophagous bats feeding preferably on liquid food has gone further in a similar direction. Characteristic of these is an increase in volume of the gastrointestinal tract, the absence of a visible glycocalyx layer, adaptations to a fast absorption of either liquid carbohydrate-rich food or water already present in the stomach. On the whole, a so diversely directed adaptatiogenesis of structures and organs in representatives of different trophic groups of chiropterans does retain such common features as a high daily consumption of food, a high efficiency and a high rate of digestion.

Functional Morphology of the Pancreas in Chiropterans with Different Trophic Specializations

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Trophic divergence within the order Chiroptera has resulted in a diversity of morphological adaptations of the digestive organs, including the pancreas. The mass of the pancreas expressed in appropriate indices indicates a close relationship between this parameter and the type of feeding. Indices of the pancreas in carnivorous chiropterans are considerably higher (often 10 times or more) than those in phytophagous Phyllostomatidae and Pteropidae. Langerhans islets in the phytophagous bats studied belong to the macroinsular type and account for 17.46% to 29.49% of the total area of pancreatic sections. Evidently, a high carbohydrate content of the food has led to an increase in the amount of pancreatic insular tissue, which ensures an adequate maintenance of the blood glucose level. The pancreas of carnivorous bats is characterized by a relatively strong development of the acinar tissue, which has resulted in the high secretary activity of this organ. Their Langerhans islets are considerably smaller and occur relatively infrequently (1.15% to 4.46% of the total section area). A common vampire bat Desmodus rotundus has an intermediate position according to this parameter (7.54%). Therefore, chiropterans demonstrate a high degree of specialization of pancreatic micro- and macrostructure in response to different types of food.

The Increase in Numbers of Wintering Bats in a Cave over a 20 Year Period

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Visual censuses of wintering bats have been performed in the B´yrí Skála (Bull Rock) Cave in the Moravian Karst since 1977. A significant gradual increase in the total numbers of bats was recorded. The most striking upward trend in numbers was observed in the greater mouse-eared bat *Myotis myotis*.

Preliminary Results of Studies Concerning the Contents of Metals in Bat Hair

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Bats living in the temperate climatic zone feed exclusively on insects and occupy a secondary or tertiary trophic level in the food chain. Therefore, different chemical substances, including metals, introduced into the environment as a result of human activities, may accumulate in bats. For this study, the authors have chosen bat hair for two main reasons:

1. Hair samples can be taken without harming the animals;

2. The contamination of the enviromnent with metals can be compared with an earlier situation using museum specimens caught some years or decades ago. In that way the dynamics of metals introduced into the environment can be studied. Hair samples of about 0.08 and 0.2 g. taken from museum or live specimens were digested in heated high-purity nitric acid and de-ionized water. A high-pressure microwave system (MDS-IS Plasmotronika) was employed for hair sample digestion. In order to measure the concentration of the various elements in the samples, the inductively coupled plasma atomic emission spectrometry method (ICP-AES) was used. A sequential ICP-AES spectrometer (Jobin Yvon JY38S) was used here. Selected major and trace elements have been determined. As a rule, the two most sensitive lines for each element were selected. In addition to those, the argon line Ar 356.766 nm was monitored to control the stability of plasma excitation conditions. All measurements were performed with blank signal corrections. The results of some analyses are given in the table below.

Table 1.
The metal concentrations in *Myotis myotis* hair in ppm (micrograms of the element/g dry weight) hibernating in the Miedzianka seminaturatal cave (Swietokrzyskie Mts., Poland). The samples were taken on February 21,1995.

		Myotis myotis	*Myoiis myotis*
Hair sample weight (g)		0.0107	0.0155
Element	Al	240 ppm	120 ppm
	Ba	136	35
	Ca	30	2850
	Cu	114	73
	Fe	38	250
	Mg	9	114
	Mn	17	14
	Si	710	570
	Zn	124	116

Our introductory studies of metal concentrations in the analysed samples prove that the inductively coupled plasma atomic emission spectrometry method (ICP-AES) allows a quick and precise determination of the metal concentrations in hair samples and so can be used to study the contamination of the natural environment using bats as biomonitors.

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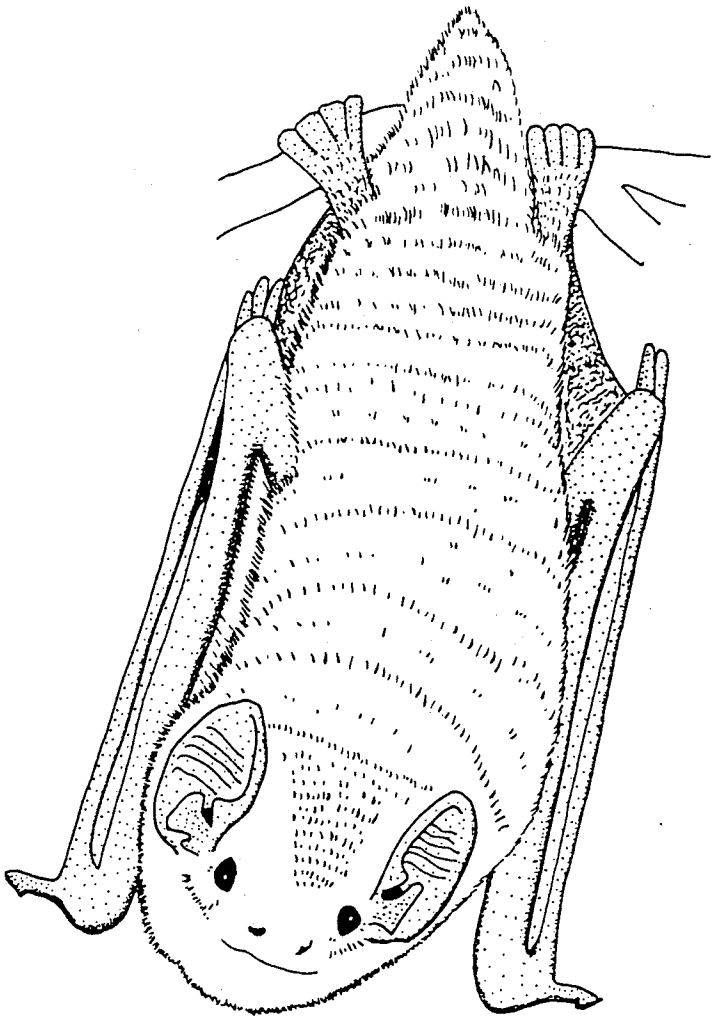

Volume 37: No.4 **Winter 1996**

BAT RESEARCH NEWS

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Subscriptions to institutions are $ 25.00 per volume(year).

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Bat Research News is : ISSN 0005-6227
United States Internal Revenue Service tax exemption number 16-1356633

Bat Research News is printed and mailed at:
Potsdam College of the State University of New York,
Potsdam, NY, 13676, U.S.A.

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Front Cover

The front cover illustration is the logo of the 26th Annual North American Symposium on Bat Research held October 23-26, 1996 at Illinois Wesleyan University. The drawing of a red bat *Lasiurus borealis* is the art work of Tom Griffiths.

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Volume 37: Number 4 **Winter 1996**

Original Issue Compiled by Dr. G. Roy Horst, Publisher and Managing Editor of *Bat Research News*, 1996.

Bat Research News is ISSN # 0005-6227.

BAT RESEARCH NEWS

Volume 37: Number 4 **Winter 1996**

Bat Collisions with Wind Turbines in Southwestern Minnesota

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Introduction

Sporadic reports of bat mortality due to collisions with man-made objects exist in the literature. Van Gelder (1956) reported that five red bats (*Lasiurus borealis*) were killed after colliding with a television tower in Kansas, and Crawford and Baker (1981) reported that over a 25-year period, 54 bats from seven species were killed at a television tower in Florida. Additionally, Saunders (1930) reported that five bats, representing three species, were killed after colliding with a lighthouse at Long Point, Ontario. Bat collisions with wind turbines used to produce electricity also have been noted. At California windplants, Howell and DiDonato (1991) reported finding one dead red bat during a 12-month period, and Orloff and Flannery (1992) reported finding two bat carcasses during a 24-month period.

Recent technological advances have reduced costs associated with wind-power production to a level that is competitive with more traditional methods of producing electricity (Nelson and Curry, 1995). As a result, utility companies increasingly use wind power as an alternative source of energy (Hanson et al., 1992). While wind power is generally viewed as an environmentally friendly source of energy, the number of avian moralities at existing windplants has caused concern among many state, federal, and non-profit organizations.

To date, most studies were designed to assess the biological impacts of windplants on bird species. In comparison to birds, bat collisions with wind turbines appear to be infrequent and therefore have received little attention by natural resource agencies or the scientific community. While conducting a study to assess the impacts of a windplant on birds in southwestern Minnesota, we found several dead bats. The purpose of this paper is to document the species composition and timing of bat mortality associated with the Minnesota windplant during 1994 and 1995. We also review some current theories regarding bat collisions with man-made structures and speculate on the possible causes of bat mortality at windplants.

Methods

From April 1994 through December 1995, we searched the Buffalo Ridge Wind Resource Area (WRA), located in southwestern Minnesota, Lincoln County, near Lake Benton. Currently, the Buffalo Ridge WRA is a 25-megawatt facility and consists of 73 KVS-33 wind turbines that were grouped into 10 strings. The number of turbines per string ranged from three to 20. Within strings, wind turbines were separated by 91-183 m. Each wind turbine was installed on top of a 37-m-high tubular tower and had a blade diameter of 33 m. The primary habitats within the Buffalo Ridge WRA are agricultural (corn, soybeans, small grains, pasture, and hay) or Conservation Reserve Program (CRP) fields. The majority of CRP fields have been planted to stands of either a smooth brome (*Bromus inermis*) and alfalfa (*Medicago sativa*) mixture or switchgrass (*Panicum virgatum*). Small patches of woodland exist near farmsteads and in ravines.

The ground within at least a 46-m radius of wind turbines was searched for carcasses. Search intensity varied by season. During spring and fall, all 73 turbine plots were searched once per week; however, during summer and winter only 30 plots were searched once per week, with the same 30 plots being searched each week. Turbine mortality plots were searched for carcasses by walking parallel transects. The distance between transects ranged from 5-11 m, depending on the ability of searchers to see the ground, and was primarily influenced by vegetation height. A complete description of search procedures and frequency is provided in Higgins et al. (1996).

Results

During 20 months of continuous monitoring, 2,941 turbine plots were searched for dead bats during 855 hours. We found 13 bat carcasses representing five species (Table 1). In the late summer 1994, two

additional bat carcasses were not collected, so we were unable to confirm the cause of mortality or determine species for these bats. Carcass-recovery dates ranged from 12 May to 22 September (Table 1). One collision (8% of the total) occurred during spring, 11 (85%) during summer, and one (8%) on the first day of fall (Table 1). Six of 13 (46%) bats were found within 15 m of turbines and 69% were found within 20 m (Table 1).

On 13 September 1995, we found the carcass of an eastern pipistrelle (*Pipistrellus subflavus*). Previously, this species had not been recorded in Minnesota, west of the city of Saint Cloud. An earlier report of an eastern pipistrelle from Traverse Co., Minnesota, is not valid (E. Birney, Bell Museum, University of Minnesota, pers. comm.), and our record extends the known range of the eastern pipistrelle in Minnesota approximately 160 km farther west. The specimen, catalog # 17508, was deposited in the Bell Museum.

Discussion

The reasons for bat collisions with man-made objects are poorly understood, and a number of theories exist. Older articles in the popular press speculated that television transmitters somehow interfered with the echolocation system of bats (Van Gelder 1956), perhaps producing ultrasound in addition to electromagnetic radiation. However, Van Gelder (1956) pointed out that bat collisions with buildings and lighthouses could not have been the result of echolocation interference and reported that a television tower at Topeka, Kansas, was probably not transmitting when several bats collided with it. We can offer no data as to whether sounds produced by wind turbines affected the ability of bats to echolocate.

Van Gelder (1956) also reported that most bat collisions involved migratory species of bats and occurred during fall, on nights with inclement weather (i.e., fog or low clouds), and in association with large numbers of bird mortalities. Van Gelder (1956) suggested that adverse weather conditions forced migrating birds down to lower than normal elevations, which confused migrating bats. However, Crawford and Baker (1981) reported that 16 bats killed at a television tower in Florida were killed on nights when only one bird was recovered. Our data also do not support the theory that migrating birds may confuse bats. Approximately 62% of our dead bats were found from June through August (Table 1), which is after the spring bird migration and before the onset of fall migration. Additionally, bird and bat carcasses were found together on the same turbine string, on the same day, only once during this study (Higgins et al., 1996), on a date (1 August 1995) that is before peak fall migration for many bird and most bat species. Moreover, most occurrences of migration-related mortality reported in the literature have involved large numbers of bird fatalities and several bat fatalities during a single evening (Crawford and Baker, 1981; Saunders, 1930; Van Gelder, 1956).

Crawford and Baker (1981) hypothesized that migrating bats were not echolocating and thus did not detect obstacles in their path. If bats frequenting Buffalo Ridge were visually navigating between roosting, watering, and feeding sites and were not echolocating, this may explain some of the bat mortality that occurred at the Buffalo Ridge WRA. Visually navigating bats may be influenced by many of the same factors (e.g., species abundance, climatic conditions, landscape features, surrounding land use, rotor speed, presence of migration corridors or daily flight lanes, etc.) that are believed to cause birds to collide with turbines (Nelson and Curry 1995).

The timing of bat carcass recovery at the Buffalo Ridge WRA suggests that bats are susceptible to collisions with man-made objects at times other than during migration. While it is possible that the bat found in May and the bats found in late August and September were migrants, the bats found from June to mid-August were probably summer residents. Crawford and Baker (1981) also reported one summer (July) mortality at a Florida television tower.

Structural components of wind turbines also may contribute to bat mortality. In California, a factor contributing to avian mortality was the use of wind turbines as perching or nesting sites (Howell and DiDonato, 1991; Orloff and Flannery, 1992; Nelson and Curry, 1995). The use of tubular (rather than lattice-frame) towers at the Buffalo Ridge windplant seems to have reduced the attractiveness of wind turbines as perching or nesting sites to birds (Higgins et al., 1996). Although maintenance personnel never observed any evidence of bats roosting inside towers or nacelles (the cab or housing that sits on top of the tower), it is possible that bats may use the catwalk or other external structures as temporary roosting sites during the night.

Several factors (e.g., observer efficiency, scavenging, and decomposition) influence the ability of searchers to find carcasses. At the Buffalo Ridge windplant, approximately 66% of small carcasses (robin-sized birds) were found during searches of turbine plots that had been salted with bird carcasses (Higgins et. al., 1996). Because the bat species found in Minnesota are smaller and more cryptically colored than most birds used during the trials of Higgins et al. (1996), it is reasonable to assume that several bat carcasses were overlooked as well.

Scavengers present on the Buffalo Ridge windplant removed approximately 25% of avian carcasses over a seven-day period (Higgins et al. 1996); however the scavenging rate may be lower for bat carcasses. During this study, seven of the 13 bat carcasses were recovered on maintenance roads located next to turbine strings. Five of the seven carcasses recovered from access roads were desiccated and decomposed, indicating that they had been there for several days but had not been removed by scavengers.

Decomposition did not influence the ability of searchers to locate avian carcasses at the Buffalo Ridge windplant during seven-day trials (Higgins et al., 1996). During this study, even the desiccated and decomposed bat carcasses were still recognizable. Therefore, decomposition was not likely a factor influencing the recovery of bat carcasses. However, if the time interval between plot searches extends beyond seven days, this source of bias should be re-evaluated.

To our knowledge, our findings are the first evidence of frequent bat collisions with wind turbines. The number of bats (n = 13) killed at Buffalo Ridge during the 20-month period was similar to the number of birds (n = 12) killed (Higgins et al., 1996). However, without knowing the population size of bats and birds in the Lake Benton area, it is not possible to determine whether bats or birds are more susceptible to collisions with wind turbines. Furthermore, most bat species involved in collisions at the Buffalo Ridge WRA were solitary, tree-roosting species. We can offer no data concerning the potential effects of wind turbines on colonial species that roost in tree cavities or caves.

Our findings are important to the siting of future windplants. New windplants have been or are being developed in California, Texas, and Minnesota and consideration is being given in Wyoming, Wisconsin, Washington, Maine, West Virginia, and some areas of southern Canada (Nelson and Curry, 1995). Additionally, Minnesota and Texas have plans to expand the size of existing windplants. Globally, windplants are in operation or are being constructed in Spain, the United Kingdom, the Netherlands, the Ukraine, and Costa Rica (Nelson and Curry, 1995). As the number of windplants increases, it will become increasingly important to understand their effects upon bat populations. Currently, even baseline information is lacking. Our findings indicate that it may be wise to avoid construction of windplants near areas with large bat populations. Further research is necessary to clarify the potential impacts of wind turbines on bat populations.

Acknowledgments

Funding for this project was provided by KENETECH Windpower to the South Dakota Cooperative Fish and Wildlife Research Unit in cooperation with South Dakota University, the South Dakota Department of Game, Fish, and Parks, the U.S. Fish and Wildlife Service, the National Biological Survey, and the Wildlife Management Institute. We would like to thank J. Stewart, H. Nelson, J. Schadweiler, and D. Curry for their assistance on contracting, study design, and technical assistance. P. Beauzay, J. Bien, K. Cieminski, T. Cooper, R. Hanson, B. Harris, and K. Leddy assisted with field work. E. Birney assisted with bat identification and prepared the eastern pipistrelle specimen for deposition. We also would like to thank the fields and maintenance personnel at the Buffalo Ridge Wind Research Area for their help and cooperation throughout the study.

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Table 1. Date of collection and distance from the nearest turbine for dead bats at the Buffalo Ridge Wind Resource Area, near Lake Benton, Minnesota, from May 1994 through December 1995.

Year	Date	Species	Distance from turbine (m)
1994	18 July	*Eptesicus fuscus*	13.7
	24 Aug.	*Lasionycteris noctivagans*	15.9
	6 Sept.	*Lasionycteris noctivagans*	12.8
	14 Sept.	*Lasiurus cinereus*	37.2
	22 Sept.	*Lasiurus cinereus*	19.2
1995	12 May	*Lasionycteris noctivagans*	20.1
	14 July	*Lasiurus cinereus*	32.0
	29 July	*Lasiurus borealis*	3.1
	1 Aug.	*Lasionycteris noctivagans*	18.0
	9 Aug.	*Lasiurus cinereus*	39.0
	22 Aug.	*Lasiurus borealis*	7.9
	25 Aug.	*Lasiurus cinereus*	9.1
	13 Sept.	*Pipistrellus subflavus*	10.1

On the Occurrence of Microbats in Taiwan

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Introduction

Little is known about the bats of Taiwan. A previous report indicated the presence of 22 bat species (Chen, 1956), but recent surveys confirmed 19 species of microbats in Taiwan (Cheng, 1995; Lin, 1996; Table 1). The only megabat, the Formosan flying fox, *Pteropus dasymallus formosus*, was once common on a 15-km^2 island, known as Green Island. Heavy hunting pressure and deforestation during the 1970s and early 1980s brought the flying fox population to extinction. A few years ago, a new species of long-eared bat, *Plecotus taivanus*, was discovered in the central mountains (Yoshiyuki, 1991), but its taxonomic status has not been assessed (Corbet and Hill, 1992). Some aspects of the reproduction of the pipistrelle, *Pipistrellus abramus*, from northern Taiwan, have been recently reported (Lee, 1995). In this paper, I present data on the occurrence and population size of microbats at a site in southern Taiwan.

Methods

The study site is in Kenting National Park (21°90'N, 120°80'E), which is located on the southernmost tip of Taiwan. The national park covers 17,731 ha of land and 14,900 ha of adjacent ocean (Yang, 1993). Because of its location in the only, lowland, tropical, rainforest habitat, I selected the Kenting area for long-term monitoring of microbats. Predominant tree species at the study site are: swamp oak, *Casuarina equisetifolia*; mountain oak, *C. montana*; Indiapoon beautyleaf, *Calophyllum inophyllum*; and Taiwanese acacia, *Acacia confusa* (Hsu and Lin, 1993, 1994, 1996).

Between November 1994 and July 1996, 40 caves and three abandoned tunnels were investigated to record data on the population of microbats. Population size of bats roosting in the caves or mines was estimated from visual counts and photographs (Swift, 1980; Thomas and West, 1989). Mist-netting was used to capture bats in forested areas. All captured bats were sexed and weighed, their forearm length was measured, and forearms were marked with bands for long-term monitoring.

Results and Discussion

Eight species of bats were captured during the study, including four of the five taxa endemic to Taiwan (Table 1). Six species of bats were observed in caves and tunnels: *Rhinolophus monoceros*, *R. luctus formosae* (Rhinolophidae), *Hipposideros armiger terasensis*, *Coelops frithi formosanus* (Hipposideridae), *Miniopterus schreibersii fuliginosus*, and *Myotis taiwanensis* (Vespertilionidae) (Table 1). The population sizes of *R. monoceros* and *M. s. fuliginosus* reached a maximum of 5,000 and 6,000, respectively, during my study. The third most common species, occupying 25% of the surveyed caves and tunnels, was *H. a. terasensis*, including one sighting of a partial albino. The population sizes of the other three cave-roosting

bats--*M. taiwanensis, C. f. formosanus*, and *R. l. formosae*--were low, numbering from a few individuals to a maximum of 400.

Maternity colonies of bats were observed for all cave-roosting species, except *R. l. formosae*. Females of *M. s. fuliginosus* and *M. taiwanensis* shared the maternity caves and tunnels to raise their young. Similar cases of sympatric bats sharing maternity caves and roosting sites have been widely reported among insectivorous bats (Arlettaz and Perrin, 1995; Swift and Racey, 1983). However, *H. a. terasensis* did not share their maternity caves with other bat species.

Two other species of vespertilionid bats, *M. muricola orii* and *Murina puta*, were only found by mist-netting in the forest (Table 1). The single *M. puta* that was captured weighed 12 g; other measurements were as follows: total length, 95 mm; tail length, 36 mm; hind-foot length, 10 mm; and ear height, 17 mm. Interestingly, this specimen had two fetuses, one in each uterine horn. A similar case of twin fetuses has been reported for *M. cyclotis peninsularis* captured from Pahang, Malaysia (Medway, 1978).

To maintain viable populations of all bat species, rooting sites must be protected, not only in Kenting, but also throughout Taiwan. The only bat species currently protected by the Wildlife Conservation Law of Taiwan (Anonymous, 1989) is the flying fox *P. d. formosus*, which appears to be extinct in its natural habitat. Although little is known about the populational status of microbats in Taiwan, it is vital to include the five endemic taxa (*H. a. terasensis, R. monoceros, P. taivanus, M. taiwanensis* and *M. puta*) in the protected list of wildlife.

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Table 1. Microbats in Taiwan. An asterisk indicates an endemic species; a plus sign indicates a species found in Kenting National Park during the present study. Taxonomy is based on Corbet and Hill (1992).

Family and species name
Family: Rhinolophidae
Rhinolophus luctus formosae +
R. monoceros * +
Family: Hipposideridae
Coelops frithii formosanus +
Hipposideros armiger terasensis * +
Family: Vespertilionidae
Barbastella leucomelas
Eptesicus serotinus horikawai
Harpiocephalus harpia
Miniopterus schreibersii fuliginosus +
Myotis formosus watasei
Myotis frator
Myotis muricola orii +
Myotis taiwanensis * +
Murina puta * +
Nyctalus noctula
Pipistrellus abramus
Plecotus taivanus *
Scotophilus kuhlii
Vespertilio orientalis
Family: Molossidae
Tadarida teniotis insignis

Harp-trapping Bats at Tree Roosts in Tall Forest and an Assessment of the Potential for Disturbance

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Abstract

Some species of bats roost in small holes high in the forest canopy, making behavioral studies difficult. We adapted a harp trap for catching long-tailed bats, *Chalinolobus tuberculatus*, at tree roosts in temperate rainforest in Fiordland, New Zealand. Potential for disturbance was assessed by examining bat emergence behavior, roost occupancy, colony composition, and influence of trapping on young bats. There were no significant differences in the behavior of bats using trapped roosts compared with those using untrapped roosts. We concluded that harp-trapping at tree roosts did not adversely affect *C. tuberculatus*.

Introduction

Harp traps have been used widely to sample bats (Kunz and Kurta, 1988) and can provide information on species composition, age and sex ratios, reproductive status, and survivorship. The harp trap was developed by Constantine (1958) and improved by Tuttle (1974). Tidemann and Woodside (1978) designed a smaller, double-framed, collapsible trap that is highly portable and easy to use in the field. Harp traps are usually placed on the ground (Tidemann and Woodside, 1978) or in flyways but have been used in a variety of situations (Kunz and Kurta, 1988).

The New Zealand bat fauna is limited to two extant species: the long-tailed bat, *Chalinolobus tuberculatus* (Vespertilionidae), and lesser short-tailed bat, *Mystacina tuberculata* (Mystacinidae). Both species are classified as vulnerable (Bell, 1986) and are predominantly forest dwellers (Daniel and Williams, 1984). Information on their ecology is currently being sought in an attempt to understand better the threats these species may be facing (Molloy, 1995).

We have been studying *C. tuberculatus* in temperate rainforests in southern New Zealand since 1990. This species is rarely caught in mist nets, and it roosts in tree cavities high in the forest canopy (mean: 16m

above ground; range: 2-35 m). To obtain detailed information on their ecology, we used harp traps to catch *C. tuberculatus* at their roosts as they emerged at dusk. This paper describes how we adapted the harp trap for use high in the forest canopy and examines the potential impact of this capture technique on the time at which bats first emerge from the roost, roost occupancy, colony composition, and the desertion rate of young bats by mothers.

Methods

The study was conducted in southern beech (*Nothofagus*) rainforest in the Eglinton Valley, a steep glaciated valley in Fiordland, South Island, New Zealand (44°58'S, 168°01'E). This study took place over three summers between 1993 and 1996. We conducted a preliminary study of roosting behavior (untrapped roosts). Roost sites were found by mistnetting bats, fitting them with radiotransmitters and then tracking them to their communal day roosts. The exact roost hole was identified either by observing bats entering their roost at dawn, or by climbing the tree and using a radioreceiver. The majority of roosts that were later trapped were maternity sites dominated by breeding females and their young.

To trap bats, we used a commercially available 4.2 m^2 harp trap (Austbat Research Equipment, Melbourne, Australia). Simple modifications were required to enable this normally free-standing, collapsible trap to be hoisted up trees (Fig. 1). The existing guy ropes at the top of the frame were tied tightly to the hip mounts, to prevent the frame from pulling apart when the trap was lifted. New guy ropes were attached on both sides, at top and bottom; these were used to position the trap in front of the roost hole. To hoist the harp trap into a tree, a nylon line was fired over a branch above the roost hole, using a sling shot to dispense a lead weight and fishing line from a fishing reel. This line was used to pull an 11-mm static climbing rope that was then attached to the trap (Fig. 1). The trap was positioned in close proximity to the roost entrance (Fig. 2), such that the edge of the trap bag was no more than 10 cm below the roost hole, whenever possible.

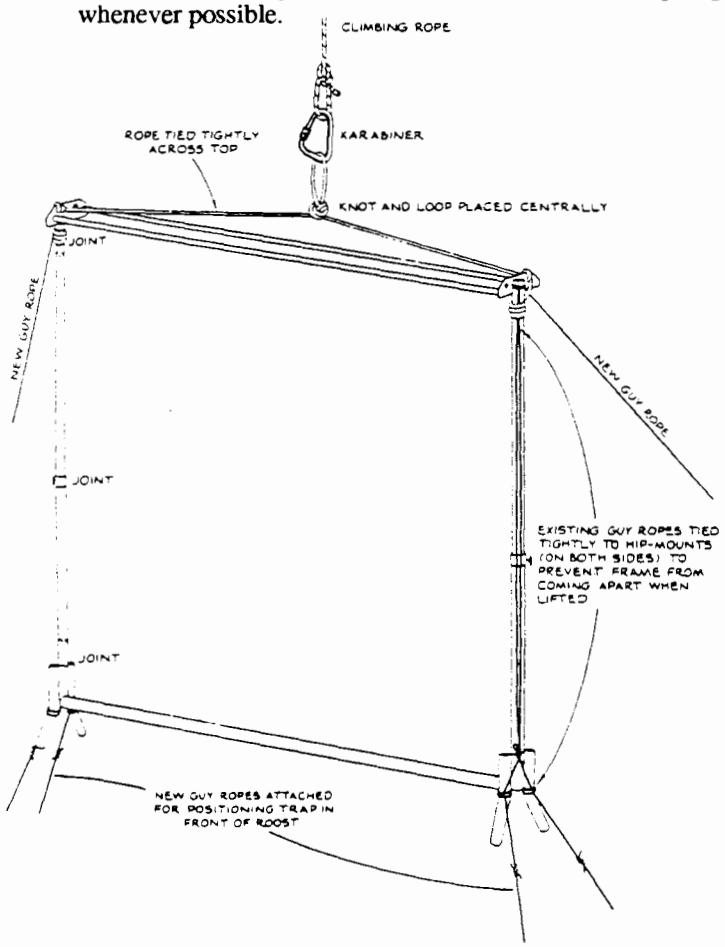
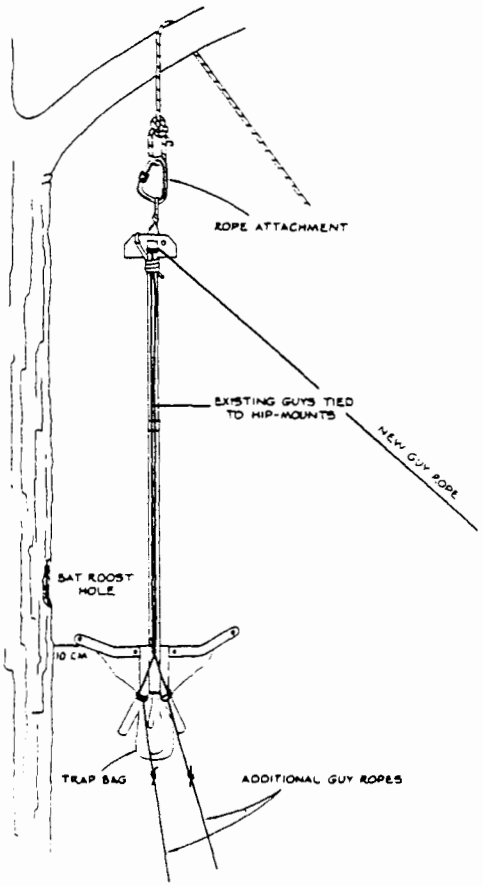


Figure 1.
Modifications for hoisting the harp trap into trees.



drawings not to scale

Figure 2.
Positioning the harp trap in front of a tree roost.

If the space between the roost hole and the branch from which the trap was suspended was too small to accommodate the trap, we modified the trap further. The sides of the harp-trap frame were made of two or three, adjustable, telescopic poles, and the trap was made smaller by leaving these poles on their minimum adjustment or by removing one of the pole sections completely. The banks of strings were then shortened correspondingly by rolling up the two, bottom, line carriers and securing them with electrical insulating tape. It was necessary to push each string back to its original position after the bars were taped.

The trap was generally placed in the tree 5 to 10 h before sunset. We returned to the roost 1 h before sunset and watched the trap for the whole emergence period so that the number of escapees could be recorded. The trap was usually lowered about 1 h after sunset, and the bats quickly processed and released. The trap was not put back at the roost during the night to prevent interference with the bats' return.

To test for detrimental effects of harp-trapping, we looked at four aspects of bat behavior: 1) timing of emergence, 2) roost desertion, 3) changes in colony composition, and 4) desertion of dependent young. First, to detect whether emergence was delayed on trapping nights, we compared the time, in relation to sunset, at which the first bat emerged from harp-trapped and from untrapped roosts, on any given night. Second, to determine whether trapping led to an increase in the rate of roost desertion, we compared the reoccupancy of harp-trapped roosts with reoccupancy of untrapped roosts on two time scales. We examined potential short-term effects by looking at the proportion of roosts that were occupied the day following trapping (checked at dusk), as well as the number of subsequent days on which the roost was occupied consecutively. Long-term effects on reoccupancy were examined by comparing the proportion of harp-trapped and untrapped roosts that were occupied by bats in the two summers subsequent to our study. Third, we looked for a change in colony composition at roosts that were reoccupied on the night following trapping by counting the number of bats occupying the roost on subsequent nights and comparing the identity of banded individuals over those nights; we did this in four cases. Finally, all trapped roost trees were checked the next day for the presence of dead or abandoned young. The trees were climbed, and the roost holes thoroughly investigated using a torch and dentist's mirror. In addition, seven roosts were monitored using infrared video-equipment, subsequent to harp-trapping, and the number of young were counted.

Results

During the study, a total of 308 roosts in 264 different trees was found after radiotracking 60 bats. In total, the roosts were monitored for 503 nights. Forty-eight communal roosts were trapped, resulting in 1,503 recaptures of 376 individuals. However, complete data sets on roost occupancy and emergence were not collected for all roosts.

Capture rates proved to be dependent on the position of the trap relative to the roost hole. Traps set 1 m from the roost hole caught, on average, 52% (SD = 8.5, range = 36-63%, n = 8) of bats emerging, compared to 94% (SD = 9.5, range = 65-100%, n = 37) for traps set immediately in front of the hole, as illustrated in Fig. 2. There was no significant difference between first-emergence time of bats for trapped (n = 21) and untrapped roosts (n = 183; Mann Whitney *U*-test, P = 0.24; e.g., Fig. 3). Sample sizes for other months were not large enough to compare statistically.

The preliminary study of untrapped roosts showed that 60% were occupied for only one night (n = 22), implying there would inherently be a low risk of causing bats to abandon roosts after trapping. While occupancy of communal roosts varied from 1 to 5 days over the whole study, 84% of trapped roosts and 77% of untrapped roosts were only used for one night (Fig. 4). There was no significant difference between the number of days occupied for trapped (n = 44) and untrapped roosts (n = 195; X^2 = 3.41, d.f. = 4, P = 0.49, Fig. 4). Bats returned to 16% of roosts the day after trapping, compared to 22% for roosts which were not trapped. This difference was not significant (X^2 = 0.95, d.f. = 1, P = 0.33). During two summers after initial trapping, bats were recorded returning to 35% of trapped roosts and 31% of untrapped roosts. The difference was not significant (X^2 = 0.06, d.f. = 1, P = 0.81). The number of bats in roosts occupied the night after trapping was slightly variable, with the number of bats at roosts increasing, decreasing, or staying the same. The number of banded individuals returning to the roost the following night was also very variable (over 80% of bats in the population are banded). For example, in Roost 72, 35% of bats returning were recaptures from the previous night. Roost 98 was harp-trapped over three nights. On night two, two of 10 bats were recaptures from the previous night, but of eight bats caught on night three, three were from the first night and three were from night two.

There was no evidence of desertion of dependent young by adults in harp-trapped roosts. No dead or abandoned young were found. All trapping was done at dusk when females were leaving without their young, and the trap was not left in place for the night. Video-monitoring confirmed that lactating females returned to the roosts after trapping at the normal time (1-3 hours after sunset), to feed their young and carry them to a new roost. It also indicated that similar numbers of young were being carried by lactating females

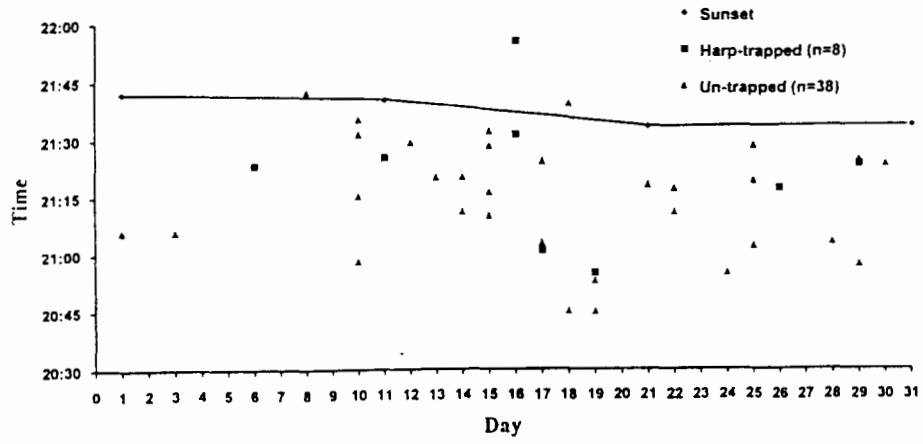


Figure 3. Time of first emergence, in relation to sunset, from trapped and untrapped roosts, in January (1994-1996 combined).

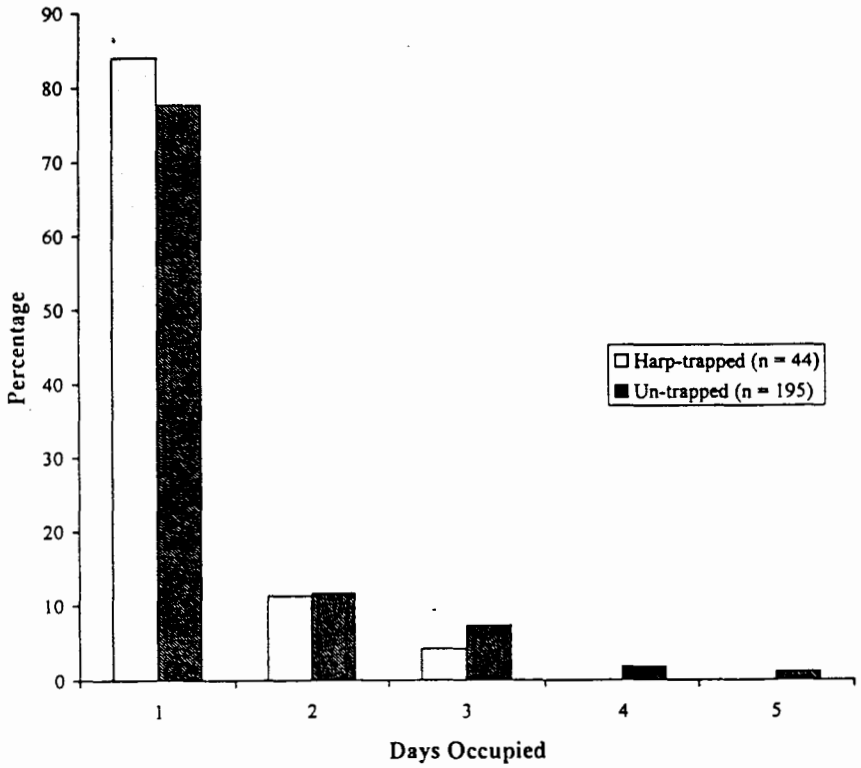


Figure 4. Number of days on which trapped and untrapped roosts were occupied.

after trapping (as at untrapped roosts), and there was high, overwinter survival of banded young from harp-trapped roosts (minimum average survival = 67% over 3 yr).

Discussion

Harp-trapping at roosts has proved to be an invaluable research tool for our studies of *C. tuberculatus*. From its use we were able to learn much about roosting behavior, social structure, and breeding that we would have otherwise been unable to observe, and we would not have been able to capture a large enough sample of bats for marking, to investigate long-term survival patterns. Capture success using most bat-trapping techniques can be biased by a bat's prior experience, age, sex, and reproductive condition (Kunz and Kurta, 1988). For example, adult bats are more adept at avoiding traps than juveniles, and lactating females

are more adept at avoidance than are heavily pregnant females (Kunz and Anthony, 1977). However, by using harp traps outside *C. tuberculatus* roost holes, with optimal trap positioning, up to 100% of emerging bats were caught, avoiding these sampling biases. This gave us a much more detailed understanding of changes in roost composition and revealed information about the presence of otherwise cryptic sub-groups in the population (O'Donnell, 1995).

The nature of *C. tuberculatus* roosting patterns in the Eglinton Valley made it difficult to assess the effects of harp-trapping directly. Our preliminary work indicated that 60% of roosts observed were occupied for only one night. At the completion of this study this high turn-over rate of roost occupancy was confirmed, with 77% of 195 untrapped roosts being occupied for only one night. A particular maternity roost may only be used once or twice over a summer. Despite this, we felt that by using several criteria to measure potential trapping effects we should record some observable evidence of changes in roosting behavior if trapping caused significant disturbance. We detected no significant differences in the behavior of bats from trapped roosts, and the population remains healthy and continues to breed successfully. Therefore we conclude that harp-trapping at tree roosts did not adversely affect *C. tuberculatus* behavior.

Caution, however, should be exercised before extrapolating these results to other species. While we found no evidence to suggest we were disturbing the bats in this particular situation, this may not be the case in different habitats, or for different roost types and other bat species. Therefore, we recommend that workers embarking on similar investigations undertake pilot studies to assess potential for disturbance so that trapping has no significant impact on potentially sensitive populations.

Acknowledgments

We thank the large number of volunteers who helped with harp-trapping, Sandra Parkkali for drafting the diagrams, and Peter Webb and Lindy Lumsden for helpful comments on the manuscript.

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A Reminder

Included in this issue is a postage paid card on which you may list your e-mail number. This is not a ***bat-line*** or ***chat-line*** project, merely an attempt to compile an e-mail directory for your colleagues in volved in bat research, conservation and education. This directory will be published in Bat Research News. It will be of special value to those of our colleagues outside of North America. If you do not want your e-mail address published, kindly check the box indicated and return the card. That way we will know that you didn't lose or misplace it [or like I often do, throw it on the pile never to surface again].

Thank you very much for your cooperation. Sincerely, G. Roy Horst

Letters to the Editor

Editor's Note. Unlike technical articles, letters are not peer-reviewed, but they are edited for grammar, style, and clarity. Letters provide an outlet for opinions, speculations, anecdotes, and other interesting observations that by themselves may not be sufficient or appropriate for a technical article. Letters should be no more than two manuscript pages in length and should be sent to the Feature Editor, Allen Kurta.

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An Unusual Technique for Catching *Nyctophilus geoffroyi*

At approximately 2230 hours on 9 January 1997, whilst driving home with a colleague, Dr. Fritz Geiser, from an evening of field work trying to catch Australian owlet-nightjars in the Eastwood State Forest, about 10 km SE of Armidale NSW, Australia, we captured a bat in a very unusual manner. Fritz was driving about 70-80 km/h, when, from the side of the road, a bat flew in front of the car and was lit up in the headlights. A second before the car hit the bat, it turned sharply to fly in the same direction that we were going, before it disappeared from our view under the "bonnet." This in itself was a strange occurrence to me, because in all the night-time driving I have done, I have rarely seen bats, and, even more rarely, come close to hitting one.

Fritz stopped the car, and we drove slowly back along the road, fully expecting to come across a carcass. Having gone past the spot where the contact must have occurred, I got out with a "torch" and heavy heart, ready to peel the bat off the front grill of the car. Getting down on my hands and knees, I discovered a cavity underneath and behind the front bumper (below the grill) of the car. My attention was drawn to this because I spotted a wing tip protruding from it. I reached in and scooped out a shaking, juvenile, female *Nyctophilus geoffroyi*.

I took the bat inside the car to get a good look. There was no evidence of abrasions, all wing and finger bones were intact, and within seconds, the bat began to crawl over my hand. Feeling that the bat had had enough excitement for one night, I opened the door, and the bat quickly flew off, out of my hands. Although this observation is not likely something that you could base a grant proposal on, it is another example of the fact that bats can do the darndest things!

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Possible Use of a Basal Cavity as a Maternity Roost by the Eastern Pipistrelle *Pipistrellus subflavus*

The eastern pipistrelle, *Pipistrellus subflavus*, is one of the most common bats in many areas of the eastern United States (R. W. Barbour and W. H. Davis, 1969, Bats of America, Univ. Press Kentucky). There are many reports describing hibernacula of this species, but little information is available regarding maternity roosts. Maternity sites primarily have been associated with buildings; they include a porch in New York, barns in New York, Pennsylvania, and Massachusetts, and an abandoned store on a coastal island of Georgia (M. S. Fujita and T. H. Kunz, 1984, Mammal. Species, 228:1-6; Menzel et al., 1995, Georgia Dept. of Nat. Res., Tech. Rept., 60 pp.). In addition, Humphrey et al. (1976, Trans. Ill. Acad. Sci., 69:367) located maternity roosts in two caves in Missouri. All previously reported roosts were occupied in June or July.

On 28 June 1996, a lactating, adult, female eastern pipistrelle (5.4 g) was recovered from a pitfall trap at the base of a sweetgum tree (*Liquidamber styraciflua*, dbh = 32.5 cm). The pitfall was a 1.1-L plastic cup, filled with 0.1 L of water, and had an opening that was 11 cm in diameter; the trap was one of a series, set as part of a small mammal and herptile survey of the Oconee National Forest in Green County, Georgia. The pitfall was located at the entrance to a basal cavity of the tree. The entrance to the cavity was 58-cm in height, 10-cm wide, and oval in shape, and from the top of the entrance, the basal cavity extended upwards an additional 52 cm. The inside diameter of the cavity was 13 cm.

The capture of the pipistrelle was considered accidental. However, three days later, on 1 July 1996, a prevolant, female eastern pipistrelle (1.9 g) was also collected in the same pitfall. The collection of an adult, lactating female and prevolant young in the same pitfall suggested the cavity served as a maternity roost; if so, this would be the first report of a cavity being used as a maternity roost by the eastern pipistrelle.

Eastern pipistrelles have previously been reported roosting in trees, in addition to buildings and caves (J. S. Findley, 1954, J. Mammal., 35:433; W. L. Jennings, 1958, Unpubl. Ph. D. diss., Univ. Florida, Gainesville; Menzel et al., 1995). Since cavities are common in mature hardwood trees and maternity roosts for the eastern pipistrelle are infrequently reported, it may be that such cavities are an important, yet unrecognized, maternity roosting habitat.

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Observations of a Winter Colony of LeConte's Free-Tailed Bats *Tadarida brasiliensis cynocephala* in Lee Co., Alabama

LeConte's free-tailed bat (*Tadarida brasiliensis cynocephala*) occurs only in the southeastern United States and roosts almost exclusively in buildings or other man-made structures. Although numerous summer colonies (usually <200 individuals) have been located in Alabama since 1990 (W. M. Kiser, In press, Occ. Pap., North Carolina State Mus. Nat. Sci.), few winter colonies are known, and little information on the natural history of this species in winter has been published. *Tadarida b. cynocephala* is neither a true hibernator nor a true homeotherm, but a bat that exhibits some attributes of each thermoregulatory pattern, and unlike many bats in North America that hibernate, LeConte's free-tailed bats can be active in winter (J. F. Pagels, 1975, Comp. Biochem. Physiol., 50:237-246).

On 3 March 1995, ca. 100 *Tadarida* were present in an attic of an old, three-story, wooden house in Opelika, Lee Co., Alabama. Comments by the property owner and the amount of guano present indicated that bats had used this attic for several years. At 0915 hours, ca. 50 free-tailed bats were roosting at the top of a hollow wall-space in the attic, which recently had been renovated into living quarters. A 500-watt, quartz, halogen floodlight was focused on the central cluster of bats in the wall, illuminating much of the area; however, the bats appeared torpid and no vocalizations were heard.

The owner stated that the floodlight, which had been left on for >1 week, had driven many bats deeper into the attic walls. The floodlight was turned off at 0940 hours, and bats became active and began vocalizing. While inspecting the house from the outside, to our surprise, we observed bats beginning to exit the building at 1000 hours. No bats were heard or observed from 4-6 March. On 6 March a maximum-minimum thermometer was installed near the top of the wall-space where bats had roosted, and the temperature at 1545 hours was 23.9°C.

On 7 March, the attic was inspected, and >50 bats had returned. During 6-7 March, maximum temperature in the wall-space was 23.9°C, and minimum temperature was 18.3°C. At 0745-0800 hours, bats were heard vocalizing. Of eleven bats captured at random, all were male. At 0800 hours the floodlight again was turned on, and at this point, bats became active and began crawling into the illuminated area. By 0810 hours, >40 bats were present in the apex of the wall-space.

At 0820 hours, the floodlight burned out, and the number of vocalizations dropped. However, bats did not leave the apex, nor did they exit the building this time. The temperature near the apex of the wall-space at 0825 hours was 20°C. Using a digital thermometer and probe, we determined that the temperatures at which two separate clusters of bats were roosting was 22.2°C. At 1700 hours, the temperature of one of these clusters was 22.8°C. No other observations were made because the colony was excluded shortly thereafter.

Illumination is sometimes mentioned as a technique for removing bats from a building (A. M. Greenhall, 1982, U.S. Fish Wildl. Serv., Res. Publ. 143; W. J. Laidlow and M. B. Fenton, 1971, J. Wildl. Manage., 35:843-846). In one of our observations, however, LeConte's free-tailed bats seemed to be attracted to a light, possibly as a source of heat. More comprehensive studies of winter roosts are needed to determine the temperature requirements of this species in winter.

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Comments on "The Study of Chinese Bats: a Review"

The following comments concern an abstract published recently in Bat Research News. Presumably, this was an abstract of a paper or poster presented at the Tenth International Bat Research Conference in Boston in August 1995. I was not able to attend that conference, and therefore, my comments are based entirely on the printed abstract. In their abstract, entitled "The Study of Chinese Bats: a Review," Wang and Lou (1995) stated, "In China, there are about 99 species of bats (including 4 species endemic to Taiwan) belonging to 6 families, 29 genera, over 10% of the total number of species in the world." I question the validity of their statement and would like to offer some comments on the bats of Taiwan.

The systematics and biology of Taiwanese bats are poorly known, and most studies on Taiwanese bats were conducted by Japanese researchers during their occupation of Taiwan (Chen, 1984). A few western researchers (e.g., Jones, 1971; Jones et al., 1969a, 1969b, 1971; Linde, 1908) contributed to collections and the distribution records of some bat species early in this century and in the decades following World War II. Native Taiwanese biologists did not start research until the 1980s, and biologists from mainland China have not studied the Taiwanese bat fauna for nearly 50 years. Therefore, I assume the statement that there are four species of bats endemic to Taiwan is based on a literature search.

According to currently available literature, my own field surveys, and communications with Taiwanese biologists, there are 18 to 20 species of bats (depending on different taxonomic opinions) occurring on the main island of Taiwan and smaller offshore islands (Lee, 1994). About half are considered endemic, either at the specific or subspecific level. The five proposed endemic species are *Rhinolophus monoceros* (Taiwanese lesser horseshoe bat), *Hipposideros terasensis* (Taiwanese leaf-nosed bat), *Myotis taiwanensis* (Taiwanese myotis), *Plecotus taivanus* (Taiwanese long-eared bat), and *Murina puta* (Taiwanese tube-nosed bat) (Corbet and Hill, 1992; Koopman, 1993; Nowak, 1991; Yoshiyuki, 1991a, 1991b).

Although *R. monoceros* and *M. puta* are currently recognized as endemic species of Taiwan (Corbet and Hill, 1992; Nowak, 1991; Koopman, 1993), Yoshiyuki (1989) considered *M. puta* similar to *M. huttonii rubella*, and Koopman (1993) commented that *R. monoceros* may be a subspecies of *R. cornutus*. The status of the other three endemics also is controversial due to different taxonomic treatments. Yoshiyuki (1991a) treated *H. terasensis* as a distinct species, however it was considered indistinguishable from *H. armiger* (or *H. a. armiger*) by all other taxonomists. Yoshiyuki (1991b) described *P. taivanus* as a new species from Taiwan, but its status remained unconfirmed in Corbet and Hill (1992). In addition, Koopman (1993) considered *P. taivanus* similar to *P. puck* and *P. homochrous*, both of which were treated as synonyms of *P. auritus*. *M. taiwanensis* was recognized by Nowak (1991) but not confirmed by Corbet and Hill (1992) or Koopman (1993). The latter author considered *M. taiwanensis* as a subspecies (*M. adversus taiwanensis*). In summary, of the five proposed and/or listed endemic species of Taiwanese bats, only *M. puta* and *R. monoceros* appear to have been accepted as valid species. *P. taivanus* is likely a candidate for specific status, but further assessment is needed. The statuses of *H. terasensis* and *M. taiwanensis* are unclear. Currently, no conclusions about how many species of bats are endemic to Taiwan can be reached.

In addition, Wang and Lou (1995) apparently failed to recognize that Taiwan and mainland China are different, political entities. Any claim for including the endemic Taiwanese species in the fauna of China is analogous to including the species endemic to Malaysia in the fauna of Indonesia, which is inappropriate. My last comment is not an attempt to bring political issues into biology, and I apologize if I have made that impression.

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News from around the world

from American Somoa

Most of us manage to get to Central or South America, Europe, Australia, or even Africa at least once in our careers, but it is unlikely that many of us will have to opportunity to work in a truly isolated mid-ocean location for an extended period. Anne Brooke has been working in American Samoa and has offered to share her experiences of those islands with us. I hope you find her "travelogue" as fascinating as I have. Here in Anne's own words... GRHorst

American Samoa is a series of small islands in the South Pacific Ocean, in the middle of that big blank area on most maps. It is north of Fiji and Tonga, west of Tahiti, and east of the Solomon Islands. Our closest neighbor is the independent country of Western Samoa, about 50 miles away. American Samoa is physically and culturally closer to these other South Pacific nations than it is to America but as a United States Territory, we are linked with Hawaii, 2,000 miles to the north. Two weekly flights carry people and, most importantly, mail. The Government of American Samoa is basically autonomous although funded by the United States. The Territory consists of five volcanic islands and two atolls. The largest and most populated island, Tutuila, is about 30 miles long, and 6 miles across at the widest point. Within this short distance there are two 2,000 foot high eroded volcanic peaks. Most of the island is very, very steep. The humidity fluctuates between 80 -100% and the mountains trap winds which practially guarantee daily rain. The population is about 50,000(and is expected to double in 19 years) and the indigenous language is Samoan, a Polynesian language related to Hawaiian.

I work "upstairs in the forest". Getting into the forest is a vertical scramble, in some places there are ladders mounted into the hillside that get you started. Compared to Central America there isn't much wildlife but some of the animals that have managed to colonize these islands are incredibly beautiful. Multi-colored Fruit Doves and Purple Capped Fruit Pigeons are emerald green, golden and purple. Red and black Cardinal Honeyeaters are common in roadside flowers and shrubs. Long-tailed Tropic birds, Fairy Terns and Brown Noddies are constantly shuttling between the ocean and the forest where they lay eggs directly on branches or nest in ferns. Of course the flying foxes are the best.

The Samoan flying fox *Pteropus samoensis* looks like a flying triangular wedge as it soars. They catch updrafts from the valleys then glide for long distances over the ridges. They are one of the few bats that are active during the day although our radio-tracking that shows that the bats move more frequently and travel for longer distances at night. The other flying fox is the white-collared or Tongan bat *P. tonganus*. The two species differ in sociality and roosting habits: *P. tonganus* forms large colonies of several thousand individuals and roosts in 'harem' groups while *P. samoensis* roosts singly in the forest. Both species are hard to catch because they fly above the forest canopy and land in the canopy of trees. Bat populations declined in the 1980s with commercial hunting to supply market demand in Guam. After two devastating hurricanes in the early 1990s, the number of *P. tonganus* dropped to 1,500 from somewhere between 12,000-20,000. There are no good estimates for *P. samoensis* prior to the hurricanes because of the difficulty in distinguishing between the species. A hunting ban has helped the populations to recover but the law isn't enforced and people continue to hunt bats, but at a reduced rate. Few Samoans realize that there are two species. Currently the *P. tonganus* population is around 6,000, *P. samoensis* around 1,000 individuals.

"Downstairs at the ocean" there are few sandy beaches. Coral reefs fringe the island and extend out to deep water. Reef fish, lobsters, octopus, and a variety of invertebrates are gathered on the reefs for local consumption. Deep waters are fished for marlin, swordfish, and tuna. Two tuna canneries are major employers, second in importance only to the government. They give a very distinctive smell to the harbor area.

Christian missionaries have been very successful in Samoa and Christian religions of all kinds have proliferated. Early missionaries convinced the native people to wear clothing but didn't consider that fewer clothes in a hot climate is more comfortable. Women dress very modestly, a rude shock for me after working in Puerto Rico; I no longer wear shorts and tank tops. Only foreigners wear bathing suits, locals wear a T-shirt and shorts when swimming. For everyday use people wear a T-shirt and a lava lava, loud "Hawaiian" print fabric that's tied like a sarong.

A traditional Samoa house has a thatched roof and no walls. Palm leaves woven into small mats were used to protect people from wet weather. Modern houses are concrete adaptations of this simple plan. My house has concrete end walls and screening the length of the building. It's pleasant having ocean breezes blowing through the house and hearing birds in the morning, but you also hear everything the neighbors say. People are serious about lawn maintenance and weed-whackers seem to run constantly. If the sound of Samoa is a weed-whacker, the smell of Samoa is barbecue. Three dollars will buy a plate of bananas and grilled chicken legs or pork from a roadside vendor. My favorite is food cooked in an umu: fish wrapped in leaves, or whole pigs, along with breadfruit, taro, and bananas are placed on white-hot rocks then covered with a mound of banana leaves. The leaves seal in the heat, steam the food and flavor the food. But this is Sunday fare, what people eat during the week isn't as delectable; canned corned beef, turkey tails, lamb flaps, taro, and bananas. It would seem that they have picked up both the best and the worst of our more typical American customs.

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from Australia

Flying Fox Research in Sydney Australia. A few bat researchers with long memories may remember the *Pteropus poliocephalus* colony in the Sydney suburb of Gordon. The visit of researchers attending the 4th International Bat Research Conference in 1989 to the municipal council responsible for the site was an important factor in its subsequent designation as the 'Ku-ring-gai Flying-fox Reserve.

M. L. Augee (University of N.S.W.), the Ku-ring-gai Bat Colony Committee and the N.S.W. National Parks and Wildlife Service are carrying out a joint research program at the site. Maree Treadwell, a graduate student at U.N.S.W., is examining the effect of habitat variables on the situation of the colony in the valley and the reverse effect of the flying-fox colony on the habitat. A bush regeneration project has been underway for 10 years to remove invaders such as lantana and restore the native vegetation, especially trees suitable for roosts.

Hand-reared juvenile flying-foxes were radio-tracked in 1995(Bat Research News 36: 16-17). Transmitters glued to their backs allowed only a brief tracking period, but much better results have been achieved from tracking studies just completed using an expanding break-away collar similar to that described by T. E. Soderquist(Wildlife Research 20:383-386, 1993). Several flying-foxes were located many miles from the Gordon colony using a fixed wing National Parks aircraft fitted with tracking antennas. Tracking data is supplemented by weekly counts of flying-foxes as they fly out of the site, conducted by volunteers of the Ku-ring-gai Bat Colony Committee.

Related projects at the U.N.S.W. include a study of the functional anatomy of the palate of grey-headed flying-foxes by Anthea Thomas, and an examination of the possible nutritional benefits of leaf-eating by Lis Silva. Two published reports and local observations have shown that this species ingests leaves, surprisingly those from introduced trees such as poplars and from mangroves.

Submitted by M.L. Augee and Denise Ford, Biological Sciences, University of New South Wales, Sydney, 2052, Australia

from Cost Rica

Richard LaVal of Monteverde, Costa Rica is working part-time as instructor for an undergraduate level course, offered by the Council on International Educational Exchange, called Tropical Biology and Conservation. He also acts as advisor for students in the Education Abroad Program of the University of California. All students must do a major research project during the course and so far since 1992 seventeen have been completed on various aspects of bat ecology. He also gives bat slide lectures to 15-20 other groups of students annually, usually following up with a night of bat netting. In early March, 1997 he will help present a workshop on bats to educators from all over Costa Rica. He has been trying to catch a "Chupacabra" but has yet to see one.

more from Costa Rica

I am particularly interested in an article that came out about 2 years ago about marking bats with plastic neck collars and using colored beads. I am currently using this system. Dr. Rodrigo Medellin from Mexico and a student of his contacted me and advised me that I should cover the plastic collar with surgical rubber tubing. I have had good success with the system without the surgical rubber. I always put the collar on loose enough to avoid rubbing the neck. I have had more than 400 recaptures with no injury during 2 years of my study. It might be worth publishing an additional note about this marking technique. Kathryn Stoner, Interlink 826, P.O. Box 02-5635, Miami, FL 33102

Editor's note:

An invitation, a threat, and a promise (along with a little tongue-in-cheek)

We never seem to receive any news from our own local folks here in the U.S. and Canada, yet, when I meet you at meetings, conferences, talk to you on the phone, etc., you are all excited about what you have been doing, projects you are undertaking, grants (great and small) that you have received (and certainly told your Dean about). What's the big secret? Our colleagues around the world are interested in our current activities.

Perhaps, beginning next issue, I (and some of my more devious and creative colleagues who, cowardly as they are, refuse to identify themselves) might begin to write news releases about the more well-known among you. Unless, of course, we hear from you in the mean time with real news. We thought we would begin with the crew at the American Museum of Natural History, that hot-bed of mono- and di-phylogeny, Kunz' Kids in Boston, and to be fair, we haven't heard from the Fenton Family either for a long time. And what about what's his name in McCrackenville, Tennessee? And all those guys in Washington whose salaries we are paying? And where is Texas Tech anyway, and what about the Best down there in Troy, Alabama? Unlike the people who have agreed to invent the threatened aforementioned "news", I am not reluctant to sign my name to this, after all, I'm retired, what can I lose!

Seriously, write up a few lines or paragraphs and send them along to me. Others surely are interested in projects that you have in progress, or are planning. Do you have bight and enthusiastic new graduate students who have decided to join our ranks? Here is a good way to introduce them to their future colleagues. I recall reading a note some time ago about one of our colleagues who was planing a trip to the tropics, while at the same time I had an enthusiastic undergrauate student who wanted experience in the field. A brief note got the two of them connected, the student had a great field experience and is now in a Ph.D. program. Such opportunites are lost if people don't knows about them. So share a little information about your program, great or small, and lets make *Bat Research News* a little more "newsworthy."

The first person who sends me a news item for the next issue of Bat Research News (April) will receive a **free ticket to the banquet** at the Symposium in Tucson. All other contributers of news items will receive a **free drink at the reception.** So, let's hear from you. G. Roy Horst

RECENT LITERATURE

Authors are requested to send reprints of their papers to the Editor (Tom Griffiths, Dept. of Biology, Illinois Wesleyan Univ., Bloomington, IL. 61702-2900, U.S.A.) for inclusion in this section. If reprints are scarce, please send a complete citation (including complete name of journal and author's mailing address) to **tgriff@titan.iwu.edu** by e-mail. Receipt of reprints is preferred at it will facilitate complete and correct citation. Our Recent Literature section is based on several bibliographic sources and for obvious reasons can never be up-to-date. Any error or omission is inadvertent. Voluntary contributions for this section, especially from researchers outside the United States, are most welcome.

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Abstracts of Presentations at the 26th North American Symposium on Bat Research October 23 to 26, 1996 Illinois Wesleyan University, Bloominton, Illinois

Co-Hosts: Thomas A. Griffiths and Margaret A. Griffiths
Program Director: Thomas A. Griffiths

These abstracts are listed alphbetically by first author. Some abstracts had to be retyped, others edited slightly. Some authors requested minor changes and these have been added to the abstracts as published in the official program. Several authors made changes to their abstract at the meeting, and then sent the editor additional changes. In those confusing cases the original abstract is given here. Any changes leading to misconception or misinterpretation are unintentional and the responsibility of the editor. G.R. Horst

Growth and development of the calcar in the little brown bat, *Myotis lucifugus*

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With the use of cleared and stained (alcian blue, alizarin red) fetuses and juveniles, we documented development of the calcar in *Myotis lucifugus*. The calcar appears as an ovoid cartilaginous condensation early in skeletogenesis. As development continues, the calcar grows medial to the calcaneus in a sleeve of tissue along the trailing edge of the uropatagium. Development of an articulation surface between the calcar and the calcaneus forms a hinge-joint. The hinge-joint becomes calcified in utero and a core of calcification runs partly through the calcar's central axis. A re-curved, hook-like structure develops on the lateral edge of the calcar, remains cartilage, and is the point of insertion for the *m. depressor ossis styliformis*.

Mild hypothermia as a thermoregulatory strategy in phyllostomid bats

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The energetics and physiological ecology of thermoregulation of tropical bats are poorly understood. In captivity, bats of the Family Phyllostomidae seem to present a continuum of thermoregulation patterns ranging from strict normothermy to moderate thermolability but there are conflicting views regarding the role of facultative hypothermia as a thermoregulatory strategy. The purpose of this study was to determine whether mild hypothermia can represent a thermoregulatory strategy in some phyllostomid bats. We collected data from *Carollia perspicillata* and *Sturnira lilium* in the Guanacaste Province, Costa Rica, between February and April,1994. We first tested the conditions under which bats entered hypothermia in the laboratory when exposed to an ambient temperature of 21°C, which is within the normal range of environmental temperatures for both species. In those experiments, we found that there existed two distinct thermoregulatory patterns: bats either remained normothermic (T_b = 36.0 + 1.33°C, n = 17 for *C. perspicillata* and T_b = 35.9 + 1.33°C, n = 17 for *S. lilium*) or entered mild reversible hypothermia (T_b = 27.8 + 1.9°C, n = 13 for *C. perspicillata* and T_b = 27.6 + 2.2°C, n = 17 for *S. lilium*). For both species, body temperature was significantly correlated with mass and was independent of time in captivity. We also determined the relationship between oxygen consumption and body temperature at 21°C using 30 *C. perspicillata* and 14 *S. lilium*. Our results here suggest that bats of both species can spend close to half the energy required for normothermy when entering hypothermia.

Roosting behaviour and roost-site preference of forest dwelling California bats, *Myotis californicus*

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We followed 8 radio-tagged California bats to a total of 16 roosts in trees at two study sites in southern British Columbia. Individuals regularly switched roosts, moving at times over one km between roosts. Maternity colonies included up to 52 individuals although the number emerging from known roosts fluct-

uated widely from night to night. Discriminant function analysis showed that reproductive females (n=7) preferred trees higher above the canopy and with shorter neighboring trees than available trees in the immediate vicinity the roost. DBH and percent canopy closure significantly discriminated between roosts and available trees found in other areas of the same forest stand. Roost trees had significantly larger diameters and lower percent canopy closure than did available trees. Our results, combined with those of other recent studies, lead to the general hypothesis that forest-roosting bats of various species require a number of large dead trees of specific species, in specific (early) stages of decay, that project above the canopy in relatively open areas. For management and conservation reasons, this hypothesis should be evaluated for other species in other locations to test its generality. Roost switching also means that management must take a larger (landscape) view of bat roosting habitat than might have been expected based on information from bats roosting in buildings.

The importance of flower variation for nectarivorous bats and for fruit production

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Pollination systems which involve attracting and rewarding visitors to flowers to maximize reproductive success are considered to have involved co-evolution. Chiropterophilous plants are pollinated by bats and their patterns of flowering and structures of the flowers should ensure that bats visit as many flowers as possible, acquiring the greatest amounts of food for the lowest energy cost. The pressures exerted by bats are presumed to have influenced key features of the plants by affecting reproductive success. To determine if individual plants within a population vary in traits related to the attraction of pollinators and to determine the relationship between variation in flowers and fruit output, I studied one population of the bat pollinated tree *Caryocar brasiliense* (Caryocaraceae), in the Cerrado of Central Brazil. This plant is common and has large brushlike flowers positioned in racemous inflorescences of 10-25 buds. The flowering takes place from August to October (end of dry season to early wet season), and each flower lasts for one night. On any tree on any night there may be one to more than one hundred flowers. My field work was done in the flowering season of 1991, Each day in a 1 ha area, I assessed the numbers of flowers available, and the morphology of the flowers. I tagged 1928 flowers to determine the flower-fruit ratio. The flowers showed significant variation in mean nectar production rate and volume at anthesis and there was significant variation in the numbers of flowers available per plant. There was no evidence of a significant relationship between features of flowers and flowering and flower-fruit ratio. The evidence suggests that the bats which pollinate *C. brasiliense* (*Glossophaea soricina, Anoura geoffroyi, Carollia perspicillata* and *Phyllostomus discolor*) do not exert a strong stabilizing pressure on plant attributes. The variety of pollinators by size, energetic demand and behaviour, did not support an obvious optimum strategy for the plant.

An unusual *Myotis sodalis* nursery colony in Ohio

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The first maternity colony (and consequently breeding record) of the endangered Indiana Bat *Myotis sodalis* in Ohio was discovered about 60 km northeast of Cincinnati in early July, 1996. The colony was located in a recently dead maple tree, 20 m tall, species unknown, that was cut down to avoid hitting a house. Large slabs of peeling bark provided at least two roosting space out 5 and 10 m above the ground. The tree was in an upland woodlot characterized by varied maples and shagbark hickories. Fields surround the woodlot, which is divided into residential lots. There is no visible water in the area although what had been described as "classic" Indiana Bat foraging habitat occurs within about 8 km of the site. A recently dead lactating female and 33 non-volent juveniles, all of which were weighed and measured, were retrieved by the property owner after the tree fell. No adult bats were seen to exit the tree at that time. The property owner allowed a man-made bat house to be placed on a tree about 5 m from the fallen maple to serve as temporary housing for the juveniles (16 male, 17 female) whose weights varied from 2.5 to 5.8 g and forearm measurements from 16 to 35 mm. Shortly after dusk, all the juveniles, which were vocalizing audibly, were placed in the bat house. Almost immediately adult bats began circular flights around the tree on which the bat house had been placed. They "buzzed" around and landed on the person replacing the young, the holding cage in which the young were contained, and the bat house. Larger young attempted to

fly out of the house and were retrieved and placed on the fallen maple, at which time flying bats landed on that as well. The site was re-visited on several days and evenings after the roost was destroyed and only 2 dead juveniles were found in the bat house. No subsequent traces of the bats were found until mid-August when 15 bats, presumed to be *M. sodalis*, were observed flying from beneath the bark of another dead tree, about 20 m from the original roost.

Microclimate in Hell's Canyon mines used by *Myotis yumanensis* for maternity colonies

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The Hell's Canyon of the Snake River has a long history of mining and homesteading. At least 46 of the more than 100 mines and caves and numerous old buildings show signs of bat use. Three mines contain maternity colonies of *Myotis yumanensis* even though the latitude is higher than the predicted limit for maternity colonies of small, warm temperate bats. Prior to the arrival of the bats in 1995 and 1996, data loggers with temperature, relative humidity, and air flow sensors were placed in these three mines and two mines lacking maternity colonies. *M. yumanensis* seems to choose mines that have higher and more constant ambient temperatures and relative humidities than found in mines they don't use. By roosting in large, tight clusters in domed areas, the bats are able to raise T_a more than 20°C. A small cluster raised T_a, a lesser amount. Temperatures at the roost sites drop significantly when adults leave during the first evening foraging period, but still remain higher than ambient. These mines are probably critical habitat for *M. yumanensis* in this area. In addition to the natural deterrents currently present in these mines, further protection during presence of maternity colonies may become necessary in the future.

Radiotelemetry of Indiana bats at the Indianapolis International Airport

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Approximately 67.4 hectares of forested land was affected by runway development at the Indianapolis International Airport. 3D/International, Inc., Environmental Group completed a biological assessment to evaluate effects of the action, and comply with the Endangered Species Act. Impact mitigation required in the Incidental Take Statement issued by the U. S. Fish and Wildlife Service included 5 years of radio-telemetry studies of federally endangered Indiana bats *Myotis sodalis*. In 1995, radio-transmitters were attached to 7 adult Indiana bats (5 female: 1 male: 1 juvenile). Foraging locations were identified for 5 bats (3 females: 1 male: 1 juvenile), and roost locations were documented for 6 bats. We defined the size of home ranges based on 30 to 137 triangulation fixes. Home range sizes were 684 ha (pregnant female) to 918 ha juvenile male). The distance from roosts to the center of foraging activity ranged between 0 and 3.7 km. Bats were documented a maximum of 4.6 km from known roosts. Between 55% and 59% of each home range was agricultural land. Forest made up between 11 to 16% of each home range. Each bat roosted south, and traveled north, of a 4-lane interstate highway. We observed this behavior frequently. Roosts included 4 types of artificial roost structures, a shellbark hickory, *Carya laciniosa*, American elm, *Ulmus americana*, and other trees. This study will continue through 1999. Information gained will be useful in developing management strategies for this species.

Human odor detection as a probe into the chemical ecology of bats

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Most mammals gather information about their environment using a combination of visual, auditory and olfactory cues. Because bats are nocturnal and highly social animals, chemical cues are likely to play a vital role in their communication. Several studies have explored the role of olfactory communication in the Chiroptera, but little attention has focused on specific chemical cues or their behavioral significance. Because there is evidence for convergence in odor receptor-proteins and olfactory neural organization in animals ranging from insects to mammals, the use of human chemical detection provides a valuable probe to investigate aspects of chemical ecology and phylogeny. Using gas chromatography olfactometry, we analyzed air samples to characterize the chemical nature of the odors present at maternity sites of Mexican

free-tailed bat *Tadarida brasiliensis*. Analysis of scents collected from other bat species indicate species-specific signatures exist. The use of behavioral assays coupled with gas chromatography olfactometry offers enormous potential for the study of phylogeny, behavior and ecology of bats.

Ecology of the southern blossom bat in Papua New Guinea: Use of habitat and resources

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Thirteen southern blossom bats, *Syconycteris australis* (Pteropodidae), fitted with radio-transmitters were monitered for up to 30 days at Kau Wildlife Area, Madang Province, Papua New Guinea. Though gardens and successional forest were used for foraging movements, this bat preferred subcanopy trees in old growth forest for day roosts. All individuals showed fidelity to their dayroost areas and were solitary with no overlap in individual roost areas. Foraging began 15 minutes after sunset, and although activity was intermittent, continued until sunrise. Mean cumulative flight time occupied 45% of the night. These bats selectively foraged in large light gaps within old forest, riparian vegetation, and in old or active gardens. They fed on fruits, nectar and pollen at Kau. Seeds with highest frequency in feces were from an introduced shrub, *Piper aduncum*, and native *Ficus* species. Flowers of native bananas in forest gaps or domestic bananas in forest gaps or domestic bananas in gardens were also important food resources. Individuals used multiple food patches within a night, had stereotyped movements between patches on successive nights, and shifted to new feeding patches as ephemeral fruit or flower production ceased at a previous patch.

Pelvic vascularization of the common noctule, *Nyctalus noctula*

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The arteries of *Nyctalus noctula* (Schreber, 1774) were injected with a solution of gouache and gelatine; the abdominal cavity was dissected and fixed with 4% formaldehyde. The dorsal aorta propagates paired ovarian or testicular arteries and the posterior hemorrhoidal artery. Subsequently it divides into paired external and internal iliacs and the coccygeal artery, which extends towards the ventral part of the tail. The external iliac produces the anterior urogenital artery (in females), branches to the muscular wall of the body, and the external pudendal artery, continuing along the limb as the femoral artery. The internal iliac produces the posterior urogenital and internal pudendal arteries, branches to the pelvic muscles and tail, and, further on, carries blood to the uropatagium. The veins basically follow the arteries in topography, except for those of the reproductive tract. Intersexual differences were found in the vascularization of the genitalia. Pelvic vascularization and of *N. noctula* is basically similar with that of *Myotis lucifugus*, as described by Kallen (1977; in: Biology of Bats, W.A.Wimsatt, Ed.,Vol. III, NY), differing from it in four minor traits.

Social interactions and communication in the molossid *Chaerephon pumila*.

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Bats, by their nature, are very difficult to observe and the roosts they occupy contribute to the problem, often making it impossible to do direct observations. Therefore, many aspects of bat social behavior are still largely unknown.*Chaerephon pumila*, the little free-tailed bat,is an African molossid that can reproduce three(possibly up to five) times a year with females experiencing postpartum oestrus. Males and females of all ages roost together throughout the year making them an ideal subject for a study of social interactions and communication. A small colony of *C. pumila* (n=10 and increasing), caught in South Africa, has been held captive since May 1,1996. I observed the bats by a remote camera, infrared illuminator and a time-lapse VCR. Two 24 hours tapes are made weekly and the analysis is concerned with activity budget and quantitative description of social interactions. Recordings have been used to create ethograms of different social interactions, including roost entry, hierarchy establishment, mating and mother-infant relationship. The role of the males' crest and the effect of male dominance on the weight of other males will be discussed. Bats' vocalizations accompanying different behavior and interaction have also been recorded and

analysed using a broad band bat detector(USA S200) and Canary® software. These preliminary data will allow us to shed some light on the behaviors exhibited by *C. pumila* within the roost and on the type of signals the bats are transmitting and receiving in their everyday life.

Forest habitat use between and within two guilds of insectivorous bats

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Studies have been conducted examining the roosting and foraging habits of forest bats such that a general pattern of forest use has been described. Foraging bats appear to prefer uncluttered areas such as edges, gaps or over water, and roosting preferences appear to be large, recently dead trees. I further examined these trends in the interior wet-belt forest of British Columbia. This region falls within the range of eight bat species including *Myotis evotis* and *M. septentrionalis*, a red-listed bat in B.C. (The B.C. red-list consists of species which are flagged as those to be considered for the endangered species list). These two species can be distinguished from the other *Myotis* species present by the length of their ears and their ability to glean. This strategy allows them to forage in the forest understory effectively and thus exploit a separate range of insect prey. I analyzed fecal samples of four *Myotis* species, the two long-eared and two non-gleaning species. Within the gleaning species, competition for roost sites could influence the interaction and distribution of these species. I placed radio transmitters on both *M. evotis* and *M. septentrionalis* to find day roost sites. Preliminary examination suggests that although the choice of roost tree is similar, the forest stand characteristics differ. *M. septentrionalis* appeared to favor old-growth cedar-hemlock forest with many large diameter trees and little or no understory, whereas *M. evotis* was more variable in the age and clutter of the forest stands it used. Overall, examining the use of the forest environment by the *Myotis* species allows us to clarify which aspects are key for bat conservation, particularly the red-listed *M. septentrionalis*.

Ecology and behavior of the Indiana bat along the Raisin River: Preliminary observations

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This report describes the first year of a multiyear study concerning the roosting habits of the endangered Indiana bat *Myotis sodalis* along the Raisin River, in Washtenaw and Jackson counties, Michigan. The purpose of the study was to discover new roosting localities in the state and to further document the roosting requirements of this species on the northern edge of its maternity range. Fourteen roost trees were discovered. These included 1 cottonwood *Populus deltoides*, 6 silver maple *Acer saccharinum*, 3 green ash *Fraxinus pennslyvanica*, and 4 black ash *F. nigra* ; this is the first report of Indiana bats using black ash. Average DBH was 36.9 +/- 7.5 (SE) cm, and average height was 14.9 +/- 1.3 m. Most trees were in exposed situations and received direct sunlight for more than 50% of the day. The roost tree used by the largest number of bats was totally exposed to the sun and lacked exfoliating bark; this tree had been snapped by a tornado, and the bats were roosting in a crevice near the top of the remaining trunk. Individual bats used from one to four different trees, switching roosts every 2-3 days. Although alternate roosts were generally within 50-60 m of each other, one roost was 5 km from its nearest neighbor and 6 km from the most distant roost used by any bat during the study.

Summer roosting habits of *Myotis evotis, M. volans,* and *M. thysanodes* in pinyon-juniper woodlands of New Mexico

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Of the 26 bat species that may be found in New Mexico, two are federally endangered and 13 are species of concern, (formerly U.S.F.W.S. Category 2 Candidates). Little is known of the roosting habits of three species of concern *Myotis evotis*, *M. volans*, and *M. thysanodes*, in pinyon-jumper woodlands, one of the largest ecosystems in the Southwest. During the summers of 1995 and 1996, roost use by females of these species was studied in pinyon-juniper woodlands of the Cibola National Forest in central New Mexico. Forty-three pregnant or lactating females (18*M. evotis*, 13*M. volans*, and 12*M. thysanodes*) were radio-tagged and tracked to their day roosts. Once found, characteristics of the roost and the immediate area were recorded. Thirty seven bats were relocated, leading us to 74 unique roosts (12 colonies and 62

solitary roosts). *M. evotis* typically roosted alone with their young, occasionally formed small groups, and frequently changed roosts which were primarily junipers (*Juniperus monosperma* or *J. deppeana*). *M. volans* and *M. thysanodes* exhibited greater fidelity to their larger colony roosts. Colony roosts were primarily ponderosa pine trees (live and dead) with lightning or wind damage. *M. volans* not roosting colonially were often found under the sloughing bark of pinyon snags or wedged in crevices of junipers.

The use of microsatellites in *Pteropus* captive breeding programs

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Many *Pteropus* species have experienced drastic population decreases necessitating captive breeding programs to prevent extinction. Special precautions must be taken with these colonies to preclude inbreeding and conserve remaining genetic diversity. Microsatellite markers have proven amenable to this task. Microsatellites consist of random repeats of short nucleotide motifs which provide good codominant markers. Four variable microsatellite loci have been identified that function for all *Pteropus* species examined to date(*P. hypomelanus*, *P. rodricensis*, and *P. pumilus*). T hese loci exhibit abundant variation. For example, 14 different alleles were observed in only 23 *P. pumilus*). The captive colony of *P. rodricensis*, despite its certain history of inbreeding, displays considerable microsatellite variation. These high levels of variation allow the matching of mother/pup genotypes and the identification of paternal gene contributions to the pup. Because suites of potential sires are known for the Lubee Foundation captive colonies, large percentages of potential fathers have been excluded from paternity in every case examined. In some cases all males were eliminated except the father of the pup.

Noctilio leporinus feeds upon crustacea as well as upon insects and fish in Trinidad

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Fresh fecal samples were taken from a day roost of the fishing bat *Noctilio leporinus* in Cedros, Trinidad early in the rainy season, using a fiberglass sheet held in the tree cavity beneath the bats. The droppings were collected in plastic bags, preserved with alcohol and examined with a microscope. Three colors of droppings corresponded to three different predominate types of remains: silvery droppings contained mainly fish scales, crustacean remains dominated in yellow to orange droppings, and brown droppings had primarily insect remains. Crustacean exoskeletal fragments were differentiated from those of insects because they were calcified and reacted with acid. These results suggest that the diet of these bats is more diverse than previously known, for they evidently fed not only upon the fish and insects in nearby marine and freshwater habitats, but upon crustacea as well.

Are fruit bats nitrogen constrained?

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Nitrogen limitation has been invoked to explain why specialized frugivorous bats ingest nitrogen-rich supplements in the form of pollen or leaves, and why pteropodid bats are forced to over-ingest energy on all -fruit diets. Although we know that frugivorous bats incorporate nitrogen-rich supplements into their diet, the key questions are 1) are they forced to supplement their diets with nitrogen-rich food because they are unable to meet nitrogen requirements, and 2) do they have to over-consume energy in order to meet their nitrogen requirements? We directly address these questions by measuring the nitrogen and energy requirements in adult *Carollia perspicillata*, *Artibeus jamaicensis* and *Rousettus aegyptiacus*. Experimental feeding trials were performed and daily fecal material were collected for the determination of the maintenance nitrogen and energy requirements, dry matter digestibility, metabolizable energy coefficient, apparent and true nitrogen digestibilities, metabolic fecal nitrogen, and endogenous urinary nitrogen. Our research has shown that the non-reproductive phyllostomid bats, *C. perspicillata*, and *A. jamaicensis* and the non -reproductive pteropodid bat, *R. aegyptiacus* are able to meet their nitrogen requirements without resorting to folivory and without incurring an over-ingestion of energy on most fruits. Very low metabolic fecal nitrogen allows fruit bats to survive on low nitrogen diets.

The North American bats and mines project: New industry partnerships create habitat for mine-roosting bats

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The North American Bats and Mines Project is a partnership effort between Bat Conservation International and the Bureau of Land Management founded to minimize the loss of mine-roosting bat populations during mine land reclamation. The Project is providing national leadership, training, and coordination among public and private agencies and organizations responsible for wildlife and mine land management. The project has already taught mine assessment and bat conservation skills to more than 500 natural resource managers from across the United States and Canada, published a handbook on bat conservation and mine land management distributed nationwide, presented technical papers on bat conservation and mine land reclamation to thousands of resource managers at national mining and wildlife conferences, and collaborated with numerous state, federal, and private agencies and organizations to protect some of the largest and most threatened bat colonies in North America. While tremendous progress has been made in halting the destruction of millions of bats and their habitat on public lands, it soon became apparent that private industry lands were also vital to the future of mine and cave roosting bats. Many of the largest and most complex mines, which often harbor the largest bat colonies, are sites that are now owned by mining companies. Because of safety, these sites are often sealed, and many are destroyed during renewed mining in historic mining districts. Our new initiative, Mining for Habitat, is working with mining industry partners, such as WHC members Monsanto and the Unimin Corporation, to prevent the listing of additional endangered species by developing proactive bat conservation and management plans, and even creating artificial underground bat roosts during mine reclamation.

Relationships within the New World emballonurids and hypotheses concerning the origins of their ecology an behaviour

Jenna M. Dunlop, York University, North York, ON

Phylogenetic analyses are hypotheses of evolutionary relationships within any given group, however they also serve as a framework from which to investigate the influences of current selection pressure versus historical constraints on organisms within that group. The ecology and behaviour of bats have not been addressed in a macroevolutionary context. In order to examine the effects of current selection and common phylogenetic history on the ecology and behaviour of Chiroptera, I am examining the behaviour and ecology of New World emballonurid bats and comparing that information to a phylogenetic hypothesis of relationships within this branch of the family Emballonuridae. Several phylogenetic analyses of the Emballonuridae, based on different types of data have failed to unambiguously resolve the evolutionary relationships of the group. Examination of cranial morphology, external skin characteristics and scapular and humeral morphology should resolve the relationships within the New World genera. Observations of emballonurids in day roosts will be added to the morphological data, and will allow hypotheses of the origin of behaviour and ecology of this group and also indicate the mechanisms of maintenance of these different traits.

The hunt for airborne prey: How bats make ends meet

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It is becoming increasingly clear that energy often is not the currency that limits the success of bats. Data from three species demonstrate that a combination of behaviour (roosting and foraging) and physiology can maximize the chances of insectivorous bats achieving a positive energy balance. Radio-tracking of *Lasiurus cinereus* has demonstrated how the bats use three strategies to maximize their energetic return, namely: the exploitation of concentrations of prey, switching foraging areas, and the use of torpor. A comparison of the reproductive output of *Myotis lucifugus* in two years of different weather shows how selection of roosts and foraging behaviour can minimize this species' vulnerability to inclement weather conditions. Radio-tracking studies of *Molossus ater* suggest that efficient, low cost flight combined with heterothermy and high foraging efficiency, translate into very short foraging times.

Relocating Central Florida bats: Can it be done?

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Attempts to physically relocate bats from buildings to bat houses have met with limited success. Most successful attempts involve bat houses placed directly on the building that housed the original roost. Two experiments in central Florida have added optimism to the problem of removing bats from buildings. In one experiment a mixed colony of *Tadarida brasiliensis cynocephala* and *Nycticeius humeralis* were evicted from a community college in Sanford, FL, and relocated to a set of bat houses 1/4 mile from the original roost. The other experiment involved moving a bat house, occupied by a maternity colony of both species, 5 miles from the original site. Methods involved, results, and thoughts for future work will be discussed.

Annual population cycle of *Leptonycteris curasoae* (Phyllostomidae) at a roost in Chamela Bay, Jalisco, Mexico

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We estimated population size and sex ratio and recorded mass, fat levels, and reproductive condition of adults of *Leptonycteris curasoae* living in a sea cave in Chamela Bay, Jalisco, Mexico, 10 times between October 1992 and February, 1994. We used carbon and nitrogen stable isotope techniques to determine the general diet of this plant-visiting bat in 1993-94. Roost size in 1993 varied from about 5,000 individuals in March to 75,000 in November. Females were uncommon or absent from the roost in March through September. Beginning in July, many males and females migrated to the roost and left the roost in December. Some females migrate to the Sonoran Desert to form maternity colonies in the spring. Testis size in males increased markedly in October through December, which we postulate is a mating period in this roost. Bats were lean in April and June (dry season) and fat in October and November (end of wet season). Stable isotope analysis revealed that bats fed primarily at non-succulent (C3) plants throughout the year; nitrogen values were higher in the wet season than in the dry season. From a review of data on other roosts of *L. curasoae*, we conclude that most roosts fluctuate in size and sexual composition seasonally. We also postulate that two reproductive populations of females exist in Mexico -- a 'spring birth' population and a 'winter birth' population. Seasonal fluctuations in roost size mean that the timing of roost visits is critical for assessing the population status of this federally endangered bat.

Phylogeny and adaptive radiation in phyllostomid bats

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No family of mammals has undergone greater adaptive radiation than phyllostomid bats. The rest of the microchiropterans, which are overwhelmingly insectivorous, have remained churning in a relatively small eco-morphological space. Phyllostomids have escaped this space along four avenues. Extremes of these lines are bats like *Musonycteris* with its greatly elongated rostrum; *Centurio* with its highly abbreviated rostrum; *Desmodus* with its highly modified blood-feeding teeth; and *Vampyrum*, the giant of the phyllostomids. My analysis of both the phylogenetic information and morphological data indicate that ancestral phyllostomid morphologies remain extant and are living fossils to show how this adaptive radiation took place. Phyllostomids at the ancestral center are abundant morphological and ecological generalists. Extremes, with the exception of the common vampire bat, are morphological and ecological specialists and are usually rare.

Evaluation of bat diversity in New Mexico using the AnaBat detector.

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Surveys of bats are burdened by problems of sampling bias. Mist nets and harp traps are mechanical techniques commonly used for assessing bat diversity. The efficacy of the AnaBatII bat detector and analysis system for use as an inventory tool is becoming more and more accepted among biologists as these acoustic "traps" become more commonly employed in bat surveys. We have been using the ANA-

BAT II bat detector in New Mexico for the past three years completing both summer and winter surveys. It is true that more species are detected using the acoustic detector than nets or harp traps alone. However, both the mechanical and the acoustical techniques should be used simultaneously in order to more greatly assess bat diversity; some bats are only located by netting, such as *Corynorhinus townsendii*, while others, such as *Tadarida brasiliensis*, are more commonly found acoustically. We report on nearly 50 mechanically and acoustically surveyed sites throughout New Mexico and compare the abilities of these two methods in determining bat species diversity.

Temporal variation in movement patterns of adult female *Myotis grisescens*

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In 1993 and 1994, radio-telemetry was used to record patterns of movement of female gray bats *Myotis grisescens* throughout their annual period of activity. Movement patterns were used to determine variation in foraging patterns. Each year, from April to September, ≤ 10 bats per month were equipped with radiotransmitters. Radio signals were monitored from sites along the Guntersville Reservoir in northeastern Alabama. Effect of reproductive status on movement patterns of bats was investigated. Activity of female gray bats inside a maternity cave, inside a non-maternity cave, and outside caves was compared among months. Movement patterns of bats changed throughout the period of activity. Considerable variation was observed in movement patterns of individuals and among individuals. Gray bats arrived at the maternity colony after 9 April. Bats were detected for the longest periods of time outside caves in May, during pregnancy. During lactation in June and July, radio-equipped gray bats did not spend more time foraging than in May. However, bats flew farther in July than in September, suggesting they were foraging more selectively during lactation than during post-lactation. After young were volant in August, female gray bats did not fly greater distances than during lactation or pregnancy. Time spent by adult females inside a non-maternity cave did not increase after young were weaned.

The distribution of four endangered bat species in Illinois

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Four bat species, *Myotis sodalis* (Indiana bat), *M. grisescens* (gray bat), *M. austroriparius* (southeastern myotis), and *Plecotus rafinesquii* (Rafinesque's big-eared bat) are listed as endangered in Illinois. Since 1985, mist-netting at 191 surface sites and surveys of numerous caves and mines have provided information on the current distribution of these species. The Indiana bat has been found in 22 counties throughout the southern three-fourths of Illinois during the summers, whereas the other three species are limited to the southernmost portion of the state. Indiana bat nursery colonies were located in 16 counties and the first maternity colony of southeastern bats in Illinois was discovered at Little Black Slough in Johnson County. The summer distribution and known hibernation sites for all four species will be presented and gaps in existing knowledge about these species will be identified.

Distribution and roost selection of bats in a undisturbed native short-grass prairie

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The grassland prairie is one of the largest biomes in North America, but virtually nothing is known about prairie bats. The prairie ecosystem is also one of the habitats most impacted by human development both agricultural and industrial. Understanding the ecology of bats in a native prairie, is one key to assessing the impacts of modern technology on prairie bat populations. I studied bat habitat selection on Suffield Army Base, Alberta, one of the largest tracts of undisturbed native short-grass prairie. The most abundant species was the Western small-footed bat, *M. ciliolabrum*, with long-eared (*M. evotis*), big brown(*Eptesicus fuscus*), and little brown bats(*M. lucifugus*) relatively common. Hoary bats (*Lasiurus cinereus*) appeared to be rare. The riparian habitat along the South Saskatchewan River was the most important habitat for bats. All species were rarely heard on the open prairies, but appeared to spend most of their time foraging over the open water, and back in the coulees of the river valley. Bat captures and foraging activities were most abundant in areas along the river where the coulees were steep and extensive.

I placed transmitters on five female bats: three *M. ciliolabrum*, *M. evotis*, and *M. lucifugus*. All individuals roosted during the day in the cliffs along the river valley and roosted in small crevices, usually on steep inclines. One *M. ciliolabrum* roost was found in a cave extending into the vertical cliff face. All individuals were colonial. *M. evotis* and *M. ciliolabrum* had relatively small colonies, with usually 5 -10 bats seen emerging from each roost. *M. lucifugus* had larger colonies, with 20-45 bats seen emerging at dusk. Four of five bats with transmitters did not return to the same roost every morning, but returned to a roost in the same area, less than 200 m away. Small opening size for crevices used for day roosting was consistently found for all individuals. As well, individuals of all three species were observed using caves as night roosts.

Milk intake and milk composition of *Eptesicus fuscus* in New England

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Female bats invest heavily in the postpartum nourishment of their offspring. The production of milk is generally considered the most costly aspect of mammalian reproduction and thus, its requirements are likely to have an important influence on life history strategies and reproductive success. Most studies that have examined the nutritional requirements of female mammals and their young during lactation have focused on the energy or caloric needs of females and the proximal composition of their milk. Few studies have examined the possibility that nutritional factors other than milk energy may limit the growth rate in young bats. Additionally, all studies examining milk intake and milk composition of Eptesicus fuscus lack adequate sample sizes. Therefore variation in these parameters over the course of lactation were not examined. Mineral composition of milk has been determined for few species and only one uniparous insectivorous bat, *Tadarida brasiliensis*. Milk calcium in *Tadarida* was found to be higher than that predicted for their diet. Calcium is required for full development and calcification of wing bones and thus is vital to the growth of young, flight, and foraging efficiency. Nutritional calcium in milk is generally found associated with the milk protein casein. Casein coagulates within the stomach of neonates where it is slowly degraded by digestive enzymes. This mode of slow calcium release may improve its utilization. Yet, despite the potential importance of milk casein for growth and development in bats, only one study to date has examined casein concentration. This study also neglected to examine changes over the course of lactation. This study examines milk composition and milk intake by *Eptesicus fuscus* in New England, where this species regularly produces twins. Milk lipid, carbohydrate, and protein, including casein, as well as several minerals, including calcium, are examined over the course of lactation. These values are compared to other species of bats and non-volant mammals. Milk intake is also examined throughout lactation with special attention paid to variation in intake between siblings and sexes. Preliminary results on digestive efficiency by pups and adults will also be presented. Future research will compare these results, as well as diet and growth rates, to regions where *Eptesicus* only produces one young per reproductive season.

Bat activity in managed and unmanaged forests in the Pacific Northwest.

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One of the objectives of management within the Late Successional Reserves proposed in current forest management plans in the Pacific Northwest is to manage younger forests for development of older-forest characteristics. Thinning is one silvicultural tool that can be used to accelerate development of older-forest characteristics in younger stands.We used automated ultrasonic detectors to compare bat activity among thinned, unthinned, and old-growth stands in 11 sites in the Oregon Coast Range during the summers of 1994 and 1995. Each site consisted of a 50 to 100-year-old forest stand that has been thinned, an adjacent unthinned stand, and a nearby old-growth (200+ year-old) stand. We measured selected vegetation and environmental variables in conjunction with bat activity. Bat activity, as measured by the number of bat passes per two-night sampling period, differed significantly among stand types ($p = 0.05$), and tended to be higher in old growth than in younger stands ($p = 0.08$) and higher in thinned than in unthinned stands ($p = 0.071$). Vegetation structure, including tree diameters, tree densities, and shrub cover, varied between old-growth and younger stands and between thinned and unthinned stands. There were significant correlations

between bat activity and percent shrub cover and distance from the detector to a canopy gap. These results suggest that bats are responding to stand structure, although more work is needed to determine which components of stand structure are most important to different species of bats. Thinning seems to hold promise for creating structure in stands which would be suitable for some species of bats.

Food habits of *Corynorhinus rafinesquii* in Southeastern Kentucky

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The diet of Rafinesque's big-eared bat *Corynorhinus rafinesquii* was determined from 94 fecal pellets and 86 culled moth wings collected from 4 roosts and 5 feeding shelters in southeastern Kentucky in 1995. Fecal pellets and culled moth wings were obtained from roosts during a biennial hibernacula census, and additional culled wings were recovered from feeding shelters in June and October. Emergence counts and the biennial hibernacula census revealed that 2 roosts were used as maternity sites and hibernacula, and 1 roost as a non-maternity site and hibernaculum; the remaining roost received sporadic use in summer and winter. Seven orders of insects were consumed, with Lepidoptera occurring at over 90% volume and at 100% frequency in all fecal samples, indicating that *C. rafinesquii* is a moth specialist. Seven species of moths from 5 families (Arctiidae, n = 1; Geometridae, n = 1; Noctuidae, n = 37; Notodontidae, n = 1; Sphingidae, n = 45) were identified from culled wings. The average wingspan of the moth species was 45.4 mm (SD = 8.4). This and other studies suggest that *Corynorhinus spp.* prey primarily upon moths ranging in size from 31 to 57 mm.

Conservation Ecology and Population Genetics of *Pteropus rufus*: Preliminary Results as Revealed by the RAPD Technique

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The Madagascar flying-fox *Pteropus rufus* is the sole representative of its genus on the island of Madagascar. Although this species is generally considered to be high in numbers, a reanalysis of historical data on its distribution and abundance suggests that *P. rufus* is, in fact, on the decline. While it is very likely that commerce between roosts of bats obtains in the few remaining large tracts of forest, these tracts are rapidly disappearing. Moreover, as the fragmentation of Madagascar's forests continues, the geographic and genetic isolation of the bat sub-populations will undoubtedly increase. To assess the effects of isolation on populations of *P. rufus*, DNA samples from specimens captured at five geographically or ecologically distinct localities were analyzed using the RAPD technique. The implications of geographic isolation and genetic diversity for the conservation of this species will be discussed.

Emergence behaviour of the Azorean bat *Nyctalus azoreum*

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The Azorean bat *Nyctalus azoreum* is the only bat species found on the Azores archipelago in the mid-Atlantic. It closely resembles but is morphologically distinct from Leislers bat *N. leisleri* which is found throughout continental Europe. The Azores archipelago has no diurnal or nocturnal raptorial birds that are likely to prey upon bats, although there is a large species of hawk *Buteo buteo* common throughout the islands. The bat has extensive diurnal activity, which has been attributed to the absence of predation risk in the day. We observed emergences of bats from roosts in the town of San Antonio on Pico to test the hypothesis that clustering behaviour of emerging bats is an anti-predatory response. We hypothesized that if predation was the cause of clustering, then Azorean bats, in the absence of predation, would not cluster during emergences. We found that the extent of clustering was related to the numbers of emerging bats and that taking size of emergence into account Azorean bats clustered just as much as pipistrelle bats in the United Kingdom. Two alternative interpretations of these data are possible. First, we could reject the hypothesis that the behaviour is an anti-predatory device. Alternatively, it might be argued that the key

factor precipitating clustering during emergence is not the risk from aerial predators which are absent, but terrestrial based predators, such as rats and cats, both of which were common around day roost sites, and are known to take emerging bats at other roosts.

Effects of a fruit bat on the seeds of a pioneer plant: A case study from Northeastern Argentina

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If a pioneer plant were asked to state the three most important requirements for its seed disperser, it would list as follows; (1) that the disperser not destroy the seeds while dispersing; (2) that the disperser visit secondary forests; and (3) that the disperser increase the probability of germination on its seeds. By following the stated requirements I present data that supports all three of these requirements. By direct examination of the samples I evaluate whether *Sturnira lilium* was damaging seeds of *Solanum riparium.* In addition, capture data was analyzed to decide if *Sturnira lilium* frequents disturbed areas and by comparing percent germination of ingested and uningested seeds I estimate if *S. lilium* affects the physiology of the seeds of *Solanum riparium.* Results suggest that (1) *Sturnira lilium* does not prey upon seeds of *Solanum riparium*; (2) *Sturnira lilium* visits disturbed areas more than any other captured bat species; and (3) dispersal by *Sturnira lilium* may increase germination of *Solanum riparium* seeds by as much as 20 percent.

Phylogenetic relationships of "Phyllostomine" bats: Results of an analysis using a dense-sampling approach

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Phyllostominae (as traditionally defined) is a large subfamily of phyllostomid bats whose members feed on insects, fruit, and small vertebrates. These bats are generally believed to represent the most basal branches of the phyllostomid radiation, but relationships between these taxa are poorly understood. Efforts to resolve relationships among subfamilies and genera of phyllostomids have been hampered by lack of resolution in the "phyllostomine" part of the tree. While most systematists agree that Phyllostomine is not monophyletic, there is no consensus on how to subdivide the group. This may have resulted (at least in part) from incomplete sampling in previous studies and use of exemplar species to represent diverse genera. To address this problem, we adopted a dense-sampling approach. Members of all 36 phyllostomine species were examined and scored for over 150 characters including features of the skull, dentition, tongue, postcranial skeleton, and pelage. Data from the hyoid apparatus, brain, reproductive tracts, and rDNA restriction sites were gathered from the literature. In addition to phyllostomines, members of two outgroups (Noctilionidae and Mormoopidae) and 13 species from other phyllostomid subfamilies were included to test monophyly of Phyllostominae and other higher-level groups. Preliminary results of parsimony analyses suggest that: [1] all currently recognized phyllostomine genera are monophyletic except *Micronycteris* (which contains *Macrotus*) and *Mimon* (which is paraphyletic; [2] *Macrophyllum* and *Lonchorhina* and sister taxa; [3] *Phylloderma* and *Phyllostomus* are sister taxa; [4] *Vampyrum* and *Chrotopterus* are sister taxa; and [5] Vampyrinae (comprising *Trachops, Chrotopterus,* and *Vampyrum*), is monophyletic. Two large clades of phyllostomines were identified: A *Micronycteris/Macrotus* clade and another clade comprising the remaining genera. The *Micronycteris/Macrotus* clade appears to be more closely related to the frugivorous and nectarivorous subfamilies than other phyllostomines, although support for this grouping is weak. Little support was found for monophyly of Phyllostominae as traditionally recognized.

Foraging flexibility in two populations of pallid bats *Antrozous pallidus*

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Fecal samples were taken from tagged individual adult male pallid bats for the 1993 and 1994 summers from a colony on the California coast and from a colony in Death Valley for the 1994 and 1995 summers. A comparison of pooled dietary data from individuals with the diets of these same bats treated as individuals

suggest a generalist population with specialized individuals in the coast population and a generalist population with generalized individuals in the Death Valley population. Coastal bats did not significantly change their diets temporally during summer months, but the Death Valley bats did. A positive correlation exists between individual variation in diet and individual foraging style in the coastal bats, but I did not observe differences in foraging styles among the Death Valley bats. Both populations ate significantly different prey than arthropods caught in pit traps suggesting both populations are selective foragers. An analysis of fecal pellets suggests that dietary analysis by culled parts will bias results by underestimating small and soft prey Although I observed dead chewed slugs at the bottom of an evening roost, only four of eleven mature male bats ate a slug when offered one in captivity, and I never observed a bat eating a slug more than once. Samples of individuals from each population with known dietary histories suggests that the coastal population has faster latency rates of learning than the Death Valley bats.

Spatial and temporal habitat use by bats along a vertical gradient in temperate forest.

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We monitored bat echolocation to determine spatial and temporal habitat us, below, within and above the canopy of mature boreal forest of central Canada. To access sites along a vertical gradient of the forest, we used three of the Boreal Ecosystem Atmosphere Study (BOREAS) towers, one in each of mature trembling aspen *Populus tremuloides* (OA tower), black spruce *Picea mariana* (OBS tower), and jack pine *Pinus banksiana* (OJP tower) stands. Three ANABAT detector systems were used simultaneously on a given tower to assess habitat use below, within and above the forest canopy. The system operated from 2200h to 0400h the following morning on 10 nights at the OA tower, 6 nights at the OBS tower, and 7 nights at the OJP tower. In total, 1054 sequences from individual bats were recorded. Calls were recorded from hoary *Lasiurus cinereus*, big brown *Eptesicus fuscus*, little brown *Myotis lucifugus*, and northern long-eared *M. septentrionalis* bats. There were no significant differences in the number of bats recorded below, within and above the canopies of black spruce or jack pine forests. However, in aspen forest, significantly more bats were recorded from within and above the canopy than below the canopy. At the species level, hoary bats spent significantly more time above the canopy than below the canopy presumably reflecting ecomorphological constraints on flight abilities of hoary bats. In all cases, the temporal distribution of bat activity was negatively skewed, with a peak of activity between 50 and 150 minutes after sunset. The peak, however was not very pronounced and activity levels generally remained steady, and high, up until 350 minutes after sunset, presumably a response to short periods of true night in the boreal forest. Our results demonstrate that habitat use by bats along a vertical gradient varies and that sampling bat activity from forest floor alone, may not reflect the overall habitat use.

Bat house success criteria

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The North American Bat House Research Project and its approximately 1,700 volunteer researchers are rapidly advancing knowledge of bat house designs, dimensions, colors, heights, mounting locations, and solar exposures needed by bats. Success criteria will be summarized, and examples of experiments leading to new discoveries will be illustrated. Specific criteria for bat house success will be covered, including roughened roosting and landing surfaces, crevice widths, appropriate color and sun combinations, and suitable habitats. Bat houses used in conjunction with exclusion from buildings are particularly successful.

The successful occupancy of a bat house in Gainesville, Florida.

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In 1987, Johnson Hall at the University of Florida burned and the colony of *Tadarida brasiliensis* that lived in its attic moved to the newly completed Track and Tennis Stadiums. By 1990, the colony in the Track Stadium had approximately 3,000 bats roosting in it. In the summer of 1991, the University Ath-

-letic Association constructed a large artificial bat roost adjacent to a large freshwater lake on the campus. The structure is 9.1 m tall with the bottom edge of the roosting crevices 6.1 m above the ground. The roosting crevices are spaced at 19 mm, 25 mm, and 32 mm. The area of the underside of the structure is 23 m^2. The initial introductions of bats captured during the exclusions performed at the Track and Tennis stadiums in September 1991 were not successful. All the 'seeded' bats left the structure within two days. The bat house stood vacant from September 1991 until February 1993. In the Spring of 1993, the house was occupied from February 24 to March 11 with the bat population fluctuating from 3-18 individuals. In September 1993, 34 *Tadarida brasiliensis* were counted in the SE quadrant of the house. In the Spring of 1994, the number of bats increased from 5 in January to 275-300 on April 4. The bats occupied 9 crevices in the SE quadrant but on April 15, 1994, they all left. On January 26, 1995, there were more than 200 bats in the SE quadrant and numbers increased to 3460 ± 700 on May 7. The first *Tadarida* pup was seen on May 26, 1995. By September 11,1995, the population was estimated at 8070 ± 2000 and the SE and SW quadrants were occupied. By November 21, 1995, all four quadrants were occupied and by February 15, 1996, the structure housed ≥ 2,000 *Tadarida brasiliensis* and over 100 *Myotis austroriparius*. In the severe winter of January and February 1996, 137 bats froze to death and 54 were rescued and returned to the roosting crevices. The 1996 birth season was successful and 234 fallen pups were successfully returned to the roost. The University of Florida Bat House has become a local tourist attraction with plans in the works for a bat viewing area including an educational kiosk.

Further on the possibility that micropterans are paraphyletic

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We have extended our DNA-hybridization study of bats to 16 species representing ten families and five outgroups. The resulting tree, now including additional emballonurids, continues to show a remarkable alliance of Rhinolophoidea with Pteropodidae. This result does not seem to be the result either of the attraction of long branches (as every bat lineage was subdivided, usually near its midpoint, and inclusion of 17 other pteropodids did not otherwise alter the tree), *or* of a rooting problem (as jackknifing on just the outgroups also produced the rhinolophoid-megachiropteran association). Moreover, the only problematic relationship among other microchiropterans is the separation of emballonurids from a clade including rhinolophoids, although Simmons has questioned the affinity of (all) Emballonuroidea and Rhinolophoidea as well. However, we compiled and reanalyzed the serological data of Pierson, procuring a 27-taxon tree very similar to ours except in that (as reported by Pierson) emballonurids and not rhinolophoids were the closest taxa to pteropodids. Our placement of Rhinolophoidea with Megachiroptera may still be a computational artifact due to the relatively shorter branch lengths uniting rhinolophoids and megabats, such shorter distances possibly being a consequence of shared AT-bias as noted by Pettigrew. Alternatively, the affinity may be phylogenetically true. If so, not only must the evolution of characters such as echolocation be reconsidered, but also the formal classification of bats. Most obviously, the current subordinal dichotomy within bats would need to be abandoned, perhaps in favor of a redefined Yinochiroptera that includes Megachiroptera as a subsidiary group and excludes Emballonuridae (as also suggested by Simmons' cladistic analysis). In this respect, it will be critical to include Craseonycteridae, Nycteridae, and Rhinopomatidae in future molecular investigations.

Survey of *Lasiurus cinereus* and *Lasiurus borealis* (s.l.) with special reference to Galapagos populations

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The larger *Lasiurus* of the Galapagos has been compared with all three currently recognized subspecies of *Lasiurus cinereus* and cannot be separated from the South American *L. c. villosissimus* as currently recognized. *Lasiurus borealis* (s.l.) shows great variability in color and size, but cannot be broken very rapidly into separate species on morphological grounds. The smaller Galapagos *Lasiurus (brachyotis)* is probably derived from *frantzii* of Central and northern South America, but is larger and very different in color. *L. b. frantzii* from western Ecuador shows some approach to *L. b. brachyotis* in size but not in color.

The Mexican free-tailed bat *Tadarida brasiliensis* has elevated plasma cholesterol but low triglycerides and plaque-free coronary arteries

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Female mammals typically become hyperphagic from mid-to late pregnancy and during lactation. The Mexican free-tailed bat, *Tadarida brasiliensis mexicana*, doubles its nightly food intake from late pregnancy to peak lactation, and consume insects consisting of approximately 60% dry matter of fat. We tested the hypotheses that this high intake of dietary fat would lead to increased levels of circulating lipids, atherosclerosis, hyperinsulinemia, and hyperglycemia. During late pregnancy and throughout lactation, fasting plasma levels of cholesterol in *T. brasiliensis* were high (215 ± 8 mg/dL), and nearly 10-fold higher than in three species of Old-World plant-visiting bats. Fasting triglycerides were unexpectedly low in *T. brasiliensis* (25 ± 2 mg/dL) despite the evidence of high fat intake (post-prandial cholesterol and triglycerides, 268 ± 18 and 122 ± 20 mg/dL respectively). HDL-cholesterol levels were extraordinarily high (124 ± 5 mg/dL),and unaffected by feeding. LDL-cholesterol levels were correspondingly low (86 ± 7 mg/dL). This unusual plasma lipid profile was not associated with coronary or aortic atherosclerosis, nor was there evidence of hyperglycemia or hyperinsulinemia. The high fat diet and high levels of cholesterol in *T. brasiliensis* were not correlated with cardiovascular disease or (possibly) insulin resistance. Thus, in contrast to the hyperphagic and genetically obese strains of mice and other mammals, females of *T. brasiliensis* do not experience the classic consequences of hyperphagia and high dietary intake of fat. Among several possible factors that may account for these observations, nightly bouts of powered flight (commuting and foraging for insects) may contribute to elevated HDL-cholesterol, and thus protect this species from developing atherosclerosis.

Diet of the endangered Indiana bat *Myotis sodalis* in Michigan

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A potential cause of the continuing decline of the Indiana bat is the indirect effects of pesticides. Knowledge of where these bats forage and the types of insects that are eaten is potentially valuable in deciding which pesticides and which application procedures might be involved. Our goal in this study was to determine the dietary preferences of Indiana bats living near the northern edge of their geographic range and to make comparisons with available data from more southern regions. Dietary preferences of Indiana bats were determined by analyzing fecal pellets that were collected beneath a number of closely spaced roost trees, in Eaton Co., Michigan, over parts of three years. Twenty six samples, varying from two to more than 125 pellets were obtained, and 364 pellets were examined for this study. Although Lepidoptera and Coleoptera usually formed the major part of the diet of Indiana bats in southern states, those in Michigan consumed mostly insects that are generally associated with aquatic environments. Overall, Indiana bats in Michigan ate Trichoptera (55.6 % of volume) and Diptera (25.5 %), followed by Lepidoptera (14.0 %) and just a few Coleoptera (1.3 %), the remaining 3.7 % consisted of six insect orders and spiders (Arachnida). Mosquitoes (Diptera: Culicidae) were a consistent component of the diet, appearing in 21 of the 26 samples; they made up only 2.8 % of the total sample, but comprised up to 28.5 % of individual collections.

Food habits of maternal colonies of *Tadarida brasiliensis mexicana* in Central Texas

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Food habits of Mexican free-tailed bats, *Tadarida brasiliensis mexicana* were investigated from June 1995 to May 1996. During the summer of 1995, feces were collected periodically from individual bats of three maternity colonies at Bracken Cave, Frio Cave, and Eckert James River Cave respectively in central Texas. Each night, in accordance with the returning time of these bats from feeding, two sets of fecal samples were collected; one during the midnight and the other in the early dawn. Fecal analysis was applied to determine the diets. In total, ten orders and 17 families of insects have been found in feces. The relative

importance of each prey type, presented as percent frequency of occurrence and percent volume, was determined at the level of order. Coleopterans and lepidopterans were the two most important prey types throughout the summer. Hemipterans were also commonly taken by *T. b. mexicana*, followed by homopterans and hymenopterans but in lesser volume. All other insect orders identified in feces were either rarely or occasionally found, and counted for trivial proportions in the volume. Temporal dietary variation was found between the two nightly sample sets. Coleopterans were dominant in percent frequency and percent volume in midnight samples, however, the relative importance of lepidopterans increased and outnumbered coleopterans in the dawn samples during June and July. In late summer, the relative importance of lepidopterans at Bracken and Frio was exceeded by other insect orders, however, Eckert James River Cave still showed a higher relative importance of lepidopterans. Further field studies will be continued to assess prey availability and to monitor foraging activities of *T. b. mexicana* in order to understand their diet breadth and resource utilization.

Bats in a dam

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Since December 1993, we have studied a colony of bats using the concrete spillway of a hydroelectric in Manistee Co, Michigan. About 20,000 bats hibernated in the spillway. Random sampling showed that 97% were little brown bats *Myotis lucifugus* and that most others were northern bats *M. septentrionalis*, although three Indiana bats *M. sodalis* and two eastern pipistrelles *Pipistrellus subflavus* have been identified. The dam is the only known bat hibernaculum in the Lower Peninsula of Michigan and it is located more than 200 km from previous capture localities of the latter two species. About one-third of the bats, mostly males, were still in hibernation in early May, but only two were present in June. The buildup of a torpid population had begun by 8 September, when 1,078 bats were in the dam. In August and September, the dam also was used as a swarming/mating site by little brown (91%) and northern bats (9%), and by a single Indiana bat (n=2,701 over four nights). Air temperature inside the dam showed little diurnal variation, but internal ambient temperature was as high as 22 °C in summer and as low as 0.3 °C in winter; internal air temperature seemed to reflect the temperature of the water impounded behind the dam. External air temperature varied from 35 °C in summer to -30 °C in winter. Relative humidity inside the spillway was 75-90% in summer and 90-100% in winter.

Noise as a component of Indiana bat *Myotis sodalis* summer habitat suitability

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Protecting summer habitat for Indiana bats has become a recovery priority. Habitat suitability ranking is frequently used to identify and prioritize areas of summer habitat. The U. S. Fish and Wildlife Service required the Indianapolis International Airport to mitigate impacts to Indiana bat summer habitat by creating and acquiring suitable habitat near the impact area. The potential impacts of increased noise to existing and created habitats are unknown. Although no data exists in the literature, urban noise has often been regarded as having a negative impact on endangered bat habitat suitability. We recently initiated studies to measure and characterize noise within Indiana bat summer foraging and roosting habitat, as well as a maternity site, near the Indianapolis International Airport and Interstate 70. We measured peak sound pressure levels and spectral characteristics within Indiana bat habitats from noise associated with air and highway traffic. This study is the first documentation of the noise environment in summer habitat used by Indiana bats.

High altitude predation by Mexican free-tailed bats on migratory insect pests

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A maize growing region in the Lower Rio Grande Valley of Mexico annually produces an estimated seven billion corn earworms, Helicoverpa zea(Lepidoptera:Noctuidae). Adult moths emerge shortly after sunset in June and ascend to altitudes of several hundred meters where southerly winds assist their northward long distance migration. By early morning, one night's migration places the moths in agricultural

regions of Central Texas. The NFXRAD doppler radar documents that many of the millions of Mexican free-tailed bats that occupy central Texas fly at the same altitudes and locations as the migratory moths. The foraging activity of these bats at high altitudes was monitored using radiomicrophone bat detectors attached to free-floating tetrahedral weather balloons (tetroons). The tetroons were launched at the sites of moth emergences and were ballasted to float at altitudes with the migrating insects. The radiomicrophones detected bat orientation calls and feeding buzzes as high as 1000 m above ground level, confirming that the bats are foraging at the same altitudes as the migrating moths. The conclusion that free-tailed bats are major predators of agricultural pests is supported by dietary analysis and the carbon isotope ratios in their guano. The moths migrating from Mexico are source populations for the infestation of agricultural regions throughout much of the Central U.S. and (even) Canada. Insect eating by bats is often thought to be of value to local farmers. Linking high altitude foraging by bats with major insect pest migrations suggests ecological and economic value on a much larger, regional scale.

Indiana bat summer habitat patterns in Northern Missouri

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The Indiana bat population in Missouri has declined > 80% between 1983 and 1995. This study is one of a series of studies designed to identify factors contributing to the observed decline. The objective of this study was to identify habitat characteristics associated with Indiana bat (*Myotis sodalis*) maternity colonies. Study area included 14 sites in northern Missouri where Indiana bats had been previously been mist-netted during 1977-1983 and 14 comparable sites where mist-netting attempts were unsuccessful. Mist-netting in 1995 at the 14 previous capture sites verified current Indiana bat maternity colony presence or absence. Percent land cover, forest perimeter, tree species, tree diameter at breast height, and percent canopy closure were measured at the two categories of sites. No significant differences were found in the percent coverage of forest, row crop, grassland, and water cover types between previous captures sites and unsuccessful netting sites. The high variability in percent land cover between sites that contributed to the lack of significant differences suggests that Indiana bats are able to accommodate a wide range of habitat conditions in the vicinity of maternity colony sites. One important difference between colony and noncolony sites, however, was a significantly greater number of large diameter trees, irrespective of species, in areas where Indiana bats were captured. The abundance of large diameter trees, which are potential roosts, at sites that have supported maternity colonies may be used by resource agencies to identify and manage potential summer habitat. An absence of differences in the measured land cover and habitat variables between 1995 presence and former capture sites suggests that factors other than changes in habitat may be responsible for the population's decline.

Habitat use by *Myotis evotis* and *M. thysanodes* in a Southern California pine-oak woodland

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As part of a southern California forest and woodland bat study, five *Myotis evotis* (2 females and 3 males), and three *M. thysanodes* (1 female and 2 males) were radio-tracked for two weeks during August '96 in the Laguna Mountains of San Diego County, California. While the bats were captured and observed foraging within the pine-oak woodland, day roosts were primarily located in rock crevices on sunny escarpments or rock outcrops in chaparral habitat. A maternity colony of approximately 30 *M. evotis* was located between tar paper and corrugated metal on the roof of a barn. The ears of several individuals in this colony were truncated; presumably burnt from contact with the hot metal. *M. thysanodes* in this study were found to travel further between day roosts and foraging sites and to forage for longer periods of time than *M. evotis*. The data suggest that *M. thysanodes* forage above or near the top of the canopy, while *M. evotis* hunts below the canopy. Results of this preliminary study indicate that habitat models and conservation strategies for these species need to consider the importance of rocky substrates as roosts and the distribution of these roosts relative to preferred foraging habitat.

Eutrophication and foraging by insectivorous bats

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Large blooms of duckweed are often characteristic of eutrophication of fresh-water ponds. In this study I examined the potential relationship between amount of duckweed present and foraging activity by bats and between duckweed and insect abundance. Bat activity was monitored with an ultrasound detector, during summer 1995, at a sewage lagoon, located at Boston University's Sargent Camp, Hillsboro County, New Hampshire. Throughout the study, duckweed cover was mapped and insects were collected and identified. Biomass of aquatic insects was negatively correlated with amount of duckweed. Although duckweed cover increased over the summer and bat activity decreased, these two were not significantly correlated. Potential effects of eutrophication on foraging by insectivorous bats warrant further study.

Reproduction and postnatal growth and development in *Artibeus jamaicensis* and *Phyllostomus discolor*

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Reproduction and post-natal growth and development are being monitored in a captive colony of *Artibeus jamaicensis* and *Phyllostomus discolor*. Although growth and development of captive *Artibeus jamaicensis* has been described, no such data exists for *Phyllostomus discolor*. Neonates of known age were used to collect data on body mass, forearm length, total/proximal/distal epiphyseal gaps, wing area, aspect ratio, and tip index. Salient features of growth and development were that newborn *Artibeus jamaicensis* pups had forearm lengths of 33.26 ± 1.58 mm, body masses of 12.53 ± 1.31 g and wing areas of 33.24 ± 5.90 cm^3. Average newborn *hyllostomus discolor* pups had forearm lengths of 26.72 ± 1.31 mm, body masses of 8.39 g ± 0.47 g and wing areas of 15.91 ± 3.03 cm^3. *Artibeus jamaicensis* had an average weaning date at 54.43 ± 9.90 days of age compared to 79.33 + 13.01 days for *Phyllostomus discolor*. Regression analysis for early, linear development indicated that *Artibeus jamaicensis* gained on average, 1.06 mm forearm length per day, 0.50 g body mass per day and 2.43 mm wing area per day, while *Phyllostomus discolor* gain, on average, 0.74 mm forearm length per day, 0.74 g body mass per day and 0.67 mm wing area per day. Discussion will focus on differences in development of the two species with respect to adult reproductive strategies and life history traits.

The Ohio bat database: A work in progress

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The Cincinnati Museum of Natural History (CMNH) has begun to compile a computerized bat database to collect, maintain, an make available information on the distribution, characteristics and status of Ohio bats. The database (stored in Paradox 7) consists of 7,000+ records. About 1,500 catalogue records from 15 natural history collections, dating back to the late 1800s, form its historic foundation. About 5,500 banding records from southcentral and northcentral Ohio, most compiled before 1972, augment this "baseline" data set. A concerted effort is underway to collect additional more recent data on bat distributions and related vital statistics throughout the state. Information sources include: Literature Records, Live Bat Records, Nuisance Bat Call Records, Bat House Occupancy Records, Bat Rehabilitator Records, and bat specimens routinely submitted to the Ohio Department of Health (ODH) for rabies testing. The most important new Ohio bat records collected are for *Myotis sodalis*, the endangered Indiana Bat, and include the state's large bat hibernaculum. This site was found in December 1995 in an abandoned mine in southwestern Ohio. It houses about 25,000 bat including 9,300 Indiana Bats. An active maternity colony was found in July 1996, also in southwestern Ohio. Last, an adult female submitted to the ODH for rabies testing after it was collected in an apartment building in northcentral Ohio. All represent new county records. The hibernaculum and breeding colony were both brought to the attention of the CMNH by members of the public. Bats submitted to the ODH and examined for the database include an additional 30 new county records for 7 of Ohio's 11 bat species. While conventional information sources (museum collections, the literature, research-related banding efforts) are important for the production of bat databases- less conventional sources(the lay public, health department specimens)may actually prove to be more important. The latter represent a broader range of "collecting sites" that might be overlooked in more conventional collecting efforts.

The influence of roosting habits of Neotropical bats on ectoparasite loads and host specificity of batflies

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The specificity of host-parasite relationships is strongly influenced by the degree to which both remain in physical contact throughout their life cycles. Extremes in host-parasite coupling of ectoparasitic arthropods are probably shown by chewing lice (which complete all phases of their life cycle on a single host and tend to be strongly host specific) and hard ticks (which may spend >90% of their life off-host and are much less discriminating). Bats and batflies (Diptera: Streblidae and Nycteribiidae) represent a single system offering great variation in linkage of host and parasite. Batflies are obligate blood-sucking ectoparasites of the fur and flight membranes. Like other dipterans, batflies must metamorphose and pupation occurs - over a span of days to weeks - in the roost itself. Therefore, the duration of bat residency at roosts constitutes a crucial feature in the reassociation of newly emerged batflies with their hosts. We hypothesize that the host specificity of batflies and the infestation rates and parasite loads of bats increases with the durability of roosts and the duration they are occupied by bats. Using a collection database of streblids on Neotropical bats, we examine and analyze records obtained from bats roosting in the canopy of trees, leaf and stem tents, tree cavities, and in rock crevices or caves. Additional analyses explore the effects of bats roosting in polyspecific associations.

Skull growth and the presence of auxiliary fontanels in Rhinolophoid bats

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Cephalometry was used to detect patterns of cranial growth in fetal bats that have been differentially stained for bone and cartilage. Rhinolophoid bats exhibit elaborate nasal cavities with coincidental distortions of the maxilla. The expansion of these cavities creates paired auxiliary fontanels among the nasal, maxillary, and frontal bones. This distortion of the rostrum is also associated with the loss of the lacrimal bones and the modification of the infraorbital foramen into a shallow canal. The rhinolphoid rostrum is incapable of resonating at the second harmonic until well after birth, sometime in the 3rd - 4th week postpartum. It would appear that a juvenile must "grow into" its second harmonic and that there exists a point at which the sounds produced by the larynx come to match those sustained by the resonant qualities of the supra-glottal vocal tract. There is little support for the suppression of $f3$ by Helmholtz resonance (dorsal nasal chambers) in the current study. The fundamental, $f2$ and $f3$ are not affected by KA filtering whereas the fourth harmonic is removed by a KA filter in all three species.

Phyllostomid phylogeny: A total evidence analysis of morphological and molecular data

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In the past twenty years many studies have investigated relationships among the 50 extant genera of phyllostomid bats. Current debate surrounds the monophyly of traditionally recognized subfamilies (e.g., Glossophaginae) and several genera (e. g., *Artibeus*). Data collected to address these problems include hyoid and lingual morphology, reproductive tract morphology, alimentary canal morphology, brain anatomy, postcranial myology and osteology, craniodental morphology, facial morphology, external characters, cytochrome b sequences, rDNA restriction sites, *Eco* Rl-defined satellite DNA repeats, G-banded chromosomes, protein electrophoresis, and immunological distances. Subsets of these data have been used to address various systematic problems, producing many contradictory hypotheses of relationships within and among subfamilies. A previous consensus attempt using taxonomic congruence (Baker, Hood, and Honeycutt, 1989) focused on higher-level relationships among phyllostomids, but did not address relation-

-ships among all subfamilies and genera. To test the monophyly of various phyllostomid taxa and to produce a single phylogenetic hypothesis, we analyzed all discrete morphological data sets and some molecular data together in a "total evidence" approach. We included several new facial and external characters and sampled craniodental features and lingual morphology in more than 50 taxa. In addition to problems of subfamilial monophyly, we also addressed generic monophyly of *Mimon, Phyllostomus, Vampyressa,* and *Artibeus*. Using Noctilionidae and Mormoopidae as outgroups, our analysis of more than 100 characters produced a well-resolved tree that permits evaluation of the monophyly of traditionally recognized groups. Many groups were well supported; however, problems still persist, especially with the placement of various "phyllostomine" species.

Relationships of bat abundance to roost avialability in a managed forest

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We compared abundance of bat captures and species diversity with mean numbers/acre of two size classes (10-20 inches, <20 inches dbh) of living and dead trees from 11 sites on the Wallowa Whitman National Forest. We used GIS data to determine mean numbers of snags and trees by size and species within a two mile radius of capture sites. Bat abundance was negatively correlated with living Douglas fir 10"-20" ($p \geq 0.024$), and the abundance of all living trees 10"-20"dbh. Our statistics indicate that as numbers of stems per acre increase for this tree species and size there are significantly fewer snags, resulting in the negative correlations. Bat abundance was positively and significantly correlated with abundance of snags for all species but *Abies lasiocarpa* (both class sizes), *Larix occidentalis* (10"-20"size), *Pinus ponderosa* (10"-20"size) and *Picea engelmanni* (<20" size). We considered differences in snag morphology and habitat to account for nonsignificant correlations in these species. *Picea engelmanni* (10"-20") and *Abies grandis* snags correlate significantly and positively.

Five year down under: Evaluation of bat activity at bridges in Willamette and Deschutes National Forests

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Over the past five years nearly 100 bridges on the Willamette and Deschutes National Forest have been surveyed for use by bats. Nine species have been observed to use these structures as day or night roosts including *Myotis lucifugus, M. evotis, M. californicus, M. thysanodes, M. volans, M. yumanensis, Corynorhinus townsendii, Lasionycteris noctivagans* and *Eptesicus fuscus*. Using a combination of techniques that included direct observations, guano accumulations, or the presence of staining, we found that concrete cast-in-place or concrete "I" beam bridges were preferred structures for day and night roosting activity, while wooden and metal "I" beam bridges were rarely used bats. Solitary male *C. townsendii* was the most common species to use bridges as day roosts and they showed a high degree of site fidelity. Three species, *M. lucifugus, M. yumanensis* and *M. volans* represent the majority of bats found night roosting at bridges. Recapture data indicates that 87% of all bats were found at the bridge where they were first banded. Bridge size and waterway characteristics appear to influence species distribution at different bridges used for night roosting. Clusters of bats at night roosts are composed almost exclusively of females, while males in almost all instances were roosting alone. Significant temporal and seasonal differences in night roosting patterns were found between *M. lucifugus* and *M. volans*. Analysis of cluster formation indicated that both arrivals and departures occurred in "bouts" for both of these species, but significant differences were found in the timing of cluster formation and dispersal between *M. lucifugus* and *M. volans*. These bridges provide a useful location for monitoring several species of forest dwelling bats. Efforts are underway to develop a uniform set of procedures to be used by forest biologists to survey activity levels at bridges within their jurisdictions. These survey techniques will include the establishment of systematic counting schedules at bridges, quantifying levels of guano accumulation, and the use of closed-circuit TV. This data will provide the Willamette National Forest with long-term information on site fidelity and seasonal variation in night roosting populations across the forest.

Reproductive synchrony in greater spear-nosed bats *Phyllostomus hastatus*

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This research addresses the occurrence and mechanisms of parturition synchrony in wild greater spear-nosed bats. Discovering how the bats coordinate reproductive timing not only may provide information about fertility regulation in mammals, but also may suggest how members of this species might benefit from synchronous reproduction. Reproductive groups of greater spear-nosed bats consist of multiple adult females (I8 on average) and a single adult male, and each group exhibits fidelity to a particular solution depression in the cave ceiling for roosting. Data collected in Trinidad for four birth seasons revealed that birth dates varied significantly less within these highly stable social groups than between groups roosting in the same cave. Each of two groups in captivity at the National Zoological Park have given birth with a similar degree of synchrony, providing further evidence that social cues, beyond any seasonal cues from the habitat, organize within-group reproductive synchrony in greater spear-nosed bats. Natural variation in the spatial proximity among wild groups habitual roosting spots provided a way to test whether female bats coordinate their births via social cues that would likewise be transferred to conspecifics in close proximity, such as volatile chemical cues. Contrary to the prediction, groups roosting in physical contact with one another were not more similar in their mean birth dates than groups roosting a meter or more apart in the same cave. If female groupmates synchronize their reproduction, information about reproductive timing might be transferred through active, group-specific social contact, such as allogrooming. The reproductive male may synchronize the females' conceptions with scent material and/or sexual behavior, a strategy reported only rarely in mammals.

Comparison of the visual optics of new and old world fruit bats

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The role vision plays in the lives of bats is not well understood. Within the Microchiroptera, there is a large range of both eye size and echolocation call intensity, suggesting that the relative importance of these two sensory systems varies among species. Bats in the family Phyllostomidae have relatively large eyes and produce low-intensity echolocation calls. This combination suggests that vision may play a prominent role in their daily lives. We were interested in determining whether the optical qualities of two Phyllostomid species, *Artibeus jamaicensis* & *Carollia perspicillata*, were good enough to support the use of vision in orientation and foraging. For a comparison, we also examined the optical qualities of megachiropteran bats (*Rousettus aegyptiacus, Pteropus vampyrus, P. hypomelanus, P. rodricensis, P. pumilus, Eidolon helvum, Cynopterus brachyotis*). Of second interest, was whether any of the megachiropteran bats we tested had functional accommodation. We used dynamic infrared photorefraction to determine whether the bats were myopic (near-sighted), hyperopic (far-sighted) or emmetropic. For some bats we also measured the optics of the isolated lenses using a scanning laser apparatus. *C. perspicillata* had a severely aberrated retinoscopic reflex suggesting poor optics. *A. jamaicensis* had a hyperopic reflex of 10-15 diopters (D). The refractive state of *R. aegyptiaciis* was less hyperopic (8-10 D), but greater than any of the other megachiropteran bats. All Megachiroptera, except for *C. brachyotis*, showed emmetropic reflexes or slight hyperopic responses (<5D). We did not observe accommodation in any of the bats. The good optical quality of *A. jamaicensis* suggests that vision is important for at least some species of echolocating bats. The variation of optical quality among species suggests varying degrees of visual function. Differences in echolocation, habitat and foraging strategies may be related to the very different visual optics of these species of bats.

A genetic marker for the detection of *Helicoverpa zea* in bat feces

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Fecal analysis is a convenient and non-invasive approach to determining an animal's diet. Visual examination of fecal specimens, however, is limited by its lack of precision. It is generally impossible to identify digested insect prey below the family level. With soft-bodied insects such as the corn earworm

Helicoverpa zea (Lepidoptera: Noctuidae), often only the order can be determined. A genetic assay, however, is capable of discriminating prey at the species level. The development of such an assay is described here. A genetic marker has been designated from the intron region of a published *H. zea* neuropeptide gene sequence (preproHez-PBAN), and PCR primers have been designed for it. PCR amplification with these primers consistently yields a 173bp fragment when performed on DNA extracted from *H. zea* tissue. This fragment is not present in the related species tobacco budworm *Heliothis virescens* or mealworm *Tenebrio sp.*, suggesting specificity to at least the genus level. In controlled feeding experiments with hoary and little brown bats *Lasiurus cinereus* and *Myotis lucifugus*, feces containing remains of either *H. zea* or *H. virescens* were collected. PCR amplification of DNA extracted from fecal specimens yielded the 173bp marker when *H. zea* was present and did not when *H. virescens* was present. These results confirm the sensitivity of genetic detection, but still more work is required to render the fecal assay reliable. It is expected that the *H. zea* genetic marker can be used to establish the frequency of predation on migratory *H. zea* by Mexican free-tailed bats *Tadarida brasiliensis mexicana*, and that this technique will be applicable to other dietary studies.

The validation of total body electrical conductivity to assess lean mass and body composition in *Myotis lucifugus*

D. Scott Reynolds. Boston University, Boston, MA

Many questions in population ecology and conservation biology require the ability to accurately measure body composition without sacrificing the subject animals. The purpose of this study was to evaluate the use of total body electrical conductivity (TOBEC) to predict lean mass, fat content and water content of little brown bats, *Myotis lucifugus*. TOBEC readings were taken in the field on individual bats weighing 2.5 - 10.0 grams, including neonates and non-reproductive, pregnant and lactating adults. These bats were then sacrificed, brought into the laboratory, and frozen until proximate composition analysis of the carcass was performed. Multivariate regression models were then created to assess the predictability of body composition (lean mass, fat content, and water content) from the TOBEC indices and mensural characters (forearm length, body mass). These models show that the TOBEC indices are strongly correlated with lean body mass and water content, but not fat content. Although the TOBEC device may not be precise enough to measure fat content directly, the non-invasive nature of this method will allow researchers to study seasonal variation and life history variation in lean body mass and water content.

Habitat exploitation by pipistrelle bats *Pipistrellus pipistrellus*

J. Reynolds[1], T. Laine[2], and J.R. Speakman[1]

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We studied the pattern of activity of pipistrelle bats in a 5x5 km square, 35 km south of Aberdeen. The square was subdivided into 100 500 x 500m sampling sites, and observations were made using static detectors, at 60 of these 100 squares, selected at random. Recordings of bat activity were made for approximately 90 minutes commencing a standard period after dusk on two occasions at each site during summer 1996. Seconds of bat activity was recorded and averaged across the two nights of data collection at each site. We related bat activity to two weather variables (temperature and windspeed) and seven habitat variables (habitat complexity-number of-land use types in area, distance to water, distance to linear habitat features, distance to nearest tree, number of trees in area and canopy closure). Temperature had a positive and windspeed a negative effect on activity. We removed these effects statistically and then examined the effects of habitat variables on the 'weather corrected' activity. Using multiple regression two habitat factors emerged as significant - habitat complexity and distance to water. Many of the predictors were significantly correlated with one another. We used PCA to redefine the habitat variables. Three dominant PCs emerged. PC1 was a habitat complexity component, the second PC reflected all the features connected with woodland, and the third PC concerned all the features connected with water. Only PC1 and PC3 emerged as significant predictors of bat activity. Habitat complexity was the dominant habitat factor influencing activity in any 500 x 500m square in this area. Trees appear to be an unimportant factor, as suggested previously by Rydell. The second most important factor was distance to water. Linear landscape features

emerged as important only as a subsidiary to habitat complexity - more complex habitats have more linear features at the boundaries to each component, thus bat activity was incidentally related to distance from nearest linear feature.

Seasonal variation in brown adipose tissue mass and plasma cortisol levels in the little brown bat, *Myotis lucifugus*

Cristopher S. Richardson. Boston University, Boston, MA.

A mammal must first meet the energetic demands and costs of maintenance metabolism and thermoregulation before energy can be expended on other functions. As compared with large mammals, small mammals are particularly challenged by cold exposure. Brown adipose tissue (BAT) is a major source of regulatory nonshivering thermogenesis(NST; additional heat production that occurs at ambient temperatures below the thermoneutral zone). BAT-mediated NST is very important in small temperate bats, such as *Myotis lucifugus*, both during activity and during arousal from torpor. Hormones, such as glucocorticoids (cortisol and corticosterone), are known to influence thermoregulation, and, for many mammals, cold stress leads to increased glucocorticoid production. During cold exposure, BAT activity is associated with elevated circulating glucocorticoid levels. Seasonal changes in BAT mass have been found in some rodent species and two vespertilionid bats. Seasonal cycles of cortisol levels have been reported in *M. lucifugus*, but, in rats, corticosterone decreased NST function while increasing BAT lipid storage. Thus, the ecological and evolutionary significance of glucocorticoid function in NST is not entirely clear. We predicted that total lipid mass in interscapular BAT and plasma cortisol levels will decrease in parallel from May to August and then increase from August to September. Blood was taken and interscapular BAT removed from sacrificed bats. Plasma levels of cortisol were assessed using a radioimmunoassay kit. Results of these preliminary analyses will be discussed.

Tongues, papilla patterns, and phyllostomid bats: Morphology, homology and phylogeny

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Phyllostomidae is a large (>140 species), trophically diverse family of neotropical bats which includes species that feed on fruit, nectar, insects, vertebrates, and blood. The variety of phyllostomid feeding strategies has drawn attention both from systematists, interested in the interrelationships among taxa, and from morphologists, concerned with novel adaptations of the feeding mechanisms. Curiously, few studies have examined tongue morphology in a systematic context, and none has included the entire range of phyllostomid feeding diversity in a single systematic analysis. We studied the lingual morphology of more than 60 species, including representatives of almost every genus. *Noctilio* and mormoopids were used as outgroups. More than twenty characters were identified, including features of circumvallate, hairlike, and basketlike papillae. Hypotheses of homology concerning patterns of horny papillae (shield-shaped keratinized papillae near the lingual apex) have been controversial; we erected alternative hypotheses and tested them for congruence with other characters. An analysis of the resulting tongue data yields a poorly resolved phylogeny, which nonetheless supports the monophyly of several traditionally recognized groupings. Mapping lingual characters onto previously published trees reveals that members of several groups (eg., Desmodontinae, Lonchophyllinae, Stenodermatinae) share characters that can be interpreted as synapomorphies in the context of these phylogenies. An analysis constrained *a priori* by the subfamily-level relationships proposed by Baker, Hood, and Honeycutt (1989) yields increased resolution of intergeneric relationships. Tongue characters clearly preserve phylogenetic information and are useful for total evidence analyses of phyllostomid relationships.

Artificial roost structure use by Indiana bats in wooded areas in central Indiana

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This study documented use of artificial roost structures by two federally endangered Indiana bats *Myotis sodalis*. Designed to determine if Indiana bats will roost in man-made structures, the study is being conducted near the Indianapolis International Airport. Potential roosting habitat for Indiana bats was lost as the result of runway construction. As partial fulfillment of habitat replacement requirements, 3,202 artificial roost structures were placed in wooded areas near the airport. Artificial structures are checked a minimum of once per year for the presence of roosting bats. This poster provides documentation of two adult male Indiana bats roosting in artificial structures. The first bat was found in a single bat box on 26 June 1995 and fitted with a radio transmitter. During eight days the bat was tracked, it was found in natural roosts on three occasions and artificial roosts(another single box, a triple box, a cedar shake garland) on five occasions. This suggests the bat found artificial roost sites equally suitable to natural roosts. This is the first documented observation of an Indiana bat using man-made structures. Natural roosts used by the bats were an American elm *Ulmus americana* and a shagbark hickory *Carya ovata*. The second bat was found in a triple bat box on 25 June 1996 and fitted with a radio transmitter. The bat was tracked later that day to a single box before the signal was lost. Prior to roost structure installation, the density of potential roosts in the woodlot was 15 trees per hectare; after structure installation the density of potential roosts was raised to 30.4 roost sites per hectare. By monitoring artificial roost structures during the next four years we hope to further identify roost site preference by this species.

Risk contours used to delineate safe / unsafe chemical aerosol concentrations for *Myotis sodalis* and *Myotis grisescons*

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Certain military installations use aerosols that may be toxic to endangered species. Military aerosols are commonly released from grenades, smoke pots, and generators and function as obscurants for troops and equipment. To determine the toxicity of aerosols and at what concentrations they cause adverse toxic effects, toxicity threshold values were determined for specific aerosols being studied. Threshold values are concentrations that are expected to result in adverse toxic effects. We selected NOAEL (No Observable Adverse Effect Level) as our toxicological benchmark value. Specific *Myotis sodalis* and *Myotis grisescens* NOAEL values were not available for any of the aerosols under investigation. NOAEL values for *Myotis sodalis* and *Myotis grisescens* were estimated by normalizing (adjusting for differences in doses based on body weight) values reported for standard laboratory test animals (e.g. rats, mice, guinea pigs). The normalized NOAEL values for the two species of bat were used in an air dispersion model to determine the distance the NOAEL concentration travels from release points. Down wind and cross wind dispersion were modeled. Risk contours were developed to depict areas where toxicity threshold values may be exceeded. Chemical release guidelines were based on developed risk contours. These contours indicate how far away from a hibernaculum or maternity colony an aerosol release could occur without causing toxic effects to bats.

Chiropteran hindlimb morphology: Use in determining phylogenetic relationships

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In an ongoing study, I am investigating phylogenetic relationships among bats using characters from the hindlimb. Over 35 characters have been identified through an anatomical comparison of hindlimb bones and related structures in over 40 species of bats (including members of each extant family). Dermoptera and Scandentia were used as outgroups. Some characters (e.g., fusion of digits 3 and 4 in the Thyroptera) appear in only one family, while others (e.g. a bony hook on the greater trochanter of the femur) appear to be homologs shared by some families but not others. Interesting observations include significant structural variation in the calcar. In microchiropterans that possess a calcar, the base of this structure articulates with the calcaneal tuberosity (the distal end of the "heel bone" in humans). In megachiropterans, the calcar does not articulate with the calcaneal tuberosity but emerges proximal to the calcaneus, from the tendon of the

gastrocnemius muscle. Preliminary parsimony analyses of the hindlimb data indicate that, while a number of relationships are supported (e.g., monophyly of megachiropterans, relationships among vampire bats), these data alone are incapable of clearly resolving higher-level relationships among bats. This lack of resolution is likely due to the small number of characters and additionally, to multiple instances of homoplasy. Since many bats that are not closely related exhibit behavioral similarity with regard to hindlimb function (e.g., use during flight, hanging, and quadrupedal locomotion), it is not surprising to find instances of homoplasy associated with hindlimb structures. Data from this study have therefore been combined with existing data sets in an attempt to resolve interfamilial relationships. The phylogenetic implications this "total evidence" analysis will be discussed.

The influence of atmospheric pressure on insectivorous bat foraging activity

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It has been suggested that insectivorous bats may use atmospheric pressure to predict relative abundance of aerial insects. In this study I examined two potential explanations for correlations of bat activity with atmospheric pressure; prediction of aerial insect abundance and avoidance of poor flying conditions. Observations of bat foraging activity, aerial insect abundance, and meteorological conditions were collected on 115 nights at two study sites in Tennessee. Precipitation, atmospheric pressure, temperature, aerial insect abundance and date significantly influenced the number of feeding bats. However, atmospheric pressure conditions that corresponded with the highest aerial insect abundance typically preceding thunderstorms, appeared to depress bat feeding activity. Thus the influence of atmospheric pressure on insectivorous bats foraging activity appears to be related avoidance of poor flying conditions rather than prediction of insect abundance. The influence of atmospheric pressure on exit of insectivorous bats from day roosts was also examined.

A histological examination of scent glands found in some Chiroptera

William M. R. Scully, York University, North York, ON

Olfactory communication plays an important role in the everyday life of bats. Bats use specialized chemical communication to provide information about the sender, defuse tension, mark feeding territories and secure social harmony within populations. The glands that produce the scent are located in various regions, depending upon the species, e.g., frontal gular, facial, ear, chest, genital, shoulder, and antibrachial wing membrane. Often these glands show differences between the sexes and taxa. The glandular regions in the females are often rudimentary or nonexistent when compared to males of the same species. My research involves a three dimensional reconstruction of the glands of bats from five different families, Emballonuridae, Hipposideridae, Mollosidae, Phyllostomidae and Vespertilionidae. The histological examination of the glandular regions will help to determine the possible origin of the odoriferous secretions and allow for a comparison of the glandular sexual dimorphism. The glandular regions are made up of sebaceous and sweat glands. Research conducted to date shows a greater abundance in sebaceous and sweat glands found in males than in females. There also appears to be a great diversity of sebaceous and sweat glands at the species level. Glandular regions often have modified hairs known as osmetrichia. The osmetrichia are more effective in holding and distributing the glandular secretion. A comparison of these glandular hairs is being conducted using the scanning electron microscope. Examination of these modified glandular hairs shows that the osmetrichia have a larger diameter and modified scales. The morphology of the hairs shows great diversity at the species level.

Seasonal changes in fatty acid composition of depot fats and tissue lipids of *Myotis lucifugus*.

James R. Serach, Boston University and Lawrence Academy, Boston, MA

It has been shown that several species of hibernating mammals require polyunsaturated fatty acids, such as linoleic and linolenic acids, in order to utilize torpor and for successful hibernation. This study investigated temporal changes in these fatty acids in depot fats and tissue lipids from *Myotis lucifugus*. These essential fatty acids appear to play a role in the use of torpor as a means of energy conservation. Use of torpor by bats is incompletely understood but also appears to be coupled to deposition of fat in autumn.

Thus, the assembly of fat depots with an optimum ratio of saturated and unsaturated fatty acids may be the key to maximization and efficient utilization of energy stores. The amount of PUFA(polyunsaturaed fatty acids) should increase from the reproductive period (early spring to mid-summer) to some optimal amount at the onset of the hibernation season and PUFA should be conserved throughout hibernation. The question was investigated through a field experiment involving determination of fatty acid profiles of brown and white adipose tissue, liver, muscle, and heart of the little brown bat *Myotis lucifugus* throughout the year. Seasonal changes in fatty acid composition were determined. Lipid analyses were conducted using gas liquid chromatography. This preliminary study of autumn fattening in *Myotis lucifugus* will lead to further studies of the role of PUFA in torpor and hibernation. Of particular interest is the role of monoglyceroacyltransferase in autumn fattening and hibernation.

Bat Wintering in New Mexico.

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For as long as the temperate North American Microchiroptera have been studied they have been perceived as animals which react to winter resource decline in one of two ways: migration and hibernation. Recent data as well as various historical anecdotes illustrates the ability of insectivorous bats to resist winter constraints and maintain flight and foraging activity during this period at temperatures approaching, and in several cases, dropping below O° C. This information suggests wintering behavior in bats. Ten nights of mist-netting and acoustic sampling by the New Mexico Bat Survey yielded 29 individual bats of eight species during the months of January and February, 1996: *Antrozous pallidus, Eptesicus fuscus, Idionycteris phyllotis, Lasionycteris noctivagans, Myotis californicus, Myotis ciliolabrum, Pipistrellus hesperus,* and *Tadarida brasiliensis.* Of these species, five were previously undocumented as being active in winter.

Bat Gating and Management of Logan Cave, Utah: A Cooperative Effort

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Logan Cave contains the largest known maternity roost of Townsend's big-eared bats *Corynorhinus townsendii* in Utah. Population numbers have fluctuated dramatically since monitoring was initiated in 1993. In an effort to stabilize and protect the colony a bat gate was installed in September, 1996. Population numbers began to increase during the gate installation and continue to remain above pre-gating levels. A monitoring program has been initiated in an effort to identify gating affects upon this population. The gate design will be modified if any adverse effects are detected. Preliminary results indicate a positive reaction to gate installation and public exclusion.

Putting Fossils in Context: Phylogenetic Relationships of Eocene Bats and Extant Lineages

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The Eocene bat genera *Paleochiropterix, Icaronycteris, Archaeonycteris,* and *Hassianycteris* are generally thought to represent early branches of Microchiroptera. Inner ear and basicranial morphology indicate that these forms were probably capable of echolocation, but other characters suggest that they do not belong to any extant family. Relationships of these fossil forms to each other and to extant lineages of bats have never been investigated in a formal phylogenetic analysis. Toward this end, we scored the four fossil genera for skeletal characters included in a larger data set that was initially developed to investigate higher-level relationships among extant bats. Data were collected from 4 specimens of *Icaronycteris*, 54 specimens of *Palaeochiropteryx*, 6 specimens of *Archaeonycteris* and 20 specimens of *Hassianycteris*. The Eocene fossil taxa and 24 extant family-level clades (including Pteropodidae) were included in a series of analyses using Dermoptera and Scandentia as outgroups. The complete data set included 183 morphological characters, 12

characters based on rDNA restriction-sites, and one character based on D-loop mtDNA tandem repeats. Completeness of the fossil taxa (measured in the context of this data set) varied between 23% and 38%, compared with values between 52% and 100% for the extant groups. Nevertheless, relationships among the fossil taxa were well resolved in parsimony analyses of the data set. Preliminary results suggest that the fossil taxa are more closely related to extant microchiropterans than to megachiropterans. Rather than forming a monophyletic group ("Palaeochiropterygoidea") as previously suggested, the Eocene bats appear to represent at least three consecutive sister lineages to the microchiropteran crown group (i.e., the clade comprising extant forms). Icaronycteris occupies the most basal branch of the microchiropteran tree. The next branch comprises Archaeonycteris, which is the sister group of a clade containing *Palaeochiropteryx* + *Hassianycteris* + extant microchiropterans. Relationships among *Palaeochiropteryx*, *Hassianycteris*, and the microchiropteran crown group clade could not be adequately resolved, although bootstrap results suggest that *Hassianycteris* may be the sister taxon of the crown group clade. Inclusion of fossil taxa changes perceived relationships among extant forms only slightly, reducing resolution at one node that was poorly supported in prior analyses.

Bats and bottlenecks: Do large emergences of bats promote or disrupt clustering behavior?

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When bats emerge from their roosts it has been frequently observed that they do not leave at random but do so in small groups, which have generally been called outbursts or clusters. The functional significance of this behavior has been a matter of dispute, with some claiming it is anti-predatory, or a feeding adaptation but others suggesting it is only an artefact of large numbers of animals moving through constricted spaces. One frequent observation is that the extent of clustering, characterised by the deviation of the observed inter-event distribution from that expected at random (using Chi^2), is strongly positively related to emergence size. Large emergences of bats appear therefore to be more clustered, which has been cited in support of the bottleneck hypothesis. However, increases in the statistical deviation from random are expected when sample size increases, even if the actual pattern of events has a constant amount of clustering. The increase in Chi^2 may thus be an artefact of the increase in sample size rather than an increase in the extent of clustering. Using computer modeled emergence sequences we devised a method for removing the artefact effect of size to reveal the biological effect, and applied this to emergences of bats from colonies of Pipistrellus pipistrellus in NE Scotland. This analysis reveals that when the artefact is removed colony size actually has a negative effect on clustering. We suggest this is because when small numbers of bats are emerging they can accurately control their emergence timing but in large emergences bats waiting at the exit get pushed out by the force of numbers behind them. Subdividing large emergences into early middle and late periods, when the intensity of numbers emerging differs, support this conclusion. However attempts to experimentally manipulate emergences by shining lights at the exits provided more equivocal support.

Emergence behavior of a colony of *Myotis yumanensis* in British Columbia

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Observations were made at a large colony of *M. yumanensis* inhabiting a house in British Columbia on ten consecutive nights during late June 1995. The colony contained between 320 and 715 bats. The bats emerged predominantly from two separate exit holes. Observations were made at both holes simultaneously on six nights and at only one hole on the remaining four nights. The times of emerging bats were recorded to the nearest second using a data logging program running on laptop PCs. Departing speeds of emerged bats were measured using doppler radar. On two nights the emergence was disrupted by placing a harp trap immediately outside one of the exit holes. We characterized the extent of clustering in each emergence using the CLUSTAN software. There was a strong positive effect of numbers of emerging bats on the extent of clustering but no effect of emergence hole. We removed the effect of numbers of emerging bats statistically by calculating the residual to the fitted regression. Residual clustering (i.e., the extent of clustering at a given hole after the numbers of bats emerging at that hole is taken into account)

varied from night to night but was unaffected by the use of the harp trap. On unmanipulated nights (n=4) the residual clustering was correlated positively across the two exit holes. That is when the bats were very clustered for the size of emergence at one hole they were also very clustered for the size of emergence at the other hole. The extent of residual clustering was not related to the flight speeds of emerged bats.

Radio telemetry and light-tagging studies of *Corynorhinus townsendii* : Preliminary results

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Adult female *Corynorhinus townsendii virginianus* in a maternity colony in Cave Mountain Cave, Pendleton County, WV, were fitted with radio transmitters and tracked for three 2-week sessions. Tracking sessions examined the time periods before parturition (May,'91), shortly after parturition (late June to early July, '94), and just before the young became volent (mid-to late July,'92). A total of 34 females were tracked. These bats foraged in a variety of habitats including deciduous woods (mostly oak/hickory types), mixed woods composed mainly of oaks, hickories, Virginia pine, and eastern red cedar, hay fields, old fields, and grazed areas. Although the South Branch of the Potomac River flows below the cave, bats did not appear to visit the river to drink. Most bats foraged in both wooded and open habitats, and foraging areas were often fields characterized by a mosaic of these habitat types. One bat, tracked almost continuously for a 7-day period, fed in hay fields in the early portion of each night and in wooded habitats later in the night. Bats were observed foraging in areas up to 10.75 km from the maternity cave. Several night roosts were noted including old buildings, trees, and a state highway bridge. Alternate day roosts were observed: one bat moved to another maternity colony away and stayed there for the remainder of the study. One female spent one day in a cave near the maternity cave, and heavy rains near dawn forced one bat to spend the day in an abandoned house. The number of trips made to the cave during the night was highest shortly after parturition. Light-tagging sessions at Cave Mountain Cave (one night) and Minor Rex Cave (six nights), also in Pendleton County, confirmed the use of both wooded and open habitats. Eighty-four bats (male and female) were observed on nights in May, August, September, and October. Heavily-grazed lands around Minor Rexrode Cave were not used by the bats; grazed lands in the Cave Mountain Cave area, however, exhibited more vegetative structure and were used for foraging.

Social organization of an old-world tentmaking bat *Cynopterus sphinx*

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Adult males of the short-nosed fruit bat, *Cynopterus sphinx* , chew the stems of trees and dense flower/fruit clusters, creating enclosed roost-cavities (stem tents) which attract groups of up to 25 females. These compact harem groups represent the fundamental unit of *C. sphinx* social organization and facilitate a male mating strategy of resource defense polygyny. We investigated the social structure of *C. sphinx* at two sites in peninsular India by sampling tent-roosting harem groups and censusing marked individuals. Preliminary data on the length of male breeding tenure and the size and compositional stability of harem groups indicate the potential for high variance in male reproductive success and small effective population sizes for social demes. These behavioral observations complement an ongoing genetic analysis by providing a framework for predicting the way in which patterns of mating, dispersal, and social group fission influence population genetic structure and rates of evolution in these highly social mammals.

Behavioral response of guppies to the Fishing bat *Noctilio leporinus*

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Intrapecific variations in anti-predator behavior can be studied easily in guppies (*Poecilia reticulata*) on the island of Trinidad, because these fishes occur in geographically isolated populations exposed to different

predation regimes. Although there exist many studies that deal with the effects of fish predation on behavior in guppies, the few studies that have focused on aerial predation have all been based on responses of guppies to cues from diurnal birds. I have begun studying the defenses of guppies against predation by the fishing bat *Noctilio leporinus*. Sampling in areas where these bats were observed to hunt yielded an abundance of guppies, suggesting that the bats are feeding on these fishes. Trinidadian guppies were collected from a site at the Caroni Aquaculture Ponds where *Noctilio* were observed fishing and from a site on the Paria River heavily overhung with vegetation, where no fishing bats were detected on two nights of observation. The guppies were maintained in ten gallon aquaria, and the preferred swimming depth of the group in each tank was recorded during 7 nights and 6 days. Preliminary results showed that fishes from both populations usually swam below the depth where *Noctilio* commonly drag (Altenbach 1989). However, fishes from the Paria River were close enough to the surface on three of the seven nights to be vulnerable. No significant difference existed in day and night time swimming depth of the guppies within the Caroni population, but the Paria fishes were significantly closer to the surface at night (P=0.015). Fishes from the two populations differed significantly in swimming depth in their tanks at night (P=0.002). These preliminary data suggest that differences in day and night time swimming depth are consistent with differences between the two populations in predation by *Noctilio leporinus*.

Timing of visitation to ponds by a Coloradan bat assemblage

Katherine M. Thibault and Rick A. Adams
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Two hundred and twenty nine bats were captured with mist nets over 1,100 net nights at nine sites in Boulder County, Colorado. Bats were identified tospecies and data were taken on age, sex, weight and reproductive condition. Times were kept for each capture. For most of the nine species, most captures were males. Highest diversity of species used sites associated with steep, rocky habitats in Montane forest between 6,000 and 8,000 feet. Four of the sites had between six and seven species utilizing them. Interestingly, species diversity and evenness was highest at shallow ponds of small diameters. Visitation times varied per species although some overlap did occur. For example, *Myotis lucifugus* tended to be the earliest visitor to the ponds, tended to visit the sites as a group, and to visit only once during the night. *Myotis evotis* and *M. ciliolabrum* had more dispersed visitation patterns and made several visits per night.

Anatomy of a Bat Box

Marilee Thorsby, and Susan M. Barnard,
Basically Bats Wildlife Conservation Society, Inc., Atlanta, GA, and Zoo Atlanta, Atlanta, GA.'

The completed BBI bat house should have everything a bat family needs. Bats can easily climb the mesh sides. Pups can find a secure nook without fear of falling. Their living space is kept sanitary with drop-through plumbing. The bats even have a launching pad for take-offs and landings. By assembling and placing BBI's bat houses, people of all ages can learn about bat morphology, behavior and survival in the wild. Students can sharpen their observation skills by listing the flora and fauna living under the bat box before and after its placement. This educational activity will document micro-environmental changes caused by the bats. Our poster presentation will show how we relate the physical components of a bat box to the anatomical, physiological, and behavioral characteristics of a bat.

Formation of national bat conservation partnership for natural resource managers

Merlin D. Tuttle. Bat Conservation International, Austin, TX

The purpose of this project is to improve communication between land managers and bat biologists, provide the most up-to-date resources for land managers, encourage collaboration on education, research, and habitat protection, and substantially increase opportunities for cost-share funding. Bat Conservation International has a private funding commitment of $150,000 annually in "start-up" funds for the first three years. We anticipate more than matching these funds with additional private and federal dollars. The project will be coordinated by a Director and an Assistant Director at BCI, who will rely on extensive field support from colleagues, and will set priorities based on the recommendations of regional experts and bat groups.

A substantial portion of funds raised will be dedicated to matching fund projects with federal and state agencies, universities, private conservation organizations, and land owners. A similar approach to conserving bats in mines has proven highly successful on a smaller scale. We now solicit colleague suggestions and participation in expanded support and collaboration.

A comparison of roost-site preferences of big brown and silver-haired bats in the Pend d'Orielle Valley in southern British Columbia

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I examined the roost-site preferences of big brown bats *Eptesicus fuscus* and silver-haired bats *Lasionycteris noctivagans* in the Pend d'Oreille River Valley in southern British Columbia during the summers of 1995-96. Roost trees were located via radio-telemetry, then observed at dusk to confirm use and determine colony sizes. I found a total of 70 roost trees used by the two species. Preliminary results indicate that both big brown bats and silver-haired bats preferred large trees (either tall or with a large dbh) that were uncluttered by surrounding trees. Both species preferred trembling aspen, although silver-haired bats tended to use Douglas-fir trees in proportion to their availability. To determine which tree and site characteristics big brown bats and silver-haired bats select, the characteristics of roost trees used by the two bat species will be compared to those of randomly available trees both in the immediate vicinity of the roost tree and in other areas of the same stand. In addition, the characteristics of roosts used by the two bat species will be compared to determine interspecific differences in roost-site preferences. Results from this study will be compared and contrasted with the results from previous studies in different areas with different forest types to illustrate generalities in the roost-site preferences of forest-dwelling bats and develop recommendations for maintaining bat roosting habitat in forested ecosystems.

A Bionic Bug Detector

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Strong evidence that one understands a particular mechanism can be demonstrated by the ability to build a working model of it. Models used to describe the sensor mechanisms underlying animal behaviour are often constructed using mathematics or computer simulation. Increasingly, it is becoming possible to build *physical* models of these mechanisms. A physical model mimics biological control mechanisms by reconstructing them via functional analogous transducer and electro-mechanical circuitry. Because a physical model inhabits the same environment as the animal under investigation, it affords examination of realistic (e.g., real-time, noisy, etc.) environmental interactions. We present a physical model of a bat head for the purposes of investigating echolocation behaviour. This model consists of a five degree of-freedom steerable sensorhead upon which an ultrasonic transmitter and a pair of receivers are mounted. All transducers rotate around a common 'neck' aids and receivers can change their azimuth and elevation angles independently. The coordination of sensorhead movements and the transmission/reception of sensory signals are controlled via a transputer network. Presently, the sensorhead is being used to investigate localization of targets moving with characteristic periodic motion. In this context, the transmitter is driven continuously using a high frequency pure tone. Received echoes are passed through a bank of narrowband filters whose central frequencies are clustered around that of the transmitted tone. Signals emerging from the outputs of these frequency channels are then rectified and sent to a series of low pass filters. Activity in the bandpass frequency channels provides a measure of the relative speed of a target. Instantaneous amplitudes at the output of combinations of low-pass filters yields a description of the rate of target motion (e.g., flutter rate). Binaural comparison of waveforms demodulated in this way is made in order to extract the angular location of targets. This model, though a crude approximation to the lower auditory system of an echolocating bat , is sufficiently representative to highlight some of the challenges inherent in extracting weak acoustic signals in highly reflective environments.

Progress report: United States and Mexico migratory bat initiative

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The Programa Para la Conservacion de Murcielagos Migratorios de Mexico y Estados Unidos de Norteamerica (PCMM) was started by Bat Conservation International in 1994 in response to alarming declines in migratory nectarivorous and insectivorous bats. With support from the U.S. Department of State Fish and Wildlife Service and the Mexican Government, a binational team of scientists and educators was assembled to facilitate programs to: 1) Identify and protect key migratory roosting caves in Mexico; 2)develop and implement educational programs in schools and communities near key caves, and public awareness campaigns in major Mexican cities; and 3) iniate research to document the ecological and economic values of these bat species. Progress has exceeded expectations, and an ambitious long-term conservation agenda lies ahead.

Bat utilization of wildlife ponds and roadway reserviors on the Ozark National Forest, Arkansas

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During May through August of 1996 wildlife ponds (man-made and/or naturally occurring) and roadway reservoirs on the Sylamore Ranger District, Ozark National Forest Arkansas, were mist-netted to determine the extent of utilization by bats. Thirty nine ponds and roadway reservoirs were netted one or more times over 52 nights. These water sources were constructed to support the more popular wildlife species; deer, turkey, etc. This study demonstrated that taxonomically and numerically diverse bat populations use these water sources. Seven hundred and sixty nine bats of nine species, including two endangered species, were netted. Bats were identified and sex, reproductive status, forearm length, and weight, were recorded. All bats were banded and released at the site of capture.

Evolution of tandem repeats in the D-loop region of bat mitochondria

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Analysis of mitochondrial DNA control region sequences from 41 species of bats representing 11 families revealed that direct tandem R1 repeats near the tRNA-Pro gene evolved in the ancestor to vespertilionine bats. Among 18 vespertilionine species R1 repeats varied in size from 78-85 bp, arrays contained 3 to 9 copies, and heteroplasmy ranged from 15% to 41% independent of phylogenetic relationships. Comparison of average repeat copy number between heteroplasmic and homoplasmic individuals indicated a bias against both low and high copy number. Two species with a mode of five repeats had higher copy number among heteroplasmic individuals while one species with a mode of eight repeats had lower copy number among heteroplasmic individuals. Furthermore, significant regressions of average repeat copy number on heteroplasmy and on θ which estimates $2N_{ef}\mu$ for seven vespertilionine species suggest that copy number correlates with repeat mutation rate. Comparison of bat consensus repeats to mammal control region sequences revealed that mammalian mtDNA possess an 80 bp sequence that contains two highly conserved protein-binding regions and that is homologous to a bat R1 repeat unit. In addition to vespertilionine bats, R1 tandem repeats of similar size, sequence and copy number occur in several species of shrews, several species of cats, and sheep. We suggest that tandem repeats of this regulatory region provide signal redundancy and a repair mechanism in the event of somatic mutations.

Movements of common blossum bats in Papua New Guinea: Home ranges and roost areas

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Movements of Common Blossom Bats, *Syconycteris australis*: Pteropodidae, were followed by radiotelemetry in primary lowland forest in the Kau Wildlife Area, Madang, Papua New Guinea. We report on four bats that were monitored during the same time period, June 4 to July 6, 1996. Position data were calculated from radio triangulations or from single bearings along which distances were estimated from signal strength data calibrated in the field. Home ranges (convex polygons) of three adult females were approximately 7.0 ha (n=176), 7.8 ha (n=69) and 5.2 ha (n=93). There was overlap of the total use areas of these bats, with a small area used by all three. The home range of a single adult male was approximately 3.5 ha (n=97). The activity of this bat overlapped that of one of the females. Long axes of HR's were from 270 m to 535 m. During most nights bats visited most parts of their HR's. During the day bats roosted separately in the foliage of trees. Day roost sites varied for each bat within a small area of its home range. Day roost areas of the four bats did not overlap, but those of the three females were nearly contiguous and each was overlapped by the home range of at least one other female.

Teacher Education Workshop on the Bats of Illinois

The 26th Annual North American Symposium on Bat Research hosted a teacher workshop as part of its program. Bloomington's own "Bat Man" and symposium chairman, Tom Griffiths did a great job of publicizing the workshop and 75 teachers from Bloomington, Normal, Champaign, and Peoria areas came at 8:00 on a Saturday morning to hear seven presentations on various bat biology and conservation topics. Speakers included: Tom Griffiths (Illinois Wesleyan University) on *the Bats of Illinois*; Gary Kwiecinski (University of Scranton) on *Bat Anatomy and Physiology*; Brock Fenton (York University) on *Bat Echolocation and Using Bat Detectors*; Charles Trimarchi (NY State Department of Health) on *Bats and Public Health* ; William Kern, Jr.(University of Florida) on *House Bat Management* ; Jackie Belwood (Cincinnati Museum of Natural History) on *Teaching about Bats* ; and Merlin Tuttle (Bat Conservation International) on *the Bats of North America*. Jackie also presented an extensive exhibit of bat teaching tools and materials, many of which will be put into a "traveling trunk". The Illinois Department of Natural Resources will make this "bat trunk" available to teachers for their classroom use.

The workshop committee - Pat Morton, Tom Griffiths and Jackie Belwood - organized the workshop as a contribution to local communities. This workshop, which will be a regular feature of the annual symposium. By teaching teachers the workshop will multiply local bat conservation education efforts as these informed and enthusiastic educators return to the classroom. The academic and scientific talent at the annual symposium is a tremendous resource from which to create opportunities, like this workshop, to reach thousands of children. Speakers graciously took time out from the regular meeting to participate in this important out-reach event.

Each participant also received a packet of materials that included articles on house bat management, using bat detectors, a key to the bats of Illinois, public health issues, as well as BCI's *Educator's Activity Book About Bats*, and a *Bats of North America* poster. Materials were purchased with a grant from the Illinois Department of Natural Resources-Wildlife Preservation Fund, and with contributions from the Lubee Foundation and Bat Research News. The committee is grateful for these generous donations and for the door prizes donated by Emily Mobley of *Speleobooks* and Bat Conservation International. Submitted by Pat Morton, Texas Department of Parks and Wildlife, Austin, TX

Twenty-sixth Annual North American Symposium on Bat Research

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The twenty-sixth annual North American Symposium on Bat Research met at Jumer's Chateau in Bloomington, Illinois, from October 23-26, 1996, sponsored by Illinois Wesleyan University. Co-hosts were Tom Griffiths of Illinois Wesleyan University and Margaret Griffiths of the University of Illinois. There were 201 registered participants (not counting the teachers who attended the special Bat Conservation Workshop on Saturday morning). In terms of numbers of participants, the 26th annual meeting was the third largest regular (non-international) North American meeting ever held, behind only the 23rd annual meeting in Gainesville, Florida and the 21st in Austin, Texas (Horst, 1995). Eighty-six scientific papers were presented at the meeting, not counting the nine special presentations for teachers made during the Saturday morning workshop.

Following a long-standing tradition, graduate and undergraduate student participants were invited to enter their presentations (both platform papers and posters) in a competition which judged their merits. A special committee headed by Roy Horst judged sixteen student papers and posters. The committee reported that the competition was especially keen this year, and the judging was particularly difficult because of the high quality of submissions. Three prizes of $250 each were awarded to Johanna M. Bloss of Boston University, Lisa Comeaux of the University of Tennessee, and Matthew V. Rockman of the American Museum of Natural History for their platform presentations. Two prizes of $100 each were awarded to Carlos Iudica of the University of Florida and Mark Nebzydoski of the University of Scranton for their poster presentations. Generous donations from *Bat Research News*, The Lubee Foundation, and SPELEOBOOKS made the prizes possible.

Pat Morton and Jackie Belwood organized and ran a special workshop on Saturday morning of the conference entitled "Education Symposium on Bats of Illinois." Thanks to a grant from the Illinois Wildlife Preservation Fund of the Illinois Department of Natural Resources and support from The Lubee Foundation and *Bat Research News*, the workshop was open to the public free of charge. It was very well attended by Illinois teachers, park and conservation workers, and other local persons interested in the conservation of bats. I have received literally dozens of positive reports from local participants, each of whom rated the workshop as "outstanding." Pat has reported on the workshop more extensively elsewhere in this issue, and so I will merely add my sincerest thanks to Pat and Jackie, M. Brock Fenton, Bill Kern, Gary Kwiecinski, Charles Trimarchi, and Merlin Tuttle for their hard work which made the workshop possible.

Finally, let me extend a special thanks to Tom Kunz, who attempted to teach a reluctant audience the steps to the macarena, and to Brock Fenton who good-naturedly helped demonstrate the proper method of ascertaining quality in a chocolate mousse. The banquet would not have been the same without them.

Literature Cited

Horst, G. R. 1995. A brief history of the Annual North American Symposia on Bat Research. Bat Research News, 36: 129-132.

List of Conference Participants - 26th Annual NASBR

The list below is mostly correct and complete. Several persons canceled at the last minute and asked us to substitute somebody else in their place. At least a few of the substitutes are missing from the list below. We also know that the list does not include some last minute registrants. We were under-prepared for the flood of walk-in registrations, and after the blank forms we had prepared were all used up, we were reduced to taking names and addresses on pieces of scratch paper that we (fortunately) had handy. Some of these were inadvertently misplaced and a few have illegible handwriting. We apologize if your name has been omitted from the following list. TAG

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Attendees at 26th Symposium continued...

Charles V. Trimarchi, NYS DOH Rabies Lab, Wadsworth Center, Albany, NY 12201-0509

Merlin D. Tuttle, Bat Conservation International, P. O. Box 162603, Austin, TX 78716

Cynthia Vann, Box 10130, Prescott, AZ 86304

Maarten J. Vonhof, Dept. of Biology, York University, 4700 Keele Street, North York, Ontario, Canada M3J 1P3

Julia Wade, Department of Biology, Milligan College, P. O. Box 500, Milligan College, TN 37682

Ashley Walker, University of Edinburgh, D. A. I., 5 Forrest Hill, Edinburgh, U. K. EH1 2QL

Steve Walker, Bat Conservation International, P. O. Box 162603, Austin, TX 78716

John O. Whitaker, Jr., Dept. of Life Sciences, Indiana State University, Terre Haute, IN 47805

Kathy Wildman, Hearts & Flowers Butterfly Farm, P. O. Box 1069, Sunbury, OH 43074

J. D. Wilhide, Department of Biology, Arkansas State University, P. O. Box 599, State University, AR 72467

Carole E. Wilkey, Colorado Bat Society &, Colorado Division of Wildlife, P. O. Box 241, Rollinsville, CO 80474

Jerry Wilkinson, Department of Zoology, University of Maryland, College Park, MD 20742

Kim Williams, Eastern Michigan University, 2300 Epley Road, Williamstown, MI 48895

John Winkelmann, Department of Biology, Gettysburg College, Gettysburg, PA 17325

Bob Young, Bat Conservation Society of Canada, Box 56042, Airways P. O., Calgary, Alberta, Canada T2E 8K5

Guthrie Zimmerman, University of Maine, 307 Murray Hall, Orono, ME 04468

Research Project : Funding Opportunity

Jonathan D. Van De Venter has asked us to post the following notice

1. Army Materiel Command (AMC) may provide at least $60K through the ORISE (Oak Ridge Institute for Science and Education) program for student/major professor conducted research at Army installations for Threatened/Endangered Species surveys.
2. Picatinny is being given first opportunity within our major command (TACOM) since we have mandated requirements to assess summer habitat use by local Indiana bats.
   a. A scope of work for next season (spring-fall '97) has been formulated by USFWS N.J. Field Office. Field work will entail lots of night work with mist nets (live capture), possible banding of select bats, telemetry and tracking of female Indiana bats, as well as specialized acoustical recording in the field of bat echolocation vocalizations/signals.
   b. Researchers must be familiar/involved in current bat issues, and preferably possess some field experience in handling bats. USFWS permit to handle/monitor federally listed endangered species will be required.
   c. When netting is done at least 3 persons (preferably 4) is required. Two nets (up to 30') are usually deployed at one site and operated for two consecutive nights (4 net-nights/site).
   d. The scope of work calls for surveys at 16 sites on post, entailing at least 12 weeks of field work. Four to eight of the sites may be surveyed via automatic recording device, with subsequent analysis for Indiana bats "signature" echolocation calls/signals.

Any prospective candidates interested in such an undertaking should contact the undersigned as soon as possible.

John D. Van De Venter
Picatinny Arsenal, New Jersey, U.S.A.
201-724-4691 e-mail: jvande@PICA.ARMY.MIL

The Luis F. Bacardi Graduate Fellowships in Bat Conservation

Purpose : To provide financial support to qualified graduate students in the area of bat conservation biology.

Benefits : To enhance and facilitate the research/conservation goals and objectives of the Lubee Foundation Inc.

Eligibility : Graduate students(MA, MS, or PhD level) in good standing in the University of Florida, or students with pending acceptance in a University of Florida graduate program are eligible to apply for a Luis F. Bacardi Graduate Fellowship. Candidates should be recommended by their host department to be considered for an award. Fellowship candidates must submit a one or two page summary of reseach interests in bat conservation, as well as a current curriculum vitae, copies of college transcripts, and two letters of recommendation. Fellowships will be awarded on a competitive basis.

Award Benefits : per student per year		
	Salary (stipend)	$12,000.00
	Tuition costs	$ 2,500.00
	Research Expences	$ 5,000.00

Administration : The Luis F. Bacardi Graduate Fellowship program will be administered by the University of Florida's Biotechnologies for the Ecological, Evolutionary, and Conservation Sciences (BEECS) Program. The Luis F. Bacardi Fellowship Executive Committee, consisting of three BEECS faculty, will review all applications, administer awards and funding as well as receive and review required annual progress reports.

Recipients of a Luis F. Bacardi Graduate Fellowship will be designated as Luis F. Bacardi Graduate Fellows. Degrees will be awarded by the University of Florida and the appropriate Departments. Luis F. Bacardi Graduate Fellowships are limited to the disciplines consistent with the goals of the Lubee Foundation Inc. Research projects may include both field and laboratory components. Up to two years of support will be available for each MA or MS student and up to four years of support will be made available for each Ph.D. student. First year students will be expected to serve a three month internship at the Lubee Foundation Inc. Continued support will be based on a positive evaluation of an annual report to be submitted by the student to the Lubee Foundation Inc and the Luis F. Bacardi Graduate Fellowship Committee at the end of each award year.

Facilities and personnel at the Lubee Foundation Inc (in Gainesville, Florida), the BEECS Program and the School of Veterinary Medicine will be available to Luis F. Bacardi Fellows in support of their research.

Deadlines : Submission deadlines will be March 31 for all requested application materials and decisions will be announced as of May 15 for a starting date of August 1. Position availability will be dependent upon continued funding by the Lubee Foundation Inc Board of Trustees. Inquiries concerning availability should be directed to the Chair, Luis F. Bacardi Graduate Fellowship Executive Committee.

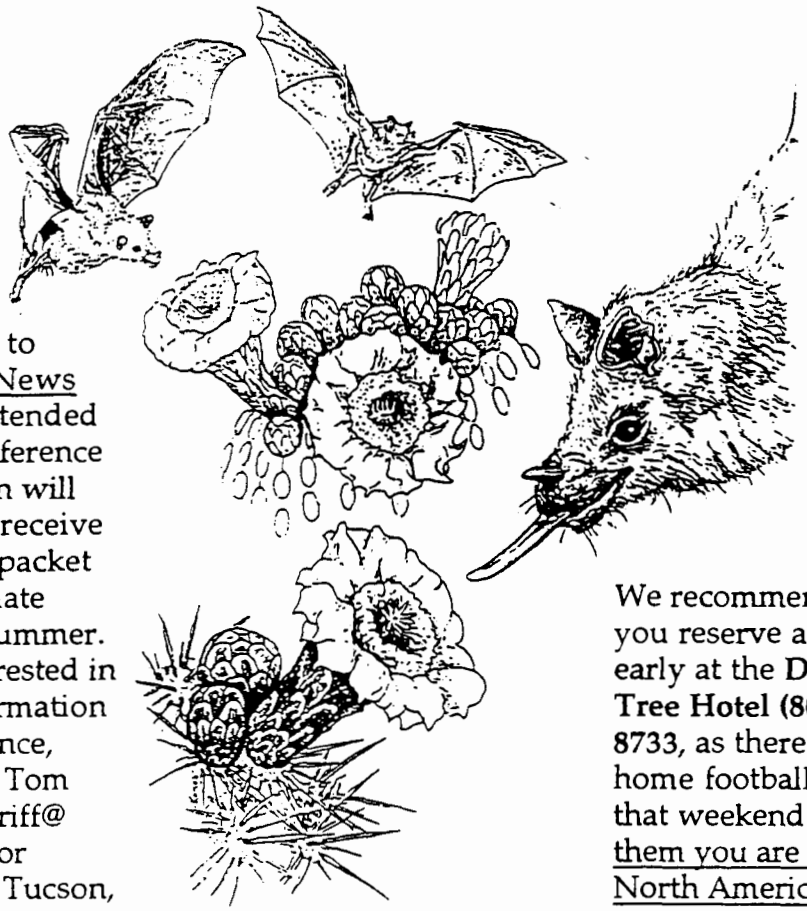
Application Submission : Dr. Timothy S. Gross
Chair, Luis F. Bacardi Graduate Fellowship Committee
12085 Research Drive, Alachua, FL 32615, tel. 904-462-0864

University of Florida Graduate Program Information :
Office of Research, Technology, and Graduate Education, Grinter Hall
University of Florida, Gainesville, FL 32611, tel. 353-391-1282

This announcement was provided to BRN by John Seyjaget of The Lubbee Foundation Inc.

The 27th Annual North American Symposium on Bat Research

will be held October 8-12, 1997 in Tucson, Arizona (where it all began)



Artist: Kim Duffek
Sonora Desert Museum

All subscribers to Bat Research News and all who attended last year's conference in Bloomington will automatically receive a registration packet by mail in the late spring/early summer. All others interested in receiving information on the conference, please contact Tom Griffiths at tgriff@titan.iwu.edu or 309-556-3230. Tucson, where the very first NASBR was held in 1970, is beautiful in October, and we anticipate a large turnout.

We recommend that you reserve a room early at the **Double Tree Hotel (800) 222-8733**, as there is a home football game that weekend. Tell them you are with the North American Symp on Bat Research and see if you can get a courtyard room (the best rooms, but numbers are limited!)

Conference Host: Ginny Dalton, D^2 Chiropterology, Tucson, AZ
Program Director: Tom Griffiths, Illinois Wesleyan U., Bloomington, IL

***KNNV Uitgeverij* is pleased to announce the publication of:**

ATLAS VAN DE NEDERLANDSE VLEERMUIZEN

Edited by H.J.G.A. Limpens, K. Mostert, and W. Bongers

The Netherlands Bat Research Foundation (Stichting Vleermuis-Onderzoek) and the Netherlands Bat Workers Group conducted the 'Dutch Bat Survey' in the period 1986 -1993. The survey was based primarily upon data gathered using bat detectors. The results of the Dutch Bat Survey will be published in the ***Atlas van de Nederlandse Vleermuizen*** (Atlas of Dutch Bats). This atlas contains a large amount of new information on the ecology of bats, accurate distribution maps of all species (both summer and winter). The atlas is richly illustrated with pen drawings and photographs. The introductory chapters ***Atlas van de Nederlandse Vleermuizen*** describe the development of bat research using bat detectors, the ecology of bats, the mechanics of bat flight, and how bats orientate, localize and catch prey with the aid of echolocation. This is followed by a description of how the Dutch Bat Survey was organized. Next comes a general discussion of the results of the Dutch Bat Survey, followed by a chapter in which desirable and possible conservation measures for bats are discussed. All this leads to the core of the Atlas where each species ever found in the Netherlands is discussed. The results of the Dutch Bat Survey are presented for each of the species including distribution in summer and winter, as well as the most recent knowledge of the species and its ecology. The ***Atlas van de Nederlandse Vleermuizen*** should be indispensable to anyone involved in bat research and/or bat conservation.

The atlas is written in Dutch. Each chapter contains an English summary.
The atlas will be available by March, 1997.
Price:NLG (Dutch guilders) 49.50
224 pages, illustrated
ISBN: 90 5011 091 6

If you wish to order the ***Atlas van de Nederlandse Vleermuizen*** please write or FAX to the address below. You will receive an invoice by mail, after payment the atlas will be sent to you directly after publication.

KNNV Uitgeverij
Ouddegracht 237
3511 NK Utrecht
the Netherlands
Tel: +31 30 2333544
FAX: +31 30 2368907

Additional Information on the Dutch Bat Survey

The Dutch Bat Survey was - when started- unique in its character. The main objective was to carry out a systemic survey of bats in their summer habitats. The survey was set up around the use of bat detectors. Many new roosts were discovered, and migration routes and feeding areas were mapped. This provided a more complete picture of the distribution of bats in their summer habitats and as well as in winter hibernacula. New information on feeding behaviour and other aspects of bat ecology is included. Approximately 300 volunteers co-operated in the survey, and co-ordinated their efforts with professional bat researchers. An important additional benefit of the survey was an enormous positive stimulation of public interest in bats and their protection.

Stellaluna Fans

For those who use the Stellaluna book there are some new classroom activities available. Lynne Jessup and Dave Worthington submitted to Bat Research News a new publication called: Stellaluna, Teaching Ideas. The booklet contains a number of classroom activities(across a variety of subject areas) as well as a bibliography and world directory of bat conservation organizations. Contact Lynne Jessup, P.O. box 941, Rota MP, 96951, U.S.A. for information on how to obtain a copy.

Future Meetings of Interest to Bat Biologists, Conservationists and Educators

American Society of Mammalogists

77th Annual Meeting, June 14 -18, 1977
Oklahoma State Univerwsity, Stillwater, OK
Program Chair: Karen McBee,
Dept of Zoology, Oklahoma State University, Stillwater, OK 74078-3052
405-744-9680 e-mail: mcbee@okway.okstate.edu

Seventh International Theriological Congress

Acapulco, Mexico September 7-11, 1977
Rodrigo Medellín, Chair, ITC-7 Organizing Committee
Centro de Ecología, UNAM Ap. Postal 70-275
04510 Mexic, D.F.
e-mail: medellin@miranda.ecologia.unam.mx

11th International Bat Research Conference

Universidade de Brasília, August, 1998
(exact dates to be announced)
Conference Host: Jader Marinho-Filho
Departmento de Zoologia, Universidade de Brasília
Brasília, DF 70910-900 Brazil
e-mail: jmarinho@guarany.cpd.unb.br